Naval Facilities Engineering Command Northwest
Silverdale, Washington

Final

Engineering Evaluation/Cost Analysis Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island
Oak Harbor, Washington

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Prepared for NAVFAC Mid-Atlantic
by CH2M HILL, Inc.
Seattle, Washington
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Acronyms and Abbreviations

µg/L	microgram(s) per liter
AFFF	aqueous film-forming foam
ARARs	applicable or relevant and appropriate requirements
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COPC	constituent of potential concern
CSM	conceptual site model
DCVA	double check valve assembly
DI	ductile iron
EE/CA	Engineering Evaluation/Cost Analysis
GAC	granular activated carbon
GHG	greenhouse gas
gpd	gallons per day
gpm	gallons per minute
HDPE	high-density polyethylene
HI	hazard index
ID	internal diameter
IDW	investigation-derived waste
IX	ion exchange
LF	linear feet
mL	milliliter
msl	mean sea level
NAS	Naval Air Station
Navy	Department of the Navy
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
ng/L	nanograms per liter
NTCRA	non-time-critical removal action
O&M	operations and maintenance
PA	preliminary assessment
PAL	project action level
PFAS	per- and polyfluoroalkyl substances
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
PIL	project indicator limit
POE	point of entry
POU	point-of-use
PRG	preliminary remediation goal
PRSC	post-removal site control
RAO	removal action objective
RI	remedial investigation
RPBA	reduced pressure backflow assembly

RSL	regional screening level
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SI	site investigation
TBC	to be considered
TCRA	Time-Critical Removal Action
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UV	ultraviolet

SECTION 1

Introduction

This report presents an Engineering Evaluation and Cost Analysis (EE/CA) for a non-time-critical removal action (NTCRA) to address perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) in drinking water wells for off-Base residential properties near Naval Air Station (NAS) Whidbey Island, in Oak Harbor, Washington. This EE/CA is specific to Ault Field and Area 6 (a 260-acre tract in the southeastern corner of Ault Field) at NAS Whidbey Island. This EE/CA has been prepared under the Naval Facilities Engineering Command CLEAN 9000 Program, Contract Number N62470-16-D-9000, Contract Task Order 4041.

PFOA and/or PFOS have been detected at concentrations exceeding the United Stated Environmental Protection Agency (USEPA) Health Advisory level at the following locations:

- Two off-Base drinking water wells adjacent to Ault Field, one well south of and one well east of Ault Field. These are associated with two private residences referred to herein as Ault Field Residence 1 and Ault Field Residence 2.
- Six off-Base drinking water wells located southwest of Area 6. Five of these serve individual residential properties referred to as the Easy Street Residences. The sixth well can serve up to 21 mobile home units in the Evergreen Mobile Home Park.

The USEPA has established a Health Advisory level for PFOA and PFOS in drinking water at 70 nanograms per liter (ng/L) combined, which represents the project action level (PAL). The PAL is the concentration threshold at which the Department of the Navy (Navy) will implement a removal action. Of the 14 per- and polyfluoroalkyl substances (PFAS) that have been analyzed in off-Base drinking water wells to date, only PFOA and PFOS have a current published Health Advisory level.

An emergency removal action was implemented in December 2016 (Navy, 2017a), to supply bottled water for drinking and cooking to Ault Field Residence 1 and Residence 2 and residences associated with the five of the now six[1] impacted drinking wells near Area 6. The Navy then implemented a Time-Critical Removal Action (TCRA) in early 2018, to offer the affected residents the option to have a point-of-use (POU) treatment system installed for their kitchen sink water tap as a replacement for the bottled water (Navy, 2018a). Both removal actions are designed to minimize resident PFAS-related risks before the implementation of a long-term remedial solution. This EE/CA is required to identify long-term removal actions to protect human health exposure to impacted groundwater through ingestion via off-Base drinking water wells. This document develops and evaluates removal action alternatives for protecting human health by preventing human ingestion of impacted groundwater from the eight off-Base drinking water wells with total combined PFOA and PFOS concentrations above the USEPA Health Advisory level.

1.1 Regulatory Background

This document is issued by the Navy, the lead agency responsible for environmental remediation at NAS Whidbey Island, the Island County Public Health, and the Washington State Department of Ecology and Department of Health.

Section 104 of CERCLA and SARA allows an authorized agency to conduct a removal action or arrange for removal of hazardous substances, pollutants, or contaminants at any time, or to take any other response measures consistent with the National Oil and Hazardous Substance Pollution Contingency Plan (NCP), as deemed necessary to protect public health or welfare and the environment.

[1] During the fall 2019 drinking water sampling event, an additional drinking water well on Easy Street was sampled and results indicated exceedance of the Health Advisory for PFOS. The impacted residence was provided bottled drinking water within 24 hours of receipt of results.

The NCP, Title 40 of the *Code of Federal Regulations* (CFR), Section 300, provides regulations for implementing CERCLA, SARA, and regulations specific to removal actions. The NCP defines a removal action as follows:

> [The] cleanup or removal of released hazardous substances from the environment, such actions as may be necessary to monitor, assess, and evaluate the threat of release of hazardous substances; the disposal of removed 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.

A removal action is being considered for the off-Base residential properties near Ault Field (including Area 6), to protect current human health receptors from ingestion of groundwater-impacted with PFOA and/or PFOS at levels greater than the USEPA Health Advisory. Under 40 CFR Section 300.415, the lead agency (Navy, in this case) is required to conduct an EE/CA when a removal action is planned for a site and a planning period of at least 6 months exists. The purpose of an EE/CA is discussed in Section 1.2.

Community involvement requirements for removal actions include preparing an EE/CA and making it available for public review and comment for a 30-day period. Notifications of the public review and comment period are required to be published in a local newspaper. Written responses to significant comments are summarized in a Responsiveness Summary that is included in an Action Memorandum, which is placed in the Administrative Record file.

1.2 Purpose and Objectives

Submittal of this document fulfills the requirements for NTCRAs defined by CERCLA, SARA, and the NCP. This EE/CA has been prepared in accordance with USEPA's guidance document, *Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA* (USEPA, 1993). The purpose of this EE/CA are as follows:

- Satisfy environmental review and public information requirements for removal actions.
- Satisfy Administrative Record requirements for documenting the removal action selection.
- Provide a framework for evaluating and selecting removal action alternative technologies.

The goals of the EE/CA are to identify the objectives of the removal action; identify removal action alternatives to achieve those objectives; and evaluate the effectiveness, implementability, and cost of those alternatives.

The objective of the removal action alternatives evaluated in this EE/CA is to identify appropriate measures to protect human health by preventing ingestion of drinking water impacted with PFOA and/or PFOS at levels greater than the Health Advisory level. The nature and extent of PFOA and PFOS in groundwater and potential risks associated with future use of impacted groundwater are being evaluated separately.

This EE/CA compares four general categories of removal actions based on their effectiveness, implementability, and cost, to address current exposure to drinking water at off-Base properties impacted with PFOA and/or PFOS at levels greater than USEPA Health Advisory of 70 ng/L (also called the PAL):

- No Further Action (continue the current TCRAs) (for example, bottled water or POU treatment system).
- Point-of-Entry (POE) Water Treatment of Affected Off-Base Well Water (to treat whole-house water from the existing drinking water well).
- Connection to Navy or Public Water Supply (to connect the homes to the nearest existing Navy, city, or community water supply line).
- New (Replacement) Well (to provide a new drinking water well in an unimpacted aquifer unit, if available)

These four general removal action categories can have different and unique considerations for the various affected off-Base residences that impact alternative evaluation considerations. Therefore, this EE/CA compares the four general removal action categories (alternatives) to four different site groupings. Site groupings are used because of the unique characteristics for each area that will impact the effectiveness, implementability, and cost

evaluations associated with the different remedial alternative categories. The four site groupings evaluated in the EE/CA are:

- Ault Field Residence 1 - A single-family residence located east of Ault Field with USEPA Health Advisory exceedances of PFOA and/or PFOS in the drinking water well. This location has unique considerations regarding potential connections to a Navy or public water supply and viability of new well option.
- Ault Field Residence 2 - A single-family residence located south of Ault Field with USEPA Health Advisory exceedances of PFOA and/or PFOS in the drinking water well. This location has unique considerations regarding potential connections to a Navy or public water supply, the viability of the new well option, and the POE treatment needs (this well has consistently exhibited one to two orders of magnitude higher PFOA and/or PFOS concentrations than the other affected wells).
- Easy Street Residences – Five single-family residences south of Area 6 with USEPA Health Advisory exceedances of PFOA and/or PFOS in the drinking water wells associated with each residence. These locations have unique considerations regarding potential connections to a public water supply and the viability of the new well option.
- Evergreen Mobile Home Park – A mobile home community currently with 19 units, with the possibility of up to 21 units, that is served by a single drinking water well with USEPA Health Advisory exceedances of PFOA and/or PFOS. This location has unique considerations regarding potential connections to a public water supply, the viability of the new well option, and POE treatment (because of the larger treatment water rates and volumes).

The following lists subcategories of the four general alternatives that were developed for this EE/CA to address site-grouping-specific needs:

- Alternative 1 – No Further Action
  - 1a – Continue supplying bottled water to affected off-Base residences that do not have a granular activated carbon (GAC) POU treatment system. Currently, no residences have a POU treatment system installed at their home; however, one is contracted to be added at the Evergreen Mobile Home Park.
    - 1a-1: Ault Field Residence 1
    - 1a-2: Ault Field Residence 2
    - 1a-3: Easy Street Residences
    - 1a-4: Evergreen Mobile Home Park
  - 1b – Providing maintenance for one Evergreen Mobile Home Park GAC POU treatment system.
- Alternative 2 – POE Water Treatment of Affected off-Base Well Water.
  - 2a – GAC Treatment to remove PFOA and PFOS from drinking water well supplies.
    - 2a-1: Ault Field Residence 1
    - 2a-2: Ault Field Residence 2
    - 2a-3: Easy Street Residences
    - 2a-4: Evergreen Mobile Home Park
  - 2b – Ion Exchange (IX) Treatment to remove PFOA and PFOS from drinking water well supplies.
    - 2b-1: Ault Field Residence 1
    - 2b-2: Ault Field Residence 2
    - 2b-3: Easy Street Residences
    - 2b-4: Evergreen Mobile Home Park
- Alternative 3 – Connection to Navy or Public Water Supply.
  - 3a – Ault Field Residence 1 connection to a City of Oak Harbor Water line via Navy-maintained connection.

  - 3b – Ault Field Residence 2 connection to an on-Base Navy water line (originating from the City of Oak Harbor's Water System).
  - 3c – Ault Field Residence 2 connection to the Pine Terrace Water System.
  - 3d – Easy Street Residences individual connections to an extension of City of Oak Harbor water lines.
  - 3e – Evergreen Mobile Home Park single connection to an extension of the City of Oak Harbor water lines (with owner distribution to individual mobile home park residences).
- Alternative 4 - New (Replacement) Well (note: this alternative is not applicable to Ault Field Residence 2, which does not have an appropriate, deeper aquifer to use for drinking water as determined in the *New Residential Well Remedial Alternative* technical memorandum (Navy 2018i).
  - 4a – Conversion of an existing monitoring well on the property to a new drinking water well for Ault Field Residence 1.
  - 4b – Further site investigation (installation of a new monitoring well, aquifer testing, and PFAS analytical sampling) with potential conversion of the monitoring well to a new drinking water well.
    - 4b-1: For Easy Street Residences
    - 4b-2: For the Evergreen Mobile Home Park

The use of site groupings and alternatives designed to be specific for the unique characteristics of each site grouping, allows the Navy to better evaluate and select the best remedial alternative for each site grouping. This approach provided the most streamlined means to present a transparent evaluation of alternatives given the unique and complex variables of each site grouping (for example, number of residents, location with respect to different water purveyors, and confidence in being able to provide safe drinking water using residential groundwater).

SECTION 2

Site Characterization

2.1 Site Background

The NAS Whidbey Island complex is located in Island County, Washington on Whidbey Island, and consists of Ault Field, Outlying Landing Field Coupeville, and Seaplane Base. Ault Field occupies approximately 4,300 acres, 3 miles northwest of the City of Oak Harbor, Washington, and includes Area 6, a 260-acre tract in the southeastern corner of Ault Field (**Figure 2-1**). Ault Field was commissioned in 1942 and was used for the rearming and refueling of Navy patrol planes and other tactical aircraft operating in the Puget Sound region (Navy, 2016). Currently, Ault Field supports Navy tactical electronic attack squadrons flying the EA-18G Growler aircraft, the P-3 Orion Maritime Patrol squadrons, and two Fleet Reconnaissance squadrons flying the EP-3E Aries aircraft (Navy, 2017b).

The historical use of aqueous film-forming foam (AFFF) at Ault Field for firefighting and fire response training purposes has been identified as a source of PFAS releases to local groundwater. Known and potential source areas are being investigated as part of preliminary assessment (PA) and SI work that is currently underway. The Ault Field PA identified 34 potential source areas at Ault Field for the release of PFAS into the environment (Navy, 2018e). The following areas are three potential primary source areas of AFFF, where historical firefighting and fire response training activities occurred: Area 16 (Ault Field Runway Ditches), Area 31 (the former Runway Fire Training School), and the current firefighting school (**Figure 2-2**).

Although it is unknown if AFFF was used or disposed of at Area 6, its historical site use as a disposal area suggests that AFFF disposal within Area 6 is possible. Wastes are known to have been previously disposed of at two locations within Area 6: the former industrial waste disposal area (Site 55), which received acids, caustics, and solvents between the 1970s and 1980s and liquid sludge between 1969 and the mid-1970s, and the Area 6 landfill, which received Navy waste from 1969 through the mid-1990s (Foster, 1997; URS, 1993; URS-AECOM, 2016). There is no known disposal of regulated wastes at the Area 6 landfill since 1983 (URS, 1993).

2.2 Summary of Previous Investigations

The following is a summary of both the on-Base and the off-Base PFAS-related investigation activities completed at Ault Field (including Area 6) to date.

2.2.1 Groundwater Investigation

In September 2015, the Navy conducted on-Base groundwater sampling at Ault Field to evaluate the presence of PFAS in groundwater at Areas 16, 31, and Hangar 5 (MMEC, 2016). Concentrations of PFOA and PFOS exceeded applicable 2009 USEPA Provisional Health Advisory screening levels (PFOA at 0.4 microgram per liter [µg/L]; PFOS at 0.2 µg/L) at two monitoring wells in Area 31 (referred to in this report as Former Runway Fire School) (MMEC, 2016). Additional detections of PFAS were observed in two monitoring wells near Hangar 5; however, both detections were below the Provisional Health Advisory screening levels. There were no detections of PFAS in two wells sampled at Area 16.

In December 2017, the Navy conducted an on-Base groundwater study for PFAS at Area 6. During this event, 13 monitoring wells were sampled along with influent and effluent samples from the current groundwater treatment system. Results indicate that one of the 13 monitoring wells sampled exceeded the USEPA Health Advisory for PFOA. Additional detections of PFAS were observed in seven of the monitoring wells and the groundwater treatment system influent and effluent samples. However, the concentrations were below the Health Advisory for both PFOA and PFOS individually, and combined PFOA and PFOS.

Following the 2017 on-Base PFAS sampling event, a second phase of groundwater sampling was conducted between February and August 2018 for Area 6. During this time, four additional on-Base groundwater monitoring

wells, twelve off-Base groundwater monitoring wells, and four off-Base privately-owned groundwater (nonpotable) supply wells were sampled. Results indicate detections of PFOA and/or PFOS in seven of the twenty wells. However, the concentrations were all below the Health Advisory for PFOA and/or PFOS. Other PFAS compounds were detected in eleven of the twenty wells sampled. Two additional off-Base wells were identified for sampling but are currently inaccessible. These wells will be sampled in early 2019 following vegetation reduction to allow for safe access.

2.2.2 Drinking Water Well Investigation

From November 2016 to June 2017, Ault Field off-Base drinking water wells were sampled under a voluntary sampling program for PFAS. Because of the uncertainty of groundwater flow direction at the time, the Navy used the Current Fire Fighting School (referred to in this report as Current Fire Training Area), Runway and Drainages, and Former Fire Fighting School (referred to in this report as Former Runway Fire School) as the center points to draw a 1-mile radius to initiate the Phase 1 off-Base drinking water sampling. The Phase 1 results indicate that PFOA and/or PFOS are above the Health Advisory in one off-Base drinking water well south of Ault Field (Residence 2) (CH2M, 2017). Based on the Phase 1 results, the Navy expanded the drinking water investigation an additional 1/2-mile in some portions south and east of Ault Field. This additional area is referred to as the Phase 2 sampling area. The Phase 2 results indicate that PFOA and/or PFOS are above the USEPA Health Advisory in one off-Base drinking water well east of Ault Field (Residence 1) (CH2M, 2017). Based on the Phase 2 results, the Navy expanded the drinking water investigation an additional 1/2-mile from this property. This additional area is referred to as the Phase 3 sampling area. There were no exceedances of the USEPA Health Advisory for PFOA and/or PFOS in the Phase 3 area. Based on the Phase 3 results, the Navy did not expand the drinking water sampling area near Ault Field beyond the Phase 3 area. In October 2018, the Navy identified PFAS in a storm water drain near Hangar 6 and in an associated storm water drainage system that empties into Clover Valley Stream and Dugualla Bay. As a result of this new information, the Navy initiated Phase 4 of drinking water sampling for wells located within a half mile to the north-northeast and south-southeast of the surface water body where the PFAS was detected above the USEPA Health Advisory. This Ault Field Phase 4 sampling began in January 2019 and was completed in April 2019. No additional wells have been identified with USEPA Health Advisory Exceedances of PFOA and/or PFOS as part of Phase 4.

Eleven new monitoring wells, including two off-Base wells (one each at Ault Field Residence 1 and Residence 2), were drilled and sampled between January and March 2018 as part of the Ault Field Phase 1 SI (Navy, 2018h). The two new Ault Field Residence 1 and Residence 2 monitoring wells (MW-611 and MW-615) met State and County drinking water well construction standards to allow the wells to be converted and permitted as household drinking water wells if the water quality could be proven appropriate. The Ault Field Residence 1 new well was installed deeper than the existing, impacted residential water supply well, below a potential confining clay layer. At Ault Field Residence 2, no viable deeper water-bearing unit was identified, so the new well was screened at a similar depth to the existing PFAS-impacted residential water supply well (although the existing well construction is uncertain). The initial sample from the Ault Field Residence 1 new monitoring well was non-detect for PFAS. The initial samples from the Ault Field Residence 2 new monitoring well had detections of PFOA and PFOS that were below the USEPA Health Advisory. Therefore, these new monitoring wells were selected for aquifer testing and additional PFAS sampling (Navy, 2018g). Aquifer testing was performed in July 2018 at Ault Field Residence 1 and in June 2018 at Ault Field Residence 2. Results from aquifer testing and PFAS sampling at the new Ault Field Residence 1 monitoring well (MW-611) showed PFOA and/or PFOS remained nondetect with no evidence of hydraulic connection with the existing, impacted drinking water well (Navy, 2018i). Results from aquifer testing and PFAS sampling at the new Ault Field Residence 2 monitoring well (MW-615) showed a slight increase in PFOA and/or PFOS concentrations during aquifer testing and pumping of the new well-induced measurable drawdown in the pre-existing drinking water well, indicating significant hydraulic connection between the newly installed well and the existing, impacted drinking water well.

Due to the detection of PFOA above the USEPA Health Advisory in one of the Area 6 monitoring wells during the December 2017 groundwater sampling event, the Navy conducted two voluntary off-Base drinking water well

sampling events for wells hydraulically downgradient of Area 6. The Phase 1 sampling event, conducted in winter/spring 2018, included wells one-half mile to the west and south of the Area 6 boundary. The Phase 2 sampling event, conducted in the summer 2018, area included parcels within the Phase 1 sampling area that were not sampled in the spring and wells within one-half mile to the southwest of the drinking water wells with PFAS exceedances in the Phase 1 sampling area. One additional well within the Phase 1 sampling area was sampled in the summer 2018. No responses to sample request letters were received from drinking water wells within the Phase 2 area. Drinking water samples were collected from 17 wells during the Phase 1 and Phase 2 events. Results from the Phase 1 and Phase 2 sampling events indicate that 5 of the 17 drinking water wells sampled contain PFOA and/or PFOS above the USEPA Health Advisory; the exceedances occurred at the Evergreen Mobile Home Park and four Easy Street Residences.

Following the initial phased voluntary drinking water sampling performed at Ault Field, a periodic drinking water sampling program was developed in 2017 to monitor PFAS within drinking water wells. As part of the periodic drinking water sampling, residences with PFAS detections and residences adjacent to residences with PFAS exceedances would be sampled bi-annually to evaluate temporal and spatial variability of PFAS. In spring 2019 Area 6 residences were added to the periodic drinking water sampling program for Ault Field. In preparation for the November 2019 sampling event, request letters were sent to seven residences adjacent to the five exceedances on Easy Street and Evergreen Mobile Home Park. Of the seven residences, one residence located on Easy Street responded to the request and was added to the fall 2019 periodic drinking water sampling event. PFOS was above the Health Advisory for the additional Area 6 residence; thus, the residence was added to the periodic drinking water sampling program and this EECA.

2.2.3 Emergency Actions

An emergency removal action was implemented in December 2016 (Navy, 2017a) to supply affected residents at Ault Field Residence 1 and Residence 2 with bottled water for drinking and cooking. The same emergency response action was performed for Area 6 off-Base residences after receiving the preliminary results of drinking water samples collected in February, March, and April 2018 for four Easy Street Residences and the Evergreen Mobile Home Park water system. Emergency response action was also performed upon receipt of the Novmeber 2019 results for the additional residence on Easy Street. Residents were verbally notified of the USEPA Health Advisory level exceedances within 24 hours of receipt of the preliminary data from the laboratory. Bottled water for drinking and cooking was delivered within 48 hours of receipt of the preliminary data and the residents were scheduled for routine bottled water deliveries. Ault Field Residence 1 and Residence 2, five Easy Street Residences, and 19 Evergreen Mobile Home Park units are currently receiving bottled water for drinking and cooking purposes.

The Navy also implemented a TCRA in early 2018 to allow residents the option to have a POU treatment system installed for their kitchen sink water as a replacement for the bottled water (Navy, 2018a). The POU treatment system is designed to minimize risks in the same manner as bottled water but with potential greater convenience to the resident. Only one Area 6 off-Base resident expressed interest in having the POU treatment system installed. However, this system has not been installed to date.

Both removal actions (bottled water and POU treatment systems) were designed to minimize resident PFOA- and/or PFOS-related risks before the implementation of the long-term remedial solution, which will be selected subsequent to this EE/CA.

2.3 Conceptual Site Model

An RI has not been completed for PFAS at NAS Whidbey Island; therefore, the conceptual site model (CSM) has not been fully developed. A CSM would include a description of the sources of PFAS, the nature and extent of PFAS-impacted groundwater, and its expected fate and transport over time. The CSM presented here is preliminary, and for the purposes of this EE/CA, the CSM discussion focuses on information pertaining to the off-Base residential drinking water wells near Ault Field with exceedances of the Health Advisory for PFOA and/or

PFOS. The CSM for PFAS at NAS Whidbey Island will continue to be refined as additional data are collected as part of ongoing SI and RI activities.

2.3.1 Geology

Whidbey Island lies within the Puget Lowland, a topographic and structural depression between the Olympic Mountains and the Cascade Range. The geology of the area is heavily influenced by glacial advances and retreats. At the height of the most recent glaciation, ice is estimated to have reached a thickness of about 4,500 feet in the Oak Harbor area. The geologic units on Whidbey Island consists of a sequence of Quaternary-age (less than 2 million years old) glacial and interglacial deposits that may be over 3,000 feet thick (USGS, 2005) with near-surface deposits being mostly glacial sediment of the Fraser glaciation (20,000 to 10,000 years old).

The Everson and Vashon units of the Fraser glaciation, post-glacial sediment, and artificial fill make up most of the surface and near-surface soil underlying Ault Field. In general, stratigraphic units up to 100 feet thick, consisting of relatively impermeable clay, silt, and silty fine sand (Everson glaciomarine drift and Vashon till), form the near-surface layers. Underlying the Vashon Outwash in most places are sand, silt, and clay of the Whidbey Formation.

Three parallel active fault zones exist at Ault Field that are regionally significant. The Devil's Mountain, Strawberry Point, and Utsalady Point fault zones trend from southeast to northwest across Ault Field. Fault movement is oblique with both horizontal and vertical components. In general, the horizontal component is left-lateral, while the vertical component is normal with the north wedge up (USGS, 2005).

2.3.2 Hydrogeology

The United States Geological Survey (USGS) has identified five major hydrogeologic units, labeled A through E, on Whidbey Island. However, only Units D and E are present at Ault Field (USGS, 2005). Units D and E are termed intermediate and shallow aquifers, respectively (URS, 1993). Locally perched zones may exist over discontinuous areas of till or other clay-rich units (MMEC & AECOM, 2016).

The shallow aquifer (Unit E) is a locally discontinuous unconfined aquifer consisting of sand and gravel with an average groundwater elevation of 20 feet above mean sea level (msl). At Ault Field, the shallow aquifer is found in the Vashon Outwash deposits at or near the surface. The intermediate aquifer (Unit D) is a moderately continuous sandy unit that is generally confined. Potentiometric surface elevations vary from 10 to 75 feet above msl (URS, 1993).

Groundwater beneath Ault Field is recharged by infiltration of precipitation. Groundwater flow in specific regions of Ault Field was documented in previous environmental investigations (URS, 1993; MMEC & AECOM, 2016). However, there is a lack of monitoring wells in the flight line and along the eastern boundary of Ault Field, thus the groundwater flow directions in these areas are unknown. In general, groundwater flows to the east towards Dugualla Bay and mimics the topography of the Clover Valley. A groundwater divide extends southwest to northeast along the topographic high of the coastal bluff in the western part of Ault Field. Groundwater to the northwest of the divide flows west towards the Strait of Juan de Fuca, and groundwater to the southeast of the divide flows east towards the interior of the island.

2.3.3 Affected Media

The affected media for this EE/CA is off-Base groundwater withdrawn and used for drinking water supply. The two affected off-Base drinking water wells at Ault Field Residence 1 and Residence 2 have total depths of 35 feet and approximately 120 feet below ground surface (bgs), respectively. The six affected off-Base drinking water wells at the Easy Street and Evergreen Mobile Home Park Residences have estimated total depths ranging from approximately 55 to 100 feet bgs. Although formal well construction information is not available for the well at Ault Field Residence 2 or the wells at the Easy Street and Evergreen Mobile Home Park Residences, it is likely that all eight affected off-Base drinking water wells associated with Ault Field and Area 6 are screened in the shallow

aquifer based on owner-provided information about their potential well depths. However, formal boring and well logs are not available for most of the affected wells).

The locations of the eight impacted off-Base drinking water wells near Ault Field (including Area 6) are shown on **Figure 2-2**.

2.3.4 Nature and Extent of Contamination

An RI has not been completed for PFAS at NAS Whidbey Island. Therefore, the nature and extent of PFAS near the eight impacted off-Base drinking water wells has not been fully delineated and will be addressed in SI work currently underway and an RI for PFAS, which is planned for 2019/2020. A summary of current information follows.

Of the 143 off-Base drinking water wells sampled adjacent to Ault Field through March 2019, water from the two wells at Ault Field Residence 1 and Residence 2 have PFOA and/or PFOS concentrations greater than the Health Advisory levels (**Figure 2-2**). In the existing off-Base drinking water well at Ault Field Residence 1, recent concentrations range from 35.2 to 140 ng/L for PFOA, nondetect to 1.1 ng/L for PFOS, and 36.3 to 140 ng/L for PFOA and PFOS combined. In the existing off-Base drinking water well at Ault Field Residence 2, recent concentrations range from 5.99 to 46.1 ng/L for PFOA, 538 to 8,030 ng/L for PFOS, and 544 to 8,076 ng/L for PFOA and PFOS combined. The remaining 140 off-Base drinking water wells sampled adjacent to Ault Field contain PFOA and PFOS below the detection limits or below the USEPA Health Advisory level.

Two new off-Base monitoring wells (one each at Ault Field Residence 1 [MW-611] and Residence 2 [MW-615]) were sampled in February and March 2018, following their installation as part of the Ault Field Phase I SI (Navy, 2018d and 2018g). At Ault Field Residence 1, the new well is screened in a deeper aquifer unit than the current drinking water well on the property, with a potential upper confining layer between the two groundwater source areas (Navy, 2018h). PFOA and PFOS have not been detected in the new monitoring well at Ault Field Residence 1. At Ault Field Residence 2, no confining layer or distinct deeper productive aquifer unit was identified, and the new monitoring well was screened at a similar depth as the existing impacted drinking water well (Navy, 2018h). In the new monitoring well at Ault Field Residence 2, recent concentrations range from 7.4 to 9.46 ng/L for PFOA, nondetect to 3.37 ng/L for PFOS, and 7.4 to 11.2 ng/L for PFOA and PFOS combined.

As discussed in Section 2.2.1, aquifer testing in July 2018 at the new Ault Field Residence 1 monitoring well (MW-611) indicated a deeper, confined aquifer unit at this location that was nondetect for PFOA and/or PFOS and could be a viable drinking water source for the residence. Aquifer testing results from June 2018 at Ault Field Residence 2 showed the new monitoring well (MW-615) has detections of PFOA and/or PFOS and is not a viable drinking water source (Navy, 2018i).

Of the 16 off-Base residential drinking water wells sampled during the off-Base sampling event at Area 6, six drinking water wells (five Easy Street Residences and the Evergreen Mobile Home Park well) contained PFOA and/or PFOS concentrations above the USEPA Health Advisory limit (**Figure 2-2**). PFOA concentrations in these wells ranged from 3.86 to 577 ng/L, PFOS concentrations ranged from 2.19 to 7690 ng/L, and combined PFOA and PFOS concentrations ranged from 6.1 to 7741.7 ng/L[2]. PFOA and PFOS concentrations were below the detection limits or below the Health Advisory at all other wells sampled during this event.

County well logs were evaluated in the area surrounding the Easy Street Residences and the Evergreen Mobile Home Park. There is evidence in surrounding-area boring logs of a potential confining layer between the shallow aquifer and deeper (sea-level) aquifer around Area 6. The actual presence of such a confining layer has not been confirmed and, if present, such a confining layer may not be continuous in the impacted drinking water wells. However, based on an evaluation of available well logs and the owner-reported depths of the Easy Street Residences and Evergreen Mobile Home Park wells, it appears that the PFOA and PFOS in this vicinity may be concentrated in the shallow portion of the aquifer.

[2] The lowest and highest concentrations observed are shown.

Table 2-1 summarizes the available well depth, PFOA, PFOS, and general chemistry data in the eight off-Base drinking water wells with PFOA and/or PFOS exceedances near Ault Field (including Area 6) and two new off-Base monitoring wells.

2.3.5 Water Use

Interview questionnaires regarding household water use were completed by the residents at Ault Field Residence 1, Ault Field Residence 2, and the Easy Street Residences. The information gathered from these questionnaires was used to estimate approximate daily water demand for each of these residences, which are summarized in **Table 2-2**. The estimates in Table 2-2 suggest an annual average household water use of around 80 to 100 gallons per capita daily, which is within the range of typical values for western Washington.

The Evergreen Mobile Home Park water system and supply well is maintained and operated by King Water Company. A summary of recent pumping usage for the supply well is included in **Table 2-3**. The well typically operates at a supply rate of around 25 gallons per minute (gpm) based on recent King Water Company pumping records, and a review of metered well water production trends spanning from 2008 through 2017 suggests that an annual average water usage rate of around 170 gallons per connection per day is typical, with some years averaging as high as 200 to 250 gallons per connection per day.

The Washington State Department of Health provides recommended methodologies for estimating potential residential water use and demands in their 2009 Water System Design Manual. These methodologies were used to develop estimates of potential residential water demands for Ault Field Residences 1 and 2, the Easy Street Residences, and for the Evergreen Mobile Home Park water system, based on representative single-family residential water use estimates using representative water usage values indicated in the 2014 City of Oak Harbor Water System Plan, and Evergreen Mobile Home Park well water supply records. These water demand estimates are applied in subsequent sections relative to sizing required water supply capacities.

2.4 Risk Assessment Summary

In accordance with current Navy policy on PFAS (Navy, 2017b), a screening-level risk assessment has been performed for the Ault Field and Area 6 off-Base drinking water wells and is documented in **Appendix A**. The risk assessment was conducted in two steps using the risk ratio technique described in *Overview of Screening, Risk Ratio, and Toxicological Evaluation. Procedures for Northern Division Human Health Risk Assessments* (Navy, 2000).

Step 1 includes comparing the maximum-detected PFAS concentrations in groundwater in each well, compared to both the USEPA tap water regional screening levels (RSLs) for PFAS and the USEPA Health Advisory for PFOA and PFOS. RSLs are based on noncarcinogenic effects using a hazard quotient of 0.1 to account for exposure to multiple constituents with the same target organ/target effect. RSL values are included in the screening level risk assessment for perfluorobutane sulfonic acid, PFOA, and PFOS, which are the only PFAS with available toxicity values. The tap water RSLs for PFOA and PFOS were calculated as 40 ng/L for combined PFOA and PFOS concentration using the USEPA Risk Screening Level Calculator (USEPA, 2018) since these analytes are not included in the most recent RSL table (USEPA, 2018). Lifetime Health Advisories provide information on pollutants that can affect drinking water quality, but they are not regulated under the Safe Drinking Water Act (SDWA). The health advisory levels are developed to provide a margin of protection against adverse health effects to the most sensitive population (fetuses during pregnancy and breastfed infants). If the maximum detected concentration exceeded the RSL (which is lower than the Health Advisory for PFOA and PFOS), the constituent was identified as a Step 1 constituent of potential concern (COPC) and carried forward to Step 2.

Step 2 includes calculating risk levels for the constituents identified as COPCs in Step 1 following the approach discussed in *Overview of Screening, Risk Ratio, and Toxicological Evaluation. Procedures for Northern Division Human Health Risk Assessments* (Navy, 2000). Both carcinogenic risk and hazard indexes (HIs) were calculated for COPCs that act through carcinogenic and noncarcinogenic effects and the risks evaluated for each well. If the

cumulative HI was greater than 0.5, or the cumulative carcinogenic risk was greater than 5×10^{-5}, the chemicals contributing to these values were retained as COPCs.

The results of the screening-level risk assessment (**Appendix A)** identified PFOA and PFOS as COPCs. However, only one drinking water well (at Ault Field Residence 2) was identified as having potential unacceptable risks associated with PFAS in groundwater. Although the risk evaluation only identifies one drinking water well location with potential unacceptable PFAS-related risks, all residential wells with PFOA and/or PFOS concentrations above the USEPA Health Advisory are carried forward for removal actions.

Although future receptors were not considered for the scope of this EE/CA, land use at the off-Base properties is currently zoned as Rural for Ault Field Residences 1 and 2 and as Residential (Municipality/Nonmunicipal Urban Growth Area) for the Easy Street Residences and Evergreen Mobile Home Park (Island County, 2018). Future land use is assumed to stay the same as current use for the affected parcels. Additionally, groundwater will continue to be used as a drinking water source for individuals at off-Base private properties who already use wells unless measures are taken to provide an alternate water supply.

This EE/CA only addresses human exposure to PFOA and PFOS in off-Base drinking water.

2.5 Determination of Removal Action Area

The eight drinking water wells at the off-Base residential properties that are currently affected are included in this EE/CA, and their locations are shown on **Figure 2-2** (Ault Field Residence 1 and 2, five Easy Street Residences, and the Evergreen Mobile Home Park [currently housing 19 units]). The two impacted residential properties near Ault Field (Residence 1 and Residence 2) each have their own private drinking water well. Ault Field Residence 1 is located on a 5.24-acre parcel near the eastern border of Ault Field, and Residence 2 is located on a 4.89-acre parcel along the southwestern border of Ault Field. Of the six impacted off-Base drinking water wells located southwest of Area 6, one currently supplies water to 19 units in the Evergreen Mobile Home Park west of Goldie Road and north of Easy Street in Oak Harbor, Washington (but could serve up to 21 units). The other five impacted wells each serve individual residential properties along Easy Street. The parcels near Area 6 encompass a total of 7.75 acres near the intersection of NE Goldie Street and State Route 20.

The removal action area is defined as the residential drinking water system associated with each affected residence. The average daily use of the residential systems is estimated to be about 200 to 400 gallons per day (gpd) based on typical household activities and number of residents living in the home as described in Section 2.3.5 (**Tables 2-2 and 2-3**).

The removal action areas are split into four groups for this EE/CA because of their unique characteristics which affect removal action evaluations (see Section 1.2):

- Ault Field Residence 1
- Ault Field Residence 2
- Easy Street Residences
- Evergreen Mobile Home Park

Table 2-1. Analytical Data Summary of Affected Off-Base Residential Wells

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

WELL ID	WI-AF-1RW40					MW-611		WI-AF-1RW32				MW-615					WI-A06-RW05			WI-A06-RW20	
LOCATION	Ault Field Residence 1					Ault Field Residence 1		Ault Field Residence 2				Ault Field Residence 2					Easy Street Residence A			Easy Street Residence B	
WELL DEPTH (feet bgs)	35					170		~100[b]				95.93					55 to 60[a]			60[a]	
SCREEN INTERVAL (feet bgs)	Unknown					145-165		Unknown				70 - 90					Unknown			Unknown	
SAMPLE ID	*WI-AF-1RW40-0217*	*WI-AF-1RW40P-0217*	*WI-AF-1RW40-1017*	*WI-AF-1RW40-0318*	*WI-AF-1RW40-0918*	*WI-AF-MW-611-0318*	*WI-AF-MW-611A-0718*	*WI-AF-1RW32-0217*	*WI-AF-1RW32-1017*	*WI-AF-1RW32-0318*	*WI-AF-1RW32-0918*	*WI-AF-MW-615-0318*	*WI-AF-MW-615A-0618*	*WI-AF-MW-615B-0618*	*WI-AF-MW-615C-0618*	*WI-AF-MW-615CP-0618*	*WI-A06-RW05-0218*	*WI-A06-RW05P-0218*	*WI-A06-RW05-0818*	*WI-A06-RW20-0418*	*WI-A06-RW20-0818*
SAMPLE DATE	2/24/17	2/24/17	10/18/17	3/28/18	9/18/18	3/1/18	7/12/18	2/21/17	10/11/17	3/19/18	9/19/18	3/1/18	6/26/18	6/28/18	6/30/18	6/30/18	2/6/18	2/6/18	8/29/18	4/20/18	8/30/18
CHEMICAL NAME																					
Volatile Organic Compounds (µg/L)																					
Vinyl chloride	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.04 U	0.04 U	NS	0.04 U	NS
Semivolatile Organic Compounds (µg/L)																					
1,4-Dioxane	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0.053 J**	**0.055 J**	NS	**0.11**	NS
Semivolatile Organic Compounds (ng/L)																					
EtFOSAA	NS	NS	4.92 U	5 U	4.92 U	5.63 U	4.27 U	NS	4.9 U	5.02 U	5.53 U	5.48 U	4.63 U	4.24 U	4.5 U	4.35 U	4.98 U	5.02 U	4.98 U	4.84 U	5.17 U
MeFOSAA	NS	NS	4.92 U	5 U	4.92 U	5.63 U	4.27 U	NS	4.9 U	5.02 U	5.53 U	5.48 U	4.63 U	4.24 U	4.5 U	4.35 U	4.98 U	5.02 U	4.98 U	4.84 U	5.17 U
PFBS	100 U	100 U	**3.87 J**	**4.02 J**	**7.19 J**	5.63 U	4.27 U	**130**	**64.5**	**213 J**	**114**	**89.1**	**91.2**	**111**	**118**	**113**	**28.9**	**28.9**	**26.2**	**20**	**18.7**
PFDA	NS	NS	4.92 U	5 U	4.92 U	5.63 U	4.27 U	NS	4.9 U	5.02 U	5.53 U	5.48 U	4.63 U	4.24 U	4.5 U	4.35 U	4.98 U	5.02 U	4.98 U	4.84 U	5.17 U
PFDoA	NS	NS	4.92 U	5 U	4.92 U	5.63 U	4.27 U	NS	4.9 U	5.02 U	5.53 U	5.48 U	4.63 U	4.24 U	4.5 U	4.35 U	4.98 U	5.02 U	4.98 U	4.84 U	5.17 U
PFHpA	NS	NS	**3.99 J**	**4.3 J**	**6.74 J**	5.63 U	4.27 U	NS	**4.34 J**	**15.7**	**7.32 J**	**8.41 J**	**7.25** J	**8.75**	**9.42**	**9.78**	**20.2**	**21.4**	**16.2**	**3.33 J**	5.17 U
PFHxS	NS	NS	**23.2**	**15.6**	**21.2**	5.63 U	4.27 U	NS	**156**	**1,230**	**362**	**123**	**123**	**187**	**169**	**167**	**210**	**232**	**200**	**118**	**11.9**
PFHxA	NS	NS	4.92 U	**6.85 J**	**10.5**	5.63 U	4.27 U	NS	**40.8**	**141**	**70.8**	**51.7**	**53.7**	**63.7**	**70.5**	**67.4**	**48.6**	**49.8**	**37.5**	**19.1**	**17.5**
PFNA	NS	NS	4.92 U	5 U	4.92 U	5.63 U	4.27 U	NS	4.9 U	5.02 U	5.53 U	5.48 U	4.63 U	4.24 U	4.5 U	4.35 U	4.98 U	**1.67 J**	4.98 U	4.84 U	5.17 U
PFOS	44 U	45 U	4.92 U	**1.1 J**	4.92 U	5.63 U	4.27 U	**3,800**	**538**	**8,030**	**819 D**	**3.37 J**	4.63 U	4.24 U	4.5 U	4.35 U	**54.1**	**63.8**	**95.3**	**30.5**	**27.8**
PFOA	**140**	**120**	**73.1**	**35.2**	**39**	5.63 U	4.27 U	**23 J**	**5.99 J**	**46.1**	**9.71 J**	**7.85 J**	**7.4** J	**10.8**	**7.52**	**9.46**	**57.7**	**55.3**	**55.4**	**43.7**	**45.3**
PFTeDA	NS	NS	4.92 U	5 U	4.92 U	5.63 U	4.27 U	NS	4.9 U	5.02 U	5.53 U	5.48 U	4.63 U	4.24 U	4.5 U	4.35 U	4.98 U	5.02 U	4.98 U	4.84 U	5.17 U
PFTrDA	NS	NS	4.92 U	5 U	4.92 U	5.63 U	4.27 U	NS	4.9 U	5.02 U	5.53 U	5.48 U	4.63 U	4.24 U	4.5 U	4.35 U	4.98 U	5.02 U	4.98 U	4.84 U	5.17 U
PFUnA	NS	NS	4.92 U	5 U	4.92 U	5.63 U	4.27 U	NS	4.9 U	5.02 U	5.53 U	5.48 U	4.63 U	4.24 U	4.5 U	4.35 U	4.98 U	5.02 U	4.98 U	4.84 U	5.17 U
PFOA + PFOS	**140**	**120**	**73.1**	**36.3**	**39**	5.63 U	4.27 U	**3,823**	**544**	**8,076**	**829**	**11.2**	**7.4**	**10.8**	**7.52**	**9.46**	**111.8**	**119.1**	**150.7**	**74.2**	**73.1**
Total Metals (mg/L)																					
Iron	NS	NS	**16**	NS	NS	NS	NS	NS	**8.1**	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.47 U	NS	**0.23 J**
Dissolved Metals (mg/L)																					
Aluminum	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.44 U	NS	0.44 U
Calcium	NS	NS	**72**	NS	NS	NS	NS	NS	**46**	NS	NS	NS	NS	NS	NS	NS	NS	NS	**43**	NS	**46**
Iron	NS	NS	**1.5**	NS	NS	NS	NS	NS	**0.46 J**	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.47 U	NS	0.47 U
Magnesium	NS	NS	**55**	NS	NS	NS	NS	NS	**80**	NS	NS	NS	NS	NS	NS	NS	NS	NS	**44**	NS	**42**
Manganese	NS	NS	**0.88**	NS	NS	NS	NS	NS	**0.18**	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0.0050 J**	NS	**0.075**
Potassium	NS	NS	**3.7**	NS	NS	NS	NS	NS	**21**	NS	NS	NS	NS	NS	NS	NS	NS	NS	**3.2 J**	NS	**3.7**
Silicon	NS	NS	**19**	NS	NS	NS	NS	NS	**15**	NS	NS	NS	NS	NS	NS	NS	NS	NS	**17**	NS	**14**
Wet Chemistry (mg/L)																					
Alkalinity	NS	NS	**290**	NS	NS	NS	NS	NS	**410**	NS	NS	NS	NS	NS	NS	NS	NS	NS	**250**	NS	**250**
Ammonia	NS	NS	**0.16 J**	NS **J**	NS	NS	NS	NS	**0.46 J**	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.3 U	NS	0.3 U
Chloride	NS	NS	**87**	NS	NS	NS	NS	NS	**85**	NS	NS	NS	NS	NS	NS	NS	NS	NS	**54**	NS	**37**
Fluoride	NS	NS	0.08 U	NS U	NS	NS	NS	NS	**0.13 J**	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.08 U	NS	0.08 U
Nitrate/Nitrite	NS	NS	0.12 U	NS U	NS	NS	NS	NS	**0.12 U**	NS	NS	NS	NS	NS	NS	NS	NS	NS	**3**	NS	0.12 U
Phosphate	NS	NS	0.08 U	NS U	NS	NS	NS	NS	**0.20 J**	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.08 U	NS	0.08 U H
Sulfate	NS	NS	**19**	NS	NS	NS	NS	NS	**32**	NS	NS	NS	NS	NS	NS	NS	NS	NS	**31**	NS	**32**
TDS	NS	NS	**520**	NS	NS	NS	NS	NS	**660**	NS	NS	NS	NS	NS	NS	NS	NS	NS	**390**	NS	**340**
TSS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	2 U	NS	**2.4**
TUO (254 nm, 1/cm)	NS	NS	**0.333**	NS	NS	NS	NS	NS	**0.246**	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0.036**	NS	**0.052**

Table 2-1. Analytical Data Summary of Affected Off-Base Residential Wells

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

WELL ID	WI-AF-1RW40					MW-611		WI-AF-1RW32				MW-615					WI-A06-RW05			WI-A06-RW20	
LOCATION	Ault Field Residence 1					Ault Field Residence 1		Ault Field Residence 2				Ault Field Residence 2					Easy Street Residence A			Easy Street Residence B	
WELL DEPTH (feet bgs)	35					170		~100[b]				95.93					55 to 60[a]			60[a]	
SCREEN INTERVAL (feet bgs)	Unknown					145-165		Unknown				70 - 90					Unknown			Unknown	
SAMPLE ID	*WI-AF-1RW40-0217*	*WI-AF-1RW40P-0217*	*WI-AF-1RW40-1017*	*WI-AF-1RW40-0318*	*WI-AF-1RW40-0918*	*WI-AF-MW-611-0318*	*WI-AF-MW-611A-0718*	*WI-AF-1RW32-0217*	*WI-AF-1RW32-1017*	*WI-AF-1RW32-0318*	*WI-AF-1RW32-0918*	*WI-AF-MW-615-0318*	*WI-AF-MW-615A-0618*	*WI-AF-MW-615B-0618*	*WI-AF-MW-615C-0618*	*WI-AF-MW-615CP-0618*	*WI-A06-RW05-0218*	*WI-A06-RW05P-0218*	*WI-A06-RW05-0818*	*WI-A06-RW20-0418*	*WI-A06-RW20-0818*
SAMPLE DATE	2/24/17	2/24/17	10/18/17	3/28/18	9/18/18	3/1/18	7/12/18	2/21/17	10/11/17	3/19/18	9/19/18	3/1/18	6/26/18	6/28/18	6/30/18	6/30/18	2/6/18	2/6/18	8/29/18	4/20/18	8/30/18
CHEMICAL NAME																					
Dissolved Wet Chemistry (mg/L)																					
Dissolved organic carbon	NS	NS	**9.4**	NS	NS	NS	NS	NS	**8.9**	NS	NS	NS	NS	NS	NS	NS	NS	NS	**2.3**	NS	**3.4**

Notes:

[a]Depth information from home owner; well log not available.

[b]Depth information very uncertain. Homeowner indicated pump may be at 80 feet bgs. Well log not available.

[c]Most conservative values from regular and field duplicate samples

Detected concentrations are shown in **bold type**.

PFOS/PFOA concentrations that exceed the USEPA Lifetime Health Advisory are shaded gray.

µg/L = microgram(s) per liter

1/cm = reciprocal centimeters

bgs = below ground surface

D - Compound identified in an analysis at a secondary dilution factor.

H = Sample analyzed outside of holding time

ID = identification

J = Analyte present. Value may or may not be accurate or precise

mg/L = milligram(s) per liter

ng/L = nanogram(s) per liter

nm = nanometer(s)

NS = not sampled

U = The material was analyzed for, but not detected

Chemical Name Abbreviations:

EtFOSAA - N-Ethyl Perfluorooctanesulfonamidoacetic Acid

MeFOSAA - N-Methyl Perfluorooctanesulfonamidoacetic Acid

PFBS - Perfluorobutanesulfonic acid

PFDA - Perfluorodecanoic Acid

PFDoA - Perfluorododecanoic Acid

PFHpA - Perfluoroheptanoic acid

PFHxA - Perfluorohexanoic Acid

PFHxS - Perfluorohexanesulfonic acid

PFNA - Perfluorononanoic acid

PFOA - Perfluorooctanoic acid

PFOS - Perfluorooctane Sulfonate

PFTeDA - Perfluorotetradecanoic Acid

PFTrDA - Perfluorotridecanoic Acid

PFUnA - Perfluoroundecanoic Acid

TDS - Total dissolved solids

TSS - Total suspended solids

TUO - Total unspecified organics

Table 2-1. Analytical Data Summary of Affected Off-Base Residential Wells

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

WELL ID	WI-A06-RW08		WI-A06-RW18			WI-A06-RW24	WI-A06-RW19		
LOCATION	Easy Street Residence C		Easy Street Residence D			Easy Street Residence E	Evergreen Mobile Home Park		
WELL DEPTH (feet bgs)	100[a]		Unknown			Unknown	67		
SCREEN INTERVAL (feet bgs)	Unknown		Unknown			Unknown	55 - 65		
SAMPLE ID	*WI-A06-RW08-0218*	*WI-A06-RW08-0918*	*WI-A06-RW18-0418*	*WI-A06-RW18P-0418*	*WI-A06-RW18-0818*	*WI-A06-RW24-1019*[c]	*WI-A06-RW19-0318*	*WI-A06-RW19-0818*	*WI-A06-RW19P-0818*
SAMPLE DATE	2/6/18	9/27/18	4/20/18	4/20/18	8/29/18	10/29/19	3/28/18	8/28/18	8/28/18
CHEMICAL NAME									
Volatile Organic Compounds (µg/L)									
Vinyl chloride	0.04 U	NS	**0.014 J**	0.04 U	NS		0.04 U	NS	NS
Semivolatile Organic Compounds (µg/L)									
1,4-Dioxane	**0.26**	NS	**0.1**	**0.11**	NS		0.029 U	NS	NS
Semivolatile Organic Compounds (ng/L)									
EtFOSAA	5.02 U	4.9 U	4.83 UJ	4.86 U	5.51 U	ND	5.02 U	4.98 U	4.77 U
MeFOSAA	5.02 U	4.9 U	4.83 U	4.86 U	5.51 U	ND	5.02 U	4.98 U	4.77 U
PFBS	**23**	**25.9**	**22.6**	**20.5**	**22**	**29.8**	**64.7**	**64.9**	**68.2**
PFDA	5.02 U	4.9 U	4.83 U	4.86 U	5.51 U	ND	5.02 U	4.98 U	4.77 U
PFDoA	5.02 U	4.9 U	4.83 U	4.86 U	5.51 U	ND	5.02 U	4.98 U	4.77 U
PFHpA	**8.81 J**	**11.3**	**9.21 J**	**11.3**	**11.4**	**8.43 J**	**33.4**	**37.6**	**36.5**
PFHxS	**116**	**103**	**135**	**125**	**87.5**	**429 D**	**233 J**	**22.4**	**24.2**
PFHxA	**15.1**	**18.6**	**26.1**	**29.3**	**27.8**	**49.1**	**61.8**	**69.2**	**67.3**
PFNA	**2.51 J**	**3.4 J**	4.83 U	**1.59 J**	5.51 U	ND	**2.36 J**	4.98 U	4.77 U
PFOS	**78.2**	**95.7**	**44.7**	**43**	**18**	**225**	**75.1**	**73.8**	**80.1**
PFOA	**25.4**	**31.2**	**29.1**	**30.6**	**26.1**	**53**	**44.7**	**45.6**	**48.2**
PFTeDA	5.02 U	4.9 U	4.83 U	4.86 U	5.51 U	ND	5.02 U	4.98 U	4.77 U
PFTrDA	5.02 U	4.9 U	4.83 U	4.86 U	5.51 U	ND	5.02 U	4.98 U	4.77 U
PFUnA	5.02 U	4.9 U	4.83 U	4.86 U	5.51 U	ND	5.02 U	4.98 U	4.77 U
PFOA + PFOS	**103.6**	**126.9**	**73.8**	**73.6**	**44.1**	**278**	**119.8**	**119.4**	**128.3**
Total Metals (mg/L)									
Iron	NS	0.47 U	NS	NS	**0.49 J**		NS	0.47 U	0.47 U
Dissolved Metals (mg/L)									
Aluminum	NS	0.44 U	NS	NS	0.44 U		NS	0.44 U	0.44 U
Calcium	NS	**36**	NS	NS	**39**		NS	**38 J**	**36**
Iron	NS	0.47 U	NS	NS	0.47 U		NS	0.47 U	0.47 U
Magnesium	NS	**45 J**	NS	NS	**45**		NS	**32.1**	**31**
Manganese	NS	**0.22**	NS	NS	**0.081**		NS	0.0068 U	0.0068 U
Potassium	NS	**3.1 J**	NS	NS	**3.5**		NS	**2.9 J**	**2.7 J**
Silicon	NS	**17**	NS	NS	**13**		NS	**15**	**14**
Wet Chemistry (mg/L)									
Alkalinity	NS	**270**	NS	NS	**240**		NS	**200**	**190**
Ammonia	NS	0.3 U	NS	NS	0.3 U		NS	0.3 U	0.3 U
Chloride	NS	**85**	NS	NS	**37**		NS	**23**	**22**
Fluoride	NS	**0.058 J**	NS	NS	0.08 U		NS	0.08 U	0.08 U
Nitrate/Nitrite	NS	**1.7**	NS	NS	0.12 U		NS	**1.63**	**1.6**
Phosphate	NS	0.08 U	NS	NS	0.08 U		NS	0.08 U	0.08 U
Sulfate	NS	**32**	NS	NS	**40**		NS	**27**	**27**
TDS	NS	**64**	NS	NS	**330**		NS	**280**	**280**
TSS	NS	2 U	NS	NS	2 U		NS	2 U	2 U
TUO (254 nm, 1/cm)	NS	**0.050**	NS	NS	**0.056**		NS	**0.023**	**0.029**

Table 2-1. Analytical Data Summary of Affected Off-Base Residential Wells

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

WELL ID	WI-A06-RW08		WI-A06-RW18			WI-A06-RW24	WI-A06-RW19		
LOCATION	Easy Street Residence C		Easy Street Residence D			Easy Street Residence E	Evergreen Mobile Home Park		
WELL DEPTH (feet bgs)	100[a]		Unknown			Unknown	67		
SCREEN INTERVAL (feet bgs)	Unknown		Unknown			Unknown	55 - 65		
SAMPLE ID	*WI-A06-RW08-0218*	*WI-A06-RW08-0918*	*WI-A06-RW18-0418*	*WI-A06-RW18P-0418*	*WI-A06-RW18-0818*	*WI-A06-RW24-1019*[c]	*WI-A06-RW19-0318*	*WI-A06-RW19-0818*	*WI-A06-RW19P-0818*
SAMPLE DATE	2/6/18	9/27/18	4/20/18	4/20/18	8/29/18	10/29/19	3/28/18	8/28/18	8/28/18
CHEMICAL NAME									
Dissolved Wet Chemistry (mg/L)									
Dissolved organic carbon	NS	**3.2**	NS	NS	**3.6**		NS	**2**	**1.8**

Notes:

[a]Depth information from home owner; well log not available.

[b]Depth information very uncertain. Homeowner indicated pump may be at 80 feet bgs. Well log not available.

[c]Most conservative values from regular and field duplicate samples

Detected concentrations are shown in **bold type**.

PFOS/PFOA concentrations that exceed the USEPA Lifetime Health Advisory are shaded gray.

µg/L = microgram(s) per liter

1/cm = reciprocal centimeters

bgs = below ground surface

D - Compound identified in an analysis at a secondary dilution factor.

H = Sample analyzed outside of holding time

ID = identification

J = Analyte present. Value may or may not be accurate or precise

mg/L = milligram(s) per liter

ng/L = nanogram(s) per liter

nm = nanometer(s)

NS = not sampled

U = The material was analyzed for, but not detected

Chemical Name Abbreviations:

EtFOSAA - N-Ethyl Perfluorooctanesulfonamidoacetic Acid

MeFOSAA - N-Methyl Perfluorooctanesulfonamidoacetic Acid

PFBS - Perfluorobutanesulfonic acid

PFDA - Perfluorodecanoic Acid

PFDoA - Perfluorododecanoic Acid

PFHpA - Perfluoroheptanoic acid

PFHxA - Perfluorohexanoic Acid

PFHxS - Perfluorohexanesulfonic acid

PFNA - Perfluorononanoic acid

PFOA - Perfluorooctanoic acid

PFOS - Perfluorooctane Sulfonate

PFTeDA - Perfluorotetradecanoic Acid

PFTrDA - Perfluorotridecanoic Acid

PFUnA - Perfluoroundecanoic Acid

TDS - Total dissolved solids

TSS - Total suspended solids

TUO - Total unspecified organics

Engineering Evaluation/Cost Analysis
Long-term Solutions for Ault Field and
Area 6 Drinking Water
Naval Air Station Whidbey Island
Oak Harbor, Washington

NOTIFICATION: TABLE 2-2 CONTAINS SENSITIVE BUT UNCLASSIFIED INFORMATION WHICH IS PROTECTED BY THE FREEDOM OF INFORMATION ACT

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Table 2-3. Evergreen Mobile Home Park Well Pumping Data - January 2017 through May 2018

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking
Naval Air Station Whidbey Island, Oak Harbor, Washington

Month	Pump Rate (gpm)	Monthly Usage (gal)	Average Daily Usage (gal)	Average per Home per Day (gal)
January 2017	24	83,600	2,039	107
February 2017	24	36,040	1,716	90
March 2017	24	62,850	1,746	92
April 2017	No data	51,210	2,439	128
May 2017	24	67,870	1,885	99
June 2017	24	114,720	4,249	224
July 2017	23	96,450	2,756	145
August 2017	24	93,470	3,338	176
September 2017	24	82,830	2,958	156
October 2017	24	115,090	3,713	195
November 2017	No data	70,360	2,513	132
December 2017	24	60,960	1,966	103
January 2018	24	71,076	2,221	117
February 2018	24	89,550	3,198	168
March 2018	24	71,220	2,456	129
April 2018	24	60,600	2,244	118
May 2018	23	88,540	2,459	129

Notes:
Pump rate, monthly usage, and average daily usage data in this table represent water service to 19 homes.
gal = gallon(s)
gpm = gallon(s) per minute

R:\ENBG\00_Proj\N\Navy\CLEAN\MULTI_REGION\PFC_679580\MapFiles\NW\Whidbey_NAS\CTO4041\Coupeville\WaterSystem\Figure_2-1_AF_Base_Reference_Map.mxd12/19/2018SSAVAGE1

Legend
- City
- Secondary Road
- Local Connecting Road
- Important Local Road
- Area 6 Boundary
- Base Boundary

N

0 0.75 1.5 3 Miles

1 inch = 1.5 miles

Figure 2-1
Ault Field Base Reference Map
Naval Air Station Whidbey Island
Oak Harbor, Washington

DRAFT

Engineering Evaluation/Cost Analysis
Long-term Solutions for Ault Field and
Area 6 Drinking Water
Naval Air Station Whidbey Island
Oak Harbor, Washington

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SECTION 3

Identification of Objectives

3.1 Removal Action Objective and Scope

3.1.1 Removal Action Objective

The removal action objective (RAO) in this EE/CA addresses current human receptors ingesting groundwater used as drinking water at levels above the Health Advisory for PFOA and/or PFOS. Therefore, the RAO only applies to the eight private drinking water wells associated with drinking water at Ault Field Residences 1 and 2, the five Easy Street Residences, and the 19 Evergreen Mobile Home Park units. The RAO is as follows:

- Protect current human receptors from ingestion of PFOA and/or PFOS at levels that exceed the Health Advisory level in groundwater used as drinking and cooking water.

To meet the RAO, the following preliminary remediation goal (PRG) was established:

- Reduce receptor exposure to PFOA and/or PFOS to a cumulative concentration of less than the Health Advisory of 70 ng/L through treatment and/or provision of an alternative water supply.

The PRG was established based on the Health Advisory since there are no SDWA maximum contaminant levels, nor any Clean Water Act ambient water quality criteria for protection of human health for any PFAS.
For contaminants not subject to any national primary drinking water regulation, the SDWA authorizes USEPA to publish nonregulatory Lifetime Health Advisories or take other appropriate actions. These Lifetime Health Advisories are created to assist state and local officials in evaluating risks from these contaminants in drinking water. In May 2016, the USEPA issued a Health Advisory for two PFAS, specifically PFOA and PFOS. The USEPA Health Advisory only applies to PFOA and PFOS, and USEPA does not advocate applying these levels to any other PFAS. Additionally, no applicable or relevant and appropriate requirements (ARARs) currently exist from either the USEPA or Washington State relative to PFAS exposure through drinking water.

3.1.2 Removal Action Scope

This EE/CA is intended to address current receptor exposure to PFOA and PFOS in drinking water for the eight off-Base private drinking water wells near NAS Whidbey Island's Ault Field (including Area 6). Additional action may be necessary to address PFOA and PFOS concentrations in groundwater, soil, surface water, and sediment within and around the installation. However, these impacts are not included in this removal action scope.

Removal action alternatives were scoped and developed to meet the RAO previously listed after a technology screening process. A preliminary screening of potential remedial technologies was performed before selecting alternatives for the EE/CA. The preliminary screening of technologies is included in **Table 3-1**. Remedial technologies and process options retained after screening were used to assemble removal action alternatives for this EE/CA. The scope of the engineering measures for each removal action that is retained for further evaluation as an alternative is defined as follows:

1. No Further Action: No further action would be conducted, and the site would remain "as is." Thus, bottled water and/or POU treatment systems would continue to be provided to affected off-Base residences where drinking water contains PFOA and/or PFOS concentrations above the Health Advisory. This action is applicable to all four site groupings (Ault Field Residence 1, Ault Field Residence 2, Easy Street Residences, and Evergreen Mobile Home Park).
2. POE Treatment: This action alternative would address PFOA and PFOS in groundwater before the potable water supply enters the distribution piping for the house. This is associated with residences where drinking water wells have PFOA and/or PFOS concentrations greater than the Health Advisory. The following two

treatment technologies are being considered under this alternative (reverse osmosis and nanofiltration were screened out as indicated in **Table 3-1**):

a. GAC Treatment – This action would include the installation and continued maintenance of GAC treatment systems configured to remove PFOA and/or PFOS from the well water supply.

b. IX Treatment – Installation and continued maintenance of IX vessels configured to remove PFOA and/or PFOS from the well water supply.

This alternative is evaluated for single-family residences (including Ault Field Residence 1, Ault Field Residence 2, and the Easy Street Residences), and the Evergreen Mobile Home Park, which currently supplies 19 mobile home park units (but could serve up to 21 units) and requires a larger capacity treatment system than a single-family residence well.

3. Connection to Navy or Public Water Supply: This action alternative would address PFOA and/or PFOS impacts by supplying each impacted residence from a Navy or municipal/community water system that can provide an alternate water supply that maintains PFOA and/or PFOS levels below the Health Advisory. Potential Navy or public water supply connections are residence-dependent and include the following different alternatives:

   a. Ault Field Residence 1: City of Oak Harbor water system line, with the connection made and maintained by the Navy under an agreement with the City of Oak Harbor.

   b. Ault Field Residence 2: Two public water supply connection options are evaluated: (1) connection to a nearby Navy system water line (originating from City of Oak Harbor water line), north of the property, and (2) connection to Pine Terrace Water System, about one mile east of property.

   c. Easy Street Residences: City of Oak Harbor water main extension and system supply connections for each of the five homes.

   d. Evergreen Mobile Home Park: City of Oak Harbor water main extension and system supply connection into the existing onsite water supply piping network feeding each residence.

4. New (Replacement) Drinking Water Well: This action alternative would provide replacement drinking water wells for the existing drinking water wells that have concentrations of PFOA and/or PFOS above the Health Advisory. The new drinking water wells would serve as replacement water sources for each impacted residence, if drilled and screened in an appropriate aquifer not impacted by PFOA and/or PFOS above the Health Advisory and not hydraulically connected to the impacted well. The potential new drinking water well option applicability is residence-specific and includes the following groupings:

   a. Ault Field Residence 1: Conversion of the new, deeper monitoring well on the property to a drinking water supply well. Routine monitoring would be required.

   b. Ault Field Residence 2: Conversion of the new monitoring well on the property is not a viable drinking water source because aquifer testing results showed the new monitoring well (MW-615) had detections of PFOA and PFOS and was hydraulically connected to the existing impacted drinking water well.

   c. Easy Street and Evergreen Mobile Home Park Residences: Additional evaluation and field data collection is required to assess the viability of this alternative for these locations; therefore, costing of the work needed to decide on the effectiveness of this alternative for these areas is considered.

3.2 Determination of Removal Schedule

This EE/CA will be made available for a 30-day public comment period. Notice of its availability for public review, along with a summary of the EE/CA, will be published in the *Whidbey News-Times*. The public comment period will be scheduled following approval of the EE/CA. A public information session will be held if sufficient interest is expressed by the public and will take place during or immediately following the public comment period. If public comments are received during the public comment period, a Responsiveness Summary documenting the Navy's responses to significant comments will be prepared and included in the Action Memorandum, which will also

require a public comment period. If additional public comments are received on the Action Memorandum, then they will also be included in the Responsiveness Summary. The Action Memorandum and EE/CA will be placed in the Administrative Record for NAS Whidbey Island.

Because this removal action has been designated as non-time-critical, the start date of the removal action will be determined by factors other than the immediate urgency of the threat. Possible factors include weather, availability of resources, and site constraints. The total project period is anticipated to last 16 months from the beginning of the public comment period to completion of the associated construction completion documentation.

Critical milestone periods for the removal action are as follows:

- EE/CA public comment period—30 days.
- Action Memorandum public comment period – 30 days.
- Site-specific POE treatment laboratory study (if the POE option is selected; applicable to Alternative 2 only) – 10 to 12 months.
- Design, work plan, subcontracting, and mobilization—0 weeks for Alternatives 1a and 1b; 2 to 4 months for Alternative 4a (specific to Ault Field Residence 1); and 6 to 12 months for Alternatives 2a and 2b, Alternatives 3a through 3e; 12 to 18 months for Alternative 4b (specific to Evergreen Mobile Home Park and Easy Street Residences because of the need for monitoring well installation and aquifer testing to verify alternative viability).
- Removal action construction—0 weeks for Alternatives 1a and 1b; about 1 months for Alternative 4a, specific to Residence 1; about 3 months for Alternatives 2a and 2b; up to 6 months for Alternatives 3a through 3e; and up to 18 months for Alternative 4b.
- CERCLA documentation—Up to 6 months.
- Performance monitoring—Until PFAS on-Base remedial action eliminates the source and all PFOA and/or PFOS concentrations fall below the Health Advisory in off-Base groundwater for Alternatives 1, 2a, 2b, and 4 (assumed to be 30 years for costing purposes).

3.3 Potential Applicable or Relevant and Appropriate Requirements

Actions taken to address contamination under CERCLA must comply with substantive requirements of local, state, and federal regulations. Therefore, the EE/CA process requires a review and identification of ARARs which are to be considered during remedy implementation.

As identified above, no ARARs currently exist from either the USEPA or Washington State relative to PFAS exposure through drinking water. During the EE/CA process, CERCLA requires that potential ARARs be reviewed and identified for removal actions conducted in accordance with the Installation Restoration Program and CERCLA programs at United States Department of Defense installations. ARARs are the basis for the development of RAOs for a site and include the laws, regulations, standards, criteria, and requirements that may apply to potable water supply alternatives developed for the off-Base private drinking water wells near Ault Field and Area 6. ARARs in this EE/CA are limited to remedies to address groundwater used as drinking water.

The ARARs identification process[3] reviews substantive standards of promulgated regulations pertaining to each removal action that is retained for further evaluation as an alternative proposed in this EE/CA. CERCLA Section 121(d) requires, with exceptions, that any promulgated substantive applicable or relevant and appropriate standard, requirement, criterion, or limitation under any federal environmental law, or any more stringent state

[3] The ARARs identification process is based on CERCLA Section 121(d) and USEPA guidance (EPA/540/G-89/004; EPA/540/G-89/006, *CERCLA Compliance with Other Laws Manual: Interim Final*; EPA/540/G-89/009, *CERCLA Compliance with Other Laws Manual: Part II. Clean Air Act and Other Environmental Statutes and State Requirements*).

requirement pursuant to a state environmental statute, be met (or a waiver justified) for any hazardous substance, pollutant, or contaminant that will remain onsite after completion of remedial action. Additionally, 40 CFR 300.435(b)(2) requires that ARARs be attained (unless waived) during the remedial action (for example, during construction and operation).

3.3.1 Regulatory Setting

PFOA and PFOS are not currently identified as CERCLA hazardous substances; however, application of CERCLA criteria suggests that it is appropriate to consider them to be CERCLA pollutants and/or contaminants as the Navy has provided alternative drinking water where USEPA's Health Advisory levels have been exceeded (Navy, 2018c).

