August 13, 2018
File No. 94200.00

Mr. David Sullivan, Town Administrator
Town of Windham
4 N. Lowell Road
Windham, New Hampshire 03087

Re: SITE INVESTIGATION REPORT
Windham Senior Center Area
2 N. Lowell Road
Windham, New Hampshire
NHDES Site No. 201709003

Dear Mr. Sullivan:

The Nobis Group (Nobis) is pleased to submit this *Site Investigation Report* (Report) for the above referenced site. This report was prepared in accordance with New Hampshire Department of Environmental Services (NHDES) requirements as defined in New Hampshire Code of Administrative Rules Env-Or-600 *Contaminated Site Management* and our proposal dated November 14, 2017.

This Report presents the results of the advancement of test borings, installation of groundwater monitoring wells, a wellhead elevation survey, and soil and groundwater laboratory analysis.

If you have questions concerning this report, please contact the undersigned.

Sincerely,

NOBIS ENGINEERING, INC.

Jason H. Pelchat
Senior Project Manager

Mark R. Henderson, P.G.
Senior Project Manager

cc: With Appendices:

Mr. Gary Garfield – Town of Windham Economic Development Committee

Nobis Group®
18 Chenell Drive
Concord, NH 03301
T (603) 224-4182

SITE INVESTIGATION REPORT

Windham Senior Center Area
2 N. Lowell Road
Windham, New Hampshire
NHDES Site No. 201709003

Prepared for:
Mr. David Sullivan, Town Administrator
Town of Windham
4 N. Lowell Road
Windham, New Hampshire 03087

Prepared by:
Nobis Group, Inc.
18 Chenell Drive
Concord, New Hampshire 03301
(603) 224-4182
Jason H. Pelchat
jpelchat@nobiseng.com

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APPENDICES

1.0 INTRODUCTION

1.1 Purpose

Nobis Engineering, Inc. (Nobis) has prepared this Site Investigation (SI) Report for the Windham Senior Center and surrounding area in Windham, New Hampshire (site). Th purpose of this SI was to assess the extent and magnitude of perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) impacts previously observed in drinking water samples collected at the site.

1.2 Scope of Work

The SI was conducted in general accordance with the Work Plan prepared by Nobis on November 30, 2017 and subsequently approved by NHDES. This SI investigation was also conducted in accordance with the requirements outlined in New Hampshire Code of Administrative Rules, Part Env-Or 606.01 through Env-Or 606.09.

This report includes, but is not limited to the following:

- A description and brief history of the site;
- A summary of the investigations performed by Nobis;
- A discussion of local geologic and hydrogeologic conditions;
- An assessment of local soil and groundwater quality;
- A conceptual model that describes the occurrence and movement of groundwater and contamination at the site;
- An assessment of the nature and extent of contamination;
- An evaluation of potential receptors;
- An evaluation of potential remedial alternatives to address impacted soil and groundwater.

The contents of this report are subject to the limitations included in Appendix A.

1.3 Background

In 2017, the New Hampshire Department of Environmental Services (NHDES) began an initiative investigating for the presence of perfluoroalkyl and polyfluoroalkyl substances (PFAS) in drinking water in several southern New Hampshire communities. As part of this initiative, the NHDES began collecting public drinking water supply samples at and in the immediate vicinity of town and city Fire Departments. Based on the results of public water supply sampling completed at the site

by the NHDES in June 2017 and August 2017, concentrations of PFOA and PFOS were detected at a combined concentration above the established NHDES combined PFOA/PFOS ambient groundwater quality standard (AGQS) of 0.07 micrograms per liter (µg/L). Based on the June and August 2017 AGQS exceedances observed at the site, additional public water supply sampling was completed by the NHDES at two (2) downgradient properties (30 Indian Rock Road [Dunkin Donuts] and 3 Fellows Road [current Windham Fire Department facility]). Results of the additional public water supply sampling and analysis revealed PFAS concentrations were detected in exceedance of the PFOS and/or combined PFOA/PFOS AGQS. Based on the above, the NHDES requested this SI, in a September 5, 2017 letter. The September 5, 2017 NHDES SI request letter as well as other pertinent historical site environmental documents are available for public review online via the NHDES OneStop database and can be accessed by clinking the link below: (https://www4.des.state.nh.us/DESOnestop/PRSDetail.aspx?ID=0038086&Type=PRS).

2.0 SITE AND SURROUNDING AREA DESCRIPTION

2.1 General Site Description

The actual site, located at 2 North Lowell Road is identified on the town of Windham Tax Assessor's Map 11, as Block C, Lot 1200 and is currently the location of the Windham Senior Center (WSC). The current owner of record for the WSC is the town of Windham. However, for the purposes of this study, the site or site area encompasses the regions in the vicinity of the former and current fire station, the WSC, and the immediate surrounding residential/commercial areas. A Site Location Map is presented as Figure 1. A Site Vicinity Map, illustrating the relative location of pertinent site properties and physiographic features are presented as Figure 2.

The WSC is situated within a historic district of Windham and consists of a 0.57-acre parcel improved with a 3,816-square foot (sq. ft.), wood framed structure with an asphalt shingled gable/hip roof and vinyl clapboard siding constructed circa 1890 and identified as the Windham Senior Center (WSC). The WSC was established to provide social and recreational needs for senior citizens in the town of Windham and surrounding towns. The WSC is also utilized by local scouting groups, the Lions Club, and other non-profit groups for social gatherings and events.

The WSC property is mostly unpaved, consisting of the WSC facility and grass lawn/landscaping areas. The facility is accessed via a handicapped ramp on the north side and several paved walk-ways on the east side of the facility. A small paved parking area is accessible from North Lowell

Road and a larger paved parking area also services the senior center behind the abutting property at 4 North Lowell Road. The site area is serviced by private drinking water supply wells and private septic systems.

The site area topography in the vicinity of the WSC and upgradient former town of Windham Fire Station generally slopes down to the east, southeast toward Indian Rock Road. The site area topography in the vicinity of the current town of Windham Fire Station generally slopes down to the north/northwest toward Fellows Road and Indian Rock Road. Golden Brook transects the Bartley Building (town of Windham Administrative Offices) property (Figure 2).

2.2 Adjoining Properties

The surrounding area is moderately developed with commercial/industrial, institutional facilities and residential neighborhoods. Visual observations of adjoining properties are summarized below by the following:

North

North Lowell Road abuts the site to the north. The town of Windham's Town Hall, Clerks and former Fire Station facilities are located farther north. The town of Windham's Selectman's Office, abuts the site to the northeast. Church Street, the Windham Presbyterian Church and a residential complex (Windham Terrace) are located farther northeast.

South

NH Route 111 abuts the site to the south. The current town of Windham's Fire Department, Police Department and Nesmith Library facilities are located farther south. In addition, residential properties and Enterprise Bank are located farther southeast.

