Expert Report of Charles F. McLane III, Ph.D.

Town of Hempstead

v.

the United States of America, et al.

Case No. 16-cv-03652 (JFB)(SIL)

Prepared for:

The United States and the Department of the Navy

Prepared by:

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January 17, 2020

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1.0 INTRODUCTION

This report was prepared at the request of the United States and the Department of the Navy, Defendants in the matter Town of Hempstead vs. the United States of America, et al. (Case No. 16-cv-03652 (JFB)(SIL)). The Plaintiff, Town of Hempstead (TOH), alleges that three public water supply wells that it operates, Levittown Water District (LWD) public supply wells 7A, 8A, and 13, have been impacted by several Contaminants of Concern (COCs), namely 1,1,2-Trichloro-1,2,2-trifluoroethane (commonly known as Freon-113), emanating from the Northrop Grumman (NG) and Naval Weapons Industrial Reserve Plant (NWIRP) properties in Bethpage, NY (referred to hereafter as the NG and NWIRP "sites" or "properties", shown in **Figure 1**). TOH is seeking compensation for the design, construction, and operation of groundwater treatment systems for these three wells.

As part of my work in this matter, I was asked to review and evaluate the August 6, 2019 joint expert report of Mr. Richard Humann and Dr. Timothy Hazlett of H2M Architects and Engineers (H2M), prepared on behalf of Plaintiff (TOH). For the purposes of my comments, I will refer to the report as the H2M Report, and address its findings as though they were offered by the company, as I am not able to directly attribute statements or conclusions in the report to one or the other of its authors.

Based on my review of H2M's August 2019 report, I find that their conclusions and opinions are highly speculative and tenuously supported. Specifically, as demonstrated further in subsequent sections of this expert report,

1. H2M has not demonstrated that detections of Freon 113 in the LWD wells are associated with a specific release from the NG or NWIRP properties, and in fact, analysis of available sampling data supports the presence of a separate Freon-113 plume that is located to the west of, and deeper than, the OU-2 groundwater plume, which consists of predominantly TCE;
2. the capture zone analysis performed by H2M is overly simplistic and inadequate; and,
3. There are numerous likely and potential sources of Freon-113 (and other COCs) located hydraulically upgradient from the LWD wells, which H2M failed to consider as part of their evaluation.

The opinions expressed herein are based on the documents and information that I have reviewed to date. I reserve all rights to supplement the analyses, conclusions, and opinions presented in my report if additional information and data are provided for my review.

1.1 Qualifications

I am the founding Principal of McLane Environmental, LLC, an environmental consulting firm located in Princeton, New Jersey. I specialize in groundwater flow system analysis, and in the fate and transport of chemical contaminants in the subsurface, including the use of computer simulation and data visualization techniques to support contaminant pathways analyses, human and ecological risk assessment, and remedial engineering investigations.

With more than 30 years of diverse experience, my work at McLane Environmental includes providing strategic consulting for corporate clients regarding investigative and remedial activities at operating industrial facilities; technical direction for site characterization, remediation and groundwater modeling activities at Department of Defense and Department of Energy sites (including several sites where the Department of the Navy historically operated); quantitative hydrogeologic analyses to support municipal and residential groundwater management planning; and providing expert witness testimony regarding the fate and transport of chemicals in the subsurface and the adequacy and necessity of investigation and remediation efforts. I have managed and consulted in hydrogeologic and modeling studies of groundwater flow and the transport of organic chemicals, including chlorinated solvents, in a wide variety of aquifer settings including numerous investigations of chemical sources and resulting contamination in Nassau and Suffolk Counties, Long Island, New York.

I hold a B.A. in Geology from Susquehanna University and an M.S. in Geology from the Earth Resources Department of Colorado State University. I hold a Ph.D. in Environmental Sciences from the University of Virginia, where I completed a hydrogeology coursework and research program that included the quantification of, and development of a computer simulation model for, groundwater flow processes. Prior to forming McLane Environmental, I was a Senior Science Advisor and Manager with ENVIRON International Corporation, Principal Hydrogeologist with Geraghty and Miller Groundwater Consultants, and Senior Engineer with Rockwell International Corporation. I have authored or delivered over thirty publications and presentations in the areas of groundwater flow and contamination, risk assessment methodologies, and groundwater modeling. On numerous occasions, I have chaired or lectured in groundwater seminars and short courses including a course outlining the techniques of Environmental Forensics sponsored by the National Ground Water Association; presented technical papers at scientific meetings; and conducted seminars for groups of regulators and clients on the topics of groundwater flow and contaminant migration, analysis of site investigation data, and the use of computer simulation models. I am a member of the Hydrology Division of the American Geophysical Union. I am also a member of the National Groundwater Association.

My current rate of compensation for my work in this matter is $220 per hour. A copy of my curriculum vitae is included as **Appendix A**., and a summary of previous testimony is provided in **Appendix B**.

1.2 Areas of Investigation

In addition to reviewing H2M's August 2019 report, I also reviewed the deposition testimony of Mr. Humann and Dr. Hazlett, I was also asked to review the expert report (and subsequent deposition testimony) of Mr. William Merklin of D&B Engineers and Architects, P.C. (D&B), and evaluate documents and data related to the LWD wells, including engineering design reports, well construction logs, and chemical sampling data. Additionally, I was asked to review regulatory documents and related information (including Record of Decision (ROD) documents issued for the NWIRP and NG sites, and the related Public Water Supply Contingency Plan (PWSCP)); documents, data, and information regarding operation of the Operable Unit 2 (OU-2)[1] On-Site Containment System (ONCT system)[2] at the NG and NWIRP sites; chemical sampling results for groundwater wells at and in the vicinity of the NWIRP and NG sites; hydrogeologic data (e.g., information regarding aquifer characteristics, groundwater elevation data, etc.); maps and geospatial data; published studies and literature; and other relevant information, including information regarding potential sources of Freon-113 in groundwater in the vicinity of the LWD wells. A full list of documents considered and relied upon in preparation of this report is included in **Appendix C**.

While I examined H2M's groundwater flow model, and performed additional alternative simulations with their model as part of my evaluation, I did not construct and calibrate a groundwater model due to the current lack of adequate hydrogeologic data and information for the area located to the west of the NG and NWIRP properties and hydraulically upgradient from the LWD wells - - a data absence that calls into question H2M's modeling and conclusions, as I discuss further below. Neither did I install and sample additional monitoring wells in that area, as field investigations were beyond the scope of the evaluation I was asked to perform.

Based on my review of the documents, data, and information described above, I was asked to evaluate the analyses and associated conclusions drawn by experts working on behalf of Plaintiff TOH regarding the source of Freon-113 (and other COCs) in LWD Wells 7A, 8A, and 13, and to offer opinions in response to those conclusions, as

[1] As noted in the March 2001 ROD issued by New York State Department of Environmental Conservation (NYSDEC) for the NWIRP and NG sites, Operable Unit 2 refers to the regional groundwater contaminant plume emanating from the NG and NWIRP sites.

[2] The ONCT System consists of five groundwater extraction wells, two treatment systems, and two recharge basins located on the NG property. The system is designed to contain and treat impacted groundwater associated with the NG and NWIRP sites by extracting groundwater, treating it, and discharging the treated water to recharge basins located along the western and southern portions of the NG property.

well as opinions regarding likely and potential sources of Freon-113 impacts observed in the LWD wells.

A brief summary of my opinions is included in Section 1.3 below. A detailed discussion of those opinions is included in Sections 2.0 through 4.0. Finally, my conclusions based on documents and information reviewed to date are included in Section 5.0.

1.3 Summary of Opinions

A brief summary of my opinions in this matter is set forth below. Further discussion of the bases for these opinions is provided in subsequent sections of this report.

Opinion 1: By its own acknowledgement, H2M has not identified any specific releases of Freon-113 from the NG or NWIRP sites that would have resulted in the generation of a separate Freon-113 plume. In fact, analysis of available sampling data supports the presence of a separate Freon-113 plume that is located to the west of, and deeper than, the OU-2 groundwater plume, which consists of predominantly TCE.

Opinion 2: Groundwater modeling analyses performed by H2M to evaluate groundwater capture zones for LWD wells 7A, 8A and 13 are overly simplistic, and do not demonstrate that detections of Freon-113 in these wells are attributable to a release (or releases) from the NG or NWIRP sites.

Opinion 3: Evaluation of regional water quality data and information regarding potential sources of Freon-113 (and other COCs) detected in LWD Wells 7A, 8A, and 13 indicate that these constituents are commonly detected at similar concentrations in groundwater in areas hydraulically upgradient from these wells, and that available documents and data indicate that there are numerous potential sources of these compounds that H2M failed to consider as part of its evaluation.

2.0 OPINION 1

By its own acknowledgement, H2M has not identified any specific releases of Freon-113 from the NG or NWIRP sites that would have resulted in the generation of a separate Freon-113 plume. In fact, analysis of available sampling data supports the presence of a separate Freon-113 plume that is located to the west of, and deeper than, the OU-2 groundwater plume, which consists of predominantly TCE.

In its August 6, 2019 expert report, H2M concludes that releases of Freon-113 at the NG and NWIRP sites in Bethpage, NY resulted in a distinct Freon-113 plume that has contaminated LWD wells 7A, 8A, and 13. As it acknowledges in its report, however, aside from establishing that Freon-113 was historically utilized at the NG and NWIRP sites, H2M cites to no specific documentation of bulk Freon-113 releases and/or source areas on the properties. Further, H2M offers misleading, highly speculative, and incorrect allegations regarding (i) completeness of containment by the NG and NWIRP ONCT groundwater remediation system, (ii) the processes governing the fate and transport of chemicals in groundwater, and (iii) interpretation of groundwater chemistry data.

2.1 H2M Has Not Identified Any Releases or Source Areas of Freon-113 at the NG and NWIRP Sites

H2M incorrectly asserts in the conclusions section of its report that *"… there is a distinct Freon-113 plume emanating from the NG / NWIRP site…"*. First, H2M is incorrect in stating that there is a Freon-113 plume emanating from the NG and NWIRP properties, as discussed in Section 2.4 below. Second, despite the review of historical operational records produced by the Navy and NG, there is no information indicating an historical release of Freon-113 from the NWIRP and NG facilities that would serve as the source for such a plume. H2M even acknowledges that *"…it is not specifically known when Freon-113 was in use or when and where it was stored, released or disposed of onsite."*[3] Available documentation indicates that Freon-113 was historically utilized and stored on the NG and NWIRP properties[4], as confirmed by testimony provided by the NG manager of environmental and the health, medical and the environmental project manager for the NWIRP site, who stated that specific areas where Freon-113 was historically utilized are not well known, and that no Freon-113 source areas have been identified at either property.[5,6] In the absence of documentation regarding bulk releases of Freon-113, and/or environmental sampling data indicating the presence of Freon-113 source areas on the NG or NWIRP properties, H2M's conclusion that a distinct Freon-

[3] H2M 2019. Expert Report - TOH v. United States of America, et al. -16-CV-3652. August 6. pg. 8.
[4] See, for example, the 1986 IAS Report (Rogers, Golden and Halpern, 1986. Initial Assessment Study, Naval Weapons Industrial Reserve Plant, Bethpage and Calverton, NY. UIC: N6095/N0845. December.) prepared for the NWIRP Site, which indicates that Freon-113 was stored on the property.
[5] Deposition of Lora Fly, August 14, 2019. pg. 202 line 21 to pg. 203 line 18
[6] Deposition of Edward Hannon, June 21, 2019. pg. 58 lines 12-25

113 plume is emanating from the NG and NWIRP sites is unfounded, and highly speculative (See Section 2.4 for further discussion of this flawed H2M conclusion).

H2M states in the conclusions section of its report that "*Freon-113 is a COC established by the NYSDEC in its Record of Decision for OU2, meaning the contaminant was used on-site, was released/discharged into the environment, contaminated the groundwater and threatened sensitive receptors.*"[7] Freon-113 is not established as a COC in either the New York State Department of Conservation (NYSDEC) ROD or the Navy's CERCLA ROD for OU-2.[8] It is, however, identified as a Volatile Organic Compound (VOC) in the post-ROD PWSCP developed by ARCADIS in 2003.[9] Although Freon-113 (and other COCs identified in Table 1 of the PWSCP) are identified as "site-related", as discussed further in Section 4.0 below, these compounds (including Freon-113) are not unique to the NG and NWIRP sites, and in fact, are commonly detected in regional groundwater. As such, a thorough evaluation (e.g., analysis of groundwater quality data, groundwater flow conditions, contaminant fate and transport) would be required to establish a nexus between releases of Freon-113 at the NG or NWIRP properties and groundwater impacts observed in the LWD wells; an evaluation that H2M has not completed.

2.2 H2M's Interpretation of ONCT System Capture

In an attempt to link Freon-113 impacted groundwater found to the southwest of the NG and NWIRP sites to site-related releases (none of which have been identified, as noted above) , H2M speculates that there is 1) underflow of the OU-2 ONCT system (i.e., that the ONCT system only extends to 500 feet below ground surface (ft bgs), and would not capture deeper groundwater), and that 2) contaminated groundwater on the northwestern portion of the NG and NWIRP sites would not be captured by ONCT Wells 1 and 3R, and would be "pushed" further west by Site recharge basins located on the western boundary of the NG property.[10] H2M provides no supporting evidence for this theory. In fact, H2M's theory is contradicted by available data and information regarding the OU-2 ONCT system, and by H2M's own groundwater modeling analyses (as discussed further in Section 3.0 below).

The OU-2 ONCT system consists of five groundwater extraction wells (Well 1, Well 3/3R, Well 17, Well 18, and Well 19), two treatment systems, and two sets of recharge basins. In its expert report, H2M asserts that the ONCT extraction wells only

[7] H2M 2019. Expert Report - TOH v. United States of America, et al. -16-CV-3652. August 6. pg. 8.
[8] The Navy and NG have been implementing a remedy identified in the NYSDEC 2001 ROD and the Navy 2003 ROD for OU2. The RODs call for on-site containment of impacted groundwater from source areas; groundwater extraction and treatment of hotspots (VOCs at concentrations greater than 1,000 µg/l); a public water supply contingency plan for monitoring and potentially providing treatment at down-gradient public water supply wells; and off-site monitoring of groundwater.
[9] ARCADIS 2003. Public Water Supply Contingency Plan. July 22. Table 1.
[10] H2M 2019. Expert Report - TOH v. United States of America, et al. -16-CV-3652. August 6. pg. 4.

extend to a depth of approximately 500 ft bgs, and since the Magothy aquifer extends to a depth of approximately 800 ft bgs in this area, any contamination from the NG and NWIRP properties that is deeper than 500 ft bgs would not be captured/contained by the ONCT system. This is not correct. First, all OU2 ONCT system wells extend to depths greater than 500 ft bgs, and Well 19 extends to over 600 ft bgs (**Table 1, Figures 2a-b**).[11] Second, H2M provides no support for its assertion regarding contaminants "underflowing" the ONCT System, nor for the assertion that there is off-Site migration of contaminated groundwater in western portions of the NG and NWIRP sites.

An evaluation of ONCT system effectiveness performed by ARCADIS (consultants working on behalf of NG) indicated that the system has effectively captured and contained impacted groundwater at the NG and NWIRP sites, contradicting H2M's assertions. Specifically, between 2011 and 2013, ARCADIS collected data as part of the "ONCT Hydraulic Effectiveness Program" to evaluate whether the system's performance was consistent with the remedial objective of eliminating off-site migration of contaminants to the extent practicable.[12] Following data collection, ARCADIS concluded that the results of routine groundwater monitoring indicated that hydraulic containment was being achieved, and that extraction well pumpage, coupled with discharge of clean water via recharge basins forms a hydraulic barrier to groundwater flow that is preventing the off-site migration of VOC impacted groundwater (see **Figures 3a and 3b,** which show bifurcation (i.e., separation) of on- and off-property groundwater impacts).[13]

H2M's assertions regarding ONCT system underflow and ineffectiveness in the western portions of the NG or NWIRP properties are incorrect, unfounded, and contradicted by available data and information.