There are no promulgated federal, chemical-specific ARARs for PFOA and/or PFOS presence in drinking water. Currently, PFOA and/or PFOS are classified as unregulated or "emerging" contaminants, which have no SWDA regulatory standards. In the absence of ARARs, cleanup levels are based upon "…other reliable information…" (See 40 CFR § 300.430(e)(2)(i)). Reliable information is derived from other to-be-considered criteria, advisories or guidance (40 CFR § 300.400(g)(3)). In May 2016, USEPA's Office of Water issued a Health Advisory for PFOA and/or PFOS at 70 ng/L (USEPA, 2016). This Health Advisory is believed to offer a margin of lifetime protection from adverse health effects resulting from exposure to PFOA and/or PFOS in drinking water (USEPA, 2016). Health Advisory levels are health-based concentrations above which the USEPA recommends action should be taken to reduce exposure to unregulated contaminants in drinking water. Therefore, in the absence of an ARAR, the Health Advisory value can be used as a trigger level to justify an appropriate response action.

3.3.2 ARARs Evaluation Process

Under CERCLA, ARARs consist of two sets of requirements:

1. Those promulgated substantive standards that would be applicable requirements if the remediation were not being conducted under authority of CERCLA.
2. Those substantive standards that are relevant and appropriate requirements of promulgated environmental regulations.

Only the substantive requirements (for example, use of control/containment equipment, compliance with numerical standards) associated with ARARs apply to CERCLA onsite activities. ARARs associated with administrative requirements, such as permitting, are not applicable to CERCLA onsite activities (CERCLA, Section 121(e)(1), "Cleanup Standards," "Permits and Enforcement.").

USEPA has affirmed that ARARs do not include occupational safety or worker protection requirements although compliance with the Occupational Safety and Health Administration standards and other worker protection requirements in 40 CFR 300.150 of the NCP, is necessary, but it is not through the ARARs process (55 FR 8679, March 8, 1990).

A requirement or cleanup standard under state and federal law may be either "applicable" or "relevant and appropriate," but not both. Applicable and relevant and appropriate are defined according to the NCP (40 CFR 300.5) as follows:

- "Applicable" requirements are those substantive standards that specifically address the situation at a CERCLA site and would legally apply to remedial actions in the absence of CERCLA authority. All jurisdictional prerequisites of the requirement must be met for the requirement to be applicable, including specific application to federal agencies (for example, through a waiver of federal sovereign immunity). Applicable requirements are those cleanup standards, standards of control, or other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by the state in a timely manner and that are more stringent than federal requirements may be applicable.

- "Relevant and appropriate" requirements mean those environmental requirements such as cleanup standards that address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site (40 CFR 300.400(g)(2)). Relevant and appropriate requirements are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations that are promulgated under federal or state environmental or facility siting laws that, while they may not be "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to a particular site.

Potential ARARs for the actions to be taken to address PFOA and/or PFOS concentrations greater than the USEPA Health Advisory in off-Base residential drinking water wells near NAS Whidbey Island were examined to determine if they fall into one of three categories defined by USEPA guidance:

- **Chemical-specific ARARs** are health or risk-based concentration limits or ranges for particular chemicals that may be found in, or discharged to, the ambient environment.
- **Action-specific ARARs** are requirements that govern particular technologies or activities. They typically set performance, design, or other similar action-specific controls or restrictions on particular kinds of activities.
- **Location-specific ARARs** are requirements that apply based on the location of the site (for example, wetlands, floodplains, historic areas, native burial areas, and wildlife refuges) or siting restrictions (for example, industrial versus residential properties and native versus disturbed land).

In summary, an environmental requirement is applicable if the specific terms or jurisdictional prerequisites of a law or regulation directly address the circumstances at the site. If not applicable, an environmental requirement may nevertheless be relevant and appropriate if circumstances at the site are, based on best professional judgment, sufficiently similar to the problems or situations regulated by the requirement and the requirement's use is well suited to the site.

CERCLA also provides for the identification of to-be-considered (TBC) standards, which are not legally enforceable and are not ARARs. TBCs are nonpromulgated guidance or advisories established by federal or state agencies and may also be identified to assist in implementing ARARs. In some circumstances, TBCs may be considered along with ARARs in determining the remedial action necessary for protection of human health and the environment. Some TBC information can complement ARARs in determining protectiveness at a site or implementation of certain actions. For example, because soil cleanup standards do not exist for all contaminants, screening levels, which that are TBCs, may be helpful in defining suitable remedial action goals.

3.3.3 Potential ARARs Identified for Off-Base Residential Drinking Water Wells near NAS Whidbey Island

Table 3-2 presents potential federal and Washington State ARARs. The final remedy selection for the drinking water wells will be documented in an Action Memorandum.

3.4 General Disposal Requirements

Waste disposal procedures implemented for the removal action will be in accordance with the state and federal laws and regulations that govern offsite disposal. For the purposes of this EE/CA, the cost estimates assume that any spent treatment media (for example, GAC and IX resin), and any PFAS-impacted groundwater can be managed and characterized as nonhazardous and PFAS-containing. Soils excavated under Alternative 3a-e, connection to city water, and drill cuttings under Alternative 4b are assumed for cost estimating purposes to be characterized as nonhazardous. Waste characterization testing will be conducted in accordance with the requirements of state and federal regulations. Used GAC and IX material may be taken offsite for regeneration and/or reactivation, based on approval by the Navy. However, it is likely IX material will need to be disposed of (by incineration) rather than regenerated. Nonhazardous waste, including PFAS-impacted soils, will be disposed of in a state-permitted disposal facility that is approved by the Navy, and is permitted to accept CERCLA waste generated during the selected

removal action (Navy, 2017b). The CERCLA Off-Site Rule (40 CFR 300.440) would be applicable to CERCLA wastes shipped for off-site disposal from the removal action.

3.5 Public Water System and Supply Considerations

Potential removal actions considered under Alternative 3, including sub-alternatives 3a through 3e, involve making new water supply connections to area Navy and/or public water systems, including the City of Oak Harbor, NAS Whidbey Island, and/or the Pine Terrace Water Association water systems. General background information relative to each of these water systems along with a summary of relevant considerations is provided herein.

3.5.1 City of Oak Harbor Water System

As detailed in its 2014 City Water System Plan (Gray & Osborne, Inc., 2014), the City of Oak Harbor water system provides municipal water supply and utility service to retail and wholesale customers within and adjacent to its city limits and designated water service area. The system receives wholesale water supply from the City of Anacortes regional water system supported via a surface water intake and water treatment plant located along the Skagit River near the City of Mount Vernon. City of Oak Harbor wholesale water supply customers include NAS Whidbey Island, the North Whidbey Water District, and Deception Pass State Park water systems.

The 2014 City of Oak Harbor Water System Plan documents the existing and future service areas for its water system. The Evergreen Mobile Home Park water system and the Easy Street Residences are located within the Oak Harbor City Limits and within the future City water service area.

The 2014 City Water System Plan (Gray & Osborne, Inc., 2014) details planning considerations and requirements related to operations and development of its water system. Alternatives involving new connections and extensions to provide water supply would need to conform to City of Oak Harbor requirements, as detailed in the Water System Plan, City codes and ordinances, and associated water utility policies. This includes established standards and codes relating to water mains, water service lines, water meters, backflow prevention, and fire hydrants.

3.5.2 Naval Air Station Whidbey Island Water System

The NAS Whidbey Island water system receives supply as a wholesale customer of the City of Oak Harbor system via the City of Anacortes regional supply system, as described previously. NAS Whidbey Island policy is normally to not provide water to customers outside the military reservation. The Navy is, however, currently providing service to a small number of nonmilitary customers adjacent to the boundaries of the military reservation. These services were extended on an individual basis, as allowed by US Code Title 10-2686 because no other source of potable water was available to these customers. Services to these customers are through metered connections and are billed on a unit volume basis by the City of Oak Harbor at City residential rates, with the unit volume credited to the Navy at the wholesale rate (Navy, 2014). The NAS Whidbey Island water system operates with a primary supply feed from the Oak Harbor Water System and Anacortes regional supply pipelines located along Forrestal Avenue near Charles Porter Avenue. Pine Terrace Water System

The Pine Terrace Water Association water system provides service to approximately 70 residences and customers located south of NAS Whidbey Island and northwest of Oak Harbor. The Pine Terrace Water System is located outside of the Oak Harbor city limits but is located inside the future City of Oak Harbor water service area. As the City of Oak Harbor and its water system expands with new growth and development, the Pine Terrace Water Association anticipates that its water system will eventually be absorbed into and made part of the City of Oak Harbor system. To this end, the Water Association has sought to develop its water system infrastructure consistent with City of Oak Harbor utility standards and requirements.

Table 3-1. Screening of Remedial Technologies for Ault Field and Area 6 Drinking Water

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking
Naval Air Station Whidbey Island, Washington

General Response Action	Remedial Technology	Process Options	Description	Ault Field		Area 6		Primary Screening Comments
				Retain	Reject	Retain	Reject	
No Further Action	No Further Action	Continue current TCRA actions	No further action to address contaminated drinking water. Continue current use of bottled water or single POU treatment unit, as applicable.	X		X		Required for EE/CA evaluation as a point of comparison.
Institutional Controls	Administrative Restrictions or Engineering Controls	LUCs	LUCs are implemented for property within potentially contaminated areas to restrict property use, well installation, and other intrusive activities.		X		X	The Navy does not own impacted properties off-Base and will not restrict land use on these properties.
Water Treatment (Ex Situ)	GAC Adsorption	Wellhead or POE Treatment	Water is treated at the wellhead or POE to each household using GAC. GAC adsorption is a well-established technology for removing PFOA and PFOS from drinking water. Water is passed through GAC beds to remove PFAS via adsorption to the media, normally using two or more GAC vessels in series. POE-scale equipment and suppliers are readily available; the appropriate GAC must be obtained from a GAC supplier. Monitoring is conducted at midpoint and final effluent locations to determine when the GAC is spent and to verify treatment effectiveness. GAC has a finite lifespan, and must be removed/managed as a waste material when its effective treatment capacity is exhausted, and replaced with fresh GAC. Spent GAC can be reactivated offsite through thermal desorption, resulting in ultimate destruction of the PFOA/PFOS.	X		X		The GAC adsorption technology is well established and demonstrated for treatment of PFOA/PFOS and is currently the most widely used technology for PFOA/PFOS removal. The POE process option allows treatment of all household water in one small-scale treatment system. Periodic replacement and management (via offsite disposal and/or reactivation) of used GAC is required for this technology. The GAC/POE technology/process option is retained for further evaluation.
		POU Treatment	Water is treated to remove PFOA/PFOS at the POU (e.g., under kitchen sink) for potable purposes (i.e., for cooking and drinking) via GAC adsorption. The mode of treatment is the same as in a GAC POE system, but the units are considerably smaller. Although "off-the-shelf" GAC POU units may not be ideal for PFOA/PFOS treatment (e.g., insufficient GAC quantity, inappropriate GAC type, lack of intermediate sampling points), effective POU systems can be easily assembled from readily available vessels and an appropriate GAC type by commercial suppliers. These units have a finite lifespan, and the GAC must be replaced when its effective treatment capacity is exhausted.		X		X	GAC adsorption is demonstrated to be effective for PFOA/PFOS treatment. POU GAC equipment is readily available and easily installed, but multiple POU systems per residence would be required to ensure protectiveness. Despite installing multiple POU units throughout the house at different water outlets, it would not be a practical solution as these units have limited treatment capacity (i.e., only good for a fixed volume of water treated), need appropriate contact time with GAC for the treatment to be effective and only can produce water at a certain flow rate. In addition, POU units are not practical to use with showers (where unintended water ingestion is possible). Like all GAC systems, periodic replacement and disposal of spent GAC would be required as part of this technology/process option. For these reasons, the GAC POU technology/process option is not retained.
		On-Base or Off-Base Centralized Treatment Plant	Potable water is supplied from a centralized treatment plant built and maintained by the Navy. The treatment plant would use GAC adsorption for removal of PFOA/PFOS, as described above.		X		X	GAC is an effective technology for removing PFOA/PFOS constituents. However, building a water plant off-Base to support residents is not feasible because the Navy does not own property off-Base. Supplying off-base residents with water from on-Base also is not typically advisable as water supply is not within the Navy's mission and the potential exists for future emerging contaminants to be discovered that the Navy would then be responsible for as a water supplier. For Ault Field there are only two affected properties, which are several miles apart, and a centralized treatment plant would not be cost effective. For Area 6, the affected properties are within the future water service area of the City of Oak Harbor and this would preclude developing a new community water system here for centralized treatment. For these reasons, this option was not retained for further evaluation.
	IX	Wellhead or POE Treatment	Water is treated at the wellhead or POE using IX. IX has been shown to be effective for removal of PFAS, although it is not as well-demonstrated as GAC adsorption. Water is passed through beds of IX resin, normally using at least two vessels in series, where PFAS compounds exchange with non-toxic ions on the resin surface. The PFAS remain in the resin, while the non-toxic ions exit with the effluent water. POE-scale equipment and suppliers are readily-available; the appropriate IX resin must be obtained from a resin supplier. Monitoring is conducted at midpoint and final effluent locations to determine when the IX capacity is spent and to verify treatment effectiveness. While regeneration of the IX resin is theoretically possible, it is highly unlikely that it would be practical for a POE system (because management/disposal of regenerant-containing concentrated PFAS, brine, and any solvent used is problematic). Rather, the IX resin would likely be used until its effective capacity is exhausted, and then removed for proper disposal and replaced with fresh resin.	X		X		The use of IX to remove PFOA/PFOS is an emerging and promising technology. Bench and/or pilot testing might be warranted for selection of appropriate IX resin, and to develop design and operating information. The POE process option allows treatment of all household water in one small-scale treatment system. Periodic replacement and disposal of spent IX resin is a requirement for this technology/process option. The IX/POE technology/process option is retained for further evaluation.

Table 3-1. Screening of Remedial Technologies for Ault Field and Area 6 Drinking Water

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Washington

General Response Action	Remedial Technology	Process Options	Description	Ault Field		Area 6		Primary Screening Comments
				Retain	Reject	Retain	Reject	
Water Treatment (Ex Situ) (con't)	IX (con't)	POU Treatment	Water is treated to remove PFOA/PFOS at the POU (e.g., under kitchen sink) for potable purposes (i.e., for cooking and drinking) via IX. The mode of treatment is the same as in an IX POE system, but the units are considerably smaller. Although "off-the-shelf" IX POU units are not available, they could be assembled using readily available contact vessels and the appropriate IX resin by commercial suppliers. These units have a finite lifespan, and the IX resin must be replaced when its effective treatment capacity is exhausted.		X		X	IX has been shown to be effective for PFOA/PFOS treatment but is less thoroughly demonstrated and widely used than GAC adsorption, so bench-and/or pilot-testing might be warranted. Multiple POU systems per residence would be required to ensure protectiveness. Despite installing multiple POU units throughout the house at different water outlets, it would not be a practical solution as these units have limited treatment capacity (i.e., only good for a fixed volume of water treated), need appropriate contact time with resins for the treatment to be effective and only can produce water at a certain flow rate. Periodic replacement and disposal of spent IX resin would be required as part of this technology/process option. In addition, POU units are not practical to use with showers (where unintended water ingestion is possible). For these reasons, the IX POU technology/process option is not retained.
		On-Base or Off-Base Centralized Treatment Plant	Potable water is supplied from a centralized treatment plant built and maintained by the Navy. The treatment plant would use IX, as described above.		X		X	IX is potentially an effective technology for removing PFOA/PFOS constituents. However, since it is less thoroughly demonstrated and widely used than GAC, a bench-and/or pilot testing might be warranted. In addition, building a water plant off-Base to support residents is not feasible because the Navy does not own property off-Base. Supplying off-Base residents with water from on-Base is also not typically advisable as water supply is not within the Navy's mission and the potential exists for future emerging contaminants to be discovered that the Navy would then be responsible for as a water supplier. For Ault Field there are only two affected properties, which are several miles apart, and a centralized treatment plant would not be cost effective. For Area 6, the affected properties are within the future water service area of the City of Oak Harbor and this would preclude developing a new community water system here for centralized treatment. For these reasons, this option was not retained for further evaluation.
	RO or NF	Wellhead or POE Treatment	Water is treated at the wellhead or POE to each household using RO or NF. RO and NF differ in the size of molecule removed from water, with RO capable of removing smaller ions. The RO technology is well-demonstrated for PFOA/PFOS treatment; NF is less proven, although it offers the potential for reduced fouling. Both technologies are membrane separation methods where high pressure is applied to push a clean water (permeate) stream through a semi-permeable membrane, leaving contaminants behind in a concentrated (reject) stream. POE-scale equipment and suppliers are readily available. The high volume reject stream, as well as other membrane cleaning solutions, must be managed/disposed of. Pre-treatment of the water would be needed because of high calcium carbonate and iron and manganese in the well water.		X		X	The RO technology has been shown to be very effective for removal of PFOA/PFOS with very little potential for treatment failure. NF is less well-demonstrated, and may warrant pilot testing to verify performance. POE-scale RO equipment is commercially available, and the POE process option allows treatment of all household water in one small-scale treatment system. The main drawback of membrane separation technologies is that they generate a considerable volume of liquid residuals (reject stream and cleaning solutions) that must be managed, probably requiring off-site disposal, and this may not be practical or cost-effective. In addition, RO or NF would require pre-treatment to remove fouling and scaling substances. Because of the known need for costly well water pre-treatment for this option, as well as the disposal of significant volumes of residuals, this option is not retained (GAC and IX provide more cost-effective options that have similar effectiveness).
		POU Treatment	Water is treated to remove PFOA/PFOS at the POU (e.g., under kitchen sink) for potable purposes (i.e., for cooking and drinking) via RO or NF. The mode of treatment is the same as in a RO POE system, but the units are considerably smaller. RO POU units are readily available from commercial suppliers. The membrane units have a finite lifespan and must be replaced periodically. RO POU units generate a concentrated reject stream that must be managed properly (RO POU units used for purposes other than PFOA/PFOS removal typically discharge reject to the drain, but this probably would not be allowed for the present application).		X		X	RO is demonstrated to be effective for PFOA/PFOS treatment. NF is less well-demonstrated. POU-scale RO equipment is readily available and easily installed by commercial suppliers, but multiple POU systems per residence would be required to ensure protectiveness. Despite of installing multiple POU units throughout the house at different water outlets, it would not be a practical solution as these units have limited treatment capacity (i.e., good for a fixed volume of water treated) and only can produce water at a certain flow rate. Also, maintaining sufficient pressure and flow rates through RO POU systems may require additional feature, such as a water storage tanks or booster pump, which may add to the size of these systems. RO normally requires pre-treatment to remove fouling substances. In addition to periodic disposal of the filter cartridge, the RO and NF process options generate a high-volume liquid waste stream that must be properly managed, probably via offsite disposal. In addition, POU units are not practical to use with showers (where unintended water ingestion is possible). For these reasons, the RO POU technology/process option is not retained.

Table 3-1. Screening of Remedial Technologies for Ault Field and Area 6 Drinking Water

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Washington

General Response Action	Remedial Technology	Process Options	Description	Ault Field		Area 6		Primary Screening Comments
				Retain	Reject	Retain	Reject	
Water Treatment (Ex Situ) (con't)	RO or NF (con't)	On-Base or Off-Base Centralized Treatment Plant	Water would be supplied from a centralized treatment plant built and maintained by the Navy. The treatment plant would use RO filtration, as described above.		X		X	RO is an effective technology for removing PFOA/PFOS constituents. However, building a water plant off-Base to support residents is not feasible because the Navy does not own property off-Base. Supplying off-Base residents with water from on-Base is also not typically advisable as water supply is not within the Navy's mission and the potential exists for future emerging contaminants to be discovered that the Navy would then be responsible for as a water supplier. For Ault Field, there are only two affected properties that are several miles apart, and a centralized treatment plant would not be cost effective. For Area 6, the affected properties are within the future water service area of the City of Oak Harbor and this would preclude developing a new community water system here for centralized treatment. For these reasons, this option was not retained for further evaluation.
Alternate Water Supply	City or Community Water Supply Lines	Extend water supply from Navy on-Base line to Residence 2	Residential water supply would be connected to the on-Base Navy water line (which receives wholesale water supply from City of Oak Harbor water system) running just north of Residence 2. The Navy would need to establish a water use agreement with the resident.	X		NA		While supplying an alternate water source would not result in reduction of toxicity, mobility, or volume of contaminants in groundwater beneath the property, it would prevent drinking/domestic water supply exposure to PFOA/PFOS without uncertainty. City of Oak Harbor water supplies to the Navy water line is from a surface water source and has been determined to be non-detect for PFOA and PFOS. Hence this option is retained for further evaluation.
		Extend water supply from Pine Terrace line to Residence 2	Residential water supply would be connected to the Pine Terrace community water supply line running east of Residence 2.	X		NA		While supplying an alternate water source would not result in reduction of toxicity, mobility, or volume of contaminants in groundwater beneath the property, it would prevent drinking/domestic water supply exposure to PFOA/PFOS. The Pine Terrace Water Company water supply (two wells) were sampled in December 2016. The results show that PFOA, PFOS, and PFBS are non-detect in this water supply as of the sampling date. Hence this option is retained for further evaluation.
		Extend water supply from on-Base City of Oak Harbor line to Residence 1	Residential water supply would be connected from the on-Base City of Oak Harbor line (located 1 mile west) to Residence 1. The Navy would need to establish a water use agreement with the City of Oak Harbor, purchase the water, and supply water to the residence.	X		NA		While supplying an alternate water source would not result in reduction of toxicity, mobility, or volume of contaminants in groundwater beneath the property, it would prevent drinking/domestic water supply exposure to PFOA/PFOS without uncertainty. City of Oak Harbor water is from a surface water source and has been determined to be non-detect for PFOA and PFOS. Hence this option is retained for further evaluation.
		Extend water supply from Sleeper Farm Community Well to Residence 1	Residential water supply would be connected from the Sleeper Farm Community well to Residence 1 (well located just south of this residence).		X	NA		The Sleeper Farm community well has detections of PFAS (about 0.030 µg/L PFOA). Adding an additional home to this community drinking water well, which is currently a Group B water system, will require it to be upgraded to a Group A water system because it will service more than 25 people. The well does not currently meet Group A water system requirements. Adding an additional residence to the well would require increased pumping which could also increase the PFAS concentrations, potentially above the USEPA Lifetime Health Advisory (this would require additional PFAS plume nature and extent study to evaluate). Additional hydraulic testing would be needed at this well to evaluate if the well could supply enough water volume to add an additional residence. This hydraulic testing could also increase PFAS concentrations in this well. There are also water pressure problems with the current system that would need to be addressed before adding another residence. Because there is risk of increasing PFAS contamination (both from the hydraulic testing evaluation and the increased pumping needed to add an additional residence), and because there are other appropriate water supply options available for this residence, this alternative was not retained.
		Extend water supply from City of Oak Harbor to affected off-Base Area 6 residences	Residential water supply would be connected from the City of Oak Harbor to the affected off-Base Area 6 residences from nearby water lines. The Navy would need to facilitate water supply agreements with the City of Oak Harbor and install water system piping and supply connection improvements such that the Oak Harbor system would then supply water to the residences.	NA		X		While supplying an alternate water source would not result in reduction of toxicity, mobility, or volume of contaminants in groundwater beneath the property, it would prevent drinking/domestic water supply exposure to PFOA/PFOS without uncertainty. City of Oak Harbor water is from a surface water source and has been determined to be non-detect for PFOA and PFOS. Hence this option is retained for further evaluation. The off-Base Area 6 residences are within the future service area of the City of Oak Harbor water district.

Table 3-1. Screening of Remedial Technologies for Ault Field and Area 6 Drinking Water

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Washington

General Response Action	Remedial Technology	Process Options	Description	Ault Field		Area 6		Primary Screening Comments
				Retain	Reject	Retain	Reject	
Alternate Water Supply(con't)	Groundwater Well Conversion at Residence 1	Use the newly drilled monitoring well at Residence 1 in a deeper, unimpacted aquifer as a new drinking water well	The new, deeper monitoring well installed at Residence 1 (MW-611), will be evaluated for use as a new drinking water well.	X		NA		The new, deeper monitoring well meets State and County drinking water well construction standards and could be converted/permitted as a household drinking water well. The initial water samples from this new well were nondetect for PFOA/PFOS. Aquifer testing indicates there is no hydraulic connection between the current drinking water well and the new monitoring well at Residence 1. Additional evaluation will be needed to identify if PFOA/PFOS would remain below the USEPA Lifetime Health Advisory if it is pumped long-term for water supply. The retention of this remedial option in the EE/CA will follow a decision tree as additional data is collected (see **Figure 4-10**). Hence this option is retained for further evaluation.
	Groundwater Well Conversion at Residence 2	Use the newly drilled monitoring well at Residence 2 as a new drinking water well	The new monitoring well installed at Residence 2 (MW-615), will be evaluated for use as a new drinking water well.		X	NA		The new monitoring well meets State and County drinking water well construction standards and could be converted/permitted as a household drinking water well. The initial water samples from this new well had detections of PFOA/PFOS below the USEPA Lifetime Health Advisory. Aquifer testing indicates there is a hydraulic connection between the current drinking water well and the new monitoring well at Residence 2 and the potential for increased PFOA/PFOS concentrations with prolonged pumping. Using the decision-tree shown in **Figure 4-10**, this option is rejected.
	Drill New Drinking Water Wells	Drill new drinking water wells in a deeper, unimpacted aquifer for Evergreen Mobile Home Park and Easy Street Residences	New monitoring wells could be drilled in a deeper aquifer on each affected Area 6 off-Base parcel and evaluated for use as a new drinking water well.	NA		X		Available geology and PFAS data in the vicinity of the affected Area 6 off-Base parcels suggests PFAS contamination may be limited to the shallow and/or mid-level aquifer and that a confining layer may exist between these shallower aquifers and the deeper (sea-level) aquifer. Additional field data would need to be collected in the area to evaluate this option (including drilling a deeper well and performing an aquifer test). The retention of this remedial option in the EE/CA will follow a decision-tree as additional data is collected (see **Figure 4-10**). The new well option is retained for further evaluation for Area 6.
	Drill New Community Water Supply Well	Drill and use a new community drinking water well for off-Base Area 6 residences	Water would be supplied from a new community well central to the affected Area 6 off-Base residences. This would either maintained by the Navy or a third party. This is only applicable to Area 6 where the affected parcels are clustered together.	NA			X	Drilling and maintaining a new community drinking water well (Group A) is not feasible because the Navy does not own property off-Base. Water supply is not within the Navy's mission and the potential exists for future emerging contaminants to be discovered that the Navy would then be responsible for as a water supplier. For Area 6, the affected properties are within the future water service area of the City of Oak Harbor and this would preclude developing a new community water system here. For these reasons, the new community well option is not retained.
	Household Tank	Fill and maintain a water supply tank adjacent to the home	Provide an external household water storage tank connected to the house. Provide routine water refilling and chlorination by water truck from a potable water supply (such as the City of Oak Harbor).		X		X	Both the City of Oak Harbor and the State indicated this option would not be approved for long-term residential use because of potential difficulties with water sanitation in the external water tank and connections. Therefore, this alternative was not retained.
	Bottled Water	Supply bottled water	Bottled water would be supplied and delivered for potable purposes at a single POU (main kitchen sink) within the household. Bottled water is readily available for delivery to residential homes in the area.		X		X	Supplying clean bottled water to residence likely would be effective where implemented; however, water can be consumed only from a single POU in the household. It would not be a practical solution as these the volume is limited and inconvenient for the resident to use long-term. In addition, bottled water is not practical to use with showers (where unintended water ingestion is possible). For these reasons, the bottled water option is not retained for the long-term solution.

Notes:

µg/L = microgram(s) per liter

EE/CA = Engineering Evaluation/Cost Analysis

GAC = granular activated carbon

IX = ion exchange

LUC = Land Use Controls

Navy = Department of the Navy

NF = nanofiltration

PFAS = per- and polyfluoroalkyl substances

PFOA = perfluorooctanoic acid

PFOS = perfluorooctane sulfonate

POE = Point-of-Entry

POU = Point-of-Use

RO = reverse osmosis

Table 3-2. Potential Federal and Washington State ARARs and TBCs for the NAS Whidbey Island Offsite Residential Wells
Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking
Naval Air Station Whidbey Island, Oak Harbor, Washington

Media	Regulatory Citation	ARAR Category	Description of Regulatory Requirement	Possible Application	Potential Relevancy
EPA Fact Sheet. PFOA & PFOS Drinking Water Health Advisory					
Groundwater	EPA-800-F- 16-003. May 2016.	Chemical	Establishes Lifetime Health Advisory (Lifetime Health Advisory) levels for PFOS and PFOA in drinking water at 70 ppt.		TBC
"Water Well Construction Act of 1971" (Chapter 18.104 RCW, as amended); "Minimum Standards for Construction and Maintenance of Wells" (Chapter 173-160 WAC)					
Groundwater	"How Shall Each Water Well Be Planned and Constructed?" (WAC 173-160-161)	Action	Identifies well planning and construction requirements.	Investigative and remediation activities that require siting, installation, construction, operation, maintenance, and decommissioning of wells and borings.	ARAR
Groundwater	"What Are the Requirements for the Location of the Well Site and Access to the Well?" (WAC 173-160-171)	Action	Identifies the requirements for locating a well.	Investigative and remediation activities that require siting, installation, construction, operation, maintenance, and decommissioning of wells and borings.	ARAR
Groundwater	"What Are the Requirements for Preserving the Natural Barriers to Ground Water Movement Between Aquifers?" (WAC 173-160-181)	Action	Identifies the requirements for preserving natural barriers to groundwater movement between aquifers.	Investigative and remediation activities that require siting, installation, construction, operation, maintenance, and decommissioning of wells and borings.	ARAR
Groundwater	"What Are the Minimum Standards for Resource Protection Wells and Geotechnical Soil Borings?" (WAC 173-160-400)	Action	Identifies the minimum standards for resource protection wells and geotechnical soil borings.	Investigative and remediation activities that require siting, installation, construction, operation, maintenance, and decommissioning of wells and borings.	ARAR
Groundwater	"What Are the General Construction Requirements for Resource Protection Wells?" (WAC 173-160-420)	Action	Identifies the general construction requirements for resource protection wells.	Investigative and remediation activities that require siting, installation, construction, operation, maintenance, and decommissioning of wells and borings.	ARAR
Groundwater	"What Are the Minimum Casing Standards?" (WAC 173-160-430)	Action	Identifies the minimum casing standards.	Investigative and remediation activities that require siting, installation, construction, operation, maintenance, and decommissioning of wells and borings.	ARAR
Groundwater	"What Are the Equipment Cleaning Standards?" (WAC 173-160-440)	Action	Identifies the equipment cleaning standards.	Investigative and remediation activities that require siting, installation, construction, operation, maintenance, and decommissioning of wells and borings.	ARAR
Groundwater	"What Are the Well Sealing Requirements?" (WAC 173-160-450)	Action	Identifies the well sealing requirements.	Investigative and remediation activities that require siting, installation, construction, operation, maintenance, and decommissioning of wells and borings.	ARAR
Groundwater	"What Is the Decommissioning Process for Resource Protection Wells?" (WAC 173-160-460)	Action	Identifies the decommissioning process for resource protection wells.	Investigative and remediation activities that require siting, installation, construction, operation, maintenance, and decommissioning of wells and borings.	ARAR
"Washington Clean Air Act" (Chapter 70.94 RCW, as amended); "Ambient Air Quality Standards for Particulate Matter" (Chapter 173-470 WAC)					
Air	"Ambient Air Quality Standards" (WAC 173-470-100)	Action	Sets maximum acceptable levels for particulate matter in the ambient air at 150 µg/m^3 over a 24-hour period, or 60 µg/m^3 annual geometric mean. It also sets the 24-hour ambient air concentration standards for particles less than 10 µm in diameter (PM_{10}) at 105 µg/m^3 and 50 µg/m^3 geometric mean.	Investigative and remediation activities (e.g., excavation) that have the potential to emit particulate matter above maximum acceptable levels.	ARAR
Air	"Particle Fallout Standards" (WAC 173-470-110)	Action	Establishes the standard for particle fallout not to exceed 10 g/m^2 per month in an industrial area or 5 g/m^2 per month in residential or commercial areas. Alternative levels for areas where natural dust levels exceed 3.5 g/m^2 per month are set at 6.5g/m^2 per month, plus background levels for industrial areas and 1.5 g/m^2 per month, plus background in residential and commercial areas.	Investigative and remediation activities (e.g., excavation) that have the potential to emit particulate matter above maximum acceptable levels.	ARAR

Table 3-2. Potential Federal and Washington State ARARs and TBCs for the NAS Whidbey Island Offsite Residential Wells
Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking
Naval Air Station Whidbey Island, Oak Harbor, Washington

Media	Regulatory Citation	ARAR Category	Description of Regulatory Requirement	Possible Application	Potential Relevancy
"Solid Waste Management—Reduction and Recycling" (Chapter 70.95 RCW, as amended); "Solid Waste Handling Standards" (Chapter 173-350 WAC)					
	"Owner Responsibilities for Solid Waste (WAC 173-350-025) "Performance Standards" (WAC 173-350-040) "On Site Storage, Collection and Transportation Standards" (WAC 173-350-300) "Remedial Action" (WAC 173-350-900)	Action	Establishes minimum functional performance standards for the proper handling and disposal of solid waste. Requirements for the proper handling of solid waste materials originating from residences, commercial, agricultural and industrial operations and other sources and identifies those functions necessary to ensure effective solid waste handling programs at both the state and local level.	Investigative and remedial actions that generate solid, nondangerous waste.	ARAR
"Hazardous Waste Management Act of 1976" (Chapter 70.105 RCW, as amended); "Dangerous Waste Regulations" (Chapter 173-303 WAC)					
	"Designation of Dangerous Waste" (WAC 173-303-070)	Action	Establishes the method for determining if a solid waste is a dangerous waste (or an extremely hazardous waste).	Investigative and remediation (including waste treatment) activities that generate wastes (e.g., drums, barrels, tanks, containers, bulk wastes, debris, and contaminated soil).	ARAR
	"Requirements for Generators of Dangerous Waste" (WAC 173-303-170)	Action	Establishes the requirements for dangerous waste generators. WAC 173-303-170(3) includes the substantive provisions of WAC 173-303-200, "Accumulating Dangerous Waste On-Site," by reference. WAC 173-303-200 further includes certain substantive standards from WAC 173-303-630, "Use and Management of Containers," and WAC 173-303-640, "Tank Systems," by reference. Specifically, the substantive standards for management of dangerous/mixed waste are applicable to the management of dangerous waste that will be generated during the remedial action.	IDW and remediation wastes (contaminated soil and groundwater, personnel protective gear, and treatment chemicals).	ARAR

Notes:
No Location-specific ARARs have been identified at this time. These could include regulations that protect cultural, historic, and Native American sites and artifacts, and those that protect critical habitats of federally endangered and threatened species, bald eagles, and migratory bird species.
$\mu g/m^3$ = microgram(s) per cubic meter
µm = micrometer(s)
ARAR = applicable or relevant and appropriate requirement
EPA = United States Environmental Protection Agency
g/ m^2 = grams per square meter(s)
IDW = investigation-derived waste
PFAS = per- and polyfluoroalkyl substances
PFOA = perfluorooctanoic acid
PM_{10} = particulate matter 10 micrometers or less in diameter
ppt = parts per trillion
RCW = Revised Code of Washington
TBC = to be considered
WAC = Washington Administrative Code

SECTION 4

Description and Evaluation of Removal Action Alternatives

The alternatives for this NTCRA were developed and evaluated using professional judgment based on preliminary information from the PA, SI, emergency removal actions, and experience with current scientific knowledge of potential treatment for PFAS at similar sites. Site characterization for PFAS is still under development. Alternatives were evaluated by site-groupings (defined in Section 1.2) in consideration of effectiveness, implementability, and cost.

4.1 Description of Removal Action Alternatives

4.1.1 Alternative 1: No Further Action (Baseline)

No further action would be conducted under this alternative; the site would remain "as is". Thus, bottled water and/or POU treatment systems would continue to be provided to affected off-Base residents whose drinking water contains PFOA and/or PFOS concentrations above the USEPA Health Advisory level.

There are no state or federal regulations that currently restrict the homeowners use of their existing well. The Navy will give the residents the option to have their well decommissioned, used for non-potable uses (e.g. irrigation) and/or used for Navy's groundwater PFAS monitoring purposes. If future regulations restrict the use of the existing well for non-potable uses, then the Navy will disconnect the well from any points of uses and only use it for monitoring purposes (if approved by homeowner).

Preliminary Implementation Activities

Because the continued supply of bottled water and use of the existing POU treatment system does not require implementation activities, no preliminary implementation activities are required under this alternative.

Site Layout

There is no site layout information required for supplying bottled water and use of existing POU treatment systems to the off-Base private residences.

System Installation

Because there are no installation requirements for supplying bottled water, no system installation activities are required under this alternative, unless additional residents choose to use a POU treatment system. At the time of this EE/CA, all affected residents were offered a POU system and only one Ault Field/Area 6 resident requested the POU system installation.

Operations and Maintenance

Continued maintenance activities include bi-weekly (every other week) bottled water supply delivery to the residences associated with the eight affected off-Base drinking water wells (Ault Field Residence 1 and Residence 2, five Easy Street Residences, and the 19 Evergreen Mobile Home Park units). For the purposes of this EE/CA, bottled water supply needs at each off-Base private residence is assumed to be the same as the current deliveries. Alternative 1 bottled water volume assumptions for the four site groupings includes the following:

- 1a-1: Ault Field Residence 1 (one single-family residence): about 20 gallons delivered every other week (one 12-pack of 700 milliliter (mL) sport-top bottes, one 24-pack of 500 mL bottles, three 5-gallon bottles).
- 1a-2: Ault Field Residence 2 (one single-family residence): about 15 gallons delivered every other week (one 12-pack of 700 mL sport-top bottes, one 24-pack of 500 mL bottles, two 5-gallon bottles).

- 1a-3: Easy Street Residences (five single-family residences): about 90 gallons delivered every other week (three 12-packs of 700 mL sport-top bottles, five 24-packs of 500 mL bottles, nine 5-gallon bottles, seven 3-gallon bottles).
- 1a-4: Evergreen Mobile Home Park (currently 19 mobile home units): about 270 gallons delivered every other week (fourteen 12-packs of 700 mL sport-top bottes, twenty-nine 24-packs of 500 mL bottles, fourteen 5-gallon bottles, fifteen 3-gallon bottles, thirty-three 1-gallon bottles).

In addition, one Evergreen Mobile Home Park resident has requested a TRCA POU treatment system to replace the bottled water delivery. This POU system installation is contracted and awaiting resident availably to complete the installation. This POU treatment system will require routine PFAS sampling for system performance monitoring on a 6- to 12-week basis as specified in the POU Monitoring SAP (Navy, 2018f) and the Evaluation of Time-Critical Removal Action, Point-of-Use Treatment System Twelve-Week Use Monitoring Technical Memorandum (Navy, 2019). It will require GAC cartridge change out every 3 to 6 months, although required replacement intervals could be subject to change in the future if PFAS concentrations increase or decrease. The operation and maintenance (O&M) of this one POU treatment system is included in Alternative 1b. However, the POU treatment system installation cost is not included in the Alternative 1b because it is already contracted and assumed to be completed prior to the final EE/CA.

Off-Base bottled water supply and POU system maintenance would be required until groundwater concentrations of PFOA and PFOS fell below the USEPA Health Advisory limit in the drinking water wells and the on-Base CSM indicates that PFAS will not migrate to the wells. The assumed operating timeframe for cost analysis purposes for this EE/CA is 30 years in order to capture capital and long-term O&M costs.

4.1.2 Alternative 2: Point-of-Entry Water Treatment

This section details POE removal action alternatives. POE treatment of PFAS-impacted groundwater at the existing drinking water wells will reduce PFOA and PFOS concentrations to levels below the USEPA Health Advisory at the well-head, before whole-house use.

These alternatives would include the installation and continued maintenance of either GAC or IX treatment systems. These treatment systems would consist of vessels containing appropriate media for PFOA and PFOS removal.

There are no state or federal regulations that currently restrict the homeowners use of their existing well. The Navy will give the residents the option to have their well decommissioned, used for non-potable uses (e.g. irrigation) and/or used for Navy's groundwater PFAS monitoring purposes. If future regulations restrict the use of the existing well for non-potable uses, then the Navy will disconnect the well from any points of uses and only use it for monitoring purposes (if approved by homeowner).

4.1.2.1 Alternative 2a: Granular Activated Carbon

GAC adsorption is an established technology for removing PFOA and PFOS from drinking water. Water can be treated at the wellhead or POE to each household using small-scale GAC systems. Water is passed through GAC media beds to remove PFAS via adsorption to the media. GAC is a form of carbon processed to have small, low-volume pores that increase the surface area available for adsorption. Given sufficient GAC media and surface area contact time for effective adsorption to occur, organic contaminants are attracted into and retained within the GAC media. GAC is widely used in water treatment to remove or adsorb organic molecules like PFOA and PFOS.

GAC treatment trains normally use two or more GAC vessels operating in series (that is, in lead-lag configuration). Effectiveness and cost of GAC treatment depends on the type and characteristics of GAC used, the influent water quality (including PFAS concentrations, the type and concentrations of organic and inorganic substances present, residual chlorine concentrations, water temperature, and pH), flow rates, and the media contact times. Hence, GAC systems must be appropriately sized, and appropriate GAC media selected. The well water characteristics from individual wells and available room to accommodate the POE units could influence

implementation and costs of the systems. Careful consideration should be made for appropriate pretreatment and post-treatment as necessary to enhance performance of GAC units and improve end-users experience. For example, to prevent premature fouling of the GAC media a prefilter cartridge might be required as pretreatment step. Whereas, a basic post-treatment step might include a polishing sediment post filter or a water sterilizer (that is, ultraviolet [UV] light) if microbial contamination is of concern. GAC media have treatment finite lifespans and contaminant adsorption capacity. Adsorption sites within the GAC media progressively approach saturation as compounds are adsorbed, and the capacity for further adsorption declines. The media bed is considered exhausted and consumed when contaminants targeted for removal "break through" and are detected at or greater than a predetermined concentration in the effluent. Once this occurs, the exhausted media must be removed and replaced with fresh or reactivated media. The exhausted media can be appropriately disposed of or thermally regenerated and reactivated offsite to remove adsorbed contaminants and restore adsorption capacity such that the media can be reused.

Details are provided herein regarding the preliminary implementation activities, general system layout, system installation, and O&M assumed for this EE/CA. The alternative is evaluated for the following types of systems:

- Single-family residence GAC treatment unit:
  - 2a-1: GAC treatment of the drinking water well supply for Ault Field Residence 1, a single-family residence.
  - 2a-2: GAC treatment of the drinking water well supply for Ault Field Residence 2, a single-family residence where PFAS concentrations are almost two orders of magnitude higher than other off-Base drinking water wells with PFOA and/or PFOS USEPA Health Advisory Exceedances (see **Table 2-1**).
  - 2a-3: GAC treatment of the drinking water well supplies for Easy Street Residences, five single-family residences. GAC treatment units to be installed at each residence.
- Evergreen Mobile Home Park GAC treatment unit:
  - 2a-4: GAC treatment of the drinking water well supply for the Evergreen Mobile Home Park (currently serving 19 units; with a potential to serve up to 21 units).

A single POE system design is used for all single-family residences (2a-1 through 2a-3), although, the Ault Field Residence 2 treatment unit (2a-2) will require more frequent monitoring and GAC change-outs than the other POE systems because of the higher PFAS concentrations in the current drinking well water. The design for the Evergreen Mobile Home Park is similar to the single-family residences, except that the units are much larger and treated water storage is provided. Consequently, this system is discussed separately. The GAC changeout and monitoring frequency assumed in this EE/CA is based on the available site data. However, the actual system performance may differ from these assumptions.

Preliminary Implementation Activities

Preliminary implementation activities would include further evaluation of the homeowner-maintained system layout, characterization of system influent, as well as media selection, final POE system selection, and design. Laboratory treatability testing of GAC treatment of representative site waters is recommended to support and refine POE system design and operation (estimated costs for this testing are included in the cost estimates in Appendix B). This would consist of flow-through column testing using the selected GAC type to assess the media capacity for removing the target contaminants. The testing would evaluate media bed pore volumes of throughput until PFOA and/or PFOS breakthrough for each test water (that is, the effective service life of the GAC for a residents' well water). GAC lab testing would be conducted as rapid small-scale column tests (RSSCTs), which allow lower flow rates, shorter run times, and appreciably smaller sample water volumes than normal (larger) column tests.

Before finalizing the design for the treatment systems, site visits would be required to further evaluate each existing water supply system and layout. The site visits will include drawings of system layout and potential installation space, and documentation of conversations with property owners.

These initial site visits will also be used to collect water samples from selected residences for use in lab RSSCTs. The intent would be to limit the number of RSSCTs to wells representing different water qualities and/or warrant water-specific testing. For the selected residences, drum-sized water samples would be collected from the existing systems upstream from any current treatment and shipped to the selected treatability lab. At the lab, the samples would be analyzed for water quality parameters pertinent to treatment. These water quality characterization results would be used to finalize the RSSCT design, which would be documented in a test plan. Then, the RSSCTs would be conducted according to the test plan to evaluate PFAS treatment capacity, in support of the POE system design and operation.

Site Layout

General flow diagrams of POE GAC treatment systems for a single-family residence and for the Evergreen Mobile Home Park are depicted on **Figure 4-1** and **Figure 4-2**, respectively**.** The system configurations may vary during installation to accommodate conditions present at each residence. Each POE GAC system will be housed either in an existing building (for example, garage), if available, or in its own treatment enclosure, and will be connected to the existing well, pump, and pressurized water tank.

POE-scale equipment and suppliers are readily available. The proposed POE GAC treatment train could include:

- Sediment Pre- and Post-filters.
- GAC vessels plumbed in a lead-lag configuration with appropriate GAC media. In general, bituminous-based activated carbons have demonstrated enhanced PFOA and PFOS removal relative to carbons derived from other sources (for example, coconut).
- Distribution piping, shut off valves, flow meter, sampling ports, and additional system feed pumps (if needed).

Additional details specific to each system type are indicated below.

- **Single-family residence GAC treatment unit** - Each off-Base single-family residence POE GAC system will be housed in its own treatment enclosure or installed within an existing building. As shown in **Figure 4-1**, the POE GAC system will be connected to the existing well, pump, and pressurized water tank. The GAC system will include system valving and sample ports, a cartridge prefilter, flow meter, and two 8-cubic-foot GAC vessels plumbed in series. The GAC vessels are sized to provide a 20-minute empty bed contact time at a design flow rate of 6 gpm.
- **Evergreen Mobile Home Park GAC treatment unit** - The existing building for the well serving the Evergreen Mobile Home Park would not be able to accommodate the proposed GAC treatment system. Hence, a new treatment building would be constructed to house the GAC system. As shown in **Figure 4-2**, the system configuration for the Evergreen Mobile Home Park is very similar to the POE GAC system for a single-family residence, except for unit sizing and treated water storage. The Evergreen Mobile Home Park GAC system uses two 64-cubic foot GAC vessels to accommodate a design peak flowrate of 60 gpm.

  The well serving the Evergreen Mobile Home Park typically experiences a maximum demand of 25 gpm based on recent King Water Company well pumping records. However, as described in Section 4.1.3.5, maximum instantaneous, peak hour demands were conservatively estimated (using demand estimating protocols outlined in the 2009 Washington State Department of Health Water System Design Manual) at up to 50 to 60 gpm for the system as a whole. Hence, to accommodate the possible 60 gpm peak flowrate, a treated water holding tank is proposed downstream of the GAC unit. This 8,000-gallon capacity tank is sized to allow the system to provide 60 gpm for at least 2 hours on a continuous-flow basis. The tank would require disinfection by adding sodium hypochlorite using a small feed pump (using 5% bleach). The 2 X 100% (that is, one active pump and one spare pump) treated water distribution pump ensures seamless supply of the treated water to the mobile homes in the community.

For the purposes of this EE/CA, it is assumed that the treatment medium used in each GAC vessel is Calgon Filtrasorb F-400 or F-600 bituminous-based carbon, which has been implemented successfully for removal of PFOA or PFOS at other Navy sites (for example, Naval Auxiliary Landing Field Fentress). If selected as the preferred

removal action, the final full-scale treatment medium would be selected as part of the design, and selection would consider continuing studies on PFAS removal efficacy of GAC from different sources.

System Installation

Before the system installation, the footprint of the proposed treatment train would be determined, and a layout prepared so that the unit fits within the identified location per each individual site survey. If the system installation warrants excavation (that is, for piping or to create a level pad for the system housing), then an archeological survey might also be required to ensure "no adverse effect" resulting from the installation.

System installation would consist of placing the GAC vessels, pre- and post-treatment units, and treated water storage tank (for the Evergreen Mobile Home Park system) in position; installing connective plumbing, ports, valves, instrumentation, and pumps; connecting power to electrical equipment; and loading the GAC vessels with media (if not supplied pre-filled). Once connected to the water supply, the vessels and associated piping would be pressure tested to ensure there are no leaks in the system.

For this EE/CA, installation costs are assumed to include installation of the complete systems as shown in **Figures 4-1** and **4-2** and as previously described. For the purposes of this EE/CA, it is assumed that the contractor, who will be installing and maintaining the POE systems, will be responsible for all changeout, profiling, and management of spent media (for costing purposes).

Additional details specific to each installation type are as follows:

- **Single-family residence GAC treatment unit** - These POE units would be installed in an existing structure (garage), if available. However, the cost of an approximate 2-foot x 5-foot x 6-foot outdoor enclosure to house each system is included in the capital cost estimate, in the event no existing building is available with sufficient space. However, in such cases, there could be a need to prep the ground and build a pad to place the unit. The cost of this is within the uncertainty of the EE/CA level cost estimate.
- **Evergreen Mobile Home Park GAC treatment unit** - In addition to the items previously described, installation cost of this treatment unit also includes installation of a treated water tank and treated water pump. The installation cost of this unit also includes cost of an 18-foot by 18-foot building to house the treatment units, treated water tank, and pump.

Operations and Maintenance

To verify treatment effectiveness and determine when the GAC media is spent and due for replacement, PFAS water quality sampling and monitoring is conducted at influent (before the lead vessel), midpoint (between the lead and lag vessel), and final effluent (after the lag vessel) locations. As previously mentioned, operating a GAC POE system would also include replacement of the GAC, as needed, to maintain effective treatment. The spent GAC in the lead vessel will be replaced with fresh media when the cumulative PFOA and PFOS concentration in the midpoint sample (between the lead and lag vessel) exceeds the project indicator level (PIL) of 35 ng/L (half of the USEPA Health Advisory) or the predetermined operating time (Navy, 2018f). Then, the GAC vessel order will be changed so that the prior lag vessel is in the lead position and the vessel with fresh carbon is in the lag position. The GAC changeout and monitoring frequency assumed in this EE/CA is based on the available site data. However, the actual system performance may differ from these assumptions. The following sampling and changeout frequency have been assumed for the current analysis:

- **Single-family residence GAC treatment unit**
  - **Monitoring** - Quarterly (four times per year) at Ault Field Residence 2 and semiannually (twice per year) at the rest of the single-family residences.
  - **Changeout** - Semiannually (twice per year) for Ault Field Residence 2, and once every 2 years for the rest of the single-family residences.

- **Evergreen Mobile Home Park GAC treatment unit**
  - **Monitoring** - Quarterly (four times per year).
  - **Changeout** - Semiannually (twice per year).

Based on the results of the first 2 years of initial monitoring, a conservative timeframe would be established for GAC changeout. The used GAC will be taken offsite for appropriate management (via thermal reactivation). After the first 2 years of operation, monitoring would continue but the changeout and monitoring frequency may be reduced. However, for the cost analysis, no reduction in monitoring and changeout frequency was assumed after 2 years of operation.

The cost analysis for the EE/CA was carried out over 30 years to capture capital and long-term O&M costs.

Sustainability

Sustainability considerations for this alternative include the treatment system using considerable amounts of GAC media that will have to be managed offsite and appropriately reactivated/incinerated. The POE system infrastructure will need to be put in place at each residence as well as at the Evergreen Mobile Home Park. The social burden of increased homeowner water pumping/electricity costs for operating this system is also a consideration.

4.1.2.2 Alternative 2b: Ion Exchange

This POE alternative addresses PFOA and PFOS impacts at the off-Base single-family residences and the mobile home park by using IX technology for PFOA and/or PFOS removal. Water can be treated at the wellhead or POE using IX. Although it's not as well-established for PFAS treatment as GAC adsorption, the use of IX to effectively remove PFAS has been demonstrated through numerous studies. IX is a treatment process that uses specialized resin media that exchanges undesirable ions in water with benign ions on the resin surface to remove dissolved contaminants to produce a clean water product. The resins used in IX processes include small plastic, porous beads with a fixed ionic charge that facilitates the exchange of ions and associated contaminant removal. IX can involve cation exchange of positively charged ions, or anion exchange of ions that are negatively charged. Treatment and removal of PFOA and PFOS via IX primarily involves anion exchange. IX resins are somewhat selective, but their treatment effectiveness may be influenced by water temperature and pH, flow rates, contact time, types and concentrations of organic and inorganic substances present, and residual chlorine present. Specifically, for PFOA and PFOS removal using IX, water with high concentrations of total dissolved solids, iron, other dissolved organics, sulfates, chlorides, and competing anions, as well as potential foulants and scalants, can potentially hinder the treatment and IX performance of resins. The well water characteristics at the individual well and available room to accommodate the POE units could influence implementation and costs of the systems. Careful consideration should be made for apt pretreatment and post-treatment as necessary to enhance performance of IX units and improve end-users experience. For example, to prevent premature fouling of the media a prefilter cartridge might be required as pretreatment step. Also, a basic post-treatment step might include a polishing carbon post filter or a water sterilizer (that is, UV light) if microbial contamination is of concern.

The off-Base drinking water systems would include two IX vessels, operated in series (that is, in lead-lag configuration). The water is passed through beds of IX resin, where PFAS compounds are captured as they exchange with non-toxic ions present on the resin surface. The PFAS remain in the resin, while the non-toxic ions exit with the water supply. For effective removal, the appropriate IX resin must be obtained from a resin supplier. While regeneration of the IX resin is theoretically possible, it is not practical for a POE system given regeneration process chemical handling and disposal challenges. Currently, IX resins available for treatment of PFOA and PFOS are considered single-use. Consequently, the IX resin would be used until spent and then removed, disposed of, and replaced.

Details are provided herein regarding the preliminary implementation activities, general system layout, system installation, and O&M assumed for this EE/CA. The alternative is evaluated for the following types:

- **Single-family residence IX treatment unit**
  - 2b-1: IX treatment of a drinking water well for Ault Field Residence 1, a single-family residence.
  - 2b-2: IX treatment of a drinking water well for Ault Field Residence 2, a single-family residence with higher PFAS concentrations than other off-Base drinking water wells.
  - 2b-3: IX treatment of a drinking water well for Easy Street Residences, five single-family residences.
- **Evergreen Mobile Home Park IX treatment unit**
  - 2b-4: IX treatment of a drinking water well for the Evergreen Mobile Home Park (currently serving 19 units; has the potential to serve up to 21 units).

A single POE system design is used for all the single-family residences (2b-1 through 2b-3), although the Ault Field Residence 2 treatment unit (2b-2) will require more frequent monitoring and GAC change-out than the other POE systems because of the higher PFAS concentrations in that groundwater well. The design for the Evergreen Mobile Home Park is similar to that for the single-family residences, except the units are much larger and treated water storage is provided; consequently, this system is discussed separately herein.

Preliminary Implementation Activities

Preliminary implementation activities for IX would be very similar to that of GAC systems and would include all the elements presented in the GAC Preliminary Implementation Activities section (Section 4.1.2.1).

Similar to the GAC systems, laboratory treatability testing of IX treatment of representative site waters is recommended to support and refine POE system design and operation (estimated costs for this testing are included in the cost estimates). This would consist of flow-through column testing using the selected IX resin to assess the media capacity for removing the target contaminants, in terms of media bed pore volumes of throughput until breakthrough (that is, the effective service life) for each test water. RSSCTs require media particle size reduction and this is not feasible for IX resins. Therefore, IX testing must employ somewhat larger columns, longer run times, and appreciably larger sample water volumes than RSSCTs.

Site Layout

The general process flow diagram of a POE IX treatment system for a single-family residence is depicted on **Figure 4-3** and for Evergreen Mobile Home Park in **Figure 4-4.** Each off-Base POE IX system will be housed in an existing building, when possible, or its own treatment enclosure. Each POE IX system will be housed either in an existing building (for example, garage), if available, or in its own treatment shed, and will be connected to the existing well, pump, and pressurized water tank.

POE-scale equipment and suppliers are readily available. The IX treatment system could include the following components:

- Sediment prefilter(s).
- IX vessels plumbed in a lead-lag configuration with appropriate resin**.**
- Distribution piping, shut off valves, flow meter, sampling ports, and additional system feed pumps (if needed).

However, the system configurations will vary during installation, to meet conditions present at each residence. Additional details specific to each site layout type are indicated as follows:

- **Single-family residence IX treatment unit** - Each off-Base single-family residence POE IX system will be housed in its own treatment enclosure or installed within a treatment shed. As shown in **Figure 4-3**, the POE IX system will be connected to each existing well, pump, and pressurized water tank. Upstream from the IX vessels on the inlet piping, there will be an isolation valve, influent sample port, 25-micrometer cartridge prefilter, and a flow meter. The IX system will include two 1.5-cubic-foot IX vessels plumbed in series, with a lead and lag setup. These vessels are sized to provide a 3-minute empty bed contact time at a design flow rate

of 5 gpm. There will be a sampling port in-between the lead-lag vessel. Downstream from the IX vessels, the system will have another isolation valve before connection with the main distribution piping to the house.

- **Evergreen Mobile Home Park IX treatment unit -** As shown in **Figure 4-4**, the system configuration for the Evergreen Mobile Home Park is very similar to the POE IX system for single-family homes. This IX treatment systems contains two 17-cubic foot IX vessel to accommodate a peak flowrate of 60 gpm.

  As explained in the Evergreen Mobile Home Park GAC unit layout section, the well serving the mobile home community is rated to accommodate a peak demand of 60 gpm (though currently it typically experiences a max demand of 25 gpm). To accommodate the possible 60 gpm peak, a treated water holding tank is proposed downstream of the IX vessel. This 8,000-gallon capacity tank can meet water peak water demand of 60 gpm for at least 2 hours on a continuous flow basis. The 2 X 100% (that is, one active pump and one spare pump) treated water distribution pump ensures seamless supply of the treated water to the mobile homes in the community.

For the purposes of this EE/CA, it is assumed that the treatment medium used in each IX vessel is a single used resin such as Purolite PFA694E. This type of resin has been implemented successfully for removal of PFOA or PFOS at other sites. If selected as the preferred removal action, the final full-scale treatment medium would be selected as part of the design, and selection would take into consideration of continuing studies developments of IX resins for PFAS treatment, including multi-use resins for regeneration.

System Installation

Before system installation, the footprint of the proposed treatment train would be determined and a layout prepared so that the unit fits within the identified location per each individual site survey. If the system installation warrants excavation (that is, for piping or to create a level pad for the system housing), an archeological survey might also be required to ensure "no adverse effect" results from the installation.

System installation would consist of placing the IX vessels, pre- and post-treatment units, and treated water storage tank (for the Evergreen Mobile Home Park system) in position; installing connective plumbing, ports, valves, instrumentation, and pumps; connecting power to electrical equipment; and loading the IX vessels with media (if not supplied pre-filled). Once connected to the water supply, the vessels and associated piping would be pressure tested to ensure there are no leaks in the system.

For this EE/CA, installation costs are assumed to include installation of the complete systems as shown in the **Figures 4-3** and **4-4** and previously described. In addition, for the purposes of this EE/CA, it is assumed that the Subcontractor, who will be installing and maintaining the POE systems, will be responsible for all changeout, profiling, and management of spent media (for costing purposes).

Additional details specific to each installation type are as follows:

- **Single-family residence IX treatment unit** - These POE units could likely be installed in an existing structure (that is, garage), if available. However, the cost of a 2-foot 8-inch x 4-foot 5-inch x 6-foot outdoor enclosure to house each system is included in the capital cost estimate, in the event no existing building is available with sufficient space. However, in such cases, there could be a need to prep the ground and build a pad to place the enclosure.
- **Evergreen Mobile Home Park Unit IX treatment unit -** In addition to the items previously described, installation cost of this treatment unit also includes installation of a treated water tank and treated water pumps. The installation cost of this unit also includes cost of a 16-foot x 16-foot building to house the treatment units.

Operations and Maintenance

To verify treatment effectiveness and determine when the IX resin is spent and due for replacement, monitoring is conducted at influent (before the lead vessel), midpoint (between the lead and lag vessel), and final effluent (after the lag vessel) locations for PFAS. Under this alternative, system operations would include periodic

monitoring at these three sample locations for PFAS). For the purposes of this EE/CA, the sampling frequency is assumed based on available PFAS concentration at each location.

System maintenance would also include replacement of the IX media, as needed, to maintain effective treatment. The spent IX in the lead vessel will be replaced by fresh media when the combined PFOA and PFOS concentration in the midpoint sample (between the lead and lag vessel) exceeds the PIL of 0-35 ng/L or after a predetermined operating time (Navy, 2018f). Then, the IX vessel order will be changed so that the prior lag vessel is in the lead position and the vessel with fresh Media is in the lag position.

For this EE/CA, the following sampling and changeout frequency has been assumed based on established service life of the Purolite PFA694E in laboratory studies.

- **Single-family residence IX treatment unit**
  - **Monitoring** - Monthly (twelve times per year) at Ault Field Residence 2 and quarterly (four times per year) at rest of the single-family residences.
  - **Changeout** - Every 2 months (six times per year) for Ault Field Residence 2 and once every 10 months for the rest of the single-family residences.
- **Evergreen Mobile Home Park IX treatment unit**
  - **Monitoring -** Quarterly (four times per year).
  - **Changeout -** Annually (once per year).

Based on the results of the system operations monitoring, the IX change-out schedule would be updated. The revised changeout schedule could be more or less frequent than the assumptions used for costing in this EE/CA. However, for the cost analysis, no reduction in monitoring and changeout frequency was assumed. Based on the assumed single-use IX resin chosen for this EE/CA, used IX resin will be taken offsite for incineration or any other appropriate method that is approved by the Navy. Other maintenance activities include semiannual change-out of the prefilter at the off-Base systems (included in the cost estimate in Appendix B).

The cost analysis for the EE/CA was carried out over 30 years to capture capital and long-term O&M costs.

Sustainability

Sustainability considerations for this alternative include the treatment system utilizing sizable amounts of IX resin that will have to be managed offsite for appropriate disposal. The POE system infrastructure will need to be put in place at each residence. The infrastructure impacts associated with the single-family residence alternative are considered low. The social burden of increased homeowner water pumping/electricity costs for operating this system.

4.1.3 Alternative 3: Connection to Navy or Public Water Supply

This alternative, and associated sub-alternatives, would address PFOA and/or PFOS impacts by connecting affected residences to a reliable potable water supply from an existing neighboring water system.

- Alternative 3a: Ault Field Residence 1 would be connected to receive water from the City of Oak Harbor water system via a new supply piping system that would be managed by/through a water supply agreement with the Navy.
- Alternatives 3b and 3c: Ault Field Residence 2 would be connected to receive water from either the NAS Whidbey Island or the Pine Terrace Water System via new a new supply piping system.
- Alternative 3d: Easy Street Residences would be connected to receive water through new residential/retail water service connections to the City of Oak Harbor water system via a new water main extension to be constructed along Easy Street and interconnecting with existing City water mains.

- Alternative 3e: Evergreen Mobile Home Park would be connected to receive water through a new wholesale water service connection to the City of Oak Harbor water system via a new water main and wholesale meter connection to be constructed extending off an existing City water main.

Details are provided herein regarding the preliminary implementation activities, general system layouts, system installation, and O&M needs, and sustainability implications for each alternative.

There are no state or federal regulations that currently restrict the homeowners use of their existing well. The Navy will give the residents the option to have their well decommissioned, used for non-potable uses (e.g. irrigation) and/or used for Navy's groundwater PFAS monitoring purposes. If future regulations restrict the use of the existing well for non-potable uses, then the Navy will disconnect the well from any points of uses and only use it for monitoring purposes (if approved by homeowner).

4.1.3.1 Alternative 3a: Connect Ault Field Residence 1 via Navy/Oak Harbor System

This alternative involves installing a new water service connection and piping to provide water supply from the City of Oak Harbor water system to Ault Field Residence 1 as shown in **Figure 4-5**.

Ault Field Residence 1 is located beyond the designated limits of the City of Oak Harbor water service area, and this alternative would be structured to provide water supply to a single residence. Consequently, representatives from the City of Oak Harbor have indicated that the City would prefer not to be responsible for ownership and long-term O&M of the proposed alternative improvements. Thus, the alternative improvements would remain the responsibility of the Navy and/or other contracted/assigned third parties of the Navy's choosing.

Because the alternative improvements as envisioned would provide water service to only one single-family residence, the improvements would likely not be considered to be a public water system under the authority of Chapters 246-290 and 291 of the Washington Administrative Code.

Preliminary Implementation Activities

Before the final design and implementation of this alternative the following actions would need to be completed:

- Exemption granted by Navy as allowed by US Code Title 10-2686 to connect residence to the Navy's water system.
- Site visits and engagement with the owners/residents of Ault Field Residence 1 would need to be completed, and piping connection and implementation details would need to be agreed to.
- System design and sizing criteria would need to be formalized, including estimated residential demands and flows, hydraulic performance parameters, piping alignments, and construction requirements.
- Property access agreements and requirements would need to be evaluated and finalized, including public right of way utility franchise agreements, private property construction and utility easements, and right of entry agreements to support construction of improvements within the Ault Field Residence 1 property limits.
- Design alignments and routes would need to be surveyed, to include property and public right-of-way boundaries, topography, surface features, and existing above and below grade utility locations. Existing utility alignments, where available, are shown on **Figure 4-5** and based on site reconnaissance and owner provided information.
- Substantive permitting requirements would need to be established and planned for, and a water service agreement with the City of Oak Harbor would need to be negotiated and established.

Site Layout

Alternative improvements are illustrated in **Figure 4-5** and would generally include the following:

- Service connection to an existing Navy/City of Oak Harbor water supply line, to include service meter, isolation valving, and a reduced pressure backflow assembly (RPBA) to provide cross connection protection.

- Approximately 6,500 linear feet (LF) of below grade 2.5-inch internal diameter (ID) high-density polyethylene (HDPE) water line, including associated roadway pavement, shoulder, and surface restoration along the pipe alignment. Potential residential water demands were preliminarily estimated according to the demand estimating protocols outlined in the 2009 Washington State Department of Health Water System Design Manual using representative single-family residential water use estimates consistent with the 2014 City of Oak Harbor Water System Plan. Preliminary water line sizing was estimated as needed to maintain appropriate water service pressures to Ault Field Residence 1 given estimated residential demands and approximate available system feed pressure from the existing Navy/City of Oak Harbor water supply line at the proposed connection point.
- An automatic flushing station to be installed along the proposed water line near Ault Field Residence 1 and programmed to periodically flush the proposed water line so as to maintain acceptable water age and quality to the residence.
- Connection from the proposed water line into Residence 1 interior plumbing. If desired, a connection may also be provided to support flexibility to be able to continue onsite irrigation using either water supplied from the existing private onsite well, or potable water supplied through the proposed water supply connection and line. This would typically involve installation of a double check valve assembly (DCVA) and a three-way valve to provide cross connection protection, along with associated plumbing adjustments to existing well system piping and appurtenances to provide for continued well supply functionality. This design feature is included in the alternative costs for Ault Field Residences 1 and 2 and the Easy Street Residences.

System Installation

The proposed water line and associated appurtenances would generally be installed below grade, typically with at least 3 feet of cover to protect against freezing and damage resulting from shallow surface excavations and improvements. Trenching for the water line installation would typically involve an approximately 4 feet deep by 2.5 feet wide excavation, although narrower trench limits may be possible for installation via a “Ditch Witch” style trenching machine.

Operations and Maintenance

The Navy, and/or other contracted/assigned third parties of the Navy’s choosing, would be responsible for O&M of the proposed system outside of the Ault Field Residence 1 property limits. The automatic flushing station O&M is included in the cost estimate (over a 30-year period to be comparable to the other alternatives). The Ault Field Residence 1 property owners would be responsible for O&M of the system within the limits of their private property. Water supply and delivery charges based on metered supply from the City of Oak Harbor water system would become the responsibility of the Ault Field Residence 1 property owner, subject to standard City of Oak Harbor billing rate schedules. The property owner would also be responsible for annual RPBA inspections and testing, with results to be reported to the Navy.

Sustainability

Sustainability considerations for this alternative are related to the materials and equipment required to construct the alternative. This alternative is significantly more labor intensive as compared to POE or new well installation alternatives.

4.1.3.2 Alternative 3b: Connect Ault Field Residence 2 to Navy Water System

This alternative involves installing a new water service connection and piping to provide water supply from the NAS Whidbey Island water system to Ault Field Residence 2, as shown in **Figure 4-6**.

Pre-Implementation Activities

Prior to final design and implementation of this alternative the following actions would need to be completed:

- Exemption granted by Navy as allowed by US Code Title 10-2686 to connect residence to the Navy's water system.

- Site visits and engagement with the owners/residents of Ault Field Residence 2 would need to be completed, and piping connection and implementation details would need to be agreed to.
- System design and sizing criteria would need to be formalized, including estimated residential demands and flows, hydraulic performance parameters, piping alignments, and construction requirements.
- Property access agreements and requirements would need to be evaluated and finalized, including public right-of-way utility franchise agreements, private property construction and utility easements, and right of entry agreements to support construction of improvements within the Ault Field Residence 2 property limits.
- Design alignments and routes would need to be surveyed, to include property and public right-of-way boundaries, topography, surface features, and existing above and below grade utility locations. Existing utility alignments, where available, are shown on **Figure 4-6** and based on site reconnaissance and owner provided information.
- Substantive permitting requirements would need to be established and planned for, and the NAS Whidbey Island system water service area designation would need to be amended to include Ault Field Residence 2.