East

A landscaped grassy area associated with the WSC and the town of Windham Administrative Offices (Bartley Building) is located to the east. A small brook (Golden Brook) transverses the landscaped grassy area. NH Route 111, a Dunkin Donuts franchise, B&H Oil Company and Anytime Fitness are located on the south side of NH Route 111 farther to the east. The Commons of Windham and Windham Towne Shoppes are located on the north side of NH Route 111 farther to the east and house numerous commercial retail businesses including: Residential Mortgage Services, the Stove Shoppe, Happy Feet Dance School, Kumo Sushi, Crown Jewelers, Windham Orthopedics, Kahlil Dental Associates, Style'n Salon and Spa, A Plus Cleaners, State Farm

Insurance, Klemm's Bakery and Renew MediSpa.

West

Undeveloped land and North Lowell Road abut the site to the west with undeveloped land farther west.

3.0 HISTORICAL USE INFORMATION

In accordance with Env-606.04 Site Background Information, Nobis reviewed the following historical sources for indications of Recognized Environmental Conditions (RECs) in association with/or pertaining to the site as defined in ASTM standard E-1527-13: *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process (ASTM 1523-13)*.

To meet this requirement, Nobis subcontracted Environmental Data Resources (EDR), a contract information services company to supply readily available historical topographic maps, aerial photographs, local city directories as well as Sanborn fire insurance maps. In addition to EDR, Nobis also reviewed local historical files for the site readily available from the town of Windham Municipal offices and historical society.

3.1 Historical Topographic Maps

Based on inquiries to EDR, readily available historical U.S. Geological Survey (USGS) topographic maps were reviewed to identify RECs in connection with the site. The historical EDR reports are included in Appendix B. Reviewed historical topographic maps are summarized below.

PUBLISHED	TITLE	QUADRANGLE
1905	1:62,500	Manchester, NH
1941	1:62,500	Manchester, NH
1943	1:62,500	Lowell, NH
1953	1:24,000	Windham, NH - Photorevised from 1952
1974	1:24,000	Windham, NH - Photorevised from 1974
1985	1:24,000	Windham, NH - Photorevised from 1982
2012	1:24,000	Windham, NH

1905 to 1985: The maps depict one structure on site and is assumed to be the WSC based on the date of construction identified via the town of Windham Tax Assessors office. Pertinent site details were not ascertainable from the reviewed maps.

2012: The site is depicted in a developed/urban area; however, based on the urban location, pertinent site details were not ascertainable from the reviewed maps.

We note, based on the lack of detail for the site and surrounding area within the supplied topographic maps provide by EDR, pertinent site features could not be ascertained from the historical topographic maps reviewed.

3.2 Historical Aerial Photographs

Selected historical aerial photographs supplied by EDR were reviewed for the site to obtain information concerning the history of development on and near the site. Evaluation of these aerials may be limited by a photograph's quality and scale. The reviewed photographs are summarized below.

YEAR	SCALE	DETAILS	SOURCE
1947	1"=500'	Flight Date: April 28, 1947	USGS
1953	1"=500'	Flight Date: May 03, 1953	USGS
1960	1"=500'	Flight Date: May 01, 1960	USGS
1969	1"=500'	Flight Date: September 13, 1969	USGS
1975	1"=500'	Flight Date: May 17, 1975	USGS
1977	1"=500'	Flight Date: May 04, 1977	USDA
1985	1"=500'	Flight Date: April 17, 1985	USGS
1992	1"=750'	Flight Date: April 29, 1992	USGS
1998	1"=500'	Acquisition Date: April 11, 1998	USGS/DOQQ
2006	1"=500'	Flight Year: 2006	USDA/NAIP
2009	1"=500'	Flight Year: 2009	USDA/NAIP
2012	1"=500'	Flight Year: 2012	USDA/NAIP
2016	1"=500'	Flight Year: 2016	USDA/NAIP

1947 to 1952: A structure residential in nature is depicted onsite and is assumed to be the WSC based on the age of its construction. Another structure is located immediately adjacent to the northeast and is assumed to be what is now the Bartley Building (town of Windham Administrative Offices). The former Route 111/Indian Rock Road abuts the site to the

north and east with several residential dwellings and undeveloped land farther north. A sand/gravel quarry operation is farther east. The structures to the north of the site are assumed to be the current towns offices and former town Fire Station. The areas to the south and west of the site are depicted as residential/agricultural in nature;

1960 to 1975: Photograph image resolution, scale or photographic quality is poor and pertinent site features could not be ascertained;

1977: The photograph depicts the site to be similar in configuration to the 1952 photograph. A small asphalt parking area of the town of Windham selectman building that abuts the site to the east. Other than a small addition to the former town fire station building and the Presbyterian church to the northeast, the surrounding area to the north, northeast and west remain similar to the 1952 photograph and appear residential in nature. Route 111/Indian Rock Road is depicted to have been relocated and abuts the site to the south and the sand and gravel operation to the east appears to have expanded;

1985: The photograph depicts the site to be similar in configuration to the 1977 photograph, Residential development is notable to the southwest. The sand/gravel and quarry operation appears to have expanded to the northeast. The southern portion of the site is depicted as vacant wooded and undeveloped land. The newly reconstructed Route 111 is also depicted north and west of the site;

1992: Photograph image resolution, scale or photographic quality is poor and pertinent site features could not be ascertained;

1998: The site and area immediately surrounding the site are depicted to be similar to the 1985 photograph. The current town of Windham Police station and Nesmith Library are depicted for the first time south of Route 111/Indian Rock Road. The sand/gravel quarry to the east is still present; however, a large multi-unit complex is now depicted for the first time and is assumed to be the “Commons of Windham” facility. A new large residential development is also depicted farther north of the undeveloped land north of the town offices structures. The remaining areas surrounding the site appear to be agricultural or residential in nature;

2006: Photograph image resolution, scale or photographic quality is poor and pertinent site features could not be ascertained; however, it appears the current fire station faciality had been constructed south of Route 111/Indian Rock Road and northeast of the Nesmith Library. In addition, a large complex is depicted for the first time to the northeast of the

site and the Presbyterian church and is assumed to be the current Windham Terrace;

2009: The site and surrounding areas are depicted to be in a similar configuration as they are currently. A residential structure located southeast of the site and Route 111/Indian Rock Road, is depicted to have been razed and the lot covered with asphalt;

2012 to 2016: The site and surrounding areas are depicted to be in a similar configuration as they are currently. The former residential structure located southeast of the site and Route 111/Indian Rock Road, had been covered with asphalt is now depicted to be a refueling station and multi-unit retail facility assumed to be B&H Oil and Anytime Fitness, respectively.

3.3 Historical Town Directories

Cole Information Services directories used in this study were made available through EDR, if readily available for historic target property and target property vicinity usage. The target property was not identified within the 1985 to 2014 Cole Information Services City Directories.

3.4 Historical Sanborn Fire Insurance Maps

During the late 19th Century, companies such as the Sanborn Company began preparing maps of central business districts for use by fire insurance companies. These maps were periodically updated and expanded geographically through the 20th century. Fire insurance maps often indicate construction materials, specific property use, and the location of other features such as gasoline storage tanks. Based on inquiries to EDR, a licensed Sanborn provider, fire insurance maps covering the target property were **not** found.

3.5 Municipal Regulatory Review

A review of the local files maintained by the town of Windham concerning the site was conducted by a Nobis representative. Department employees were interviewed in regard to environmental conditions such as complaints, violations, USTs, hazardous materials incidents, and permits.