2.3 H2M's Interpretation of Freon-113 and TCE Transport in Groundwater

To explain how Freon-113 could be transported from the NG and NWIRP sites and yet arrive at the LWD wells without significant accompanying concentrations of TCE (a chemical identified as a marker for releases from the NG and NWIRP sites – as discussed further in the subsection below), H2M erroneously suggests that Freon-113 must travel faster than TCE because of its physical and chemical properties. To support this invalid concept, H2M introduces a novel theory on dissolved phase fate and transport based on the density and viscosity properties of TCE and Freon-113 Dense Non-Aqueous Phase Liquids (DNAPLs, which are liquids that are denser than water).

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[11] ARCADIS 2015. Interpretive Report for the On-Site Containment System Hydraulic Effectiveness Program.
[12] ARCADIS 2014. 2013 Periodic Review Report. pg. 3 (pdf pg. 11)
[13] ARCADIS 2014. 2013 Periodic Review Report. pg. 4 (pdf pg. 12)

H2M asserts that Freon-113 "…*will flow much easier than TCE*", and as such, will "…*always outpace TCE*" in groundwater .[14]

Specifically, H2M states,

> *"Generally, Freon-113 will always outpace TCE, which will always outpace water flowing through porous media such as that found in the Magothy aquifer. Based on these principles, TCE and Freon-113 groundwater plumes of similar quantity sourced from the same place and time would tend to separate by approximately 8% by density and viscosity effects alone under otherwise identical subsurface conditions."*[15]

First, H2M's use of the DNAPL properties to try to explain the movement of TCE and Freon-113 in the OU2 plume is not supported by scientific concepts. The DNAPL properties of density and viscosity are relevant to the transport of a chemical in its pure form – not to a chemical dissolved in water. The concentrations of Freon-113 and TCE cited by H2M in its August 2019 report are in the single parts per billion (ppb) to the hundred ppb range.[16] Based on these observed concentrations, and concentrations of these compounds observed in OU-2 monitoring wells, properties governing the transport of dissolved TCE and Freon-113 in groundwater – not properties for undissolved separate phase DNAPL - must be considered when evaluating the fate and transport of these compounds, as discussed further below.

The related error in H2M's concept is that H2M ignores the factor that actually controls the rate of movement of a dissolved organic contaminant in groundwater - - the retardation factor. The primary factor controlling the rate of movement of a dissolved chemical in a groundwater plume, in addition to the groundwater velocity itself, is the retardation factor.[17] This factor, which depends on the chemical's affinity for aquifer material (i.e., water-bearing unconsolidated materials, including sand, silt, gravel or clay) and therefore its likelihood to adsorb (i.e., adhere) onto the aquifer materials it is flowing through, is an indicator of the relative rate of movement of the chemical relative to the rate of movement of an un-adsorbed and thus unretarded chemical. A retardation factor of 2.0 for Chemical B, for example, indicates that it will move twice as slowly (i.e. at one-half the speed) as an unretarded Chemical A with a retardation factor of 1.0.

The retardation factor associated with a particular chemical is dependent upon its measured organic carbon portioning coefficient, referred to as K_{oc}.[18] The USEPA

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[14] H2M 2019. Expert Report - TOH v. United States of America, et al. -16-CV-3652. August 6. pg. 6-7
[15] H2M 2019. Expert Report - TOH v. United States of America, et al. -16-CV-3652. August 6. pg. 6-7
[16] H2M 2019. Expert Report - TOH v. United States of America, et al. -16-CV-3652. August 6. pg. 5
[17] See for example, Fetter, 1999, pg. 123; Freeze and Cherry, 1979, pgs. 402-405; and Pankow and Cherry, 1996, pgs. 239-242
[18] The magnitude of the retardation factor, which governs the rate of a chemical dissolved in a groundwater plume to travel, is determined from aquifer properties and contaminant properties. When two contaminants

reports that the K_{oc} for TCE is approximately 61 L/Kg and the reported K_{oc} for Freon-113 is approximately 200 L/Kg.[19] Based on these K_{oc} values, dissolved phase Freon-113 will tend to move slower than TCE in groundwater by a factor of more than 3 (i.e., Freon-113 would be expected to move more than three times slower than TCE in groundwater). Accordingly, H2M's assertion that Freon-113 would separate from TCE by moving approximately 8% faster (based on its erroneous use of DNAPL properties of density and viscosity of these compounds) is incorrect, because that concept is not applicable to dissolved transport of these compounds in groundwater. Further, H2M's theory that Freon-113 must always outpace TCE is groundwater is shown to be incorrect; and in fact it is actually the reverse. This critically hinders H2M's attempt to explain the presence of Freon-113 without TCE in LDW 7A, 8A and 13 wells.

Finally, H2M's assertion is not supported by available groundwater sampling data. Specifically, data recently collected (December 2017) from wells BPOW 3-4, RE-117D1, and RE117D2 (a comprehensive map showing these monitoring well locations is included in **Attachment 1),** located near the distal portion of the known OU-2 plume (which is located to the southeast of the LWD wells), showed the following concentrations[20]:

BPOW 3-4:	TCE – 106 ug/L, Freon-113 – 2.7 ug/L
RE117D1:	TCE – 13 ug/L, Freon-113 – ND
RE117D2:	TCE – ND, Freon-113 – ND

These data, which indicate the presence of TCE and absence of Freon-113 in the RE117 well cluster, and the presence of TCE at much higher concentrations than Freon-113 in BPOW-3-4 (i.e., consistent with the OU-2 plume signature, as discussed further below), refute H2M's claim that " *Freon-113 will always outpace TCE*". If H2M's assertion were correct, one would expect to see predominantly Freon-113 – and not TCE – in these wells.

H2M's assertions that Freon-113 "*…will flow much easier than TCE*", and as such, will "*…always outpace TCE*" in groundwater are deeply flawed, and are not supported by available sampling data, and are at odds with sound scientific principals regarding the fate and transport of contaminants in groundwater.

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move through the same aquifer material, dissolved in groundwater, the difference in their velocities (i.e. the rate at which each contaminant will move through the groundwater), is dependent on each contaminant's tendency to adhere onto aquifer materials. The tendency for a chemical to adhere to aquifer materials is typically determined based on the chemical's organic carbon portioning coefficient, referred to as K_{oc}, values for which are readily available in publicly accessible literature. In general, for two chemicals traveling along the same path in an aquifer, a chemical with a larger value of K_{oc}, will have a larger retardation factor and move slower in groundwater.

[19] USEPA 2019. Regional Screening Level (RSL) Chemical-specific Parameters Supporting Table. November. pg. 8

[20] NYSDEC 2019. Water Quality Database. February.

2.4 H2M's Interpretation of Groundwater Chemistry Data

H2M concluded (incorrectly) that the NG and NWIRP properties are the source of Freon-113 impacting LWD wells 7A, 8A and 13. H2M acknowledges that the plume impacting the LWD wells consists of predominantly Freon-113 (with little to no detections of other COCs, including TCE). Although both on- and off-Site groundwater investigations performed by the Navy and NG have identified TCE as a marker for releases from the NG and NWIRP sites[21], H2M asserts that the assumption that all contaminated groundwater originating from the NG and NWIRP properties contains TCE is invalid.[22] H2M provides no supporting analysis of water quality sampling data to back up this assertion. In fact, analysis of available sampling data supports the presence of a separate Freon-113 plume that is located to the west of, and deeper than, the OU-2 groundwater plume which consists of predominantly TCE.

The presence of a separate, distinct Freon-113 plume to the west of the OU-2 plume (and the predominance of TCE in the OU-2 plume) is described in the Navy's 2018 Report to Congress, which states, *"…there is evidence of a relatively pure Freon-113 plume (VPB-165) along the western edge of the Deep Western Plume (OU2) that appears to be influenced by additional plumes further north and west of the former NWIRP Bethpage and Northrop Grumman facilities (Appendix A and the 2017 Annual Report). The plumes associated with the former NWIRP Bethpage and Northrop Grumman facilities have TCE as the primary component of the total VOCs present, whereas Freon-113 is only a minor component."*[23] Using available data from public water supply wells and groundwater monitoring wells, **Figures 4 and 5** show a comparison of Freon-113 concentrations relative to other OU-2 plume related COCs (including TCE, PCE [and related breakdown products]). **Figures 4 and 5** clearly show that the LWD wells, which are located further to the west, have generally not been impacted by TCE (the primary OU2 plume constituent), whereas shallower wells located further to the east (and within the OU-2 plume) exhibit a chemical signature that consists of predominantly TCE. For example, as shown in **Figures 4 and 5**, the RE-131 well cluster, which is located along the western periphery of the OU-2 plume, shows predominantly TCE impacted groundwater at shallower depths (e.g., RE-131-D1, located at approximately 440 ft bgs), and predominantly Freon-113 impacts in deeper portions of the aquifer (e.g., RE-131-D2, located at a depth of approximately 578 ft bgs). The presence of a deeper Freon-113 plume to the west of the OU-2 plume is further depicted in **Figure 6a-b**, which shows a cross-sectional view along several groundwater monitoring well, VPB, and PWS well

[21] Deposition of Lora Fly, August 14, 2019. pg. 196 lines 3-25
[22] H2M 2019. Expert Report - TOH v. United States of America, et al. -16-CV-3652. August 6. pg. 4.
[23] 2018 NAVY REPORT TO CONGRESS, Section 3-1, pg. 3-3, Par 4

locations. Specifically, as shown in **Figure 6b**, Freon-113 is detected at deeper depths than TCE.

The distinction between these two separate plumes is further shown in **Figures 7a-c**, which display pie charts with the relative percentage of Freon-113 and TCE measured at each location, along with the maximum concentrations of Freon-113 observed at each location, and pathlines representing LWD well groundwater capture zones generated by H2M (discussed further in Section 3.0 below). As shown in these figures, consistent with testimony from the environmental project manager for the NWIRP site, the chemical signature of the OU-2 plume (i.e., sampling locations located hydraulically downgradient from the NG and NWIRP properties) is dominated by TCE (i.e., the blue color in the pie charts), whereas the wells located just to the west of the OU2 plume, and at deeper depths, appear to be dominated by Freon-113 (i.e., the red color in the pie charts). Since little to no TCE has been detected in LWD wells 7A, 8A and 13, the low VOC concentrations observed in these wells is not likely associated with the OU-2 plume, and is likely attributable to a source (or sources) of VOCs located to the northwest, as discussed further in Section 4.0 below.

For the reasons noted above, H2M's assertion that there is a distinct Freon-113 plume emanating from the NG and NWIRP sites is incorrect. Available sampling data clearly demonstrate that there are different chemical signatures observed in the LWD wells (and in the limited number of wells located hydraulically upgradient from the LWD wells). The predominance of Freon-113 in these locations indicates that these wells are likely being impacted by an unknown source located to the north or northwest, and not the OU-2 plume (which predominantly consists of TCE). Possible sources of Freon-113 impacts to the LWD wells are discussed further in Section 4.0.

3.0 OPINION 2

Groundwater modeling analyses performed by H2M to evaluate groundwater capture zones for LWD wells 7A, 8A and 13 are overly simplistic, and do not demonstrate that detections of Freon-113 in these wells are attributable to a release (or releases) from the NG or NWIRP sites.

H2M constructed a groundwater flow model and performed analyses to delineate zones of capture[24] for these wells in an attempt to demonstrate that detections of Freon-113 have been observed within the capture zone areas. Review of H2M's groundwater model indicates that the model greatly oversimplifies the complex stratigraphy of the Magothy Aquifer (information for which is limited in the area modeled by H2M), does not contain key model stresses (e.g., remedial extraction wells, infiltration basins, and pumping from nearby public water supply wells), and greatly overestimates the amount of pumping associated with the LWD wells (and, in turn, overestimates the extent of the LWD well capture zones). Further, even if one were to accept the LWD well capture zones delineated by H2M, they do not demonstrate that groundwater will be captured from the NG or NWIRP sites.

3.1 H2M's Representation of the Magothy Aquifer

H2M uses a simple single layer homogeneous (uniform aquifer properties) model to represent the Magothy Aquifer.[25] Previous modeling studies performed in the region have noted that, "*The Magothy aquifer and the upper zone of the Raritan formation are heterogeneous mixtures of high- and low-permeability materials through which groundwater flows preferentially within the permeable materials*."[26] The more permeable materials through which flow preferentially occurs (i.e., groundwater tends to flow more easily through more permeable materials, such as sand and gravel, as opposed to less permeable materials, such as silt and clay) control the flow of groundwater and thus the movement of contaminants. H2M's single-layer, homogeneous model greatly oversimplifies this complex system, and as a result, for this reason alone, cannot be utilized to accurately delineate the zones of capture for the specific LWD wells.

Since H2M chose to represent the Magothy Aquifer as a single-layer, homogeneous aquifer in its model, the LWD wells that they placed in the model fully penetrate the entire model layer, and pump from the entire 625 feet thick aquifer (i.e., the area in which the well draws water from extends across the entire aquifer thickness). In reality, the LWD wells are screened over intervals of between 70 and 120

[24] A zone of capture refers to the three-dimensional, volumetric portion of a groundwater-flow field that a well draws from. The zone of capture of a well, which is often depicted two-dimensionally, is typically estimated using a groundwater flow model.
[25] H2M 2019. Expert Report - TOH v. United States of America, et al. -16-CV-3652. August 6. pg. 7
[26] Misut, 2011 (USGS Open-File Report 2011-1128), pg. 5

feet starting at a depth of 500 ft bgs to approximately 600 ft bgs (i.e., the screened area, or the areas in which wells draw water from, extends over a much smaller portion of the aquifer, ranging in thickness from 70 to 120 ft, at depths of 500 to 750 ft bgs).[27] As such, particle pathline analyses (i.e., tracing of groundwater flow paths that contribute to a pumping well over a specified period of time) performed by H2M from these fully penetrating wells are misleading, as they are not representative of the discrete zones at which the LWD wells are actually screened.

3.2 H2M's Failure to Include Key Pumping and Discharge Features

In addition to using an overly-simplistic representation of the Magothy Aquifer, the H2M model is missing key pumping and discharge features that are located in the real aquifer within the model domain boundaries, including the OU-2 ONCT system (which, as noted in Section 2.0 above, includes five groundwater extraction wells, and two sets of recharge basins). Review of H2M groundwater modeling files indicate that, although several other public water supply wells appear to have been represented in the model, none of them are pumping.[28] Review of available pumping data for these wells indicates that these wells pumped a significant amount of water between 2009 and 2014, and therefore, these pumping and discharge features would have a significant effect on groundwater flow conditions, and should have been considered in the model (see my analysis that demonstrates this in the latter part of this section).

The only operational wells within the H2M model are LWD wells 7A, 8A, and 13, each pumping at their maximum permitted rate of 2 Million Gallons per Day (MGD). Applying the maximum permitted pumping rates to delineate zones of capture for the LWD wells is unrealistic, and significantly overestimates the extent of the modeled capture zones. Review of pumping rates for the LWD wells between 2009 and 2014 indicates each well had a maximum monthly pumping rate of 1.3 MGD to 1.6 MGD between 2009 and 2014 (**Table 2**).[29] H2M's use of 2 MGD rather than the observed maximum monthly pumping rate increases the pumping of the LWD wells by up to 65% and results in zones of capture that are overestimated, as demonstrated by the following analysis.

To illustrate the effect of using more realistic groundwater pumpage rates for all public water supply wells represented in H2M's model, average annual pumping rates (based on historical monthly pumpage reports for wells included in the H2M model) were estimated and incorporated into H2M's model (**Table 3**). Re-running the model

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[27] LWD well boring logs and well completion logs. Email exchange between Bill Merklin and Steven Scharf, 8/23/2013

[28] H2M 2019. AnAqSim Groundwater Modeling Files.