Site Layout

Alternative improvements are illustrated in **Figure 4-6** and would generally include the following:

- Service connection to an existing NAS Whidbey Island water supply line, to include service meter, isolation valving, and a RPBA to provide cross connection protection.
- Approximately 800 LF of below grade 2-inch ID HDPE water line, including associated roadway pavement, shoulder, and surface restoration along the pipe alignment. Potential residential water demands were preliminarily estimated according to the demand estimating protocols outlined in the 2009 Washington State Department of Health Water System Design Manual using representative single-family residential water use estimates consistent with the 2014 City of Oak Harbor Water System Plan. Preliminary water line sizing was estimated as needed to maintain appropriate water service pressures to Ault Field Residence 2 given estimated residential demands and approximate available system feed pressure from the existing NAS Whidbey Island water supply line at the proposed connection point.
- Connection from the proposed water line into Ault Field Residence 2 interior plumbing. If desired, a connection may also be provided to support flexibility to be able to continue onsite irrigation using either water supplied from the existing private onsite well, or potable water supplied through the proposed water supply connection and line. This would typically involve installation of a DCVA and a three-way valve to provide cross connection protection, along with associated plumbing adjustments to existing well system piping and appurtenances to provide for continued well supply functionality.

System Installation

The proposed water line and associated appurtenances would generally be installed below grade, typically with at least 3 feet of cover to protect against freezing and damage resulting from shallow surface excavations and improvements. Trenching for the water line installation would typically involve an approximately 4-feet deep by 2.5-feet wide excavation, although narrower trench limits may be possible for installation via a “Ditch Witch” style trenching machine.

Operations and Maintenance

The Navy, and/or other contracted/assigned third parties of the Navy’s choosing, would be responsible for O&M of the proposed system outside the NAS Whidbey Island and Ault Field Residence 2 property limits. The Ault Field Residence 2 property owners would be responsible for O&M of the system within the limits of their private property. Water supply and delivery charges based on metered supply from the NAS Whidbey Island water system would become the responsibility of the Ault Field Residence 2 property owner, subject to negotiated/standard water billing rate schedules. The property owner would also be responsible for annual RPBA inspections and testing, with results to be reported to the Navy.

Sustainability

Sustainability considerations for this alternative are related to the materials and equipment required to construct the alternative. This alternative is significantly more labor intensive as compared to POE or new well installation alternatives.

4.1.3.3 Alternative 3c: Connect Ault Field Residence 2 to Pine Terrace Water System

This alternative involves installing a new water service connection and piping to provide water supply from the Pine Terrace Water System to Ault Field Residence 2, as shown in **Figure 4-6**.

Preliminary Implementation Activities

Before final design and implementation of this alternative the following actions would need to be completed:

- Site visits and engagement with the owners/residents of Ault Field Residence 2 would need to be completed, piping connection and implementation details would need to be agreed to.
- System design and sizing criteria would need to be formalized, including estimated residential demands and flows, hydraulic performance parameters, piping alignments, and construction requirements.
- Property access agreements and requirements would need to be evaluated and finalized, including public right of way utility franchise agreements, private property construction and utility easements, and right of entry agreements to support construction of improvements within the Ault Field Residence 2 property limits.
- Design alignments and routes would need to be surveyed, to include property and public right-of-way boundaries, topography, surface features, and existing above and below grade utility locations. Existing utility alignments, where available, are shown on **Figure 4-6** and based on site reconnaissance and owner provided information.
- Substantive permitting requirements would need to be established and planned for, the Pine Terrace Water System service area designation would need to be amended to include Ault Field Residence 2, and a water service agreement with Pine Terrace Water Association would need to be negotiated and established.

Site Layout

Alternative improvements are illustrated in **Figure 4-6** and would generally include the following:

- Service connection to an existing Pine Terrace water supply line, to include service meter, isolation valving, and a RPBA to provide cross connection protection.
- Approximately 6,000 LF of below grade 2.5-inch ID HDPE water line, including associated roadway pavement, shoulder, and surface restoration along the pipe alignment. Potential residential water demands were preliminarily estimated according to the demand estimating protocols outlined in the 2009 Washington State Department of Health Water System Design Manual using representative single-family residential water use estimates consistent with the 2014 City of Oak Harbor Water System Plan. Preliminary water line sizing was estimated as needed to maintain appropriate water service pressures to Ault Field Residence 2 given estimated residential demands and approximate available system feed pressure from the existing Pine Terrace water supply line at the proposed connection point.
- An automatic flushing station to be installed along the proposed water line near Ault Field Residence 2 and programmed to periodically flush the proposed water line, to maintain acceptable water age and quality to the residence.
- Connection from the proposed water line into Ault Field Residence 2 interior plumbing. If desired, a connection may also be provided to support flexibility to be able to continue onsite irrigation using either water supplied from the existing private onsite well, or potable water supplied through the proposed water supply connection and line. This would typically involve installation of a DCVA and a three-way valve to provide cross connection protection, along with associated plumbing adjustments to existing well system piping and appurtenances to provide for continued well supply functionality.

System Installation

The proposed water line and associated appurtenances would generally be installed below grade, typically with at least 3 feet of cover to protect against freezing and damage resulting from shallow surface excavations and improvements. Trenching for the water line installation would typically involve an approximately 4-feet deep by 2.5-feet wide excavation, although narrower trench limits may be possible for installation via a "Ditch Witch" style trenching machine.

Operations and Maintenance

Pine Terrace Water Association would become responsible for O&M of the proposed system outside the Ault Field Residence 2 property limits. The automatic flushing station O&M is included in the cost estimate (over a 30-year period to be comparable to the other alternatives). The Ault Field Residence 2 property owners would be responsible for O&M of the system within the limits of their private property. Water supply and delivery charges based on metered supply from the Pine Terrace Water System would become the responsibility of the Ault Field Residence 2 property owner, subject to negotiated/standard water billing rate schedules. The property owner would also be responsible for annual RPBA inspections and testing, with results to be reported to the Pine Terrance Water Association.

Sustainability

Sustainability considerations for this alternative are related to the materials and equipment required to construct the alternative. This alternative is significantly more labor intensive as compared to POE or new well installation alternatives.

4.1.3.4 Alternative 3d: Connect Easy Street Residences to Oak Harbor Water System

This alternative involves installing a new water main with new retail customer water service connections to provide water supply from the City of Oak Harbor water system to the Easy Street Residences as shown in **Figures 4-7** and **4-8**. Note that the assumed connection depicted in **Figure 4-7** is based on information from King Water Management Services.

Preliminary Implementation Activities

Before final design and implementation of this alternative the following actions would need to be completed:

- Site visits and engagement with the owners/residents of the Easy Street Residences would need to be completed, and piping connection and implementation details would need to be agreed to.
- System design and sizing criteria would need to be formalized with the City of Oak Harbor, including piping alignments and installation details, as well as construction requirements.
- Property access agreements and requirements would need to be evaluated and finalized, including private property construction and utility easements, and right of entry agreements to support construction of improvements within private property limits.
- Design alignments and routes would need to be surveyed, to include property and public right-of-way boundaries, topography, surface features, and existing above and below grade utility locations. Existing utility alignments, where available, are shown on **Figure 4-8** and based on site reconnaissance and owner provided information.
- Substantive permitting requirements would need to be established and planned for.

Site Layout

Alternative improvements are illustrated in **Figure 4-8** and would generally include the following:

- Approximately 1,100 LF of 8-inch diameter below grade ductile iron (DI) water main, including associated roadway pavement, shoulder, and surface restoration along the pipe alignment, with connections to existing City of Oak Harbor water mains located along Goldie Road and NE Koetje Street, along with associated water

main isolation valving. A new fire hydrant would also be provided along the new water main near the intersection of Easy and Koetje Streets in accordance with minimum hydrant spacing requirements for City water mains.

- Single-family residential water service connections and below grade HDPE service lines between the new water main and the Easy Street Residences, to include service meters, isolation valving, and RPBAs to provide cross connection protection.
- Connection from the proposed water service lines into Easy Street Residence interior plumbing. If desired, connections may also be provided to support flexibility to be able to continue onsite irrigation using either water supplied from the existing private onsite well, or potable water supplied from the City of Oak Harbor connections. This would typically involve installation of a DCVA and a three-way valve to provide cross connection protection, along with associated plumbing adjustments to existing well system piping and appurtenances to provide for continued well supply functionality.

System Installation

The proposed water main and service line piping, along with associated appurtenances, would generally be installed below grade, typically with at least 3 feet of cover to protect against freezing and damage resulting from shallow surface excavations and improvements. Trenching for the water main installation would typically involve an approximately 5-feet deep by 3-feet wide excavation. Trenching for the water service line installations would typically involve an approximately 4-feet deep by 2.5-feet wide excavation, although narrower trench limits may be possible for installation via a "Ditch Witch" style trenching machine.

Operations and Maintenance

The City of Oak Harbor would become responsible for O&M of the proposed improvements outside the Easy Street Residence property limits. The Easy Street Residence property owners would be responsible for O&M of the system within the limits of their private property. Water supply and delivery charges based on metered supply from the City of Oak Harbor water system would become the responsibility of the individual Easy Street Residence property owners, subject to standard single-family residential water billing rate schedules. The property owner would also be responsible for annual RPBA inspections and testing, with results to be reported to the City.

Sustainability

Sustainability considerations for this alternative are related to the materials and equipment required to construct the alternative. This alternative is significantly more labor intensive as compared to POE or new well installation alternatives.

4.1.3.5 Alternative 3e: Connect Evergreen Mobile Home Park to Oak Harbor Water System

This alternative involves installing a new water main with a new wholesale customer water service connection to provide water supply from the City of Oak Harbor water system to the existing Evergreen Mobile Home Park system as shown in **Figures 4-7** and **4-9**. Note that the assumed connection depicted in **Figures 4-7 and 4-9** is based on information from King Water Management Services.

Preliminary Implementation Activities

Before final design and implementation of this alternative the following actions would need to be completed:

- Site visits and engagement with the Evergreen Mobile Home Park water system owners and operators would need to be completed, and piping connection and implementation details would need to be agreed to.
- System design and sizing criteria would need to be formalized with the City of Oak Harbor, including piping alignments and installation details, as well as construction requirements.
- Property access agreements and requirements would need to be evaluated and finalized, including private property construction and utility easements.

- Design alignments and routes would need to be surveyed, to include property and public right-of-way boundaries, topography, surface features, and existing above and below grade utility locations. Existing utility alignments, where available, are shown on **Figure 4-9** and based on site reconnaissance and owner provided information.
- Substantive permitting requirements would need to be established and planned for, and a water service agreement between the City of Oak Harbor and the Evergreen Mobile Home Park would need to be negotiated and established.

Site Layout

Alternative improvements are illustrated in **Figure 4-9** and would generally include the following:

- Approximately 20 LF of 8-inch diameter below grade DI water main, including associated roadway pavement, shoulder, and surface restoration along the pipe alignment, with connections to existing City of Oak Harbor water mains located along Goldie Road, along with associated water main isolation valving. A new figure hydrant would also be provided near the end of the new water main.
- A wholesale supply water service connection and below grade HDPE service line installed between the new water main and existing Evergreen Mobile Home Park water system piping, to include a wholesale service meter, isolation valving, a RPBA to provide cross connection protection, and a PRV to ensure a suitable water pressure is delivered to the existing system. Given that the mobile home park is on common property of the same ownership, the entire system will be served off a single wholesale supply meter connection. System demands and water supply capacity requirements for the Evergreen Mobile Home Park water system, and its existing 19 to 21 water service connections, were preliminarily estimated according to the demand estimating protocols outlined in the 2009 Washington State Department of Health Water System Design Manual. This was based on a review of the system's well water supply metered production and historical water use records spanning from 2008 to 2017. Based on historical use, average and maximum day demands were conservatively estimated at approximately 200 to 250 gpd and 750 gpd per connection respectively. Maximum instantaneous, peak hour, demands were conservatively estimated at up to 50 to 60 gpm for the system as a whole.

System Installation

The proposed water main and service line piping, along with associated appurtenances, would generally be installed below grade, typically with at least 3 feet of cover to protect against freezing and damage resulting from shallow surface excavations and improvements. Trenching for the water main installation would typically involve an approximately 5-feet deep by 3-feet wide excavation. Trenching for the water service line installations would typically involve an approximately 4-feet deep by 2.5-feet wide excavation, although narrower trench limits may be possible for installation via a "Ditch Witch" style trenching machine.

Operations and Maintenance

The City of Oak Harbor would become responsible for O&M of the proposed improvements upstream of the proposed wholesale supply meter. The Evergreen Mobile Home Park owners would remain responsible for O&M of the system downstream of the wholesale meter location. Water supply and delivery charges based on metered supply from the City of Oak Harbor water system would become the responsibility of the Evergreen Mobile Home Park owners, subject to standard wholesale supply water billing rate schedules. The Evergreen Mobile Home Park would also be responsible for annual RPBA inspections and testing, with results to be reported to the City.

Sustainability

Sustainability considerations for this alternative are related to the materials and equipment required to construct the alternative. This alternative is significantly more labor intensive as compared to POE or new well installation alternatives.

4.1.4 Alternative 4: New (Replacement) Drinking Water Well

This alternative would provide replacement drinking water wells for the existing private drinking water wells which have concentrations of PFOA and/or PFOS above the USEPA Health Advisory. The new drinking water wells would serve as replacement water sources for each residence, if drilled and screened in an appropriate (deeper) aquifer not impacted by PFOA and/or PFOS above the USEPA Health Advisory.

The viability of this option is dependent on each affected residence's (parcel's) geology, hydrogeology, and PFAS plume extents. This alternative includes replacing an existing drinking water well (replacing the existing household well connection) and does not include creating a new well for a community water supply (that option has been rejected for the reasons described in **Table 3-1**). Therefore, this alternative needs to be assessed on an area-specific basis. The alternative is evaluated for three area types:

- 4a: Conversion of a monitoring well to a new drinking water well for Ault Field Residence 1 (See **Figure 4-10**).
- 4b: Further site investigation (installation of a new monitoring well, aquifer testing, and PFAS analytical sampling) with potential conversion of the monitoring wells to new drinking water wells for:
  - 4b-1: Easy Street Residences
  - 4b-2: Evergreen Mobile Home Park

There are no state or federal regulations that currently restrict the homeowners use of their existing well. The Navy will give the residents the option to have their well decommissioned, used for non-potable uses (e.g. irrigation) and/or used for Navy's groundwater PFAS monitoring purposes. If future regulations restrict the use of the existing well for non-potable uses, then the Navy will disconnect the well from any points of uses and only use it for monitoring purposes (if approved by homeowner).

4.1.4.1 Alternative 4a – Existing Monitoring Well Conversion

As discussed in Sections 2.2.2 and 2.3.4, the new Ault Field Residence 1 monitoring well was drilled in a deeper aquifer unit with a potential upper confining layer between the shallow PFOA and PFOS concentrations in the current drinking water well and the new, deeper well screen. This new Ault Field Residence 1 monitoring well has been non-detect for PFOA and PFOS based on groundwater sample results before and after aquifer testing. Results from aquifer testing showed no evidence of hydraulic connection with the existing, impacted drinking water well (Navy, 2018i). A better understanding of the nature and extent, and migration pathways, of PFOA and/or PFOS near Ault Field Residence 1 (as part of future site SI and RI work) is needed to better understand the potential risk for future PFOA and/or PFOS impacts to the new well (and the deeper aquifer) if it is used as a long-term residential water supply well. However, preliminary data suggest the well could be an appropriate drinking water source for the residence. Routine groundwater monitoring would be needed to verify the PFOA and/or PFOS concentrations in this well water remain below the USEPA Health Advisory and contingency actions put in place in case concentrations approach or exceed the PAL.

Preliminary Implementation Activities

Preliminary implementation activities include work planning documents, sizing the new well pump, designing the new connection to the existing home water pipes, and obtaining appropriate permits and approvals to establish the current monitoring well as a drinking water well.

Site Layout

The site layout will include the connection of the new pump to the existing home water piping. It is assumed the existing home piping and appurtenances can be used once connected to the new well. Alternative improvements for Residence 1 are illustrated in **Figure 4-10**.

System Installation

The system installation will include installing the new pump and connecting the new well pump to the existing home water pipes.

Operations and Maintenance

O&M will include routine groundwater monitoring at the new well to confirm PFOA and/or PFOS concentrations remain below the USEPA Health Advisory. Quarterly (four times per year) groundwater sampling of the well water for PFAS at a location prior to any treatment by the resident (for example, owner installed water softeners) will be conducted for the first two years. If PFOA and/or PFOS remains non-detect, then sampling frequency would be reduced to semiannually (twice per year) thereafter. Once the Ault Field RI is complete and the site conceptual model refined, including PFOA and PFOS fate and transport, then monitoring frequency could be reduced further, or ceased.

The cost analysis for the EE/CA was carried out over 30 years to capture capital and long-term O&M costs and assumed quarterly (four times per year) sampling the first two years, and semiannually sampling (twice per year) for 28 years.

Sustainability

Sustainability considerations for this alternative are related to installation of transmission lines from the new wells to the residence, operation of the pump, and impacts associated with routine groundwater sampling work (for example, travel by car).

4.1.4.2 Alternative 4b – Site Investigation and Monitoring Well Conversion

Using available data for off-Base wells near Area 6, it appears a new, deeper water supply well option may be viable for the Area 6 off-Base residential water supply wells impacted by PFOA and/or PFOS concentrations above the USEPA Health Advisory. There is evidence in surrounding-area boring logs of a potential confining layer between the shallow aquifer and deeper (sea-level) aquifer in the vicinity of Area 6. The actual presence of such a confining layer has not been confirmed and, if present, such a confining layer may not be continuous in the area of the impacted drinking water wells.

New monitoring wells are not currently planned to investigate the new water supply well option near Area 6 prior to the submittal of the EE/CA. Therefore, the cost for such an evaluation is included in this alternative evaluation. A better understanding of the hydrogeology and PFOA and PFOS concentrations in groundwater in the deeper aquifer beneath the Easy Street Residences and Evergreen Mobile Home Park is required to assess the viability of a new (replacement) drinking water well option in this area. Additional investigation work would need to be performed as outlined in the decision flow-chart in **Figure 4-11** before the effectiveness of this alternative can be evaluated. Because of the uncertainty, if this alternative were chosen, contingency removal actions would need to be identified.

In addition to an initial investigation with new monitoring wells to assess the aquifer conditions in the vicinity of the Easy Street Residences and Evergreen Mobile Home Park a better understanding of the nature and extent, and migration pathways, of PFOA and/or PFOS (as part of future site SI and RI work) is also needed to better understand the potential risk for future PFOA and/or PFOS impacts to any new wells (and the deeper aquifer) if they are used as a long-term residential water supply well. Routine groundwater monitoring would be needed to verify the PFOA and/or PFOS concentrations in any new drinking water well water remains below the USEPA Health Advisory and contingency actions put in place in case concentrations approach or exceed the PAL if the new well alternative is chosen as the preferred removal action.

Preliminary Implementation Activities

Extensive preliminary implementation activities would be required for this alternative because of the need for additional site investigation work to evaluate the viability of the alternative. The investigation work for the Easy Street Residences and Evergreen Mobile Home Park would be implemented together. The work would be similar to what was performed for Ault Field Residence 1 and Residence 2 investigation work (Navy, 2018i and 2018h) and include the following:

- Property access agreements and requirements would need to be evaluated and finalized, including right of entry agreements to support construction of improvements within private property limits.

- Drilling of three 12-inch borings up to 250-feet deep – one on Evergreen Mobile Home Park property and two on Easy Street Residence properties (one on the east end, one on the west end). This is a subset of the total wells that would be needed for the alternative but considered sufficient for initial investigation and testing. If testing indicates the new (replacement) well option is viable for this subset of wells (per the decision diagram in **Figure 4-11**), then two additional replacement wells would be drilled for the remaining two Easy Street Residence properties.
- Installing 6-inch diameter monitoring wells in each 12-inch boring, constructed to meet specifications for a private drinking water wells (including 20-feet of stainless-steel screen and end cap, a steel riser starting at the surface of the well and ended 20 feet bgs, with the remainder of the monitoring well constructed of Schedule 80-PVC in between the steel riser and the stainless-steel screen).
- Developing the wells (pumping to remove dirt and debris and improve water quality) for use as monitoring wells.
- Sampling the three new monitoring wells. If PFOA and/or PFOS concentrations are less than the USEPA Health Advisory Level in all three wells, then additional testing would proceed. If not, this alternative would be rejected (see **Figure 4-11**).
- Performing aquifer testing, including one 8-hour variable rate step test and one 72-hour continuous constant rate test, pumping one well up to 50 gpm and monitoring the remaining two new monitoring wells and the five existing drinking water wells (if feasible). This could require removal of the existing drinking water well pumps during the test (disrupting water to the house for the duration of the testing).
- Performing PFAS sampling of groundwater from the three new monitoring wells before and after aquifer testing.
- Analyzing the hydraulic and analytical data from the testing, and potentially performing groundwater modelling work to inform the evaluation. The decision diagram in **Figure 4-11** would be used to decide if the monitoring wells could be converted to drinking water wells.
- If the analysis from the first three wells indicates there is a clean, confined, deeper aquifer for the Easy Street and Evergreen Mobile Home Park properties, then two additional wells would be drilled, installed, developed, and sampled. These would be on the two remaining Easy Street Residence properties.

Once it is determined the monitoring wells are appropriate for use as a new drinking water wells for each residence, preliminary implementation activities would include sizing the new well pump, designing the new connection to the existing home water piping, and obtaining appropriate permits and approvals to establish the current monitoring well as a drinking water well. Each current drinking water well would be replaced with the new, deeper drinking water well if an appropriate water bearing unit is available.

Site Layout

The site layout will include the connection of the new pump to the existing home water piping. It is assumed the existing home piping can be used once connected to the new well.

System Installation

The system installation will include installing the new pump and connecting the new well pump to the existing home water piping.

Operations and Maintenance

O&M will include routine groundwater monitoring at the new well to confirm PFOA and/or PFOS concentrations remain below the USEPA Health Advisory. Quarterly (four times per year) groundwater sampling of the well water for PFAS at a location prior to any treatment by the resident (for example, owner-installed water softeners) will be conducted for the first two years. If PFOA and/or PFOS remains non-detect, then sampling frequency would be reduced to semiannually (twice per year) thereafter. Once the Area 6 RI is complete and the site conceptual

model refined, including PFOA and PFOS fate and transport, then monitoring frequency could be reduced further, or ceased.

The cost analysis for the EE/CA was carried out over 30 years to capture capital and long-term O&M costs and assumed quarterly (four times per year) sampling the first two years, and semiannually sampling (twice per year) for 28 years.

Sustainability

Sustainability considerations for this alternative are related to installing new water supply wells (drilling and infrastructure). Other sustainability impacts include installation of water lines from the new wells to the residence, operation of the pump, and impacts associated with routine groundwater sampling work (for example, travel).

4.2 Evaluation of Alternatives

4.2.1 Evaluation Criteria

The criteria used to evaluate the removal action alternatives are based on *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (USEPA, 1993).

4.2.2 Effectiveness

The ***effectiveness*** criterion addresses the expected results of the removal action alternatives. It includes two major subcategories: protectiveness and ability to achieve the removal objectives.

- Protectiveness
  - Protective of public health and community
  - Protective of workers during implementation
  - Protective of the environment
  - Complies with ARARs
- Ability to Achieve Removal Objectives
  - Ability to meet the expected level of treatment or containment
  - Has no residual effect concern
  - Maintains long-term control

4.2.3 Implementability

The ***implementability*** criterion encompasses the technical and administrative feasibility of the removal action. It includes three subcategories: technical feasibility, availability of resources, and administrative feasibility.

- Technical feasibility
  - Construction and operational considerations
  - Demonstrated performance and useful life
  - Adaptability to environmental conditions
  - Contribution to performance of long-term removal actions
  - Implementation within the allotted time
- Availability of resources
  - Availability of equipment
  - Availability of personnel and services
  - Laboratory testing capacity
  - Post-removal action site control

- Administrative feasibility
  - Required permits or easement or rights-of-way
  - Impacts on adjoining property
  - Ability to impose institutional controls
  - Likelihood of obtaining exemptions from statutory limits (if needed)

4.2.4 Cost

The ***cost*** criterion encompasses the life-cycle costs of a project, including the projected implementation costs and the long-term O&M costs of each alternative. For the detailed cost analysis, the expenditures required to complete each alternative were estimated in terms of capital costs, including direct and indirect costs, to complete initial construction activities. Direct costs include the cost of construction, equipment, land and site development, treatment, transportation, and disposal. Indirect costs include engineering expenses and contingency allowances.

Future O&M costs would be required to ensure the continued effectiveness of Alternatives 1a and 1b, 2a and 2b, 3a and 3c, and 4a and 4b. The future costs were calculated using an assumed annual inflation rate of 2.6 percent for a 30-year timeframe. After inflating the future costs, they were analyzed using present worth, which discounts all future costs to a common base year (2018). Present-worth analysis allows the cost of the removal action to be compared on the basis of a single figure representing the amount of money that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the life of the removal action. The present-worth calculations included an assumed discount rate of 2.6 percent (White House OMB, 2014).

The estimated costs are provided to an expected accuracy of +50 percent and -30 percent. The cost estimates are in 2018 dollars, and the unit pricing is based on costs from similar projects, vendor quotes, or engineering estimates. The enclosed Engineer's Estimate (**Appendix B**) is only an estimate of possible costs for budgeting purposes.

4.2.5 Sustainability Considerations

In addition to the protectiveness and ability to achieve the RAO, sustainability should be considered, in accordance with the Department of the Navy Environmental Restoration Program Manual (Navy, 2018b). Therefore, a sustainability assessment was conducted using SiteWise Version 3.0 (SiteWise), a standalone tool that assesses the environmental footprint of a removal alternative to compare the overall life-cycle environmental impacts of each remedy (Battelle, 2013). The sustainability assessment provides an additional comparison criterion with respect to effectiveness, implementability, and costs that may allow options with smaller environmental impacts to be selected when all other criteria are met. The sustainability assessment is included in **Appendix C**. In addition, the environmental footprint of the selected alternative may be further evaluated in the design phase of the project to explore opportunities to optimize the environmental footprint of the project and integrate sustainable remediation best practices in the design, construction, and operation of the removal action.

4.2.6 Alternatives Evaluation Results

Table 4-1 summarizes the results of the alternatives evaluation with respect to effectiveness, ease of implementation, and cost.

Table 4-1. Evaluation of Removal Action Alternatives

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking
Naval Air Station Whidbey Island, Oak Harbor, Washington

Alternative	Description	Effectiveness	Ease of Implementation	Cost
Alternative 1 - No Further Action	Removal action would include continued implementation of actions already being implemented on site. This includes supply of bottled water to the off-base privately-owned properties and continued operation of the POU GAC undersink treatment systems. No further action is evaluated for the following group types based on current actions: • 1a-1: Ault Field Residence 1 (bottled water to a single-family residence) • 1a-2: Ault Field Residence 2 (bottled water to a single-family residence) • 1a-3: Easy Street residences (bottled water to five single-family residences) • 1a-4: Evergreen Mobile Home Park (bottled water to 18 units) • 1b: Evergreen Mobile Home Park (maintenance of one POU unit)	**Minimally Effective.** Is protective of human health, but allows for redistribution of contaminants in septic systems and potential for incidental ingestion. For current off-Base drinking water receptors, although PFOA and/or PFOS impacted groundwater would not be used for drinking and cooking, it may be ingested during showering or other household/recreational activities. There are no potential short-term risks to site workers since the systems are already implemented. There are no potential short-term risks to the community under this alternative. Although there are no chemical-specific ARARs, the contaminant concentrations pose potential unacceptable risk and/or exceed the Lifetime Health Advisory. Does not achieve removal objective for current off-base drinking water receptors. Long-term protectiveness is not achieved as impacted groundwater may incidentally be used as drinking water. Additionally, impacted groundwater remains untreated and is recirculated back into the ground via the septic system. Environmental impacts are primarily associated with material production and transportation of bottled water and routine sampling of POU undersink treatment systems. The SiteWise evaluation indicates greenhouse gas, energy use and accident risk are comparatively moderate and priority pollutant emissions are comparatively low.	**Moderately easy.** Implementation is technically feasible. Off-Base drinking water (bottled water and POU system treated water) is already being provided. Bottled water delivery is assumed to continue on a bi-weekly delivery schedule at the same average volumes currently used per household. POU system installation is associated with one Evergreen Mobile Home Park resident with components that are well-established, available and can be replaced easily. If additional POU systems are requested by impacted residents, they could be installed within 4 weeks (assuming it could be performed under an existing subcontract). PRSCs are required and include routine water sampling (up to 12-weeks apart) and anticipated relatively frequent change out of the GAC cartridges every 3 to 6 months for the POU treatment systems.	1a-1: Ault Field Residence 1: Capital Cost $1,300 Total Present Value O&M Costs $52,400 Total Present Value $53,700 1a-2: Ault Field Residence 2: Capital Cost $1,300 Total Present Value O&M Costs $97,700 Total Present Value $99,000 1a-3: Five Easy Street Residences: Capital Cost $1,300 Total Present Value O&M Costs $279,200 Total Present Value $280,500 1a-4 and 1b (combined): Evergreen Mobile Home Park: Capital Cost $1,300 + $5,100 = $6,400 Total Present Value O&M Costs $934,400 + $853,800 = $1,788,200 Total Present Value $935,700 + $858,900 = $1,794,600

Table 4-1. Evaluation of Removal Action Alternatives

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking
Naval Air Station Whidbey Island, Oak Harbor, Washington

Alternative	Description	Effectiveness	Ease of Implementation	Cost
Alternative 2a - Point of Entry - Granular Activated Carbon	Removal action includes treatment of water at the POE to each private property using GAC. GAC is a form of carbon processed to have small, low-volume pores that increase the surface area available for adsorption or chemical reactions. GAC is capable of adsorbing PFOA and PFOS. GAC can be regenerated through thermal desorption, of disposed of via incineration, resulting in ultimate destruction of the PFAS. POE GAC treatment is evaluated for two group types: • 2a-1 through 2a-3: Individual private resident drinking water wells (considered representative for Ault Field Residence 1 [2a-1], Ault Field Residence 2 [2a-2], and Easy Street Residences [2a-3] evaluations) • 2a-4: Evergreen Mobile Home Park drinking water well (this currently supplies 19 residents, but up to 21 residences are possible in the mobile home park)	**Effective.** Is protective of human health to current off-base drinking water receptors because PFOA and/or PFOS would be removed from groundwater used as drinking water through treatment via GAC. Potential short-term risks to site workers would be managed through provisions of proper PPE. There are no potential short-term risks to the community under this alternative. Although there are no chemical-specific ARARs, the contaminant concentrations pose potential unacceptable risk and/or exceed the Lifetime Health Advisory, which Alternative 2a would remove. Achieves removal objective for current drinking water receptors. Long-term protectiveness is achieved, provided that treatment media is changed out in a timely manner once the PIL for PFOA and/or PFAS of 35 ng/L (half of the USEPA Lifetime Health Advisory) are reached, and impacted treatment media is transported safely offsite for disposal. Environmental impacts are primarily associated with material production, transportation and incineration (or other approved disposal methods) of GAC, and energy usage associated with the treatment systems. The SiteWise evaluation indicates greenhouse gas, energy use and accident risk are comparatively moderate and priority pollutant emissions are comparatively low.	**Moderately easy.** Implementation is technically feasible. System installation procedures and system components are well-established, available and can be replaced easily. System installation timeframe is moderate to long (up to 12 months for lab testing, up to 15 months for work planning, design, subcontracting, and installation). Lab column testing of GAC treatment of representative waters is recommended to support and refine POE system design and operation. GAC POE equipment installation does not require specialized equipment. PRSCs are required and include routine sampling and changeout frequencies which could vary for each POE system based on water use, general water quality, and PFAS concentrations. However, a conservative sampling and change out frequency is assumed for the specific group types as follows: • Individual private resident POE: System sampling 4 times per year at Ault Field Residence 2 well (2a-2) and 2 times per year at rest of the single-family residence wells (2a-1 and 2a-3). • Evergreen Mobile home park POE (2a-4): System sampling 4 times per year and GAC change out 2 times per year.	2a-1: Ault Field Residence 1: Capital Cost $139,000 Total Present Value O&M Costs $420,000 Total Present Value $560,000 2a-2: Ault Field Residence 2: Capital Cost $139,000 Total Present Value O&M Costs $640,000 Total Present Value $780,000 2a-3: Five Easy Street Residences: Capital Cost $2,300,000 Total Present Value O&M Costs $1,690,000 Total Present Value $1,920,000 2a-4: Evergreen Mobile Home Park: Capital Cost $451,000 Total Present Value O&M Costs $1,115,000 Total Present Value $1,570,000 Note: some sub-option costs presented above may over-estimate actual costs if multiple Alternative 2 sub-options are implemented, due to efficiencies in combining work planning, reports, treatability testing, and subcontracting.

Table 4-1. Evaluation of Removal Action Alternatives

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking
Naval Air Station Whidbey Island, Oak Harbor, Washington

Alternative	Description	Effectiveness	Ease of Implementation	Cost
Alternative 2b - Point of Entry - Ion Exchange	Removal action includes treatment of water at the POE to each private property using IX. During IX, resins loaded with non-toxic ions are "exchanged" for PFAS constituents, allowing the PFAS to remain in the resin, while non-toxic ions are added to the water exiting the treatment process. Used IX resins would be taken offsite for incineration or other destructive treatment, resulting in ultimate destruction of the PFAS. POE IX treatment is evaluated for two group types: • 2b-1 through 2b-3: Individual private resident drinking water wells (considered representative for Ault Field Residence 1 [2b-1], Ault Field Residence 2 [2b-2], and Easy Street Residences [2b-3] evaluations) • 2b-4: Evergreen Mobile Home Park drinking water well (this currently supplies 19 residents, but up to 21 residences are possible in the mobile home park)	**Effective:** Protective of human health to current off-base drinking water receptors because PFOA and/or PFOS would be removed from groundwater used as drinking water through treatment via IX. Potential short-term risks to site workers would be managed through provisions of proper personal protective equipment (PPE). There are no potential short-term risks to the community under this alternative. Although there are no chemical-specific ARARs, the contaminant concentrations pose potential unacceptable risk and/or exceed the Lifetime Health Advisory, which Alternative 2b would remove. Achieves removal objective for current off-base drinking water receptors. Long-term protectiveness is achieved, provided that treatment media is changed out in a timely manner once PIL for PFOA and/or PFAS of 35 ng/L (half of the USEPA Lifetime Health Advisory) are reached, and impacted treatment media is transported safely offsite for disposal. Environmental impacts are primarily associated with transportation and disposal through incineration (or other approved disposal method) of used IX and energy usage associated with the treatment system. The SiteWise evaluation indicates greenhouse gas, energy use, and priority pollutant emissions are comparatively low, and accident risk is comparatively moderate.	**Moderately Easy.** Implementation is technically feasible - components are well established, available, and can be completed with conventional equipment and equipment. System installation timeframe is moderate to long (up to 12 months for lab testing, up to 15 months for work planning, design, subcontracting, and installation). Lab column testing of IX treatment of representative waters is recommended to support and refine POE system design and operation. IX POE equipment installation does not require specialized equipment. PRSCs are required and include a conservative sampling and change out frequency for the specific group types as follows: • Individual private resident POE: System sampling 12 times per year at Ault Field Residence 2 well and 4 times per year at rest of the single-family residence wells. Changeout frequency for Ault Field Residence 2 (2b-2) is assumed to be every 2 months. However, for the rest of the houses, changeout is assumed once every 2 years 21b-1 and 2b-3). • Evergreen Mobile home park POE (2b-4): System sampling 4 times per year and media change out is assumed to be once a year.	2b-1: Ault Field Residence 1: Capital Cost $157,000 Total Present Value O&M Costs $560,000 Total Present Value $720,000 2b-2: Ault Field Residence 2: Capital Cost $157,000 Total Present Value O&M Costs $1,300,000 Total Present Value $1,460,000 2b-3: Five Easy Street Residences: Capital Cost $248,000 Total Present Value O&M Costs $2,350,000 Total Present Value $2,600,000 2b-4: Evergreen Mobile Home Park: Capital Cost $467,000 Total Present Value O&M Costs $1,018,000 Total Present Value $1,490,000 Note: some sub-option costs presented above may over-estimate actual costs if multiple Alternative 2 sub-options are implemented, due to efficiencies in combining work planning, reports, treatability testing, and subcontracting.

Table 4-1. Evaluation of Removal Action Alternatives

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking
Naval Air Station Whidbey Island, Oak Harbor, Washington

Alternative	Description	Effectiveness	Ease of Implementation	Cost
Alternative 3 – Navy or Public Water Connection	Water supply lines from existing Navy or public water supply agencies would be run to impacted off-base properties with PFOA/PFOS drinking water concentrations greater than the USEPA Lifetime Health Advisory. Navy or public water connection is evaluated for the following group types: • 3a: Ault Field Residence 1 connection to City of Oak Harbor Water line via Navy-maintained connection • 3b: Ault Field Residence 2 connection to on-Base Navy water line • 3c: Ault Field Residence 2 connection to Pine Terrace Water System • 3d: Easy Street Residences five individual connections to City of Oak Harbor water line • 3e: Evergreen Mobile Home Park single connection to the City of Oak Harbor water line (with owner distribution to individual mobile home park residences with existing connections)	**Effective to Very Effective.** Protective of human health to current off-base drinking water receptors because contaminated groundwater contaminated by PFOA and/or PFOS would no longer be used as a drinking water source, being replaced by the alternative supply of drinking water from the Navy or public water supply agencies. Most alternatives will include use of City of Oak Harbor supplied water (the Navy on-Base water is derived from the City of Oak Harbor) which originates from the Skagit River in Anacortes. This water is not impacted by PFAS.. Ault Field Residences 1 and 2 and Easy Street Residences will have the opportunity to continue using well water only for irrigation purposes, significantly reducing risk to human health. Use of isolation valves and reduced backflow prevention assemblies at these residences further ensure that drinking water is not contaminated by well water. Potential short-term risks to site workers would be managed through provisions of proper PPE. Potential short-term risks to the community as a result of transporting fill material would be managed by ensuring trucks are not overloaded and are covered as they transport fill material to the site. There would also be added traffic and noise impacts to the community due to installing water lines in county roads. Traffic control will be used to reduce the impact to the flow of traffic. Although there are no chemical-specific ARARs, the contaminant concentrations pose potential unacceptable risk and/or exceed the Lifetime Health Advisory. Alternative 3 would eliminate potential exposure. Achieves removal objective for current off-base drinking water receptors. No residual effect concerns, because impacted groundwater would no longer be used for drinking water purposes. Provides a permanent, long-term solution. Environmental impacts are primarily associated with production of materials and operation of mechanical earthwork equipment. The SiteWise evaluation indicates the greenhouse gas emissions and energy use as moderate and the priority pollutant emissions as comparatively high due to material production of the water main. The accident risk is comparatively low. The on-Base Navy water line connection and Pine Terrace Water System connection have the following additional group specific effectiveness considerations: • 3b. Ault Field Residence 2 connection to on-Base Navy water line: This could pose a low-risk security threat (to the Base) by having an off-base connection to the Base water supply. This will be addressed by ensuring the RPBA is placed within the boundary of the Base, so that it is secure and under Navy control. • 3c. Ault Field Residence 2 connection to Pine Terrace Water System: This water supply is from two groundwater wells which have a small risk of being impacted by on-Base PFAS contamination sources. This will not be known until the Ault Field RI is complete. All the water connection alternatives are considered **Very Effective**, except for 3c (Ault Field Residence 2 connection to Pine Terrace Water System), which is considered **Effective** because of the slight uncertainty that the groundwater wells from the Pine Terrace Water System could be affected by PFAS in the future.	**Moderate to Moderately Easy.** Implementation is technically feasible. Components are well established and available, and can be completed with conventional equipment. Water line installation timeframe is a moderate timeframe (around 12 to 18 months for work planning, design, permitting, subcontracting and construction). Ease of implementation varies for each of the site groupings as noted below. This alternative requires earth moving equipment, access to right of ways, construction right of entries on private property, potential disruption of traffic, and large amount of earth moving. Additionally, implementation requires coordination with the Navy, Pine Terrace Water Association, and/or the City of Oak Harbor. There are no PRSCs required for Alternatives 3b, 3d or 3e. For Alternatives 3a and 3c the automatic flushing stations will require routine checks, maintenance, and battery replacements. Group specific implementation considerations include the following: • 3a. Ault Field Residence 1 connection to City of Oak Harbor Water line via Navy-maintained connection: **Moderate.** This will require extensive coordination with the Navy and the City of Oak Harbor than other areas because of the need to designate the Navy as the water supplier of City of Oak Harbor water. This could lengthen the implementation schedule. The long pipe-length will require a flushing station. This may involve directing discharged water to a catch basin and groundwater infiltration trench. Relevant permits may need to be obtained. • 3b. Ault Field Residence 2 connection to on-Base Navy water line: **Moderately Easy**. This requires special Navy approvals to implement. • 3c. Ault Field Residence 2 connection to Pine Terrace Water System: **Moderate**. This will require coordination with the Pine Terrace Water Association to implement. The long pipe-length will require a flushing station. This includes specific flushing station implementation considerations and noted in 3a. 3d. Easy Street residences connections to City of Oak Harbor water line: **Moderately Easy**. This will require coordination with the City of Oak Harbor to implement, who has indicated a willingness to support this alternative. 3e. Evergreen Mobile Home Park connection to City of Oak Harbor water line: **Moderately Easy**. This will require coordination with the City of Oak Harbor to implement, who has indicated a willingness to support this alternative.	3a. Ault Field Residence 1 connection to City of Oak Harbor Water line via Navy-maintained connection: Capital Cost $1,132,700 Total Present Value O&M Costs $74,400 Total Present Value $1,207,100 3b. Ault Field Residence 2 connection to on-Base Navy water line: Capital Cost $288,700 Total Present Value O&M Costs $0 Total Present Value $288,700 3c. Ault Field Residence 2 connection to Pine Terrace Water System: Capital Cost $1,055,800 Total Present Value O&M Costs $74,400 Total Present Value $1,130,200 3d. Easy Street residences connections to City of Oak Harbor water line: Capital Cost $515,000 Total Present Value O&M Costs $0 Total Present Value $515,000 3e. Evergreen Mobile Home Park connection to City of Oak Harbor water line: Capital Cost $385,500 Total Present Value O&M Costs $0 Total Present Value $385,500

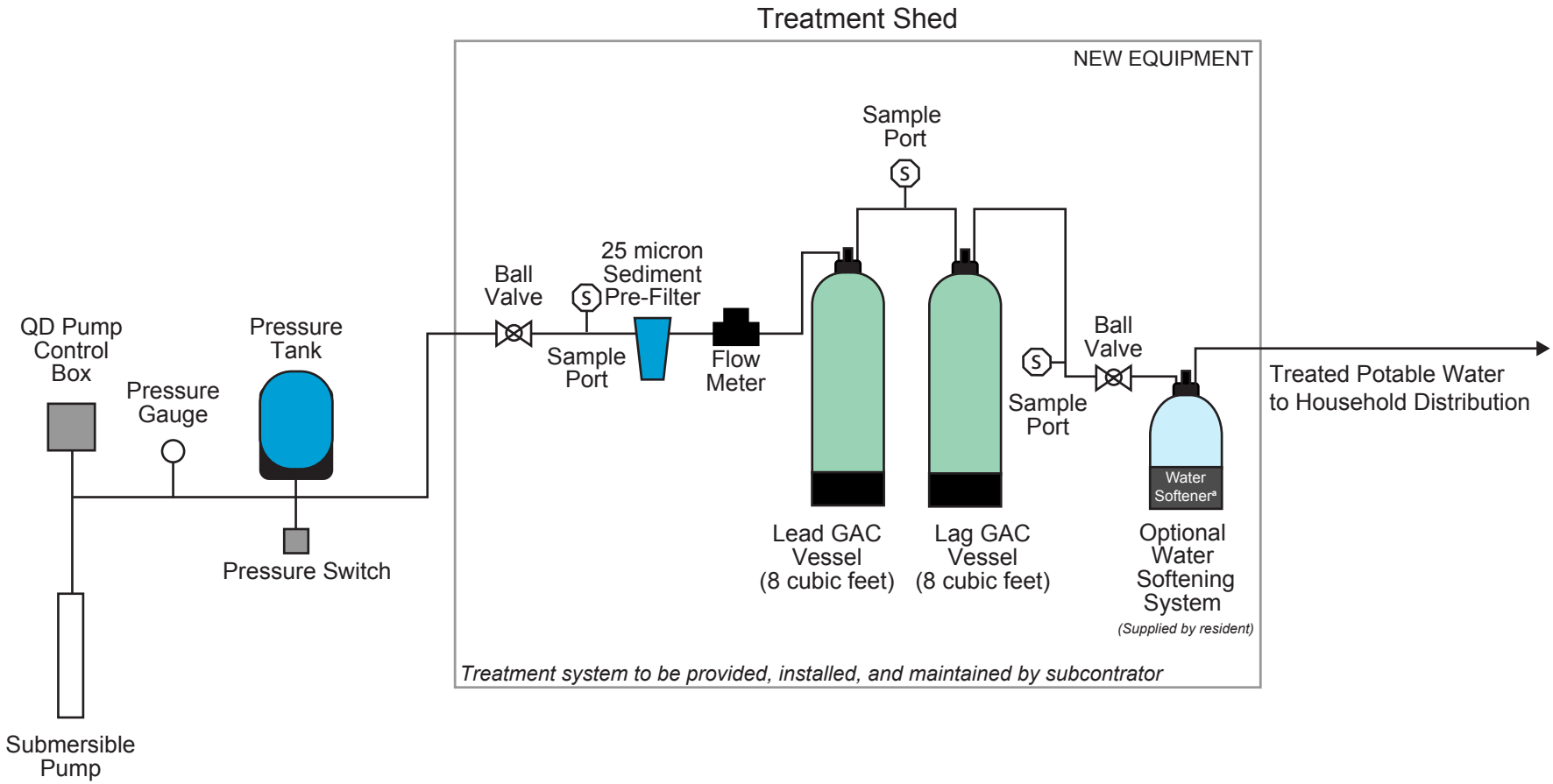
Table 4-1. Evaluation of Removal Action Alternatives

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking

Naval Air Station Whidbey Island, Oak Harbor, Washington

Alternative	Description	Effectiveness	Ease of Implementation	Cost
Alternative 4 – New (Replacement) Well	Removal action includes two versions of a new (replacement) well for affected residences, where applicable. 4a: Ault Field Residence 1 Existing Well Conversion: this includes the use of the newly drilled monitoring well at Residence 1 in a deeper, unimpacted aquifer as a new drinking water well. The new, deeper monitoring well installed at Residence 1 (MW-611), adjacent to Ault Field (during the Ault Field site investigation), could be converted for use as a new drinking water well. 4b: Investigation and Potential Well Conversion for Area 6 Off-Base residences: this includes drilling monitoring wells in a deeper, potentially unimpacted aquifer for Easy Street Residences (4b-1) and Evergreen Mobile Home Park (4b-2), and testing these wells for PFAS and hydraulic properties (especially connections to shallower-impacted groundwater). If appropriate, the monitoring wells could be converted to new drinking water wells for the residences.	4a: **Effective**. The new monitoring well drilled on Ault Field Residence 1 meets State and County drinking water well construction standards and could be converted/permitted as a household drinking water well. The initial water samples from this new well are nondetect for PFOA/PFOS. Aquifer testing indicates there is minimal hydraulic connection between the current drinking water well and the new monitoring well at Residence 1. Additional evaluation will be needed to identify if PFOA/PFOS would remain below the USEPA Lifetime Health Advisory if it is pumped long-term for water supply. Contingency actions would be needed to address potential future PFAS contamination. If PFAS approached the USEPA Lifetime Health Advisory in this well, then POE treatment would be required (contingency action). 4b: **Minimally Effective to Effective**. This alternative is classified as potentially Minimally Effective because of the uncertainty if a deeper, confined, non-PFAS impacted aquifer unit is available at the location of the effected off-Base Area 6 residences. Available geology and PFAS data in the vicinity of the affected Area 6 off-Base parcels suggests PFAS contamination may be limited to the shallow and/or mid-level aquifer and that a confining layer may exist between these shallower aquifers and the deeper (sea-level) aquifer. Additional field data would need to be collected in the area to evaluate this option (including drilling deeper wells and performing aquifer testing). The retention of this remedial option in the EE/CA will follow a decision-tree as additional data is collected (see **Figure 4-10**). Potential short-term risks to site workers would be managed through provisions of proper PPE. Potential short-term risks to the community as a result of drilling and IDW transport. There would also be added traffic and noise impacts to the community during drilling, well development, and aquifer testing. Although there are no chemical-specific ARARs, the contaminant concentrations pose potential unacceptable risk and/or exceed the Lifetime Health Advisory. Alternative 4 may eliminate potential exposure and achieve removal objectives for current off-base drinking water receptors (with continued monitoring to assess effectiveness). Long-term protectiveness may be achieved, provided that well monitoring continues to show PFAS concentrations below PALs in the drinking water wells. Environmental impacts are primarily associated with production of materials and operation of mechanical drilling equipment, IDW transport and disposal, and installing transmission lines from the new wells. The SiteWise evaluation indicates the greenhouse gas emissions and energy use as moderate and the priority pollutant emissions as comparatively large quantities of IDW. The accident risk is comparatively low.	4a: **Easy.** Implementation is technically feasible and easy. Components are well established and available, and can be completed with conventional equipment. Well connection timeframe is fairly quick (up to 5 months). 4b: **Moderately Easy**. Implementation is technically feasible. Components are well established and available, and can be completed with conventional equipment. The investigation period would be about 6 months to determine if the option is appropriate/effective, with a short time-frame to convert the well. This alternative requires drilling and aquifer testing equipment, access to right of ways, construction right of entries on private property and potential disruption of traffic and resident home use (during aquifer testing). PRSCs, including routine PFAS monitoring of the drinking water well, would be required.	4a: Ault Field Residence 1 Existing Well Conversion: Capital Cost $38,900 Total Present Value O&M Costs $284,500 Total Present Value $323,400 4b-1: Investigation and Potential Well Conversion for Easy Street residences: Capital Cost $1,802,300* Total Present Value O&M Costs $820,600 Total Present Value $2,367,300* 4b-2: Investigation and Potential Well Conversion for Evergreen Mobile Home Park: Capital Cost $1,166,000* Total Present Value O&M Costs $469,500 Total Present Value $1,635,500* *If Alternatives 4b-1 and 4b-2 are combined the Capital Cost of the alternatives would be reduced compared to the sum of the costs for 4b-1 and 4b-2 (requiring only one aquifer test and combined site planning work).

Notes:
ARAR = Applicable or Relevant and Appropriate Requirements
GAC = granular activated carbon
IDW = investigation-derived waste
IX = ion exchange
NALF = Naval Auxiliary Landing Field
Navy = Department of the Navy
ng/L = nanograms per liter
O&M = Operations and Maintenance
PFAS = per- and polyfluoroalkyl substances
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonic acid
PIL = project indicator level
POE = point-of-entry
POU = point-of-use
PPE = personal protective equipment
PRSC = Post-Removal Site Controls
PPE = personal protective equipment
USEPA = United States Environmental Protection Agency



Note:

[a] A water softening system is not required for PFOA/PFOS treatment. However, a well owner could choose to supply and install one.

Figure 4-1.

Single Family Home Drinking Water Granulated Activated Carbon Treatment System

Engineering Evaluation and Cost Analysis for Drinking Water
NAS Whidbey Island, Oak Harbor, Washington

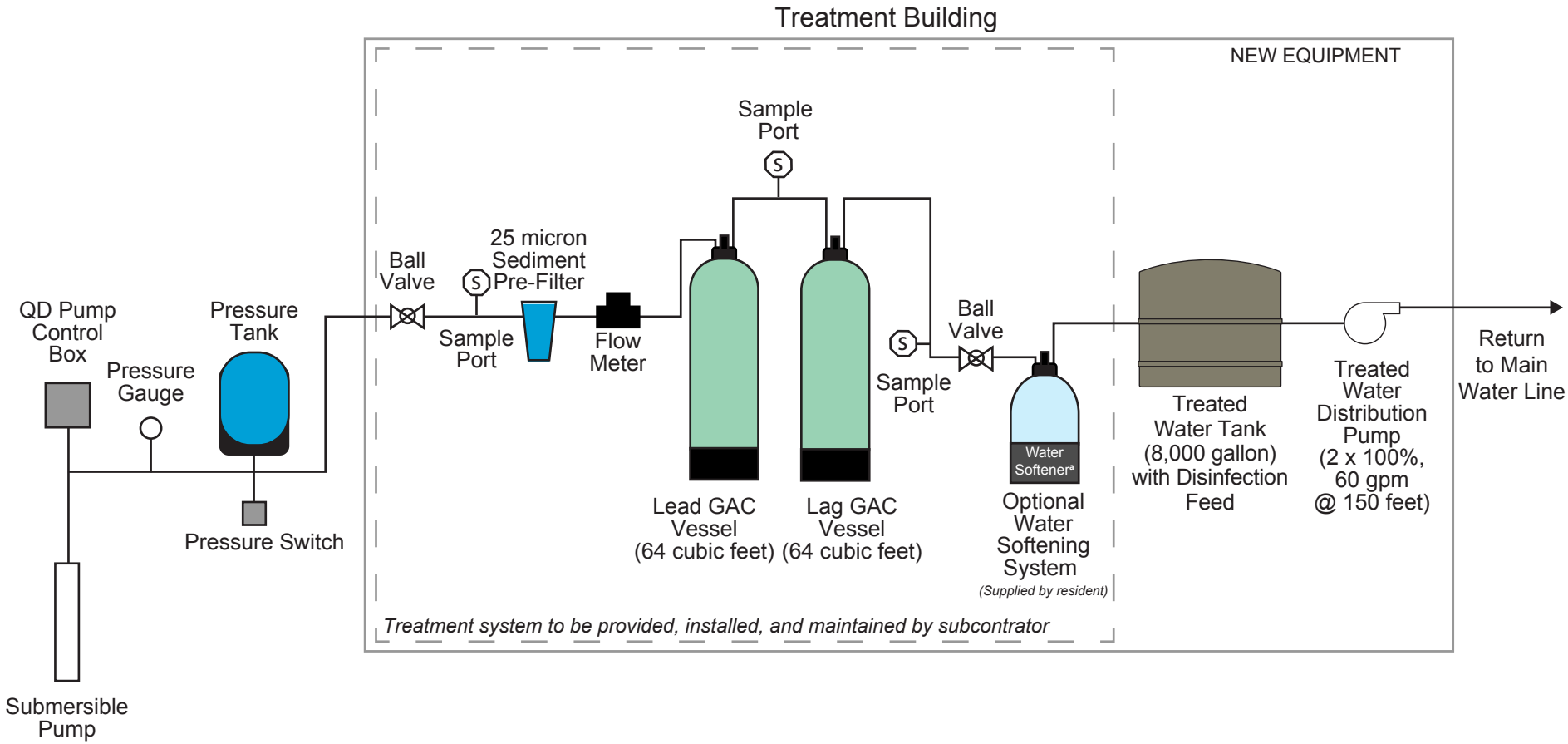
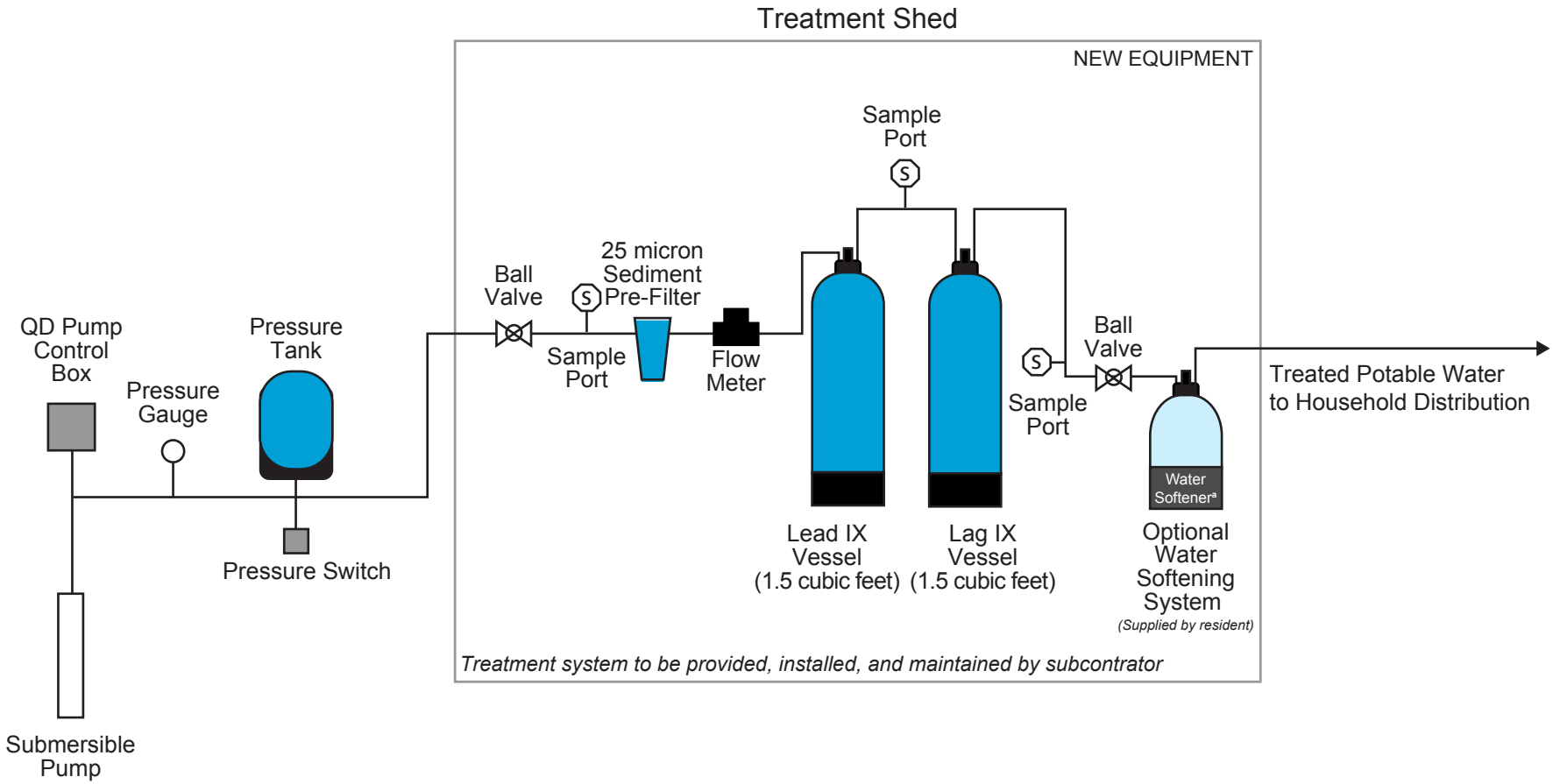


Figure 4-2.
Evergreen Mobile Home Park
Granulated Activated Carbon Treatment System
Engineering Evaluation and Cost Analysis for Drinking Water
NAS Whidbey Island, Oak Harbor, Washington

Note:
[a] A water softening system is not required for PFOA/PFOS treatment. However, a well owner could choose to supply and install one.



Note:

[a] A water softening system is not required for PFOA/PFOS treatment. However, a well owner could choose to supply and install one.

Figure 4-3.
Single Family Home Drinking Water Ion Exchange Treatment System
Engineering Evaluation and Cost Analysis for Drinking Water
NAS Whidbey Island, Oak Harbor, Washington

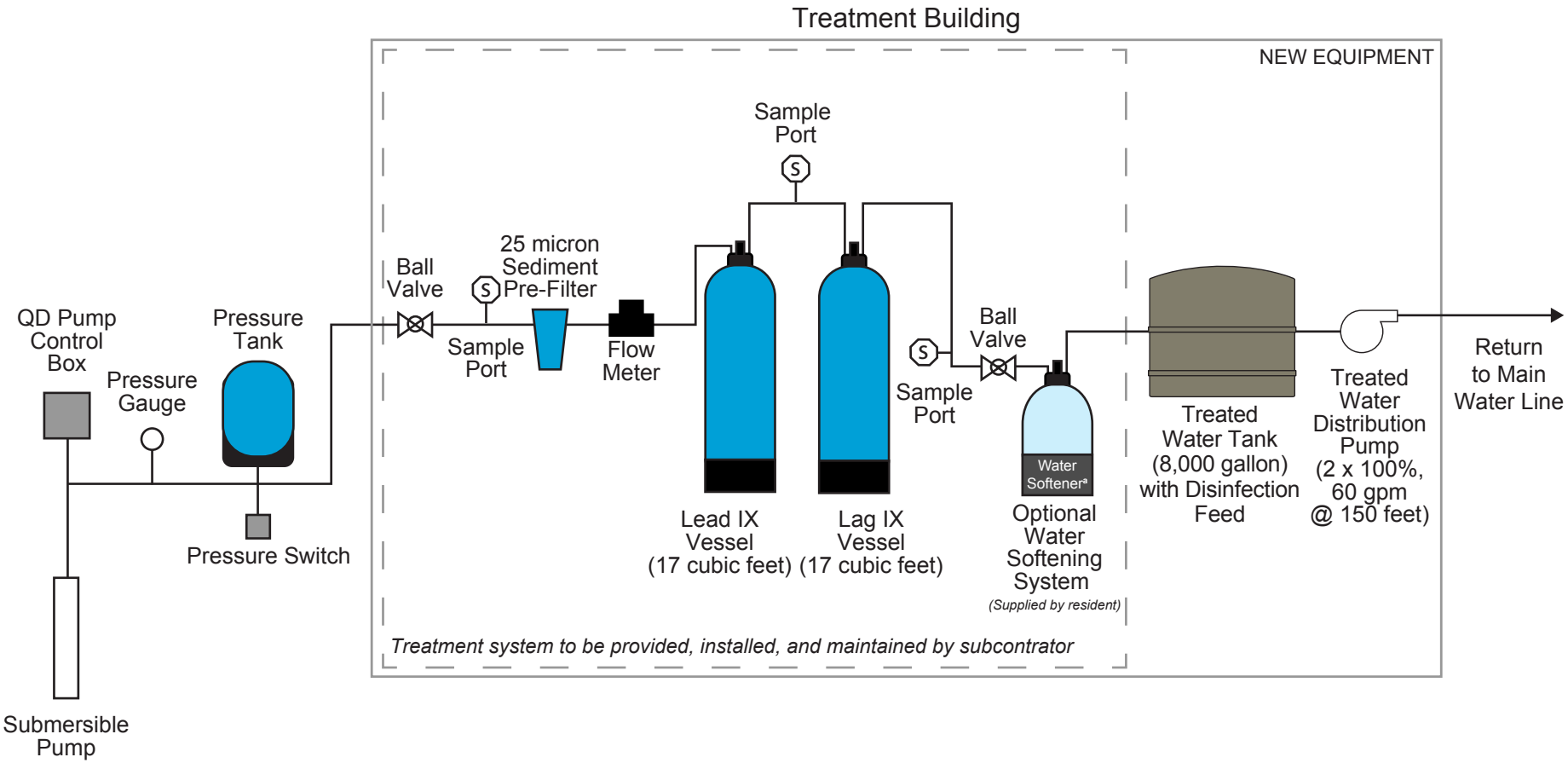


Figure 4-4.
Evergreen Mobile Home Park
Ion Exchange Treatment System
Engineering Evaluation and Cost Analysis for Drinking Water
NAS Whidbey Island, Oak Harbor, Washington

Note:
[a] A water softening system is not required for PFOA/PFOS treatment. However, a well owner could choose to supply and install one.

Engineering Evaluation/Cost Analysis
Long-term Solutions for Ault Field and
Area 6 Drinking Water
Naval Air Station Whidbey Island
Oak Harbor, Washington

NOTIFICATION: FIGURE 4-5 CONTAINS SENSITIVE BUT UNCLASSIFIED INFORMATION WHICH IS PROTECTED BY THE FREEDOM OF INFORMATION ACT

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Naval Air Station Whidbey Island
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Naval Air Station Whidbey Island
Oak Harbor, Washington

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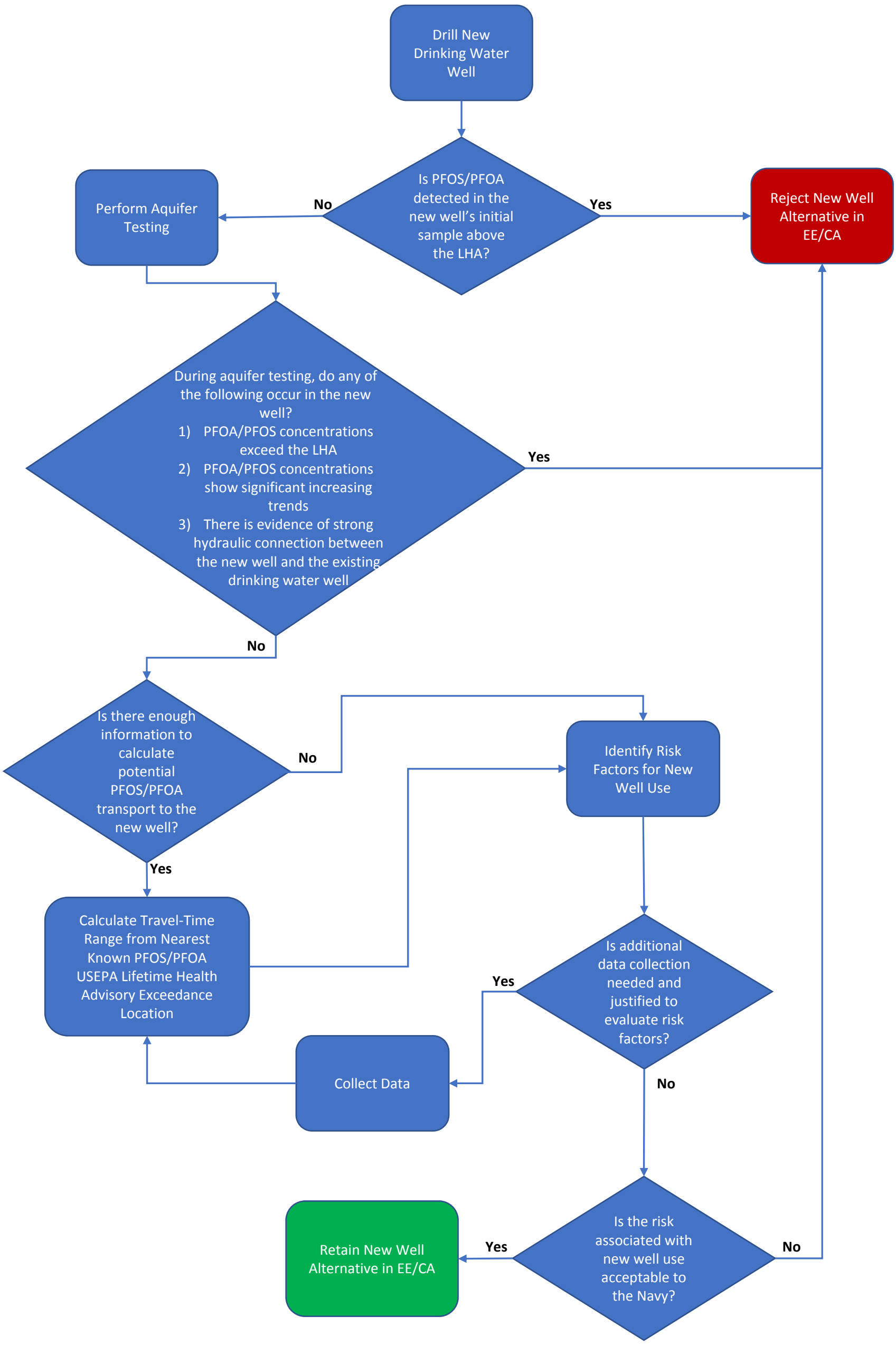

Notes:
EE/CA = Engineering Evaluation/Cost Analysis
USEPA = U.S. Environmental Protection Agency
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Figure 4-11
Ault Field New Residential Well Remedial Alternative Decision Tree
Naval Air Station Whidbey Island
Oak Harbor, Washington

SECTION 5

Comparative Analysis of Removal Action Alternatives

Section 5 evaluates the alternatives by providing a comparative analysis related to their effectiveness, ease of implementation, and cost, to assist the decision-making process by which a removal action will be selected. Section 4 described the alternatives in detail and provided alternative evaluation in **Table 4-1**. In this section, the alternatives are compared to one another for each of the three criteria.

Table 5-1 summarizes the results of the alternatives comparison. Comparative terms used in **Table 5-1** are defined relative to other alternatives.

5.1 Effectiveness

Alternative 1 (continued use of bottled water [1a] or POU treatment for one home [1b]) is considered **minimally effective** because it is only moderately protective of human health. Although there are no chemical-specific ARARs, Alternative 1 is only minimally effective in addressing exposure to PFOA and PFOS because it does not eliminate PFOA- and PFOS-impacted water use for the whole house. Although Alternatives 1a and 1b provide bottled water or POU treatment for drinking and cooking water for the off-Base parcels, it does not address ingestion that may occur for inadvertently using impacted well water from the tap or shower. It also provides less long-term control and does not contribute to the effective performance of a future groundwater remedy, if any, because PFOA and PFOS in water used for non-potable purposes at off-Base homes would be re-released to the environment in septic leach fields with no controls. There are minimal risks to workers and the community associated with bottled water delivery (driving and truck traffic) and POU treatment system monitoring and maintenance (GAC cartridge changeouts) for this alternative.

Alternative 2 (POE treatment by GAC [2a] and IX [2b]) is considered **effective** and protective of human health because PFOA or PFOS is removed from the groundwater supply through treatment. Water used for household purposes under Alternatives 2a and 2b will not contain PFOA or PFOS above the USEPA Health Advisory. Therefore, PFOA and PFOS would not be released back into the environment through disposal of household wastewater (via the septic system). However, the homeowners will have the option to continue to use current (untreated) well water for irrigation purposes, which could release PFOA and/or PFOS to the subsurface. Alternatives 2a and 2b pose short-term construction phase risks to workers during implementation of the alternatives, although risk can be managed through the use of personal protective equipment and standard health and safety protocols. There are minor risks to the community during implementation because of worker road-way travel.