- Assessors
- Planning/Zoning /Code Enforcement
- Building
- Health Department
- Fire Department

According to Mr. Dave Sullivan, administrator for the town of Windham, and Chief Thomas McPherson, Jr. of the town of Windham's Fire Department, the former Fire Station had a previous gasoline release circa 1990's that was remediated and overseen by the NHDES. According to Mr. Sullivan and Chief McPherson, an unknown amount of gasoline (could not recall the total gallons) was released to the ground surface during an accidental overfilling of a former 2,000-gallon capacity UST located at the former fire station. According to Mr. Sullivan the NHDES oversaw the release, closed the site file and the information is available at NHDES. Accordingly, Nobis completed a search of the NHDES OneStop database for information associated with this release. According to the NHDES OneStop database, the release was issued a NHDES site No. 199301018 and was closed via a *No Further Action Letter* in 1994.

Other than this SI investigation and the aforementioned UST overfill, there are no known pending, threatened or past environmental litigation, proceedings or notices of possible violations of environmental laws or liability in connection with the site.

3.6 Interviews Conducted During Visual Reconnaissance

The following individuals were interviewed regarding historical site area operations, known presence of hazardous waste (specifically PFAS,) or petroleum storage or usage on the site or in the surrounding facilities, as well as any known pending, threatened and/or past environmental litigation, proceedings or notices of possible violations of environmental laws or liability in connection with the site.

INTERVIEWER	INTERVIEWEE	TITLE	DATE/TIME
Jim Ricker	Chief Thomas McPherson, Jr.	Chief	March 27, 2018

According to Chief. McPherson, other than the aforementioned UST overfill discussed in Section 3.2. the site has been utilized as the WSC for as long as he can remember and does not recall the WSC ever having utilized and/or stored hazardous waste (including PFAS,) or petroleum. However, he did state it's possible the WSC could have utilized heating oil in the past to heat the building. In addition, Chief McPherson stated he was not aware of threatened and/or past environmental litigation, proceedings or notices of possible violations of environmental laws or liability in connection with the site.

Chief McPherson was also interviewed regarding the daily operations of the fire department and it's possible past and/or current use of Class B firefighting foam (fluorinated Aqueous Film-

Forming Foam [AFFF]) at the former and current fire department stations. According to Chief McPherson, very little Class B is/has been used at the new fire department location during his time as Chief (2006) due to its costs. The foam is typical saved for car fires. Chief McPherson further stated he knew of only three (3) training sessions over the past eighteen years 18 years that may have utilized Class B foams at the former and current fire department stations. Typically, the training sessions utilize water.

3.7 Site Ownership

In accordance with 8.3.2 of ASTM 1523-13, the sites history was researched back to it's first developed use, or back to 1940, whichever was earlier. Therefore, Nobis compiled a partial ownership history based on the town of Windham Tax Assessor's records, town of Windham Historical Society records, and Rockingham County Registry of Deeds. A summary of the property ownership is summarized below:

GRANTEE	DATE OF OWNERSHIP	BOOK AND PAGE
Town of Windham	1980 to Present	2364/121
Helen R. Tareila	1964 to 1980	1786/478
Miriam C and Jack Tareila	1963 to 1964	1674/102-105
Josephine C. Adams	1928 to 1963	838/413
Benjamin T. Adams	1923 to 1928	772/315
John W. W. Worledge	1922 to 1923	761/337
Israel Goodwill	1907 to 1922	627/141
Thomas Simpson	1891 to 1907	540/248

Based on a review of the historical information for the site, the site has been developed since as early as 1891 and has been utilized as a residential homestead and/or community center since it's construction. The ownership information presented above is provided for reference only and is not intended to represent or replace a title search.

4.0 SITE GEOLOGY AND HYDROGEOLOGY

4.1 General Site Setting

According to the *Surficial Geologic Map of the Windham Quadrangle, New Hampshire (Larson,*

1984), the surficial soil in the site vicinity is classified as uplands consisting of till and/or bedrock. Glacial lake-bottom deposits (clay to fine sand) associated with the lowland of Beaver Brook basin are shown to occur approximately 2,500 feet west of the site.

According to the United States Geological Survey (USGS) Water Resources Investigation Report No. 91-4025 entitled *Geohydrology and Water Quality of Stratified-Drift Aquifers in the Lower Merrimack and Coastal River Basins, Southeastern New Hampshire* (Stekl and Flanagan, 1992) and available via http://pubs.usgs.gov/wri/1991/4025/plate-4.pdf, the site vicinity is mapped as glacial till over bedrock. However, a stratified drift deposit is mapped approximately 1,500 feet south-southwest of the site. Although not encountered within the soil boring advanced for this SI, relatively thick stratified drift deposits may be encountered on either side of the hill in the vicinity of the current fire station, given the relatively steep topography adjacent to the wetlands.

According to the USGS *Open File Report 98-190 entitled Lineament Map of Area 7 of the New Hampshire Bedrock Aquifer Assessment; West-Central New Hampshire*, major photolineaments (photolinear features indicative of vertical or high-angle bedrock fractures) have been mapped in the area, including a north-northeast to south-southwest lineament that starts along the southern portion of Lowell Road and continues beneath the former Fire Station building and town hall facilities to Collins Brook Road (Ferguson et al., 1997). The northeast-southwest lineament is depicted on Figure 2.

According to the *Bedrock Geologic Map of New Hampshire* (Lyons et alt., 1997), the site is underlain by the Berwick Formation (SOb), which is part of the Merrimack Trough. The bedrock, consists of a biotite-quartz-feldspar granofels/schist with interbeds of calc-silicate granofels and minor metapelites fine-grained pinkish-brown granulite composed of quartz, biotite, oligoclase, muscovite, and epidote. Bedding within the bedrock strikes N45°E and dips to the northwest at approximately 75°. Bedrock outcrops were not observed on the site in the surrounding area; however, bedrock was encountered during the advancement of soil boring SB-1 and each of the monitoring well locations at approximate depths ranging from 8 ft. to 17.4 ft. bsg.

5.0 FIELD EXPLORATION AND SAMPLING PROGRAM

Field investigation activities conducted as part of this SI included a soil boring program; the installation, development, and elevation survey of shallow overburden groundwater monitoring wells; and the collection and laboratory analysis of soil, surface water, groundwater, and residential/commercial drinking water samples. A detailed discussion of the analytical results is

provided in Section 6. Field sampling methodologies and procedures are presented in the subsections below.

5.1 Soil Boring/Soil Sampling Program

Due to the know presence of PFAS within Class B firefighting foams and their historic use, the soil sampling program for this SI focused primarily on the areas in the immediate vicinity of the former and current fire stations, in an area where fire training exercises had previously been performed herein referred to as the fire training area (FTA). The downgradient WSC and Bartley building (town of Windham Administrative Offices) were also subject to soil sampling. The locations of the soil borings are depicted on Figure 2.

Prior to conducting intrusive activities at the site and surrounding properties (investigation area), each drilling location was marked for utility clearance by DigSafe Systems, Inc. (DigSafe) and the town of Windham.