[29] LWD-7A had a maximum monthly pumping rate of 1.42 MGD in June 2010 [Levittown W.D. Pumpage Report for the Month of June 2010]. LWD-8A had a maximum monthly pumping rate of 1.28 MGD in July 2010 [Levittown W.D. Pumpage Report for the Month of July 2010]. LWD-13 had a maximum monthly pumping rate of 1.57 MGD in July 2010 [Levittown W.D. Pumpage Report for the Month of July 2010].

with these steady state (i.e., static) average pumping rates yields entirely different capture zones for the LWD wells that do not intersect the NWIRP or NG properties (**Figure 8**). Furthermore, using the most conservative approach based on reported data (i.e., the highest reported monthly pumping rate) for each well within the H2M model still indicates that capture zones for LWD 7A, 8A, or 13 do not intersect the NWIRP or NG properties (**Figure 9**). Although there are still several issues with H2M's model that render it scientifically inaccurate (as discussed in the sections above and summarized below), inclusion of more reasonable groundwater pumping rates for LWD wells and other public water supply wells within the H2M model domain demonstrates the significant effect that these features have on groundwater zones of capture for the LWD wells.

3.3 H2M's LWD Well Zones of Capture are Unrealistic

As noted in the sections above, H2M's use of an overly simplistic representation of the complex Magothy Aquifer conditions, its use of fully penetrating wells, its failure to include key pumping and discharge features in the model, and its use of maximum permitted rates for the LWD wells results in zones of capture that are unrealistic, as each of these factors (e.g., heterogeneities in the subsurface (e.g., presence of clay and silt lenses), pumping from nearby water supply wells, and operation of the ONCT system) would have an influence on the area from which the LWD wells would capture water and must be accounted for in a scientifically accurate analysis.

Even if one were to accept the zones of capture estimated using H2M's model, pathline tracing depicted in Figure 3 of H2M's report (reproduced herein as **Figure 10**, and modified to differentiate pathlines from LWD-7A/8A from LWD-13) clearly shows that the zones of capture for LWD-7A and LWD-8A are west of the NG and NWIRP sites, and that they would not capture water originating at the NG and NWIRP sites.

4.0 OPINION 3

Evaluation of regional water quality data and information regarding potential sources of Freon-113 (and other COCs) detected in LWD Wells 7A, 8A, and 13 indicate that these constituents are commonly detected at similar concentrations in groundwater in areas hydraulically upgradient from these wells, and that available documents and data indicate that there are numerous potential sources of these compounds that H2M failed to consider as part of its evaluation.

As noted in Section 2.0 above, H2M's conclusion that the NG and NWIRP sites are the source of Freon-113 impacting the LWD wells is predicated on the unsupported assumption that the Freon-113 plume must originate at one (or both) of these properties simply because it appears on the site-specific chemical list in the PWSCP. Although H2M correctly notes that there is a distinct Freon-113 plume located to the west of the OU-2 plume, they fail to consider other possible sources of Freon-113 (and other COCs) located hydraulically upgradient[30] from the LWD wells. In fact, as they readily admitted during their depositions, neither Mr. Humann or Dr. Hazlett considered water quality data for public water supply wells located to the north and west of the LWD wells[31,32], or other sources of Freon-113 to the LWD wells.[33]

Review of water quality data for other public water supply (PWS) wells in the area to the north and west of the LWD wells indicates that several COCs detected in LWD wells 7A, 8A and 13 (including Freon-113, 1,1-Dichloroethane (1,1-DCA) and Chloroform) have been detected in several PWS wells located to the northwest and hydraulically upgradient from LWD wells 7A, 8A, and 13 (**Figures 11a-c),** in areas west of, and not associated with, the NG and NWIRP sites**.** As these data demonstrate, these COCs are relatively ubiquitous in the region, and in several instances, greatly exceed observed concentrations in the LWD wells 7A, 8A, and 13. Accordingly, these COCs are not unique to the NG and NWIRP sites and occur in areas not associated with these properties.

As H2M noted in its August 2019 report, in addition to being used as a cleaning agent for electrical and electronic components, Freon-113 was also widely used *"… as a refrigerant in refrigeration equipment, air conditioners, and non-contact cooling systems."*[34] In addition to these applications, Freon-113 was also utilized as a solvent for dry cleaning delicate fabrics and in special applications.[35] In 1964, DuPont patented Valcene Freon-113, which was used to treat delicate fabrics such as leather, furs,

[30] The term "hydraulically upgradient" refers to areas that have higher groundwater elevations and are sources of groundwater to a specific location or area.
[31] Deposition of Richard Humann, December 3, 2019. pg. 235 line 23 to pg. 237 line 6.
[32] Deposition of Timothy J Hazlett, Ph.D., December 5, 2019. pg. 29 line 24 to pg. 30 line 3.
[33] Deposition of Richard Humann, December 3, 2019. pg. 99, lines 7-12.
[34] H2M 2019. Expert Report - TOH v. United States of America, et al. -16-CV-3652. August 6. pg. 2.
[35] Morrison and Murphy, 2013. Chlorinated Solvents: A Forensic Evaluation

garments with decorations, and vinyl coated fabrics.[36] It was estimated that in 1975, 2 million pounds of Freon-113 was used for dry cleaning in the US and in 1989, 4.4 million pounds were used.[37]

As part of the remedial design process for LWD wells 7A, 8A, and 13 in 2013,[38] D&B reportedly conducted a 2-mile radius search around the wells to identify potential sources of contamination.[39,40,41] Although Mr. Merklin noted that no sources were identified within the search radius[42], it is not entirely clear as to how sites were evaluated, and how they were ultimately ruled out as potential sources of Freon-113 to the LWD wells. Further, the radius search that was performed by D&B was centered on the LWD wells, and as such, included a large area located hydraulically downgradient from the wells, which omitted the heavily industrialized area to the north and west of (and hydraulically upgradient from) LWD wells 7A, 8A, and 13.

As part of my analysis, I performed a similar 2-mile radius search to be inclusive of the industrialized area to the north and west of the LWD wells (and to the west of the NG and NWIRP properties) to identify potential sources of Freon-113.[43] Information obtained from the multiple state and federal databases for sites included in that search area resulted in the identification of several sites where Freon-113 may have been utilized (**Figure 12**).[44] Further, additional documentation obtained for one of these locations (Servo Corporation, which is located at 111 New South Road in Hicksville, NY, and reportedly began operating in the early 1960s), indicates that at least one documented Freon-113 release occurred at this site.[45] H2M, however, failed to identify this site, or any other sites that are located hydraulically upgradient and may have utilized Freon-113 (or other LWD well related COCs) as part of their operations.

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36 Morrison and Murphy,2013. Chlorinated Solvents: A Forensic Evaluation
37 Ibid.
38 It should be noted that the design of the wellhead treatment systems for LWD wells 7A, 8A, and 13 was based on a TCE concentration of 420 ug/L, which was reportedly measured in the GM-38 well cluster (see Merklin Deposition, pg. 229, line18 to pg. 230, line 6). This well cluster is located approximately 1.7 miles to the northeast of the LWD wells (see Attachment 1), and as such, is not located hydraulically upgradient from the LWD wells. Further, as noted in Mr. Merklin's expert report, TCE did not appear to be a driver for treatment on these wells.
39 D&B Engineers and Architects, 2016. Design Report, Packed Tower Aeration System Well 13. Town of Hempstead Department of Water, Levittown Water District. pg. 2-3
40 D&B Engineers and Architects, 2016. Design Report, Packed Tower Aeration System Wells 7A & 8A. Town of Hempstead Department of Water, Levittown Water District. pg. 2-3
41 W. Merklin 2019. Expert Report - TOH v. United States of America, et al. -16-CV-3652. August 6. pg. 4.
42 Deposition of William Merklin, December 3, 2019. pg. 62 line 2 to pg. 63 line 23.
43 EDR 2019. EDR GeoCheck Report. Inquiry No. 560728.5s. March 29.
44 Ibid.
45 USEPA 1987. Potential Hazardous Waste Site Preliminary Assessment. Servo Corporation of America. EPA ID No. NYD002418911. pg. 1

5.0 CONCLUSION

At the request of the United States and the Department of the Navy, I was asked to review and evaluate the conclusions presented in the August 6, 2019 H2M expert services reports from H2M and D&B Engineers, prepared on behalf of Plaintiff TOH. Based on my review of those reports (and other related documents, data, and information), I was asked to evaluate the conclusions drawn by H2M regarding the source of Freon-113 (and other COCs) in LWD wells 7A, 8A, and 13, along with the supporting information and analyses described by H2M, and to offer opinions in response to those conclusions.

My review of H2M's report indicates that the bases for its conclusion that the Freon-113 detections in the LWD wells are associated with releases from the NG and NWIRP sites are highly speculative, tenuously supported, and with respect to chemical fate and transport scientifically incorrect; that H2M employed overly simplistic modeling analyses to delineate unrealistic zones of capture for the LWD wells; and that H2M failed to consider other sources of Freon-113 (and other COCs). Specifically:

1. H2M fails to demonstrate that the Freon 113 detections in the LWD wells are associated with a specific release (or releases) from the NG or NWIRP properties, and in fact, analysis of available sampling data supports the presence of a separate Freon-113 plume that is located to the west of, and deeper than, the OU-2 groundwater plume, which consists of predominantly TCE (see Section 2.0 above).
    a. H2M did not identify any specific source areas on the NG and NWIRP properties where releases of Freon-113 historically occurred, nor have any been identified as part of investigations performed by NG and the Navy (see Section 2.1).
    b. H2M's assertions regarding ONCT system underflow are unfounded and contradicted by available data and information regarding ONCT system effectiveness (see Section 2.2).
    c. H2M's use of DNAPL properties (including density and viscosity) to evaluate the fate and transport of Freon-113 and TCE is not based on sound science and ignores the key property that affects dissolved phase transport of these compounds (see Section 2.3).
    d. The primary mechanism governing the fate and transport of dissolved phase chemicals is the retardation factor. Regarding Freon-113 and TCE, retardation factors for Freon-113 are greater, and as such, this compound would be expected to move slower than TCE, not faster as H2M theorizes (see Section 2.3).
    e. Although H2M asserts that the assumption that all contaminated groundwater originating from the NG and NWIRP properties contains TCE is invalid, they provide no supporting analysis of water quality sampling data to back up this assertion (see Section 2.4).

   f. Analysis of available sampling data supports the presence of a separate Freon-113 plume that is located to the west of, and deeper than, the OU-2 groundwater plume, which consists of predominantly TCE (see Section 2.4).

2. The capture zone analysis performed by H2M is overly simplistic and inadequate (see Section 3.0 above).
   a. H2M's groundwater model greatly oversimplifies the complex stratigraphy of the Magothy Aquifer (see Section 3.1).
   b. H2M's model does not contain key model stresses (e.g., remedial extraction wells, infiltration basins, and pumping from nearby public water supply wells), which would have significant influence on groundwater flow conditions (see Section 3.2).
   c. H2M's model greatly overestimates the amount of pumping associated with the LWD wells, and in turn, overestimates the extent of the LWD well capture zones (see Section 3.2).
   d. Even if one were to accept the LWD well capture zones delineated by H2M, they do not demonstrate that groundwater will be captured from the NG or NWIRP sites (see Section 3.3).
3. There are numerous likely and potential sources of Freon-113 (and other COCs) located hydraulically upgradient from the LWD wells, which H2M failed to consider as part of their evaluation (see Section 4.0 above).
   a. H2M readily admitted that they did not consider other sources of Freon-113 to the LWD wells.
   b. Review of available water quality data for public water supply wells located to the north and west of the LWD wells indicates the presence of Freon-113 (and other COCs that have been detected in the LWD wells).
   c. Freon-113 has been used in a number of different applications, including dry cleaning operations, and as such, it is not a unique contaminant to the NG or NWIRP sites.
   d. Review of information obtained from a number of state and federal databases indicates that there are several likely and potential sources of Freon-113 to groundwater located hydraulically upgradient from the LWD wells, which H2M failed to consider.

For the reasons outlined in my comments, conclusions, and opinions above, I find that there is no scientifically supportable basis for the opinions expressed in H2M's August 2019 report.

Tables

Table 1: ONCT System Well Depths and Screen Intervals

Former Well Name	Revised Well Name	Total Depth (ft)	Screen Interval (Ft bgs)
GP-1	Well 1	570	519 - 570
GP-3	Well 3/3R	543	483 - 543
ONCT-1	Well 17	563	480 - 563
ONCT-2	Well 18	570	466 - 570
ONCT-3	Well 19	617	465 - 617

Table 2: Pumpage for Wells LWD-7A, 8A, and 13 - 2009-2015

NY State Well Number	District Well Number	Date	Avg. Monthly Pumpage (MGD)	Monthly Pumpage (Gallons)
N 8279	7A	1/1/2009	0.416484	12,911,000
N 8279	7A	2/1/2009	0.301250	8,435,000
N 8279	7A	3/1/2009	0.396032	12,277,000
N 8279	7A	4/1/2009	0.669433	20,083,000
N 8279	7A	5/1/2009	0.682581	21,160,000
N 8279	7A	6/1/2009	0.748133	22,444,000
N 8279	7A	7/1/2009	0.672581	20,850,000
N 8279	7A	8/1/2009	1.091226	33,828,000
N 8279	7A	9/1/2009	0.756533	22,696,000
N 8279	7A	10/1/2009	0.541677	16,792,000
N 8279	7A	11/1/2009	0.418767	12,563,000
N 8279	7A	12/1/2009	0.510710	15,832,000
N 8279	7A	1/1/2010	0.286419	8,879,000
N 8279	7A	2/1/2010	0.073464	2,057,000
N 8279	7A	3/1/2010	0.641968	19,901,000
N 8279	7A	4/1/2010	0.543933	16,318,000
N 8279	7A	5/1/2010	0.741129	22,975,000
N 8279	7A	6/1/2010	1.417033	42,511,000
N 8279	7A	7/1/2010	1.243548	38,550,000
N 8279	7A	8/1/2010	1.142419	35,415,000
N 8279	7A	9/1/2010	0.767733	23,032,000
N 8279	7A	10/1/2010	0.765226	23,722,000
N 8279	7A	11/1/2010	0.840400	25,212,000
N 8279	7A	12/1/2010	0.546097	16,929,000
N 8279	7A	1/1/2011	0.837645	25,967,000
N 8279	7A	2/1/2011	0.826000	23,128,000
N 8279	7A	3/1/2011	0.661645	20,511,000
N 8279	7A	4/1/2011	0.894267	26,828,000
N 8279	7A	5/1/2011	0.968581	30,026,000
N 8279	7A	6/1/2011	1.053567	31,607,000
N 8279	7A	7/1/2011	0.967290	29,986,000
N 8279	7A	8/1/2011	0.725710	22,497,000
N 8279	7A	9/1/2011	0.473067	14,192,000
N 8279	7A	10/1/2011	0.792032	24,553,000
N 8279	7A	11/1/2011	0.436867	13,106,000
N 8279	7A	12/1/2011	0.465129	14,419,000
N 8279	7A	1/1/2012	0.313355	9,714,000
N 8279	7A	2/1/2012	0.294964	8,259,000
N 8279	7A	3/1/2012	0.153806	4,768,000
N 8279	7A	4/1/2012	0.438700	13,161,000
N 8279	7A	5/1/2012	0.528484	16,383,000
N 8279	7A	6/1/2012	0.744433	22,333,000
N 8279	7A	7/1/2012	1.145903	35,523,000