Alternatives 3a, 3b, 3d, and 3e (connection to Navy or City of Oak Harbor water supply) are considered **very effective**. These alternatives use City of Oak Harbor water, which is from the Skagit River in Anacortes that includes treatment to maintain compliance with applicable water quality standards. Alternative 3c (connection to the Pine Terrace Water System) is considered **effective** because it utilizes groundwater south of Ault Field. There is a risk the well could become impacted with PFOA and/or PFOS in the future, and continued monitoring is needed until the Ault Field RI is complete. Alternatives 3a through 3e are protective of human health because PFOA- and/or PFOS-impacted groundwater is no longer used to provide water to affected residences, thus eliminating receptor exposure (based on current City of Oak Harbor and Pine Terrace Water Association water quality). Water used for household purposes under Alternatives 3a through e currently do not contain PFOA or PFOS. Therefore, PFOA and PFOS would not be released back into the environment through disposal of wastewater (via the septic system). However, the homeowners will have the option to continue to use current (untreated) well water for irrigation purposes which could re-release PFOA and/or PFOS to the subsurface. Alternatives 3a through 3e pose short-term construction phase risks to workers during implementation of the

alternatives, although risk can be managed through the use of personal protective equipment and standard health and safety protocols. Risks are higher for the alternatives with longer service line needs (Alternatives 3a and 3c). Under Alternatives 3a through 3e, there is risk to the community through transportation of fill materials. The impacts on the community can be managed by covering trucks and implementing traffic controls, as needed.

Alternative 4a (conversion of an existing monitoring well to a drinking water well) and Alternative 4b (installation/investigation with new monitoring wells and potential conversion to a drinking water well) have different effectiveness scores. Alternative 4a is considered **effective** and protective of human health as long as the groundwater extracted from the new, deeper well remains below the USEPA Health Advisory for PFOA and/or PFOS. The effectiveness of Alternative 4b is currently unknown and further site investigation is required to assess it, as detailed in Section 4.1.4.2. Therefore, this alternative is ranked as **minimally effective** due to the uncertainty. Because both household water and irrigation water would be served by the new well, release of PFOA and/or PFOS would be mitigated for both waste-water discharge and irrigation, assuming the extracted groundwater has PFOA and/or PFOS below the USEPA Health Advisory. Alternatives 4a and b pose short-term construction phase risks to workers during implementation of the alternatives (greater for Alternative 4b), although risk can be managed through the use of personal protective equipment and standard health and safety protocols. There are minimal risks to the community during implementation of Alternative 4a, associated with worker road-way travel. But there is greater risk to the community through transportation of investigation-derived waste (IDW) from drilling and aquifer testing associated with Alternative 4b. The impacts on the community can be managed by covering trucks and implementing traffic controls.

The RAO and long-term protectiveness are not achieved under Alternative 1a and 1b and, potentially, Alternative 4b. Under Alternative 1a and 1b, the RAO is not achieved because the impacted groundwater from the drinking water well may incidentally be used as drinking water (for example, during showering or bathing). For Alternative 4b, it is unknown if the RAO will be achieved until after further site investigation. If chosen, Alternative 4b will also have long-term monitoring requirements and contingency plans. Because other known, effective treatment options are available, the cost-benefit of implementing Alternative 4b, which requires additional investigation prior to knowing if it will meet RAOs, is not warranted.

The RAO and long-term protectiveness are achieved under Alternatives 2a and 2b, 3a through 3e, and 4a. While the RAO is achieved under Alternatives 2a, 2b, 3a, 3b, 3c, and 4a, these alternatives have associated maintenance and monitoring requirements. For Alternative 2a and 2b, treatment media must be replaced in a timely manner and impacted media must be transported offsite safely for disposal to maintain effectiveness. For Alternatives 3a and 3c there is long-term maintenance of flushing stations required. For Alternatives 3c, 4a and 4b, until the PFOA and PFOS source and fate and transport conceptual model are identified, there is a risk that groundwater used as the replacement water source could become impacted with PFOA and/or PFOS under long-term pumping. For Alternative 4a, long-term monitoring needs to be performed, as well as development of contingency plans.

In general, if new, impacted off-Base drinking water wells are identified, the future long-term solution evaluations will require a property by property evaluation.

5.2 Implementability

All the alternatives are technically feasible to implement and can be implemented with components that are well established, available, and easily replaced.

Alternatives 1a and 1b (bottled water delivery or POU treatment systems) and 4a (Ault Field Residence 1 monitoring well conversion) are considered **easy** to implement. Alternatives 1a and 1b require no implementation because the bottled water delivery is already in place and functional and POU treatment systems can be installed in a timely manner based on an established implementation process. Alternative 4a requires minimal work to install a pump and connect the existing monitoring well to the home.

Alternatives 2a and 2b, and 3b, 3d, and 3e are considered **moderately easy** to implement. Alternatives 2a and 2b are well established technologies and will require laboratory testing, design, and installation of equipment for the POE treatment. Alternatives 3b, 3d, and 3e are also considered **moderately easy** to implement because existing water main connections are nearby the affected residents and the alternative is straight-forward to design and implement. It will require earth-moving equipment, access to right-of-ways, construction right of entries on private property, and coordination with the Navy and City of Oak Harbor. Alternative 3 options overall have the greatest impact on the surrounding community during implementation because of the transport of materials during construction. However, impacts could be mitigated through best management practices.

Alternative 3a is considered **hard** to implement because of the significant service line distance and the need for the Navy to implement a new water agreement with the City of Oak Harbor and become a new water purveyor to the residence. Alternatives 3c and 4b are considered **moderately hard** to implement. For Alternatives 3a and 3c, in addition to requiring earth-moving equipment, access to rights-of-way, and construction right of entries on private property, there is much longer connection pipe/trench length needed (with flushing stations), as well as more significant coordination with the Navy and water purveyors for access agreements. For Alternative 4b, the time it will take for the additional investigation (drilling, well installation, aquifer testing, sampling), and the significant IDW volume and disposal coordination, adds to the complexity of the implementation of this alternative.

Once implemented, Alternatives 3d and 3e generally have no long-term implementation requirements (Alternative 3a and 3c may require flushing station maintenance). Alternatives 1a, 1b, 2a, 2b, 3b, 4a, and 4b have post-removal site control (PRSC) requirements. Alternative 1 requires bi-weekly delivery (every other week) of bottled water to homes and routine POU system sampling and maintenance. Alternatives 2a and 2b require media change-out, routine sampling, and waste management. Alternatives 2a, 2b, 4a, and 4b also require routine sampling to verify the continued viability of the groundwater as a drinking water source for the residence. Alternatives 3a, 3b, and 3c require long-term maintenance by the Navy on the water line extension up to the resident's property line.

As part of assessing adaptability to environmental conditions, the flexibility of each RAO-compliant alternative to be adaptive if PFOA and PFOS plume migration changed in the future needs to be considered. In general, if new, impacted off-Base drinking water wells are identified, the future long-term solution evaluations will require a property by property evaluation.

5.3 Cost

The detailed cost estimates for the alternatives are provided in **Appendix B** and summarized in **Table 5-1** by Alternative and in **Table 5-2** by site grouping. Generally, Alternatives 1a, 2a and 2b, 3b, 3d, and 3e, and 4a are the least expensive alternatives. Alternative 1b, 3a, 3c, and 4b are the most expensive alternatives. Alternative 3 has moderate costs that range significantly between the different areas. Except for Alternatives 3d and 3e, the other alternatives generally have costs associated with long term PRSCs over 30 years.

There would be cost savings compared to the values shown in **Table 5-2** (and **Appendix B**) if the same alternative type were selected for multiple site groupings. For example, Alterative 4b could be implemented for less than the sum of the costs for 4b-1 (Easy Street Residences) and 4b-2 (Evergreen Mobile Home Park) if work planning, site preparation, and the aquifer testing were combined.

5.4 Sustainability

A SiteWise evaluation was performed to assess relative environmental impacts of the different alternatives (**Appendix C**). SiteWise uses various emission factors from governmental or non-governmental research sources to determine the environmental impact of each activity. The quantitative metrics calculated by the tool include:

- Greenhouse gases (GHGs) reported as metric tons of carbon dioxide equivalents, consisting of carbon dioxide, methane, and nitrous oxide.

- Energy usage (expressed as millions of British Thermal Units).
- Water usage (gallons of water).
- Air emissions of criteria pollutants consisting of metric tons of nitrogen, sulfur oxides, and particulate matter 10 micrometers or less in diameter.
- Accident risk (risk of injury and risk of fatality).

GHG and Energy Use: The highest GHG emission and energy use for Ault Field Residence 1 is associated with Alternative 3a, connection to Navy water supply. The highest GHG emission and energy use for Ault Field Residence 2 is associated with Alternative 2a-2, POE GAC treatment, followed closely by Alternative 3c, connection to Navy water supply.. The Ault Field Residence 1 and 2 public water connection GHG emission and energy use is primarily from material production (piping for the water main and asphalt for roadway repair). The Ault Field Residence 2 GAC POE treatment alternative has more GAC use and vehicle mileage for frequent change-outs and performance monitoring because of the higher PFOA/PFOS concentrations in this well water. For the Easy Street Residences, Alternative 4b (investigation and new well installation) has the highest GHG and energy use. For Evergreen Mobile Home Park, Alternative 2a (GAC POE treatment) has the highest GHG and energy use primarily from the large volume of GAC required (material production, regeneration, and transportation). Easy Street Residences and Evergreen Mobile Home Park Alternatives 3d and 3e (city water connections) and Ault Field Residence 2 Alternative 3b (connection to Navy water supply line) have some of the lowest GHG and energy use impacts.

Water Use. Other than Alternative 4b, which has significant IDW generation and disposal from well installation and aquifer testing, the alternatives have similar water use, with the majority of water use attributed to consumption of water either from groundwater or a potable source.

Criteria Air Pollutants. New (replacement) well installation Alternative 4b, Evergreen Mobile Home Park POE GAC treatment Alternative 2a, and connections to Navy and public water system Alternatives 3a, 3c, 3d and 3e have higher air pollutant impacts than the other alternatives. The other alternatives have similar criteria air pollutant footprints. The source of the contributions for each alternative varied, although equipment use was generally the majority contribution to each footprint.

Accident Risks. Navy or public water supply connection Alternatives 4b and 3a and 3c have the highest accident risk-injury footprint during construction, primarily from onsite labor hours. Navy or public water supply connection Alternatives 3b, 3d and 3e have much lower accident risk-injury and -fatality footprints during construction primarily because of the reduced amount of long-term onsite labor hours and transportation associated with the shorter pipeline-length alternatives. The accident risk-fatality footprint was highest for Alternatives 1a and 1b because of the high mileage for water delivery and period sampling and media changeout. Alternatives 2a and 2b had a similarly high accident risk-fatality primarily from the GAC and IX deliveries and monitoring. Public water supply connection Alternatives 3d and 3e do not require PRSCs and would have no long-term accident risks.

Table 5-1. Removal Action Alternative Comparison

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking
Naval Air Station Whidbey Island, Oak Harbor, Washington

Alternative	Does Alternative Meet RAO?	Effectiveness Score	Ease of Implementation Score	Cost Score	Capital Cost	Total Present Value Cost	Total Score
Alternative 1 - No Further Action							
1a-1 - No Further Action - Ault Field Residence 1 Bottled Water	No	1	4	4	$ 1,300	$ 53,700	NA[d]
1a-2 - No Further Action - Ault Field Residence 2 Bottled Water	No	1	4	4	$ 1,300	$ 99,000	NA[d]
1a-3 - No Further Action - Easy Street Residences Bottled Water	No	1	4	4	$ 1,300	$ 280,500	NA[d]
1a-4 and 1b - No Further Action - Evergreen Mobile Home Park Bottled Water and single POU system	No	1	4	2	$ 6,400	$ 1,794,600	NA[d]
Alternative 2 - Point of Entry Treatment							
2a-1 - Point of Entry - GAC - Ault Field Residence 1	Yes	3	3	3	$ 139,000	$ 560,000	9
2a-2 - Point of Entry - GAC - Ault Field Residence 2	Yes	3	3	3	$ 139,000	$ 780,000	9
2a-3 - Point of Entry - GAC - Easy Street Residences	Yes	3	3	3	$ 230,000	$ 1,920,000	9
2a-4 - Point of Entry - GAC - Evergreen Mobile Home Park	Yes	3	3	3	$ 451,000	$ 1,570,000	9
2b-1 - Point of Entry - IX - Ault Field Residence 1	Yes	3	3	3	$ 157,000	$ 720,000	9
2b-2 - Point of Entry - IX - Ault Field Residence 2	Yes	3	3	2	$ 157,000	$ 1,460,000	8
2b-3 - Point of Entry - IX - Easy Street Residences	Yes	3	3	2	$ 248,000	$ 2,600,000	8
2b-4 - Point of Entry - IX - Evergreen Mobile Home Park	Yes	3	3	3	$ 467,000	$ 1,490,000	9
Alternative 3 - City Water Connection							
3a - Ault Field Residence 1 Connection to City of Oak Harbor Water Line via Navy	Yes	5	1	2	$ 1,132,700	$ 1,207,100	8
3b - Ault Field Residence 2 Connection to On-Base Navy Water Line	Yes	5	3	3	$ 288,700	$ 288,700	11
3c - Ault Field Residence 2 Connection to Pine Terrace Water Line	Yes[b]	3	2	2	$ 1,055,800	$ 1,130,200	7
3d - Easy Street Residences Connection to City of Oak Harbor Water Line	Yes	5	3	3	$ 515,500	$ 515,500	11
3e - Evergreen Mobile Home Park Connection to City of Oak Harbor Water Line	Yes	5	3	3	$ 406,900	$ 406,900	11
Alternative 4 - New (Replacement) Well							
4a - Ault Field Residence 1 Conversion of Existing Monitoring Well	Yes[b]	3	4	3	$ 38,900	$ 323,400	10
4b-1 - Easy Street Resident New Well Investigation and Potential Conversion	Maybe[bc]	1 [a]	2	2	$ 1,802,300	$ 2,367,300	5
4b-2 - Evergreen Mobile Home Park New Well Investigation and Potential Conversion	Maybe[bc]	1 [a]	2	2	$ 1,166,000	$ 1,635,500	5

Notes:

[a]Ranked minimally effective because of the uncertainty in the viability of a deeper, clean aquifer unit. However, this ranking could increase after results of initial investigation work is complete.

[b]There is a potential risk these groundwater sources could become impacted by PFAS in the future. A better understanding of the nature and extent, fate and transport of PFAS from Ault Field and Area 6 will be developed in the RFI. Until the CSM can be verified, continued monitoring of the water source is required.

[c]Additional investigation, included in the alternative, is require to assess if the alternative meets RAOs.

[d]Not applicable because it does not meet RAO.

Effectiveness
Minimally effective - 1
Effective - 3
Very Effective -5

Ease of Implementation
Easiest - 5
Easy - 4
Moderately Easy - 3
Moderately Hard - 2
Hard - 1

Cost
Low- 5
Moderately Low - 4
Moderate - 3
Moderately High - 2
High - 1

GAC = granular activated carbon
IX = ion exchange
PFAS = per- and polyfluoroalkyl substances
POU = point-of-use
RAO = removal action objective

Table 5-2. Removal Action Alternative Comparison by Site Grouping

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking
Naval Air Station Whidbey Island, Oak Harbor, Washington

Alternative by Site Grouping	Does Alternative Meet RAO?	Effectiveness Score	Ease of Implementation Score	Cost Score	Capital Cost	Total Present Value Cost	Total Score
Ault Field Residence 1							
1a-1 - No Further Action - Ault Field Residence 1 Bottled Water	No	1	4	4	$ 1,300	$ 53,700	NA[d]
2a-1 - Point of Entry - GAC - Ault Field Residence 1	Yes	3	3	3	$ 139,000	$ 560,000	9
2b-1 - Point of Entry - IX - Ault Field Residence 1	Yes	3	3	3	$ 157,000	$ 720,000	9
3a - Ault Field Residence 1 Connection to City of Oak Harbor Water Line via Navy	Yes	5	1	2	$ 1,132,700	$ 1,207,100	8
4a - Ault Field Residence 1 Conversion of Existing Monitoring Well	Yes[b]	3	4	3	$ 38,900	$ 323,400	10
Ault Field Residence 2							
1a-2 - No Further Action - Ault Field Residence 2 Bottled Water	No	1	4	4	$ 1,300	$ 99,000	NA[d]
2a-2 - Point of Entry - GAC - Ault Field Residence 2	Yes	3	3	3	$ 139,000	$ 780,000	9
2b-2 - Point of Entry - IX - Ault Field Residence 2	Yes	3	3	2	$ 157,000	$ 1,460,000	8
3b - Ault Field Residence 2 Connection to On-Base Navy Water Line	Yes	5	3	3	$ 288,700	$ 288,700	11
3c - Ault Field Residence 2 Connection to Pine Terrace Water Line	Yes[b]	3	2	2	$ 1,055,800	$ 1,130,200	7
Easy Street Residences							
1a-3 - No Further Action - Easy Street Residences Bottled Water	No	1	4	4	$ 1,300	$ 280,500	NA[d]
2a-3 - Point of Entry - GAC - Easy Street Residences	Yes	3	3	3	$ 230,000	$ 1,920,000	9
2b-3 - Point of Entry - IX - Easy Street Residences	Yes	3	3	2	$ 248,000	$ 2,600,000	8
3d - Easy Street Residences Connection to City of Oak Harbor Water Line	Yes	5	3	3	$ 515,500	$ 515,500	11
4b-1 - Easy Street Resident New Well Investigation and Potential Conversion	Maybe[bc]	1 [a]	2	2	$ 1,802,300	$ 2,367,300	5
Evergreen Mobile Home Park							
1a-4 and 1b - No Further Action - Evergreen Mobile Home Park Bottled Water and single POU system	No	1	4	2	6400	1794600	NA[d]
2a-4 - Point of Entry - GAC - Evergreen Mobile Home Park	Yes	3	3	3	$ 451,000	$ 1,570,000	9
2b-4 - Point of Entry - IX - Evergreen Mobile Home Park	Yes	3	3	3	$ 467,000	$ 1,490,000	9
3e - Evergreen Mobile Home Park Connection to City of Oak Harbor Water Line	Yes	5	3	3	$ 406,900	$ 406,900	11
4b-2 - Evergreen Mobile Home Park New Well Investigation and Potential Conversion	Maybe[bc]	1 [a]	2	2	$ 1,166,000	$ 1,635,500	5

Notes:

[a]Ranked minimally effective because of the uncertainty in the viability of a deeper, clean aquifer unit. However, this ranking could increase after results of initial investigation work is complete.

[b]There is a potential risk these groundwater sources could become impacted by PFAS in the future. A better understanding of the nature and extent, fate and transport of PFAS from Ault Field and Area 6 will be developed in the RFI. Until the CSM can be verified, continued monitoring of the water source is required.

[c]Additional investigation, included in the alternative, is require to assess if the alternative meets RAOs.

[d]Not applicable (NA) because it does not meet RAO.

Effectiveness	**Ease of Implementation**	**Cost**
Minimally effective - 1	Easiest - 5	Low- 5
Effective - 3	Easy - 4	Moderately Low - 4
Very Effective -5	Moderately Easy - 3	Moderate - 3
	Moderately Hard - 2	Moderately High - 2
	Hard - 1	High - 1

GAC = granular activated carbon
IX = ion exchange
PFAS = per- and polyfluoroalkyl substances
POU = point-of-use
RAO = removal action objective

SECTION 6

Recommended Removal Action Alternative

Based on evaluation of the alternatives, the recommended removal action alternatives for each site grouping are discussed below. The preferred alternative for each of the site groupings addresses PFOA and/or PFOS impacts by providing each impacted private property with an alternate water supply with concentrations less than the USEPA Health Advisory. The recommended removal alternative for each site grouping is shown in **Table 5-2**, and includes the following:

- **Ault Field Residence 1:** Alternative 4a - Ault Field Residence 1 conversion of existing monitoring well. Alternative 4a is considered effective and is the easiest to implement with the lowest cost and a moderate environmental impact. However, there is some uncertainty associated with the long-term water quality of the deeper well requiring routine monitoring. The second-best alternative based on scoring and cost is the installation of a GAC POE unit to treat the existing well water (Alternative 2a-1). The GAC POE unit could be identified as a contingency action if the new well shows evidence of PFOA and/or PFOS concentration increases.
- **Ault Field Residence 2:** Alternative 3b - Ault Field Residence 2 connection to on-Base Navy water line. Alternative 3b has the highest score and lowest cost. The alternative extends the on-Base Navy water line connection to Ault Field Residence 2. It is considered very effective because it eliminates impacted groundwater used as the source of drinking water at the site and eliminates the potential for migration of PFOA and PFOS through wastewater to septic leach fields. System installation would be carried out in accordance with Navy and City of Oak Harbor considerations and Navy protocols and approvals would need to be understood and adhered to. Under this alternative, it is assumed that the off-Base private drinking water well would remain in place but would no longer be used as the water supply for the home. However, it may be used for irrigation purposes. This alternative has similar sustainability impacts (only associated with construction) as the other alternatives but is overall less expensive. However, if Naval Facilities Engineering Command, Commanding Officer does not approve a residential connection to a Navy water supply line, Alternative 2a-2, the GAC POE treatment unit, would be the next highest ranked alternative that meets RAOs.
- **Easy Street Residences:** Alternative 3d – Easy Street Residences connection to City of Oak Harbor water line. Alternative 3d is considered very effective because it eliminates impacted groundwater used as the source of drinking water at the site, eliminates the potential for migration of PFOA and PFOS through wastewater to septic leach fields and has no maintenance requirements. The alternative extends the City of Oak Harbor water connection to each of the four Easy Street Residence homes. System installation would be carried out in accordance with City of Oak Harbor requirements. Under this alternative, it is assumed that the off-Base private drinking water wells could remain in place for irrigation use. While it has greater sustainability impacts and implementation requirements than the other alternatives, this alternative is a solution that provides for unlimited use of drinking water at the off-Base residences, with no PRSCs or periodic O&M.
- **Evergreen Mobile Home Park:** Alternative 3e - Evergreen Mobile Home Park connection to City of Oak Harbor water line. Alternative 3e is considered very effective because it eliminates impacted groundwater used as the source of drinking water at the site, eliminates the potential for migration of PFOA and PFOS through wastewater to septic leach fields and has no maintenance requirements. The alternative extends the City of Oak Harbor water connection to the Evergreen Mobile Home Park property and would use the existing water distribution system (maintained and controlled by the owner) to provide water to each mobile-home unit. System installation would be carried out in accordance with City of Oak Harbor requirements. While it has greater sustainability impacts and implementation requirements than the other alternatives, this alternative is a solution that provides for unlimited use of drinking water at the off-Base residences, with no PRSCs or periodic O&M.

Navy, USEPA, State, and local representatives (City, County) had an opportunity to comment on the recommendation during the regulatory review period for this EE/CA. Following the regulatory review period, a 30-day public comment period will be held to assess public acceptance of the recommended alternative. If comments are received, a Responsive Summary addressing significant comments will be prepared as part of the Action Memorandum. The Action Memorandum will also be available for public comment. If additional public comments are received on the Action Memorandum, then they will also be included in the Responsiveness Summary. The Action Memorandum and EE/CA will be included in Administrative Record.

SECTION 7

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Appendix A
Screening-level Human Health Risk Assessment

APPENDIX A

Screening-level Human Health Risk Assessment

A human health risk screening (HHRS) evaluation was performed to assess potential human health risks associated with exposure to per- and polyfluoroalkyl substances (PFAS) in groundwater in off-Base residential drinking water wells near Naval Air Station Whidbey Island. The results of the HHRS provide an indication of potential risks from exposure to PFAS in groundwater and are used to help evaluate whether off-Base residential potable use of the groundwater is acceptable with respect to PFAS, or requires further evaluation or action.

1.1 Data Evaluation

The drinking water samples collected from each off-Base residential well were assessed separately in the HHRS. Drinking water samples were collected in November and December 2016; January, February, June, and October 2017; and February, March, April, August, September, and October 2018; April and October 2019. All of the drinking water samples were analyzed for perfluorobutanesulfonic acid (PFBS), perfluorooctanoic acid (PFOA), and perfluorooctane sulfonate (PFOS). At least one PFAS (PFOS, PFOA, and/or PFBS) was detected in 24 residential wells. Of these 24 wells, 8 wells had concentrations above the United Stated Environmental Protection Agency (USEPA) Health Advisory for PFOA and/or PFOS. An HHRS was conducted for all of the residential wells with detected concentrations of at least one PFAS.

The drinking water data evaluated in the HHRS were validated. Validation of the data identified the following criteria for data usability:

- Estimated values flagged with a B, D, or J qualifier were treated as unqualified detected concentrations.
- Values flagged with a U or UJ qualifier indicate an analyte was not detected and the quantitation limit was estimated.
- The maximum concentration between a primary and a duplicate sample was used as the sample concentration. If the analyte was only detected in one of the samples, the detected concentration was used as the sample concentration. If the analyte was not detected in either of the samples, the higher detection limit was used as the sample detection limit.

1.2 Human Health Risk Screening Methodology

The HHRS was conducted in two steps using the risk ratio technique described in *Overview of Screening, Risk Ratio, and Toxicological Evaluation. Procedures for Northern Division Human Health Risk Assessments* (Navy, 2000).

Step 1

The maximum detected PFAS concentrations in groundwater in each well were compared to the USEPA tap water regional screening levels (RSLs) from the current RSL table (USEPA, 2018). RSLs based on noncarcinogenic effects were based on a hazard quotient of 0.1, to account for exposure to multiple constituents with the same target organ/target effect. The tap water RSLs for PFOA and PFOS were calculated using the USEPA RSL Calculator (USEPA, 2018) since they are not included in the most recent RSL table (USEPA, 2018). RSL values are included in HHRS screening tables for PFBS, PFOA, and PFOS, the only PFAS with available toxicity values.

If the maximum detected concentration (MDC) exceeded the RSL, the constituent was identified as a Step 1 constituent of potential concern (COPC) and carried forward to Step 2. In addition to comparing the MDC of PFOA and PFOS to the RSL, if the sum of the PFOA and PFOS concentrations exceeded the RSL, they were both identified as COPCs. This was done following the PFOA and PFOS drinking water health advisories (USEPA, 2016a, 2016b, 2016c) that indicate that the combined concentration of PFOA and PFOS should be compared to the Health Advisory for PFOA and PFOS.

The Health Advisory for PFOA and PFOS are also included on the Step 1 screening tables. Lifetime Health Advisories provide information on pollutants that can affect drinking water quality, but that are not regulated under the Safe Drinking Water Act. The health advisory levels are developed to provide a margin of protection against adverse health effects to the most sensitive population (fetuses during pregnancy and breastfed infants). The health advisory levels for PFOA and PFOS are calculated based on drinking water intake of lactating women and are based on exposure from drinking water ingestion only, and do not consider exposure from dermal contact or inhalation. The Health Advisory also factors in other sources of exposure (for example, food and soil). The toxicity values presented in the health advisories are used in the RSL calculator to calculate the drinking water RSL for PFOA and PFOS. The differences between the tap water RSL values and the Health Advisory values for PFOA and PFOS are due to the different exposure assumptions used to calculate each, and the incorporation of the relative source contribution factor used in the calculation of the health advisory.

Step 2

A risk level was calculated for the constituents identified as COPCs in Step 1 following the approach discussed in *Overview of Screening, Risk Ratio, and Toxicological Evaluation. Procedures for Northern Division Human Health Risk Assessments* (Navy, 2000):

For carcinogenic chemicals identified as COPCs in Step 1, carcinogenic risk was calculated using the following equation:

$$\textit{Carcinogenic risk} = \frac{\textit{MDC x acceptable risk level}}{\textit{RSL}}$$

Where:

MDC = Maximum detected concentration (micrograms per liter [μg/L])
acceptable risk level = $1x10^{-6}$ (unitless)
RSL = USEPA RSL based on carcinogenic risk of $1x10^{-6}$ (μg/L)

For noncarcinogenic chemicals identified as COPCs in Step 1, a hazard index (HI) was calculated using the following equation:

$$\textit{HI} = \frac{\textit{MDC x acceptable HI}}{\textit{RSL}}$$

Where:

MDC = Maximum detected concentration (μg/L)
acceptable HI = 1 (unitless)
RSL = USEPA RSL based on HI of 1 (μg/L)

Both carcinogenic risk and HI were calculated for COPCs that act through carcinogenic and noncarcinogenic effects. The carcinogenic risks for each Step 1 COPC in a well were summed to calculate the cumulative carcinogenic risk, and the HIs for each well were summed to calculate the cumulative HI. A cumulative HI was also calculated for each target organ/effect. If the cumulative HI for a target organ/effect was greater than 0.5, or the cumulative carcinogenic risk was greater than 5×10^{-5} (the target hazard and risk levels presented in the Department of the Navy (Navy) risk ratio guidance document [Navy, 2000]), the chemicals contributing to these values were identified as COPCs.

1.3 Human Health Risk Screening Results

The results of the HHRS are presented in this section for each residential well. The residential wells evaluated include all Ault Field and Area 6 off-Base residential wells with PFOS, PFOA, and PFBS detections.

1.3.1 Residential Well WI-A06-RW03

Table A-1 presents the HHRS for residential well WI-A06-RW03. The MDCs of all of the PFAS were below the RSLs. Therefore, potable use of groundwater from this residential well would not result in unacceptable human health risks associated with PFAS based on current toxicity data.

1.3.2 Residential Well WI-A06-RW04

Table A-2 presents the HHRS for residential well WI-A06-RW04. The MDCs of all of the PFAS were below the RSLs. Therefore, potable use of groundwater from this residential well would not result in unacceptable human health risks associated with PFAS based on current toxicity data.

1.3.3 Residential Well WI-A06-RW05 (Easy Street Residence A)

Tables A-3 and A-3a present the HHRS for residential well WI-A06-RW05, which is located at Easy Street Residence A. The MDCs of PFOA and PFOS exceeded the RSL, and therefore, PFOA and PFOS were evaluated in Step 2. Based on Step 2, PFOA and PFOS were not identified as COPCs.

Potable use of groundwater from residential well WI-A06-RW05 would not result in potential unacceptable human health risks associated with PFAS based on current toxicity data.

1.3.4 Residential Well WI-A06-RW08 (Easy Street Residence C)

Tabled A-4 and A-4a present the HHRS for residential well WI-A06-RW08, which is located at Easy Street Residence C. The MDC of PFOS and the combined MDCs of PFOA and PFOS exceeded the RSL; therefore, PFOA and PFOS were evaluated in Step 2. Based on Step 2, PFOA and PFOS were not identified as COPCs.

Potable use of groundwater from residential well WI-A06-RW08 would not result in potential unacceptable human health risks associated with PFAS based on current toxicity data.

1.3.5 Residential Well WI-A06-RW12

Table A-5 presents the HHRS for residential well WI-A06-RW12. The MDCs of all of the PFAS were below the RSLs. Therefore, potable use of groundwater from this residential well would not result in unacceptable human health risks associated with PFAS based on current toxicity data.

1.3.6 Residential Well WI-A06-RW14

Table A-6 presents the HHRS for residential well WI-A06-RW14. The MDCs of all of the PFAS were below the RSLs. Therefore, potable use of groundwater from this residential well would not result in unacceptable human health risks associated with PFAS based on current toxicity data.

1.3.7 Residential Well WI-A06-RW18 (Easy Street Residence D)

Tables A-7 and A-7a present the HHRS for residential well WI-A06-RW18, which is located at Easy Street Residence D. The MDC of PFOS and the combined MDCs of PFOA and PFOS exceeded the RSL; therefore, PFOA and PFOS were evaluated in Step 2. Based on Step 2, PFOA and PFOS were not identified as COPCs.

Potable use of groundwater from residential well WI-A06-RW18 would not result in potential unacceptable human health risks associated with PFAS based on current toxicity data.

1.3.8 Residential Well WI-A06-RW19 (Evergreen Mobile Home Park Well)

Tables A-8 and A-8a present the HHRS for residential well WI-A06-RW19, which supplies the Evergreen Mobile Home Park. The MDCs of PFOA and PFOS exceeded the RSL; therefore, PFOA and PFOS were evaluated in Step 2. Based on Step 2, PFOA and PFOS were not identified as COPCs.

Potable use of groundwater from residential well WI-A06-RW19 would not result in potential unacceptable human health risks associated with PFAS based on current toxicity data.

1.3.9 Residential Well WI-A06-RW20 (Easy Street Residence B)

Tables A-9 and A-9a present the HHRS for residential well WI-A06-RW20, which is located at Easy Street Residence B. The MDC of PFOA and the combined MDCs of PFOA and PFOS exceeded the RSL; therefore, PFOA and PFOS were evaluated in Step 2. Based on Step 2, PFOA and PFOS were not identified as COPCs.

Potable use of groundwater from residential well WI-A06-RW20 would not result in potential unacceptable human health risks associated with PFAS based on current toxicity data.

1.3.10 Residential Well WI-AF-1RW12

Table A-10 presents the HHRS for residential well WI-AF-1RW12. The MDCs of all of the PFAS were below the RSLs. Therefore, potable use of groundwater from this residential well would not result in unacceptable human health risks associated with PFAS based on current toxicity data.

1.3.11 Residential Well WI-AF-1RW28

Table A-11 presents the HHRS for residential well WI-AF-1RW28. The MDCs of all of the PFAS were below the RSLs. Therefore, potable use of groundwater from this residential well would not result in unacceptable human health risks associated with PFAS based on current toxicity data.

1.3.12 Residential Well WI-AF-1RW32 (Ault Field Residence 2)

Tables A-12 and **A-12a** present the HHRS for residential well WI-AF-1RW32 (also identified as WI-AF-2RW04 during the November 2016 sampling), which is located at Ault Field Residence 2. The MDCs of PFOA and PFOS exceeded the RSL, and therefore, PFOA and PFOS were evaluated in Step 2. Based on Step 2, PFOA and PFOS were identified as COPCs.

Potable use of groundwater from residential well WI-AF-1RW32 may result in potential unacceptable human health risks associated with PFOA and PFOS.

1.3.13 Residential Well WI-AF-1RW33

Table A-13 presents the HHRS for residential well WI-AF-1RW33. The MDCs of all of the PFAS were below the RSLs. Therefore, potable use of groundwater from this residential well would not result in unacceptable human health risks associated with PFAS based on current toxicity data.

1.3.14 Residential Well WI-AF-1RW40 (Ault Field Residence 1)

Tables A-14 and **A-14a** present the HHRS for residential well WI-AF-1RW40, which is located at Ault Field Residence 1. The MDC of PFOA and the combined MDCs of PFOA and PFOS exceeded the RSL, and therefore, PFOA and PFOS were evaluated in Step 2. Based on Step 2, PFOA and PFOS were not identified as COPCs.

Potable use of groundwater from residential well WI-AF-1RW40 would not result in potential unacceptable human health risks associated with PFAS based on current toxicity data.

1.3.15 Residential Well WI-AF-1RW51

Table A-15 presents the HHRS for residential well WI-AF-1RW51. The MDCs of all of the PFAS were below the RSLs. Therefore, potable use of groundwater from this residential well would not result in unacceptable human health risks associated with PFAS based on current toxicity data.

1.3.16 Residential Well WI-AF-3RW41

Table A-16 presents the HHRS for residential well WI-AF-3RW41. The MDC of the one detected PFAS was below the RSL. Therefore, potable use of groundwater from this residential well would not result in unacceptable human health risks associated with PFAS based on current toxicity data.

1.3.17 Residential Well WI-A06-RW24 (Easy Street Residence E)

Tabled A-17 and A-17a present the HHRS for residential well WI-A06-RW24, which is located at Easy Street Residence E. The MDCs of PFOA and PFOS exceeded the RSL, and therefore, PFOA and PFOS were evaluated in Step 2. Based on Step 2, PFOA and PFOS were not identified as COPCs.

Potable use of groundwater from residential well WI-A06-RW24 would not result in potential unacceptable human health risks associated with PFAS based on current toxicity data.

Human Health Risk Screening Findings

The HHRS identified potential unacceptable risks associated with PFAS in groundwater for the following off-Base residential well:

- WI-AF-1RW32 (Ault Field Residence 2)

Although there is only one residential well with potential unacceptable risks associated with PFAS in groundwater, the Navy is taking action for all off-Base residential wells above the EPA's Health Advisory.

References

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United States Environmental Protection Agency (USEPA). 2016a. *Fact Sheet: PFOA and PFOS Drinking Water Health Advisories*. EPA 800-F-16-003. November.

USEPA. 2016b. *Drinking Water Health Advisory for PFOA*. EPA-822-R-16-005. May.

USEPA. 2016c. *Drinking Water Health Advisory for PFOS*. EPA-822-R-16-004. May.

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Tables

TABLE A-1

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Residential Well WI-A06-RW03	375-73-5	Perfluorobutanesulfonic acid (PFBS)	4.2E-02	4.2E-02	UG/L	WI-A06-RW03-0218	1/1	0.00508	4.2E-02	N/A	4.0E+01 N	N/A		NO	BSL
	375-85-9	Perfluoroheptanoic acid (PFHpA)	2.0E-02	2.0E-02	UG/L	WI-A06-RW03-0218	1/1	0.00508	2.0E-02	N/A	N/A	N/A		NO	NTX
	355-46-4	Perfluorohexanesulfonic acid (PFHxS)	1.1E-01	1.1E-01	UG/L	WI-A06-RW03-0218	1/1	0.00508	1.1E-01	N/A	N/A	N/A		NO	NTX
	307-24-4	Perfluorohexanoic Acid (PFHxA)	5.6E-02	5.6E-02	UG/L	WI-A06-RW03-0218	1/1	0.00508	5.6E-02	N/A	N/A	N/A		NO	NTX
	375-95-1	Perfluorononanoic acid (PFNA)	ND	ND		--	--	--	--	N/A	N/A	N/A		--	--
	1763-23-1	Perfluorooctane Sulfonate (PFOS)	7.6E-03 J	7.6E-03 J	UG/L	WI-A06-RW03-0218	1/1	0.00508	7.6E-03	N/A	4.0E-02 N	7.0E-02	HA	NO	BSL
	335-67-1	Perfluorooctanoic acid (PFOA)	2.8E-02	2.8E-02	UG/L	WI-A06-RW03-0218	1/1	0.00508	2.8E-02	N/A	4.0E-02 N	7.0E-02	HA	NO	BSL

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
HA = USEPA Health Advisory (May 2016)
J = Estimated Value
N = Noncarcinogenic
N/A = Not available
ND = Not detected
UG/L = Micrograms/Liter
-- = Not applicable

TABLE A-2

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Residential Well WI-A06-RW04	375-73-5	Perfluorobutanesulfonic acid (PFBS)	3.8E-02	3.8E-02	UG/L	WI-A06-RW04-0218	1/1	0.00492	3.8E-02	N/A	4.0E+01 N	N/A		NO	BSL
	375-85-9	Perfluoroheptanoic acid (PFHpA)	1.5E-03 J	1.5E-03 J	UG/L	WI-A06-RW04-0218	1/1	0.00492	1.5E-03	N/A	N/A	N/A		NO	NTX
	355-46-4	Perfluorohexanesulfonic acid (PFHxS)	5.1E-02	5.1E-02	UG/L	WI-A06-RW04-0218	1/1	0.00492	5.1E-02	N/A	N/A	N/A		NO	NTX
	307-24-4	Perfluorohexanoic Acid (PFHxA)	ND	ND		--	--	--	--	N/A	N/A	N/A		--	--
	375-95-1	Perfluorononanoic acid (PFNA)	ND	ND		--	--	--	--	N/A	N/A	N/A		--	--
	1763-23-1	Perfluorooctane Sulfonate (PFOS)	2.8E-03 J	2.8E-03 J	UG/L	WI-A06-RW04-0218	1/1	0.00492	2.8E-03	N/A	4.0E-02 N	7.0E-02	HA	NO	BSL
	335-67-1	Perfluorooctanoic acid (PFOA)	4.2E-03 J	4.2E-03 J	UG/L	WI-A06-RW04-0218	1/1	0.00492	4.2E-03	N/A	4.0E-02 N	7.0E-02	HA	NO	BSL

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
HA = USEPA Health Advisory (May 2016)
J = Estimated Value
N = Noncarcinogenic
N/A = Not available
ND = Not detected
UG/L = Micrograms/Liter
-- = Not applicable

TABLE A-3

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Residential Well WI-A06-RW05	375-73-5	Perfluorobutanesulfonic acid (PFBS)	2.6E-02	2.9E-02	UG/L	WI-A06-RW05-0218	2/2	0.00498 - 0.00502	2.9E-02	N/A	4.0E+01 N	N/A		NO	BSL
	375-85-9	Perfluoroheptanoic acid (PFHpA)	1.6E-02	2.1E-02	UG/L	WI-A06-RW05P-0218	2/2	0.00498 - 0.00502	2.1E-02	N/A	N/A	N/A		NO	NTX
	355-46-4	Perfluorohexanesulfonic acid (PFHxS)	2.0E-01	2.3E-01	UG/L	WI-A06-RW05P-0218	2/2	0.00498 - 0.01	2.3E-01	N/A	N/A	N/A		NO	NTX
	307-24-4	Perfluorohexanoic Acid (PFHxA)	3.8E-02	5.0E-02	UG/L	WI-A06-RW05P-0218	2/2	0.00498 - 0.00502	5.0E-02	N/A	N/A	N/A		NO	NTX
	375-95-1	Perfluorononanoic acid (PFNA)	1.7E-03 J	1.7E-03 J	UG/L	WI-A06-RW05P-0218	1/2	0.00498 - 0.00502	1.7E-03	N/A	N/A	N/A		NO	NTX
	1763-23-1	**Perfluorooctane Sulfonate (PFOS)**	**6.4E-02**	**9.5E-02**	**UG/L**	**WI-A06-RW05-0818**	**2/2**	**0.00498 - 0.00502**	**9.5E-02**	**N/A**	**4.0E-02 N**	**7.0E-02**	**HA**	**YES**	**ASL**
	335-67-1	**Perfluorooctanoic acid (PFOA)**	**5.5E-02**	**5.8E-02**	**UG/L**	**WI-A06-RW05-0218**	**2/2**	**0.00498 - 0.00502**	**5.8E-02**	**N/A**	**4.0E-02 N**	**7.0E-02**	**HA**	**YES**	**ASL**

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
HA = USEPA Health Advisory (May 2016)
J = Estimated Value
N = Noncarcinogenic
N/A = Not available
UG/L = Micrograms/Liter

TABLE A-3a

Risk Ratio Screening, Drinking Water, Residential Well WI-A06-RW05

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Analyte	Detection Frequency	Maximum Detected Concentration (Qualifier) (UG/L)	Sample Location of Maximum Detected Concentration	Carcinogenic Tap Water RSL (UG/L)	Acceptable Risk Level	Cancer Risk[a]	Non-carcinogenic Tap Water RSL (UG/L)	Acceptable Hazard Level	Hazard Index[b]	Target Organ
Perfluorooctane Sulfonate (PFOS)	2 / 2	9.5E-02	WI-A06-RW05-0818	N/A			4.0E-01	1	0.2	Developmental
Perfluorooctanoic acid (PFOA)	2 / 2	5.8E-02	WI-A06-RW05-0218	1.1E+00	1E-06	5E-08	4.0E-01	1	0.1	Developmental
Cumulative Hazard Index[c]									**0.4**	
Cumulative Cancer Risk[d]						**5E-08**				
								Total Developmental HI =		**0.4**

Notes:

[a] Cancer Risk equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

[b] Hazard Index equals maximum detected concentration divided by the RSL divided by the acceptable hazard level.

[c] Cumulative Hazard Index equals sum of Hazard Indices for each constituent.

[d] Cumulative Cancer Risk equals sum of Cancer Risks for each constituent.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.

Constituents selected as COPCs are indicated by shading.

COPC = Constituent of Potential Concern
HI = Hazard Index
N/A = Not available/not applicable
UG/L = Micrograms/Liter
RSL = Regional Screening Level

TABLE A-4

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Residential Well WI-A06-RW08	375-73-5	Perfluorobutanesulfonic acid (PFBS)	2.3E-02	2.6E-02	UG/L	WI-A06-RW08-0918	2/2	0.0049 - 0.00502	2.6E-02	N/A	4.0E+01 N	N/A		NO	BSL
	375-85-9	Perfluoroheptanoic acid (PFHpA)	8.8E-03 J	1.1E-02	UG/L	WI-A06-RW08-0918	2/2	0.0049 - 0.00502	1.1E-02	N/A	N/A	N/A		NO	NTX
	355-46-4	Perfluorohexanesulfonic acid (PFHxS)	1.0E-01	1.2E-01	UG/L	WI-A06-RW08-0218	2/2	0.0049 - 0.00502	1.2E-01	N/A	N/A	N/A		NO	NTX
	307-24-4	Perfluorohexanoic Acid (PFHxA)	1.5E-02	1.9E-02	UG/L	WI-A06-RW08-0918	2/2	0.0049 - 0.00502	1.9E-02	N/A	N/A	N/A		NO	NTX
	375-95-1	Perfluorononanoic acid (PFNA)	2.5E-03 J	3.4E-03 J	UG/L	WI-A06-RW08-0918	2/2	0.0049 - 0.00502	3.4E-03	N/A	N/A	N/A		NO	NTX
	1763-23-1	**Perfluorooctane Sulfonate (PFOS)**	**7.8E-02**	**9.6E-02**	**UG/L**	**WI-A06-RW08-0918**	**2/2**	**0.0049 - 0.00502**	**9.6E-02**	**N/A**	**4.0E-02 N**	**7.0E-02**	**HA**	**YES**	**ASL**
	335-67-1	**Perfluorooctanoic acid (PFOA)**	**2.5E-02**	**3.1E-02**	**UG/L**	**WI-A06-RW08-0918**	**2/2**	**0.0049 - 0.00502**	**3.1E-02**	**N/A**	**4.0E-02 N**	**7.0E-02**	**HA**	**YES**	**PFOS+PFOA**

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

COPC = Constituent of Potential Concern

HA = USEPA Health Advisory (May 2016)

J = Estimated Value

N = Noncarcinogenic

N/A = Not available

UG/L = Micrograms/Liter

TABLE A-4a

Risk Ratio Screening, Drinking Water, Residential Well WI-A06-RW08

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Analyte	Detection Frequency	Maximum Detected Concentration (Qualifier) (UG/L)	Sample Location of Maximum Detected Concentration	Carcinogenic Tap Water RSL (UG/L)	Acceptable Risk Level	Cancer Risk[a]	Non-carcinogenic Tap Water RSL (UG/L)	Acceptable Hazard Level	Hazard Index[b]	Target Organ
Perfluorooctane Sulfonate (PFOS)	2 / 2	9.6E-02	WI-A06-RW08-0918	N/A			4.0E-01	1	0.2	Developmental
Perfluorooctanoic acid (PFOA)	2 / 2	3.1E-02	WI-A06-RW08-0918	1.1E+00	1E-06	3E-08	4.0E-01	1	0.08	Developmental
Cumulative Hazard Index[c]									**0.3**	
Cumulative Cancer Risk[d]						**3E-08**				
								Total Developmental HI =		**0.3**

Notes:

[a] Cancer Risk equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

[b] Hazard Index equals maximum detected concentration divided by the RSL divided by the acceptable hazard level.

[c] Cumulative Hazard Index equals sum of Hazard Indices for each constituent.

[d] Cumulative Cancer Risk equals sum of Cancer Risks for each constituent.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.

Constituents selected as COPCs are indicated by shading.

COPC = Constituent of Potential Concern
HI = Hazard Index
N/A = Not available/not applicable
UG/L = Micrograms/Liter
RSL = Regional Screening Level

TABLE A-5

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Residential Well WI-A06-RW12	375-73-5	Perfluorobutanesulfonic acid (PFBS)	2.3E-03 J	2.3E-03 J	UG/L	WI-A06-RW12-0218	1/1	0.00463	2.3E-03	N/A	4.0E+01 N	N/A		NO	BSL
	375-85-9	Perfluoroheptanoic acid (PFHpA)	ND	ND		--	--	--	--	N/A	N/A	N/A		--	--
	355-46-4	Perfluorohexanesulfonic acid (PFHxS)	1.5E-03 J	1.5E-03 J	UG/L	WI-A06-RW12-0218	1/1	0.00463	1.5E-03	N/A	N/A	N/A		NO	NTX
	307-24-4	Perfluorohexanoic Acid (PFHxA)	ND	ND		--	--	--	--	N/A	N/A	N/A		--	--
	375-95-1	Perfluorononanoic acid (PFNA)	ND	ND		--	--	--	--	N/A	N/A	N/A		--	--
	1763-23-1	Perfluorooctane Sulfonate (PFOS)	ND	ND		--	--	--	--	N/A	4.0E-02 N	7.0E-02	HA	--	--
	335-67-1	Perfluorooctanoic acid (PFOA)	1.0E-03 J	1.0E-03 J	UG/L	WI-A06-RW12-0218	1/1	0.00463	1.0E-03	N/A	4.0E-02 N	7.0E-02	HA	NO	BSL

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
HA = USEPA Health Advisory (May 2016)
J = Estimated Value
N = Noncarcinogenic
N/A = Not available
ND = Not detected
UG/L = Micrograms/Liter
-- = Not applicable

TABLE A-6

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Residential Well WI-A06-RW14	375-73-5	Perfluorobutanesulfonic acid (PFBS)	5.8E-02	5.8E-02	UG/L	WI-A06-RW14-0218	1/1	0.00512	5.8E-02	N/A	4.0E+01 N	N/A		NO	BSL
	375-85-9	Perfluoroheptanoic acid (PFHpA)	1.6E-02	1.6E-02	UG/L	WI-A06-RW14-0218	1/1	0.00512	1.6E-02	N/A	N/A	N/A		NO	NTX
	355-46-4	Perfluorohexanesulfonic acid (PFHxS)	2.6E-01	2.6E-01	UG/L	WI-A06-RW14-0218	1/1	0.0256	2.6E-01	N/A	N/A	N/A		NO	NTX
	307-24-4	Perfluorohexanoic Acid (PFHxA)	6.1E-02	6.1E-02	UG/L	WI-A06-RW14-0218	1/1	0.00512	6.1E-02	N/A	N/A	N/A		NO	NTX
	375-95-1	Perfluorononanoic acid (PFNA)	ND	ND		--	--	--	--	N/A	N/A	N/A		--	--
	1763-23-1	Perfluorooctane Sulfonate (PFOS)	7.7E-03 J	7.7E-03 J	UG/L	WI-A06-RW14-0218	1/1	0.00512	7.7E-03	N/A	4.0E-02 N	7.0E-02	HA	NO	BSL
	335-67-1	Perfluorooctanoic acid (PFOA)	2.2E-02	2.2E-02	UG/L	WI-A06-RW14-0218	1/1	0.00512	2.2E-02	N/A	4.0E-02 N	7.0E-02	HA	NO	BSL

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
HA = USEPA Health Advisory (May 2016)
J = Estimated Value
N = Noncarcinogenic
N/A = Not available
ND = Not detected
UG/L = Micrograms/Liter
-- = Not applicable

TABLE A-7

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Residential Well WI-A06-RW18	375-73-5	Perfluorobutanesulfonic acid (PFBS)	2.2E-02	2.3E-02	UG/L	WI-A06-RW18-0418	2/2	0.00483 - 0.00551	2.3E-02	N/A	4.0E+01 N	N/A		NO	BSL
	375-85-9	Perfluoroheptanoic acid (PFHpA)	1.1E-02	1.1E-02	UG/L	WI-A06-RW18-0818	2/2	0.00483 - 0.00551	1.1E-02	N/A	N/A	N/A		NO	NTX
	355-46-4	Perfluorohexanesulfonic acid (PFHxS)	8.8E-02	1.4E-01	UG/L	WI-A06-RW18-0418	2/2	0.00483 - 0.00551	1.4E-01	N/A	N/A	N/A		NO	NTX
	307-24-4	Perfluorohexanoic Acid (PFHxA)	2.8E-02	2.9E-02	UG/L	WI-A06-RW18P-0418	2/2	0.00483 - 0.00551	2.9E-02	N/A	N/A	N/A		NO	NTX
	375-95-1	Perfluorononanoic acid (PFNA)	1.6E-03 J	1.6E-03 J	UG/L	WI-A06-RW18P-0418	1/2	0.00483 - 0.00551	1.6E-03	N/A	N/A	N/A		NO	NTX
	1763-23-1	**Perfluorooctane Sulfonate (PFOS)**	**1.8E-02**	**4.5E-02**	**UG/L**	**WI-A06-RW18-0418**	**2/2**	**0.00483 - 0.00551**	**4.5E-02**	**N/A**	**4.0E-02 N**	**7.0E-02**	**HA**	**YES**	**ASL**
	335-67-1	**Perfluorooctanoic acid (PFOA)**	**2.6E-02**	**3.1E-02**	**UG/L**	**WI-A06-RW18P-0418**	**2/2**	**0.00483 - 0.00551**	**3.1E-02**	**N/A**	**4.0E-02 N**	**7.0E-02**	**HA**	**YES**	**PFOS+PFOA**

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
HA = USEPA Health Advisory (May 2016)
J = Estimated Value
N = Noncarcinogenic
N/A = Not available
UG/L = Micrograms/Liter

TABLE A-7a

Risk Ratio Screening, Drinking Water, Residential Well WI-A06-RW18

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Analyte	Detection Frequency	Maximum Detected Concentration (Qualifier) (UG/L)	Sample Location of Maximum Detected Concentration	Carcinogenic Tap Water RSL (UG/L)	Acceptable Risk Level	Cancer Risk[a]	Non-carcinogenic Tap Water RSL (UG/L)	Acceptable Hazard Level	Hazard Index[b]	Target Organ
Perfluorooctane Sulfonate (PFOS)	2 / 2	4.5E-02	WI-A06-RW18-0418	N/A			4.0E-01	1	0.1	Developmental
Perfluorooctanoic acid (PFOA)	2 / 2	3.1E-02	WI-A06-RW18P-0418	1.1E+00	1E-06	3E-08	4.0E-01	1	0.08	Developmental
Cumulative Hazard Index[c]									**0.2**	
Cumulative Cancer Risk[d]						**3E-08**				
								Total Developmental HI =		**0.2**

Notes:

[a] Cancer Risk equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

[b] Hazard Index equals maximum detected concentration divided by the RSL divided by the acceptable hazard level.

[c] Cumulative Hazard Index equals sum of Hazard Indices for each constituent.

[d] Cumulative Cancer Risk equals sum of Cancer Risks for each constituent.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.

Constituents selected as COPCs are indicated by shading.

COPC = Constituent of Potential Concern
HI = Hazard Index
N/A = Not available/not applicable
UG/L = Micrograms/Liter
RSL = Regional Screening Level

TABLE A-8

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Residential Well WI-A06-RW19	375-73-5	Perfluorobutanesulfonic acid (PFBS)	6.5E-02	6.8E-02	UG/L	WI-A06-RW19P-0818	2/2	0.00477 - 0.00502	6.8E-02	N/A	4.0E+01 N	N/A		NO	BSL
	375-85-9	Perfluoroheptanoic acid (PFHpA)	3.3E-02	3.8E-02	UG/L	WI-A06-RW19-0818	2/2	0.00477 - 0.00502	3.8E-02	N/A	N/A	N/A		NO	NTX
	355-46-4	Perfluorohexanesulfonic acid (PFHxS)	2.3E-01 J	2.4E-01	UG/L	WI-A06-RW19P-0818	2/2	0.00477 - 0.00502	2.4E-01	N/A	N/A	N/A		NO	NTX
	307-24-4	Perfluorohexanoic Acid (PFHxA)	6.2E-02	6.9E-02	UG/L	WI-A06-RW19-0818	2/2	0.00477 - 0.00502	6.9E-02	N/A	N/A	N/A		NO	NTX
	375-95-1	Perfluorononanoic acid (PFNA)	2.4E-03 J	2.4E-03 J	UG/L	WI-A06-RW19-0318	1/2	0.00477 - 0.00502	2.4E-03	N/A	N/A	N/A		NO	NTX
	1763-23-1	**Perfluorooctane Sulfonate (PFOS)**	**7.5E-02**	**8.0E-02**	**UG/L**	**WI-A06-RW19P-0818**	**2/2**	**0.00477 - 0.00502**	**8.0E-02**	**N/A**	**4.0E-02 N**	**7.0E-02**	**HA**	**YES**	**ASL**
	335-67-1	**Perfluorooctanoic acid (PFOA)**	**4.5E-02**	**4.8E-02**	**UG/L**	**WI-A06-RW19P-0818**	**2/2**	**0.00477 - 0.00502**	**4.8E-02**	**N/A**	**4.0E-02 N**	**7.0E-02**	**HA**	**YES**	**ASL**

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
HA = USEPA Health Advisory (May 2016)
J = Estimated Value
N = Noncarcinogenic
N/A = Not available
UG/L = Micrograms/Liter

TABLE A-8a

Risk Ratio Screening, Drinking Water, Residential Well WI-A06-RW19

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Analyte	Detection Frequency	Maximum Detected Concentration (Qualifier) (UG/L)	Sample Location of Maximum Detected Concentration	Carcinogenic Tap Water RSL (UG/L)	Acceptable Risk Level	Cancer Risk[a]	Non-carcinogenic Tap Water RSL (UG/L)	Acceptable Hazard Level	Hazard Index[b]	Target Organ
Perfluorooctane Sulfonate (PFOS)	2 / 2	8.0E-02	WI-A06-RW19P-0818	N/A			4.0E-01	1	0.2	Developmental
Perfluorooctanoic acid (PFOA)	2 / 2	4.8E-02	WI-A06-RW19P-0818	1.1E+00	1E-06	4E-08	4.0E-01	1	0.1	Developmental
Cumulative Hazard Index[c]									**0.3**	
Cumulative Cancer Risk[d]						**4E-08**				
									Total Developmental HI =	**0.3**

Notes:

[a] Cancer Risk equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

[b] Hazard Index equals maximum detected concentration divided by the RSL divided by the acceptable hazard level.

[c] Cumulative Hazard Index equals sum of Hazard Indices for each constituent.

[d] Cumulative Cancer Risk equals sum of Cancer Risks for each constituent.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.

Constituents selected as COPCs are indicated by shading.

COPC = Constituent of Potential Concern
HI = Hazard Index
N/A = Not available/not applicable
UG/L = Micrograms/Liter
RSL = Regional Screening Level

TABLE A-9

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Residential Well WI-A06-RW20	375-73-5	Perfluorobutanesulfonic acid (PFBS)	1.9E-02	2.0E-02	UG/L	WI-A06-RW20-0418	2/2	0.00484 - 0.00517	2.0E-02	N/A	4.0E+01 N	N/A		NO	BSL
	375-85-9	Perfluoroheptanoic acid (PFHpA)	3.3E-03 J	3.3E-03 J	UG/L	WI-A06-RW20-0418	1/2	0.00484 - 0.00517	3.3E-03	N/A	N/A	N/A		NO	NTX
	355-46-4	Perfluorohexanesulfonic acid (PFHxS)	1.2E-01	1.2E-01	UG/L	WI-A06-RW20-0818	2/2	0.00484 - 0.00517	1.2E-01	N/A	N/A	N/A		NO	NTX
	307-24-4	Perfluorohexanoic Acid (PFHxA)	1.8E-02	1.9E-02	UG/L	WI-A06-RW20-0418	2/2	0.00484 - 0.00517	1.9E-02	N/A	N/A	N/A		NO	NTX
	375-95-1	Perfluorononanoic acid (PFNA)	ND	ND		--	--	--	--	N/A	N/A	N/A		--	--
	1763-23-1	**Perfluorooctane Sulfonate (PFOS)**	**2.8E-02**	**3.1E-02**	**UG/L**	**WI-A06-RW20-0418**	**2/2**	**0.00484 - 0.00517**	**3.1E-02**	**N/A**	**4.0E-02 N**	**7.0E-02**	**HA**	**YES**	**PFOS+PFOA**
	335-67-1	**Perfluorooctanoic acid (PFOA)**	**4.4E-02**	**4.5E-02**	**UG/L**	**WI-A06-RW20-0818**	**2/2**	**0.00484 - 0.00517**	**4.5E-02**	**N/A**	**4.0E-02 N**	**7.0E-02**	**HA**	**YES**	**ASL**

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
HA = USEPA Health Advisory (May 2016)
J = Estimated Value
N = Noncarcinogenic
N/A = Not available
ND = Not detected
UG/L = Micrograms/Liter
-- = Not applicable

TABLE A-9a

Risk Ratio Screening, Drinking Water, Residential Well WI-A06-RW20

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Analyte	Detection Frequency	Maximum Detected Concentration (Qualifier) (UG/L)	Sample Location of Maximum Detected Concentration	Carcinogenic Tap Water RSL (UG/L)	Acceptable Risk Level	Cancer Risk[a]	Non-carcinogenic Tap Water RSL (UG/L)	Acceptable Hazard Level	Hazard Index[b]	Target Organ
Perfluorooctane Sulfonate (PFOS)	2 / 2	3.1E-02	WI-A06-RW20-0418	N/A			4.0E-01	1	0.08	Developmental
Perfluorooctanoic acid (PFOA)	2 / 2	4.5E-02	WI-A06-RW20-0818	1.1E+00	1E-06	4E-08	4.0E-01	1	0.1	Developmental
Cumulative Hazard Index[c]									**0.2**	
Cumulative Cancer Risk[d]						**4E-08**				
									Total Developmental HI =	**0.2**

Notes:

[a] Cancer Risk equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

[b] Hazard Index equals maximum detected concentration divided by the RSL divided by the acceptable hazard level.

[c] Cumulative Hazard Index equals sum of Hazard Indices for each constituent.

[d] Cumulative Cancer Risk equals sum of Cancer Risks for each constituent.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.

Constituents selected as COPCs are indicated by shading.

COPC = Constituent of Potential Concern
HI = Hazard Index
N/A = Not available/not applicable
UG/L = Micrograms/Liter
RSL = Regional Screening Level

TABLE A-10

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Residential Well WI-AF-1RW12	375-73-5	Perfluorobutanesulfonic acid (PFBS)	1.2E-03 J	4.4E-03 J	UG/L	WI-AF-1RW12-0918	3/4	0.00481 - 0.11	4.4E-03	N/A	4.0E+01 N	N/A		NO	BSL
	375-85-9	Perfluoroheptanoic acid (PFHpA)	9.4E-04 J	1.4E-03 J	UG/L	WI-AF-1RW12-0318	2/3	0.00481 - 0.00502	1.4E-03	N/A	N/A	N/A		NO	NTX
	355-46-4	Perfluorohexanesulfonic acid (PFHxS)	1.1E-03 J	2.3E-03 J	UG/L	WI-AF-1RW12-0318	2/3	0.00481 - 0.00502	2.3E-03	N/A	N/A	N/A		NO	NTX
	307-24-4	Perfluorohexanoic Acid (PFHxA)	1.1E-03 J	4.8E-03 JB	UG/L	WI-AF-1RW12-1017	2/3	0.00481 - 0.00502	4.8E-03	N/A	N/A	N/A		NO	NTX
	375-95-1	Perfluorononanoic acid (PFNA)	ND	ND		--	--	--	--	N/A	N/A	N/A		--	--
	1763-23-1	Perfluorooctane Sulfonate (PFOS)	1.3E-03 J	3.6E-03 J	UG/L	WI-AF-1RW12-0318	2/4	0.00481 - 0.047	3.6E-03	N/A	4.0E-02 N	7.0E-02	HA	NO	BSL
	335-67-1	Perfluorooctanoic acid (PFOA)	4.3E-03 J	9.4E-03 J	UG/L	WI-AF-1RW12-0117	4/4	0.00481 - 0.024	9.4E-03	N/A	4.0E-02 N	7.0E-02	HA	NO	BSL

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
HA = USEPA Health Advisory (May 2016)
J = Estimated Value
JB = estimated result with associated blank sample detections
N = Noncarcinogenic
N/A = Not available
ND = Not detected
UG/L = Micrograms/Liter
-- = Not applicable

TABLE A-11

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Residential Well WI-AF-1RW28	375-73-5	Perfluorobutanesulfonic acid (PFBS)	2.1E-03 J	3.2E-03 J	UG/L	WI-AF-1RW28-0918	3/4	0.00481 - 0.11	3.2E-03	N/A	4.0E+01 N	N/A		NO	BSL
	375-85-9	Perfluoroheptanoic acid (PFHpA)	3.0E-03 J	3.7E-03 J	UG/L	WI-AF-1RW28-1017	3/3	0.00481 - 0.00525	3.7E-03	N/A	N/A	N/A		NO	NTX
	355-46-4	Perfluorohexanesulfonic acid (PFHxS)	7.1E-03 J	9.6E-03 J	UG/L	WI-AF-1RW28-0918	3/3	0.00481 - 0.00525	9.6E-03	N/A	N/A	N/A		NO	NTX
	307-24-4	Perfluorohexanoic Acid (PFHxA)	5.2E-03 J	5.6E-03 J	UG/L	WI-AF-1RW28-0918	3/3	0.00481 - 0.00525	5.6E-03	N/A	N/A	N/A		NO	NTX
	375-95-1	Perfluorononanoic acid (PFNA)	ND	ND		--	--	--	--	N/A	N/A	N/A		--	--
	1763-23-1	Perfluorooctane Sulfonate (PFOS)	ND	ND		--	--	--	--	N/A	4.0E-02 N	7.0E-02	HA	--	--
	335-67-1	Perfluorooctanoic acid (PFOA)	2.9E-02	3.4E-02	UG/L	WI-AF-1RW28-0318	4/4	0.00481 - 0.024	3.4E-02	N/A	4.0E-02 N	7.0E-02	HA	NO	BSL

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
HA = USEPA Health Advisory (May 2016)
J = Estimated Value
N = Noncarcinogenic
N/A = Not available
ND = Not detected
UG/L = Micrograms/Liter
-- = Not applicable

TABLE A-12

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Residential Well WI-AF-1RW32	375-73-5	Perfluorobutanesulfonic acid (PFBS)	6.5E-02	2.1E-01 DJD	UG/L	WI-AF-1RW32-0318	5/5	0.0049 - 0.15	2.1E-01	N/A	4.0E+01 N	N/A		NO	BSL
	375-85-9	Perfluoroheptanoic acid (PFHpA)	4.3E-03 J	1.6E-02	UG/L	WI-AF-1RW32-0318	3/3	0.0049 - 0.00553	1.6E-02	N/A	N/A	N/A		NO	NTX
	355-46-4	Perfluorohexanesulfonic acid (PFHxS)	1.6E-01	1.2E+00 DD	UG/L	WI-AF-1RW32-0318	3/3	0.0049 - 0.15	1.2E+00	N/A	N/A	N/A		NO	NTX
	307-24-4	Perfluorohexanoic Acid (PFHxA)	4.1E-02 B	1.4E-01	UG/L	WI-AF-1RW32-0318	3/3	0.0049 - 0.00553	1.4E-01	N/A	N/A	N/A		NO	NTX
	375-95-1	Perfluorononanoic acid (PFNA)	ND	ND		--	--	--	--	N/A	N/A	N/A		--	--
	1763-23-1	**Perfluorooctane Sulfonate (PFOS)**	**5.4E-01 D**	**8.0E+00 DD**	**UG/L**	**WI-AF-1RW32-0318**	**5/5**	**0.0245 - 0.277**	**8.0E+00**	**N/A**	**4.0E-02 N**	**7.0E-02**	**HA**	**YES**	**ASL**
	335-67-1	**Perfluorooctanoic acid (PFOA)**	**6.0E-03 J**	**4.6E-02**	**UG/L**	**WI-AF-1RW32-0318**	**5/5**	**0.0049 - 0.023**	**4.6E-02**	**N/A**	**4.0E-02 N**	**7.0E-02**	**HA**	**YES**	**ASL**

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
B = the result has associated blank sample detections
D = Compound identified in an analysis at a secondary dilution factor.
DD = to be provided in the next submission
DJD = to be provided in the next submission
HA = USEPA Health Advisory (May 2016)
J = Estimated Value
N = Noncarcinogenic
N/A = Not available
ND = Not detected
UG/L = Micrograms/Liter
-- = Not applicable

TABLE A-12a

Risk Ratio Screening, Drinking Water, Residential Well WI-AF-1RW32

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Analyte	Detection Frequency	Maximum Detected Concentration (Qualifier) (UG/L)	Sample Location of Maximum Detected Concentration	Carcinogenic Tap Water RSL (UG/L)	Acceptable Risk Level	Cancer Risk[a]	Non-carcinogenic Tap Water RSL (UG/L)	Acceptable Hazard Level	Hazard Index[b]	Target Organ
Perfluorooctane Sulfonate (PFOS)	5 / 5	8.0E+00 DD	WI-AF-1RW32-0318	N/A			4.0E-01	1	20	Developmental
Perfluorooctanoic acid (PFOA)	5 / 5	4.6E-02	WI-AF-1RW32-0318	1.1E+00	1E-06	4E-08	4.0E-01	1	0.1	Developmental
Cumulative Hazard Index[c]									**20**	
Cumulative Cancer Risk[d]						**4E-08**				
								Total Developmental HI =		**20**

Notes:

[a] Cancer Risk equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

[b] Hazard Index equals maximum detected concentration divided by the RSL divided by the acceptable hazard level.

[c] Cumulative Hazard Index equals sum of Hazard Indices for each constituent.

[d] Cumulative Cancer Risk equals sum of Cancer Risks for each constituent.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.

Constituents selected as COPCs are indicated by shading.