Under the oversight of Nobis, Geosearch, Inc. of Fitchburg Massachusetts, a licensed New Hampshire drilling contractor, advanced 11 soil borings (SB-1 through SB-6 and MW-1 through MW-5) at and in the vicinity of the site between December 11 and 13, 2017. The soil borings and monitoring wells were advanced utilizing 4.25 inside diameter hollow-stem augers (HSA). SB-1 through SB-6 were advanced within a dirt lot located at the end of Fellows Road, in the FTA where fire training exercises had previously been performed. SB-1 was advanced to refusal on assumed bedrock at an approximate depth of eight (8) feet below ground surface (ft. bgs). SB-2 through SB-6 were advanced to two (2) ft. bgs. We note the FTA at the end of Fellows Road is located atop a knob/hill. Groundwater was not encountered during the advancement of SB-1 through SB-6.

Monitoring well MW-1 and MW-2 were advanced northwest and northeast of the new fire station to refusal on bedrock, at depths of 17.4 ft. bgs and 10 ft. bgs, respectively. Groundwater was not encountered during the advancement of MW-2, consequently, no monitoring well was set. MW-3 was advanced to refusal on bedrock at an approximate depth of 16 ft. bgs within the paved parking lot east of the former fire station. MW-4 was advanced north of the paved parking lot and to the east of the former fire station building to refusal on a suspect boulder at an approximate depth of 10 ft. bgs. MW-5 was advanced to refusal on a suspect boulder at an approximate depth of 13 ft. bgs. to the north of the Bartley building (town of Windham Administrative Offices) located

at 4 North Lowell Road. Soil samples for laboratory analysis were collected from 0 to two (2) ft. bgs at MW-2, MW-3, and MW-4. We note, based on the firefighting activities known to have occurred at the FTA, additional soil samples were collected from this area. Additionally, a sediment sample was collected from an outfall drain at the northeast corner of the paved lot of the current fire station. The outfall discharges overland sheet flow run-off from the paved parking areas surrounding to the east. Consequently, samples were not collected from monitoring wells MW-1 and MW-5 due to the limited potential for these locations to be impacted by the former and/or current fire stations activities.

The Nobis representative visually classified the soil conditions encountered, collected soil samples for laboratory analysis and logged this information, as well as other pertinent data on the Test Boring Logs included in Appendix C. Visual soil classifications and conditions encountered at each exploration location are indicated on the individual test boring logs. Stratification boundaries on the logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual.

5.2 Monitoring Well Installation, Development and Survey

Monitoring wells MW-1, and MW-3 through MW-5 were installed on December 11 and 12, 2017. 2-inch diameter schedule 40 polyvinyl chloride (PVC) monitoring wells were installed. Details regarding the installation and development of the monitoring wells are provided within the field procedures included in Appendix D and specific monitoring well construction details are included on the test boring logs included in Appendix C.

Following the monitoring well installation, the newly-installed monitoring wells were purged using disposable high-density polyethylene (HDPE) bailers. Purging continued until the monitoring wells were either purged of five (5) well volumes or purged dry after approximately 3 wells volumes (MW-3 and MW-5). The relative elevations of the monitoring well PVC risers were surveyed with a laser level, using an arbitrary benchmark (BM) of 100.00 feet. The BM was set at the edge of a concrete pad near the utility pole located off the southeast end of the paved lot east of the former fire station proximal to North Lowell Road. Pertinent site features including the monitoring well locations are depicted on Figures 2 and 3, and the newly acquired well elevations are provided in Table 1.

5.3 Soil Sampling and Laboratory Analysis

Each soil boring and monitoring well soil sample collected for this SI was collected in accordance with the NHDES *PFAS Sample Collection Guidance Document*. Each soil sample was collected in appropriate laboratory supplied sample containers, placed on ice for delivery in accordance with proper chain-of-custody protocols to Absolute Resources Associates, LLC (ARA) of Portsmouth, New Hampshire. Each soil sample was analyzed for the NHDES nine (9) target PFAS constituents using EPA modified method 537. In addition, Nobis requested ARA report all PFAS constituents analyzed for reference. A summary of the soil laboratory analytical results is included in Table 2.

5.4 Groundwater Sampling and Analysis

On December 29, 2017 and January 15, 2018, Nobis performed two (2) events of groundwater sampling. Groundwater levels were measured in each monitoring well prior to sample collection using a Solinst electronic water level indicator. The monitoring wells were subsequently purged of at least three (3) times the standing volume of water measured using a pre-cleaned high-density polyethylene (HDPE) disposable bailer. After purging, groundwater samples were collected using the same dedicated bailer. Separate bailers were used for each monitoring well to limit the potential for cross-contamination. A field duplicate was collected from monitoring well MW-5 during both monitoring events. In addition, an equipment blank, taken from a new unused bailer was also collected during each monitoring round. Please note; the PFAS field sampling program was completed in accordance with the NHDES PFAS Sample Collection Guidance document.

The groundwater samples were collected into appropriate laboratory supplied containers and placed on ice for delivery to ARA under proper chain of custody procedures. Similar to the soil samples, groundwater samples were also analyzed for PFAS by modified EPA method 537. A summary of the groundwater laboratory analytical results is included in Table 3. A copy of the laboratory report is included in Appendix E.

5.5 Private Drinking Water Sampling and Analysis

As part of this SI, Nobis also completed a private water supply sampling program between April 9 and May 2, 2018. In total, fifteen (15) private water supplies were sampled from the Windham Senior Center (2 North Lowell Road) and the Windham Fire Station (3 Fellows Road) and surrounding area.

Typical private water supply sampling protocol involved collection of a water sample from an interior and/or exterior tap prior to treatment and/or filtration. To ensure a representative water sample was obtained, each private water supply was allowed to flow for a sufficient time to purge the pressure tank and supply lines of standing water (approximately 10 minutes). Once sufficiently purged, each water supply sample was collected in appropriate laboratory supplied sample containers and placed on ice for delivery to ARA under proper chain of custody procedures. The collected samples were analyzed for PFAS by Modified EPA Method 537. A summary of the drinking water laboratory analytical results is included in Table 4 and a copy of the laboratory report is included in Appendix E.

5.6 Surface Water Sampling and Analysis

To assess surface water conditions in the vicinity of the former and current fire station facilities, on December 13, 2017, Nobis collected grab surface water samples from an outfall pipe at the northeast corner of a paved parking lot, east of the current fire station. The outfall pipe discharges overland run-off from the current fire station. In addition, on April 9, 2018 Nobis also collected two (2) surface water samples identified as SW-1 and SW-2 from Golden Brook which transects the general site area to the south/southeast and an unnamed pond located behind the Anytime Fitness facility farther south/southeast, respectively.

Each surface water sample was collected in appropriate laboratory supplied sample containers and placed on ice for delivery to ARA under proper chain of custody procedures for PFAS analysis via modified EPA Method 537. A summary of the surface water laboratory analytical results is included in Table 5. A copy of the laboratory report is included in Appendix E.