Table 2: Pumpage for Wells LWD-7A, 8A, and 13 - 2009-2015

NY State Well Number	District Well Number	Date	Avg. Monthly Pumpage (MGD)	Monthly Pumpage (Gallons)
N 8279	7A	8/1/2012	0.905355	28,066,000
N 8279	7A	9/1/2012	0.709167	21,275,000
N 8279	7A	10/1/2012	0.096903	3,004,000
N 8279	7A	11/1/2012	0.037767	1,133,000
N 8279	7A	12/1/2012	0.147516	4,573,000
N 8279	7A	1/1/2013	0.267226	8,284,000
N 8279	7A	2/1/2013	0.487536	13,651,000
N 8279	7A	3/1/2013	0.197419	6,120,000
N 8279	7A	4/1/2013	0.717533	21,526,000
N 8279	7A	5/1/2013	0.665581	20,633,000
N 8279	7A	6/1/2013	0.909000	27,270,000
N 8279	7A	7/1/2013	1.155387	35,817,000
N 8279	7A	8/1/2013	1.114968	34,564,000
N 8279	7A	9/1/2013	1.275833	38,275,000
N 8279	7A	10/1/2013	1.144484	35,479,000
N 8279	7A	11/1/2013	0.285267	8,558,000
N 8279	7A	12/1/2013	0.469516	14,555,000
N 8279	7A	1/1/2014	0.415032	12,866,000
N 8279	7A	2/1/2014	0.550429	15,412,000
N 8279	7A	3/1/2014	0.576516	17,872,000
N 8279	7A	4/1/2014	0.664633	19,939,000
N 8279	7A	5/1/2014	0.470903	14,598,000
N 8279	7A	6/1/2014	0.903967	27,119,000
N 8279	7A	7/1/2014	1.010871	31,337,000
N 8279	7A	8/1/2014	0.931387	28,873,000
N 8279	7A	9/1/2014	0.722833	21,685,000
N 8279	7A	10/1/2014	0.384129	11,908,000
N 8279	7A	11/1/2014	0.046033	1,381,000
N 8279	7A	12/1/2014	0.215774	6,689,000
N 8279	7A	1/1/2015		11,323,000
N 7523	8A	1/1/2009	0.259226	8,036,000
N 7523	8A	2/1/2009	0.781286	21,876,000
N 7523	8A	3/1/2009	0.556645	17,256,000
N 7523	8A	4/1/2009	0.334733	10,042,000
N 7523	8A	5/1/2009	0.311742	9,664,000
N 7523	8A	6/1/2009	0.524800	15,744,000
N 7523	8A	7/1/2009	0.761645	23,611,000
N 7523	8A	8/1/2009	0.824645	25,564,000
N 7523	8A	9/1/2009	0.758600	22,758,000
N 7523	8A	10/1/2009	0.573129	17,767,000
N 7523	8A	11/1/2009	0.505000	15,150,000
N 7523	8A	12/1/2009	0.336097	10,419,000
N 7523	8A	1/1/2010	0.663419	20,566,000

Table 2: Pumpage for Wells LWD-7A, 8A, and 13 - 2009-2015

NY State Well Number	District Well Number	Date	Avg. Monthly Pumpage (MGD)	Monthly Pumpage (Gallons)
N 7523	8A	2/1/2010	0.787679	22,055,000
N 7523	8A	3/1/2010	0.544677	16,885,000
N 7523	8A	4/1/2010	0.737633	22,129,000
N 7523	8A	5/1/2010	0.906355	28,097,000
N 7523	8A	6/1/2010	1.227200	36,816,000
N 7523	8A	7/1/2010	1.278645	39,638,000
N 7523	8A	8/1/2010	1.059710	32,851,000
N 7523	8A	9/1/2010	0.914067	27,422,000
N 7523	8A	10/1/2010	0.705097	21,858,000
N 7523	8A	11/1/2010	0.490800	14,724,000
N 7523	8A	12/1/2010	0.675323	20,935,000
N 7523	8A	1/1/2011	0.495097	15,348,000
N 7523	8A	2/1/2011	0.887929	24,862,000
N 7523	8A	3/1/2011	0.883065	27,375,000
N 7523	8A	4/1/2011	0.433733	13,012,000
N 7523	8A	5/1/2011	0.783903	24,301,000
N 7523	8A	6/1/2011	0.892933	26,788,000
N 7523	8A	7/1/2011	1.181774	36,635,000
N 7523	8A	8/1/2011	0.591871	18,348,000
N 7523	8A	9/1/2011	0.736333	22,090,000
N 7523	8A	10/1/2011	0.396226	12,283,000
N 7523	8A	11/1/2011	0.676267	20,288,000
N 7523	8A	12/1/2011	0.248516	7,704,000
N 7523	8A	1/1/2012	0.537323	16,657,000
N 7523	8A	2/1/2012	0.228786	6,406,000
N 7523	8A	3/1/2012	0.436129	13,520,000
N 7523	8A	4/1/2012	0.384033	11,521,000
N 7523	8A	5/1/2012	0.513065	15,905,000
N 7523	8A	6/1/2012	0.726567	21,797,000
N 7523	8A	7/1/2012	0.898548	27,855,000
N 7523	8A	8/1/2012	0.856903	26,564,000
N 7523	8A	9/1/2012	0.512700	15,381,000
N 7523	8A	10/1/2012	0.448645	13,908,000
N 7523	8A	11/1/2012	0.185667	5,570,000
N 7523	8A	12/1/2012	0.172806	5,357,000
N 7523	8A	1/1/2013	0.263774	8,177,000
N 7523	8A	2/1/2013	0.386857	10,832,000
N 7523	8A	3/1/2013	0.492645	15,272,000
N 7523	8A	4/1/2013	0.298267	8,948,000
N 7523	8A	5/1/2013	0.576645	17,876,000
N 7523	8A	6/1/2013	0.088533	2,656,000
N 7523	8A	7/1/2013	0.577645	17,907,000
N 7523	8A	8/1/2013	0.299742	9,292,000

Table 2: Pumpage for Wells LWD-7A, 8A, and 13 - 2009-2015

NY State Well Number	District Well Number	Date	Avg. Monthly Pumpage (MGD)	Monthly Pumpage (Gallons)
N 7523	8A	9/1/2013	0.291700	8,751,000
N 7523	8A	10/1/2013	0.000000	0
N 7523	8A	11/1/2013	0.000000	0
N 7523	8A	12/1/2013	0.000000	0
N 7523	8A	1/1/2014	0.000000	0
N 7523	8A	2/1/2014	0.000000	0
N 7523	8A	3/1/2014	0.000000	0
N 7523	8A	4/1/2014	0.000000	0
N 7523	8A	5/1/2014	0.000000	0
N 7523	8A	6/1/2014	0.000000	0
N 7523	8A	7/1/2014	0.000000	0
N 7523	8A	8/1/2014	0.000000	0
N 7523	8A	9/1/2014	0.000000	0
N 7523	8A	10/1/2014	0.000000	0
N 7523	8A	11/1/2014	0.000000	0
N 7523	8A	12/1/2014	0.000000	0
N 7523	8A	1/1/2015		0
N 5303	13	1/1/2009	1.358548	42,115,000
N 5303	13	2/1/2009	0.672429	18,828,000
N 5303	13	3/1/2009	0.636677	19,737,000
N 5303	13	4/1/2009	0.694600	20,838,000
N 5303	13	5/1/2009	0.527968	16,367,000
N 5303	13	6/1/2009	0.588967	17,669,000
N 5303	13	7/1/2009	1.263000	39,153,000
N 5303	13	8/1/2009	0.986871	30,593,000
N 5303	13	9/1/2009	0.747833	22,435,000
N 5303	13	10/1/2009	0.836419	25,929,000
N 5303	13	11/1/2009	0.614400	18,432,000
N 5303	13	12/1/2009	0.688065	21,330,000
N 5303	13	1/1/2010	0.491323	15,231,000
N 5303	13	2/1/2010	0.801071	22,430,000
N 5303	13	3/1/2010	0.099161	3,074,000
N 5303	13	4/1/2010	0.543133	16,294,000
N 5303	13	5/1/2010	0.891774	27,645,000
N 5303	13	6/1/2010	1.453100	43,593,000
N 5303	13	7/1/2010	1.570387	48,682,000
N 5303	13	8/1/2010	1.523226	47,220,000
N 5303	13	9/1/2010	0.909033	27,271,000
N 5303	13	10/1/2010	1.288645	39,948,000
N 5303	13	11/1/2010	0.612233	18,367,000
N 5303	13	12/1/2010	0.965194	29,921,000
N 5303	13	1/1/2011	0.774355	24,005,000
N 5303	13	2/1/2011	0.852321	23,865,000

Table 2: Pumpage for Wells LWD-7A, 8A, and 13 - 2009-2015

NY State Well Number	District Well Number	Date	Avg. Monthly Pumpage (MGD)	Monthly Pumpage (Gallons)
N 5303	13	3/1/2011	0.991677	30,742,000
N 5303	13	4/1/2011	0.866400	25,992,000
N 5303	13	5/1/2011	1.143742	35,456,000
N 5303	13	6/1/2011	1.448467	43,454,000
N 5303	13	7/1/2011	1.290226	39,997,000
N 5303	13	8/1/2011	1.199903	37,197,000
N 5303	13	9/1/2011	0.636300	19,089,000
N 5303	13	10/1/2011	0.684000	21,204,000
N 5303	13	11/1/2011	0.593700	17,811,000
N 5303	13	12/1/2011	0.695839	21,571,000
N 5303	13	1/1/2012	0.576194	17,862,000
N 5303	13	2/1/2012	0.740643	20,738,000
N 5303	13	3/1/2012	0.327968	10,167,000
N 5303	13	4/1/2012	0.926933	27,808,000
N 5303	13	5/1/2012	0.664452	20,598,000
N 5303	13	6/1/2012	0.904600	27,138,000
N 5303	13	7/1/2012	1.087419	33,710,000
N 5303	13	8/1/2012	1.285935	39,864,000
N 5303	13	9/1/2012	0.724533	21,736,000
N 5303	13	10/1/2012	0.387677	12,018,000
N 5303	13	11/1/2012	0.434167	13,025,000
N 5303	13	12/1/2012	0.216613	6,715,000
N 5303	13	1/1/2013	0.652452	20,226,000
N 5303	13	2/1/2013	0.309143	8,656,000
N 5303	13	3/1/2013	0.000000	0
N 5303	13	4/1/2013	0.000000	0
N 5303	13	5/1/2013	0.000000	0
N 5303	13	6/1/2013	0.515800	15,474,000
N 5303	13	7/1/2013	0.562419	17,435,000
N 5303	13	8/1/2013	0.000000	0
N 5303	13	9/1/2013	0.000000	0
N 5303	13	10/1/2013	0.000000	0
N 5303	13	11/1/2013	0.000000	0
N 5303	13	12/1/2013	0.000000	0
N 5303	13	1/1/2014	0.000000	0
N 5303	13	2/1/2014	0.000000	0
N 5303	13	3/1/2014	0.000000	0
N 5303	13	4/1/2014	0.000000	0
N 5303	13	5/1/2014	0.000000	0
N 5303	13	6/1/2014	0.000000	0
N 5303	13	7/1/2014	0.000000	0
N 5303	13	8/1/2014	0.000000	0
N 5303	13	9/1/2014	0.000000	0

Table 2: Pumpage for Wells LWD-7A, 8A, and 13 - 2009-2015

NY State Well Number	District Well Number	Date	Avg. Monthly Pumpage (MGD)	Monthly Pumpage (Gallons)
N 5303	13	10/1/2014	0.000000	0
N 5303	13	11/1/2014	0.000000	0
N 5303	13	12/1/2014	0.000000	0
N 5303	13	1/1/2015		0

Table 3: Average and Maximum Pumping Rates - Select Public Water Supply Wells

Well ID	Well Location[1]		Well Pumpage (MGD)	
	X	Y	2009 - 2014 Maximum Monthly Pumping Rate	2009 - 2014 Average Monthly Pumping Rate
HWD-10-1	1,114,384.248	219,203.321	1.62	0.92
HWD-8-3	1,118,181.860	214,708.376	1.54	0.27
HWD-9-2	1,119,455.623	217,021.336	0.27	0.06
HWD-9-3	1,119,350.389	216,915.091	0.96	0.39
BWD-4-1	1,129,751.300	206,742.412	1.65	0.67
BWD-4-2	1,129,698.790	206,393.791	1.85	0.75
BWD-5-1	1,129,034.885	205,299.359	1.74	0.84
BWD-6-1	1,126,633.012	206,190.533	1.80	0.34
BWD-6-2	1,126,774.138	206,228.523	1.96	0.54
BWD-7	1,128,376.073	216,171.303	1.39	0.58
BWD-8	1,128,406.817	216,359.120	2.02	0.87
BWD-9591	1,130,085.926	215,394.910	1.91	0.41
LWD-2A	1,114,614.887	206,842.952	1.87	0.90
LWD-6B	1,115,350.716	204,583.291	1.96	1.18
LWD-9	1,115,468.712	203,161.924	0.00	0.00
LWD-5A	1,115,468.712	203,161.924	1.53	0.79
LWD-7A	1,120,814.466	201,799.273	1.42	0.65
LWD-8A	1,120,950.304	201,797.852	1.32	0.64
LWD-13	1,122,615.696	200,104.012	1.62	0.84
LWD-14	1,119,661.004	197,277.961	0.74	0.34
SFWD-1-4	1,132,937.941	202,219.520	0.00	0.00
SFWD-1-3	1,133,196.910	201,983.195	1.51	0.40
SFWD-3-1	1,127,386.910	199,413.195	2.00	0.48
SFWD-6-1	1,127,463.393	196,551.054	1.20	0.21
SFDW-6-2	1,127,485.758	196,472.853	1.97	1.18
NYAW-4S	1,124,932.392	197,626.355	ND	ND
NYAW-3S	1,125,016.858	197,642.875	ND	ND

1 - All Coordinates in NAD83 New York Long Island (ft US)
ND - No Data Available

Figures

Northrop-Grumman
NWIRP
Bethpage Community Park
Hooker-Ruco
LWD Wells

Notes:

Sources: ESRI Basemap

0 1,000 2,000 4,000
Feet

Figure 1
Site Location

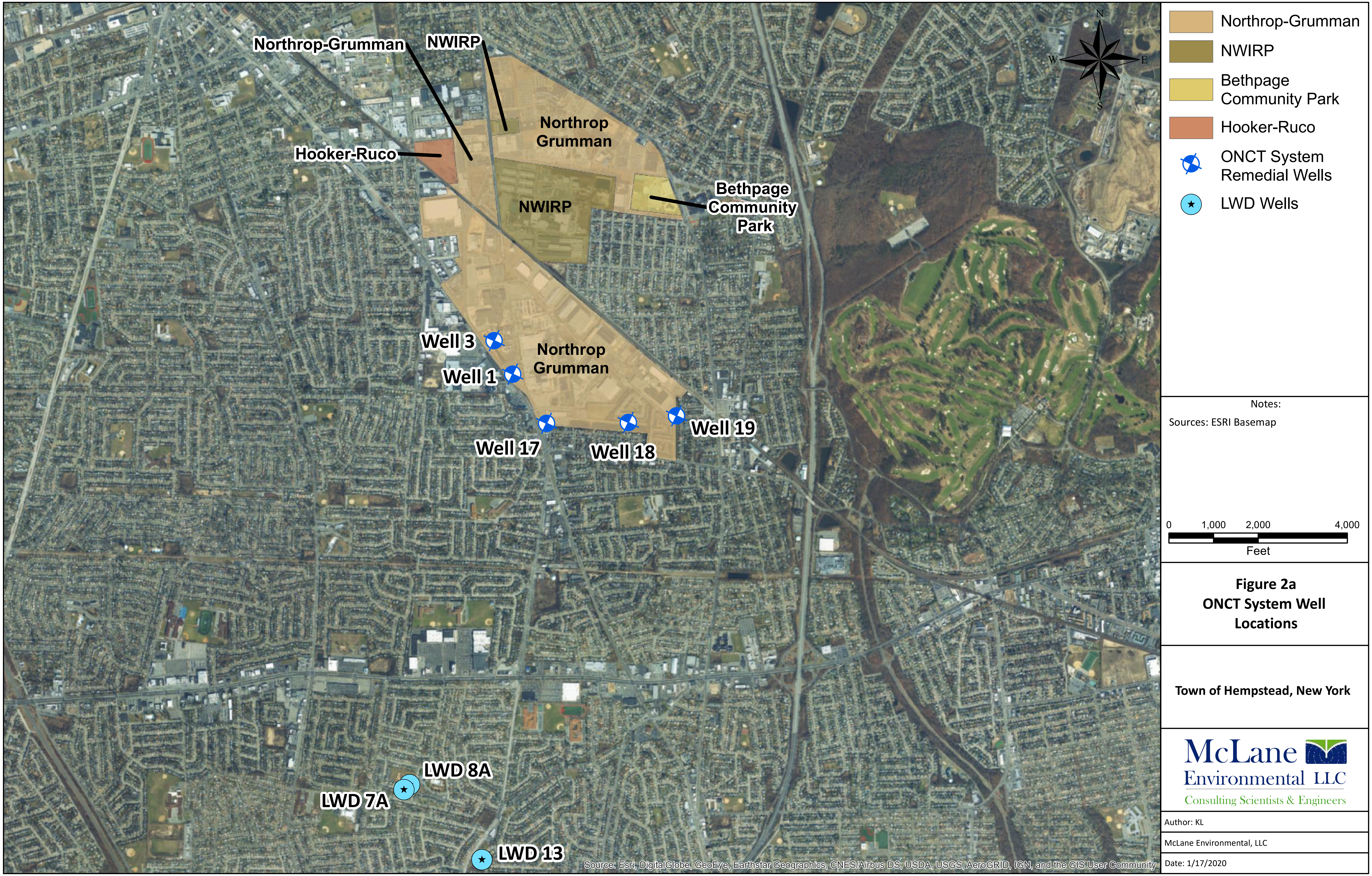
Town of Hempstead, New York

McLane Environmental LLC
Consulting Scientists & Engineers

Author: KL

McLane Environmental, LLC

Date: 1/17/2020



Notes:

Sources: ESRI Basemap

Figure 2a
ONCT System Well Locations

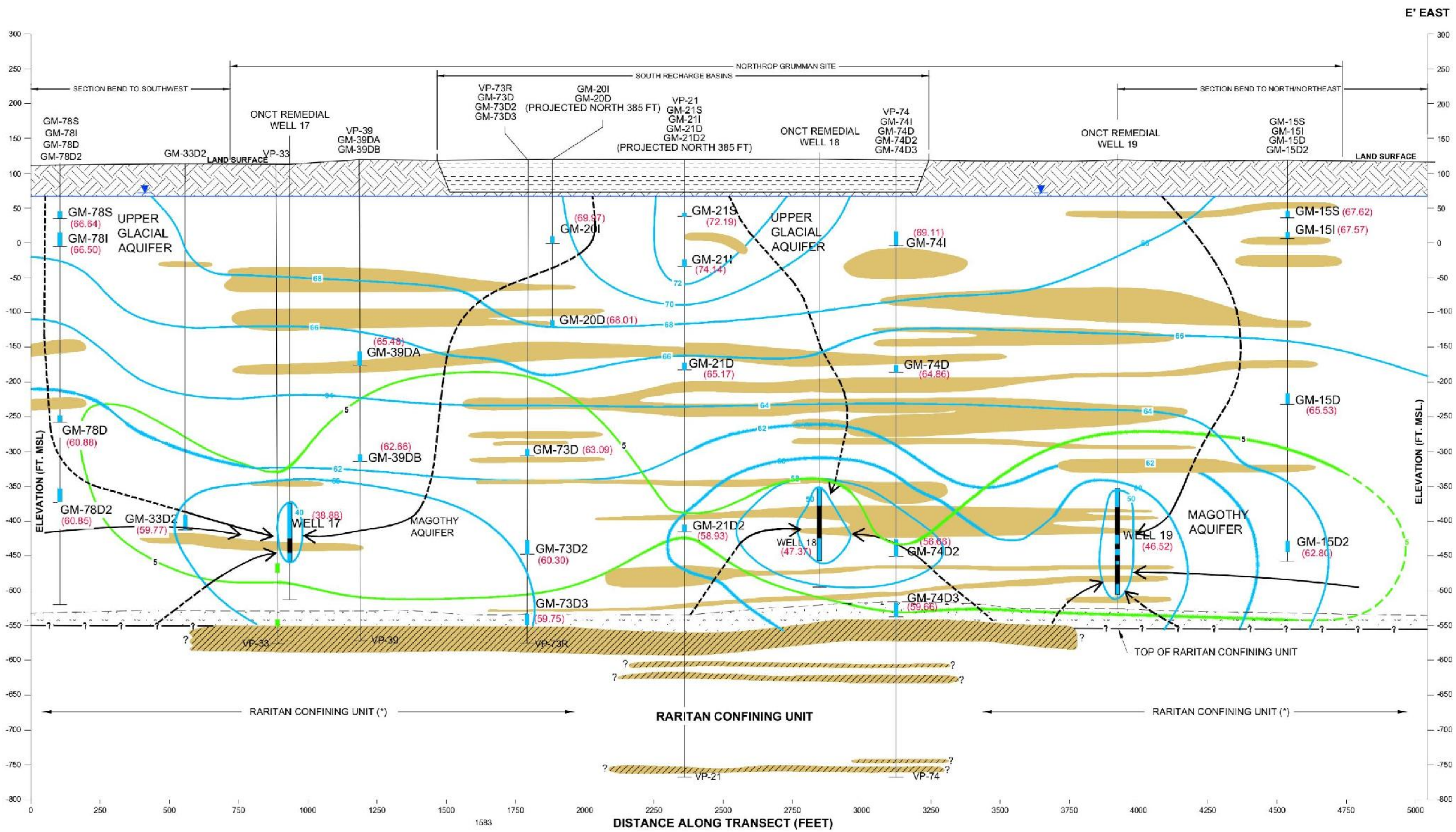
Town of Hempstead, New York

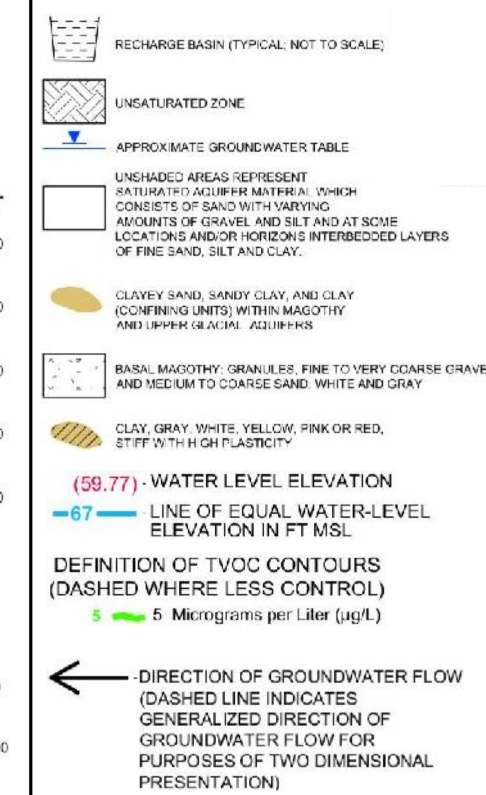
McLane Environmental LLC
Consulting Scientists & Engineers

Author: KL

McLane Environmental, LLC

Date: 1/17/2020





Notes:

Modified from ARCADIS 2015 Interpretive Report for the On-Site Containment System Hydraulic Effectiveness Program, Figure 2