COPC = Constituent of Potential Concern

HI = Hazard Index

DD = to be provided in the next submission

N/A = Not available/not applicable

UG/L = Micrograms/Liter

RSL = Regional Screening Level

TABLE A-13

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Residential Well WI-AF-1RW33	375-73-5	Perfluorobutanesulfonic acid (PFBS)	4.5E-02 J	7.0E-02	UG/L	WI-AF-1RW33-0918	4/4	0.00474 - 0.1	7.0E-02	N/A	4.0E+01 N	N/A		NO	BSL
	375-85-9	Perfluoroheptanoic acid (PFHpA)	5.9E-04 J	9.6E-04 J	UG/L	WI-AF-1RW33-0318	2/3	0.00474 - 0.00492	9.6E-04	N/A	N/A	N/A		NO	NTX
	355-46-4	Perfluorohexanesulfonic acid (PFHxS)	3.2E-03 J	6.4E-03 J	UG/L	WI-AF-1RW33-0918	3/3	0.00474 - 0.00492	6.4E-03	N/A	N/A	N/A		NO	NTX
	307-24-4	Perfluorohexanoic Acid (PFHxA)	4.2E-02 B	6.3E-02	UG/L	WI-AF-1RW33-0918	3/3	0.00474 - 0.00492	6.3E-02	N/A	N/A	N/A		NO	NTX
	375-95-1	Perfluorononanoic acid (PFNA)	ND	ND		--	--	--	--	N/A	N/A	N/A		--	--
	1763-23-1	Perfluorooctane Sulfonate (PFOS)	ND	ND		--	--	--	--	N/A	4.0E-02 N	7.0E-02	HA	--	--
	335-67-1	Perfluorooctanoic acid (PFOA)	ND	ND		--	--	--	--	N/A	4.0E-02 N	7.0E-02	HA	--	--

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
HA = USEPA Health Advisory (May 2016)
B = the result has associated blank sample detections
J = Estimated Value
N = Noncarcinogenic
N/A = Not available
ND = Not detected
UG/L = Micrograms/Liter
-- = Not applicable

TABLE A-14

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Residential Well WI-AF-1RW40	375-73-5	Perfluorobutanesulfonic acid (PFBS)	3.9E-03 J	7.2E-03 J	UG/L	WI-AF-1RW40-0918	3/4	0.00492 - 0.1	7.2E-03	N/A	4.0E+01 N	N/A		NO	BSL
	375-85-9	Perfluoroheptanoic acid (PFHpA)	4.0E-03 J	6.7E-03 J	UG/L	WI-AF-1RW40-0918	3/3	0.00492 - 0.005	6.7E-03	N/A	N/A	N/A		NO	NTX
	355-46-4	Perfluorohexanesulfonic acid (PFHxS)	1.6E-02	2.3E-02	UG/L	WI-AF-1RW40-1017	3/3	0.00492 - 0.005	2.3E-02	N/A	N/A	N/A		NO	NTX
	307-24-4	Perfluorohexanoic Acid (PFHxA)	4.9E-03 JB	1.1E-02	UG/L	WI-AF-1RW40-0918	3/3	0.00492 - 0.005	1.1E-02	N/A	N/A	N/A		NO	NTX
	375-95-1	Perfluorononanoic acid (PFNA)	ND	ND		--	--	--	--	N/A	N/A	N/A		--	--
	1763-23-1	**Perfluorooctane Sulfonate (PFOS)**	**1.1E-03 J**	**1.1E-03 J**	**UG/L**	**WI-AF-1RW40-0318**	**1/4**	**0.00492 - 0.044**	**1.1E-03**	**N/A**	**4.0E-02 N**	**7.0E-02**	**HA**	**YES**	**PFOS+PFOA**
	335-67-1	**Perfluorooctanoic acid (PFOA)**	**3.5E-02**	**1.4E-01 J**	**UG/L**	**WI-AF-1RW40-0217**	**4/4**	**0.00492 - 0.022**	**1.4E-01**	**N/A**	**4.0E-02 N**	**7.0E-02**	**HA**	**YES**	**ASL**

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
HA = USEPA Health Advisory (May 2016)
J = Estimated Value
JB = estimated result with associated blank sample detections
N = Noncarcinogenic
N/A = Not available
ND = Not detected
UG/L = Micrograms/Liter
-- = Not applicable

TABLE A-14a

Risk Ratio Screening, Drinking Water, Residential Well WI-AF-1RW40

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Analyte	Detection Frequency	Maximum Detected Concentration (Qualifier) (UG/L)	Sample Location of Maximum Detected Concentration	Carcinogenic Tap Water RSL (UG/L)	Acceptable Risk Level	Cancer Risk[a]	Non-carcinogenic Tap Water RSL (UG/L)	Acceptable Hazard Level	Hazard Index[b]	Target Organ
Perfluorooctane Sulfonate (PFOS)	1 / 4	1.1E-03 J	WI-AF-1RW40-0318	N/A			4.0E-01	1	0.003	Developmental
Perfluorooctanoic acid (PFOA)	4 / 4	1.4E-01 J	WI-AF-1RW40-0217	1.1E+00	1E-06	1E-07	4.0E-01	1	0.4	Developmental
Cumulative Hazard Index[c]									**0.4**	
Cumulative Cancer Risk[d]						**1E-07**				
								Total Developmental HI =		**0.4**

Notes:

[a] Cancer Risk equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

[b] Hazard Index equals maximum detected concentration divided by the RSL divided by the acceptable hazard level.

[c] Cumulative Hazard Index equals sum of Hazard Indices for each constituent.

[d] Cumulative Cancer Risk equals sum of Cancer Risks for each constituent.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.

Constituents selected as COPCs are indicated by shading.

COPC = Constituent of Potential Concern
HI = Hazard Index
J = Estimated Value
N/A = Not available/not applicable
UG/L = Micrograms/Liter
RSL = Regional Screening Level

TABLE A-15

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
	375-73-5	Perfluorobutanesulfonic acid (PFBS)	ND	ND		--	--	--	--	N/A	4.0E+01 N	N/A		--	--
	375-85-9	Perfluoroheptanoic acid (PFHpA)	ND	ND		--	--	--	--	N/A	N/A	N/A		--	--
Residential	355-46-4	Perfluorohexanesulfonic acid (PFHxS)	1.2E-03 J	1.7E-03 J	UG/L	WI-AF-1RW51-0318	2/3	0.00441 - 0.00506	1.7E-03	N/A	N/A	N/A		NO	NTX
Well	307-24-4	Perfluorohexanoic Acid (PFHxA)	4.4E-03 JB	4.4E-03 JB	UG/L	WI-AF-1RW51-1017	1/3	0.00441 - 0.00506	4.4E-03	N/A	N/A	N/A		NO	NTX
	375-95-1	Perfluorononanoic acid (PFNA)	ND	ND		--	--	--	--	N/A	N/A	N/A		--	--
WI-AF-1RW51	1763-23-1	Perfluorooctane Sulfonate (PFOS)	3.2E-02 J	3.2E-02 J	UG/L	WI-AF-1RW51-0617	1/4	0.00441 - 0.015	3.2E-02	N/A	4.0E-02 N	7.0E-02	HA	NO	BSL
	335-67-1	Perfluorooctanoic acid (PFOA)	6.4E-03 J	6.4E-03 J	UG/L	WI-AF-1RW51-0617	1/4	0.00441 - 0.0076	6.4E-03	N/A	4.0E-02 N	7.0E-02	HA	NO	BSL

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
HA = USEPA Health Advisory (May 2016)
J = Estimated Value
JB = estimated result with associated blank sample detections
N = Noncarcinogenic
N/A = Not available
ND = Not detected
UG/L = Micrograms/Liter
-- = Not applicable

TABLE A-16

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Residential Well WI-AF-3RW41	375-73-5	Perfluorobutanesulfonic acid (PFBS)	5.5E-02	7.2E-02	UG/L	WI-AF-3RW41-1017	4/4	0.00469 - 0.1	7.2E-02	N/A	4.0E+01 N	N/A		NO	BSL
	375-85-9	Perfluoroheptanoic acid (PFHpA)	3.0E-03 J	4.3E-03 J	UG/L	WI-AF-3RW41-0918	3/3	0.00469 - 0.00517	4.3E-03	N/A	N/A	N/A		NO	NTX
	355-46-4	Perfluorohexanesulfonic acid (PFHxS)	4.2E-02	5.2E-02	UG/L	WI-AF-3RW41P-1017	3/3	0.00469 - 0.00517	5.2E-02	N/A	N/A	N/A		NO	NTX
	307-24-4	Perfluorohexanoic Acid (PFHxA)	1.4E-02	2.0E-02 B	UG/L	WI-AF-3RW41P-1017	3/3	0.00469 - 0.00517	2.0E-02	N/A	N/A	N/A		NO	NTX
	375-95-1	Perfluorononanoic acid (PFNA)	ND	ND		--	--	--	--	N/A	N/A	N/A		--	--
	1763-23-1	Perfluorooctane Sulfonate (PFOS)	5.1E-03 J	7.1E-03 J	UG/L	WI-AF-3RW41-1017	3/4	0.00469 - 0.045	7.1E-03	N/A	4.0E-02 N	7.0E-02	HA	NO	BSL
	335-67-1	Perfluorooctanoic acid (PFOA)	5.5E-03 J	6.7E-03 J	UG/L	WI-AF-3RW41P-1017	3/4	0.00469 - 0.023	6.7E-03	N/A	4.0E-02 N	7.0E-02	HA	NO	BSL

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
HA = USEPA Health Advisory (May 2016)
B = the result has associated blank sample detections
J = Estimated Value
N = Noncarcinogenic
N/A = Not available
ND = Not detected
UG/L = Micrograms/Liter
-- = Not applicable

TABLE A-17

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Residential Well WI-A06-RW24	375-73-5	Perfluorobutanesulfonic acid (PFBS)	3.0E-02	3.0E-02	UG/L	WI-A06-RW24-1019	1/1	0.00514	3.0E-02	N/A	4.0E+01 N	N/A		NO	BSL
	375-85-9	Perfluoroheptanoic acid (PFHpA)	8.4E-03 J	8.4E-03 J	UG/L	WI-A06-RW24-1019	1/1	0.00514	8.4E-03	N/A	N/A	N/A		NO	NTX
	355-46-4	Perfluorohexanesulfonic acid (PFHxS)	4.3E-01 D	4.3E-01 D	UG/L	WI-A06-RW24-1019	1/1	0.00514	4.3E-01	N/A	N/A	N/A		NO	NTX
	307-24-4	Perfluorohexanoic Acid (PFHxA)	4.9E-02	4.9E-02	UG/L	WI-A06-RW24-1019	1/1	0.00514	4.9E-02	N/A	N/A	N/A		NO	NTX
	375-95-1	Perfluorononanoic acid (PFNA)	ND	ND		--	--	--	--	N/A	N/A	N/A		--	--
	1763-23-1	**Perfluorooctane Sulfonate (PFOS)**	**2.3E-01**	**2.3E-01**	**UG/L**	WI-A06-RW24-1019	1/1	**0.00514**	**2.3E-01**	**N/A**	**4.0E-02 N**	**7.0E-02**	**HA**	**YES**	**ASL**
	335-67-1	**Perfluorooctanoic acid (PFOA)**	**5.3E-02**	**5.3E-02**	**UG/L**	WI-A06-RW24-1019	1/1	**0.00514**	**5.3E-02**	**N/A**	**4.0E-02 N**	**7.0E-02**	**HA**	**YES**	**ASL**

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
D = Compound identified in an analysis at a secondary dilution factor.
HA = USEPA Health Advisory (May 2016)
J = Estimated Value
N = Noncarcinogenic
N/A = Not available
ND = Not detected
UG/L = Micrograms/Liter
-- = Not applicable

TABLE A-17a

Risk Ratio Screening, Drinking Water, Residential Well WI-A06-RW24

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Analyte	Detection Frequency	Maximum Detected Concentration (Qualifier) (UG/L)	Sample Location of Maximum Detected Concentration	Carcinogenic Tap Water RSL (UG/L)	Acceptable Risk Level	Cancer Risk[a]	Non-carcinogenic Tap Water RSL (UG/L)	Acceptable Hazard Level	Hazard Index[b]	Target Organ
Perfluorooctane Sulfonate (PFOS)	1 / 1	2.3E-01	WI-A06-RW24-1019	N/A			4.0E-01	1	0.6	Developmental
Perfluorooctanoic acid (PFOA)	1 / 1	5.3E-02	WI-A06-RW24-1019	1.1E+00	1E-06	5E-08	4.0E-01	1	0.1	Developmental
Cumulative Hazard Index[c]									**0.7**	
Cumulative Cancer Risk[d]						**5E-08**				
								Total Developmental HI =		**0.7**

Notes:

[a] Cancer Risk equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

[b] Hazard Index equals maximum detected concentration divided by the RSL divided by the acceptable hazard level.

[c] Cumulative Hazard Index equals sum of Hazard Indices for each constituent.

[d] Cumulative Cancer Risk equals sum of Cancer Risks for each constituent.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.

Constituents selected as COPCs are indicated by shading.

COPC = Constituent of Potential Concern
HI = Hazard Index
N/A = Not available/not applicable
UG/L = Micrograms/Liter
RSL = Regional Screening Level

TABLE A-1

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Medium: Drinking Water
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Residential Well WI-A06-RW02	355-46-4	Perfluorohexanesulfonic acid (PFHxS)	1.3E-03 J	1.3E-03 J	UG/L	WI-A06-RW02-0218	1/1	0.00502	1.3E-03	N/A	N/A	N/A		NO	NTX

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
HA = USEPA Health Advisory (May 2016)
J = Estimated Value
N = Noncarcinogenic
N/A = Not available
UG/L = Micrograms/Liter

TABLE A-6

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Medium: Drinking Water
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Residential Well WI-A06-RW09	307-24-4	Perfluorohexanoic Acid (PFHxA)	8.3E-04 J	8.3E-04 J	UG/L	WI-A06-RW09-0218	1/1	0.00443	8.3E-04	N/A	N/A	N/A		NO	NTX

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
HA = USEPA Health Advisory (May 2016)
J = Estimated Value
N = Noncarcinogenic
N/A = Not available
UG/L = Micrograms/Liter

TABLE A-8

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Medium: Drinking Water
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Residential Well WI-A06-RW13	307-24-4	Perfluorohexanoic Acid (PFHxA)	6.8E-04 J	6.8E-04 J	UG/L	WI-A06-RW13-0218	1/1	0.00494	6.8E-04	N/A	N/A	N/A		NO	NTX

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
HA = USEPA Health Advisory (May 2016)
J = Estimated Value
N = Noncarcinogenic
N/A = Not available
UG/L = Micrograms/Liter

TABLE A-10

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Medium: Drinking Water
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Residential Well WI-A06-RW16	307-24-4	Perfluorohexanoic Acid (PFHxA)	9.1E-04 J	9.1E-04 J	UG/L	WI-A06-RW16-0218	1/1	0.00504	9.1E-04	N/A	N/A	N/A		NO	NTX

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
HA = USEPA Health Advisory (May 2016)
J = Estimated Value
N = Noncarcinogenic
N/A = Not available
UG/L = Micrograms/Liter

TABLE A-14

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Medium: Drinking Water
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Residential Well WI-AF-1RW01	307-24-4	Perfluorohexanoic Acid (PFHxA)	4.9E-03 JB	4.9E-03 JB	UG/L	WI-AF-1RW01-1017	1/3	0.00484 - 0.00496	4.9E-03	N/A	N/A	N/A		NO	NTX

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
HA = USEPA Health Advisory (May 2016)
JB = estimated result with associated blank sample detections
N = Noncarcinogenic
N/A = Not available
UG/L = Micrograms/Liter

TABLE A-15

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Medium: Drinking Water
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection
Residential Well WI-AF-1RW11	307-24-4	Perfluorohexanoic Acid (PFHxA)	5.1E-03 JB	5.1E-03 JB	UG/L	WI-AF-1RW11-1017	1/2	0.005 - 0.0051	5.1E-03	N/A	N/A	N/A		NO	NTX

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
HA = USEPA Health Advisory (May 2016)
JB = estimated result with associated blank sample detections
N = Noncarcinogenic
N/A = Not available
UG/L = Micrograms/Liter

TABLE A-22

Occurrence, Distribution, and Selection of Constituents of Potential Concern

Engineering Evaluation/Cost Analysis for Long-term Solutions for Ault Field and Area 6 Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Scenario Timeframe: Future
Medium: Drinking Water
Exposure Medium: Drinking Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Residential Well WI-AF-1RW57	307-24-4	Perfluorohexanoic Acid (PFHxA)	9.6E-04 J	9.6E-04 J	UG/L	WI-AF-1RW57-0418	1/1	0.00484	9.6E-04	N/A	N/A	N/A		NO	NTX

[1] Minimum/Maximum detected concentrations.

[2] Maximum detected concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May 2018. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
Tap Water RSLs (based on 10^{-6} for carcinogens and HQ of 0.1 for noncarcinogens).
RSL values for PFOS and PFOA were calculated using the RSL calculator tool.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Combined concentration of PFOS and PFOA exceeds the RSL (PFOS+PFOA)

Deletion Reason: Below Screening Level (BSL)
No toxicity value (NTX)

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
COPC = Constituent of Potential Concern
HA = USEPA Health Advisory (May 2016)
J = Estimated Value
N = Noncarcinogenic
N/A = Not available
UG/L = Micrograms/Liter

Appendix B
Cost Estimate

Table B-1. Engineer's Cost Estimate for Alternative 1a-1: No Further Action for Residence 1

Engineered Evaluation and Cost Estimate for Residential Drinking Water

Naval Air Station Whidbey Island, Ault Field, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents					
UFP-SAP, WMP-EPP, APP-SSHP	Lump Sum	1	$ 1,000.00	$ 1,000.00	Assumes minor updates to existing documents.
Work Planning Documents Total				**$ 1,000.00**	
Subtotal				***$ 1,000.00***	
Contingency (15%)		*15%*		$ 150.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Subtotal				***$ 1,150.00***	
Project Management (10%)		*10%*		$ 115.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL CAPITAL COSTS				**$ 1,300.00**	
Annual Operations and Maintenance (O&M)					
Bottled Water Supply	Each	1	$ 1,950.00	$ 1,950.00	bi-weekly water delivery; $75 each delivery based on October and November 2018 delivery totals from Crystal Spring Invoices.
Subtotal				***$ 1,950.00***	
Contingency (15%)		*15%*		$ 292.50	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Technical Support (15%)		*15%*		$ 292.50	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL O&M COSTS PER YEAR				**$ 2,535.00**	
Total O&M Cost Per Year				$ 2,535.00	
Total Years of O&M				30	
Total O&M Cost for 30 Years				$ 76,050.00	
Discount Rate				2.6%	Office of Management and Budget, Circular A-94 2018.
Total Present Value of O&M Costs				**$ 52,400.00**	
TOTAL PRESENT VALUE of ALTERNATIVE				**$ 53,700.00**	
			+50%	$ 80,550.00	
			-30%	$ 37,590.00	

This is not an offer for construction and/or project execution. Please note, these order of magnitude cost estimates are assumed to represent the actual installed cost within the range of - 30 percent to + 50 percent of the costs indicated. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor, material costs, and competitive variable factors. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific decisions to help ensure proper project evaluation and adequate funding.

Table B-2. Engineer's Cost Estimate for Alternative 1a-2: No Further Action for Residence 2

Engineered Evaluation and Cost Estimate for Residential Drinking Water

Naval Air Station Whidbey Island, Ault Field, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents					
UFP-SAP, WMP-EPP, APP-SSHP	Lump Sum	1	$ 1,000.00	$ 1,000.00	Assumes minor updates to existing documents.
Work Planning Documents Total				**$ 1,000.00**	
Subtotal				***$ 1,000.00***	
Contingency (15%)		*15%*		$ 150.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Subtotal				***$ 1,150.00***	
Project Management (10%)		*10%*		$ 115.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL CAPITAL COSTS				**$ 1,300.00**	
Annual Operations and Maintenance (O&M)					
Bottled Water Supply	Each	1	$ 3,640.00	$ 3,640.00	bi-weekly water delivery; $140 each delivery based on October and November 2018 delivery totals from Crystal Spring Invoices.
Subtotal				***$ 3,640.00***	
Contingency (15%)		*15%*		$ 546.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Technical Support (15%)		*15%*		$ 546.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL O&M COSTS PER YEAR				**$ 4,732.00**	
Total O&M Cost Per Year				$ 4,732.00	
Total Years of O&M				30	
Total O&M Cost for 30 Years				$ 141,960.00	
Discount Rate				2.6%	Office of Management and Budget, Circular A-94 2018.
Total Present Value of O&M Costs				**$ 97,700.00**	
TOTAL PRESENT VALUE of ALTERNATIVE				**$ 99,000.00**	
			+50%	$ 148,500.00	
			-30%	$ 69,300.00	

This is not an offer for construction and/or project execution. Please note, these order of magnitude cost estimates are assumed to represent the actual installed cost within the range of - 30 percent to + 50 percent of the costs indicated. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor, material costs, and competitive variable factors. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific decisions to help ensure proper project evaluation and adequate funding.

Table B-3. Engineer's Cost Estimate for Alternative 1a-3: No Further Action for Easy Street Residences

Engineered Evaluation and Cost Estimate for Residential Drinking Water

Naval Air Station Whidbey Island, Ault Field, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents					
UFP-SAP, WMP-EPP, APP-SSHP	Lump Sum	1	$ 1,000.00	$ 1,000.00	Assumes minor updates to existing documents.
Work Planning Documents Total				**$ 1,000.00**	
Subtotal				***$ 1,000.00***	
Contingency (15%)		*15%*		$ 150.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Subtotal				***$ 1,150.00***	
Project Management (10%)		*10%*		$ 115.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL CAPITAL COSTS				**$ 1,300.00**	
Annual Operations and Maintenance (O&M)					
Bottled Water Supply	Each	1	$ 13,000.00	$ 13,000.00	bi-weekly water delivery to 4 Easy Street homes; $400 each delivery based on October and November 2018 delivery totals from Crystal Spring Invoices.
Subtotal				***$ 13,000.00***	
Contingency (15%)		*15%*		$ 1,950.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Technical Support (15%)		*15%*		$ 1,950.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL O&M COSTS PER YEAR				**$ 16,900.00**	
Total O&M Cost Per Year				$ 13,520.00	
Total Years of O&M				30	
Total O&M Cost for 30 Years				$ 405,600.00	
Discount Rate				2.6%	Office of Management and Budget, Circular A-94 2018.
Total Present Value of O&M Costs				**$ 279,200.00**	
TOTAL PRESENT VALUE of ALTERNATIVE				**$ 280,500.00**	
			+50%	$ 420,750.00	
			-30%	$ 196,350.00	

This is not an offer for construction and/or project execution. Please note, these order of magnitude cost estimates are assumed to represent the actual installed cost within the range of - 30 percent to + 50 percent of the costs indicated. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor, material costs, and competitive variable factors. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific decisions to help ensure proper project evaluation and adequate funding.

Table B-4a. Engineer's Cost Estimate for Alternative 1a-4: No Further Action for Evergreen Mobile Home Park Residences - Bottled Water

Engineered Evaluation and Cost Estimate for Residential Drinking Water

Naval Air Station Whidbey Island, Ault Field, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents					
UFP-SAP, WMP-EPP, APP-SSHP	Lump Sum	1	$ 1,000.00	$ 1,000.00	Assumes minor updates to existing documents.
Work Planning Documents Total				**$ 1,000.00**	
Subtotal				***$ 1,000.00***	
Contingency (15%)		*15%*		$ 150.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Subtotal				***$ 1,150.00***	
Project Management (10%)		*10%*		$ 115.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL CAPITAL COSTS				**$ 1,300.00**	
Annual Operations and Maintenance (O&M)					
Bottled Water Supply	Each	1	$ 34,840.00	$ 34,840.00	bi-weekly water delivery to 19 Evergreen Mobile Home Park homes; $1,340 each delivery based on October and November 2018 delivery totals from Crystal Spring Invoices.
Subtotal				***$ 34,800.00***	
Contingency (15%)		*15%*		$ 5,220.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Technical Support (15%)		*15%*		$ 5,220.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL O&M COSTS PER YEAR				**$ 45,240.00**	
Total O&M Cost Per Year				$ 45,240.00	
Total Years of O&M				30	
Total O&M Cost for 30 Years				$ 1,357,200.00	
Discount Rate				2.6%	Office of Management and Budget, Circular A-94 2018.
Total Present Value of O&M Costs				**$ 934,400.00**	
TOTAL PRESENT VALUE of ALTERNATIVE				**$ 935,700.00**	
			+50%	$ 1,403,550.00	
			-30%	$ 654,990.00	

This is not an offer for construction and/or project execution. Please note, these order of magnitude cost estimates are assumed to represent the actual installed cost within the range of - 30 percent to + 50 percent of the costs indicated. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor, material costs, and competitive variable factors. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific decisions to help ensure proper project evaluation and adequate funding.

Table B-4b. Engineer's Cost Estimate for Alternative 1b: No Further Action for Evergreen Mobile Home Park Residences - POU System

Engineered Evaluation and Cost Estimate for Residential Drinking Water

Naval Air Station Whidbey Island, Ault Field, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents					
UFP-SAP, WMP-EPP, APP-SSHP	Lump Sum	1	$ 4,000.00	$ 4,000.00	Assumes minor updates to existing documents.
Work Planning Documents Total				**$ 4,000.00**	
Subtotal				***$ 4,000.00***	
Contingency (15%)		*15%*		$ 600.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Subtotal				***$ 4,600.00***	
Project Management (10%)		*10%*		$ 460.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL CAPITAL COSTS				**$ 5,100.00**	
Annual Operations and Maintenance (O&M)					
POU System Maintenance	Each	1	$ 3,294.00	$ 3,294.00	three GAC cartridge change out every 12 weeks and one overall annual system maintenance. Assumes occurs at same time as a sampling event; $734 per cartridge changeout (4 per year) + $358 annual maintenance (1 per year) (source: current Culligan PO)
POU System Sampling	Each	1	$ 18,857.60	$ 18,857.60	Sampling every 12 weeks (4 events per year after the first year); 5 samples for PFAS each event (influent, midpoint 1, midpoint 2, effluent, and QC sample); rental of water quality meter; 2 staff for one day trip to perform work; travel expenses
POU System Reporting	Each	1	$ 9,600.00	$ 9,600.00	Four TMs per year documenting sampling activities, results, repairs and change outs. Assumes data validation, database management, and preparation of one TM per quarter (20 hours per event at average rate of $120/hr.)
Subtotal				***$ 31,800.00***	
Contingency (15%)		*15%*		$ 4,770.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Technical Support (15%)		*15%*		$ 4,770.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL O&M COSTS PER YEAR				**$ 41,340.00**	
Total O&M Cost Per Year				$ 41,340.00	
Total Years of O&M				30	
Total O&M Cost for 30 Years				$ 1,240,200.00	
Discount Rate				2.6%	Office of Management and Budget, Circular A-94 2018.
Total Present Value of O&M Costs				**$ 853,800.00**	
TOTAL PRESENT VALUE of ALTERNATIVE				**$ 858,900.00**	
			+50%	$ 1,288,350.00	
			-30%	$ 601,230.00	

This is not an offer for construction and/or project execution. Please note, these order of magnitude cost estimates are assumed to represent the actual installed cost within the range of - 30 percent to + 50 percent of the costs indicated. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor, material costs, and competitive variable factors. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific decisions to help ensure proper project evaluation and adequate funding.

Table B-5. Engineer's Cost Estimate for Alternative 2a-1: GAC POE System for Ault Field Residence 1

Engineering Evaluation and Cost Analysis for Residential Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents					
UFP-SAP, WMP-EPP, APP-SSHP	Lump Sum	1	$ 15,000.00	$ 15,000	Includes draft and final submission with site-specific system design and AHAs for system installation
Construction Completion Report	Lump Sum	1	$ 12,000.00	$ 12,000	Includes draft and final submission for system installation
Work Planning Documents Total				**$ 27,000**	
Site Preparation					
Mobilization/Demobilization	Each	1	$ 1,000.00	$ 1,000	Prior Experience (Fentress); 1 each for Residence 1, Residence 2, and Easy Street Residences
Site Visit and Documentation	Each	1	$ 1,500.00	$ 1,500	Prior Experience (Fentress); 1 each for Residence 1, Residence 2, and Easy Street Residences
Site Access Agreements	Each	1	$ 480.00	$ 480	Right of Entry Forms; assumes 4 hours Jacobs support at $120/hour for each agreement, one need for each property
Site Preparation Total				**$ 2,980**	
Lab Treatability Testing					
Test plan	Lump Sum	1	$7,500.00	$ 7,500	Assume no SAP required. Assumed scope: 1 GAC, 1 water, 1 RSSCT + 1 abbreviated control, 6-7 wk run time, analytes = PFAS (at off-site lab), DOC and UV-25 (at treatability lab).
Treatability lab - subcontracting	Lump Sum	1	$1,500.00	$ 1,500	
Sample water collection & shipping	Lump Sum	1	$1,800.00	$ 1,800	Assume 2x55-gal drums. Assume $800 for labor, travel exp, & supplies + $1000 for shipping
Treatabilty lab - testing	Lump Sum	1	$15,750.00	$ 15,750	Based on estimate from TA-Corvallis; includes setup, supplies, testing, DOC and UV-254 analysis, waste disposal, lab report.
Treatability testing - analytics	Lump Sum	1	$5,750.00	$ 5,750	Assume $750 for initial water char'n + $5000 for PFAS analysis during RSSCT
Final report	Lump Sum	1	$10,000.00	$ 10,000	Includes lab methods/results, recommended design data, & data validation
Lab Treatability Testing Total				**$ 42,300**	
System Installation					
Point of Entry GAC System with FILTRASORB F600AR media included	System	1	$ 5,500.00	$ 5,500	Assume 2 vessels per system, 16" dia by 65" FRP Tanks, preloaded with FILTRASORB F600 carbon media. Culligan Quote
Installation of GAC systems by certified plumber	System	1	$ 1,100.00	$ 1,100	Assumes total installation cost is 20% of the equipment cost. Includes installation of equipment, and sterilization of lines.
Process Piping Allowance	System	1	$ 1,500.00	$ 1,500	Prior Experience
Electrician allowance	System	1	$ 700.00	$ 700	
Miscellaneous Items Allowance	System	1	$ 500.00	$ 500	Items purchased from the hardware store such as electrical components, flow valves etc. Based on prior experience.
Shed/Building Allowance	System	1	$ 1,800.00	$ 1,800	Assume 4' x 4'x 6' Rubbermaid shed for housing treatment equipments. Assumes no or minimal earthwork required.
System Installation Total				**$ 11,100**	
Subtotal				***$ 83,380***	
Contingency (15%)		*15%*		$ 12,507	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
General Conditions (10%)		*10%*		$ 8,338	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Subtotal				***$ 104,225***	
Performance Bond (2%)		*2%*		$ 2,085	Industry Average
Subtotal				***$ 106,310***	
Project Management (10%)		*10%*		$ 10,631	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Design Costs (6%)		*6%*		$ 6,379	Navy Estimating Guidance. Assumes that one system design will be adequate and used for all six systems.
Construction Oversight (15%)		*15%*		$ 15,946	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL CAPITAL COSTS				**$ 139,000**	
Annual Operations and Maintenance (O&M)					
Monitoring event labor	System	1	$ 1,600.00	$ 1,600	[2 event/system/year] x [8 h/event (2 hr monitoring + 2 h travel + 4 h pre/post monitoing work] x [$100/h] = $1600/system/yr.
Monitoring event expenses	System	1	$ 550.00	$ 550	[2 event/system/yr] x [$275/event ($50 sample shipping + $50 equipment/supplies + $175 travel)] = $550/system/yr.

Table B-5. Engineer's Cost Estimate for Alternative 2a-1: GAC POE System for Ault Field Residence 1

Engineering Evaluation and Cost Analysis for Residential Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Monitoring event analytics	System	1	$ 2,264.00	$ 2,264	[2 events/system/yr] x [4 samples/system (3 sample points + 1 QC sample)] x [$283 per sample based on costing CLEAN 9000] = $2264/system/yr .
GAC and filter Change Out	System	1	$ 3,840	$ 3,840	GAC: [0.5 change-outs/system/yr (1 change-out every 2 yr)] x [240 lb GAC/system/change-out (assumes lead vessel replaced and lag vessel rotated to lead position)] x $10/lb GAC] = $1200/system/yr. Sand: [2 change-outs/system/yr] x [$500/system/change-out] = $1000/system/yr. Labor: [2 visits/system/yr] x [4 h/visit] x [$205/h] = $1640/system/yr. Cost basis prior experience.
Miscellaneous Items Allowance	System	1	$ 500.00	$ 500	Items purchased from the hardware store such as piping, electrical components, flow valves etc.
On-call service	System	1	$ 820.00	$ 820	On-call rate for Culligan for pilot tests is $205. Assume one 4-hr service call per system per yr per system.
POE System Reporting	Each	1	$ 4,800.00	$ 4,800.00	One TM per year documenting sampling activities, results, repairs and change outs. Assumes data validation, database management, and preparation of one TM per year (40 hours per event at average rate of $120/hr.)
Subtotal				***$ 14,374***	
Contingency (15%)		*15%*		$ 2,156	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
General Conditions (10%)		*10%*		$ 1,437	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Technical Support (15%)		*15%*		$ 2,156	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Performance Bond (2%)		*2%*		$ 175	Industry Average on O&M items performed by subcontractor.
TOTAL O&M COSTS PER YEAR				**$ 20,300**	
Total Years of O&M				$ 30	
Total O&M Cost for 30 Years				$ 609,000	
Discount Rate				2.6%	Office of Management and Budget, Circular A-94 2018.
Total Present Value of O&M Costs				**$ 420,000**	
TOTAL PRESENT VALUE of ALTERNATIVE				**$ 560,000**	
		+50%		$ 840,000	
		-30%		$ 392,000	

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UFP-SAP = Uniform Federal Policy Sampling and Analysis Plan, WMP-EPP = Waste Management Plan-Environmental Protection Plan, APP-SSHP= Accident Prevention Plan-Site Safety and Health Plan

Table B-6. Engineer's Cost Estimate for Alternative 2a-2: GAC POE System for Ault Field Residence 2

Engineering Evaluation and Cost Analysis for Residential Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents					
UFP-SAP, WMP-EPP, APP-SSHP	Lump Sum	1	$ 15,000.00	$ 15,000	Includes draft and final submission with site-specific system design and AHAs for system installation
Construction Completion Report	Lump Sum	1	$ 12,000.00	$ 12,000	Includes draft and final submission for system installation
Work Planning Documents Total				**$ 27,000**	
Site Preparation					
Mobilization/Demobilization	Each	1	$ 1,000.00	$ 1,000	Prior Experience (Fentress); 1 each for Residence 1, Residence 2, and Easy Street Residences
Site Visit and Documentation	Each	1	$ 1,500.00	$ 1,500	Prior Experience (Fentress); 1 each for Residence 1, Residence 2, and Easy Street Residences
Site Access Agreements	Each	1	$ 480.00	$ 480	Right of Entry Forms; assumes 4 hours Jacobs support at $120/hour for each agreement, one need for each property
Site Preparation Total				**$ 2,980**	
Lab Treatability Testing					
Test plan	Lump Sum	1	$7,500.00	$ 7,500	Assume no SAP required. Assumed scope: 1 GAC, 1 water, 1 RSSCT + 1 abbreviated control, 6-7 wk run time, analytes = PFAS (at off-site lab), DOC and UV-25 (at treatability lab).
Treatability lab - subcontracting	Lump Sum	1	$1,500.00	$ 1,500	
Sample water collection & shipping	Lump Sum	1	$1,800.00	$ 1,800	Assume 2x55-gal drums. Assume $800 for labor, travel exp, & supplies + $1000 for shipping
Treatabilty lab - testing	Lump Sum	1	$15,750.00	$ 15,750	Based on estimate from TA-Corvallis; includes setup, supplies, testing, DOC and UV-254 analysis, waste disposal, lab report.
Treatability testing - analytics	Lump Sum	1	$5,750.00	$ 5,750	Assume $750 for initial water char'n + $5000 for PFAS analysis during RSSCT
Final report	Lump Sum	1	$10,000.00	$ 10,000	Includes lab methods/results, recommended design data, & data validation
Lab Treatability Testing Total				**$ 42,300**	
System Installation					
Point of Entry GAC System with FILTRASORB F600AR media included	System	1	$ 5,500.00	$ 5,500	Assume 2 vessels per system, 16" dia by 65" FRP Tanks, preloaded with FILTRASORB F600 carbon media. Culligan Quote
Installation of GAC systems by certified plumber	System	1	$ 1,100.00	$ 1,100	Assumes total installation cost is 20% of the equipment cost. Includes installation of equipment, and sterilization of lines.
Process Piping Allowance	System	1	$ 1,500.00	$ 1,500	Prior Experience
Electrician allowance	System	1	$ 700.00	$ 700	
Miscellaneous Items Allowance	System	1	$ 500.00	$ 500	Items purchased from the hardware store such as electrical components, flow valves etc. Based on prior experience.
Shed/Building Allowance	System	1	$ 1,800.00	$ 1,800	Assume 4' x 4'x 6' Rubbermaid shed for housing treatment equipments. Assumes no or minimal earthwork required.
System Installation Total				**$ 11,100**	
Subtotal				***$ 83,380***	
Contingency (15%)		*15%*		$ 12,507	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
General Conditions (10%)		*10%*		$ 8,338	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Subtotal				***$ 104,225***	
Performance Bond (2%)		*2%*		$ 2,085	Industry Average
Subtotal				***$ 106,310***	
Project Management (10%)		*10%*		$ 10,631	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Design Costs (6%)		*6%*		$ 6,379	Navy Estimating Guidance. Assumes that one system design will be adequate and used for all six systems.
Construction Oversight (15%)		*15%*		$ 15,946	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL CAPITAL COSTS				**$ 139,000**	
Annual Operations and Maintenance (O&M)					
Monitoring event labor	System	1	$ 3,200.00	$ 3,200	[4 event/system/year] x [8 h/event (2 hr monitoring + 2 h travel + 4 h pre/post monitoing work] x [$100/h] = $3200/system/yr.
Monitoring event expenses	System	1	$ 550.00	$ 550	[2 event/system/yr] x [$275/event ($50 sample shipping + $50 equipment/supplies + $175 travel)] = $550/system/yr.

Table B-6. Engineer's Cost Estimate for Alternative 2a-2: GAC POE System for Ault Field Residence 2

Engineering Evaluation and Cost Analysis for Residential Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Monitoring event analytics	System	1	$ 4,530.00	$ 4,530	[4 events/system/yr] x [4 samples/system (3 sample points + 1 QC sample)] x [$283 per sample based on costing CLEAN 9000] = $4530/system/yr .
GAC and filter Change Out	System	1	$ 7,440	$ 7,440	GAC: [2 change-outs/system/yr] x [240 lb GAC/system/change-out (assumes lead vessel replaced and lag vessel rotated to lead position)] x $10/lb GAC] = $4800/system/yr. Sand: [2 change-outs/system/yr] x [$500/system/change-out] = $1000/system/yr. Labor: [2 visits/system/yr] x [4 h/visit] x [$205/h] = $1640/system/yr. Cost basis prior experience.
Miscellaneous Items Allowance	System	1	$ 500.00	$ 500	Items purchased from the hardware store such as piping, electrical components, flow valves etc.
On-call service	System	1	$ 820.00	$ 820	On-call rate for Culligan for pilot tests is $205. Assume one 4-hr service call per system per yr per system.
POE System Reporting	Each	1	$ 4,800.00	$ 4,800.00	One TM per year documenting sampling activities, results, repairs and change outs. Assumes data validation, database management, and preparation of one TM per year (40 hours per event at average rate of $120/hr.)
Subtotal				***$ 21,840***	
Contingency (15%)		*15%*		$ 3,276	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
General Conditions (10%)		*10%*		$ 2,184	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Technical Support (15%)		*15%*		$ 3,276	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Performance Bond (2%)		*2%*		$ 284	Industry Average on O&M items performed by subcontractor.
TOTAL O&M COSTS PER YEAR				**$ 30,900**	
Total Years of O&M				$ 30	
Total O&M Cost for 30 Years				$ 927,000	
Discount Rate				2.6%	Office of Management and Budget, Circular A-94 2018.
Total Present Value of O&M Costs				**$ 640,000**	
TOTAL PRESENT VALUE of ALTERNATIVE				**$ 780,000**	
			+50%	$ 1,170,000	
			-30%	$ 546,000	

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UFP-SAP = Uniform Federal Policy Sampling and Analysis Plan, WMP-EPP = Waste Management Plan-Environmental Protection Plan, APP-SSHP= Accident Prevention Plan-Site Safety and Health Plan

Table B-7. Engineer's Cost Estimate for Alternative 2a-3: GAC POE Systems for Four Easy Street Residences

Engineering Evaluation and Cost Analysis for Residential Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents					
UFP-SAP, WMP-EPP, APP-SSHP	Lump Sum	1	$ 20,000.00	$ 20,000	Includes draft and final submission with site-specific system design and AHAs for system installation
Construction Completion Report	Lump Sum	1	$ 15,000.00	$ 15,000	Includes draft and final submission for system installation
Work Planning Documents Total				**$ 35,000**	
Site Preparation					
Mobilization/Demobilization	Each	1	$ 1,000.00	$ 1,000	Prior Experience (Fentress); 1 each for Residence 1, Residence 2, and Easy Street Residences
Site Visit and Documentation	Each	1	$ 1,500.00	$ 1,500	Prior Experience (Fentress); 1 each for Residence 1, Residence 2, and Easy Street Residences
Site Access Agreements	Each	5	$ 480.00	$ 2,400	Right of Entry Forms; assumes 4 hours Jacobs support at $120/hour for each agreement, one need for each property
Site Preparation Total				**$ 4,900**	
Lab Treatability Testing					
Test plan	Lump Sum	1	$7,500.00	$ 7,500	Assume no SAP required. Assumed scope: 1 GAC, 1 water, 1 RSSCT + 1 abbreviated control, 6-7 wk run time, analytes = PFAS (at off-site lab), DOC and UV-25 (at treatability lab). Choose 1 representative water for lab testing.
Treatability lab - subcontracting	Lump Sum	1	$1,500.00	$ 1,500	
Sample water collection & shipping	Lump Sum	1	$1,800.00	$ 1,800	Assume 2x55-gal drums. Assume $800 for labor, travel exp, & supplies + $1000 for shipping
Treatabilty lab - testing	Lump Sum	1	$15,750.00	$ 15,750	Based on estimate from TA-Corvallis; includes setup, supplies, testing, DOC and UV-254 analysis, waste disposal, lab report.
Treatability testing - analytics	Lump Sum	1	$5,750.00	$ 5,750	Assume $750 for initial water char'n + $5000 for PFAS analysis during RSSCT
Final report	Lump Sum	1	$10,000.00	$ 10,000	Includes lab methods/results, recommended design data, & data validation
Lab Treatability Testing Total				**$ 42,300**	
System Installation					
Point of Entry GAC System with FILTRASORB F600AR media included	System	5	$ 5,500.00	$ 27,500	Assume 2 vessels per system, 16" dia by 65" FRP Tanks, preloaded with FILTRASORB F600 carbon media. Culligan Quote
Installation of GAC systems by certified plumber	System	5	$ 1,100.00	$ 5,500	Assumes total installation cost is 20% of the equipment cost. Includes installation of equipment, and sterilization of lines.
Process Piping Allowance	System	5	$ 1,500.00	$ 7,500	Prior Experience
Electrician allowance	System	5	$ 700.00	$ 3,500	
Miscellaneous Items Allowance	System	5	$ 500.00	$ 2,500	Items purchased from the hardware store such as electrical components, flow valves etc. Based on prior experience.
Shed/Building Allowance	System	5	$ 1,800.00	$ 9,000	Assume 4' x 4'x 6' Rubbermaid shed for housing treatment equipments. Assumes no or minimal earthwork required.
System Installation Total				**$ 55,500**	
Subtotal				***$ 137,700***	
Contingency (15%)		*15%*		$ 20,655	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
General Conditions (10%)		*10%*		$ 13,770	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Subtotal				***$ 172,125***	
Performance Bond (2%)		*2%*		$ 3,443	Industry Average
Subtotal				***$ 175,568***	
Project Management (10%)		*10%*		$ 17,557	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Design Costs (6%)		*6%*		$ 10,534	Navy Estimating Guidance. Assumes that one system design will be adequate and used for all six systems.
Construction Oversight (15%)		*15%*		$ 26,335	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL CAPITAL COSTS				**$ 230,000**	
Annual Operations and Maintenance (O&M)					
Monitoring event labor	System	5	$ 1,600.00	$ 8,000	[2 event/system/year] x [8 h/event (2 hr monitoring + 2 h travel + 4 h pre/post monitoing work] x [$100/h] = $1600/system/yr.
Monitoring event expenses	System	5	$ 650.00	$ 3,250	[2 event/system/yr] x [$325/event ($100 sample shipping + $50 equipment/supplies + $175 travel)] = $650/system/yr.

Table B-7. Engineer's Cost Estimate for Alternative 2a-3: GAC POE Systems for Four Easy Street Residences

Engineering Evaluation and Cost Analysis for Residential Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Monitoring event analytics	System	5	$ 2,264.00	$ 11,320	[2 events/system/yr] x [4 samples/system (3 sample points + 1 QC sample)] x [$283 per sample based on costing CLEAN 9000] = $2264/system/yr .
GAC and filter Change Out	System	5	$ 3,840	$ 19,200	GAC: [0.5 change-outs/system/yr (1 change-out every 2 yr)] x [240 lb GAC/system/change-out (assumes lead vessel replaced and lag vessel rotated to lead position)] x $10/lb GAC] = $1200/system/yr. Sand: [2 change-outs/system/yr] x [$500/system/change-out] = $1000/system/yr. Labor: [2 visits/system/yr] x [4 h/visit] x [$205/h] = $1640/system/yr. Cost basis prior experience.
Miscellaneous Items Allowance	System	5	$ 500.00	$ 2,500	Items purchased from the hardware store such as piping, electrical components, flow valves etc.
On-call service	System	5	$ 820.00	$ 4,100	On-call rate for Culligan for pilot tests is $205. Assume one 4-hr service call per system per yr per system.
POE System Reporting	Each	1	$ 9,600.00	$ 9,600.00	One TM per year documenting sampling activities, results, repairs and change outs. Assumes data validation, database management, and preparation of one TM per year (80 hours per event at average rate of $120/hr.)
Subtotal				***$ 57,970***	
Contingency (15%)		*15%*		$ 8,696	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
General Conditions (10%)		*10%*		$ 5,797	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Technical Support (15%)		*15%*		$ 8,696	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Performance Bond (2%)		*2%*		$ 806	Industry Average on O&M items performed by subcontractor.
TOTAL O&M COSTS PER YEAR				**$ 82,000**	
Total Years of O&M				$ 30	
Total O&M Cost for 30 Years				$ 2,460,000	
Discount Rate				2.6%	Office of Management and Budget, Circular A-94 2018.
Total Present Value of O&M Costs				**$ 1,690,000**	
TOTAL PRESENT VALUE of ALTERNATIVE				**$ 1,920,000**	
			+50%	$ 2,880,000	
			-30%	$ 1,344,000	

This is not an offer for construction and/or project execution. Please note, these order of magnitude cost estimates are assumed to represent the actual installed cost within the range of - 30 percent to + 50 percent of the costs indicated. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor, material costs, and competitive variable factors. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific decisions to help ensure proper project evaluation and adequate funding.

UFP-SAP = Uniform Federal Policy Sampling and Analysis Plan, WMP-EPP = Waste Management Plan-Environmental Protection Plan, APP-SSHP= Accident Prevention Plan-Site Safety and Health Plan

Table B-8. Engineer's Cost Estimate for Alternative 2a-4: GAC POE System for Evergreen Mobile Home Park

Engineering Evaluation and Cost Analysis for Residential Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents					
UFP-SAP, WMP-EPP, APP-SSHP	Lump Sum	1	$ 15,000.00	$ 15,000	Includes draft and final submission with site-specific system design and AHAs for system installation
Construction Completion Report	Lump Sum	1	$ 12,000.00	$ 12,000	Includes draft and final submission for system installation
Work Planning Documents Total				**$ 27,000**	
Site Preparation					
Mobilization/Demobilization	Each	1	$ 1,000	$ 1,000	Prior Experience (Fentress)
Site Visit and Documentation	Each	1	$ 1,500	$ 1,500	Prior Experience (Fentress)
Site Access Agreements	Each	1	$ 480	$ 480	Right of Entry Forms; assumes 4 hours Jacobs support at $120/hour for each agreement
Archeological Survey - Labor	hr	24	$ 145	$ 3,480	1-day survey with travel time from Portland; assumes finding of "no adverse effect"
Archeological Survey - Travel Expenses	trip	1	$ 750	$ 750	Rental car, gas, hotel, per diem for 3-day trip
Site Preparation Total				**$ 7,210**	
Lab Treatability Testing					
Test plan	Lump Sum	1	$7,500.00	$ 7,500	Assume no SAP required. Assumed scope: 1 GAC, 1 water, 1 RSSCT + 1 abbreviated control, 6-7 wk run time, analytes = PFAS (at off-site lab), DOC and UV-25 (at treatability lab).
Treatability lab - subcontracting	Lump Sum	1	$1,500.00	$ 1,500	
Sample water collection & shipping	Lump Sum	1	$1,800.00	$ 1,800	Assume 2x55-gal drums. Assume $800 for labor, travel exp, & supplies + $1000 for shipping
Treatabilty lab - testing	Lump Sum	1	$15,750.00	$ 15,750	Based on estimate from TA-Corvallis; includes setup, supplies, testing, DOC and UV-254 analysis, waste disposal, lab report.
Treatability testing - analytics	Lump Sum	1	$5,750.00	$ 5,750	Assume $750 for initial water char'n + $5000 for PFAS analysis during RSSCT
Final report	Lump Sum	1	$10,000.00	$ 10,000	Includes lab methods/results, recommended design data, & data validation
Lab Treatability Testing Total				**$ 42,300**	
System Installation					
Point of Entry GAC System with FILTRASORB F600AR media included	System	1	$ 55,000	$ 55,000	2 vessels per system, 4' dia by 6' Carbon Steel Tanks, preloaded with FILTRASORB F600 carbon media. Calgon Quote
Treated Water Tank	System	1	$ 6,000	$ 6,000	8,000 gal holding tank. 10 ft dia, 15 ft H . Catalogue price from Pastic Mart
Tank disinfection system	System	1	$ 10,000	$ 10,000	5% bleach solution feed pump
Treated Water Distribution Pump	Each	2	$ 7,500	$ 15,000	Based on prior experience, 2X100% pumps i.e., one active and one spare
Installation of GAC systems by certified plumber	System	1	$ 7,850	$ 7,850	Assumes total installation cost is 10% of the equipment cost. Includes installation of equipment, and sterilization of lines.
Electrician allowance	System	1	$ 700.00	$ 700	
Process Piping Allowance	System	1	$ 8,000	$ 8,000	Prior Experience
Miscellaneous Items Allowance	System	1	$ 1,000	$ 1,000	Items purchased from the hardware store such as electrical components, flow valves etc. Based on prior experience.
Treatment Building Allowance	System	1	$ 90,000	$ 90,000	A 18'X18' building to house the treatment units and treated water tank. Unit cost for building $250/sq. ft and $500/cubic yard for building slab (assumes 0.75ft slab)
System Installation Total				**$ 193,550**	
Subtotal				***$ 270,060***	
Contingency (15%)		*15%*		$ 40,509	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
General Conditions (10%)		*10%*		$ 27,006	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Subtotal				***$ 337,575***	
Performance Bond (2%)		*2%*		$ 6,752	Industry Average
Subtotal				***$ 344,327***	
Project Management (10%)		*10%*		$ 34,433	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Design Costs (6%)		*6%*		$ 20,660	Navy Estimating Guidance.
Construction Oversight (15%)		*15%*		$ 51,649	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL CAPITAL COSTS				**$ 451,000**	

Table B-8. Engineer's Cost Estimate for Alternative 2a-4: GAC POE System for Evergreen Mobile Home Park

Engineering Evaluation and Cost Analysis for Residential Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Annual Operations and Maintenance (O&M)					
Monitoring event labor	System	1	$ 3,200.00	$ 3,200	[4 event/system/year] x [8 h/event (2 hr monitoring + 2 h travel + 4 h pre/post monitoing work] x [$100/h] = $3200/system/yr.
Monitoring event expenses	System	1	$ 1,100.00	$ 1,100	[4 event/system/yr] x [$275/event ($50 sample shipping + $50 equipment/supplies + $175 travel)] = $11000/system/yr.
Monitoring event analytics	System	1	$ 4,530.00	$ 4,530	[4 events/system/yr] x [4 samples/system (3 sample points + 1 QC sample)] x [$283 per sample based on costing CLEAN 9000] = $4530/system/yr .
GAC and filter Change Out	System	1	$ 14,640	$ 14,640	GAC: [2 change-outs/system/yr] x [2000 lb GAC/system/change-out (assumes lead vessel replaced and lag vessel rotated to lead position)] x $2.75/lb GAC, including freight to and from the site (based on Calgon communication, 2018)] = $11000/system/yr. Sand: [2 change-outs/system/yr] x [$1000/system/change-out] = $2000/system/yr. Labor: [2 visits/system/yr] x [4 h/visit] x [$205/h] = $1640/system/yr.
UV disinfection system maintenance	System	1	$ 2,500	$ 2,500	Assume 1 maintenance event/yr
Miscellaneous Items Allowance	System	1	$ 1,000	$ 1,000	For various miscellenious items like pipe, valves, etc.
On-call service	System	1	$ 1,640.00	$ 1,640	On-call rate for Culligan for pilot tests is $205. Assume two 4-hr service calls per system per yr per system.
POE System Reporting	Each	1	$ 9,600.00	$ 9,600.00	One TM per year documenting sampling activities, results, repairs and change outs. Assumes data validation, database management, and preparation of one TM per year (80 hours per event at average rate of $120/hr.)
Subtotal				***$ 38,210***	
Contingency (15%)		*15%*		$ 5,732	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
General Conditions (10%)		*10%*		$ 3,821	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Technical Support (15%)		*15%*		$ 5,732	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Performance Bond (2%)		*2%*		$ 554	Industry Average on O&M items performed by subcontractor.
TOTAL O&M COSTS PER YEAR				**$ 54,000**	
Total Years of O&M				$ 30	
Total O&M Cost for 30 Years				$ 1,620,000	
Discount Rate				2.6%	Office of Management and Budget, Circular A-94 2018.
Total Present Value of O&M Costs				**$ 1,115,000**	
TOTAL PRESENT VALUE of ALTERNATIVE				**$ 1,570,000**	
		+50%		$ 2,355,000	
		-30%		$ 1,099,000	

This is not an offer for construction and/or project execution. Please note, these order of magnitude cost estimates are assumed to represent the actual installed cost within the range of - 30 percent to + 50 percent of the costs indicated. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor, material costs, and competitive variable factors. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific decisions to help ensure proper project evaluation and adequate funding.

UFP-SAP = Uniform Federal Policy Sampling and Analysis Plan, WMP-EPP = Waste Management Plan-Environmental Protection Plan, APP-SSHP= Accident Prevention Plan-Site Safety and Health Plan

Table B-9. Engineer's Cost Estimate for Alternative 2b-1: IX POE System for Ault Field Residence 1

Engineering Evaluation and Cost Analysis for Residential Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents					
UFP-SAP, WMP-EPP, APP-SSHP	Lump Sum	1	$ 15,000.00	$ 15,000	Includes draft and final submission with site-specific system design and AHAs for system installation
Construction Completion Report	Lump Sum	1	$ 12,000.00	$ 12,000	Includes draft and final submission for system installation
Work Planning Documents Total				**$ 27,000**	
Site Preparation					
Mobilization/Demobilization	Each	1	$ 1,000	$ 1,000	Prior Experience (Fentress); 1 each for Residence 1, Residence 2, and Easy Street Residences
Site Visit and Documentation	Each	1	$ 1,500	$ 1,500	Prior Experience (Fentress); 1 each for Residence 1, Residence 2, and Easy Street Residences
Site Access Agreements	Each	1	$ 480	$ 480	Right of Entry Forms; assumes 4 hours Jacobs support at $120/hour for each agreement, one need for each property
Site Preparation Total				**$ 2,980**	
Lab Treatability Testing					
Test plan	Lump Sum	1	$7,500.00	$ 7,500	Assume no SAP required. Assumed scope: 1 IX resin, 1 water, 1 test column + 1 abbreviated control, 12-14 wk run time, analytes = PFAS (at off-site lab), DOC and UV-25 (at treatability lab).
Treatability lab - subcontracting	Lump Sum	1	$1,500.00	$ 1,500	
Sample water collection & shipping	Lump Sum	1	$1,800.00	$ 1,800	Assume 2x55-gal drums. Assume $800 for labor, travel exp, & supplies + $1000 for shipping
Treatabilty lab - testing	Lump Sum	1	$24,000.00	$ 24,000	Based on estimate from TA-Corvallis; includes setup, supplies, testing, DOC and UV-254 analysis, waste disposal, lab report.
Treatability testing - analytics	Lump Sum	1	$8,250.00	$ 8,250	Assume $750 for initial water char'n + $7500 for PFAS analysis during column test
Final report	Lump Sum	1	$10,000.00	$ 10,000	Includes lab methods/results, recommended design data, & data validation
Lab Treatability Testing Total				**$ 53,050**	
System Installation					
Point of Entry Ion Exchange System with IX resins included	Systems	1	$ 6,000	$ 6,000	2 vessels per system, 10" dia by 54" FRP Tanks, preloaded with IX resin. Based on Prior Experience.
Installation of IX systems by certified plumber	Systems	1	$ 1,200	$ 1,200	Assumes,total installation cost is 20% of the equipment cost. Includes installation of equipment, and sterilization of lines.
Process Piping Allowance	Systems	1	$ 1,500	$ 1,500	Prior Experience
Electrician allowance	System	1	$ 700.00	$ 700	
Miscellaneous Items Allowance	Systems	1	$ 500	$ 500	Items purchased from the hardware store such as electrical components, flow valves etc. Based on prior experience.
Shed/Building Allowance	Systems	1	$ 1,200	$ 1,200	Assume 2' 8' x 4' 5" x 6' Rubbermaid shed for housing treatment equipments. Assumes no or minimal earthwork required.
System Installation Total				**$ 11,100**	
Subtotal				***$ 94,130***	
Contingency (15%)		*15%*		$ 14,120	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
General Conditions (10%)		*10%*		$ 9,413	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Subtotal				***$ 117,663***	
Performance Bond (2%)		*2%*		$ 2,353	Industry Average
Subtotal				***$ 120,016***	
Project Management (10%)		*10%*		$ 12,002	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Design Costs (6%)		*6%*		$ 7,201	Navy Estimating Guidance. Assumes that one system design will be adequate and used for all six systems.
Construction Oversight (15%)		*15%*		$ 18,002	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL CAPITAL COSTS				**$ 157,000**	
Annual Operations and Maintenance (O&M)					
Monitoring event labor	System	1	$ 3,200.00	$ 3,200	[4 event/system/year] x [8 h/event (2 hr monitoring + 2 h travel + 4 h pre/post monitoing work] x [$100/h] = $3200/system/yr.
Monitoring event expenses	System	1	$ 1,100.00	$ 1,100	[4 event/system/yr] x [$275/event ($50 sample shipping + $50 equipment/supplies + $175 travel)] = $1100/system/yr.
Monitoring event analytics	System	1	$ 4,530.00	$ 4,530	[4 events/system/yr] x [4 samples/system (3 sample points + 1 QC sample)] x [$283 per sample based on costing CLEAN 9000] = $4530/system/yr .
Resin and filter Change Out	System	1	$ 3,315	$ 3,315	IX Resin: [1.2 change-outs/system/yr (1 change-out every 10 mo)] x [1.5 CF/system/change-out (assumes lead vessel replaced and lag vessel rotated to lead position)] x $375/CF (estimate from Purolite, including transportation costs)] = $675/system/yr. Sand: [2 change-outs/system/yr] x [$500/system/change-out] = $1000/system/yr. Labor: [2 visits/system/yr] x [4 h/visit] x [$205/h] = $1640/system/yr. Cost basis prior experience.
Used Resin Disposal	System	1	$ 544	$ 544	[1.2 changeout/system/yr] x [1.5 CF of used resin/changeout] x [$52.4/CF (based on $7/gal CERCLA rate for incineration)] + [1.2 event] x [$200/event for mobilization/demobilization] + [1.2 event] x [$175/event per system for profiling].
Miscellaneous Items Allowance	System	1	$ 500	$ 500	Items purchased from the hardware store such as piping, electrical components, flow valves etc.
On call service	System	1	$ 820.00	$ 820	On-call rate for Culligan for pilot tests is $205. Assume one 4-hr service call per system per yr per system.

Table B-9. Engineer's Cost Estimate for Alternative 2b-1: IX POE System for Ault Field Residence 1

Engineering Evaluation and Cost Analysis for Residential Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
POE System Reporting	Each	1	$ 4,800.00	$ 4,800.00	One TM per year documenting sampling activities, results, repairs and change outs. Assumes data validation, database management, and preparation of one TM per year (40 hours per event at average rate of $120/hr.)
Subtotal				***$ 18,809***	
Contingency (15%)		*15%*		$ 2,821	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
General Conditions (10%)		*10%*		$ 1,881	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Technical Support (15%)		*15%*		$ 2,821	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Performance Bond (2%)		*2%*		$ 198	Industry Average on O&M items performed by subcontractor.
TOTAL O&M COSTS PER YEAR				**$ 27,000**	
Total Years of O&M				$ 30	
Total O&M Cost for 30 Years				$ 810,000	
Discount Rate				2.6%	Office of Management and Budget, Circular A-94 2018.
Total Present Value of O&M Costs				**$ 560,000**	
TOTAL PRESENT VALUE of ALTERNATIVE				**$ 720,000**	
			+50%	$ 1,080,000	
			-30%	$ 504,000	

This is not an offer for construction and/or project execution. Please note, these order of magnitude cost estimates are assumed to represent the actual installed cost within the range of - 30 percent to + 50 percent of the costs indicated. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor, material costs, and competitive variable factors. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific decisions to help ensure proper project evaluation and adequate funding.

UFP-SAP = Uniform Federal Policy Sampling and Analysis Plan, WMP-EPP = Waste Management Plan-Environmental Protection Plan, APP-SSHP= Accident Prevention Plan-Site Safety and Health Plan

Table B-10. Engineer's Cost Estimate for Alternative 2b-2: IX POE System for Ault Field Residence 2

Engineering Evaluation and Cost Analysis for Residential Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents					
UFP-SAP, WMP-EPP, APP-SSHP	Lump Sum	1	$ 15,000.00	$ 15,000	Includes draft and final submission with site-specific system design and AHAs for system installation
Construction Completion Report	Lump Sum	1	$ 12,000.00	$ 12,000	Includes draft and final submission for system installation
Work Planning Documents Total				**$ 27,000**	
Site Preparation					
Mobilization/Demobilization	Each	1	$ 1,000	$ 1,000	Prior Experience (Fentress); 1 each for Residence 1, Residence 2, and Easy Street Residences
Site Visit and Documentation	Each	1	$ 1,500	$ 1,500	Prior Experience (Fentress); 1 each for Residence 1, Residence 2, and Easy Street Residences
Site Access Agreements	Each	1	$ 480	$ 480	Right of Entry Forms; assumes 4 hours Jacobs support at $120/hour for each agreement, one need for each property
Site Preparation Total				**$ 2,980**	
Lab Treatability Testing					
Test plan	Lump Sum	1	$7,500.00	$ 7,500	Assume no SAP required. Assumed scope: 1 IX resin, 1 water, 1 test column + 1 abbreviated control, 12-14 wk run time, analytes = PFAS (at off-site lab), DOC and UV-25 (at treatability lab).
Treatability lab - subcontracting	Lump Sum	1	$1,500.00	$ 1,500	
Sample water collection & shipping	Lump Sum	1	$1,800.00	$ 1,800	Assume 2x55-gal drums. Assume $800 for labor, travel exp, & supplies + $1000 for shipping
Treatabilty lab - testing	Lump Sum	1	$24,000.00	$ 24,000	Based on estimate from TA-Corvallis; includes setup, supplies, testing, DOC and UV-254 analysis, waste disposal, lab report.
Treatability testing - analytics	Lump Sum	1	$8,250.00	$ 8,250	Assume $750 for initial water char'n + $7500 for PFAS analysis during column test
Final report	Lump Sum	1	$10,000.00	$ 10,000	Includes lab methods/results, recommended design data, & data validation
Lab Treatability Testing Total				**$ 53,050**	
System Installation					
Point of Entry Ion Exchange System with IX resins included	Systems	1	$ 6,000	$ 6,000	2 vessels per system, 10" dia by 54" FRP Tanks, preloaded with IX resin. Based on Prior Experience.
Installation of IX systems by certified plumber	Systems	1	$ 1,200	$ 1,200	Assumes,total installation cost is 20% of the equipment cost. Includes installation of equipment, and sterilization of lines.
Process Piping Allowance	Systems	1	$ 1,500	$ 1,500	Prior Experience
Electrician allowance	System	1	$ 700.00	$ 700	
Miscellaneous Items Allowance	Systems	1	$ 500	$ 500	Items purchased from the hardware store such as electrical components, flow valves etc. Based on prior experience.
Shed/Building Allowance	Systems	1	$ 1,200	$ 1,200	Assume 2' 8' x 4' 5" x 6' Rubbermaid shed for housing treatment equipments. Assumes no or minimal earthwork required.
System Installation Total				**$ 11,100**	
Subtotal				***$ 94,130***	
Contingency (15%)		*15%*		$ 14,120	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
General Conditions (10%)		*10%*		$ 9,413	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Subtotal				***$ 117,663***	
Performance Bond (2%)		*2%*		$ 2,353	Industry Average
Subtotal				***$ 120,016***	
Project Management (10%)		*10%*		$ 12,002	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Design Costs (6%)		*6%*		$ 7,201	Navy Estimating Guidance. Assumes that one system design will be adequate and used for all six systems.
Construction Oversight (15%)		*15%*		$ 18,002	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL CAPITAL COSTS				**$ 157,000**	
Annual Operations and Maintenance (O&M)					
Monitoring event labor	System	1	$ 9,600.00	$ 9,600	[12 event/system/year] x [8 h/event (2 hr monitoring + 2 h travel + 4 h pre/post monitoing work] x [$100/h] = $9600/system/yr.
Monitoring event expenses	System	1	$ 3,300.00	$ 3,300	[12 event/system/yr] x [$275/event ($50 sample shipping + $50 equipment/supplies + $175 travel)] = $3300/system/yr.
Monitoring event analytics	System	1	$ 13,590.00	$ 13,590	[12 events/system/yr] x [4 samples/system (3 sample points + 1 QC sample)] x [$283 per sample based on costing CLEAN 9000] = $13590/system/yr .
Resin and filter Change Out	System	1	$ 9,300	$ 9,300	IX Resin: [6 change-outs/system/yr (1 change-out every 10 mo)] x [1.5 CF/system/change-out (assumes lead vessel replaced and lag vessel rotated to lead position)] x $375/CF (estimate from Purolite, including transportation costs)] = $3375/system/yr. Sand: [2 change-outs/system/yr] x [$500/system/change-out] = $1000/system/yr. Labor: [6 visits/system/yr] x [4 h/visit] x [$205/h] = $4920/system/yr. Cost basis prior experience.
Used Resin Disposal	System	1	$ 2,722	$ 2,722	[6 changeout/system/yr] x [1.5 CF of used resin/changeout] x [$52.4/CF (based on $7/gal CERCLA rate for incineration)] + [6 event] x [$200/event for mobilization/demobilization] + [6 event] x [$175/event per system for profiling].
Miscellaneous Items Allowance	System	1	$ 500	$ 500	Items purchased from the hardware store such as piping, electrical components, flow valves etc.

Table B-10. Engineer's Cost Estimate for Alternative 2b-2: IX POE System for Ault Field Residence 2

Engineering Evaluation and Cost Analysis for Residential Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
On call service	System	1	$ 820.00	$ 820	On-call rate for Culligan for pilot tests is $205. Assume one 4-hr service call per system per yr per system.
POE System Reporting	Each	1	$ 4,800.00	$ 4,800.00	One TM per year documenting sampling activities, results, repairs and change outs. Assumes data validation, database management, and preparation of one TM per year (40 hours per event at average rate of $120/hr.)
Subtotal				***$ 44,632***	
Contingency (15%)		*15%*		$ 6,695	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
General Conditions (10%)		*10%*		$ 4,463	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Technical Support (15%)		*15%*		$ 6,695	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Performance Bond (2%)		*2%*		$ 490	Industry Average on O&M items performed by subcontractor.
TOTAL O&M COSTS PER YEAR				**$ 63,000**	
Total Years of O&M				$ 30	
Total O&M Cost for 30 Years				$ 1,890,000	
Discount Rate				2.6%	Office of Management and Budget, Circular A-94 2018.
Total Present Value of O&M Costs				**$ 1,300,000**	
TOTAL PRESENT VALUE of ALTERNATIVE				**$ 1,460,000**	
			+50%	$ 2,190,000	
			-30%	$ 1,022,000	

This is not an offer for construction and/or project execution. Please note, these order of magnitude cost estimates are assumed to represent the actual installed cost within the range of - 30 percent to + 50 percent of the costs indicated. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor, material costs, and competitive variable factors. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific decisions to help ensure proper project evaluation and adequate funding.