5.7 Hydraulic Conductivity Testing

In accordance with Env-Or 606.06, Nobis personnel completed hydraulic conductivity testing at three (3) of the onsite monitoring wells (MW-1, MW-3 and MW-5) on June 8, 2018. The testing began by collecting initial static water levels, then setting a mini-troll pressure transducer within each monitoring well at the midportion of the screen and allowing the water level to equilibrate. Once the water level equilibrated within each monitoring well, Nobis personnel conducted rising and falling head tests by inserting and removing a PVC slug while the transducer concurrently collected water level readings. Data collected during the testing was used to calculate hydraulic conductivity values for the onsite subsurface material in the proximity of the three (3) monitoring wells. The hydraulic conductivity testing results are discussed in detail in Section 6.3.

5.8 Groundwater Elevations and Flow Direction

Monitoring well gauging data from the December 29, 2017 and January 15, 2018 groundwater monitoring events were used to calculate groundwater elevation contours, groundwater flow direction, and hydraulic gradient. Groundwater contours based on the water level measurement collected in December 2017 and January 2018 are depicted on Figures 3 and 4, respectively. A summary of water level elevations is presented on Table 1.

The data indicates unconfined shallow overburden groundwater flow north of Indian Rock Road, beneath the former fire station and site is generally to the east and east-southeast. Groundwater flow south of Indian Rock Road appears to flow northwest from the current fire station toward Golden Brook at a horizontal gradient (from MW-3 to Golden Brook) of approximately 0.02 ft./ft.

It should be noted; groundwater levels, flow directions and hydraulic gradients may vary depending on factors such as temperature, season, precipitation, and other conditions that may differ from those at the time of the observations. Vertical gradients were not evaluated as part of the current scope of work.

6.0 FIELD OBSERVATIONS AND LABORATORY ANALYTICAL RESULTS

6.1 Typical Subsurface Profile

Soil borings (SB-1 and SB-6) and monitoring wells MW-1 through MW-5 were generally advanced in suspect source areas and downgradient locations within the vicinity of the site area. Based on the results of the preliminary explorations, the subsurface conditions can be generalized as follows:

STRATUM	APPROXIMATE DEPTH (FT.)	MATERIAL DESCRIPTION	DENSITY/ CONSISTENCY
Asphalt/Topsoil	0.3 to 0.5	Dark brown, organic SILT, and fine Sand, with fine roots.	Loose to Medium Dense
Fill	0.5 to 8.0	Tan, fine to medium SAND, some to little Silt, some to little Gravel with debris (brick fragments, glass, plastic, coal ash, asphalt, etc.)	Medium Dense to Dense
Stratified Drift Deposit Sand (MW-1, 3 and 5)	5 to 15.0	Tan, fine to coarse SAND, little to trace Gravel, little to trace Silt,	Medium Dense to *(Cohesionless)*

STRATUM	APPROXIMATE DEPTH (FT.)	MATERIAL DESCRIPTION	DENSITY/ CONSISTENCY
		generally more fine-grained with depth.	
Glacial Till	7 to 17.4	Brown fine to coarse SAND, little to some Gravel, little Silt	Very Dense
Bedrock (1) (2)	8 to 17.4	Biotite-quartz-feldspar granofels/schist of the Berwick Formation (4)	--

Notes:

1. Auger and/or sampler refusal, presumably on bedrock, was encountered in MW-1, 2, 3, 4, 5 and SB-1.
2. Sand deposit observed in MW-3 and 5 were observed from auger cuttings.
3. Bedrock type based on a review of available Bedrock Geological maps.

6.2 Soil Analytical Results

Laboratory analytical results provide specific information regarding analyte concentrations relative to NHDES Table 600-2 soil remediation standards (SRS); however, to date, the NHDES has not established a SRS for PFAS.

Laboratory analytical results revealed concentrations of the NHDES nine (9) select PFAS constituents (perfluorononanoic acid [PFNA], perfluorooctanoic acid [PFOA], perfluorooctanesulfonic acid [PFOS], perfluoroheptanoic acid [PFHpA], perfluorohexanoic acid [PFHxA], perfluoropentanoic acid [PFPeA], perfluorobutanoic acid [PFBA], perfluorohexanesulfonic acid [PFHxS] and perfluorobutanesulfonic acid [PFBS]) were detected above laboratory method detection limits within one (1) or more of the soil samples collected for this SI at a depth of 0-2 feet bgs. In addition to the NHDES select nine (9) PFAS constituents, numerous other PFAS constituents detected as part of the modified EPA method 537 analysis were also reported above laboratory method detection limits within one (1) or more of the soil samples collected for this SI. The distribution of the PFOA, PFOS, and combined PFOA/PFOS are depicted on Figure 5. Laboratory analytical reports are included in Appendix E.

6.3 Overburden Groundwater Analytical Results

Laboratory analytical results of groundwater samples collected for this SI revealed sixteen (16) PFAS constituents were detected at concentrations above laboratory method detection limits within one (1) or more of the groundwater samples. Of these, PFOA, PFOS and consequently total PFOA/PFOS exceeded the AGQS of 70 nanogram per liter (ng/L) in the shallow overburden

groundwater samples collected from monitoring wells MW-4, MW-5 and the MW-5 laboratory duplicate during both groundwater sampling events. The highest PFAS concentrations were detected in the groundwater samples collected from MW-5 during both sampling events. PFOS and total PFOA/PFOS were detected at concentrations ranging from 110 ng/L to 160 ng/L and 121 ng/L to 168.7 ng/L, respectively. Similarly, PFOS and total PFOA/PFOS were detected during each sampling event in the groundwater samples collected from MW-4 at concentrations ranging from 79 ng/L to 100 ng/L.

PFOS and total PFOA/PFOS was also detected in the groundwater samples collected from MW-1 and MW-3 during both sampling events at concentrations above laboratory method detection limits but below AGQS. See Table 3 for a tabulated summary of the groundwater PFAS analytical results and Figure 6 for PFOA, PFOS, and combined PFOA/PFOS distribution in groundwater. Groundwater laboratory analytical reports are included in Appendix E.

6.4 Private/Public Water Supply Well Analytical Results

Laboratory analysis of private/public water supply well samples collected for this SI, with the exception of the Howie Glynn & Sons Convenience Duplicate revealed thirteen (13) PFAS constituents were detected at concentrations above laboratory method detection limits in one (1) or more of the private/public water supply well samples collected for this SI. Of the 13, only PFOS and consequently total PFOA/PFOS constituents were detected at concentrations above the established AGQS in the "raw" influent water supply samples collected from 3 Fellows Road (Windham Fire Station) and 30 Indian Rock Road (Dunkin Donuts). Additionally, other than the 32 Indian Rock Road duplicate sample, total PFOA/PFOS detections were observed in each of the remaining private/public water supply well samples collected at concentrations above laboratory method detection limits but below AGQS. We note, PFOS was not present in the water supply well samples collected from 8 Fellows Road (Nesmith Library), 15 3rd Street, 32 Indian Rock Road and the 32 Indian Rock Road duplicate.

In addition, other than the 32 Indian Rock Road duplicate sample, PFOA was also detected in each of the water supply samples collected at concentrations above laboratory method detection limits but below AGQS (Table 4). See Table 4 for a tabulated summary of the private/public water supply well analytical results and Figure 7 for the PFOA, PFOS, and combined PFOA/PFOS distribution in bedrock. Private/public water supply well laboratory analytical reports are included in Appendix E.