Figure 2b
ONCT System Well Depths

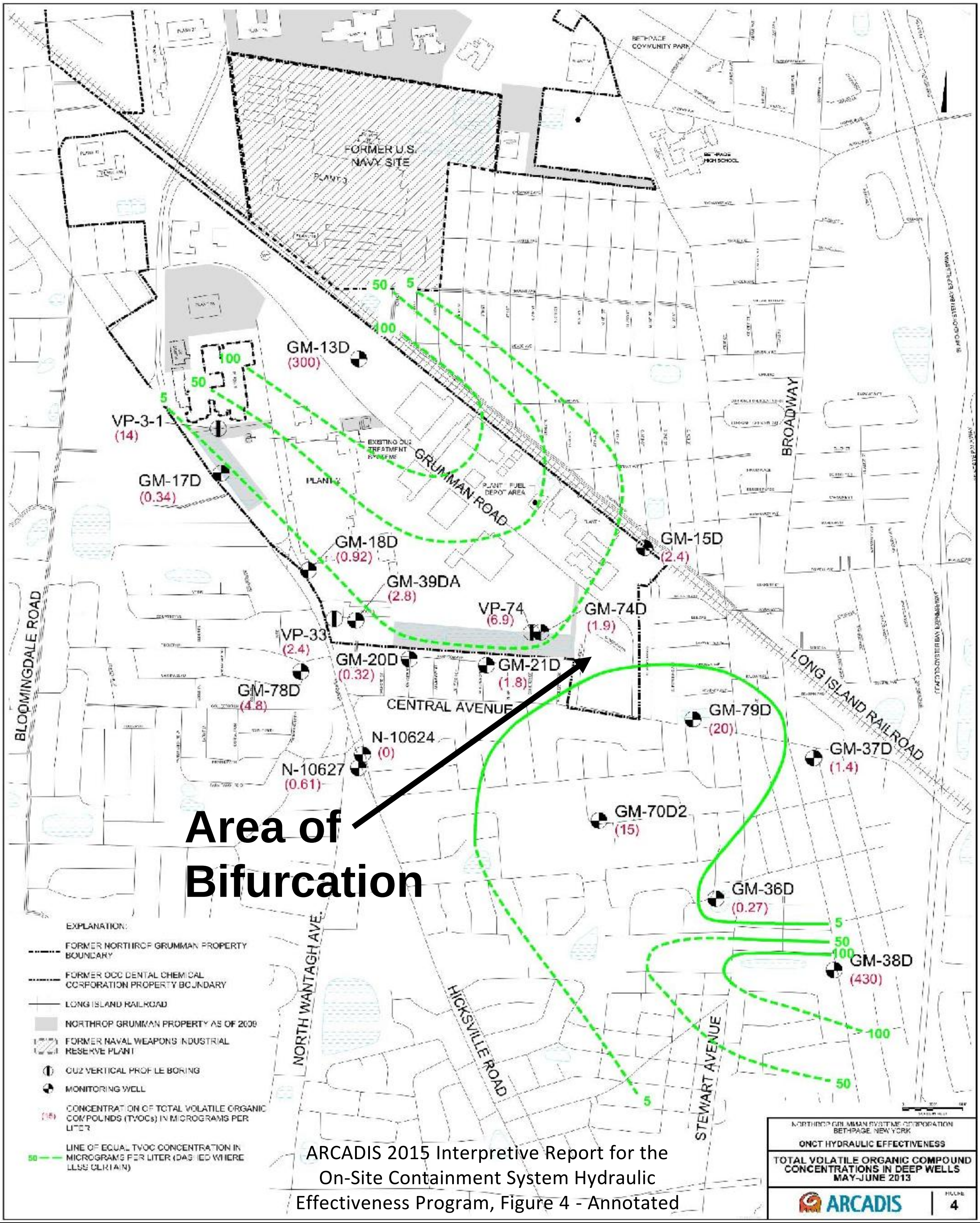
Town of Hempstead, New York

McLane Environmental LLC
Consulting Scientists & Engineers

Author: KL

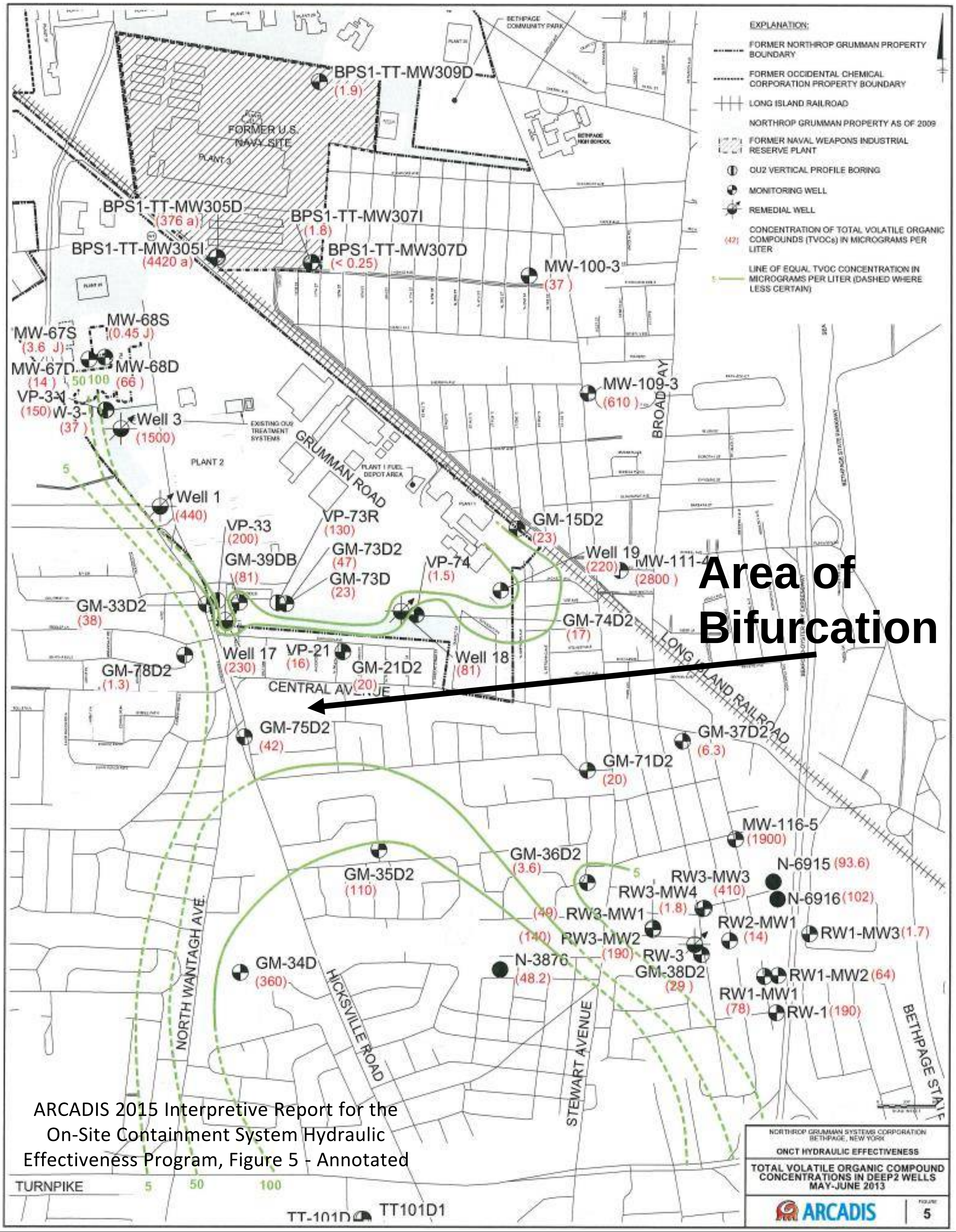
McLane Environmental, LLC

Date: 1/17/2020



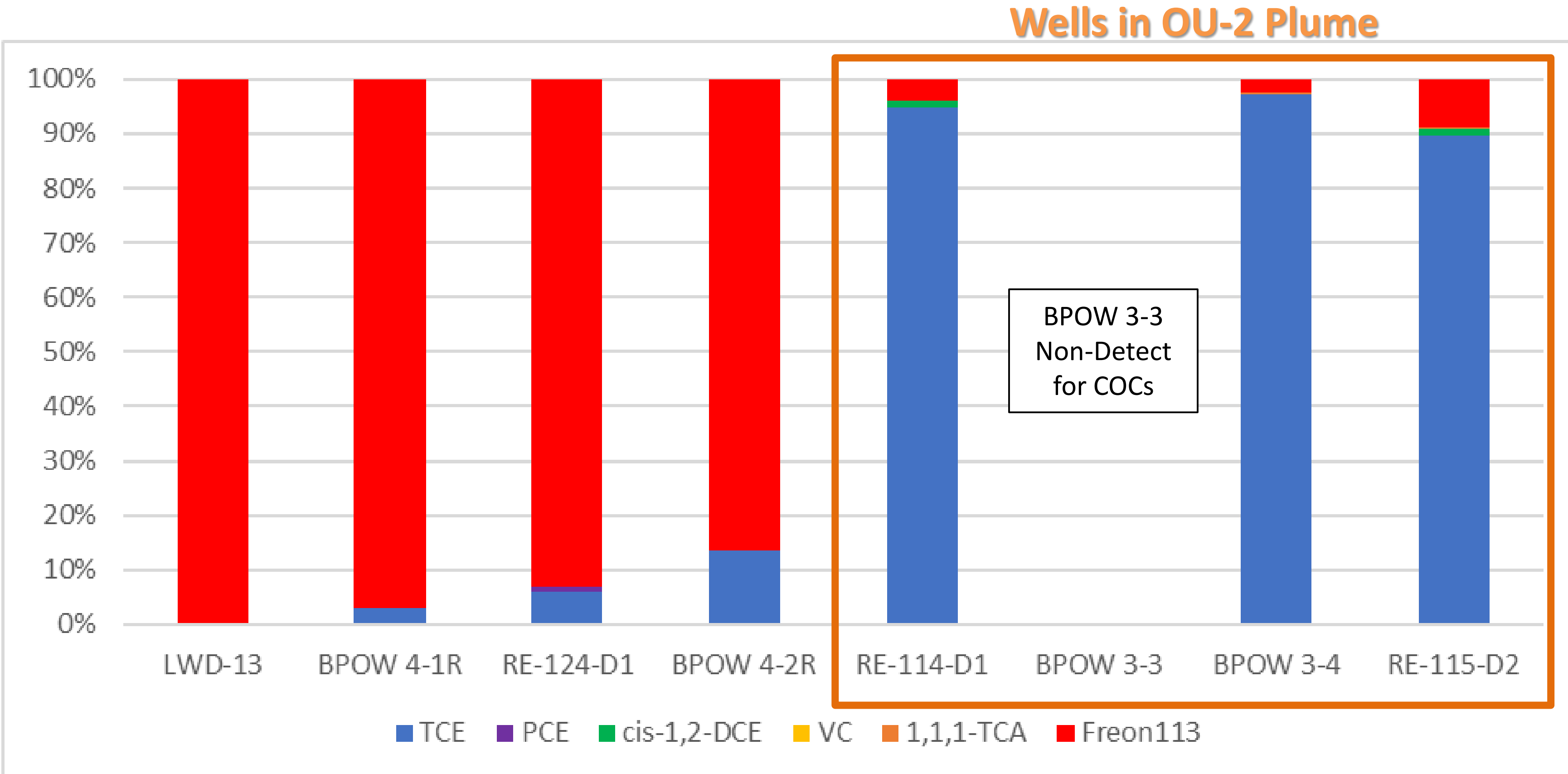
ARCADIS 2015 Interpretive Report for the On-Site Containment System Hydraulic Effectiveness Program, Figure 4 - Annotated

ARCADIS ONCT System Evaluation – TVOC Plume Depictions Indicating Plume Bifurcation, Deep Wells	Notes: Wells in the Deep Zone were sampled at depths between 200 – 340 ft below ground surface	McLane Environmental LLC Consulting Scientists & Engineers Figure 3a



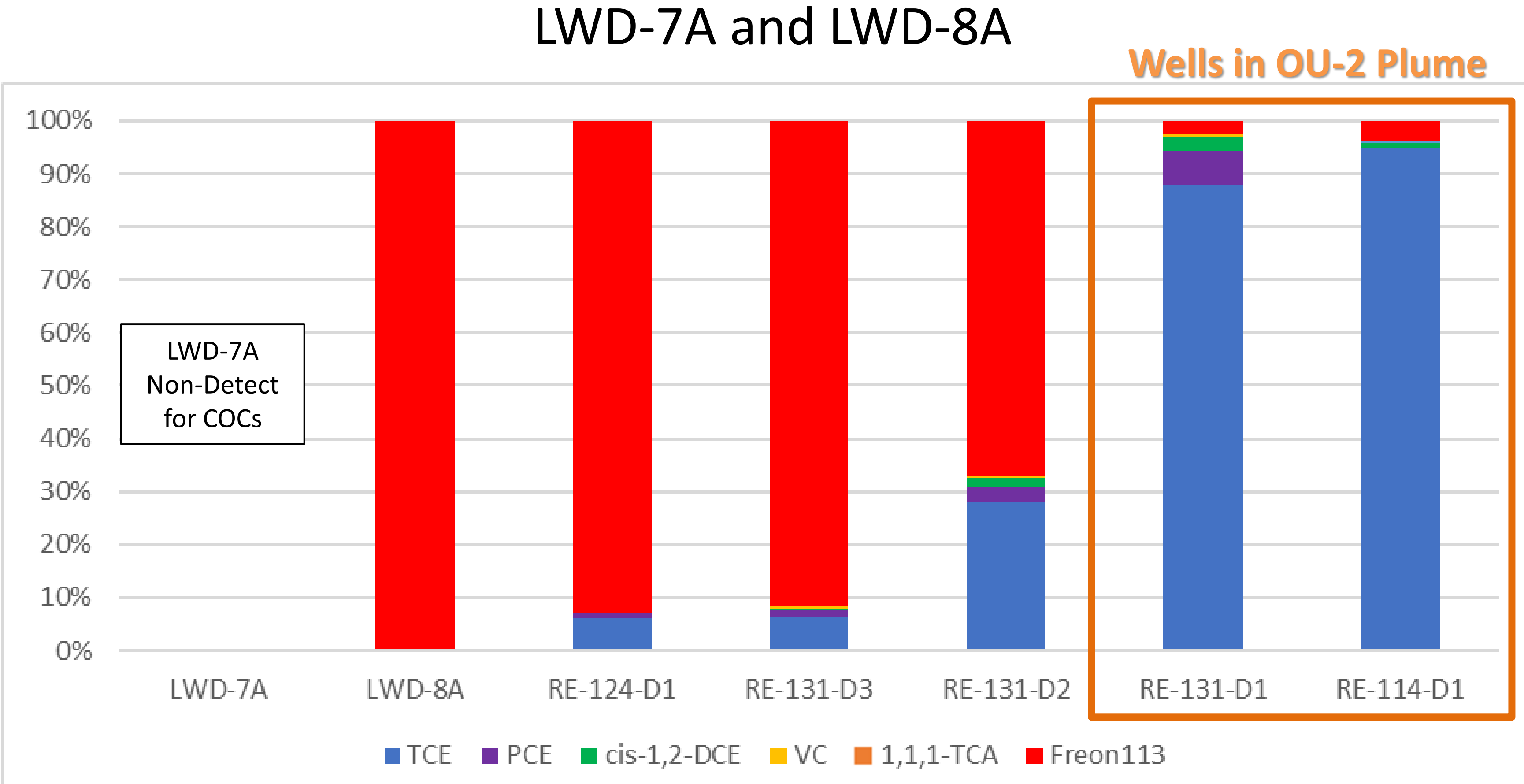
ARCADIS ONCT System Evaluation – TVOC Plume Depictions Indicating Plume Bifurcation, Deep2 Wells	Notes: Wells in the Deep2 Zone were sampled at depths between 309 – 606 ft below ground surface	McLane Environmental LLC Consulting Scientists & Engineers Figure 3b

Town of Hempstead Well Comparison
LWD-13



Depth: 675 ft 672 ft 670 ft 745 ft 545 ft 611 ft 760 ft 740 ft

Town of Hempstead Well Comparison
LWD-7A and LWD-8A



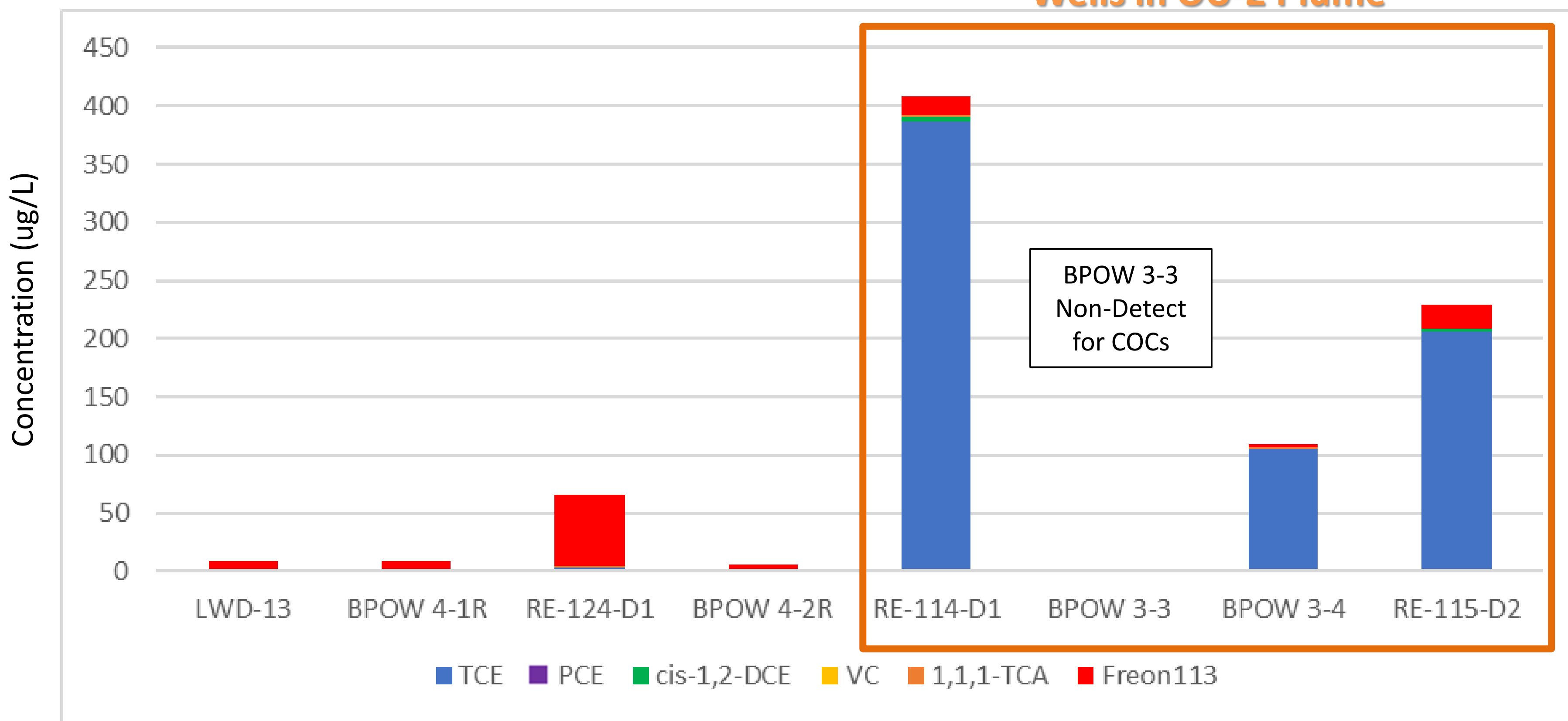
Depth: 509 ft 639 ft 670 ft 670 ft 578 ft 440 ft 545 ft

Notes:

- LWD-13 data represents average concentrations measured between September 2017 and November 2018
- LWD-7A and 8A data represents average concentrations measured between June and October 2018
- Measured Monitoring well concentrations represent data collected between November and December 2017
- Wells are plotted from westernmost location on left, to easternmost location on right
- Well depths represent the mid-point of the well's screened interval

1/17/2020	Relative Percentages of OU-2 Plume COCs in Wells Identified by Town of Hempstead	McLane Environmental LLC Consulting Scientists & Engineers	Figure 4

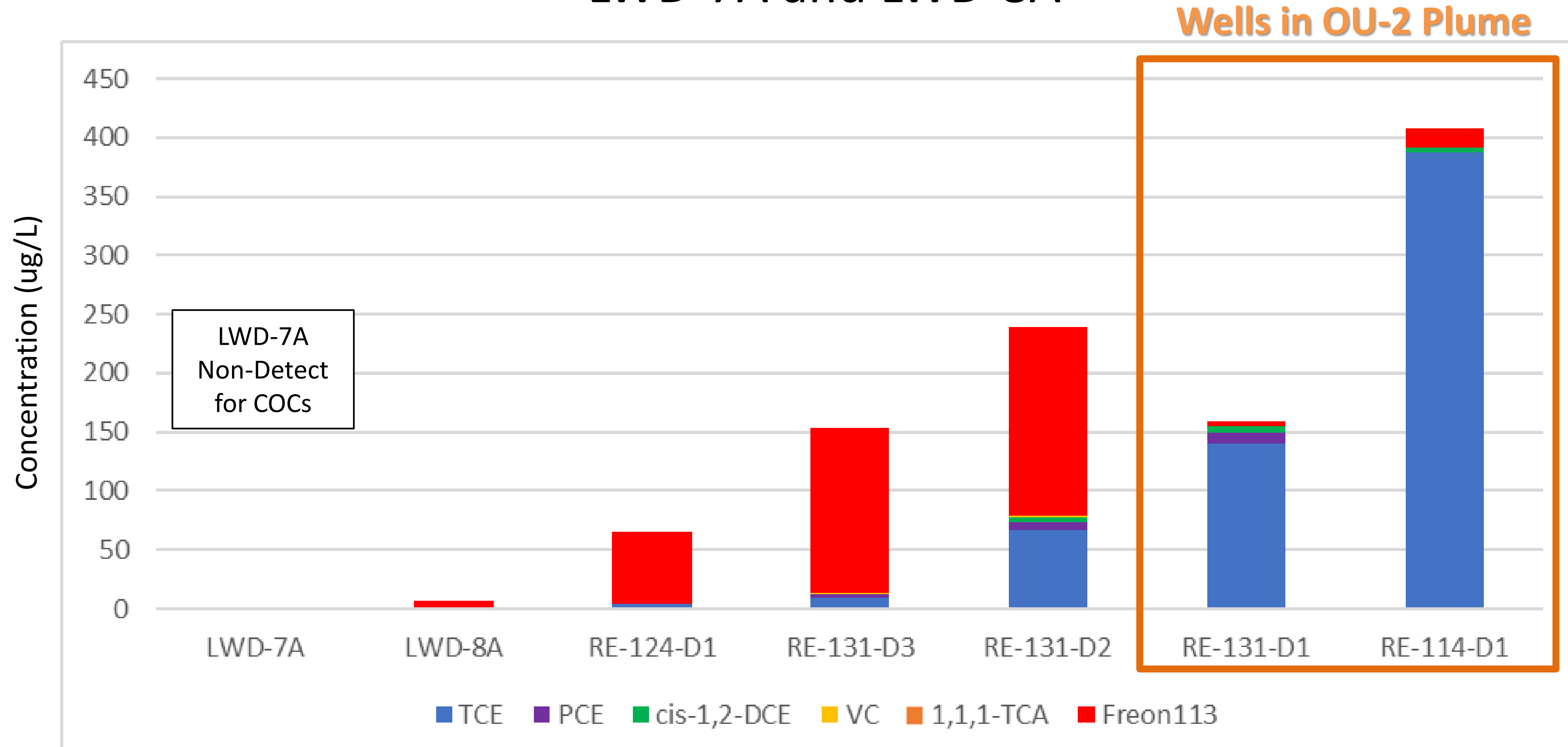
Town of Hempstead Well Comparison
LWD-13



Depth:	675 ft	672 ft	670 ft	745 ft	545 ft	611 ft	760 ft	740 ft

W ⟷ E

Town of Hempstead Well Comparison
LWD-7A and LWD-8A



Depth:	509 ft	639 ft	670 ft	670 ft	578 ft	440 ft	545 ft

Notes:

- LWD-13 data represents average concentrations measured between September 2017 and November 2018
- LWD-7A and 8A data represents average concentrations measured between June and October 2018
- Measured Monitoring well concentrations represent data collected between November and December 2017
- Wells are plotted from westernmost location on left, to easternmost location on right
- Well depths represent the mid-point of the well's screened interval

1/17/2020	Relative Concentrations of OU-2 Plume COCs in Wells Identified by Town of Hempstead	McLane Environmental LLC Consulting Scientists & Engineers	Figure 5

Notes:

Sources: ESRI Basemap

Figure 6a
Observed TCE and Freon-113 Concentrations in OU-2 Monitoring Wells/VPBs and LWD Wells - Plan View

Town of Hempstead, New York

McLane Environmental LLC
Consulting Scientists & Engineers

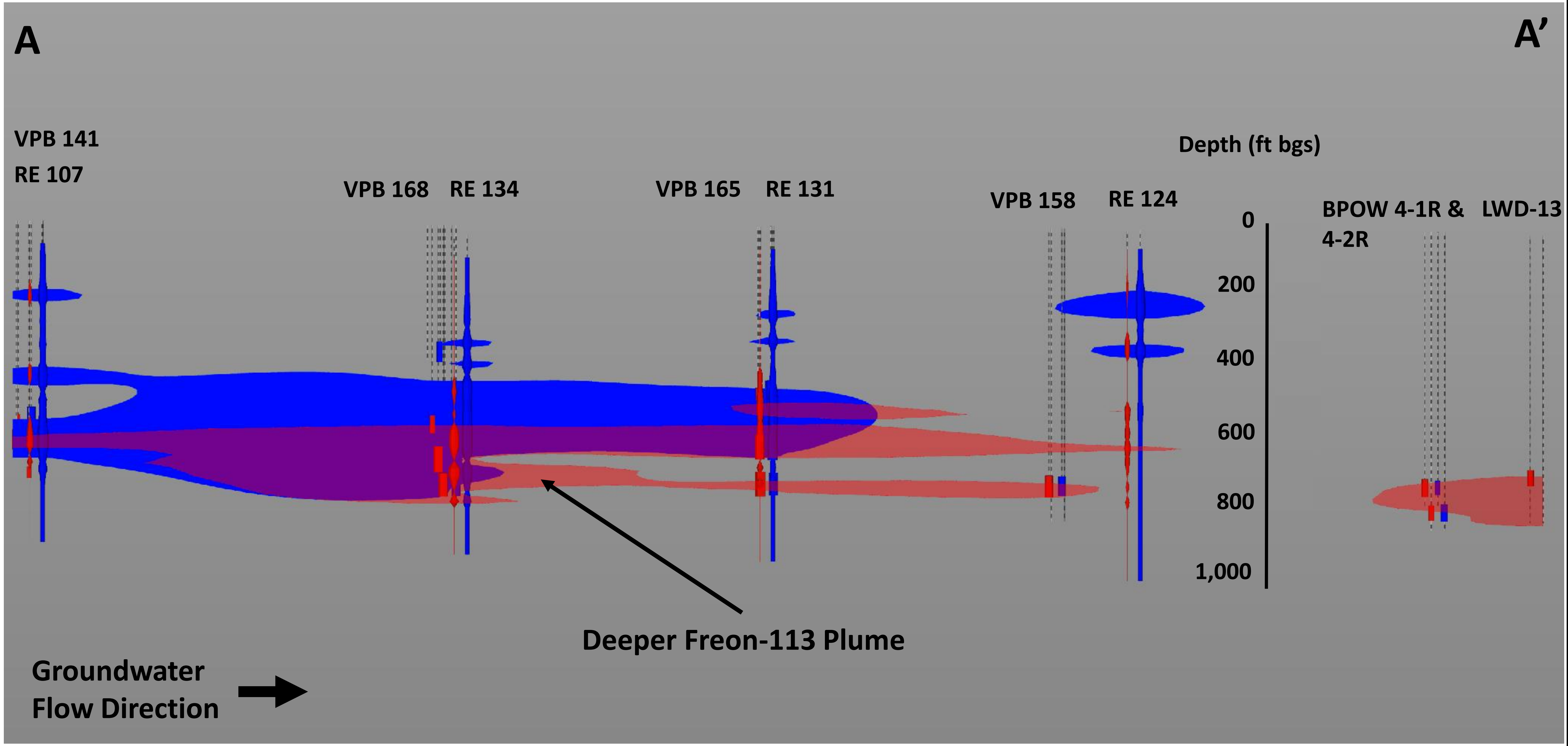
Author: KL

McLane Environmental, LLC

Date: 1/17/2020

Freon-113

TCE



Notes:

Plume Depictions generated in Earth Volumetric Studio

Plume depicted at 10 ug/L

Data obtained from NYSDEC database

Figure 6b
Observed TCE and Freon-113 Concentrations in OU-2 Monitoring wells/VPBs and LWD Wells – Cross Section View

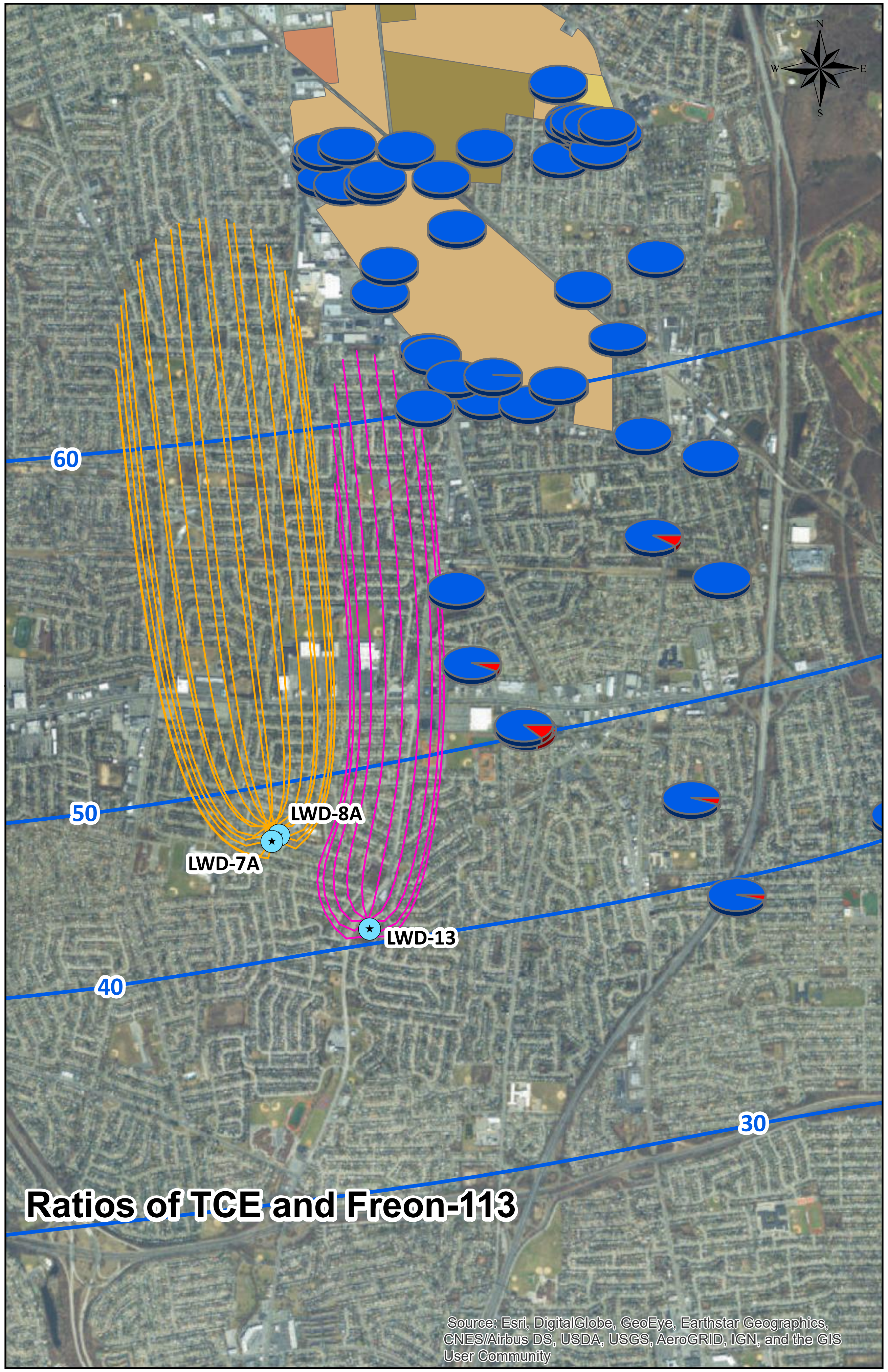
Town of Hempstead, New York

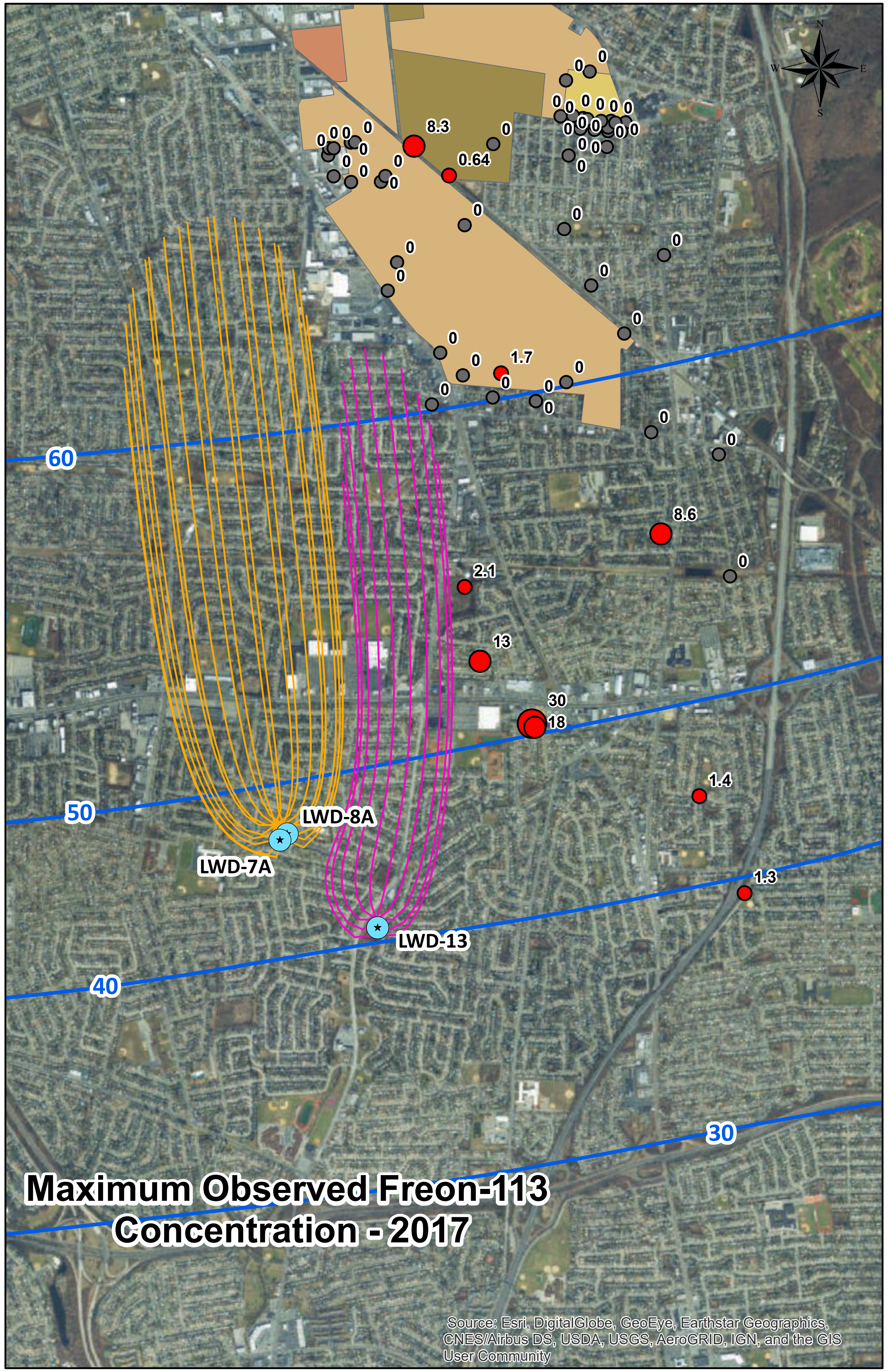
McLane Environmental LLC
Consulting Scientists & Engineers

Author: KL

McLane Environmental, LLC

Date: 1/17/2020





Freon-113 vs. TCE Pie Chart

- TCE Max Concentration (ug/L)
- Freon-113 Max Concentration (ug/L)

Freon-113 Max Conc (ug/L)

- ND
- ND - 5
- 5 - 25
- 25 - 50
- > 50
- LWD Wells
- H2M LWD-13 Model Capture Zone
- H2M LWD-7A and 8A Model Capture Zone
- Magothy Potentiometric Contours
- Northrop-Grumman
- NWIRP
- Bethpage Community Park
- Hooker-Ruco

Notes:

Sources: ESRI Basemap

Shallow Zone: > -300 ft msl
Intermediate Zone: -300 to -500 ft msl
Deep Zone: <-500 ft msl

Data utilized for maps are maximum values at each well from 2017

0 1,000 2,000 4,000
Feet

Figure 7a
Ratios of TCE and Freon-113 Concentrations in OU-2 Monitoring Wells and LWD Wells Shallow Zone