UFP-SAP = Uniform Federal Policy Sampling and Analysis Plan, WMP-EPP = Waste Management Plan-Environmental Protection Plan, APP-SSHP= Accident Prevention Plan-Site Safety and Health Plan

Table B-11. Engineer's Cost Estimate for Alternative 2b-1: IX POE System for Four Easy Street Residences

Engineering Evaluation and Cost Analysis for Residential Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents					
UFP-SAP, WMP-EPP, APP-SSHP	Lump Sum	1	$ 20,000.00	$ 20,000	Includes draft and final submission with site-specific system design and AHAs for system installation
Construction Completion Report	Lump Sum	1	$ 15,000.00	$ 15,000	Includes draft and final submission for system installation
Work Planning Documents Total				**$ 35,000**	
Site Preparation					
Mobilization/Demobilization	Each	1	$ 1,000	$ 1,000	Prior Experience (Fentress); 1 each for Residence 1, Residence 2, and Easy Street Residences
Site Visit and Documentation	Each	1	$ 1,500	$ 1,500	Prior Experience (Fentress); 1 each for Residence 1, Residence 2, and Easy Street Residences
Site Access Agreements	Each	5	$ 480	$ 2,400	Right of Entry Forms; assumes 4 hours Jacobs support at $120/hour for each agreement, one need for each property
Site Preparation Total				**$ 4,900**	
Lab Treatability Testing					
Test plan	Lump Sum	1	$7,500.00	$ 7,500	Assume no SAP required. Assumed scope: 1 IX resin, 1 water, 1 test column + 1 abbreviated control, 12-14 wk run time, analytes = PFAS (at off-site lab), DOC and UV-25 (at treatability lab).
Treatability lab - subcontracting	Lump Sum	1	$1,500.00	$ 1,500	
Sample water collection & shipping	Lump Sum	1	$1,800.00	$ 1,800	Assume 2x55-gal drums. Assume $800 for labor, travel exp, & supplies + $1000 for shipping
Treatabilty lab - testing	Lump Sum	1	$24,000.00	$ 24,000	Based on estimate from TA-Corvallis; includes setup, supplies, testing, DOC and UV-254 analysis, waste disposal, lab report.
Treatability testing - analytics	Lump Sum	1	$8,250.00	$ 8,250	Assume $750 for initial water char'n + $7500 for PFAS analysis during column test
Final report	Lump Sum	1	$10,000.00	$ 10,000	Includes lab methods/results, recommended design data, & data validation
Lab Treatability Testing Total				**$ 53,050**	
System Installation					
Point of Entry Ion Exchange System with IX resins included	Systems	5	$ 6,000	$ 30,000	2 vessels per system, 10" dia by 54" FRP Tanks, preloaded with IX resin. Based on Prior Experience.
Installation of IX systems by certified plumber	Systems	5	$ 1,200	$ 6,000	Assumes,total installation cost is 20% of the equipment cost. Includes installation of equipment, and sterilization of lines.
Process Piping Allowance	Systems	5	$ 1,500	$ 7,500	Prior Experience
Electrician allowance	System	5	$ 700.00	$ 3,500	
Miscellaneous Items Allowance	Systems	5	$ 500	$ 2,500	Items purchased from the hardware store such as electrical components, flow valves etc. Based on prior experience.
Shed/Building Allowance	Systems	5	$ 1,200	$ 6,000	Assume 2' 8' x 4' 5" x 6' Rubbermaid shed for housing treatment equipments. Assumes no or minimal earthwork required.
System Installation Total				**$ 55,500**	
Subtotal				***$ 148,450***	
Contingency (15%)		*15%*		$ 22,268	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
General Conditions (10%)		*10%*		$ 14,845	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Subtotal				***$ 185,563***	
Performance Bond (2%)		*2%*		$ 3,711	Industry Average
Subtotal				***$ 189,274***	
Project Management (10%)		*10%*		$ 18,927	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Design Costs (6%)		*6%*		$ 11,356	Navy Estimating Guidance. Assumes that one system design will be adequate and used for all six systems.
Construction Oversight (15%)		*15%*		$ 28,391	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL CAPITAL COSTS				**$ 248,000**	
Annual Operations and Maintenance (O&M)					
Monitoring event labor	System	5	$ 3,200.00	$ 16,000	[4 event/system/year] x [8 h/event (2 hr monitoring + 2 h travel + 4 h pre/post monitoing work] x [$100/h] = $3200/system/yr.
Monitoring event expenses	System	5	$ 1,300.00	$ 6,500	[4 event/system/yr] x [$325/event ($50 sample shipping + $100 equipment/supplies + $175 travel)] = $1300/system/yr.
Monitoring event analytics	System	5	$ 4,530.00	$ 22,650	[4 events/system/yr] x [4 samples/system (3 sample points + 1 QC sample)] x [$283 per sample based on costing CLEAN 9000] = $4530/system/yr .
Resin and filter Change Out	System	5	$ 3,315	$ 16,575	IX Resin: [1.2 change-outs/system/yr (1 change-out every 10 mo)] x [1.5 CF/system/change-out (assumes lead vessel replaced and lag vessel rotated to lead position)] x $375/CF (estimate from Purolite, including transportation costs)] = $675/system/yr. Sand: [2 change-outs/system/yr] x [$500/system/change-out] = $1000/system/yr. Labor: [2 visits/system/yr] x [4 h/visit] x [$205/h] = $1640/system/yr. Cost basis prior experience.
Used Resin Disposal	System	5	$ 544	$ 2,722	[1.2 changeout/system/yr] x [1.5 CF of used resin/changeout] x [$52.4/CF (based on $7/gal CERCLA rate for incineration)] + [1.2 event] x [$200/event for mobilization/demobilization] + [1.2 event] x [$175/event per system for profiling].
Miscellaneous Items Allowance	System	5	$ 500	$ 2,500	Items purchased from the hardware store such as piping, electrical components, flow valves etc.
On call service	System	5	$ 820.00	$ 4,100	On-call rate for Culligan for pilot tests is $205. Assume one 4-hr service call per system per yr per system.

Table B-11. Engineer's Cost Estimate for Alternative 2b-1: IX POE System for Four Easy Street Residences

Engineering Evaluation and Cost Analysis for Residential Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
POE System Reporting	Each	1	$ 9,600.00	$ 9,600.00	One TM per year documenting sampling activities, results, repairs and change outs. Assumes data validation, database management, and preparation of one TM per year (80 hours per event at average rate of $120/hr.)
Subtotal				***$ 80,647***	
Contingency (15%)		*15%*		$ 12,097	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
General Conditions (10%)		*10%*		$ 8,065	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Technical Support (15%)		*15%*		$ 12,097	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Performance Bond (2%)		*2%*		$ 921	Industry Average on O&M items performed by subcontractor.
TOTAL O&M COSTS PER YEAR				**$ 114,000**	
Total Years of O&M				$ 30	
Total O&M Cost for 30 Years				$ 3,420,000	
Discount Rate				2.6%	Office of Management and Budget, Circular A-94 2018.
Total Present Value of O&M Costs				**$ 2,350,000**	
TOTAL PRESENT VALUE of ALTERNATIVE				**$ 2,600,000**	
			+50%	$ 3,900,000	
			-30%	$ 1,820,000	

This is not an offer for construction and/or project execution. Please note, these order of magnitude cost estimates are assumed to represent the actual installed cost within the range of - 30 percent to + 50 percent of the costs indicated. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor, material costs, and competitive variable factors. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific decisions to help ensure proper project evaluation and adequate funding.

UFP-SAP = Uniform Federal Policy Sampling and Analysis Plan, WMP-EPP = Waste Management Plan-Environmental Protection Plan, APP-SSHP= Accident Prevention Plan-Site Safety and Health Plan

Table B-12. Engineer's Cost Estimate for Alternative 2b-4: IX POE System for Evergreen Mobile Home Park

Engineering Evaluation and Cost Analysis for Residential Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents					
UFP-SAP, WMP-EPP, APP-SSHP	Lump Sum	1	$ 15,000.00	$ 15,000	Includes draft and final submission with site-specific system design and AHAs for system installation
Construction Completion Report	Lump Sum	1	$ 12,000.00	$ 12,000	Includes draft and final submission for system installation
Work Planning Documents Total				**$ 27,000**	
Site Preparation					
Mobilization/Demobilization	Each	1	$ 1,000	$ 1,000	Prior Experience (Fentress)
Site Visit and Documentation	Each	1	$ 1,500	$ 1,500	Prior Experience (Fentress)
Site Access Agreements	Each	1	$ 480	$ 480	Right of Entry Forms; assumes 4 hours Jacobs support at $120/hour for each agreement
Archeological Survey - Labor	hr	24	$ 145	$ 3,480	1-day survey with travel time from Portland; assumes finding of "no adverse effect"
Archeological Survey - Travel Expenses	trip	1	$ 700	$ 700	Rental car, gas, hotel, per diem for 3-day trip
Site Preparation Total				**$ 7,160**	
Lab Treatability Testing					
Test plan	Lump Sum	1	$7,500.00	$ 7,500	Assume no SAP required. Assumed scope: 1 IX resin, 1 water, 1 test column + 1 abbreviated control, 12-14 wk run time, analytes = PFAS (at off-site lab), DOC and UV-25 (at treatability lab).
Treatability lab - subcontracting	Lump Sum	1	$1,500.00	$ 1,500	
Sample water collection & shipping	Lump Sum	1	$1,800.00	$ 1,800	Assume 2x55-gal drums. Assume $800 for labor, travel exp, & supplies + $1000 for shipping
Treatabilty lab - testing	Lump Sum	1	$24,000.00	$ 24,000	Based on estimate from TA-Corvallis; includes setup, supplies, testing, DOC and UV-254 analysis, waste disposal, lab report.
Treatability testing - analytics	Lump Sum	1	$8,250.00	$ 8,250	Assume $750 for initial water char'n + $7500 for PFAS analysis during column test
Final report	Lump Sum	1	$10,000.00	$ 10,000	Includes lab methods/results, recommended design data, & data validation
Lab Treatability Testing Total				**$ 53,050**	
System Installation					
Point of Entry Ion Exchange System with IX resins included	Systems	1	$ 65,000	$ 65,000	2 vessels per system, 30'' dia, 65' heigh Carbon Steel Tanks, preloaded resins. Calgon Quote
Treated Water Tank	Systems	1	$ 6,000	$ 6,000	8,000 gal holding tank. 10 ft dia, 15 ft H . Catalogue price from Pastic Mart
UV disinfection system	System	1	$ 15,000	$ 15,000	
Treated Water Distribution Pump	Each	2	$ 7,500	$ 15,000	Based on prior experience, 2X100% pumps i.e., one active and one spare
Installation of IX systems by certified plumber	Systems	1	$ 9,350	$ 9,350	Assumes total installation cost is 10% of the equipment cost. Includes installation of equipment, and sterilization of lines.
Electrician allowance	System	4	$ 700.00	$ 2,800	
Process Piping Allowance	Systems	1	$ 8,000	$ 8,000	Prior Experience
Miscellaneous Items Allowance	Systems	1	$ 1,000	$ 1,000	Items purchased from the hardware store such as electrical components, flow valves etc. Based on prior experience.
Treatment Building Allowance	Systems	1	$ 70,000	$ 70,000	A 16'X16' building to house the treatment units and treated water tank. Unit cost for building $250/sq. ft and $500/cubic yard for building slab (assumes 0.75-ft slab)
System Installation Total				**$ 192,150**	
Subtotal				***$ 279,360***	
Contingency (15%)		*15%*		$ 41,904	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
General Conditions (10%)		*10%*		$ 27,936	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Subtotal				***$ 349,200***	
Performance Bond (2%)		*2%*		$ 6,984	Industry Average
Subtotal				***$ 356,184***	
Project Management (10%)		*10%*		$ 35,618	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Design Costs (6%)		*6%*		$ 21,371	Navy Estimating Guidance.
Construction Oversight (15%)		*15%*		$ 53,428	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL CAPITAL COSTS				**$ 467,000**	
Operations and Maintenance (O&M)					
Monitoring event labor	System	1	$ 3,200.00	$ 3,200	[4 event/system/year] x [8 h/event (2 hr monitoring + 2 h travel + 4 h pre/post monitoing work] x [$100/h] = $3200/system/yr.
Monitoring event expenses	System	1	$ 1,100.00	$ 1,100	[4 event/system/yr] x [$275/event ($50 sample shipping + $50 equipment/supplies + $175 travel)] = $1100/system/yr.
Monitoring event analytics	System	1	$ 4,530.00	$ 4,530	[4 events/system/yr] x [4 samples/system (3 sample points + 1 QC sample)] x [$283 per sample based on costing CLEAN 9000] = $4530/system/yr .
Resin and Filter Change Out	System	1	$ 10,015	$ 10,015	IX Resin: [1 change-out/system/yr] x [17 CF/system/change-out (assumes lead vessel replaced and lag vessel rotated to lead position)] x $375/CF (estimate from Purolite, including transportation costs)] = $6375/system/yr. Sand: [2 change-outs/system/yr] x [$1000/system/change-out] = $2000/system/yr. Labor: [2 visits/system/yr] x [4 h/visit] x [$205/h] = $1640/system/yr. Cost basis prior experience.

Table B-12. Engineer's Cost Estimate for Alternative 2b-4: IX POE System for Evergreen Mobile Home Park

Engineering Evaluation and Cost Analysis for Residential Drinking Water

Naval Air Station Whidbey Island, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Used Resin Disposal	System	1	$ 1,266	$ 1,270	[1 changeout/system/yr] x [17 CF of used resin/changeout] x [$52.4/CF (based on $7/gal CERCLA rate for incineration)] + [1 event] x [$200/event for mobilization/demobilization] + [1 event] x [$175/event per system for profiling].
UV disinfection system maintenance	System	1	$ 2,500	$ 2,500	Assume 1 maintenance event/yr
Miscellaneous Items Allowance	System	1	$ 1,000	$ 1,000	For various miscellenious items like pipe, valves, etc.
On-call service	System	1	$ 1,640.00	$ 1,640	On-call rate for Culligan for pilot tests is $205. Assume two 4-hr service calls per system per yr per system.
POE System Reporting	Each	1	$ 9,600.00	$ 9,600.00	One TM per year documenting sampling activities, results, repairs and change outs. Assumes data validation, database management, and preparation of one TM per year (80 hours per event at average rate of $120/hr.)
Subtotal				***$ 34,855***	
Contingency (15%)		*15%*		$ 5,228	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
General Conditions (10%)		*10%*		$ 3,486	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Technical Support (15%)		*15%*		$ 5,228	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Performance Bond (2%)		*2%*		$ 470	Industry Average on O&M items performed by subcontractor.
TOTAL O&M COSTS PER YEAR				**$ 49,300**	
Total Years of O&M				$ 30	
Total O&M Cost for 30 Years				$ 1,479,000	
Discount Rate				2.6%	Office of Management and Budget, Circular A-94 2018.
Total Present Value of O&M Costs				**$ 1,018,000**	
TOTAL PRESENT VALUE of ALTERNATIVE				**$ 1,490,000**	
			+50%	$ 2,235,000	
			-30%	$ 1,043,000	

This is not an offer for construction and/or project execution. Please note, these order of magnitude cost estimates are assumed to represent the actual installed cost within the range of - 30 percent to + 50 percent of the costs indicated. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor, material costs, and competitive variable factors. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific decisions to help ensure proper project evaluation and adequate funding.

UFP-SAP = Uniform Federal Policy Sampling and Analysis Plan, WMP-EPP = Waste Management Plan-Environmental Protection Plan, APP-SSHP= Accident Prevention Plan-Site Safety and Health Plan

Table B-13. Engineer's Cost Estimate for Alternative 3a - Residence 1 Connection to Navy/City of Oak Harbor Waterline

Engineered Evaluation and Cost Estimate for Residential Drinking Water

NAS Whidbey Island, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents					
UFP-SAP, WMP-EPP, APP-SSHP	Lump Sum	1	$ 20,000.00	$ 20,000.00	Includes scoping plus draft and final submission.
Project Approvals, Construction Completion Report	Lump Sum	1	$ 15,000.00	$ 15,000.00	Includes draft and final submission. Project approvals to Dept. of Health
Work Planning Documents Total				**$ 35,000.00**	
Site Preparation					
Mobilization/Demobilization	Each	1	$ 8,500.00	$ 8,500.00	Prior Experience
Demand Calculations and Hydraulic Modeling	Lump Sum	1	$ 10,000.00	$ 10,000.00	Engineer Estimate (Fentress)
Utility Clearance	per day	1	$ 3,600.00	$ 3,600.00	From CTO4041 Project 695610 project cost; assume cleared in 1 day
Engineer Site Visit for planning/design	Each	1	$ 1,500.00	$ 1,500.00	Prior Experience
Site Access Agreements	Each	1	$ 480.00	$ 480.00	Right of Entry Forms; assumes 4 hours Jacobs support at $120/hr. for each agreement
Archeological Survey	per hour	24	$ 145.00	$ 3,480.00	Jacob's archeologist (Matt Steinkamp/PDX) performs site survey (1 day, with travel day before and day after); assumes finding is no adverse effect
Archeological Survey - Travel Expenses	per trip	1	$ 700.00	$ 700.00	Rental car, gas, hotel, per diem for 3-day trip
Erosion and Sediment Controls	Lump Sum	1	$ 1,875.00	$ 1,875.00	Engineer Estimate (1/8 Fentress, which was for 8 homes)
Dust Control	Lump Sum	1	$ 1,250.00	$ 1,250.00	Engineer Estimate (1/8 Fentress, which was for 8 homes)
Vegetative Clearing	Lump Sum	1	$ 1,875.00	$ 1,875.00	Engineer Estimate (1/8 Fentress, which was for 8 homes)
City/Navy Coordination	Lump Sum	1	$ 9,600.00	$ 9,600.00	Engineer Estimate (assumes 80 hours at $120 per hour for coordination between Navy, City, and resident)
Site Preparation Total				**$ 42,860.00**	
System Installation					
Trenching, Pipeline in Paved Street	LF	6500	$ 64.00	$ 416,000.00	Prior Experience
Tie-ins, test chlorination	LS	1	$ 8,800.00	$ 8,800.00	Prior Experience
Service Installation, Certified Plumber, Flushing Sta	LS	1	$ 10,800.00	$ 10,800.00	Prior Experience
Pavement Restoration, Cleanup	SF	20000	$ 9.00	$ 180,000.00	Prior Experience
Hydroseeding	AC	3	$ 3,900.00	$ 11,700.00	Historical
Landscaping	LS	1	$ 3,300.00	$ 3,300.00	Allowance
Miscellaneous Items Allowance	Each	1	$ 8,000.00	$ 8,000.00	Items purchased from the hardware store such as electrical components, flow valves etc. Based on prior experience.
System Installation Total				**$ 638,600.00**	
Subtotal				***$ 716,460.00***	
Contingency (15%)		*15%*		$ 107,469.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
General Conditions (10%)		*10%*		$ 71,646.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Subtotal				***$ 895,575.00***	
Performance Bond (2%)		*2%*		$ 17,911.50	Industry Average
Subtotal				***$ 913,500.00***	
Project Management (8%)		*8%*		$ 73,080.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Design Costs (6%)		*6%*		$ 54,810.00	Navy Estimating Guidance.
Construction Oversight (10%)		*10%*		$ 91,350.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL CAPITAL COSTS				**$ 1,132,700.00**	
Operations and Maintenance (O&M) Years 1-30					
Total O&M Cost Per Year				$ 3,600.00	4 hrs @$75/hr, Monthly inspection of flushing station including minor parts
Total Years of O&M				30	
Total O&M Cost for 30 Years				$ 108,000.00	
Discount Rate				2.6%	Office of Management and Budget, Circular A-94 2018.
Total Present Value of O&M Costs				**$ 74,400.00**	

Table B-13. Engineer's Cost Estimate for Alternative 3a - Residence 1 Connection to Navy/City of Oak Harbor Waterline

Engineered Evaluation and Cost Estimate for Residential Drinking Water

NAS Whidbey Island, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price		Total	Assumptions
TOTAL PRESENT VALUE of ALTERNATIVE				**$**	**1,207,100.00**	
			+50%	$	1,810,650.00	
			-30%	$	844,970.00	

This is not an offer for construction and/or project execution. Please note, these order of magnitude cost estimates are assumed to represent the actual installed cost within the range of - 30 percent to + 50 percent of the costs indicated. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor, material costs, and competitive variable factors. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific decisions to help ensure proper project evaluation and adequate funding.

Table B-14. Engineer's Cost Estimate for Alternative 3b - Residence 2 Connection to Navy On-Base Waterline

Engineered Evaluation and Cost Estimate for Residential Drinking Water

NAS Whidbey Island, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents					
UFP-SAP, WMP-EPP, APP-SSHP	Lump Sum	1	$ 20,000.00	$ 20,000.00	Includes scoping plus draft and final submission.
Project Approvals, Construction Completion Report	Lump Sum	1	$ 15,000.00	$ 15,000.00	Includes draft and final submission. Project approvals to Dept. of Health
Work Planning Documents Total				**$ 35,000.00**	
Site Preparation					
Mobilization/Demobilization	Each	1	$ 8,500.00	$ 8,500.00	Prior Experience
Demand Calculations and Hydraulic Modeling	Lump Sum	1	$ 10,000.00	$ 10,000.00	Engineer Estimate (Fentress)
Utility Clearance	per day	1	$ 3,600.00	$ 3,600.00	From CTO4041 Project 695610 project cost; assume cleared in 1 day
Engineer Site Visit for planning/design	Each	1	$ 1,500.00	$ 1,500.00	Prior Experience
Site Access Agreements	Each	1	$ 480.00	$ 480.00	Right of Entry Forms; assumes 4 hours Jacobs support at $120/hr. for each agreement
Archeological Survey	per hour	24	$ 145.00	$ 3,480.00	Jacob's archeologist (Matt Steinkamp/PDX) performs site survey (1 day, with travel day before and day after); assumes finding is no adverse effect
Archeological Survey - Travel Expenses	per trip	1	$ 700.00	$ 700.00	Rental car, gas, hotel, per diem for 3-day trip
Erosion and Sediment Controls	Lump Sum	1	$ 1,875.00	$ 1,875.00	Engineer Estimate (1/8 Fentress, which was for 8 homes)
Dust Control	Lump Sum	1	$ 1,250.00	$ 1,250.00	Engineer Estimate (1/8 Fentress, which was for 8 homes)
Vegetative Clearing	Lump Sum	1	$ 1,875.00	$ 1,875.00	Engineer Estimate (1/8 Fentress, which was for 8 homes)
Pine Terrace Coordination	Lump Sum	1	$ 7,200.00	$ 7,200.00	Engineer Estimate (assumes 60 hours at $120 per hour for coordination with Pine Terrace)
Site Preparation Total				**$ 40,460.00**	
System Installation					
Trenching, Pipeline in Paved Street	LF	800	$ 67.00	$ 53,600.00	Prior Experience
Tie-ins, test chlorination	LS	1	$ 8,800.00	$ 8,800.00	Prior Experience
Service Installation, Certified Plumber	LS	1	$ 4,500.00	$ 4,500.00	Prior Experience
Pavement Restoration, Cleanup	SF	3000	$ 9.00	$ 27,000.00	Prior Experience
Hydroseeding	AC	0.5	$ 3,900.00	$ 1,950.00	Historical
Landscaping	LS	1	$ 3,300.00	$ 3,300.00	Allowance
Miscellaneous Items Allowance	Each	1	$ 8,000.00	$ 8,000.00	Items purchased from the hardware store such as electrical components, flow valves etc. Based on prior experience.
System Installation Total				**$ 107,150.00**	
Subtotal				***$ 182,610.00***	
Contingency (15%)		*15%*		$ 27,391.50	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
General Conditions (10%)		*10%*		$ 18,261.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Subtotal				***$ 228,262.50***	
Performance Bond (2%)		*2%*		$ 4,565.25	Industry Average
Subtotal				***$ 232,827.75***	
Project Management (8%)		*8%*		$ 18,626.22	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Design Costs (6%)		*6%*		$ 13,969.67	Navy Estimating Guidance.
Construction Oversight (10%)		*10%*		$ 23,282.78	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL CAPITAL COSTS				**$ 288,700.00**	
Operations and Maintenance (O&M) Years 1-30 - Not Applicable (O&M for water line from Navy's property to private property will be adsorbed by the Navy's water rates; resident responsible for water usage costs)					
TOTAL PRESENT VALUE of ALTERNATIVE				**$ 288,700.00**	
			+50%	$ 433,050.00	
			-30%	$ 202,090.00	

This is not an offer for construction and/or project execution. Please note, these order of magnitude cost estimates are assumed to represent the actual installed cost within the range of - 30 percent to + 50 percent of the costs indicated. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor, material costs, and competitive variable factors. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific decisions to help ensure proper project evaluation and adequate funding.

Table B-15. Engineer's Cost Estimate for Alternative 3c - Residence 2 Connection to Pine Terrace Water System

Engineered Evaluation and Cost Estimate for Residential Drinking Water

NAS Whidbey Island, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents					
UFP-SAP, WMP-EPP, APP-SSHP	Lump Sum	1	$ 20,000.00	$ 20,000.00	Includes scoping plus draft and final submission.
Project Approvals, Construction Completion Report	Lump Sum	1	$ 15,000.00	$ 15,000.00	Includes draft and final submission. Project approvals to Dept. of Health
Work Planning Documents Total				**$ 35,000.00**	
Site Preparation					
Mobilization/Demobilization	Each	1	$ 8,500.00	$ 8,500.00	Prior Experience
Demand Calculations and Hydraulic Modeling	Lump Sum	1	$ 10,000.00	$ 10,000.00	Engineer Estimate (Fentress)
Utility Clearance	per day	1	$ 3,600.00	$ 3,600.00	From CTO4041 Project 695610 project cost; assume cleared in 1 day
Engineer Site Visit for planning/design	Each	1	$ 1,500.00	$ 1,500.00	Prior Experience
Site Access Agreements	Each	1	$ 480.00	$ 480.00	Right of Entry Forms; assumes 4 hours Jacobs support at $120/hr. for each agreement
Archeological Survey	per hour	24	$ 145.00	$ 3,480.00	Jacob's archeologist (Matt Steinkamp/PDX) performs site survey (1 day, with travel day before and day after); assumes finding is no adverse effect
Archeological Survey - Travel Expenses	per trip	1	$ 700.00	$ 700.00	Rental car, gas, hotel, per diem for 3-day trip
Erosion and Sediment Controls	Lump Sum	1	$ 1,875.00	$ 1,875.00	Engineer Estimate (1/8 Fentress, which was for 8 homes)
Dust Control	Lump Sum	1	$ 1,250.00	$ 1,250.00	Engineer Estimate (1/8 Fentress, which was for 8 homes)
Vegetative Clearing	Lump Sum	1	$ 1,875.00	$ 1,875.00	Engineer Estimate (1/8 Fentress, which was for 8 homes)
Navy Water Supply Coordination	Lump Sum	1	$ 7,200.00	$ 7,200.00	Engineer Estimate (assumes 60 hours at $120 per hour for coordination with Navy and resident)
Site Preparation Total				**$ 40,460.00**	
System Installation					
Trenching, Pipeline in Paved Street	LF	6000	$ 64.00	$ 384,000.00	Prior Experience
Tie-ins, test chlorination	LS	1	$ 8,800.00	$ 8,800.00	Prior Experience
Service Installation, Certified Plumber, Flushing Sta	LS	1	$ 10,800.00	$ 10,800.00	Prior Experience
Pavement Restoration, Cleanup	SF	18500	$ 9.00	$ 166,500.00	Prior Experience
Hydroseeding	AC	2.8	$ 3,900.00	$ 10,920.00	Historical
Landscaping	LS	1	$ 3,300.00	$ 3,300.00	Allowance
Miscellaneous Items Allowance	Each	1	$ 8,000.00	$ 8,000.00	Items purchased from the hardware store such as electrical components, flow valves etc. Based on prior experience.
System Installation Total				**$ 592,320.00**	
Subtotal				***$ 667,780.00***	
Contingency (15%)		*15%*		$ 100,167.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
General Conditions (10%)		*10%*		$ 66,778.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Subtotal				***$ 834,725.00***	
Performance Bond (2%)		*2%*		$ 16,694.50	Industry Average
Subtotal				***$ 851,419.50***	
Project Management (8%)		*8%*		$ 68,113.56	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Design Costs (6%)		*6%*		$ 51,085.17	Navy Estimating Guidance.
Construction Oversight (10%)		*10%*		$ 85,141.95	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL CAPITAL COSTS				**$ 1,055,800.00**	
Operations and Maintenance (O&M) Years 1-30					
Total O&M Cost Per Year				$ 3,600.00	4 hrs @$75/hr, Monthly inspection of flushing station including minor parts
Total Years of O&M				30	
Total O&M Cost for 30 Years				$ 108,000.00	
Discount Rate				2.6%	Office of Management and Budget, Circular A-94 2018.
Total Present Value of O&M Costs				**$ 74,400.00**	
TOTAL PRESENT VALUE of ALTERNATIVE				**$ 1,130,200.00**	
			+50%	$ 1,695,300.00	
			-30%	$ 791,140.00	

This is not an offer for construction and/or project execution. Please note, these order of magnitude cost estimates are assumed to represent the actual installed cost within the range of - 30 percent to + 50 percent of the costs indicated. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor, material costs, and competitive variable factors. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific decisions to help ensure proper project evaluation and adequate funding.

Table B-16. Engineer's Cost Estimate for Alternative 3d - Easy Street Residences Connection to City of Oak Harbor Water System

Engineered Evaluation and Cost Estimate for Residential Drinking Water

NAS Whidbey Island, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents					
UFP-SAP, WMP-EPP, APP-SSHP	Lump Sum	1	$ 20,000.00	$ 20,000.00	Includes scoping plus draft and final submission.
Project Approvals, Construction Completion Report	Lump Sum	1	$ 15,000.00	$ 15,000.00	Includes draft and final submission. Project approvals to Dept. of Health
Work Planning Documents Total				**$ 35,000.00**	
Site Preparation					
Mobilization/Demobilization	Each	1	$ 8,500.00	$ 8,500.00	Prior Experience
Demand Calculations and Hydraulic Modeling	Lump Sum	1	$ 10,000.00	$ 10,000.00	Engineer Estimate (Fentress)
Utility Clearance	per day	1	$ 3,600.00	$ 3,600.00	From CTO4041 Project 695610 project cost; assume cleared in 1 day
Engineer Site Visit for planning/design	Each	1	$ 1,500.00	$ 1,500.00	Prior Experience
Site Access Agreements	Each	5	$ 480.00	$ 2,400.00	Right of Entry Forms; assumes 4 hours Jacobs support at $120/hr. for each agreement
Archeological Survey	per hour	24	$ 145.00	$ 3,480.00	Jacob's archeologist (Matt Steinkamp/PDX) performs site survey (1 day, with travel day before and day after); assumes finding is no adverse effect
Archeological Survey - Travel Expenses	per trip	1	$ 700.00	$ 700.00	Rental car, gas, hotel, per diem for 3-day trip
Erosion and Sediment Controls	Lump Sum	1	$ 9,400.00	$ 9,400.00	Engineer Estimate (5/8 Fentress), which was for 8 homes
Dust Control	Lump Sum	1	$ 6,250.00	$ 6,250.00	Engineer Estimate (5/8 Fentress)
Vegetative Clearing	Lump Sum	1	$ 9,400.00	$ 9,400.00	Engineer Estimate (5/8 Fentress)
City/Navy Coordination	Lump Sum	1	$ 7,200.00	$ 7,200.00	Engineer Estimate (assumes 60 hours at $120 per hour for coordination with City of Oak Harbor)
Site Preparation Total				**$ 62,430.00**	
System Installation					
Trenching, Pipeline in Paved Street	LF	1300	$ 105.00	$ 136,500.00	Prior Experience
Tie-ins, test chlorination	LS	1	$ 13,000.00	$ 13,000.00	Prior Experience
Service Installation, Certified Plumber, fire Hydrant	Each	6	$ 5,250.00	$ 31,500.00	Prior Experience
Pavement Restoration, Cleanup	SF	3700	$ 9.00	$ 33,300.00	Prior Experience
Hydroseeding	AC	0.7	$ 3,900.00	$ 2,730.00	Historical
Landscaping	LS	1	$ 3,600.00	$ 3,600.00	Allowance
Miscellaneous Items Allowance	Each	1.00	8,000.00	8,000.00	Items purchased from the hardware store such as electrical components, flow valves etc. Based on prior experience.
				-	
				$ -	
System Installation Total				**$ 228,630.00**	
Subtotal				***$ 326,060.00***	
Contingency (15%)	*15%*			$ 48,909.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
General Conditions (10%)	*10%*			$ 32,606.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Subtotal				***$ 407,575.00***	
Performance Bond (2%)	*2%*			$ 8,151.50	Industry Average
Subtotal				***$ 415,726.50***	
Project Management (8%)	*8%*			$ 33,258.12	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Design Costs (6%)	*6%*			$ 24,943.59	Navy Estimating Guidance.
Construction Oversight (10%)	*10%*			$ 41,572.65	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL CAPITAL COSTS				**$ 515,500.00**	
Operations and Maintenance (O&M) Years 1-30 - Not Applicable (City of Oak Harbor responsible for maintenance; resident responsible for water usage costs once installed)					
TOTAL PRESENT VALUE of ALTERNATIVE				**$ 515,500.00**	
			+50%	$ 773,250.00	
			-30%	$ 360,850.00	

This is not an offer for construction and/or project execution. Please note, these order of magnitude cost estimates are assumed to represent the actual installed cost within the range of - 30 percent to + 50 percent of the costs indicated. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor, material costs, and competitive variable factors. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific decisions to help ensure proper project evaluation and adequate funding.

Table B-17. Engineer's Cost Estimate for Alternative 3e - Evergreen Mobile Home Park Connection to City of Oak Harbor Water System

Engineered Evaluation and Cost Estimate for Residential Drinking Water

NAS Whidbey Island, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents					
UFP-SAP, WMP-EPP, APP-SSHP	Lump Sum	1	$ 20,000.00	$ 20,000.00	Includes scoping plus draft and final submission.
Project Approvals, Construction Completion Report	Lump Sum	1	$ 15,000.00	$ 15,000.00	Includes draft and final submission. Project approvals to Dept. of Health
Work Planning Documents Total				**$ 35,000.00**	
Site Preparation					
Mobilization/Demobilization	Each	1	$ 8,500.00	$ 8,500.00	Prior Experience
Demand Calculations and Hydraulic Modeling	Lump Sum	1	$ 10,000.00	$ 10,000.00	Engineer Estimate (Fentress)
Utility Clearance	per day	1	$ 3,600.00	$ 3,600.00	From CTO4041 Project 695610 project cost; assume cleared in 1 day
Engineer Site Visit for planning/design	Each	1	$ 1,500.00	$ 1,500.00	Prior Experience
Site Access Agreements	Each	1	$ 480.00	$ 480.00	Right of Entry Forms; assumes 4 hours Jacobs support at $120/hr. for each agreement
Archeological Survey	per hour	24	$ 145.00	$ 3,480.00	Jacob's archeologist (Matt Steinkamp/PDX) performs site survey (1 day, with travel day before and day after); assumes finding is no adverse effect
Archeological Survey - Travel Expenses	per trip	1	$ 700.00	$ 700.00	Rental car, gas, hotel, per diem for 3-day trip
Erosion and Sediment Controls	Lump Sum	1	$ 7,500.00	$ 7,500.00	Engineer Estimate (1/2 Fentress); one connection point and 200 feet of trench
Dust Control	Lump Sum	1	$ 5,000.00	$ 5,000.00	Engineer Estimate (1/2 Fentress)
Vegetative Clearing	Lump Sum	1	$ 7,500.00	$ 7,500.00	Engineer Estimate (1/2 Fentress)
City/Navy Coordination	Lump Sum	1	$ 7,200.00	$ 7,200.00	Engineer Estimate (assumes 60 hours at $120 per hour for coordination with City of Oak Harbor)
Site Preparation Total				**$ 55,460.00**	
System Installation					
Trenching, Pipeline in Paved Street	LF	234	$ 235.00	$ 54,990.00	Prior Experience
Tie-ins, test chlorination	LS	1	$ 7,900.00	$ 11,500.00	Prior Experience
Service Connection, 6 Fire Hydrants	LS	1	$ 77,800.00	$ 77,800.00	Prior Experience
Pavement Restoration, Cleanup	SF	1170	$ 9.00	$ 10,530.00	Prior Experience
Hydroseeding	AC	0.2	$ 3,900.00	$ 780.00	Historical
Landscaping	LS	1	$ 3,300.00	$ 3,300.00	Allowance
Miscellaneous Items Allowance	Each	1	$ 8,000.00	$ 8,000.00	Items purchased from the hardware store such as electrical components, flow valves etc. Based on prior experience.
				$ -	
				$ -	
System Installation Total				**$ 166,900.00**	
Subtotal				***$ 257,360.00***	
Contingency (15%)		*15%*		$ 38,604.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
General Conditions (10%)		*10%*		$ 25,736.00	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Subtotal				***$ 321,700.00***	
Performance Bond (2%)		*2%*		$ 6,434.00	Industry Average
Subtotal				***$ 328,134.00***	
Project Management (8%)		*8%*		$ 26,250.72	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Design Costs (6%)		*6%*		$ 19,688.04	Navy Estimating Guidance.
Construction Oversight (10%)		*10%*		$ 32,813.40	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL CAPITAL COSTS				**$ 406,900.00**	
Operations and Maintenance (O&M) Years 1-30 - Not Applicable (City of Oak Harbor responsible for maintenance; resident responsible for water usage costs once installed)					
TOTAL PRESENT VALUE of ALTERNATIVE				**$ 406,900.00**	
			+50%	$ 610,350.00	
			-30%	$ 284,830.00	

This is not an offer for construction and/or project execution. Please note, these order of magnitude cost estimates are assumed to represent the actual installed cost within the range of - 30 percent to + 50 percent of the costs indicated. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor, material costs, and competitive variable factors. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific decisions to help ensure proper project evaluation and adequate funding.

Table B-18. Engineer's Cost Estimate for Alternative 4a: New (Replacement) Well for Residence 1

Engineered Evaluation and Cost Estimate for Residential Drinking Water

Naval Air Station Whidbey Island, Ault Field, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents					
UFP-SAP, WMP-EPP, APP-SSHP	Lump Sum	1	$ 12,000.00	$ 12,000.00	Includes scoping plus draft and final submission. Will include well conversion and long-term sampling plan. Based on effort for existing project documents.
Construction Completion Report	Lump Sum	1	$ 10,000.00	$ 10,000.00	Includes documentation of well conversion. Based on effort for existing project documents.
Work Planning Documents Total				**$ 22,000.00**	
Conversion to Drinking Water Well					
Permitting	Hour	4	$ 120.00	$ 480.00	Assumes 4 hours labor needed per well to pursue permitting
County Well Inspection	Each	1	$ 227.00	$ 227.00	Island County Environmental Health Well Inspection Form; <https://www.islandcountywa.gov/Health/EH/Documents/Wellsite%20Application2015.pdf>
Pump	Each	1	$ 800.00	$ 800.00	Grundfos model 16S10-10, 16 gpm max pumping rate, 4-inch diameter, 1 HP, 230V, 3-wire
Pump Installation	Each	1	$ 1,000.00	$ 1,000.00	Yellow Jacket quote for installation of aquifer testing pump
Connection to Home	Each	1	$ 6,000.00	$ 6,000.00	Engineers Estimate; assumes new well adjacent to existing well and will be connected to existing piping to home (equipment and labor)
Field Oversight	per hour	8	$ 100.00	$ 800.00	one staff, 8-hr day per well
Conversion to Drinking Water Well Total				**$ 9,307.00**	
Subtotal				***$ 31,307.00***	
Contingency (15%)		*15%*		$ 4,696.05	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Subtotal				***$ 36,003.05***	
Project Management (8%)		*8%*		$ 2,880.24	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL CAPITAL COSTS				**$ 38,900.00**	
Operations and Maintenance (O&M) Years 1-30 [a]					
Routine Sampling for PFAS - first two years	Each	2	$ 10,263.04	$ 20,526.08	4 times per year first 2 years. 1 PFAS sample plus 1 QC sample per event, 1 household. Total samples/ year = 8. $282.88 per sample (Test America MSA). 1 day per sampling event, 2 field staff. Average rate of field staff is $100/hr.
Routine Reporting of Sampling Results - first two years	Each	2	$ 9,600.00	$ 19,200.00	Four TMs per year documenting sampling activities and results. Assumes data validation, database management, and preparation of one TM per quarter (20 hours per quarter at average rate of $120/hr.)
Routine Sampling for PFAS - remaining years	Each	28	$ 5,131.52	$ 143,682.56	Semiannual sampling. 1 PFAS sample plus 1 QC sample per event, 1 household. Total samples/ year = 4; $282.88 per sample (Test America MSA). 1 day per sampling event, 2 staff. Average rate of field staff is $100/hr.
Routine Reporting of Sampling Results - remaining years	Each	28	$ 4,800.00	$ 134,400.00	Two TMs per year documenting sampling activities and results. Assumes data validation, database management, and preparation of one TM per quarter (20 hours per event at average rate of $120/hr.)
Subtotal				***$ 317,808.64***	
Contingency (15%)		*15%*		$ 47,671.30	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Technical Support (15%)		*15%*		$ 47,671.30	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL O&M COSTS				**$ 413,200.00**	
Total O&M Cost Per Year				$ 13,773.33	
Total Years of O&M				30	
Discount Rate				2.6%	Office of Management and Budget, Circular A-94 2018.
Total Present Value of O&M Costs				**$ 284,500.00**	
TOTAL PRESENT VALUE of ALTERNATIVE				**$ 323,400.00**	
			+50%	$ 485,100.00	
			-30%	$ 226,380.00	

This is not an offer for construction and/or project execution. Please note, these order of magnitude cost estimates are assumed to represent the actual installed cost within the range of - 30 percent to + 50 percent of the costs indicated. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor, material costs, and competitive variable factors. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific decisions to help ensure proper project evaluation and adequate funding.

[a]Assumes resident responsible for well, pump maintenance and electricity costs (not a Navy cost)

Table B-19.. Engineer's Cost Estimate for Alternative 4b: New (Replacement) Well for Easy Street Residences

Engineered Evaluation and Cost Estimate for Residential Drinking Water

Naval Air Station Whidbey Island, Ault Field, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents					
UFP-SAP, WMP-EPP, APP-SSHP	Lump Sum	1	$ 20,000.00	$ 20,000.00	Includes scoping plus draft and final submission. Will include drilling, aquifer testing, well conversion, and long-term sampling plan. Based on Ault Field drilling and aquifer testing SAP. Based on effort for existing project documents.
Construction Completion Report	Lump Sum	1	$ 40,000.00	$ 40,000.00	Includes aquifer testing analysis and archeological monitoring report; draft and final submissions. Based on effort for existing project documents.
Work Planning Documents Total				**$ 60,000.00**	
Site Preparation - Initial Investigation					
Drilling Mobilization/Demobilization	Each	1	$ 5,475.00	$ 5,475.00	Ault Field Yellow Jacket quote, includes Sonic Drilling Rig, Well Development Rig, Equipment, Support trucks, AHA, Chartering, subcontractor personnel, meals, & lodging
Aquifer Testing Mobilization/Demobilization	Each	1	$ 10,000.00	$ 10,000.00	Ault Field Yellow Jacket quote; Misc. equipment and supplies, support trucks, AHA, Chartering, subcontractor personnel, meals & lodging, site restoration
Utility Clearance	per day	1	$ 3,600.00	$ 3,600.00	From CTO4041 Project 695610 project cost; assume all 2 sites cleared in 1 day
Site Access Agreements	Each	2	$ 480.00	$ 960.00	Right of Entry Forms; assumes 4 hours Jacobs support at $120/hr. for each agreement
Archeological Survey	per hour	24	$ 145.00	$ 3,480.00	Jacob's archeologist (Matt Steinkamp/PDX) performs site survey (1 day, with travel day before and day after); assumes finding is no adverse effect; do for all 4 drilling sites
Archeological Survey - Travel Expenses	per trip	1	$ 700.00	$ 700.00	Rental car, gas, hotel, per diem for 3-day trip
State Dept. of Ecology Drilling Notice of Intent	Each	2	$ 40.00	$ 80.00	https://ecology.wa.gov/Regulations-Permits/Reporting-requirements/well-construction-notice-of-intent; due 72 hours before drilling
State Dept. of Ecology Water Right Permit	Each	5	$ 50.00	$ 250.00	Washington Sate Dept. of Ecology, Water Right Permit required if pumping >5000 gallons ($50/per property); https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Water-rights-permits
Site Preparation Total				**$ 24,545.00**	
Well Installation - Initial Investigation					
Hand Auguring - utility check	per hour	2	$ 800.00	$ 1,600.00	Ault Field Yellow Jacket quote hourly rate; hand auger, 3 locations to 5-ft at each well site for utility confirmation and soil sampling (1 hours each well site)
12-inch Borehole Drilling	per foot	500	$ 110.00	$ 55,000.00	Rotosonic drilling; Ault Field Yellow Jacket quote; two 250-ft holes
Archeological Oversight	per hour	24	$ 145.00	$ 3,480.00	Jacob's archeologist (Matt Steinkamp/PDX) oversight of first 15 ft of drilling (1 day, with travel day before and day after)
Archeological Survey - Travel Expenses	per trip	1	$ 700.00	$ 700.00	Rental car, gas, hotel, per diem for 3-day trip
Soil Sample Analysis	each	9	$ 288.20	$ 2,593.80	4 samples at each boring for PFAS plus one field duplicate
6-inch Well Installation	per foot	500	$ 300.00	$ 150,000.00	20-ft steel riser, 20-ft ss screen, 210-ft Sch 80 PVC; Ault Field Yellow Jacket quote; two 250-ft wells
6-inch Schedule 80 PVC casing SDR 21	per foot	420	$ 15.00	$ 6,300.00	Ault Field Yellow Jacket quote; 210-ft per well
6-inch stainless steel screen (.030 slot Domestic) - SCH80	per foot	40	$ 91.00	$ 3,640.00	Ault Field Yellow Jacket change-order quote; 20 ft per well
inch low carbon steel riser (Domestic) - SCH80	per foot	40	$ 121.40	$ 4,856.00	Ault Field Yellow Jacket change-order quote; 20 ft per well
Stainless steel 6 inch bottom cap (Domestic) - SCH80	Each	2	$ 330.00	$ 660.00	Ault Field Yellow Jacket change-order quote, 1 per well
Pitless adapter for wellhead	Each	2	$ 2,500.00	$ 5,000.00	Ault Field Yellow Jacket change-order quote, 1 per well
Surface Completion	Each	2	$ 460.00	$ 920.00	Flush mount, 8x12-inch cover; no bollards; Ault Field Yellow Jacket quote
Well Development	per well	2	$ 900.00	$ 1,800.00	rig, pump, tubing, personnel; Ault Field Yellow Jacket BOA (assumes 4 hrs for development of one well)
Equipment rental	Lump Sum	1	$ 300.00	$ 300.00	water quality meter, water level tape
Groundwater Sample Analysis	each	5	$ 282.88	$ 1,414.40	one PFAS sample per well, plus field duplicate and MS/MSD
Water Truck - 3,000 gallons	per day	12	$ 250.00	$ 3,000.00	12 days drilling three wells (50' per day, plus day setup and tear down); Ault Field Yellow Jacket quote
Forklift	per day	12	$ 350.00	$ 4,200.00	12 days drilling three wells (50' per day, plus day setup and tear down); Ault Field Yellow Jacket quote
Decon Pad Construction and Materials	lump sum	1	$ 900.00	$ 900.00	Ault Field Yellow Jacket quote; assume go to Ault Field to decon

Table B-19.. Engineer's Cost Estimate for Alternative 4b: New (Replacement) Well for Easy Street Residences

Engineered Evaluation and Cost Estimate for Residential Drinking Water

Naval Air Station Whidbey Island, Ault Field, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Decontamination	per hour	8	$ 800.00	$ 6,400.00	4 hr. per well for 2 wells (go to Ault Field on-base decon area); Ault Field Yellow Jacket quote
Drilling/Well Installation IDW Management	per hour	4	$ 120.00	$ 480.00	2 hr. per well for 2 wells; Ault Field Yellow Jacket quote
Drilling/Well Installation IDW Containers and Disposal	Lump Sum	1	$ 27,165.00	$ 27,165.00	container rental and offsite non-haz waste disposal two 20 yd3 rolloffs; one 21,000 gallon frac tanks, each with secondary containment
IDW Sampling - soil	per sample set	1	$ 1,175.53	$ 1,175.53	Washington State required IDW characterization analyses; Test America MSA
IDW Sampling - water	per sample set	1	$ 678.38	$ 678.38	Washington State required IDW characterization analyses; Test America MSA
Drilling and Well Installation Field Oversight	per hour	270	$ 100.00	$ 27,000.00	2 field engineer staff for 10 drilling days (drill 50-ft per day) and 1 IDW day; 1 field engineer for 5 days (1 day utility locate, 2 days well installation, 2 days development); 10 hr. days
Miscellaneous Items Allowance	Lump Sum	1	$ 9,000.00	$ 9,000.00	Engineer Estimate for consumable field equipment, shipping, and field engineer travel expenses
Well Installation Total				**$ 318,263.11**	
Aquifer Testing - Initial Investigation					
Furnish, install, remove pump/wellhead assemblies, sounding tubes and 50 feet of discharge hose (0 to 20 gpm)	each	1	$ 1,000.00	$ 1,000.00	Ault Field Yellow Jacket quote
Generator rental and fuel	LS	1	$ 2,030.00	$ 2,030.00	Ault Field Yellow Jacket quote
Portable lighting	LS	1	$ 2,000.00	$ 2,000.00	Ault Field Yellow Jacket quote
Step Test	per hour	12	$ 200.00	$ 2,400.00	Ault Field Yellow Jacket quote
Constant Rate Test (72 hours)	per hour	72	$ 200.00	$ 14,400.00	Ault Field Yellow Jacket quote
Temporary storage tank (poly tank 20' diameter)	LS	1	$ 1,500.00	$ 1,500.00	Ault Field Yellow Jacket quote
Water Truck - 3,000 gallons	per day	7	$ 250.00	$ 1,750.00	Ault Field Yellow Jacket quote
Forklift	per day	7	$ 295.00	$ 2,065.00	Ault Field Yellow Jacket quote
Temporary pump and associated appurtenances to transfer water from the temporary tank to the water truck	per day	7	$ 150.00	$ 1,050.00	Ault Field Yellow Jacket quote
Decontamination	per hour	2	$ 800.00	$ 1,600.00	Ault Field Yellow Jacket quote
Aquifer Testing Installation IDW Management	per hour	78	$ 150.00	$ 11,700.00	Ault Field Yellow Jacket quote
Aquifer Testing Installation IDW Containers and Disposal	Lump Sum	1	$597,900.00	$ 597,900.00	Assumes IDW is non-hazardous
Equipment rental	Lump Sum	1	$ 3,050.00	$ 3,050.00	up to 10 transducers, barologger, water quality meter, water level tape
Groundwater Sampling	each	5	$ 282.88	$ 1,414.40	two samples (pre- and post-aquifer testing), plus FD and MS/MSD
Drilling and Well Installation Field Oversight	per hour	180	$ 100.00	$ 18,000.00	Three field engineer staff for five aquifer testing days (8 hour shifts per day); one field engineer for six 10 hr. days (1 day baseline monitoring, 2 step test, 1 day post monitoring, 2 IDW)
Miscellaneous Items Allowance	Each	1	$ 7,000.00	$ 7,000.00	Engineer Estimate for consumable field equipment, shipping, and field engineer travel expenses
Aquifer Testing Total				**$ 668,859.40**	
Initial Investigation Total				**$ 1,071,667.51**	
Site Preparation - Remaining Two Drinking Water Wells					
Drilling Mobilization/Demobilization	Each	1	$ 5,475.00	$ 5,475.00	Ault Field Yellow Jacket quote, includes Sonic Drilling Rig, Well Development Rig, Equipment, Support trucks, AHA, Chartering, subcontractor personnel, meals, & lodging
Utility Clearance	per day	1	$ 3,600.00	$ 3,600.00	From CTO4041 Project 695610 project cost; assume 2 sites cleared in 1 day
Site Access Agreements	Each	2	$ 480.00	$ 960.00	Right of Entry Forms; assumes 4 hours Jacobs support at $120/hr. for each agreement
State Dept. of Ecology Drilling Notice of Intent	Each	2	$ 40.00	$ 80.00	https://ecology.wa.gov/Regulations-Permits/Reporting-requirements/well-construction-notice-of-intent; due 72 hours before drilling
Site Preparation Total				**$ 10,115.00**	
Well Installation - Remaining Two Drinking Water Wells					
Hand Auguring - utility check	per hour	2	$ 800.00	$ 1,600.00	Ault Field Yellow Jacket quote hourly rate; hand auger, 3 locations to 5-ft at each well site for utility confirmation and soil sampling (1 hours each well site)

Table B-19.. Engineer's Cost Estimate for Alternative 4b: New (Replacement) Well for Easy Street Residences

Engineered Evaluation and Cost Estimate for Residential Drinking Water

Naval Air Station Whidbey Island, Ault Field, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
12-inch Borehole Drilling	per foot	500	$ 110.00	$ 55,000.00	Rotosonic drilling; Ault Field Yellow Jacket quote; two 250-ft holes
Archeological Oversight	per hour	24	$ 145.00	$ 3,480.00	Jacob's archeologist (Matt Steinkamp/PDX) oversight of first 15 ft of drilling (1 day, with travel day before and day after)
Archeological Survey - Travel Expenses	per trip	1	$ 700.00	$ 700.00	Rental car, gas, hotel, per diem for 3-day trip
Soil Sample Analysis	each	9	$ 288.20	$ 2,593.80	4 samples at each boring for PFAS plus one field duplicate
6-inch Well Installation	per foot	500	$ 300.00	$ 150,000.00	20-ft steel riser, 20-ft ss screen, 210-ft Sch 80 PVC; Ault Field Yellow Jacket quote; two 250-ft wells
6-inch Schedule 80 PVC casing SDR 21	per foot	420	$ 15.00	$ 6,300.00	Ault Field Yellow Jacket quote; 210-ft per well
6-inch stainless steel screen (.030 slot Domestic) - SCH80	per foot	40	$ 91.00	$ 3,640.00	Ault Field Yellow Jacket change-order quote; 20 ft per well
inch low carbon steel riser (Domestic) - SCH80	per foot	40	$ 121.40	$ 4,856.00	Ault Field Yellow Jacket change-order quote; 20 ft per well
Stainless steel 6 inch bottom cap (Domestic) - SCH80	Each	2	$ 330.00	$ 660.00	Ault Field Yellow Jacket change-order quote, 1 per well
Pitless adapter for wellhead	Each	2	$ 2,500.00	$ 5,000.00	Ault Field Yellow Jacket change-order quote, 1 per well
Surface Completion	Each	2	$ 460.00	$ 920.00	Flush mount, 8x12-inch cover; no bollards; Ault Field Yellow Jacket quote
Well Development	per well	2	$ 900.00	$ 1,800.00	rig, pump, tubing, personnel; Ault Field Yellow Jacket BOA (assumes 4 hrs for development of one well)
Equipment rental	Lump Sum	1	$ 300.00	$ 300.00	water quality meter, water level tape
Groundwater Sample Analysis	each	5	$ 282.88	$ 1,414.40	one PFAS sample per well, plus field duplicate and MS/MSD
Well Survey	Lump Sum	1	$ 5,440.00	$ 5,440.00	Jacob's surveyor; email quote for 1-day survey; assume all 4 wells included
Water Truck - 3,000 gallons	per day	12	$ 250.00	$ 3,000.00	12 days drilling two wells (50' per day, plus day setup and tear down); Ault Field Yellow Jacket quote
Forklift	per day	12	$ 350.00	$ 4,200.00	12 days drilling two wells (50' per day, plus day setup and tear down); Ault Field Yellow Jacket quote
Decontamination	per hour	8	$ 800.00	$ 6,400.00	4 hr. per well for 2 wells (go to Ault Field on-base decon area); Ault Field Yellow Jacket quote
Drilling/Well Installation IDW Management	per hour	4	$ 120.00	$ 480.00	2 hr. per well for 2 wells; Ault Field Yellow Jacket quote
Drilling/Well Installation IDW Containers and Disposal	Lump Sum	1	$ 27,165.00	$ 27,165.00	container rental and offsite non-haz waste disposal two 20 yd3 rolloffs; one 21,000 gallon frac tanks, each with secondary containment
IDW Sampling - soil	per sample set	1	$ 1,175.53	$ 1,175.53	Washington State required IDW characterization analyses; Test America MSA
IDW Sampling - water	per sample set	1	$ 678.38	$ 678.38	Washington State required IDW characterization analyses; Test America MSA
Drilling and Well Installation Field Oversight	per hour	270	$ 100.00	$ 27,000.00	2 field engineer staff for 10 drilling days (drill 50-ft per day) and 1 IDW day; 1 field engineer for 5 days (1 day utility locate, 2 days well installation, 2 days development); 10 hr. days
Miscellaneous Items Allowance	Lump Sum	1	$ 9,000.00	$ 9,000.00	Engineer Estimate for consumable field equipment, shipping, and field engineer travel expenses
Well Installation Total				**$ 322,803.11**	
Conversion to Drinking Water Well					
Permitting	Hour	20	$ 120.00	$ 2,400.00	Assumes 4 hours labor needed per well to pursue permitting
County Well Inspection	Each	5	$ 227.00	$ 1,135.00	Island County Environmental Health Well Inspection Form; <https://www.islandcountywa.gov/Health/EH/Documents/Wellsite%20Application2015.pdf>
Pump	Each	5	$ 800.00	$ 4,000.00	Grundfos model 16S10-10, 16 gpm max pumping rate, 4-inch diameter, 1 HP, 230V, 3-wire
Pump Installation	Each	5	$ 1,000.00	$ 5,000.00	Yellow Jacket quote for installation of aquifer testing pump
Connection to Home	Each	5	$ 6,000.00	$ 30,000.00	Engineers Estimate; assumes new well adjacent to existing well and will be connected to existing piping to home (equipment and labor)
Field Oversight	per hour	40	$ 100.00	$ 4,000.00	one staff, 8-hr day per well
Conversion to Drinking Water Well Total				**$ 46,535.00**	
Subtotal				***$ 1,451,120.62***	
Contingency (15%)		*15%*		$ 217,668.09	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Subtotal				***$ 1,668,788.71***	
Project Management (8%)		*8%*		$ 133,503.10	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)

Table B-19.. Engineer's Cost Estimate for Alternative 4b: New (Replacement) Well for Easy Street Residences

Engineered Evaluation and Cost Estimate for Residential Drinking Water

Naval Air Station Whidbey Island, Ault Field, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
TOTAL CAPITAL COSTS				**$ 1,802,300.00**	
Operations and Maintenance (O&M) Years 1-30 [a]					
Routine Sampling for PFAS - first two years	Each	2	$ 25,052.16	$ 50,104.32	4 times per year first 2 years. 1 PFAS sample plus 1 QC sample per household per event, 4 households. Total samples/ year = 32. $282.88 per sample (Test America MSA). 2 days per sampling event, 2 staff. Average rate of field staff is $100/hr.
Routine Reporting of Sampling Results - first two years	Each	2	$ 14,400.00	$ 28,800.00	Four TMs per year documenting sampling activities and results. Assumes data validation, database management, and preparation of one TM per quarter (30 hours per quarter at average rate of $120/hr.)
Routine Sampling for PFAS - remaining years	Each	28	$ 12,526.08	$ 350,730.24	Semiannual sampling. 1 PFAS sample plus 1 QC sample per household per event, 4 households. Total samples/ year = 16; $282.88 per sample (Test America MSA). 2 days per sampling event. Average rate of field staff is $100/hr.
Routine Reporting of Sampling Results - remaining years	Each	28	$ 7,200.00	$ 201,600.00	Two TMs per year documenting sampling activities and results. Assumes data validation, database management, and preparation of one TM per quarter (30 hours per event at average rate of $120/hr.)
Subtotal				***$ 631,234.56***	
Contingency (15%)		*15%*		$ 94,685.18	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Technical Support (15%)		*15%*		$ 94,685.18	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL O&M COSTS				**$ 820,600.00**	
Total O&M Cost Per Year				$ 27,353.33	
Total Years of O&M				30	
Discount Rate				2.6%	Office of Management and Budget, Circular A-94 2018.
Total Present Value of O&M Costs				**$ 565,000.00**	
TOTAL PRESENT VALUE of ALTERNATIVE				**$ 2,367,300.00**	
			+50%	$ 3,550,950.00	
			-30%	$ 1,657,110.00	

This is not an offer for construction and/or project execution. Please note, these order of magnitude cost estimates are assumed to represent the actual installed cost within the range of - 30 percent to + 50 percent of the costs indicated. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor, material costs, and competitive variable factors. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific decisions to help ensure proper project evaluation and adequate funding.

[a]Assumes resident responsible for well, pump maintenance and electricity costs (not a Navy cost)

Table B-20. Engineer's Cost Estimate for Alternative 4c: New (Replacement) Well for Evergreen Mobile Home Park

Engineered Evaluation and Cost Estimate for Residential Drinking Water

Naval Air Station Whidbey Island, Ault Field, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents [a]					
UFP-SAP, WMP-EPP, APP-SSHP	Lump Sum	1	$ 20,000.00	$ 20,000.00	Includes scoping plus draft and final submission. Will include drilling, aquifer testing, well conversion, and long-term sampling plan. Based on Ault Field drilling and aquifer testing SAP. Based on effort for existing project documents.
Construction Completion Report	Lump Sum	1	$ 40,000.00	$ 40,000.00	Includes aquifer testing analysis and archeological monitoring report; draft and final submissions. Based on effort for existing project documents.
Work Planning Documents Total				**$ 60,000.00**	
Site Preparation					
Drilling Mobilization/Demobilization[a]	Each	1	$ 5,475.00	$ 5,475.00	Ault Field Yellow Jacket quote, includes Sonic Drilling Rig, Well Development Rig, Equipment, Support trucks, AHA, Chartering, subcontractor personnel, meals, & lodging
Aquifer Testing Mobilization/Demobilization[a]	Each	1	$ 10,000.00	$ 10,000.00	Ault Field Yellow Jacket quote; Misc. equipment and supplies, support trucks, AHA, Chartering, subcontractor personnel, meals & lodging, site restoration
Utility Clearance[a]	per day	1	$ 3,600.00	$ 3,600.00	From CTO4041 Project 695610 project cost; assume cleared in 1 day
Site Access Agreements	Each	1	$ 480.00	$ 480.00	Right of Entry Forms; assumes 4 hours Jacobs support at $120/hr. for each agreement
Archeological Survey[a]	per hour	24	$ 145.00	$ 3,480.00	Jacob's archeologist (Matt Steinkamp/PDX) performs site survey (1 day, with travel day before and day after); assumes finding is no adverse effect
Archeological Survey - Travel Expenses[a]	per trip	1	$ 700.00	$ 700.00	Rental car, gas, hotel, per diem for 3-day trip
State Dept. of Ecology Drilling Notice of Intent	Each	1	$ 40.00	$ 40.00	https://ecology.wa.gov/Regulations-Permits/Reporting-requirements/well-construction-notice-of-intent; due 72 hours before drilling
State Dept. of Ecology Water Right Permit[a]	Each	1	$ 50.00	$ 50.00	Washington Sate Dept. of Ecology, Water Right Permit required if pumping >5000 gallons ($50/per property); https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Water-rights-permits
Site Preparation Total				**$ 23,825.00**	
Well Installation					
Hand Auguring - utility check	per hour	1	$ 800.00	$ 800.00	Ault Field Yellow Jacket quote hourly rate; hand auger, 3 locations to 5-ft at each well site for utility confirmation and soil sampling (1 hours each well site)
12-inch Borehole Drilling	per foot	250	$ 110.00	$ 27,500.00	Rotosonic drilling; Ault Field Yellow Jacket quote; two 250-ft holes
Archeological Oversight[a]	per hour	24	$ 145.00	$ 3,480.00	Jacob's archeologist (Matt Steinkamp/PDX) oversight of first 15 ft of drilling (1 day, with travel day before and day after)
Archeological Survey - Travel Expenses[a]	per trip	1	$ 700.00	$ 700.00	Rental car, gas, hotel, per diem for 3-day trip
Soil Sample Analysis[a]	each	5	$ 288.20	$ 1,441.00	4 samples at each boring for PFAS plus one field duplicate
6-inch Well Installation	per foot	250	$ 300.00	$ 75,000.00	20-ft steel riser, 20-ft ss screen, 210-ft Sch 80 PVC; Ault Field Yellow Jacket quote; two 250-ft wells
6-inch Schedule 80 PVC casing SDR 21	per foot	210	$ 15.00	$ 3,150.00	Ault Field Yellow Jacket quote; 210-ft per well
6-inch stainless steel screen (.030 slot Domestic) - SCH80	per foot	20	$ 91.00	$ 1,820.00	Ault Field Yellow Jacket change-order quote; 20 ft per well
inch low carbon steel riser (Domestic) - SCH80	per foot	20	$ 121.40	$ 2,428.00	Ault Field Yellow Jacket change-order quote; 20 ft per well
Stainless steel 6 inch bottom cap (Domestic) - SCH80	Each	1	$ 330.00	$ 330.00	Ault Field Yellow Jacket change-order quote, 1 per well
Pitless adapter for wellhead	Each	1	$ 2,500.00	$ 2,500.00	Ault Field Yellow Jacket change-order quote, 1 per well
Surface Completion	Each	1	$ 460.00	$ 460.00	Flush mount, 8x12-inch cover; no bollards; Ault Field Yellow Jacket quote
Well Development	per well	1	$ 900.00	$ 900.00	rig, pump, tubing, personnel; Ault Field Yellow Jacket BOA (assumes 4 hrs for development of one well)
Equipment rental	Lump Sum	1	$ 200.00	$ 200.00	water quality meter, water level tape
Groundwater Sample Analysis[a]	each	3	$ 282.88	$ 848.64	one PFAS sample per well, plus field duplicate and MS/MSD
Water Truck - 3,000 gallons[a]	per day	7	$ 250.00	$ 1,750.00	7 days drilling each well (50' per day, plus day setup and tear down); Ault Field Yellow Jacket quote
Forklift[a]	per day	7	$ 350.00	$ 2,450.00	7 days drilling each well (50' per day, plus day setup and tear down); Ault Field Yellow Jacket quote
Decon Pad Construction and Materials[a]	lump sum	1	$ 900.00	$ 900.00	Ault Field Yellow Jacket quote; assume go to Ault Field to decon

Table B-20. Engineer's Cost Estimate for Alternative 4c: New (Replacement) Well for Evergreen Mobile Home Park

Engineered Evaluation and Cost Estimate for Residential Drinking Water

Naval Air Station Whidbey Island, Ault Field, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Decontamination	per hour	4	$ 800.00	$ 3,200.00	4 hr. per well (go to Ault Field on-base decon area); Ault Field Yellow Jacket quote
Drilling/Well Installation IDW Management	per hour	2	$ 120.00	$ 240.00	2 hr. per well; Ault Field Yellow Jacket quote
Drilling/Well Installation IDW Containers and Disposal[a]	Lump Sum	1	$ 13,142.50	$ 13,142.50	container rental and offsite non-haz waste disposal one 20 yd3 rolloffs; one 21,000 gallon frac tanks, each with secondary containment
IDW Sampling - soil	per sample set	1	$ 1,175.53	$ 1,175.53	Washington State required IDW characterization analyses; Test America MSA
IDW Sampling - water	per sample set	1	$ 678.38	$ 678.38	Washington State required IDW characterization analyses; Test America MSA
Drilling and Well Installation Field Oversight	per hour	170	$ 100.00	$ 17,000.00	2 field engineer staff for 5 drilling days (drill 50-ft per day) and 1 IDW day; 1 field engineer for 5 days (1 day utility locate, 2 days well installation, 2 days development); 10 hr. days
Miscellaneous Items Allowance	Lump Sum	1	$ 7,500.00	$ 7,500.00	Engineer Estimate for consumable field equipment, shipping, and field engineer travel expenses
Well Installation Total				**$ 169,594.05**	
Aquifer Testing[a]					
Furnish, install, remove pump/wellhead assemblies, sounding tubes and discharge hose	each	1	$ 1,000.00	$ 1,000.00	Ault Field Yellow Jacket quote
Generator rental and fuel	LS	1	$ 2,030.00	$ 2,030.00	Ault Field Yellow Jacket quote
Portable lighting	LS	1	$ 2,000.00	$ 2,000.00	Ault Field Yellow Jacket quote
Step Test	per hour	12	$ 200.00	$ 2,400.00	Ault Field Yellow Jacket quote
Constant Rate Test (72 hours)	per hour	72	$ 200.00	$ 14,400.00	Ault Field Yellow Jacket quote
Temporary storage tank (poly tank 20' diameter)	LS	1	$ 1,500.00	$ 1,500.00	Ault Field Yellow Jacket quote
Water Truck - 3,000 gallons	per day	7	$ 250.00	$ 1,750.00	Ault Field Yellow Jacket quote
Forklift	per day	7	$ 295.00	$ 2,065.00	Ault Field Yellow Jacket quote
Temporary pump and associated appurtenances to transfer water from the temporary tank to the water truck	per day	7	$ 150.00	$ 1,050.00	Ault Field Yellow Jacket quote
Decontamination	per hour	2	$ 800.00	$ 1,600.00	Ault Field Yellow Jacket quote
Aquifer Testing Installation IDW Management	per hour	78	$ 150.00	$ 11,700.00	Ault Field Yellow Jacket quote
Aquifer Testing Installation IDW Containers and Disposal	Lump Sum	1	$597,900.00	$ 597,900.00	Assumes IDW is non-hazardous
Equipment rental	Lump Sum	1	$ 3,050.00	$ 3,050.00	up to 10 transducers, barologger, water quality meter, water level tape
Groundwater Sampling	each	5	$ 282.88	$ 1,414.40	two samples (pre- and post-aquifer testing), plus FD and MS/MSD
Drilling and Well Installation Field Oversight	per hour	180	$ 100.00	$ 18,000.00	Three field engineer staff for five aquifer testing days (8 hour shifts per day); one field engineer for six 10 hr. days (1 day baseline monitoring, 2 step test, 1 day post monitoring, 2 IDW)
Miscellaneous Items Allowance	Each	1	$ 7,000.00	$ 7,000.00	Engineer Estimate for consumable field equipment, shipping, and field engineer travel expenses
Aquifer Testing Total				**$ 668,859.40**	
Initial Investigation Subtotal				**$ 922,278.45**	
Conversion to Drinking Water Well					
Permitting	Hour	4	$ 120.00	$ 480.00	Assumes 4 hours labor needed per well to pursue permitting
County Well Inspection	Each	1	$ 227.00	$ 227.00	Island County Environmental Health Well Inspection Form; <https://www.islandcountywa.gov/Health/EH/Documents/Wellsite%20Application2015.pdf>
Pump	Each	1	$ 4,000.00	$ 4,000.00	Grundfos model 62S50-9, 4-inch diameter, 3-phase, 5 HP, 230V, 3-wire
Pump Installation	Each	1	$ 1,000.00	$ 1,000.00	Yellow Jacket quote for installation of aquifer testing pump
Connection to Existing Distribution System	Each	1	$ 10,000.00	$ 10,000.00	Engineers Estimate; assumes new well adjacent to existing well and will be connected to existing piping to home (equipment and labor)
Field Oversight	per hour	8	$ 100.00	$ 800.00	one staff, 8-hr day per well
Conversion to Drinking Water Well Total				**$ 16,507.00**	
Subtotal				***$ 938,785.45***	

Table B-20. Engineer's Cost Estimate for Alternative 4c: New (Replacement) Well for Evergreen Mobile Home Park

Engineered Evaluation and Cost Estimate for Residential Drinking Water

Naval Air Station Whidbey Island, Ault Field, Oak Harbor, Washington

Description of Service/items	Unit	Quantity	Unit Price	Total	Assumptions
Contingency (15%)		*15%*		$ 140,817.82	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Subtotal				***$ 1,079,603.27***	
Project Management (8%)		*8%*		$ 86,368.26	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL CAPITAL COSTS				**$ 1,166,000.00**	
Operations and Maintenance (O&M) Years 1-30 [b]					
Routine Sampling for PFAS - first two years	Each	2	$ 10,263.04	$ 20,526.08	4 times per year first 2 years. 1 PFAS sample plus 1 QC sample each event. Total samples/ year = 8. $282.88 per sample (Test America MSA). 1 day per sampling event, 2 field staff. Average rate of field staff is $100/hr.
Routine Reporting of Sampling Results - first two years	Each	2	$ 9,600.00	$ 19,200.00	Four TMs per year documenting sampling activities and results. Assumes data validation, database management, and preparation of one TM per quarter (20 hours per quarter at average rate of $120/hr.)
Routine Sampling for PFAS - remaining years	Each	28	$ 12,515.52	$ 350,434.56	Semiannual sampling. 1 PFAS sample plus 1 QC sample per event, 1 household. Total samples/ year = 4; $282.88 per sample (Test America MSA). 1 day per sampling event, 2 staff. Average rate of field staff is $100/hr.
Routine Reporting of Sampling Results - remaining years	Each	28	$ 4,800.00	$ 134,400.00	Two TMs per year documenting sampling activities and results. Assumes data validation, database management, and preparation of one TM per quarter (20 hours per event at average rate of $120/hr.)
Subtotal				***$ 524,560.64***	
Contingency (15%)		*15%*		$ 78,684.10	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
Technical Support (15%)		*15%*		$ 78,684.10	EPA Guidance on Cost Estimates for Feasibility Studies (July, 2000)
TOTAL O&M COSTS				**$ 681,900.00**	
Total O&M Cost Per Year				$ 22,730.00	
Total Years of O&M				30	
Discount Rate				2.6%	Office of Management and Budget, Circular A-94 2018.
Total Present Value of O&M Costs				**$ 469,500.00**	
TOTAL PRESENT VALUE of ALTERNATIVE				**$ 1,635,500.00**	
			+50%	$ 2,453,250.00	
			-30%	$ 1,144,850.00	

This is not an offer for construction and/or project execution. Please note, these order of magnitude cost estimates are assumed to represent the actual installed cost within the range of - 30 percent to + 50 percent of the costs indicated. The cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor, material costs, and competitive variable factors. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific decisions to help ensure proper project evaluation and adequate funding.