6.5 Surface Water Analytical Results

Laboratory analysis of surface water samples revealed thirteen (13) PFAS constituents were detected at concentrations above laboratory method detection limits in one (1) or more of the surface water samples collected for this SI. No surface water standards currently exist for PFAS compounds; however, we note that the concentration of total PFOA (7.2 ng/L)/PFOS (69 ng/L) was detected at a concentration (76.2 ng/L). See Table 5 for a tabulated summary of surface water analytical results. Surface water laboratory reports are included in Appendix E.

6.6 Hydraulic Conductivity Results

Utilizing the hydraulic slug testing data described in Section 5.7, Nobis developed genal site specific hydraulic conductivity (K) estimates. The results were evaluated using the *Bouwer and Rice* method for unconfined aquifers and was calculated using AQTESOLV® version 4.5. The bottom of the aquifer (assumed to be bedrock) has not been confirmed at the site area but was assumed to be one (1) foot below the bottom of each well screen.

Falling head (slug entry) and rising head (slug removal) tests were run for each monitoring well tested (MW-1, MW-3, and MW-5). We note, monitoring well MW-1 was installed such that the screened portion of the monitoring well intersected the water table, therefore only rising head values were used to determine hydraulic conductivity. In addition, a rainstorm began during the monitoring well MW-3's rising head test and the overland recharge from the rain appears to have impacted the end of test; therefore, only falling head data was used to determine the final K values. Rising head test and falling well test results were averaged for MW-5. Calculated K values are shown below. See Appendix F for test details.

WELL ID	RISING HEAD K (FT./DAY)	FALLING HEAD K (FT./DAY)	FINAL K (FT./DAY)
MW-1	1.9	0.92, 0.68	1.9
MW-3	32	0.56	0.56
MW-5	3.2	4.3	3.8

These final K values suggest an overall hydraulic conductivity of approximately 2 feet/day (7.1E-4 cm/s), which falls within the range of silty sand (Table 2.2 of Freeze and Cherry, 1979).

7.0 DISCUSSION

7.1 Physical and Hydrogeologic Setting

The site area is located within the valley southeast of Butterfield Rock and northwest of Cobbetts

Pond. Measured groundwater elevations were limited but appear to suggest localized groundwater flow mimics the surface topography. Groundwater flow in the site area is expected to flow toward the southwesterly flowing Golden Brook which transects the site area (Figure 3 and 4). A portion of the site encompasses the areas in the immediate vicinity of the former and current fire stations. These areas in the immediate vicinity for the fire stations are paved; however, around these areas are grassed and forest areas. This suggests that significant overland recharge may be occurring. Additionally, as depicted on Figure 8, a fine to medium sand was observed during the advancement of MW-1, 3 and 5 and may be the outer limits of sand associated with the mapped stratified drift present south of the current fire station. No aquitards (such as clay) were encountered during drilling; however, dense to very dense till was observed in several soil borings and may slow localized recharge. Bedrock was encountered within several soil borings at depths less than 20 feet bgs, therefore, surface recharge may readily migrate to bedrock.

Although bedrock investigations were not completed as part of this SI, bedrock groundwater may also follow local topography; however, we note, municipal water is not available in the region and withdrawals from private/public water supply wells may divert bedrock groundwater flow away from its natural gradient. Further evaluation would be required to confirm actual bedrock conditions.

Potable water in the site area is supplied by numerous public and private water supply wells. Each of these water supply wells are set within bedrock at various depths ranging from 140 ft. to 1006 ft. deep (Table 4).

7.2 Potential Receptor Map

Figure 9 depicts the 1,000-foot radius around the site. A number of public water supply wells are located within 1,000 feet of the site, and four (4) private wells are located east-northeast and southwest of the site. Each of these water supply wells are set in bedrock, with total well depths ranging up to 1006 feet bgs, as described in Section 7.3.

The closest surface water body is Golden Brook, which runs from northeast to southwest adjacent to the site and terminates in a wetland area approximately 1,200 feet southwest of the site. The only wetland within 1,000 feet of the site is located approximately 900 feet to the north.

Nearby parcels consist of public use, commercial, and light industrial properties. Residential properties are scattered throughout the area. A daycare and preschool are located approximately

1,000 ft. to the east-northeast and an assisted living facility is located approximately 500 feet north-northeast of the site.

7.3 Soil Contaminant Characterization

Although PFAS have been used since the 1950s as ingredients or intermediates of surfactants and surface protectors for numerous industrial and consumer applications, until recently PFAS had not been regulated. Consequently, no EPA or NHDES SRS have been established; however, the Environmental Health Program (EHP) has derived direct contact risk-based (DCRB) soil screening level concentrations for Perfluorooctanoic Acid (PFOA) considered protective of potential exposure in a residential scenario (500 µg/kg) and for maintenance workers (4,300 µg/kg). Accordingly, the PFAS results were compared to this DCRB soil screening level.

The highest PFAS concentrations observed during this SI were detected within the shallow soil samples collected from the FTA. Of the PFAS constituents detected above laboratory detection limits; PFOA, PFOS, combined PFOA/PFOS, PFHxS and to a lesser extent PFHxA were the most prevalent PFAS constituents detected. Concentrations of PFOA, PFOS (PFOA/PFOS) and PFHxS were detected within in each soil sample collected except for MW-3 and MW-4 at concentrations ranging from 0.25 microgram/kilogram (µg/kg) to 200 µg/kg. Of particular note is the concentrations of PFOS detected within SB-3 and SB-4 and the SB-4 laboratory duplicate collected from the FTA. PFOS was detected within SB-3, SB-4, and the SB-4 laboratory duplicate at concentrations two (2) to three (3) orders of magnitude (110 µg/kg to 200 µg/kg) greater than the detected concentrations within the remaining soil samples collected for this SI. Similarly, notable concentrations of PFOS were also detected (although at lesser magnitude) within the soil sample collected from MW-2 and the outfall sediment sample at concentrations of 81 µg/kg and 11 µg/kg, respectively. PFAS were not detected at concentrations above the established DCRB soil screening levels in the soil samples collected for this SI.

As depicted on Figure 5, based on the distribution of PFAS observed across the site area, it appears the past discharges of Class B foams in the vicinity of the FTA via air dispersal and/or inadvertent direct ground applications during training exercises have impacted shallow soil with elevated concentrations of PFOA/PFOS and to a lesser extent with numerous other PFAS constituents. Although Class B foam was assumed to have been used at the former fire station also, the majority of the former fire station area is paved and shallow soil samples collected from monitoring wells advanced downgradient of the former fire station revealed PFAS constituents

were detected above laboratory method detection limits; however, concentrations detected were much less than those collected in the vicinity of the current fire station.

7.4 Groundwater/Surface Water Contaminant Characterization

In general, PFOA and PFOS are very stable in the environment and resist typical environmental degradation processes. This coupled with their high solubility can result in large plumes. As previously stated in Section 6.3, concentrations of PFOS and consequently total PFOA/PFOS were detected above established AGQS in the groundwater samples collected from MW-4, MW-5 and the MW-5 duplicate during both sampling events; both of which are downgradient of the former fire station facility. Concentrations of PFOS, and in turn total PFOA/PFOS were also detected in the groundwater samples collected from MW-1 (61/68 ng/L) and MW-3 (61/62.7 ng/L) at concentrations just below the established AGQS. MW-3 is also located in the vicinity of the former fire station while MW-1 is located downgradient of the current fire station.