[a]Cost item could be combined with Easy Street Resident work (Alternative 4b) to reduce or eliminate this costs during implementation; however, for the purposes of the EE/CA alternative screening for the Evergreen Mobile Home Park as a stand-alone site, all costs are included in this alternative to allow direct comparisons between alteratives.

[b]Assumes resident responsible for well, pump maintenance and electricity costs (not a Navy cost).

Appendix C
SiteWise Evaluation

APPENDIX C

Sustainability Analysis for Drinking Water, Naval Air Station Whidbey Island

1.1 Introduction

This appendix presents the approach taken and results obtained from a sustainability analysis performed for an Engineering Evaluation and Cost Analysis (EE/CA) for a non-time-critical removal action to address perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) in drinking water wells at off-Base residential properties near Ault Field and Area 6 (a 260-acre tract in the southeastern corner of Ault Field) at Naval Air Station (NAS) Whidbey Island, in Oak Harbor, Washington. Details of the project are provided in the EE/CA. The areas evaluated in the EE/CA include the following site groupings:

- Ault Field Residence 1 - a single-family residence located east of Ault Field with United States Environmental Protection Agency (USEPA) Lifetime Health Advisory exceedances of PFOA and/or PFOS in the drinking water well. This location has unique considerations regarding potential connections to a Department of the Navy (Navy) or public water supply and how a new (replacement) well would be implemented.
- Ault Field Residence 2 - a single-family residence located south of Ault Field with USEPA Lifetime Health Advisory exceedances of PFOA and/or PFOS in the drinking water well. This location has unique considerations regarding potential connections to a Navy or public water supply, the viability of the new well option, and the point-of-entry (POE) treatment needs (this well has consistently exhibited one to two orders-of-magnitude higher per- and polyfluoroalkyl substances (PFAS) concentrations than the other affected wells).
- Easy Street Residences – five single-family residences south of Area 6 with USEPA Lifetime Health Advisory exceedances of PFOA and/or PFOS in the drinking water wells associated with each residence. This location has unique considerations regarding potential connections to a public water supply and the viability of the new well option.
- Evergreen Mobile Home Park – a mobile home community currently with 19 units, with the possibility of up to 21 units, that is served by a single drinking water well with USEPA Lifetime Health Advisory exceedances of PFOA and/or PFOS. This location has unique considerations regarding potential connections to a public water supply, the viability of the new well option, and POE treatment (because of the larger treatment water rates and volumes).

The following alternatives were developed to address current exposure potential to drinking water at off-Base properties contaminated with PFOA and/or PFOS at levels greater than the USEPA Lifetime Health Advisory of 70 nanograms per liter (ng/L). A detailed summary of the alternatives is provided in the EE/CA.

- Alternative 1 – No Further Action
  - 1a - Continue supplying bottled water to affected off-Base properties that do not have a granular activated carbon (GAC) point-of-use (POU) treatment system
    - 1a-1: Ault Field Residence 1
    - 1a-2: Ault Field Residence 2
    - 1a-3: Easy Street Residences
    - 1a-4: Evergreen Mobile Home Park units
  - 1b - Providing maintenance of the one Evergreen Mobile Home Park units GAC POU treatment system
- Alternative 2 – POE Water Treatment of Affected Off-Base Well Water
  - 2a – GAC Treatment to remove PFOA and PFOS from drinking water well supplies

        - 2a-1: Ault Field Residence 1
        - 2a-2: Ault Field Residence 2
        - 2a-3: Easy Street Residences
        - 2a-4: Evergreen Mobile Home Park
    - 2b – Ion Exchange (IX) Treatment to remove PFOA and PFOS from drinking water well supplies
        - 2b-1: Ault Field Residence 1
        - 2b-2: Ault Field Residence 2
        - 2b-3: Easy Street Residences
        - 2b-4: Evergreen Mobile Home Park
- Alternative 3 – Connection to Navy or Public Water
    - 3a – Ault Field Residence 1 connection to a City of Oak Harbor Water line via Navy-maintained connection
    - 3b – Ault Field Residence 2 connection to an on-Base Navy water line
    - 3c – Ault Field Residence 2 connection to the Pine Terrace Water System
    - 3d – Easy Street Residences individual connections to an extension of City of Oak Harbor water lines
    - 3e – Evergreen Mobile Home Park single connection to an extension of the City of Oak Harbor water lines (with owner distribution to individual mobile home park residences)
- Alternative 4 - New (Replacement) Well (Note: this alternative is not applicable to Ault Field Residence 2, which does not have an appropriate, deeper aquifer to use for drinking water)
    - 4a – Conversion of a monitoring well to a new drinking water well for Ault Field Residence 1
    - 4b – Further site investigation (installation of a new monitoring well, aquifer testing, and PFAS analytical sampling) with potential conversion of the monitoring well to a new drinking water well, and an additional well if needed.
        - 4b-1: For Easy Street Residences
        - 4b:2: For the Evergreen Mobile Home Park

The purpose of this analysis is to provide a quantitative assessment of the potential environmental and social impact of each alternative. The sustainability analysis was performed using SiteWise Version 3.1 (Battelle, 2015) for the alternatives previously listed.

1.2 Method and Assumptions

The SiteWise tool consists of a series of Excel-based spreadsheets used to conduct a baseline assessment of sustainability metrics. The assessment is carried out using a spreadsheet-based building block approach, where every removal alternative can be broken down into components for discrete phases of work (such as construction, operation, long-term monitoring), or different systems for more complex removal actions.

SiteWise uses various emission factors from governmental or non-governmental research sources to determine the environmental impact of each activity. The quantitative metrics calculated by the tool include:

1) Greenhouse gases (GHGs) reported as metric tons of carbon dioxide equivalents (CO_2e), consisting of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)
2) Energy usage (expressed as millions of British Thermal Units [MMBTU])
3) Water usage (gallons of water)
4) Air emissions of criteria pollutants consisting of metric tons of nitrogen (NO_x), sulfur oxides (SO_x), and particulate matter 10 micrometers or less in diameter (PM_{10})
5) Accident risk (risk of injury and risk of fatality)

For the purpose of this discussion, the term "footprint" will be used to describe the quantified emissions or quantities for each metric. To estimate the sustainability footprint for each alternative, only those elements possessing important sustainability impacts were included in the assessment. A lower footprint indicates lower deleterious impacts to environmental and social metrics, which collectively make up the SiteWise sustainability metrics. Conversely, a higher footprint indicates higher deleterious impacts associated with the SiteWise metrics. The major conclusions of this sustainability analysis are incorporated into the effectiveness criteria evaluation of the EE/CA.

1.2.1 Assumptions

The following is a description of the major activities for each alternative. The assumed operation timeframe is 30 years for the purpose of this evaluation. Activities such as sampling or vessel delivery are assumed to be completed in one event, rather than separate events. The data entered into the SiteWise tool represent the total 30-year timeframe for this evaluation. Assumptions are presented in **Tables 1** through **5.**

The following general assumptions are used for the SiteWise tool evaluation:

- The complete environmental footprint for production of equipment used, or production of the vehicles used for transportation, is not considered in this analysis.
- The overall water usage is included to provide a comparison between the overall footprint for the method of extraction (pumping groundwater versus potable water source).

1.3 Results and Conclusions

The results are presented as follows:

- Ault Field Residence 1 – **Table 6** presents the relative impact of alternatives, **Table 7** presents the results of the SiteWise evaluation by activity, and **Figure 1** graphically presents the SiteWise evaluation by activity.
- Ault Field Residence 2 – **Table 8** presents the relative impact of alternatives, **Table 9** presents the results of the SiteWise evaluation by activity, and **Figure 2** graphically presents the SiteWise evaluation by activity.
- Easy Street Residences – **Table 10** presents the relative impact of alternatives, **Table 11** presents the results of the SiteWise evaluation by activity, and **Figure 3** graphically presents the SiteWise evaluation by activity.
- Evergreen Mobile Home Park – **Table 12** presents the relative impact of alternatives, **Table 13** presents the results of the SiteWise evaluation by activity, and **Figure 4** graphically presents the SiteWise evaluation by activity.

The relative impact is a qualitative assessment of the relative footprint of each alternative. A rating of high or low is assigned to each alternative based on its performance against the other alternatives. The tool assigns a rating of high to the highest footprint in each category and assigns the ratings of other alternatives based on the difference in the data between alternatives. The rating is based on a 30 percent difference; for example, if the footprints of two alternatives are within 30 percent of each other, they will be assigned the same rating. This allows for some uncertainty inherent in the assumptions used in the model.

It should be noted that while this analysis compares the environmental footprints of each of the alternatives, the alternatives may differ with respect to other evaluation criteria. Therefore, a comparison of the results of the alternatives needs to be made in the context of the benefits (for example, applicable or relevant and appropriate requirement compliance, contaminant reduction, site reuse, cost effectiveness) of each of the alternatives.

1.3.1 Ault Field Residence 1

The following is a comparison of the alternatives for each metric. Details are provided in **Tables 6** and **7** and **Figure 1**.

GHG and Energy Use. Alternative 3a, connection to public water, had the highest GHG and energy use footprints of all the alternatives by several orders of magnitude, primarily from material production (piping for the water main and asphalt for roadway repair). Alternative 2b-1 had the second highest GHG and energy footprints, followed by 2a-1 and 4a. The primary driver for GHG footprints for the four remaining alternatives is equipment use and transportation. The primary driver for energy use for the four remaining alternatives is equipment use.

Water Use. Other than Alternative 4b, which has significant volumes of investigation-derived waste from well development and aquifer testing, most alternatives had similar water use. A majority of water use is attributed to consumption of water either from groundwater or a potable source, with a minor contribution from electricity use from powering the pump (cooling water at power plant) for Alternatives 1a, 2a-1, 2b-1, and 4a, and well testing investigation-derived waste for Alternative 4b.

Criteria Air Pollutants (NO_X, SO_X, PM_{10}). Alternative 3a had the highest NO_X and SO_X footprints, compared with the other alternatives, almost exclusively from material production (between 75 and 90 percent of the total footprint). Alternatives 1a-1, 2a-1, 2b-1, and 4a had similar criteria air pollutant footprints, all within 30 percent of each other and significantly below the largest footprint (Alternative 3a). The source of the contributions for each alternative varied, although equipment use was generally the majority contribution to each footprint.

Accident Risks. Alternative 3a had the highest accident risk-injury footprint primarily from onsite labor hours. The accident risk-fatality footprint was highest for Alternative 1a-1 because of the high mileage for water delivery and performance monitoring. Alternative 2a-1 and 2b-1 had a similarly high accident risk-fatality primarily from the GAC and IX deliveries and performance monitoring. Alternative 2b-1 had the lowest accident risk-injury footprint primarily because of the reduced amount of equipment, material, and personnel transport.

1.3.2 Ault Field Residence 2

The following is a comparison of the alternatives for each metric. Details are provided in **Tables 8** and **9** and **Figure 2**.

GHG and Energy Use. Alternative 2a-2, GAC treatment, had the highest GHG footprint and second highest energy use footprint primarily from the amount of GAC used and vehicle mileage for change-outs and performance monitoring. Alternative 3c, connection to public water (Pine Terrace Water Association), had the second highest GHG and highest energy use footprints, primarily from material production (piping for the water main and asphalt for roadway repair). Alternatives 2b-2 (IX) third highest GHG and energy footprints followed by Alternatives 3b (connection to Base water) and 1a-2 (No Further Action). The primary driver for GHG and energy footprints for Alternatives 1a-2, 2a-2, and 2b-2 is equipment use and transportation. The primary driver for the GHG and energy footprints for Alternative 3b was material production, similar to Alternative 3c.

Water Use. All alternatives had similar water use, with the majority of water use attributed to consumption of water either from groundwater or a potable source, with a minor contribution from electricity use from powering the pump (cooling water at power plant) for Alternatives 1a-2, 2a-2, and 2b-2.

Criteria Air Pollutants (NO_X, SO_X, PM_{10}). Alternative 3c had the highest NO_X and SO_X footprints, compared with the other alternatives, almost exclusively from material production (between 75 and 90 percent of the total footprint). Alternative 2a-2 had the second highest NO_X and SO_X, and third highest PM_{10}, footprints primarily from waste disposal (regenerating GAC). Alternative 3b was significantly lower than 3c because of the shorter distance to connect to Navy water, and had the third highest NO_X and SO_X, and second highest PM_{10} footprints. Alternative 2b-2 had slightly lower criteria air pollutants and Alternative 1a-2 had the lowest footprints. The source of the contributions for each alternative varied.

Accident Risks. Alternative 3c had the highest accident risk-injury footprint primarily from onsite labor hours. The accident risk-fatality footprint was highest for Alternative 2b-2 because of the high mileage for IX delivery. Alternative 2a-2 had a similarly high accident risk-fatality primarily from the GAC deliveries. Alternatives 1 and 3c had significantly lower footprints than Alternatives 2a-2 and 2b-2. Alternative 3b-2 had the lowest accident risk-injury and -fatality footprints primarily because of the reduced amount of long-term onsite labor hours and transportation associated with the alternative.

1.3.3 Easy Street Residences

The following is a comparison of the alternatives for each metric. Details are provided in **Tables 10** and **11** and **Figure 3**.

GHG and Energy Use. Alternative 4b-1, investigation for and installation of a new well, had the highest GHG and energy use footprints compared with all other alternatives, primarily from material production for the wells (steel and PVC for piping and grout for the wells). Alternative 2a-3 (GAC) and 2b-3 (IX) had similarly high GHG and energy footprints. Equipment use (pumps for groundwater) and material production (GAC and IX resin) were major contributors with some contribution from material transport (GAC) for Alternative 2a-3 for the GHG footprint. Equipment use was the primary energy driver for Alternatives 1a-3, 2a-3, and 2b-3. Alternative 3d, public water, had the lowest energy use footprint and second lowest GHG footprint.

Water Use. All alternatives had similar water use, with the majority of water use attributed to consumption of water either from groundwater or a potable source, with a minor contribution from electricity use from powering the pump (cooling water at power plant) for Alternatives 1a-3, 2a-3, 2b-3, and 4b-1.

Criteria Air Pollutants (NO_X, SO_X, PM_{10}). Alternative 4b-1 had the highest NO_X footprint primarily from equipment use onsite and material production. Alternative 3d had the highest SO_X and PM_{10} footprints from material production and equipment use, respectively. Alternative 1a-3 had the lowest footprint for all three criteria air pollutants followed by Alternative 2a-3 and 2b-3.

Accident Risks. Alternative 2b-3 had the highest accident risk-injury and accident risk-fatality footprints primarily from transportation (IX resin) and onsite labor hours for sampling and maintenance change-outs. and Alternative 1a-3 had the second highest accident risk-fatality footprint, primarily from transporting bottled water.

Alternative 3d had the lowest accident risk-injury and -fatality footprints because of the reduced amount of long-term onsite labor hours and transportation associated with the alternative.

1.3.4 Evergreen Mobile Homes

The following is a comparison of the alternatives for each metric. Details are provided in **Tables 12** and **13** and **Figure 4**.

GHG and Energy Use. Alternative 2a-4 (GAC) had the highest GHG and energy use footprints primarily from the large volume of GAC required (material production, regeneration, and transportation). Alternative 4b-2, installing a new well, had the second highest energy use footprint, primarily from equipment use to install the wells and material production for the wells (steel and PVC for piping and grout for the wells). All of the alternatives except Alternative 2a-4 had similar GHG footprints. Equipment use was the primary energy driver for Alternatives 1b, 2a-4, and 2b-4. Alternative 3e, public water, had the lowest energy use footprint.

Water Use. All alternatives had similar water use, with the majority of water use attributed to consumption of water either from groundwater or a potable source, with a minor contribution from electricity use from powering the pump (cooling water at power plant) for Alternatives 1b, 2a-4, 2b-4, and 4b-2.

Criteria Air Pollutants (NO_X, SO_X, PM_{10}). Alternative 2a-4 had the highest NO_X and SO_X footprints primarily from GAC regeneration. Alternative 3e had the second highest NO_X and SO_X footprints and highest PM_{10} footprint , primarily from equipment use. Alternative 2b-4 and 4b-2 had the similar criteria air pollutant footprints . Alternative 1b had the lowest footprint for all three criteria air pollutants.

Accident Risks. Alternative 2a-4 had the highest accident risk footprints followed by 1b and 2b-4. Onsite labor hours, equipment use (pump in the well), transportation of personnel for sampling, and transportation of bottled water or materials were the primary contributors.

Alternative 3e had the lowest accident risk-injury and -fatality footprints because of the reduced amount of long-term onsite labor hours and transportation associated with the alternative.

1.4 Uncertainty

The SiteWise tool calculates environmental and risk footprints based on industry averages, published emissions factors, and generalized data sources. The footprint results are not representative of actual emissions and should be used for comparative purposes only. Additionally, it was assumed that the water bottles were refillable or recycled; potentially underestimating the environmental footprint of the NFA alternatives.

Proxies or assumptions were made that contribute to uncertainty including:

- Using regenerated GAC as a proxy for thermal treatment of GAC and IX resin.
- Ductile iron pipe and copper pipe is not included in SiteWise, however the impact was expected to be slightly lower than steel, therefore a “moderate impact material” was used as a proxy.
- Distance traveled for the waste treatment and replacement materials was assumed based on professional knowledge but may vary based on actual design and implementation.

1.5 Recommendations

The inventory from the SiteWise tool were used to estimate the environmental footprint of the alternatives. Once the alternative is selected, it is recommended that the footprint of the selected alternative be further evaluated in the design phase of the projects to explore opportunities to optimize the environmental footprint of the project and integrate sustainable remediation best practices in the design, construction, and operation of the alternative.

1.6 References

Battelle. 2015. *SiteWise Version 3.1*. NAVFAC Engineering Service Center. September.

Tables

Table 1

Alternative 1	No Further Action - Assumptions
1a-1: Ault Field Residence 1	• Bottled water delivery: 20.4 gallons bi-weekly (one 12-pack of 700 mL sport-top bottes, one 24-pack of 500 mL bottles, three 5-gallon bottles); 15,904 gallons total over 30 years. Note, it is assumed that residents will recycle or reuse bottles and that the overall footprint is negligible. • Biweekly delivery from Crystal Springs in Burlington, Washington to Oak Harbor, Washington 60 miles round-trip, one light duty truck (780 trips total; total mileage of 46,800 miles, shared load 0.085 tons transported) • Resource use (Groundwater, total usage): 360 gallons per day; 10,950 average gallons per month; 3,942,000 gallons over 30 years • Equipment use for groundwater well: assume 1 horsepower pump operating 6 hours/day (65,700 hours over 30 years)
1a-2: Ault Field Residence 2	• Bottled water delivery: 15.4 gallons bi-weekly (one 12-pack of 700 mL sport-top bottes, one 24-pack of 500 mL bottles, two 5-gallon bottles); 12,004 gallons total over 30 years • Biweekly delivery from Crystal Springs in Burlington, Washington to Oak Harbor, Washington 60 miles round-trip, one light duty truck (780 trips total; total mileage of 46,800 miles, shared load 0.064 tons transported) • Resource use (groundwater, total usage): 180 gallons per day; 5,475 average gallons per month; 1,971,000 gallons over 30 years • Equipment use for groundwater well: assume 1 horsepower pump operating 6 hours/day (65,700 hours in 30 years)
1a-3: Easy Street Residences	• Bottled water delivery: 70.7 gallons bi-weekly (three 12-packs of 700 mL sport-top bottes, five 24-packs of 500 mL bottles, nine 5-gallon bottles); 55,128 gallons total over 30 years • Biweekly delivery from Crystal Springs in Burlington, Washington to Oak Harbor, Washington 60 miles round-trip, one light duty truck (780 trips total; total mileage of 46,800 miles, shared load 0.295 tons transported) • Resource use (groundwater, total usage): 560 gallons per day; 17,030 average gallons per month; 6,132,000 gallons over 30 years • Equipment use for groundwater well: assume 4 x 1 horsepower pumps operating 6 hours/day (65,700 hours in 30 years)
1a-4 and 1b: Evergreen Mobile Home Park	1a-4: Delivery of bottled water to off-Base residences is as follows, based on current delivery information: • Bottled water delivery: 270 gallons bi-weekly (fourteen 12-packs of 700 mL sport-top bottles, twenty-nine 24-packs of 500 mL bottles, fourteen 5-gallon bottles, fifteen 3-gallon bottles, thirty-three 1-gallon bottles); 210,600 gallons total over 30 years • Biweekly delivery from Crystal Springs in Burlington, Washington to Oak Harbor, Washington 60 miles round-trip, one light duty truck (780 trips total; total mileage of 46,800 miles, shared load 1.126 tons transported per load) • Resource use (groundwater, total usage): 2,500 gallons per day; 76,040 average gallons per month; 27,375,000 gallons over 30 years • Equipment use for groundwater well: assume 1 horsepower pump operating 12 hours/day (131,400 hours in 30 years) 1b: In addition to bottle water delivery, one GAC POU undersink treatment system is used at one Evergreen Mobile Home Park unit. The assumptions for the operation and maintenance for this system is as follows: • Materials: production of off-the-shelf GAC cartridge (Culligan 01020274 TD Aqua-Cleer Total Defense Filter). Three filters (in series) are changed out approximately four times per year. Each GAC cartridge is 14.7 inches high with a diameter of 4 inches (185 cubic inches [0.1 cubic feet] of GAC per cartridge; or 555 cubic inches [0.3 cubic feet] of GAC per three-cartridge system) • Transportation of personnel: 12-week sampling events, 190 miles round-trip, one light duty truck (130 trips total) • Onsite labor hours: 16 person-hours each trip = 2,080 hours total, assume operating engineers

Table 2

Alternative 2A	GAC Treatment of Off-Base Drinking Water Wells - Assumptions
2a-1: Ault Field Residence 1	• Materials: production of GAC (virgin) – 15 cubic feet initial; 7.5 cubic feet changed out every other year x 30 years (113 cubic feet total) • Personnel Transportation: system sampled semi-annually (2x per year), 190 miles round-trip, 1 light duty truck (60 trips total), • Equipment/Materials Transport: shared load, 620 miles one-way per changeout, spent GAC to return to manufacturer, 7.5 cubic feet x 150 pounds per cubic feet = approximately 0.5 tons per trip, 18,600 miles total • Onsite labor hours: assume each trip takes 16 hours total, 60 trips, 960 hours • Disposal: regenerate GAC, transportation to regeneration facility included in equipment/materials transport as return trip • Resource use (Groundwater, total usage): 360 gallons per day; 10,950 average gallons per month; 3,942,000 gallons over 30 years • Equipment use for groundwater well: assume 1 horsepower pump operating 6 hours/day (65,700 hours over 30 years)
2a-2: Ault Field Residence 2	• Materials: production of GAC (virgin) – 15 cubic feet initial; 7.5 cubic feet x 6 changeouts per year x 30 years (1,350 cubic feet total) • Personnel Transportation: each system sampled quarterly, 190 miles round-trip, 1 light duty truck (120 trips total), • Equipment/Materials Transport: shared load, 620 miles one-way per changeout x 6 changeouts, spent GAC to return to manufacturer, 0.5 tons per trip, 223,200 miles total • Onsite labor hours: assume each trip takes 16 hours total, 120 trips, 1,920 hours • Disposal: regenerate GAC transportation to regeneration facility included in equipment/materials transport as return trip • Resource use (groundwater, total usage): 180 gallons per day; 5,475 average gallons per month; 1,971,000 gallons over 30 years • Equipment use for groundwater well: assume 1 horsepower pump operating 6 hours/day (65,700 hours in 30 years)
2a-3: Easy Street Residences	• Materials: production of GAC (virgin) – 15 cubic feet initial; 7.5 cubic feet changed out every other year x 5 units x 30 years (450 cubic feet total) • Personnel Transportation: each system sampled semi-annually (2x per year), 190 miles round-trip, 1 light duty truck (60 trips total) • Equipment/Materials Transport: shared load, 620 miles one-way per changeout, spent GAC to return to manufacturer, 2.5 tons per trip, 18,600 miles total • Onsite labor hours: assume each trip takes 16 hours total, 60 trips, 960 hours per residence group • Disposal: regenerate GAC, transportation to regeneration facility included in equipment/materials transport as return trip • Resource use (groundwater, total usage): 700 gallons per day; 21,000 average gallons per month; 7,560,000 gallons over 30 years • Equipment use for groundwater well: assume 5 x 1 horsepower pumps operating 6 hours/day (65,700 hours in 30 years)
2a-4: Evergreen Mobile Home Park	• Materials: production of GAC (virgin) – 150 cubic feet initial; 150 cubic feet per year x 30 years (4,500 cubic feet total) • Personnel Transportation: each system sampled quarterly, 190 miles round-trip, 1 light duty truck (120 trips total) • Equipment/Materials Transport: shared load, 620 miles one-way per changeout, spent GAC to return to manufacturer, 75 cubic feet x 150 pounds per cubic feet /2,000 pounds per ton = 5.6 tons per trip, 2 trips per year, 74,400 miles total • Onsite labor hours: assume each trip takes 16 hours total, 120 trips, 1,920 hours • Disposal: regenerate GAC, transportation to regeneration facility included in equipment/materials transport as return trip • Resource use (groundwater, total usage): 2,500 gallons per day; 76,040 average gallons per month; 27,375,000 gallons over 30 years • Equipment use for groundwater well: assume 1 horsepower pump operating 12 hours/day (131,400 hours in 30 years)

Table 3

Alternative 2B	Ion Exchange Treatment of Off-Base Drinking Water Wells - Assumptions
2b-1: Ault Field Residence 1	• Materials: production of single-use IX resin – 3 cubic feet initial; 1.5 cubic feet changed out every 10 months x 30 years (54 cubic feet total) • Personnel Transportation: each system sampled quarterly, 190 miles round-trip, 1 light duty truck (120 trips total) • Equipment/Materials Transport: shared load, 700 miles one-way per year, spent resin to incinerator also located approximately 700 miles away, 36 trips, 0.1 tons per trip, 50,400 miles total • Onsite labor hours: assume each trip takes 16 hours total, 120 trips, 1,920 hours • Disposal: incineration of resin, assume same sustainability footprint as "regenerated GAC" • Resource use (groundwater, total usage): 360 gallons per day; 10,950 average gallons per month; 3,942,000 gallons over 30 years • Equipment use for groundwater well: assume 1 horsepower pump operating 6 hours/day (65,700 hours over 30 years)
2b-2: Ault Field Residence 2	• Materials: production of single-use IX resin – 3 cubic feet initial, 1.5 cubic feet changed out every 2 months x 30 years (270 cubic feet total) • Personnel Transportation: each system sampled monthly, 190 miles round-trip, 1 light duty truck (360 trips total) • Equipment/Materials Transport: shared load, 700 miles one-way per year, spent resin to incinerator also located approximately 700 miles away, 180 trips, 0.1 tons per trip, 252,000 miles total • Onsite labor hours: assume each trip takes 16 hours total, 360 trips, 5,760 hours per residence group • Disposal: incineration of resin, assume same sustainability footprint as "regenerated GAC" • Resource use (groundwater, total usage): 180 gallons per day; 5,475 average gallons per month; 1,971,000 gallons over 30 years • Equipment use for groundwater well: assume 1 horsepower pump operating 6 hours/day (65,700 hours in 30 years)
2b-3: Easy Street Residences	• Materials: production of single-use IX resin – 3 cubic feet x 5 systems initial; 1.5 cubic feet changed out every 10 months x 30 years x 5 systems (285 cubic feet total) • Personnel Transportation: each system sampled quarterly, 190 miles round-trip, 1 light duty truck (120 trips total) • Equipment/Materials Transport: shared load, 700 miles one-way per year, spent resin to incinerator also located approximately 700 miles away, 36 trips, 0.5 tons per trip, 50,400 miles total • Onsite labor hours: assume each trip takes 16 hours total, 120 trips, 1,920 hours per residence group • Disposal: incineration of resin, assume same sustainability footprint as "regenerated GAC" • Resource use (groundwater, total usage): 700 gallons per day; 21,000 average gallons per month; 7,560,000 gallons over 30 years • Equipment use for groundwater well: assume 5 x 1 horsepower pumps operating 6 hours/day (65,700 hours in 30 years)
2b-4: Evergreen Mobile Home Park	• Materials: production of single-use IX resin – 34 cubic feet initial, 17 cubic feet changed out annually x 30 years (510 cubic feet total) • Personnel Transportation: each system sampled quarterly, 190 miles round-trip, 1 light duty truck (120 trips total) • Equipment/Materials Transport: shared load, 700 miles one-way per year, spent resin to incinerator also located approximately 700 miles away, 30 trips, 1 ton per trip, 42,000 miles total • Onsite labor hours: assume each trip takes 16 hours total, 120 trips, 1,920 hours per residence group • Disposal: incineration of resin, assume same sustainability footprint as "regenerated GAC" • Resource use (potable water, total usage): 2,500 gallons per day; 76,040 average gallons per month; 27,375,000 gallons over 30 years • Equipment use for groundwater well: assume 1 horsepower pump operating 12 hours/day (131,400 hours in 30 years)

Table 4

Alternative 3	Connection to Navy or Public Water Supply - Assumptions
3a: Ault Field Residence 1	• Materials: service line 6,500 linear feet of 2.5-inch HDPE pipe • Materials: asphalt for roadway repair 20,000 square feet, 6 inches thick (10,000 cubic feet) • Personnel Transportation: 33 days to install, crew of 6 people driving 30 miles roundtrip per day, 2 people per vehicle, 99 trips • Equipment transport: loader, backhoe, each weighing 15 tons transported 25 miles to area one time • Material transport: pipe 6,500 feet 2.5-inch Schedule 40 HDPE, 0.74 lbs/feet = 4,810 lbs, 2.4 tons transported 50 miles, account for empty trip • Material transport: asphalt (density 125 lbs/cubic foot) 625 tons, 20 tons per load, 31 loads trucked 30 miles (930 miles total), account for empty trips • Equipment use: trenching average 4-feet deep, 2.5-feet wide, 6,500-feet long = 65,000 cubic feet, 2,407 cubic yards by backhoe or equivalent (moved twice) • Onsite labor hours: 2,000 hours construction labor • Resource use (potable water, total usage): 360 gallons per day; 10,950 average gallons per month; 3,942,000 gallons over 30 years
3b: Ault Field Residence 2 (Base Water)	• Materials: service line 800 linear feet of 2-inch HDPE pipe • Materials: asphalt for roadway repair 3,000 square feet, 6 inches thick (1,500 cubic feet) • Personnel Transportation: 11 days to install, crew of 6 people driving 30 miles roundtrip per day, 2 people per vehicle, 33 trips • Equipment transport: loader, backhoe, each weighing 15 tons transported 25 miles to area one time • Material transport: pipe 800 feet 2-inch Schedule 40 HDPE, 0.74 lbs/feet = 592 lbs, 0.25 tons transported 50 miles, account for empty trip • Material transport: asphalt (density 125 lbs/cubic foot) 94 tons, 20 tons per load, 5 loads trucked 30 miles, account for empty trips, 150 miles total • Equipment use: trenching average 4-feet deep, 2.5-feet wide, 800-feet long = 8,000 cubic feet, 296 cubic yards by backhoe or equivalent (moved twice) • Onsite labor hours: 408 hours construction labor • Resource use (potable water, total usage): 180 gallons per day; 5,475 average gallons per month; 1,971,000 gallons over 30 years
3c: Ault Field Residence 2 (Pine Terrace Water Association)	• Materials: service line 6,000 linear feet of 2.5-inch HDPE pipe • Materials: asphalt for roadway repair 18,500 square feet, 6-inches thick (9,250 cubic feet) • Personnel Transportation: 31 days to install, crew of 6 people driving 30 miles roundtrip per day, 2 people per vehicle, 93 trips • Equipment transport: loader, backhoe, each weighing 15 tons transported 25 miles to area one time • Material transport: pipe 6,000 feet 2.5-inch schedule 40 HDPE, 0.74 lbs/feet = 4,440 lbs, 2.2 tons transported 50 miles, account for empty trip • Material transport: asphalt (density 125 lbs/cubic foot) 578 tons, 20 tons per load, 30 loads trucked 30 miles, account for empty trips, 900 miles one way • Equipment use: trenching average 4-feet deep, 2.5-feet wide, 6,000-feet long = 60,000 cubic feet, 2,222 cubic yards by backhoe or equivalent (moved twice) • Onsite labor hours: 1,900 hours construction labor • Resource use (potable water, total usage): 180 gallons per day; 5,475 average gallons per month; 1,971,000 gallons over 30 years

Table 4

Alternative 3	Connection to Navy or Public Water Supply - Assumptions
3d: Easy Street Residences	• Materials: main 1,300 linear feet of 8-inch DI pipe (21 lbs/feet = 27,300 lbs "medium impact material") • Materials: service pipe 180 feet 3/4 HDPE • Materials: asphalt for roadway repair 3,700 square feet, 6-inches thick (1,850 cubic feet) • Personnel Transportation: 13 days to install, crew of 6 people driving 30 miles roundtrip per day, 2 people per vehicle, 39 trips • Equipment transport: loader, backhoe, each weighing 15 tons transported 25 miles to area one time • Material transport: pipe 1,300 feet 8-inch DI pipe, 27,300 lbs, 13.65 tons transported 50 miles, account for empty trip, HDPE negligible • Material transport: asphalt (density 125 lbs/cubic foot) 115.6 tons, 20 tons per load, 6 loads trucked 30 miles, account for empty trips • Equipment use: trenching average 5-feet deep, 3-feet wide, 1,300 feet long = 19,500 cubic feet, 722 cubic yards by backhoe or equivalent (moved twice) • Onsite labor hours: 624 hours construction labor • Resource use (potable water, total usage): 700 gallons per day; 21,000 average gallons per month; 7,560,000 gallons over 30 years
3e: Evergreen Mobile Home Park	• Materials: main 240 linear feet of 8-inch DI pipe (21 lbs/feet = 5,040 lbs "medium impact material") • Materials: service pipe 75 feet 2-inch HDPE • Materials: asphalt for roadway repair 1,000 square feet, 6-inches thick (500 cubic feet) • Personnel Transportation: 9.5 days to install (primarily from service connections and fire-hydrants), average crew of 4 people driving 30 miles roundtrip per day, 2 people per vehicle, 20 total trips • Equipment transport: loader, backhoe, each weighing 15 tons transported 25 miles to area one time • Material transport: pipe 2.5 tons transported 50 miles, account for empty trip, HDPE negligible • Material transport: asphalt (density 125 lbs/cubic foot) 31 tons, 16 tons per load, 2 loads trucked 30 miles, account for empty trips • Equipment use: trenching average 5-feet deep, 3-feet wide, 240-feet long = 3,600 cubic feet, 133 cubic yards by backhoe or equivalent (moved twice) • Onsite labor hours: 375 hours construction labor • Resource use (potable water, total usage): 2,500 gallons per day; 76,040 average gallons per month; 27,375,000 gallons over 30 years

Table 5

Alternative 4	New (Replacement) Wells - Assumptions
4a: Ault Field Residence 1	• Conversion of existing monitoring well at Residence 1 – minimal change to existing conditions • Personnel transportation: well sampled quarterly, 190 miles round-trip, 1 light-duty truck (120 trips total) • Onsite labor hours for quarterly sampling, 30 years: 960 hours operating engineers (8-hours/trip) • Resource use (Groundwater, total usage): 360 gallons per day; 10,950 average gallons per month; 3,942,000 gallons over 30 years • Equipment use for groundwater well: assume 1 horsepower pump operating 6 hours/day (65,700 hours over 30 years)
Ault Field Residence 2	• Not applicable for Residence 2 – all aquifer zones are impacted
4b-1: Easy Street Residences	• Materials: 5 x 20 feet of 6-inch steel casing, 210-feet 6-inch Schedule 80 PVC, 20 feet of 6-inch steel screen • Well Materials from calculations sheet in SiteWise assuming 250-feet depth, 20-feet screen, 12-inch borehole: 174 kg sand, 26.5 kg bentonite, 156 kg typical cement, 696 kg general concrete x 5 wells • Personnel Transportation: 27 days to install and test, crew of 4 people driving 30 miles roundtrip per day, 2 people per vehicle • Personnel transportation: wells sampled quarterly, 190 miles round-trip, 1 light-duty truck (120 trips total) • Equipment transport: drill rig and supplies 20 tons transported 500 miles one way • Equipment transport: frac tank delivery 10 tons x 6 trips x 60 miles one way, account for empty trip (360 miles) • Equipment use: rotosonic drill rig takes 10-hours drilling time per well • Equipment use: pump test 5 horsepower gas-powered pump operating 80 hours • Onsite labor hours: 1,080-hours construction labor, 960 operating engineers • Resource use (groundwater, total usage): 7,560,000 gallons (700 gallons per day; 21,000 average gallons per month; 7,560,000 gallons over 30 years; 248,000 gallons for well installation and aquifer testing) • Equipment use for groundwater well: assume 5 x 1 horsepower pumps operating 6 hours/day (65,700 hours in 30 years) • Residuals: 5,000 gallons development water, 240,000 gallons pump test water, non-hazardous, 20 tons per 4,500-gallon tanker trip, 54 trips, 60 miles one way • Residuals: soil 3x5 ton roll-off bins transported 190 miles one-way. Non-hazardous waste. Miscellaneous solid waste negligible.

Table 5

Alternative 4	New (Replacement) Wells - Assumptions
4b-2: Evergreen Mobile Home Park	• Materials: 3 x 20 feet of 6-inch steel casing, 210 feet of 6-inch schedule 80 PVC, 20 feet of 6-inch steel screen • Well Materials from Calculations sheet in SiteWise assuming 250-feet depth, 20-feet screen, 12-inch borehole: 174 kg sand, 26.5 kg bentonite, 156 kg typical cement, 696 kg general concrete, 91 kg steel x 3 wells • Personnel Transportation: 12 days to install and test, crew of 4 people driving 30 miles roundtrip per day, 2 people per vehicle • Personnel transportation: wells sampled quarterly, 190 miles round-trip, 1 light-duty truck (120 trips total) • Equipment transport: drill rig and supplies 20 tons transported 500 miles one way • Equipment transport: frac tank delivery 10 tons x 6 trips x 60 miles one way, account for empty trip (360 miles) • Equipment use: rotosonic drill rig takes 10 hours drilling time per well • Equipment use: pump test 3 x 5 horsepower gas-powered pump operating 80 hours • Onsite labor hours: 800 hours construction labor, 960 operating engineers • Resource use (groundwater, total usage): 27,523,000 gallons (2,500 gallons per day; 76,040 average gallons per month; 27,375,000 gallons over 30 years; 148,000 gallons for well installation and aquifer testing) • Equipment use (groundwater well): 5 horsepower pump operating 6 hours per day for 30 years (65,700 hours) • Residuals: 4,000 gallons development water, 144,000 gallons pump test water (10 gpm for 80 hours x 3 tests), non-hazardous, 20 tons per 4,500-gallon tanker trip, 33 trips, 60 miles one way • Residuals: soil 2x5 ton roll-off bin transported 190 miles one-way. Non-hazardous waste. Miscellaneous solid waste negligible.

Notes:
DI = ductile iron
GAC = granular activated carbon
HDPE = high-density polyethylene
kg = kilogram(s)
lb(s) = pound(s)
IX = ion exchange
mL = milliliter(s)
POU = point-of-entry
PVC = polyvinyl chloride

Table 6. Relative Impact of Alternatives - Ault Field Residence 1

Sustainability Analysis for Residential Drinking Water

Naval Air Station Whidbey Island

Oak Harbor, Washington

Remedial Alternatives	GHG Emissions	Total Energy Used	Water Used	NO_x Emissions	SO_x Emissions	PM_{10} Emissions	Accident Risk Fatality	Accident Risk Injury
	metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Alternative 1a-1 - No Further Action	9	274	3.97E+06	8.62E-03	3.21E-03	7.42E-03	3.65E-04	2.94E-02
Alternative 2a-1 - Granular Activated Carbon (GAC) Treatment	21	405	3.97E+06	1.47E-02	7.40E-03	8.34E-03	2.71E-04	3.47E-02
Alternative 2b-1 - Ion Exchange (IX) Treatment	24	474	3.97E+06	1.81E-02	8.98E-03	8.88E-03	6.74E-04	9.01E-02
Alternative 3a - Connection to Public Water	98	1,578	3.94E+06	1.91E-01	3.40E-01	9.42E-02	2.40E-04	5.09E-02
Alternative 4a - Replacement Well	20	419	3.97E+06	1.35E-02	3.37E-03	8.14E-03	2.29E-04	3.64E-02

Relative Impact

Remedial Alternatives	GHG Emissions	Total energy Used	Water Used	NO_x emissions	SO_x Emissions	PM_{10} Emissions	Accident Risk Fatality	Accident Risk Injury
Alternative 1a-1 - No Further Action	Low	Low	High	Low	Low	Low	Medium	Medium
Alternative 2a-1 - Granular Activated Carbon (GAC) Treatment	Low	Low	High	Low	Low	Low	Medium	Medium
Alternative 2b-1 - Ion Exchange (IX) Treatment	Low	Medium	High	Low	Low	Low	High	High
Alternative 3a - Connection to Public Water	High	High	High	High	High	High	Medium	Medium
Alternative 4a - Replacement Well	Low	Low	High	Low	Low	Low	Medium	Medium

Notes:

The relative impact is a qualitative assessment of the relative footprint of each alternative, a rating of High for an alternative is assigned if it is at least 70 percent of the maximum footprint, a rating of Medium is assigned if it is between 30 and 70 percent of the maximum footprint, and a rating of Low is assigned if it is less than 30 percent of the maximum footprint.

MMBTU = million British Thermal Unit

NOx = Nitrogen Oxides

SOx = Sulfur Oxides

PM_{10} = Particulate Matter micrometers or less in diameter

GHG = Greenhouse Gases

Table 7. Sustainability Analysis Results by Activity - Residence 1

Sustainability Analysis for Residential Drinking Water

Naval Air Station Whidbey Island

Oak Harbor, Washington

Alternative	Activities	GHG Emissions		Total Energy Used		Water Used		NO_x Emissions		SO_x Emissions		PM_{10} Emissions		Accident Risk Fatality		Accident Risk Injury	
		metric ton	Percent of total	MMBTU	Percent of total	gallons	Percent of total	metric ton	Percent of total	metric ton	Percent of total	metric ton	Percent of total		Percent of total		Percent of total
Alternative 1a-1 - No Further Action	Material Production	0	0%	0	0%	NA		0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	NA		NA	
	Transportation-Personnel	0	0%	0	0%	NA		0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%
	Transportation-Equipment and Materials	1	11%	13	5%	NA		3.1E-04	4%	5.4E-06	0%	2.7E-05	0%	3.7E-04	100%	2.9E-02	100%
	Equipment Use and Miscellaneous	8	89%	261	95%	3.97E+06	100%	8.3E-03	96%	3.2E-03	100%	7.4E-03	100%	0.0E+00	0%	0.0E+00	0%
	Residual Transport and Disposal	0	0%	0	0%	NA		0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%
	Total	**9**		**274**		**3.97E+06**		**8.6E-03**		**3.2E-03**		**7.4E-03**		**3.7E-04**		**2.9E-02**	
Alternative 2a-1 - Granular Activated Carbon (GAC) Treatment	Material Production	3	16%	18	5%	NA		6.9E-06	0%	6.9E-06	0%	3.5E-07	0%	NA		NA	
	Transportation-Personnel	6	29%	79	20%	NA		2.6E-03	18%	8.2E-05	1%	3.7E-04	4%	8.9E-05	33%	7.2E-03	21%
	Transportation-Equipment and Materials	2	11%	30	7%	NA		7.2E-04	5%	1.3E-05	0%	6.4E-05	1%	1.5E-04	54%	1.2E-02	34%
	Equipment Use and Miscellaneous	8	36%	261	65%	3.97E+06	100%	8.3E-03	56%	3.2E-03	43%	7.4E-03	89%	3.7E-05	14%	1.6E-02	46%
	Residual Transport and Disposal	2	7%	16	4%	NA		3.1E-03	21%	4.1E-03	55%	5.1E-04	6%	0.0E+00	0%	0.0E+00	0%
	Total	**21**		**405**		**3.97E+06**		**1.5E-02**		**7.4E-03**		**8.3E-03**		**2.7E-04**		**3.5E-02**	
Alternative 2b-1 - Ion Exchange (IX) Treatment	Material Production	0.6	2%	22	5%	NA		1.1E-03	6%	1.5E-03	17%	4.6E-04	5%	NA		NA	
	Transportation-Personnel	12.6	53%	158	33%	NA		5.2E-03	29%	1.6E-04	2%	7.5E-04	8%	1.8E-04	26%	1.4E-02	16%
	Transportation-Equipment and Materials	1.2	5%	16	3%	NA		3.9E-04	2%	6.9E-06	0%	3.5E-05	0%	3.9E-04	58%	3.2E-02	35%
	Equipment Use and Miscellaneous	7.7	33%	261	55%	3.97E+06	100%	8.3E-03	46%	3.2E-03	36%	7.4E-03	83%	1.0E-04	15%	4.4E-02	49%
	Residual Transport and Disposal	1.5	7%	16	3%	NA		3.1E-03	17%	4.1E-03	46%	2.4E-04	3%	0.0E+00	0%	0.0E+00	0%
	Total	**23.6**		**474**		**3.97E+06**		**1.8E-02**		**9.0E-03**		**8.9E-03**		**6.7E-04**		**9.0E-02**	
Alternative 3a - Connection to Public Water	Material Production	84	85%	1469	93%	NA		1.7E-01	88%	3.3E-01	97%	6.5E-02	69%	NA		NA	
	Transportation-Personnel	2	2%	21	1%	NA		6.8E-04	0%	2.1E-05	0%	9.7E-05	0%	4.6E-05	19%	3.7E-03	7%
	Transportation-Equipment and Materials	3	4%	45	3%	NA		1.1E-03	1%	1.9E-05	0%	9.6E-05	0%	8.4E-06	4%	6.8E-04	1%
	Equipment Use and Miscellaneous	9	10%	43	3%	3.94E+06	100%	2.2E-02	11%	1.1E-02	3%	2.9E-02	31%	1.9E-04	77%	4.7E-02	91%
	Residual Transport and Disposal	0	0%	0	0%	NA		0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%
	Total	**98**		**1,578**		**3.94E+06**		**1.9E-01**		**3.4E-01**		**9.4E-02**		**2.4E-04**		**5.1E-02**	
Alternative 4a - Replacement Well	Material Production	0	0%	0	0%	NA		0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	NA		NA	
	Transportation-Personnel	13	62%	158	38%	NA		5.2E-03	39%	1.6E-04	5%	7.5E-04	9%	1.8E-04	78%	1.4E-02	39%
	Transportation-Equipment and Materials	0	0%	0	0%	NA		0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%
	Equipment Use and Miscellaneous	8	38%	261	62%	3.97E+06	100%	8.3E-03	61%	3.2E-03	95%	7.4E-03	91%	5.1E-05	22%	2.2E-02	61%
	Residual Transport and Disposal	0	0%	0	0%	NA		0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%
	Total	**20**		**419**		**3.97E+06**		**1.4E-02**		**3.4E-03**		**8.1E-03**		**2.3E-04**		**3.6E-02**	

Notes:

GHG = Greenhouse Gases

MMBTU = million British Thermal Unit

NA = Not Applicable

NOx = Nitrogen Oxides

PM_{10} = Particulate Matter 10 micrometers or less in diameter

SOx = Sulfur Oxides

Table 8. Relative Impact of Alternatives - Ault Field Residence 2

Sustainability Analysis for Residential Drinking Water

Naval Air Station Whidbey Island

Oak Harbor, Washington

Remedial Alternatives	GHG Emissions	Total energy Used	Water Used	NO_x emissions	SO_x Emissions	PM_{10} Emissions	Accident Risk Fatality	Accident Risk Injury
	metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Alternative 1a-2 - No Further Action	8	271	2.00E+06	8.54E-03	3.21E-03	7.41E-03	3.65E-04	2.94E-02
Alternative 2a-2 - Granular Activated Carbon (GAC) Treatment	107	1,187	2.00E+06	5.89E-02	5.26E-02	1.50E-02	2.02E-03	1.99E-01
Alternative 2b-2 - Ion Exchange (IX) Treatment	62	1,008	2.00E+06	4.70E-02	3.18E-02	1.33E-02	2.81E-03	3.34E-01
Alternative 3c - Connection to Public Water	87	1,448	1.97E+06	1.70E-01	3.11E-01	7.53E-02	2.29E-04	4.86E-02
Alternative 3b - Connection to Base Water	18	245	1.97E+06	3.44E-02	5.39E-02	2.41E-02	5.58E-05	1.10E-02

Relative Impact

Remedial Alternatives	GHG Emissions	Total energy Used	Water Used	NO_x emissions	SO_x Emissions	PM_{10} Emissions	Accident Risk Fatality	Accident Risk Injury
Alternative 1a-2 - No Further Action	Low	Low	High	Low	Low	Low	Low	Low
Alternative 2a-2 - Granular Activated Carbon (GAC) Treatment	High	High	High	Medium	Low	Low	High	Medium
Alternative 2b-2 - Ion Exchange (IX) Treatment	Medium	Medium	High	Low	Low	Low	High	High
Alternative 3c - Connection to Public Water	High	High	High	High	High	High	Low	Low
Alternative 3b - Connection to Base Water	Low	Low	High	Low	Low	Medium	Low	Low

Notes:

The relative impact is a qualitative assessment of the relative footprint of each alternative, a rating of High for an alternative is assigned if it is at least 70 percent of the maximum footprint, a rating of Medium is assigned if it is between 30 and 70 percent of the maximum footprint, and a rating of Low is assigned if it is less than 30 percent of the maximum footprint.

MMBTU = million British Thermal Unit

NOx = Nitrogen Oxides

SOx = Sulfur Oxides

PM_{10} = Particulate Matter micrometers or less in diameter

GHG = Greenhouse Gases

NA = Not applicable

Table 9. Sustainability Analysis Results by Activity - Residence 2

Sustainability Analysis for Residential Drinking Water

Naval Air Station Whidbey Island

Oak Harbor, Washington

Alternative	Activities	GHG Emissions		Total Energy Used		Water Used		NO_x Emissions		SO_x Emissions		PM_{10} Emissions		Accident Risk Fatality		Accident Risk Injury	
		metric ton	Percent of total	MMBTU	Percent of total	gallons	Percent of total	metric ton	Percent of total	metric ton	Percent of total	metric ton	Percent of total		Percent of total		Percent of total
Alternative 1a-2 - No Further Action	Material Production	0	0%	0	0%	NA		0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	NA		NA	
	Transportation-Personnel	0	0%	0	0%	NA		0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%
	Transportation-Equipment and Materials	1	9%	10	4%	NA		2.3E-04	3%	4.1E-06	0%	2.1E-05	0%	3.7E-04	100%	2.9E-02	100%
	Equipment Use and Miscellaneous	8	91%	261	96%	2.00E+06	100%	8.3E-03	97%	3.2E-03	100%	7.4E-03	100%	0.0E+00	0%	0.0E+00	0%
	Residual Transport and Disposal	0	0%	0	0%	NA		0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%
	Total	**8**		**271**		**2.00E+06**		**8.5E-03**		**3.2E-03**		**7.4E-03**		**3.7E-04**		**2.9E-02**	
Alternative 2a-2 - Granular Activated Carbon (GAC) Treatment	Material Production	41	38%	216	18%	NA		8.1E-05	0%	8.1E-05	0%	4.2E-06	0%	NA		NA	
	Transportation-Personnel	13	12%	158	13%	NA		5.2E-03	9%	1.6E-04	0%	7.5E-04	5%	1.8E-04	9%	1.4E-02	7%
	Transportation-Equipment and Materials	27	25%	357	30%	NA		8.6E-03	15%	1.5E-04	0%	7.6E-04	5%	1.7E-03	86%	1.4E-01	71%
	Equipment Use and Miscellaneous	8	7%	261	22%	2.00E+06	100%	8.3E-03	14%	3.2E-03	6%	7.4E-03	49%	1.0E-04	5%	4.4E-02	22%
	Residual Transport and Disposal	18	17%	194	16%	NA		3.7E-02	62%	4.9E-02	93%	6.1E-03	41%	0.0E+00	0%	0.0E+00	0%
	Total	**107**		**1,187**		**2.00E+06**		**5.9E-02**		**5.3E-02**		**1.5E-02**		**2.0E-03**		**2.0E-01**	
Alternative 2b-2 - Ion Exchange (IX) Treatment	Material Production	6.8	11%	152	15%	NA		1.4E-02	29%	1.8E-02	57%	2.3E-03	17%	NA		NA	
	Transportation-Personnel	37.7	61%	475	47%	NA		1.6E-02	33%	4.9E-04	2%	2.2E-03	17%	5.3E-04	19%	4.3E-02	13%
	Transportation-Equipment and Materials	6.2	10%	81	8%	NA		1.9E-03	4%	3.4E-05	0%	1.7E-04	1%	2.0E-03	70%	1.6E-01	47%
	Equipment Use and Miscellaneous	7.7	12%	261	26%	2.00E+06	100%	8.3E-03	18%	3.2E-03	10%	7.4E-03	56%	3.1E-04	11%	1.3E-01	40%
	Residual Transport and Disposal	3.7	6%	39	4%	NA		7.3E-03	16%	9.8E-03	31%	1.2E-03	9%	0.0E+00	0%	0.0E+00	0%
	Total	**62.1**		**1,008**		**2.00E+06**		**4.7E-02**		**3.2E-02**		**1.3E-02**		**2.8E-03**		**3.3E-01**	
Alternative 3c - Connection to Public Water	Material Production	77	89%	1359	94%	NA		1.5E-01	91%	3.0E-01	98%	6.0E-02	80%	NA		NA	
	Transportation-Personnel	2	2%	19	1%	NA		6.4E-04	0%	2.0E-05	0%	9.1E-05	0%	4.4E-05	19%	3.5E-03	7%
	Transportation-Equipment and Materials	3	4%	44	3%	NA		1.0E-03	1%	1.9E-05	0%	9.3E-05	0%	8.2E-06	4%	6.6E-04	1%
	Equipment Use and Miscellaneous	5	6%	26	2%	1.97E+06	100%	1.3E-02	8%	6.3E-03	2%	1.5E-02	20%	1.8E-04	77%	4.4E-02	91%
	Residual Transport and Disposal	0	0%	0	0%	NA		0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%
	Total	**87**		**1,448**		**1.97E+06**		**1.7E-01**		**3.1E-01**		**7.5E-02**		**2.3E-04**		**4.9E-02**	
Alternative 3b - Connection to Base Water	Material Production	12	67%	208	85%	NA		2.4E-02	71%	4.8E-02	90%	9.6E-03	40%	NA		NA	
	Transportation-Personnel	1	3%	7	3%	NA		2.3E-04	1%	7.1E-06	0%	3.2E-05	0%	1.5E-05	28%	1.2E-03	11%
	Transportation-Equipment and Materials	1	5%	11	4%	NA		2.6E-04	1%	4.6E-06	0%	2.3E-05	0%	2.3E-06	4%	1.9E-04	2%
	Equipment Use and Miscellaneous	5	25%	20	8%	1.97E+06	100%	9.4E-03	27%	5.4E-03	10%	1.4E-02	60%	3.8E-05	68%	9.6E-03	87%
	Residual Transport and Disposal	0	0%	0	0%	NA		0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%
	Total	**18**		**245**		**1.97E+06**		**3.4E-02**		**5.4E-02**		**2.4E-02**		**5.6E-05**		**1.1E-02**	

Notes:

GHG = Greenhouse Gases

MMBTU = million British Thermal Unit

PM_{10} = Particulate Matter 10 micrometers or less in diameter

NA = Not Applicable

NOx = Nitrogen Oxides

SOx = Sulfur Oxides

Table 10. Relative Impact of Alternatives - Easy Street Residences

Sustainability Analysis for Residential Drinking Water

Naval Air Station Whidbey Island

Oak Harbor, Washington

Remedial Alternatives	GHG Emissions	Total energy Used	Water Used	NO_x emissions	SO_x Emissions	PM_{10} Emissions	Accident Risk Fatality	Accident Risk Injury
	metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Alternative 1a-3 - No Further Action	34	1,088	6.23E+06	3.43E-02	1.28E-02	2.97E-02	3.65E-04	2.94E-02
Alternative 2a-3 - Granular Activated Carbon (GAC) Treatment	82	1,588	7.68E+06	6.35E-02	3.72E-02	4.03E-02	2.85E-04	4.09E-02
Alternative 2b-3 - Ion Exchange (IX) Treatment	69	1,745	7.68E+06	7.09E-02	4.58E-02	4.16E-02	6.74E-04	9.01E-02
Alternative 3d - Connection to Public Water	46	691	7.56E+06	1.02E-01	1.41E-01	7.94E-02	8.06E-05	1.65E-02
Alternative 4b-1 - Replacement Wells	114	5477	7.69E+06	1.40E-01	9.83E-02	5.41E-02	2.77E-04	2.31E-02

Relative Impact

Remedial Alternatives	GHG Emissions	Total energy Used	Water Used	NO_x emissions	SO_x Emissions	PM_{10} Emissions	Accident Risk Fatality	Accident Risk Injury
Alternative 1a-3 - No Further Action	Medium	Low	High	Low	Low	Medium	Medium	Medium
Alternative 2a-3 - Granular Activated Carbon (GAC) Treatment	High	Low	High	Medium	Low	Medium	Medium	Medium
Alternative 2b-3 - Ion Exchange (IX) Treatment	Medium	Medium	High	Medium	Medium	Medium	High	High
Alternative 3d - Connection to Public Water	Medium	Low	High	High	High	High	Low	Low
Alternative 4b-1 - Replacement Wells	High	High	High	High	Medium	Medium	Medium	Low

Notes:

The relative impact is a qualitative assessment of the relative footprint of each alternative, a rating of High for an alternative is assigned if it is at least 70 percent of the maximum footprint, a rating of Medium is assigned if it is between 30 and 70 percent of the maximum footprint, and a rating of Low is assigned if it is less than 30 percent of the maximum footprint.

MMBTU = million British Thermal Unit

NOx = Nitrogen Oxides

SOx = Sulfur Oxides

PM_{10} = Particulate Matter 10 micrometers or less in diameter

GHG = Greenhouse Gases

NA = Not applicable

Table 11. Sustainability Analysis Results by Activity - Easy Street Residences

Sustainability Analysis for Residential Drinking Water

Naval Air Station Whidbey Island

Oak Harbor, Washington

Alternative	Activities	GHG Emissions		Total Energy Used		Water Used		NO_x Emissions		SO_x Emissions		PM_{10} Emissions		Accident Risk Fatality		Accident Risk Injury	
		metric ton	Percent of total	MMBTU	Percent of total	gallons	Percent of total	metric ton	Percent of total	metric ton	Percent of total	metric ton	Percent of total		Percent of total		Percent of total
Alternative 1a-3 - No Further Action	Material Production	0	0%	0	0%	NA		0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	NA		NA	
	Transportation-Personnel	0	0%	0	0%	NA		0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%
	Transportation-Equipment and Materials	3	10%	44	4%	NA		1.1E-03	3%	1.9E-05	0%	9.5E-05	0%	3.7E-04	100%	2.9E-02	100%
	Equipment Use and Miscellaneous	31	90%	1044	96%	6.23E+06	100%	3.3E-02	97%	1.3E-02	100%	3.0E-02	100%	0.0E+00	0%	0.0E+00	0%
	Residual Transport and Disposal	0	0%	0	0%	NA		0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%
	Total	**34**		**1,088**		**6.23E+06**		**3.4E-02**		**1.3E-02**		**3.0E-02**		**3.7E-04**		**2.9E-02**	
Alternative 2a-3 - Granular Activated Carbon (GAC) Treatment	Material Production	18	22%	54	3%	NA		3.5E-05	0%	3.6E-05	0%	1.7E-06	0%	NA		NA	
	Transportation-Personnel	6	8%	79	5%	NA		2.6E-03	4%	8.2E-05	0%	3.7E-04	1%	8.9E-05	31%	7.2E-03	17%
	Transportation-Equipment and Materials	11	14%	149	9%	NA		3.6E-03	6%	6.3E-05	0%	3.2E-04	1%	1.5E-04	51%	1.2E-02	29%
	Equipment Use and Miscellaneous	39	47%	1305	82%	7.68E+06	100%	4.2E-02	65%	1.6E-02	43%	3.7E-02	92%	5.1E-05	18%	2.2E-02	54%
	Residual Transport and Disposal	8	10%	0	0%	NA		1.6E-02	25%	2.1E-02	56%	2.6E-03	7%	0.0E+00	0%	0.0E+00	0%
	Total	**82**		**1,588**		**7.68E+06**		**6.4E-02**		**3.7E-02**		**4.0E-02**		**2.9E-04**		**4.1E-02**	
Alternative 2b-3 - Ion Exchange (IX) Treatment	Material Production	7.2	11%	160	9%	NA		1.4E-02	20%	1.9E-02	42%	2.4E-03	6%	NA		NA	
	Transportation-Personnel	12.6	18%	158	9%	NA		5.2E-03	7%	1.6E-04	0%	7.5E-04	2%	1.8E-04	26%	1.4E-02	16%
	Transportation-Equipment and Materials	6.2	9%	81	5%	NA		1.9E-03	3%	3.4E-05	0%	1.7E-04	0%	3.9E-04	58%	3.2E-02	35%
	Equipment Use and Miscellaneous	38.7	56%	1305	75%	7.68E+06	100%	4.2E-02	59%	1.6E-02	35%	3.7E-02	89%	1.0E-04	15%	4.4E-02	49%
	Residual Transport and Disposal	3.9	6%	41	2%	NA		7.8E-03	11%	1.0E-02	23%	1.3E-03	3%	0.0E+00	0%	0.0E+00	0%
	Total	**68.5**		**1,745**		**7.68E+06**		**7.1E-02**		**4.6E-02**		**4.2E-02**		**6.7E-04**		**9.0E-02**	
Alternative 3d - Connection to Public Water	Material Production	27	58%	592	86%	NA		6.7E-02	65%	1.2E-01	85%	2.4E-02	30%	NA		NA	
	Transportation-Personnel	1	1%	8	1%	NA		2.7E-04	0%	8.4E-06	0%	3.8E-05	0%	1.8E-05	23%	1.5E-03	9%
	Transportation-Equipment and Materials	1	3%	17	3%	NA		4.2E-04	0%	7.4E-06	0%	3.7E-05	0%	3.5E-06	4%	2.8E-04	2%
	Equipment Use and Miscellaneous	17	37%	73	11%	7.56E+06	100%	3.5E-02	34%	2.1E-02	15%	5.5E-02	70%	5.9E-05	73%	1.5E-02	89%
	Residual Transport and Disposal	0	0%	0	0%	NA		0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%
	Total	**46**		**691**		**7.56E+06**		**1.0E-01**		**1.4E-01**		**7.9E-02**		**8.1E-05**		**1.7E-02**	
Alternative 4b-1 - Replacement Wells	Material Production	43	37%	3,758	69%	NA		5.3E-02	38%	7.6E-02	77%	1.0E-02	18%	NA		NA	
	Transportation-Personnel	13	12%	170	3%	NA		5.6E-03	4%	1.8E-04	0%	8.0E-04	1%	2.0E-04	73%	1.6E-02	71%
	Transportation-Equipment and Materials	2	2%	27	0%	NA		6.5E-04	0%	1.1E-05	0%	5.8E-05	0%	6.7E-06	2%	5.4E-04	2%
	Equipment Use and Miscellaneous	42	37%	1,349	25%	7.69E+06	100%	7.6E-02	54%	2.2E-02	22%	4.0E-02	74%	4.6E-06	2%	1.2E-03	5%
	Residual Transport and Disposal	13	12%	173	3%	NA		5.1E-03	4%	5.8E-04	1%	3.1E-03	6%	6.2E-05	23%	5.0E-03	22%
	Total	**114**		**5,477**		**7.69E+06**		**1.4E-01**		**9.8E-02**		**5.4E-02**		**2.8E-04**		**2.3E-02**	

Notes:

GHG = Greenhouse Gases

MMBTU = million British Thermal Unit

NOx = Nitrogen Oxides

NA = Not Applicable

PM_{10} = Particulate Matter 10 micrometers or less in diameter

SOx = Sulfur Oxides

Table 12. Relative Impact of Alternatives - Evergreen Mobile Home Park

Sustainability Analysis for Residential Drinking Water

Naval Air Station Whidbey Island

Oak Harbor, Washington

Remedial Alternatives	GHG Emissions	Total energy Used	Water Used	NO_x emissions	SO_x Emissions	PM_{10} Emissions	Accident Risk Fatality	Accident Risk Injury
	metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Alternative 1b - No Further Action	39	815	2.74E+07	2.42E-02	6.60E-03	1.59E-02	6.69E-04	9.27E-02
Alternative 2a-4 - Granular Activated Carbon (GAC) Treatment	329	3,389	2.74E+07	1.77E-01	1.71E-01	3.88E-02	8.61E-04	1.05E-01
Alternative 2b-4 - Ion Exchange (IX) Treatment	58	1,175	2.74E+07	6.48E-02	5.96E-02	2.24E-02	6.08E-04	8.48E-02
Alternative 3e - Connection to Public Water	69	394	2.74E+07	1.36E-01	1.01E-01	2.04E-01	4.56E-05	9.59E-03
Alternative 4b-2 - Replacement Well	56	1628	2.75E+07	7.31E-02	5.19E-02	2.28E-02	2.32E-04	1.92E-02

Relative Impact

Remedial Alternatives	GHG Emissions	Total energy Used	Water Used	NO_x emissions	SO_x Emissions	PM_{10} Emissions	Accident Risk Fatality	Accident Risk Injury
Alternative 1b - No Further Action	Low	Low	High	Low	Low	Low	High	High
Alternative 2a-4 - Granular Activated Carbon (GAC) Treatment	High	High	High	High	High	Low	High	High
Alternative 2b-4 - Ion Exchange (IX) Treatment	Low	Medium	High	Medium	Medium	Low	High	High
Alternative 3e - Connection to Public Water	Low	Low	High	High	Medium	High	Low	Low
Alternative 4b-2 - Replacement Well	Low	Medium	High	Medium	Medium	Low	Low	Low

Notes:

The relative impact is a qualitative assessment of the relative footprint of each alternative, a rating of High for an alternative is assigned if it is at least 70 percent of the maximum footprint, a rating of Medium is assigned if it is between 30 and 70 percent of the maximum footprint, and a rating of Low is assigned if it is less than 30 percent of the maximum footprint.

MMBTU = million British Thermal Unit

NOx = Nitrogen Oxides

SOx = Sulfur Oxides

PM_{10} = Particulate Matter 10 micrometers or less in diameter

GHG = Greenhouse Gases

NA = Not applicable

Table 13. Sustainability Analysis Results by Activity - Evergreen Mobile Home Park

Sustainability Analysis for Residential Drinking Water

Naval Air Station Whidbey Island

Oak Harbor, Washington

Alternative	Activities	GHG Emissions		Total Energy Used		Water Used		NO_x Emissions		SO_x Emissions		PM_{10} Emissions		Accident Risk Fatality		Accident Risk Injury	
		metric ton	Percent of total	MMBTU	Percent of total	gallons	Percent of total	metric ton	Percent of total	metric ton	Percent of total	metric ton	Percent of total		Percent of total		Percent of total
Alternative 1b - No Further Action	Material Production	1	3%	6	1%	NA		2.2E-06	0%	2.2E-06	0%	1.1E-07	0%	NA		NA	
	Transportation-Personnel	9	24%	118	15%	NA		3.5E-03	14%	1.2E-04	2%	7.1E-04	4%	1.9E-04	29%	1.6E-02	17%
	Transportation-Equipment and Materials	13	33%	169	21%	NA		4.1E-03	17%	7.2E-05	1%	3.6E-04	2%	3.7E-04	55%	2.9E-02	32%
	Equipment Use and Miscellaneous	15	40%	522	64%	2.74E+07	100%	1.7E-02	69%	6.4E-03	97%	1.5E-02	93%	1.1E-04	17%	4.8E-02	52%
	Residual Transport and Disposal	0	0%	0	0%	NA		0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%
	Total	**39**		**815**		**2.74E+07**		**2.4E-02**		**6.6E-03**		**1.6E-02**		**6.7E-04**		**9.3E-02**	
Alternative 2a-4 - Granular Activated Carbon (GAC) Treatment	Material Production	138	42%	729	21%	NA		2.7E-04	0%	2.7E-04	0%	1.1E-05	0%	NA		NA	
	Transportation-Personnel	13	4%	158	5%	NA		5.2E-03	3%	1.6E-04	0%	7.5E-04	2%	1.8E-04	21%	1.4E-02	14%
	Transportation-Equipment and Materials	102	31%	1333	39%	NA		3.2E-02	18%	5.7E-04	0%	2.9E-03	7%	5.8E-04	67%	4.7E-02	44%
	Equipment Use and Miscellaneous	15	5%	522	15%	2.74E+07	100%	1.7E-02	9%	6.4E-03	4%	1.5E-02	38%	1.0E-04	12%	4.4E-02	42%
	Residual Transport and Disposal	61	19%	647	19%	NA		1.2E-01	69%	1.6E-01	96%	2.0E-02	53%	0.0E+00	0%	0.0E+00	0%
	Total	**329**		**3,389**		**2.74E+07**		**1.8E-01**		**1.7E-01**		**3.9E-02**		**8.6E-04**		**1.1E-01**	
Alternative 2b-4 - Ion Exchange (IX) Treatment	Material Production	12.9	22%	286	24%	NA		2.6E-02	40%	3.4E-02	58%	4.3E-03	19%	NA		NA	
	Transportation-Personnel	12.6	22%	158	13%	NA		5.2E-03	8%	1.6E-04	0%	7.5E-04	3%	1.8E-04	29%	1.4E-02	17%
	Transportation-Equipment and Materials	10.3	18%	134	11%	NA		3.2E-03	5%	5.7E-05	0%	2.9E-04	1%	3.3E-04	54%	2.6E-02	31%
	Equipment Use and Miscellaneous	15.5	27%	522	44%	2.74E+07	100%	1.7E-02	26%	6.4E-03	11%	1.5E-02	66%	1.0E-04	17%	4.4E-02	52%
	Residual Transport and Disposal	6.9	12%	73	6%	NA		1.4E-02	21%	1.8E-02	31%	2.3E-03	10%	0.0E+00	0%	0.0E+00	0%
	Total	**58.2**		**1,175**		**2.74E+07**		**6.5E-02**		**6.0E-02**		**2.2E-02**		**6.1E-04**		**8.5E-02**	
Alternative 3e - Connection to Public Water	Material Production	6	9%	131	33%	NA		1.5E-02	11%	2.7E-02	27%	5.5E-03	3%	NA		NA	
	Transportation-Personnel	0	0%	4	1%	NA		1.4E-04	0%	4.3E-06	0%	2.0E-05	0%	9.4E-06	21%	7.5E-04	8%
	Transportation-Equipment and Materials	1	1%	7	2%	NA		1.6E-04	0%	2.9E-06	0%	1.4E-05	0%	1.6E-06	4%	1.3E-04	1%
	Equipment Use and Miscellaneous	62	90%	252	64%	2.74E+07	100%	1.2E-01	89%	7.3E-02	73%	2.0E-01	97%	3.5E-05	76%	8.7E-03	91%
	Residual Transport and Disposal	0	0%	0	0%	NA		0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%	0.0E+00	0%
	Total	**69**		**394**		**2.74E+07**		**1.4E-01**		**1.0E-01**		**2.0E-01**		**4.6E-05**		**9.6E-03**	
Alternative 4b-2 - Replacement Well	Material Production	18	33%	876	54%	NA		3.0E-02	41%	4.3E-02	82%	5.6E-03	25%	NA		NA	
	Transportation-Personnel	13	23%	163	10%	NA		5.4E-03	7%	1.7E-04	0%	7.7E-04	3%	1.9E-04	81%	1.5E-02	79%
	Transportation-Equipment and Materials	2	4%	27	2%	NA		6.5E-04	1%	1.1E-05	0%	5.8E-05	0%	6.7E-06	3%	5.4E-04	3%
	Equipment Use and Miscellaneous	15	27%	465	29%	2.75E+07	100%	3.4E-02	47%	8.8E-03	17%	1.4E-02	63%	2.7E-06	1%	6.9E-04	4%
	Residual Transport and Disposal	7	13%	96	6%	NA		2.9E-03	4%	3.8E-04	1%	2.0E-03	9%	3.4E-05	15%	2.7E-03	14%
	Total	**56**		**1,628**		**2.75E+07**		**7.3E-02**		**5.2E-02**		**2.3E-02**		**2.3E-04**		**1.9E-02**	

Notes:

GHG = Greenhouse Gases

MMBTU = million British Thermal Unit

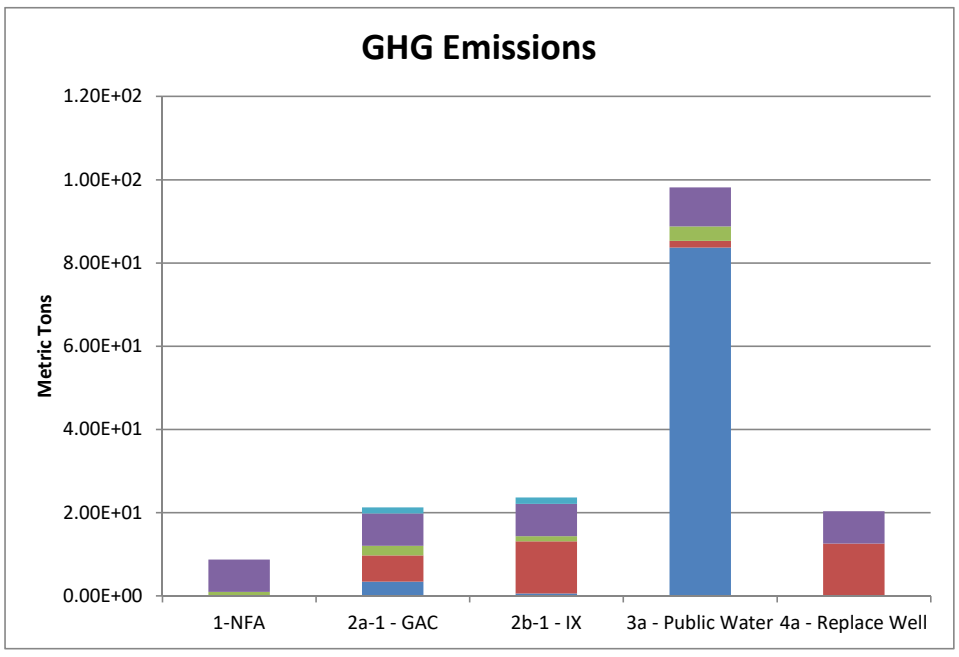
NOx = Nitrogen Oxides

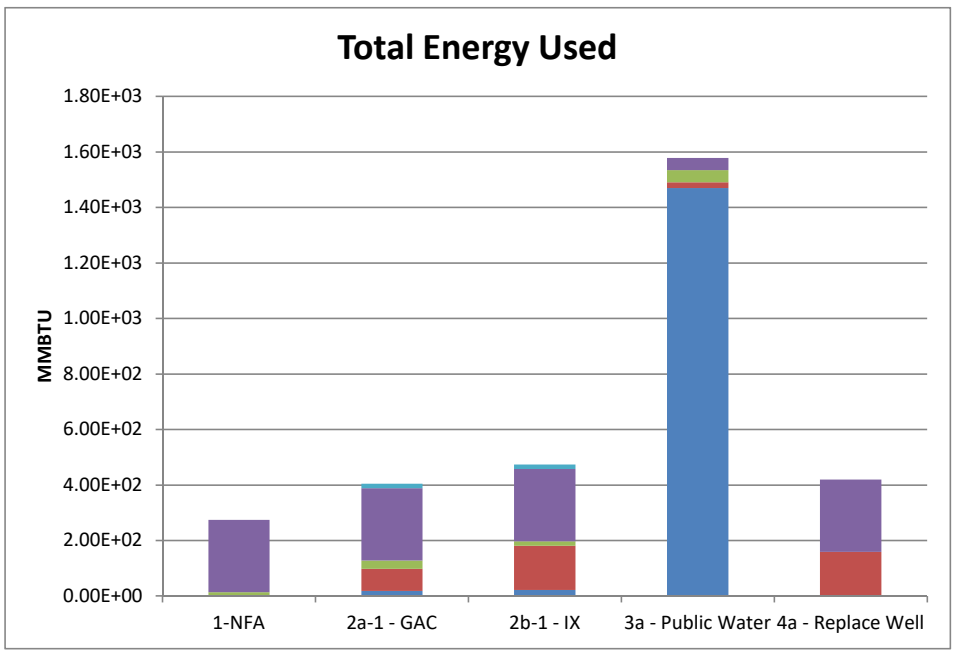
NA = Not Applicable

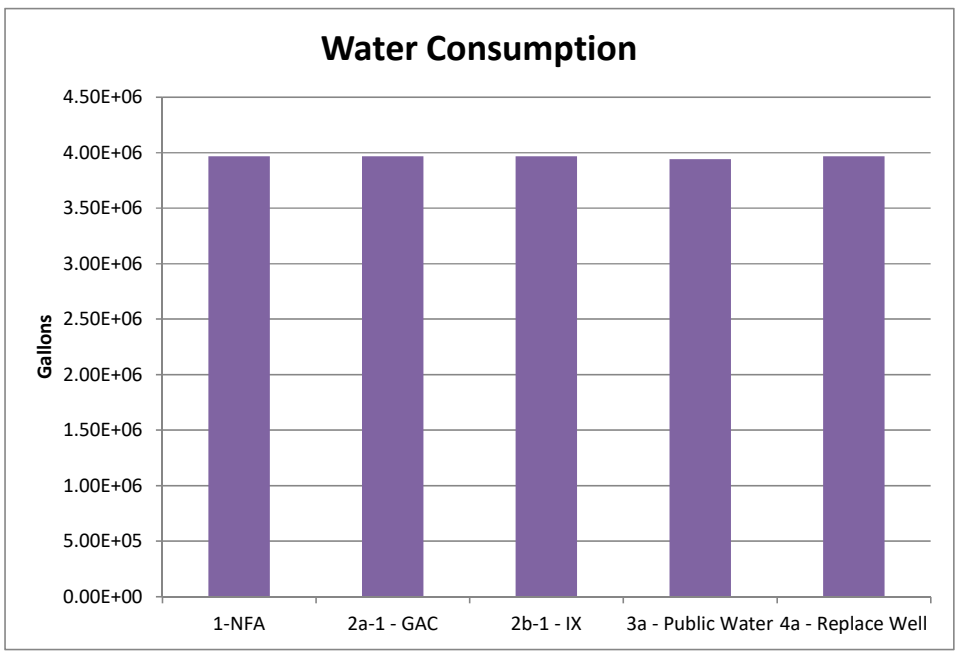
PM_{10} = Particulate Matter 10 micrometers or less in diameter

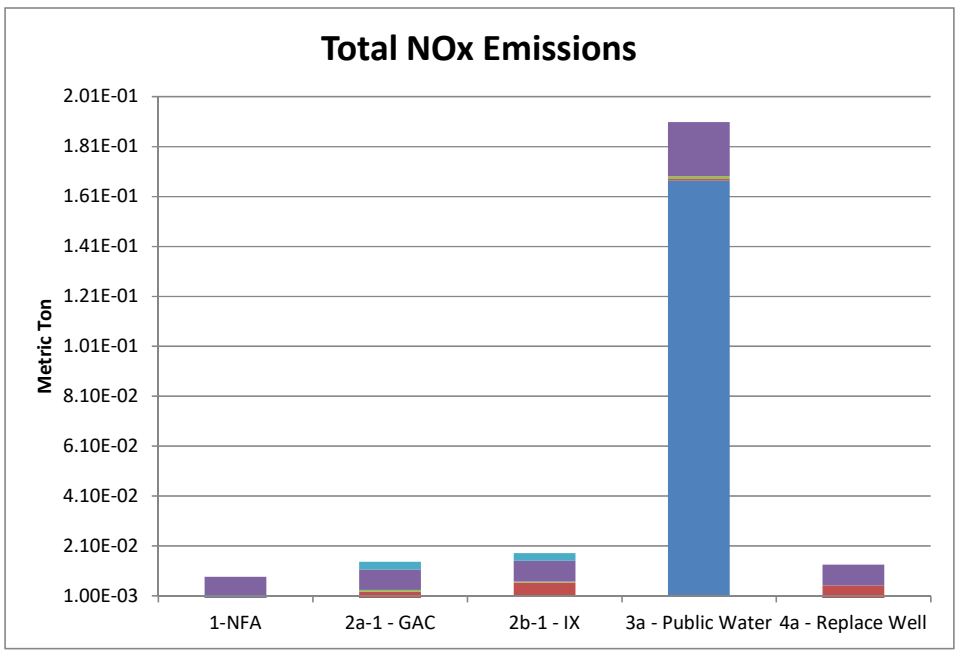
SOx = Sulfur Oxides

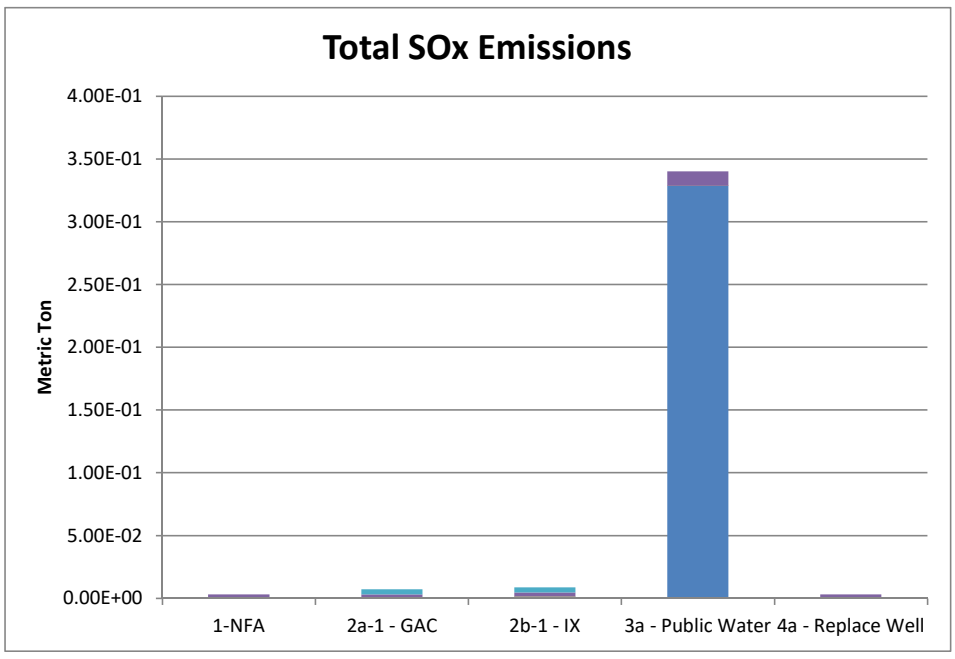
Figures

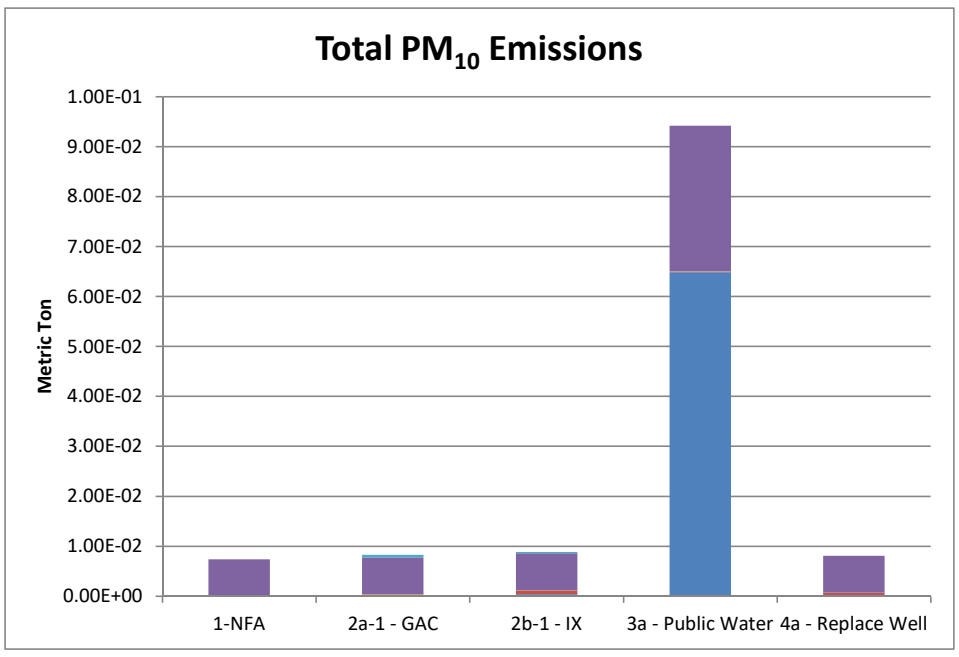


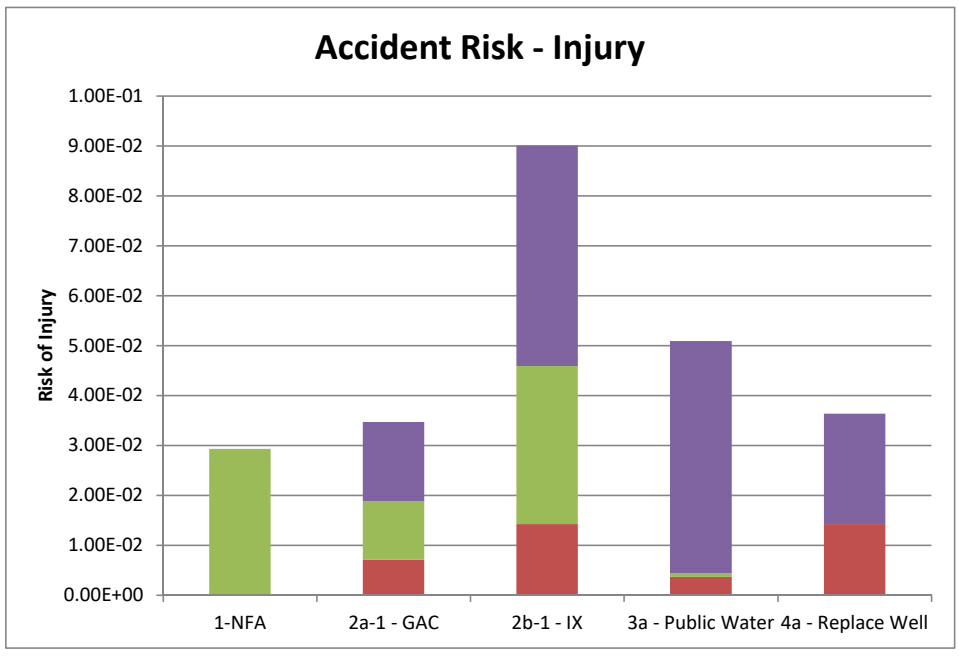


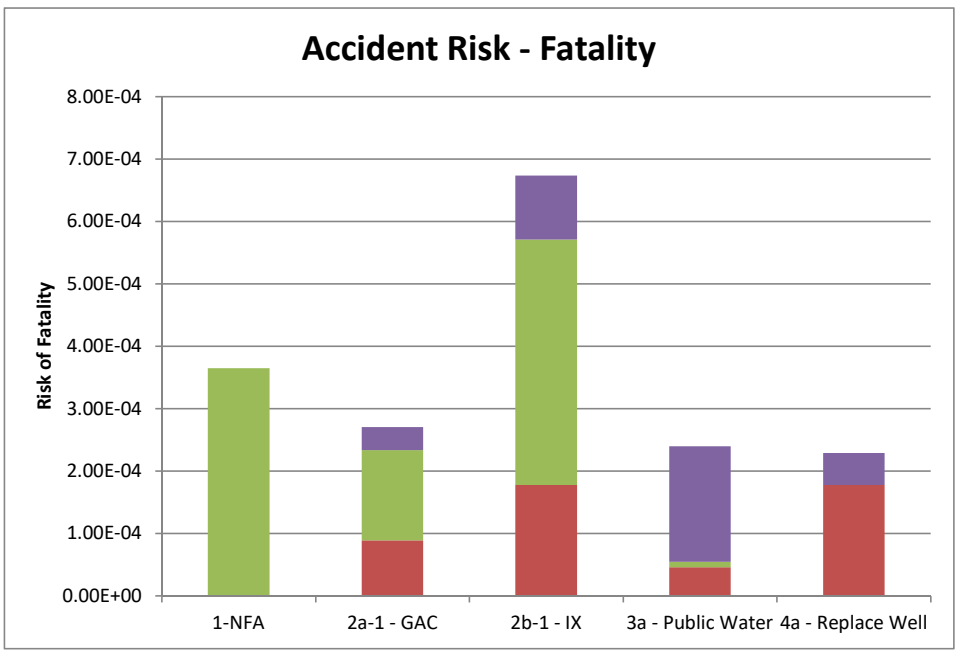






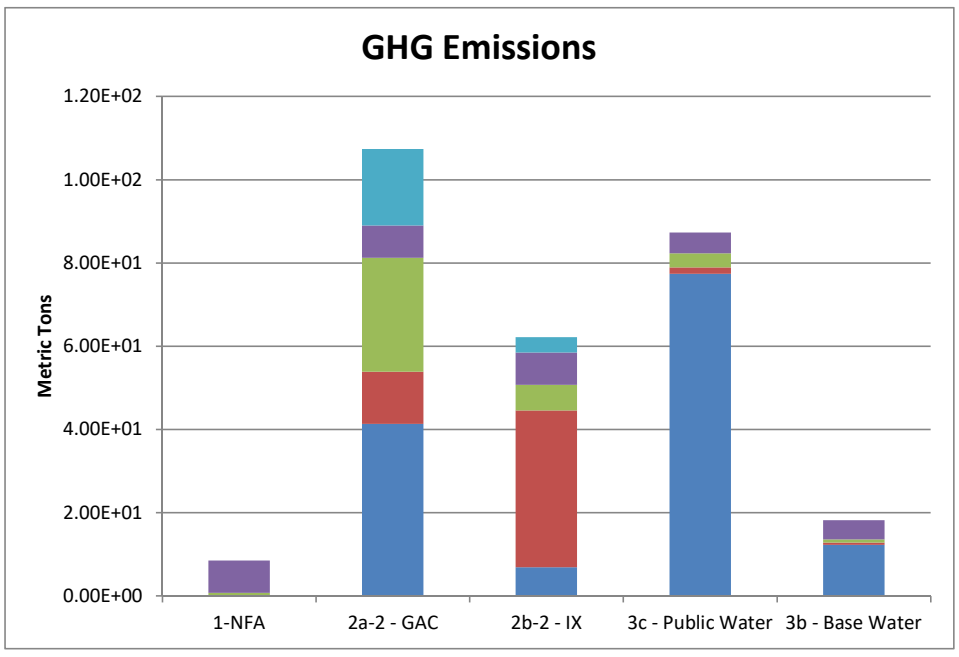


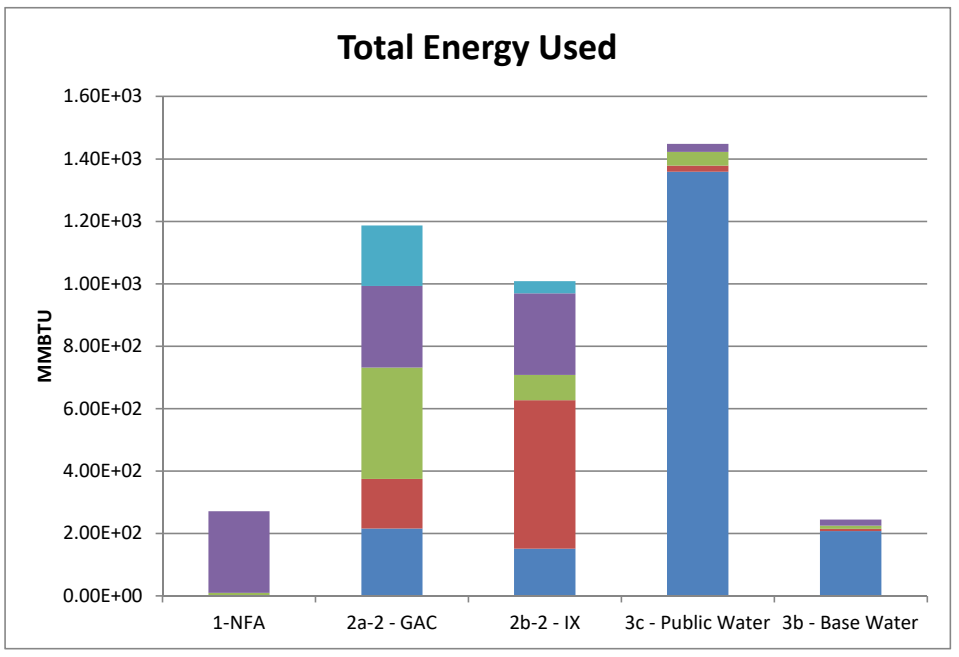


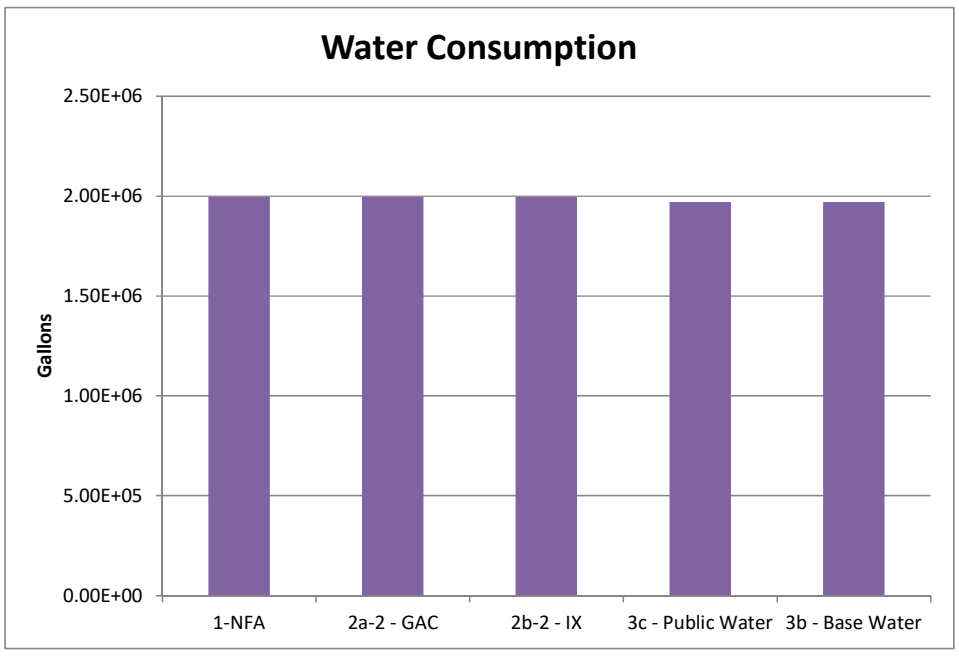


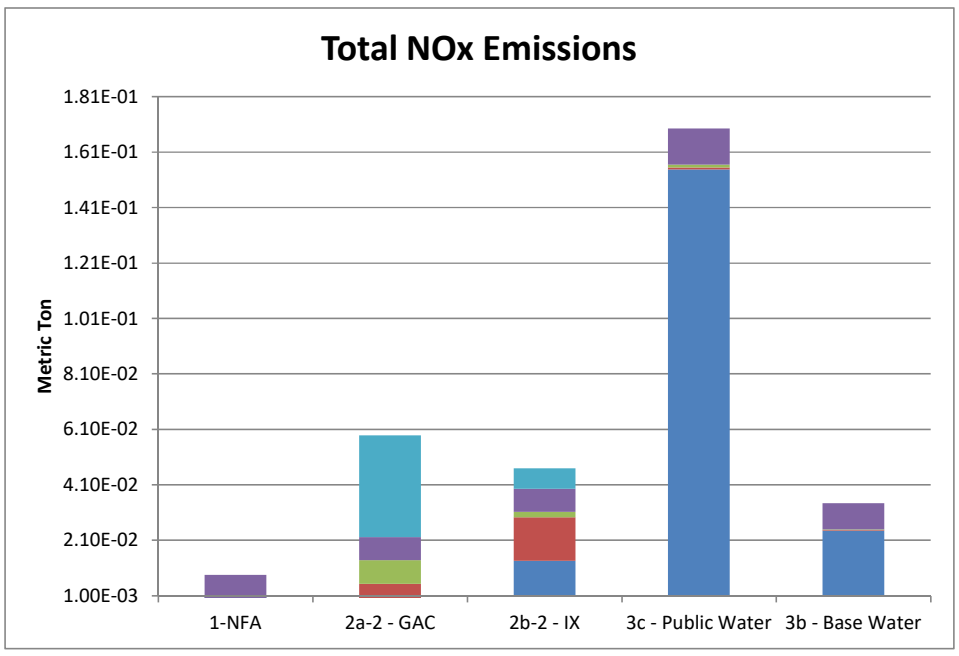
Residual Handling
Equipment Use and Miscellaneous
Transportation-Equipment
Transportation-Personnel
Material Production

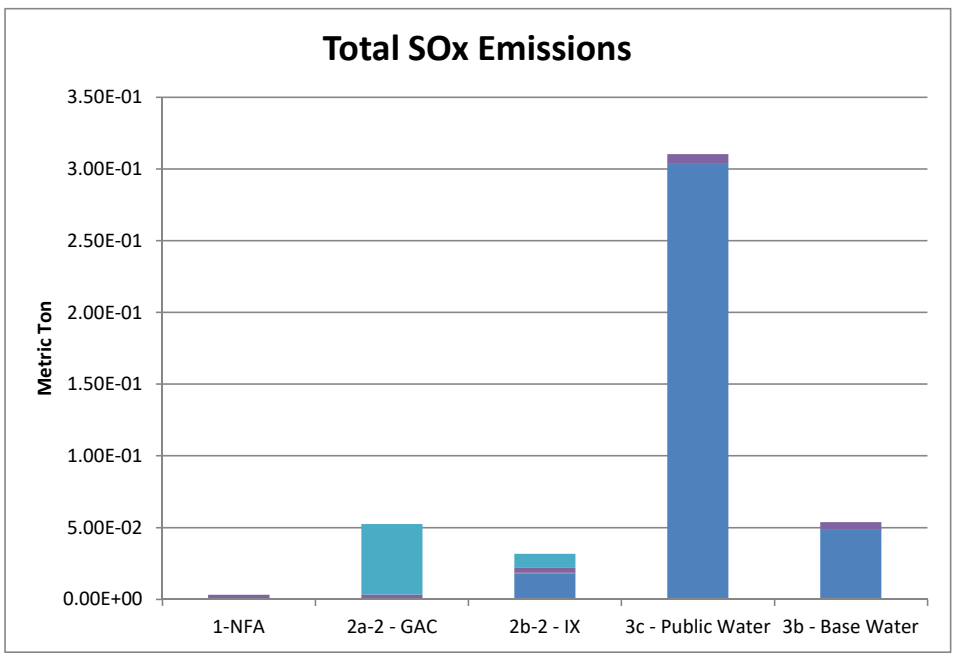
FIGURE 1
Sustainability Analysis Results - Residence 1
Sustainability Analysis for Residential Drinking Water
Naval Air Station Whidbey Island
Oak Harbor, Washington

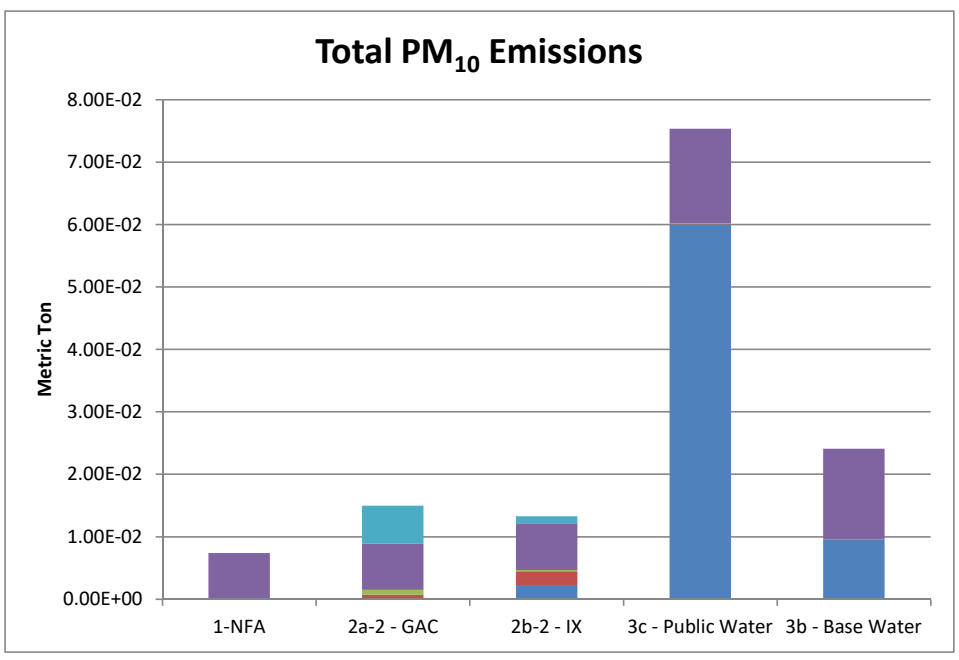


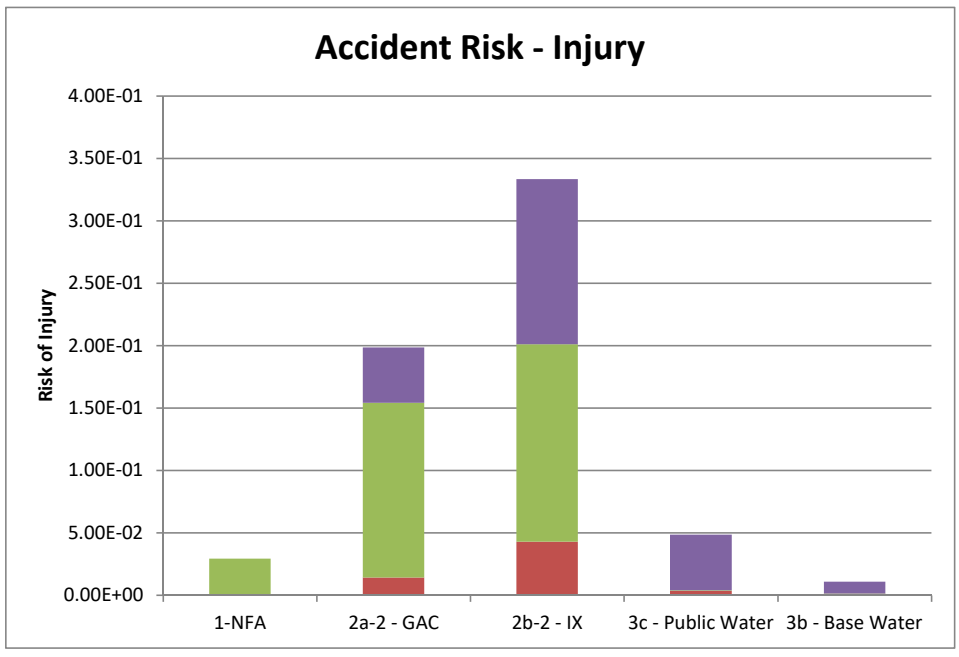


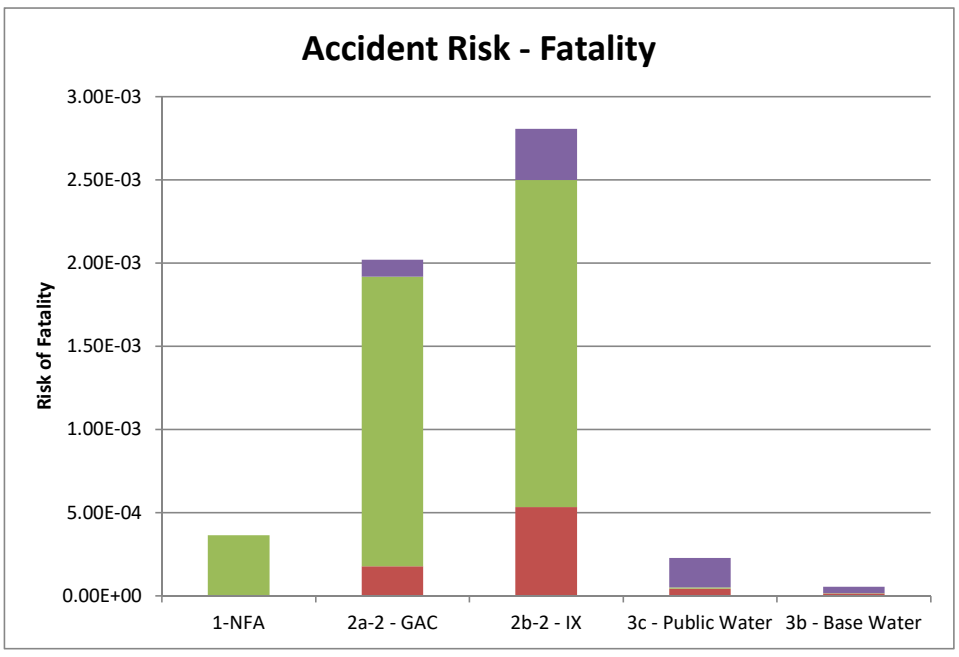






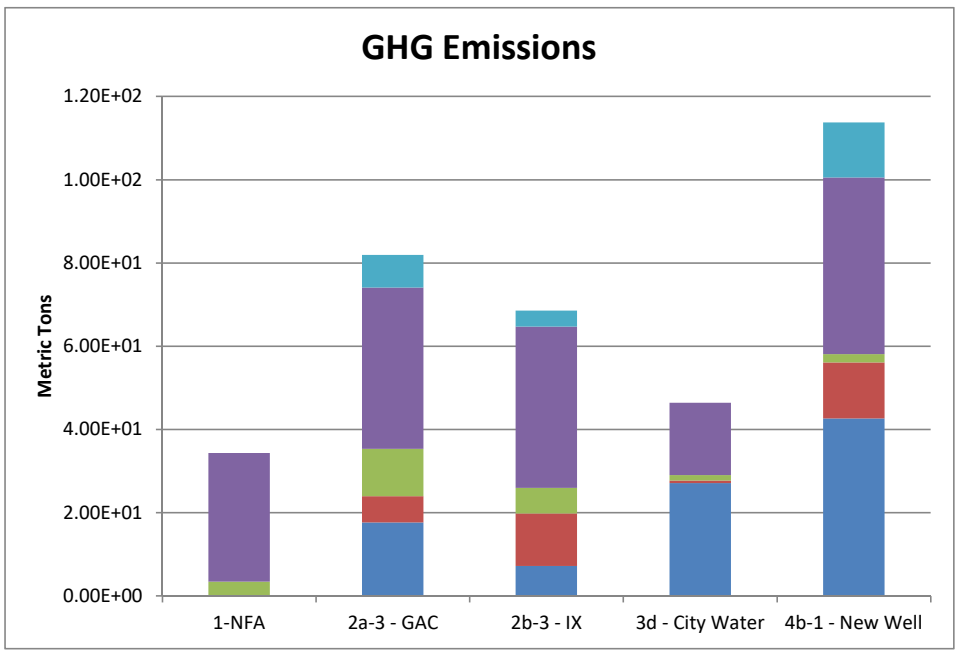


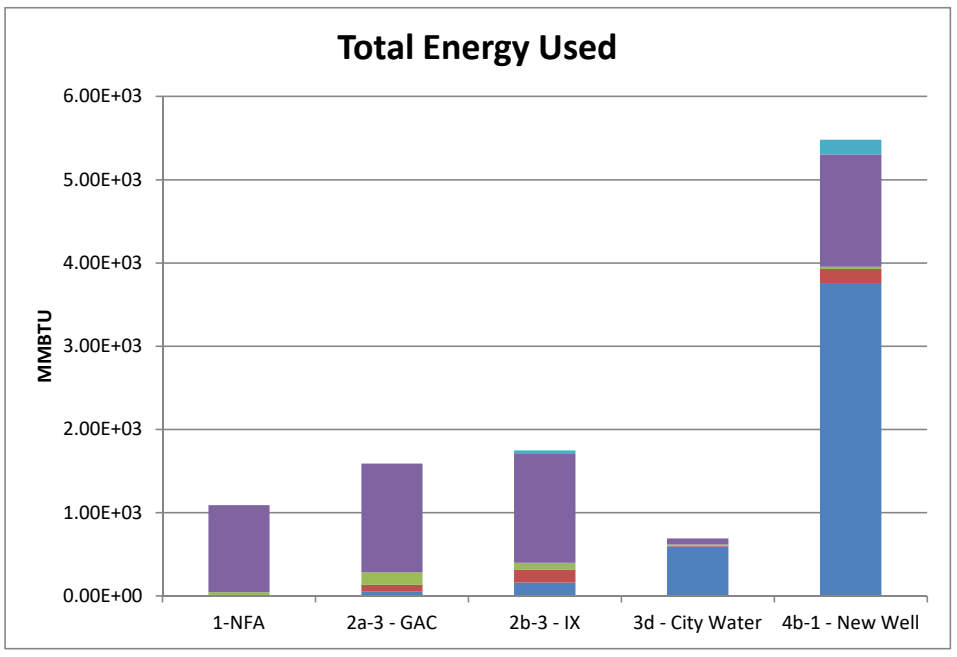


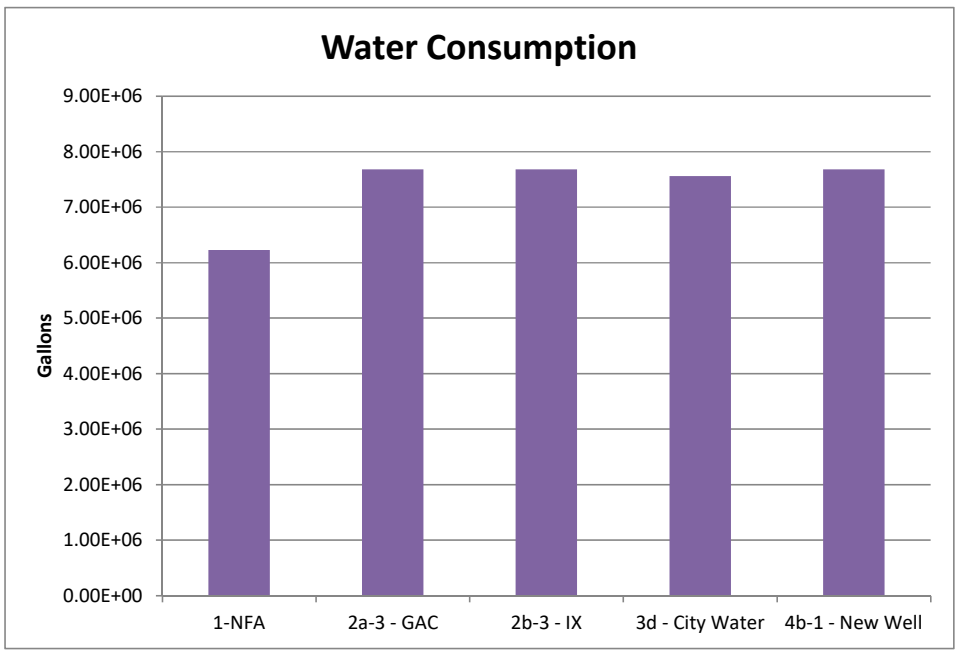


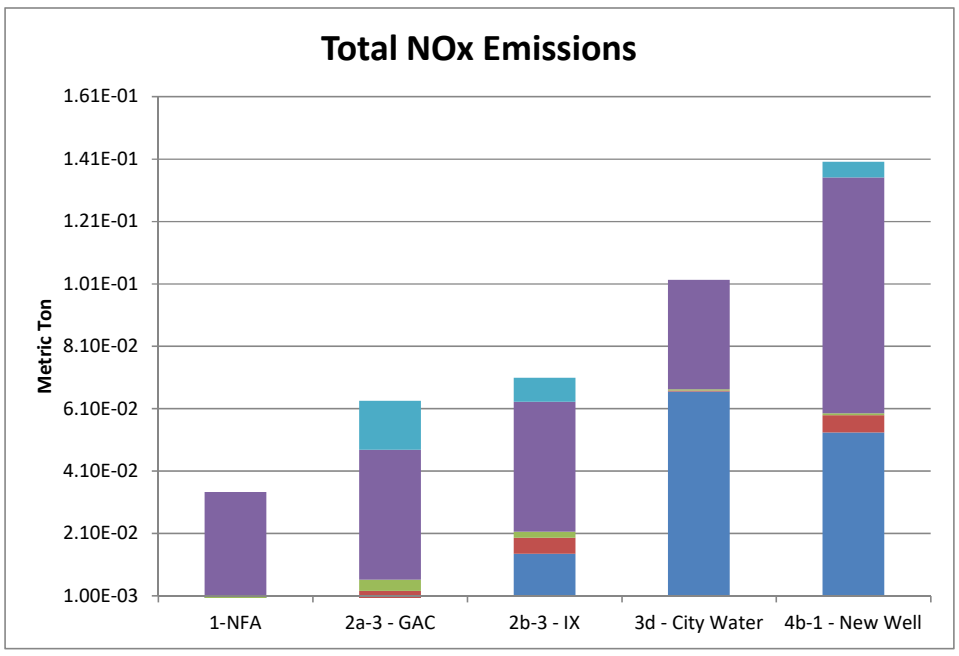
Residual Handling
Equipment Use and Miscellaneous
Transportation-Equipment
Transportation-Personnel
Material Production

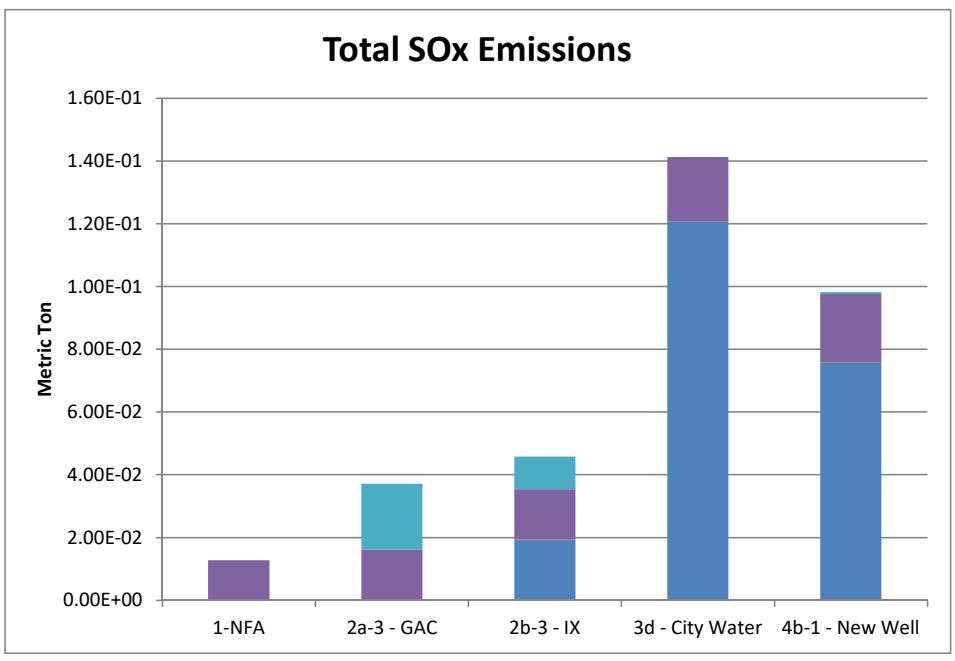
FIGURE 2
Sustainability Analysis Results - Residence 2
Sustainability Analysis for Residential Drinking Water
Naval Air Station Whidbey Island
Oak Harbor, Washington

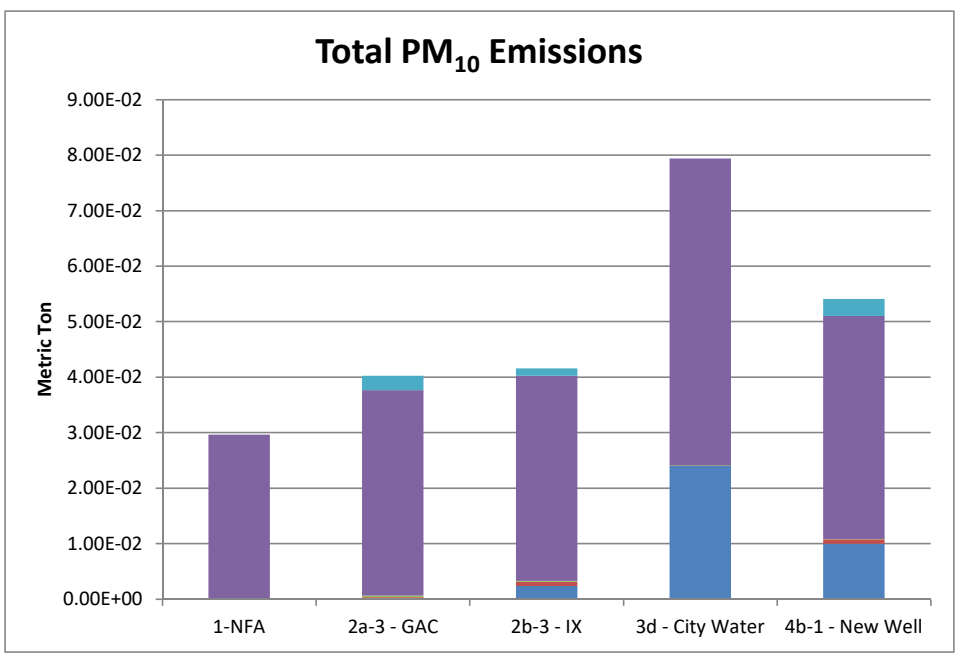


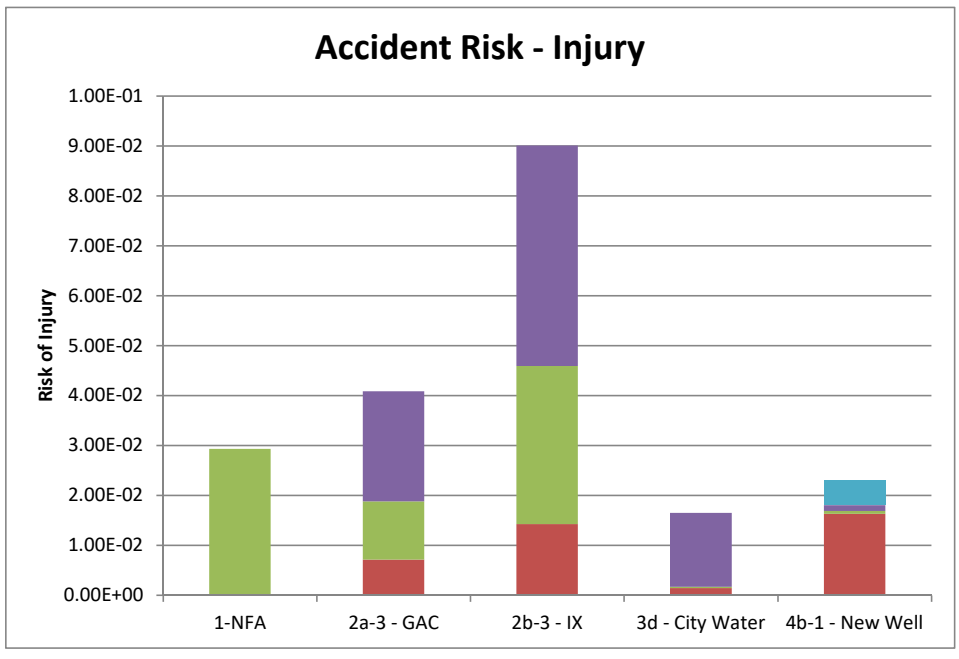


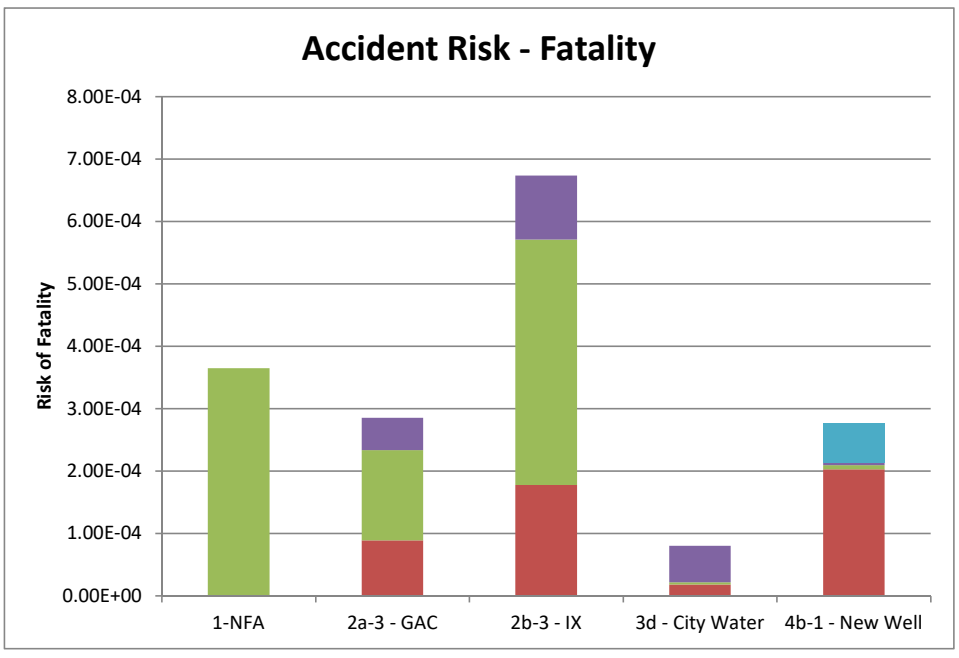






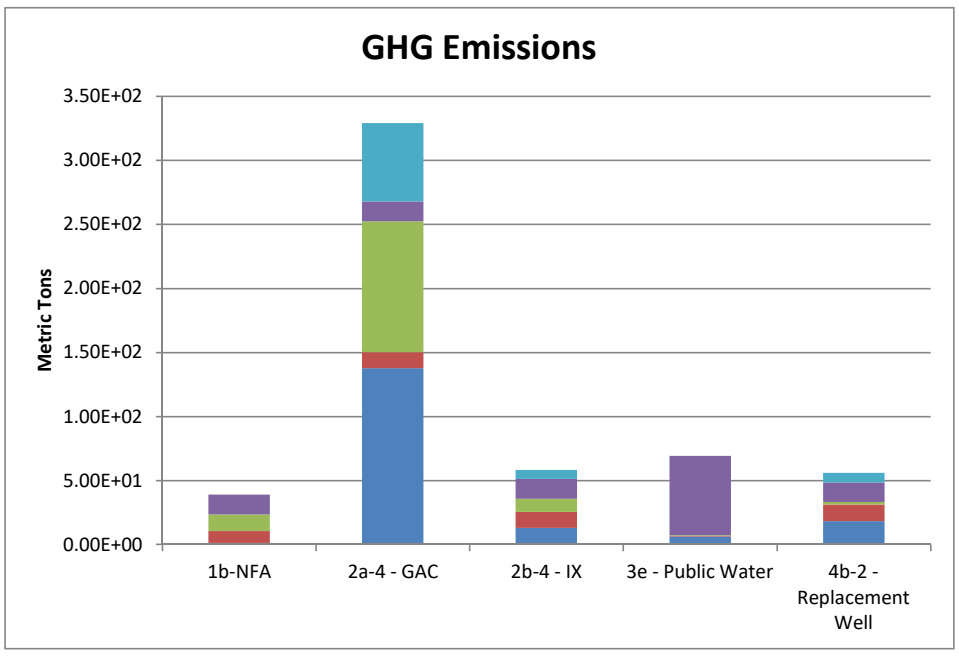


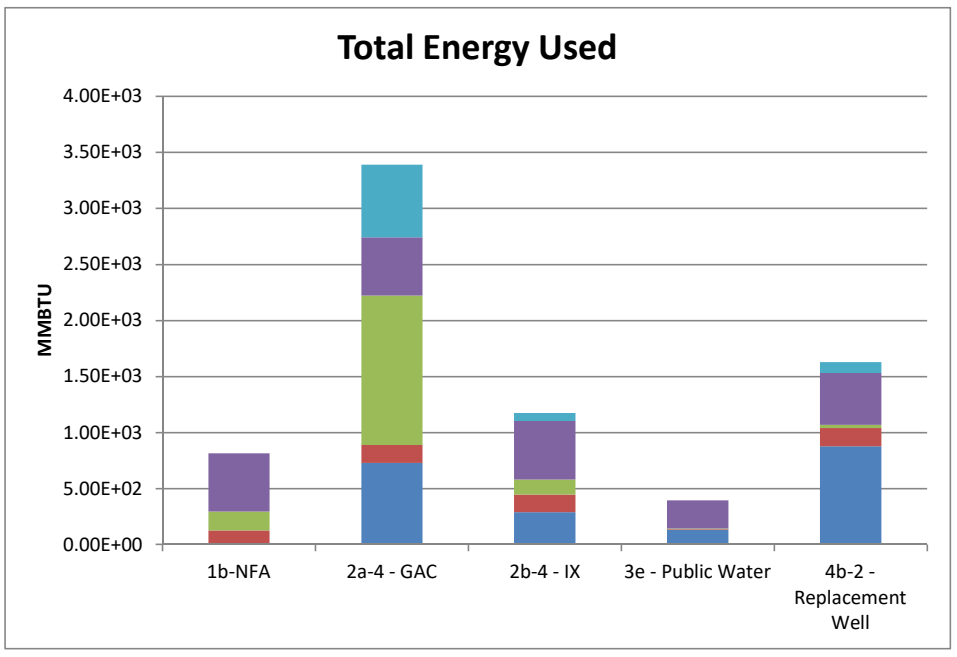


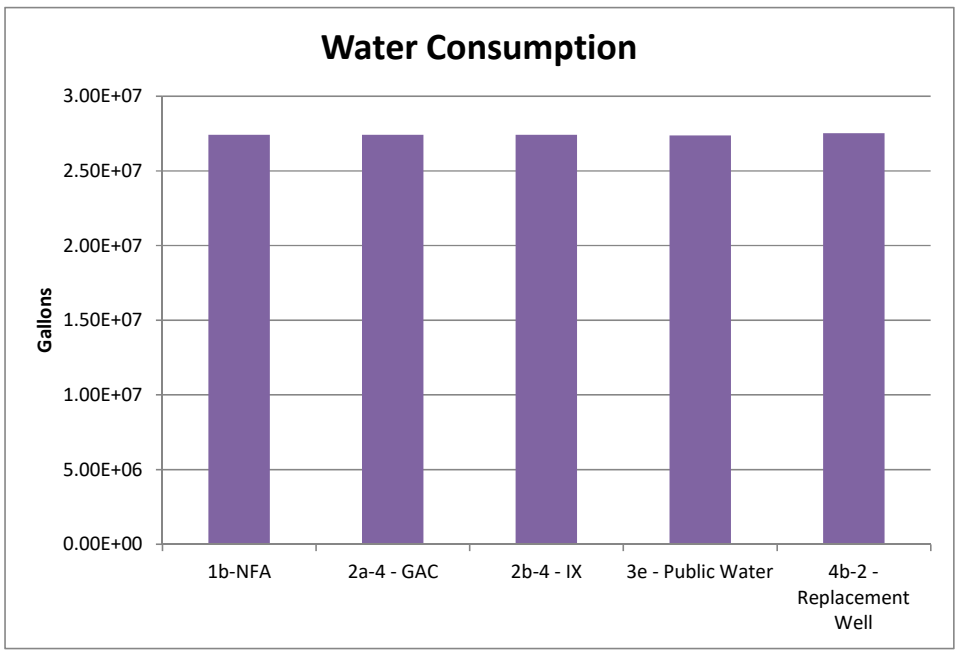


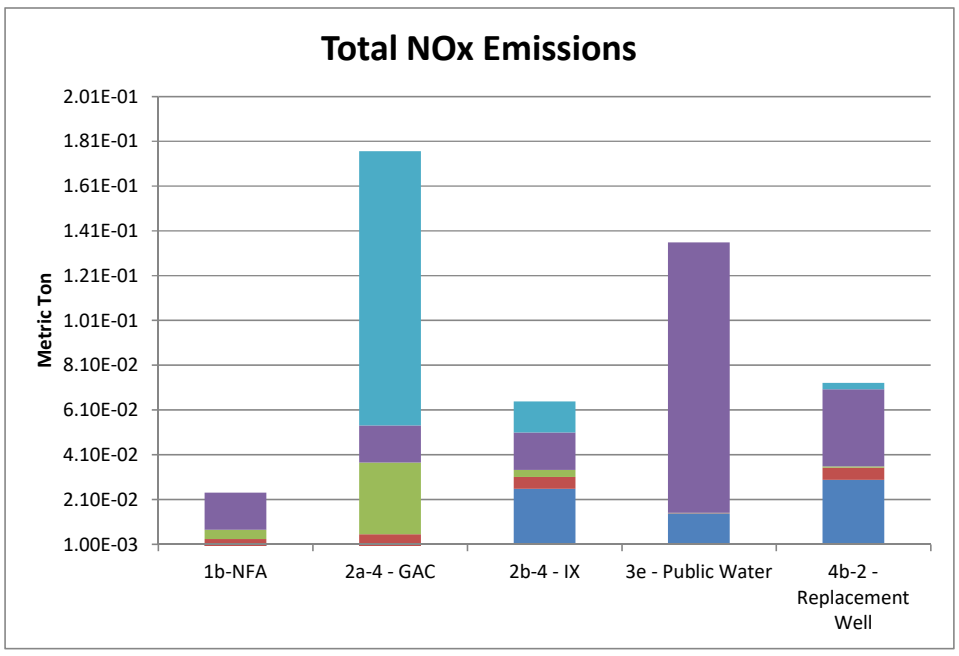
Residual Handling
Equipment Use and Miscellaneous
Transportation-Equipment
Transportation-Personnel
Material Production

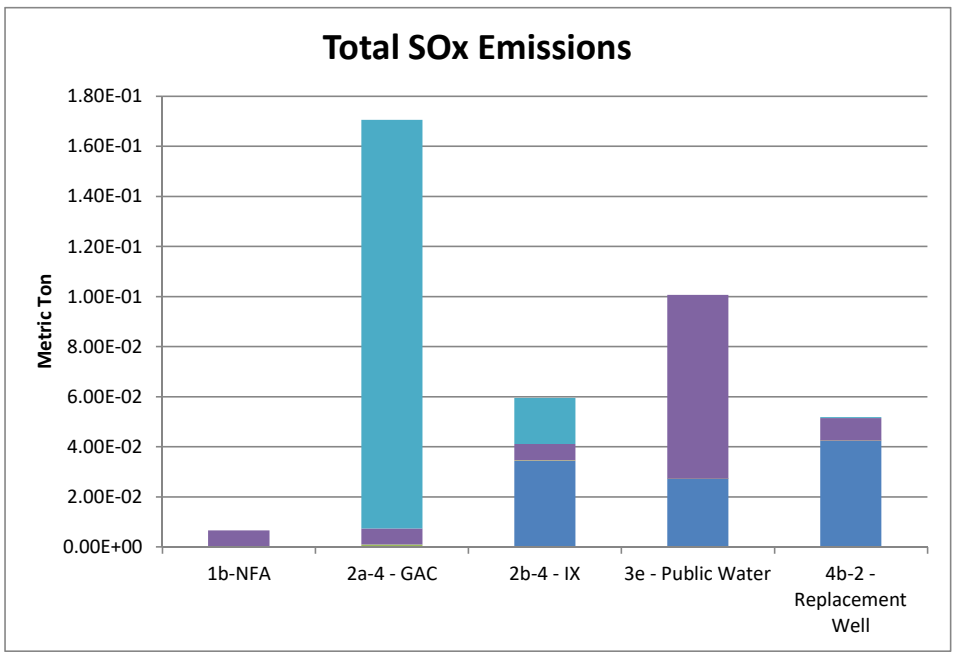
FIGURE 3
Sustainability Analysis Results - Easy Street Residences
Sustainability Analysis for Residential Drinking Water
Naval Air Station Whidbey Island
Oak Harbor, Washington

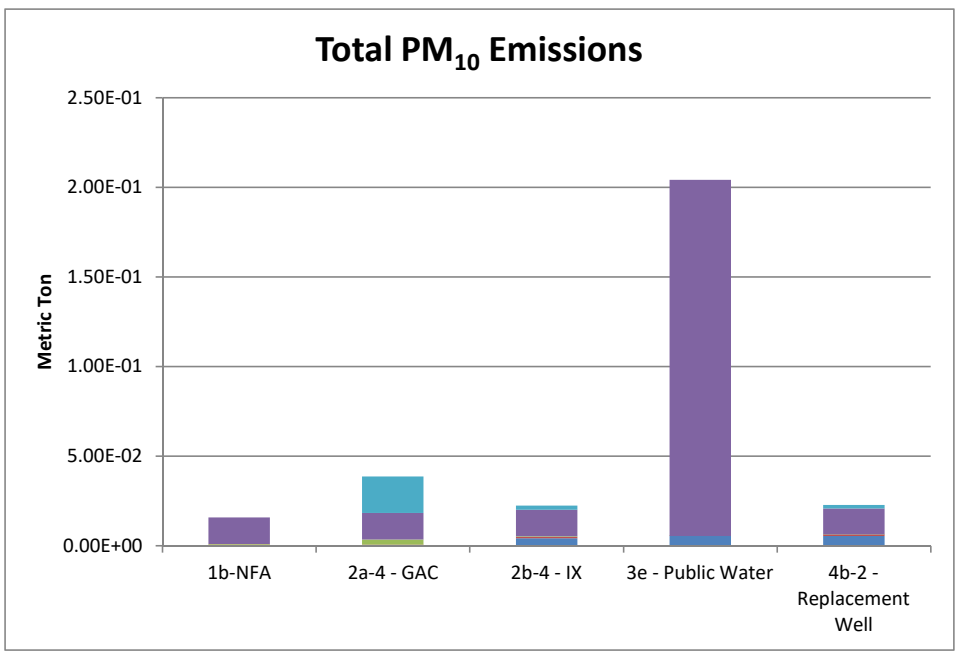


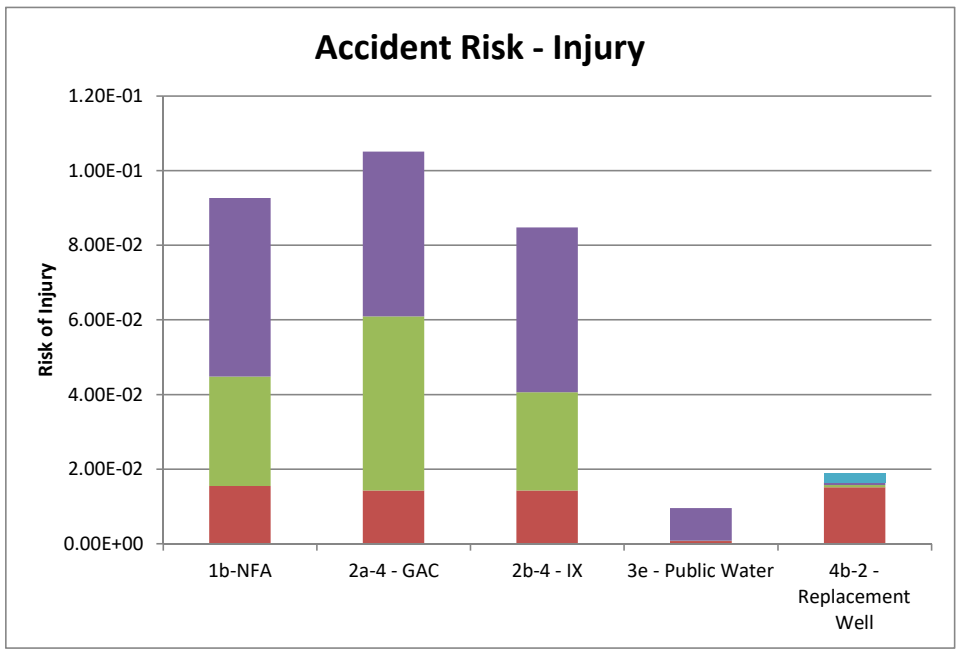


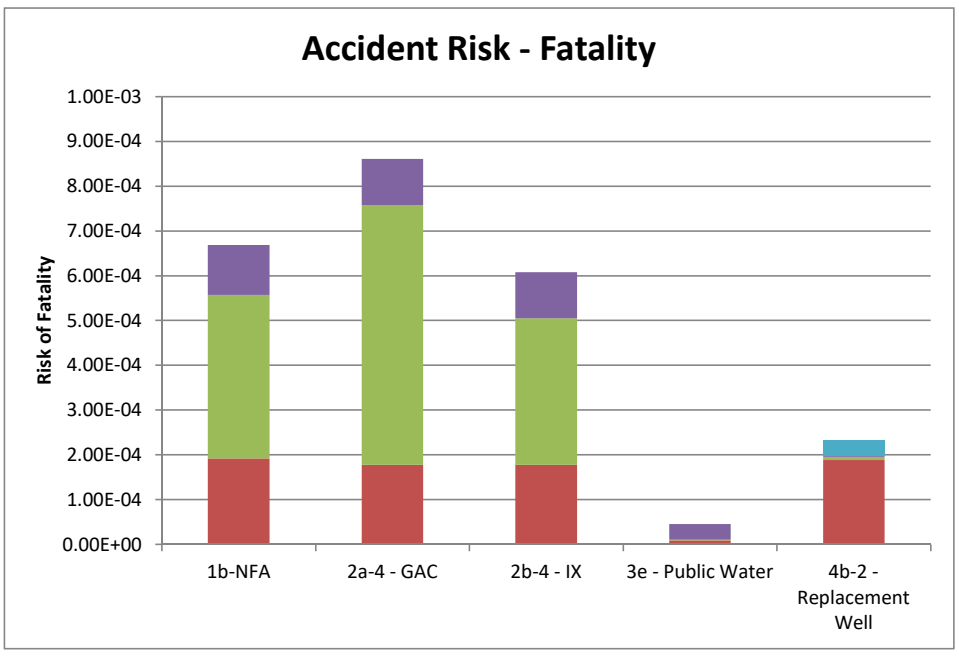












Residual Handling
Equipment Use and Miscellaneous
Transportation-Equipment
Transportation-Personnel
Material Production

FIGURE 4
Sustainability Analysis Results - Evergreen Mobile Home Park
Sustainability Analysis for Residential Drinking Water
Naval Air Station Whidbey Island
Oak Harbor, Washington