The distribution and concentrations of PFAS detected suggest that the former use of Class B foams, and the subsequent equipment cleaning at the former fire station were trans ported via overland stormwater flow drainage into the surrounding unpaved gravel, landscaped and grassy areas downgradient of the former fire station. Over time, surficial recharge leaches the inherently stable PFAS through the vadose zone to the shallow unconfined overburden water table beneath the former fire station. This is supported by the detections of PFAS within the groundwater samples collected from monitoring well MW-3 and the AGQS exceedances observed within the groundwater samples collected from monitoring wells MW-4 and MW-5. Additionally, this is further supported by the low levels PFAS concentrations observed within the shallow soil samples collected from the former fire station area as discussed is Section 7.1.

As depicted on Figure 6, the regulatory downgradient extent of the PFOS/total PFOA/PFOS plume extends from the former fire station, south-southeast beneath North Lowell Road, the WSC, the Bartley building (town of Windham Administrative Offices) and Indian Rock Road (Route 111) approximately 470-feet at its most downgradient point and appears to discharge to Golden Brook.

We note that the majority of the PFAS constituents detected above AGQS within the groundwater samples collected from the site area have consisted primarily of PFOS with minor concentrations of PFOA and other PFAS constituents. However, the concentrations of PFAS detected within the groundwater samples collected from MW-1 consisted primarily of PFOA with minor concentrations

of PFOS. This suggests a separate release/source(s) may attributable to the PFAS concentrations detected within the groundwater samples collected from MW-1.

In addition to the groundwater detections, concentrations of PFAS were also detected in the surface water samples collected for this SI. Concentrations of PFAS detected within the surface water sample collected from Golden brook contained total PFOA/PFOS at concentrations less than 5 ng/L. It is assumed that the concentrations of PFAS detected within Golden Brook originate from the same overland flow and possible groundwater recharge from the former fire station area and are diluted upon convergence. Similar to the distribution of PFAS suspected at the former fire station, concentrations of PFAS detected within the outfall sample collected southeast of the current fire station and the downgradient unnamed pond behind the Anytime Fitness facility are also anticipated to be from overland runoff from the FTA. Although no surface water standards currently exist for PFAS, we note that the concentration of total PFOA/PFOS detected within the surface water sample collected from the unnamed pond (76.2 ng/L) was above the established AGQS.

7.5 Private/Public Water Supply Well Contaminant Characterization

As depicted on Figure 7, concentrations of PFAS were detected within each private water supply samples collected for the SI. Total PFOA/PFOS concentrations ranged from 2.3 ng/L to 98 ng/L. The highest total PFOA/PFOS concentrations were detected within the public water supply samples collected from the current fire station water supply well and the downgradient 30 Indian Rock Road (Dunkin Donuts) water supply well; both of which currently maintain active Point-of-Entry (POE) treatment systems for potable water.

As depicted on Figure 8, both the current and former fire stations are located on the top of a hill with shallow bedrock present beneath each facility. The data collected to date reveal the bedrock impacts observed in the site area stem from two (2) separate sources. It appears that due to the presence of the shallow bedrock and overlying pockets of drift deposit sands in the area of the former fire station, overland surface recharge readily washed residual PFAS at the former fire station into the groundwater and subsequently shallow bedrock observed beneath the former fire station during monitoring well advancement. This is evidenced by the shallow bedrock refusals observed (10 to 16 ft. bsg.) during the advancement of monitoring wells MW-3, 4 and 5 and the AGQS exceedances observed within monitoring wells MW-3, 4 and 5. Additionally, the northeast-southwest fractures as observed on the photo-lineaments are indicative of rock fabric/feature

orientation and would explain the similar concentrations and PFAS constituents detected in each of the water supply wells tested on the north side of Indian Rock Road. The bedrock water supply wells also in line with the general bedrock fracture orientation and location are depicted on Figure 2.

Similarly, shallow bedrock was also encountered beneath the former FTA at depths less than ten (10) ft. bsg. and suggest that overland flow from the FTA at the current fire station property allowed the percolation and leaching of residual PFAS into the shallow bedrock as evidenced by the AGQS exceedances observed within the water supply samples collected from the current fire station water supply well and the immediate downgradient Dunkin Donuts water supply well. Additionally, concentrations of PFAS detected above AGQS within each well were similar in nature and concentrations.

7.6 Conceptual Site Model

Nobis developed the following conceptual site models (CSM) based on information gathered during this SI. This CSM summarizes the physical and hydrogeologic setting of the site, the nature and extent of contamination, and evaluation of potential receptors. We provide a model for both the current fire station and FTA and also the former fire station.

7.6.1 Current Fire Station/Fire Training Area (FTA)

The general site area is located within a valley southeast of Butterfield Rock and northwest of Cobbetts Pond. Measured groundwater elevations were limited but appear to suggest localized groundwater flow mimics the surface topography. Groundwater in shallow overburden is expected to flow toward the southwesterly flowing Golden Brook which transects the site area (Figure 3 and 4). Water flow in bedrock has not been well documented; however, bedrock fabric as demonstrated by photo-lineaments in the area suggest predominant southwest-northeast trending fractures/joints may be present. Therefore, water within bedrock may be conveyed via these predominant features in the site area.

Several soil borings completed at the current fire station FTA (e.g., SB-1, MW-2) encountered shallow refusals presumably on bedrock. Overburden groundwater was encountered in only one (1) location within the low lying northerly most boring;

MW-1. Shallow soil within the reported FTA has been shown to contain PFAS, predominantly PFOS. Local officials acknowledge some training exercises which included the use of AFFF have historically been completed at the FTA.

It is likely precipitation and stormwater percolates through the residual PFAS within the surficial soil at the FTA with some PFAS leaching down into the shallow bedrock entering the existing rock fractures and thereby transported via convective groundwater flow within the bedrock aquifer. The highest concentrations of PFOA/PFOS combined (above the AGQS) are found within the bedrock water supplies serving the current fire station and the adjacent water supply serving the Dunkin Donuts to the northeast.

Overland stormwater runoff may additionally transport surficial sediments from the FTA or other similarly impacted areas (e.g., MW-2) into the local stormwater conveyance system impacting local surface waters at the onsite outfall and within the adjacent unnamed impoundment at the rear of the Anytime Fitness Facility. As previously noted, PFOA/PFOS combined was detected within the impoundment at a concentration of 76.2 ng/l.

7.6.2 Former Fire Station

Groundwater in shallow overburden is expected to flow toward the southwesterly flowing Golden Brook which transects the site area (Figure 3 and 4). Soil borings advanced at the former fire station property (MW-3 and MW-4), as well as the nearby soil boring MW-5, each encountered water bearing overburden (fine to medium Sand) which overlies bedrock.

It is speculated that AFFF have historically been used, stored and associated equipment washed at this location. Stormwater runoff may have transported PFAS off paved surfaces into the adjacent gravel shoulders and surrounding vegetated areas. It is likely precipitation and stormwater percolates through the residual PFAS within this surficial soil and leach into the shallow overburden aquifer. PFOA/PFOS combined were detected within groundwater samples collected from the installed monitoring wells at MW-3, MW-4 and MW-5. The combined

concentration of PFOA/PFOS was found to exceed AGQS in groundwater samples collected from monitoring wells MW-4 and MW-5.

PFAS impacted groundwater is then likely transported to the southwest toward the southwesterly flowing Golden Brook and may discharge to the brook as evidenced by PFAS within surface water collected from the brook. We note, detected PFAS within Golden Brook are weighted more heavily to PFOA, while most of the impacted groundwater and soil in the region is predominantly impacted by PFOS.

PFAS are also found in water supplies in proximity to the former fire station but at concentrations below AGQS. The spatial orientation of the impacted water supplies are generally consistent with the presumed predominant bedrock fracture pattern along a southwest to northeast direction. It is unclear if these water supplies are impacted as a result of the overlying overburden impacted groundwater or is part of the bedrock plume emanating from the FTA.

8.0 REMEDIAL ALTERNATIVES

Preliminary screening of the impacted media and an initial recommendation are provided in the subsections below.

8.1 Preliminary Screening of Alternatives - Soil

Soil analytical results suggest a risk related to direct dermal exposure is not present as the results were significantly below the established DCRB. It is likely the near surface soil containing PFAS do act as a source for impacts to groundwater. Therefore, remedial alternatives would focus on reduction in infiltration and leaching but would not require limiting direct contact.

Although soil in the vicinity of the FTA is impacted with PFAS and excavation and offsite disposal may be an appropriate remedial technique in similar scenarios, based on the lack of an established NHDES SRS coupled with the overall lack of general disposal guidelines and/or standards for PFAS, excavation and offsite disposal of the impacted soil is not recommended at this time. Currently, offsite disposal of an unregulated hazardous material could potentially generate unwanted liability for the town and only until proper disposal protocols and action levels have been established by the EPA and NHDES, should excavation/offsite disposal be assessed

as a remedial alternative.

Alternatively, since PFAS are considered to be recalcitrant and have low volatility, capping of the PFAS impacted soil observed at the FTA via an engineered cap consisting of an asphalt and/or concrete cover would eliminate future potential recharge and run-off to downgradient surface water bodies, groundwater and subsequently private/public water supply wells. This alternative would require additional characterization of the impacted area(s) to define the areas requiring a cap.

In addition, given the lack of direct contact risk, the soil may remain in place (potentially under deed restriction) if alternative water is supplied to the receptors as described below.

8.2 Preliminary Screening of Alternatives - Groundwater/Bedrock

Due to the preliminary detections of PFAS in water supply samples collected from the current fire station water supply and the WSC, POE systems were previously installed to supply treated potable water to these facilities. Additionally, one (1) nearby business (30 Indian Rock Road [Dunkin Donuts]) also maintains a POE system for potable water.

Potential PFAS remedial alternatives documented to be capable of removing PFAS from groundwater/drinking water include:

- Membrane Filtration (MF)
- Ion Exchange (IE)
- Granular Activated Carbon (GAC)
- Alternative Water Supply (Municipal)

Of the three (3) remedial alternatives, based on empirical data collected to date, virgin GAC has been proven to be successful at removing > than 90% of PFOA, PFOS and PFNA as well as PFBA, PFPA, PFFHxA, and PFDA to a lesser extent. This is evidence by the current use of POE systems at the current fire station, the WSC and 30 Indian Rock Road (Dunkin Donuts). Additionally, since spent activated carbon, containing adsorbed PFAS, can be thermally reactivated, thereby destroying the contaminants, the reactivated GAC can be recycled and reused. Specific information regarding GAC adsorption rates should also be considered since they could extend the O&M of the POE systems and thus increasing long term treatment costs.

Although GAC has been documented to be effective at removing numerous PFAS constituents as seen with the existing POE systems currently active at the site area; based on Nobis' experience with long-term POE O&M, the total estimated cost to operate the POE systems at the current fire station and the WSC (including engineering services) over the next 15 years could range from $300,000 to $500,000. In addition, it is anticipated that new PFAS standards in groundwater will be forthcoming and it is feasible that not all PFAS constituents will be treatable via GAC and additional remedial options may also be necessary. If so, the overall estimated cost for POE treatment could increase to account for additional treatment and/or longer operational life. Moreover, it is the current policy of the NHDES that POE treatment is not considered a feasible and viable long term permanent remedial solution.

We are aware the NHDES is currently planning on the extension of a municipal water main that will extend south along Route 28 and will connect to the existing 8-inch municipal main currently extending from Salem and terminating within the Route 111/111A intersection. In addition, we also understand that the town has plans on extending the municipal water main from the Route 111/Route 111A, approximately 12,000 linear feet west to Ledge Road.

Therefore, Nobis recommends continued O&M of the POE systems until the planned municipal water main extension is complete. Once completed, we recommend the impacted water supplies maintaining a POE for potable water be connected to the municipal water main to eliminate the risk for future exposure to PFAS via untreated influent or breakthrough of the GAC units and the overall financial burden associated with POE maintenance.

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

Nobis has completed these SI activities associated with the WSC in Windham, New Hampshire. The SI was conducted to identify the nature and extent of PFAS-impacts to soil, ground and surface water and bedrock private/public water supply wells. The findings of the SI are as follows:

- Based on interviews with town officials, two (2) potential source areas for the PFAS occurrence were suggested: 1) Fire training area (FTA) associated with the current fire station, and 2) historic storage, use and equipment wash methods at the former fire station;

- PFAS were detected above laboratory method detention limits within each soil sample collected for this SI. However, we note an associated SRS standard has not yet been established for PFAS. Additionally, analysis of soil samples collected for this SI did not reveal PFAS constituents at concentrations in excess of the established DCRB soil screening concentration;
- PFAS were detected above laboratory method detention limits within each groundwater sample collected for this SI. AGQS exceedances were detected within the groundwater samples collected from monitoring wells MW-4, MW-5 and the MW-5 laboratory duplicate; each of which are located downgradient of the former fire station;
- PFAS were detected above laboratory method detection limits within each surface water sample collected for this SI. Although no surface water standard currently exists, as a comparison, the surface water sample collected from the unnamed pond south of the Anytime Fitness facility and immediately down gradient of the current fire station outfall, contained PFAS at a concentration above the AGQS; and
- PFAS were detected above laboratory method detection limits within each bedrock water supply collected for this SI. AGQS exceedances were reported from the private water supply well samples collected from the current Windham Fire station and duplicate and the 30 Indian Rock Road (Dunkin Donuts) water supplies;

9.2 Recommendations

Based on the data collected for this SI, Nobis recommends that the following actions be conducted or considered by NHDES:

1. Continued groundwater sampling and analysis of the site area monitoring well network and impacted drinking water supplies to assess concentration trends, fate and transport of PFAS in groundwater;
2. Continued POE maintenance at those locations currently utilizing POE treatment equipment;
3. Connection of the impacted water supplies with concentrations of PFAS above AGQS to the planned municipal water main extension once completed.