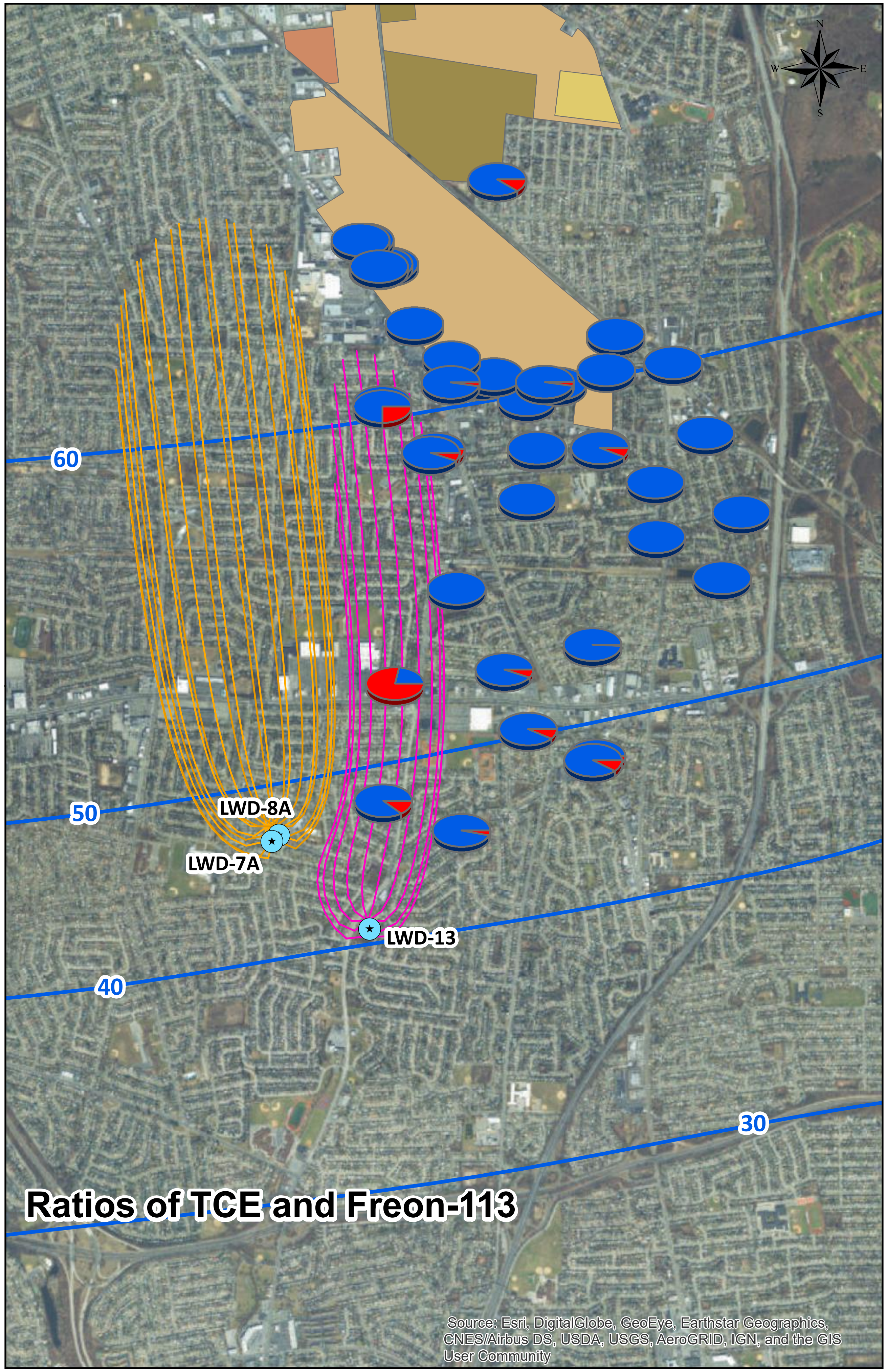
Town of Hempstead, New York

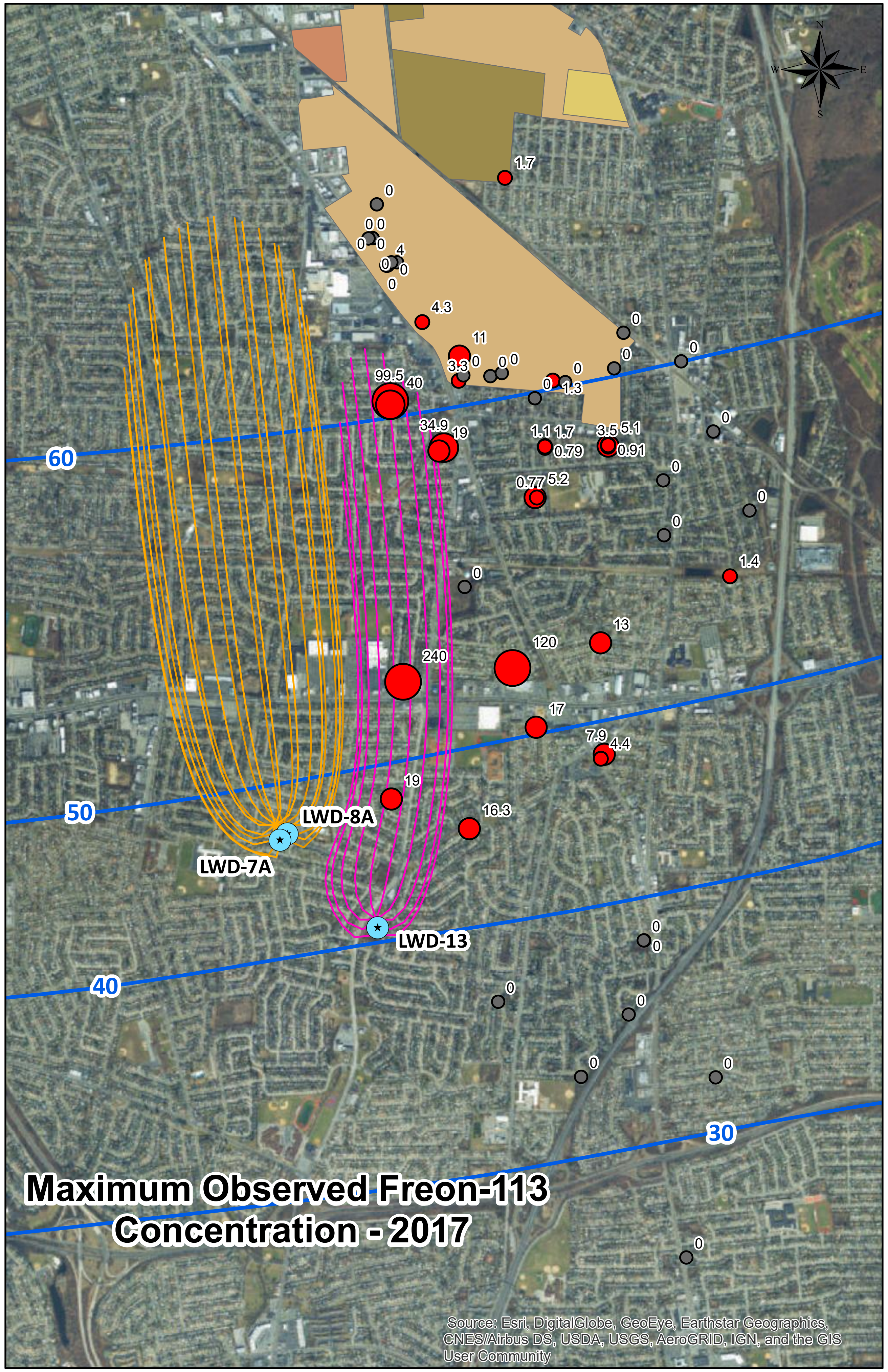
McLane Environmental LLC
Consulting Scientists & Engineers

Author: KL

McLane Environmental, LLC

Date: 1/17/2020





Freon-113 vs. TCE Pie Chart

- TCE Max Concentration (ug/L)
- Freon-113 Max Concentration (ug/L)

Freon-113 Max Conc (ug/L)

- ND
- ND - 5
- 5 - 25
- 25 - 50
- > 50
- LWD Wells
- H2M LWD-13 Model Capture Zone
- H2M LWD-7A and 8A Model Capture Zone
- Magothy Potentiometric Contours
- Northrop-Grumman
- NWIRP
- Bethpage Community Park
- Hooker-Ruco

Notes:

Sources: ESRI Basemap

Shallow Zone: > -300 ft msl
Intermediate Zone: -300 to -500 ft msl
Deep Zone: <-500 ft msl

Data utilized for maps are maximum values at each well from 2017

0 1,000 2,000 4,000
Feet

Figure 7b
Ratios of TCE and Freon-113 Concentrations in OU-2 Monitoring Wells and LWD Wells Intermediate Zone

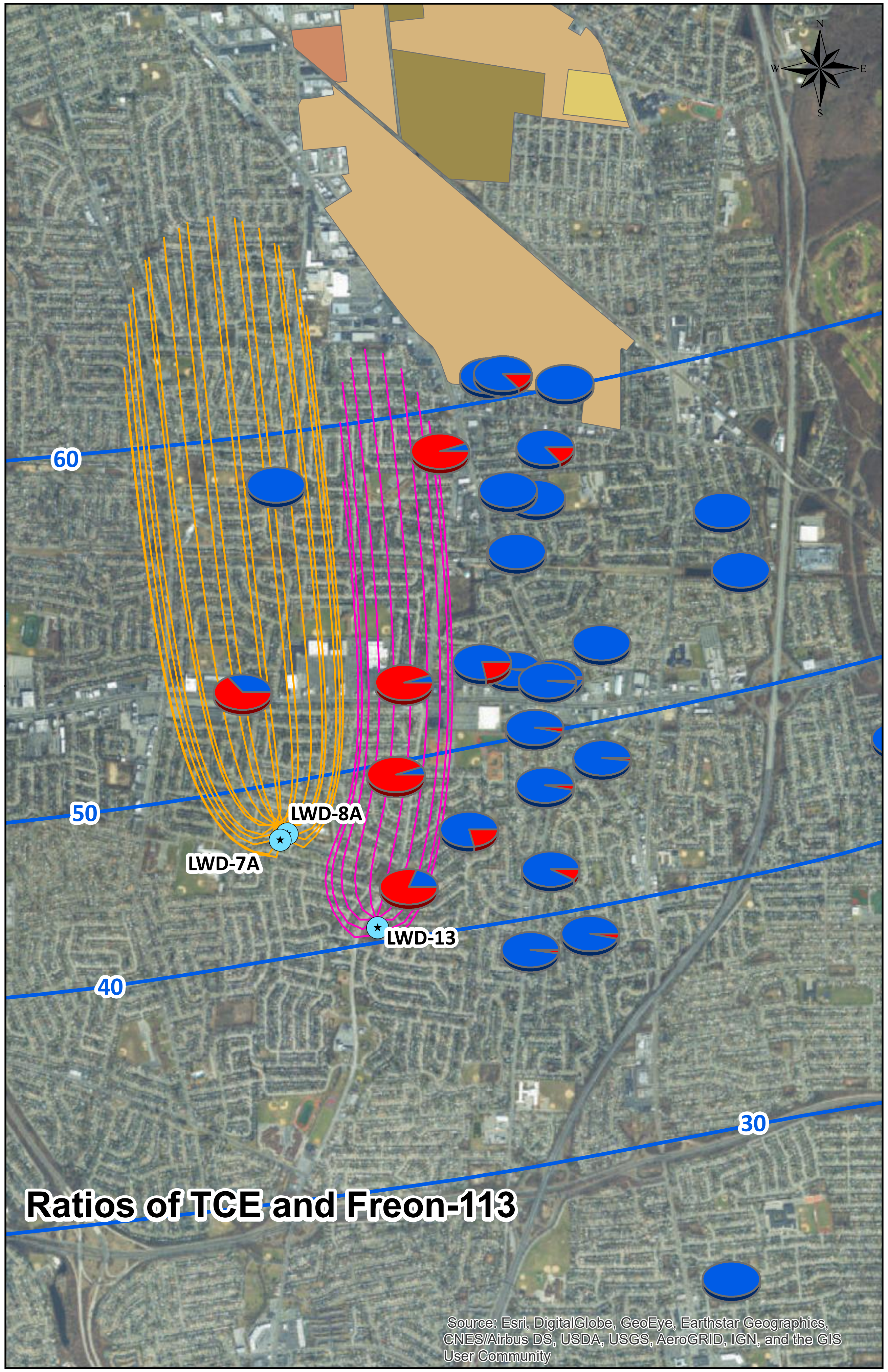
Town of Hempstead, New York

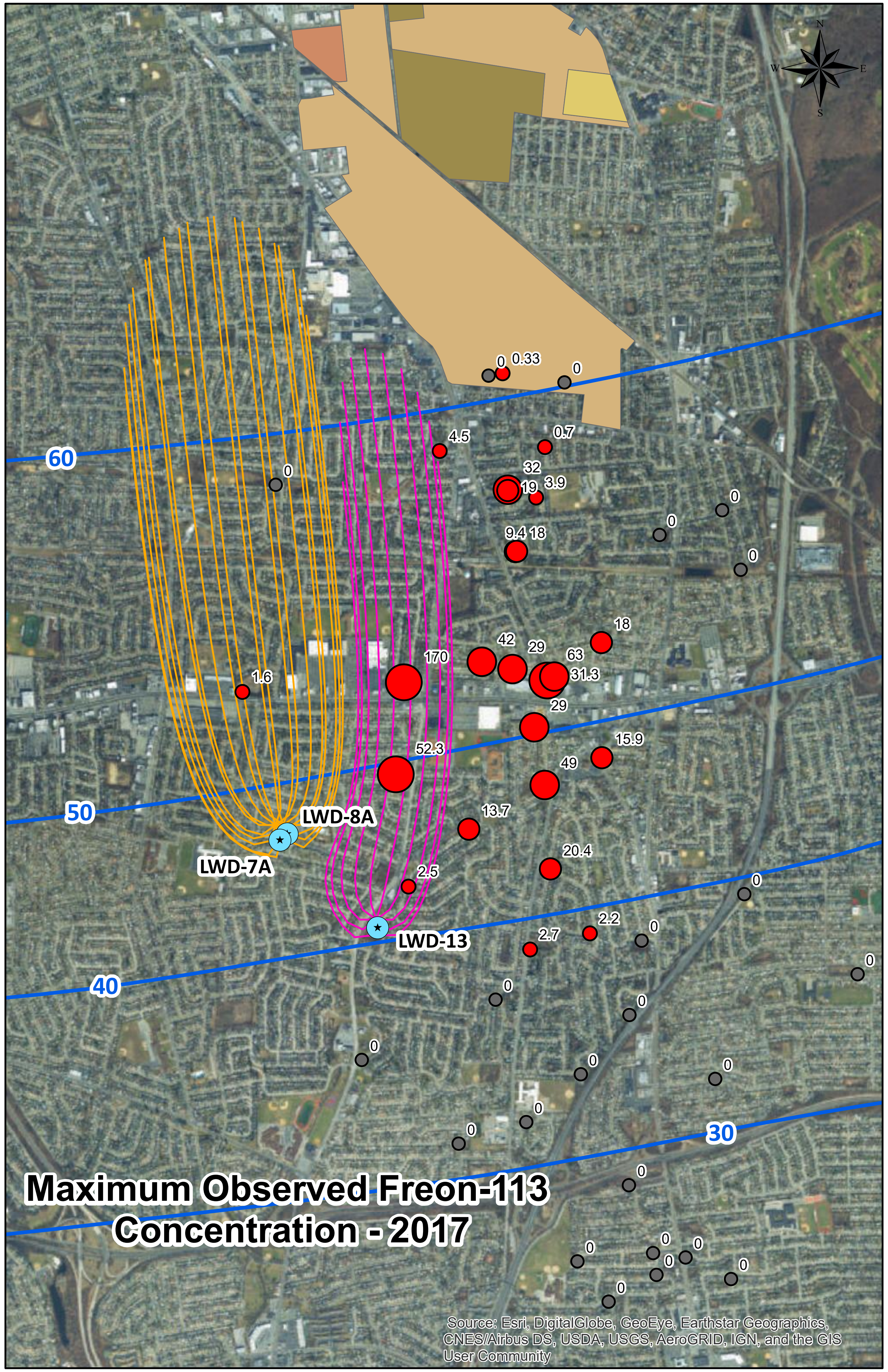
McLane Environmental LLC
Consulting Scientists & Engineers

Author: KL

McLane Environmental, LLC

Date: 1/17/2020





Freon-113 vs. TCE Pie Chart

- TCE Max Concentration (ug/L)
- Freon-113 Max Concentration (ug/L)

Freon-113 Max Conc (ug/L)

- ND
- ND - 5
- 5 - 25
- 25 - 50
- > 50
- LWD Wells
- H2M LWD-13 Model Capture Zone
- H2M LWD-7A and 8A Model Capture Zone
- Magothy Potentiometric Contours
- Northrop-Grumman
- NWIRP
- Bethpage Community Park
- Hooker-Ruco

Notes:

Sources: ESRI Basemap

Shallow Zone: > -300 ft msl
Intermediate Zone: -300 to -500 ft msl
Deep Zone: <-500 ft msl

Data utilized for maps are maximum values at each well from 2017

0 1,000 2,000 4,000
Feet

Figure 7c
Ratios of TCE and Freon-113 Concentrations in OU-2 Monitoring Wells and LWD Wells
Deep Zone

Town of Hempstead, New York

McLane Environmental LLC
Consulting Scientists & Engineers

Author: KL

McLane Environmental, LLC

Date: 1/17/2020

Pathlines

- LWD-13
- LWD-7A and 8A
- Northrop-Grumman
- NWIRP
- Bethpage Community Park
- Hooker-Ruco
- Public Wells in H2M Model
- Pumped LWD Wells in H2M Model

Notes:

Sources: ESRI Basemap

Pathlines were generated using the average monthly pumping rate for each well between 2009 and 2014

0 1,000 2,000 4,000
Feet

Figure 8
LWD Capture Zones Generated by H2M Groundwater Model - Average Observed Monthly PWS Well Pumping

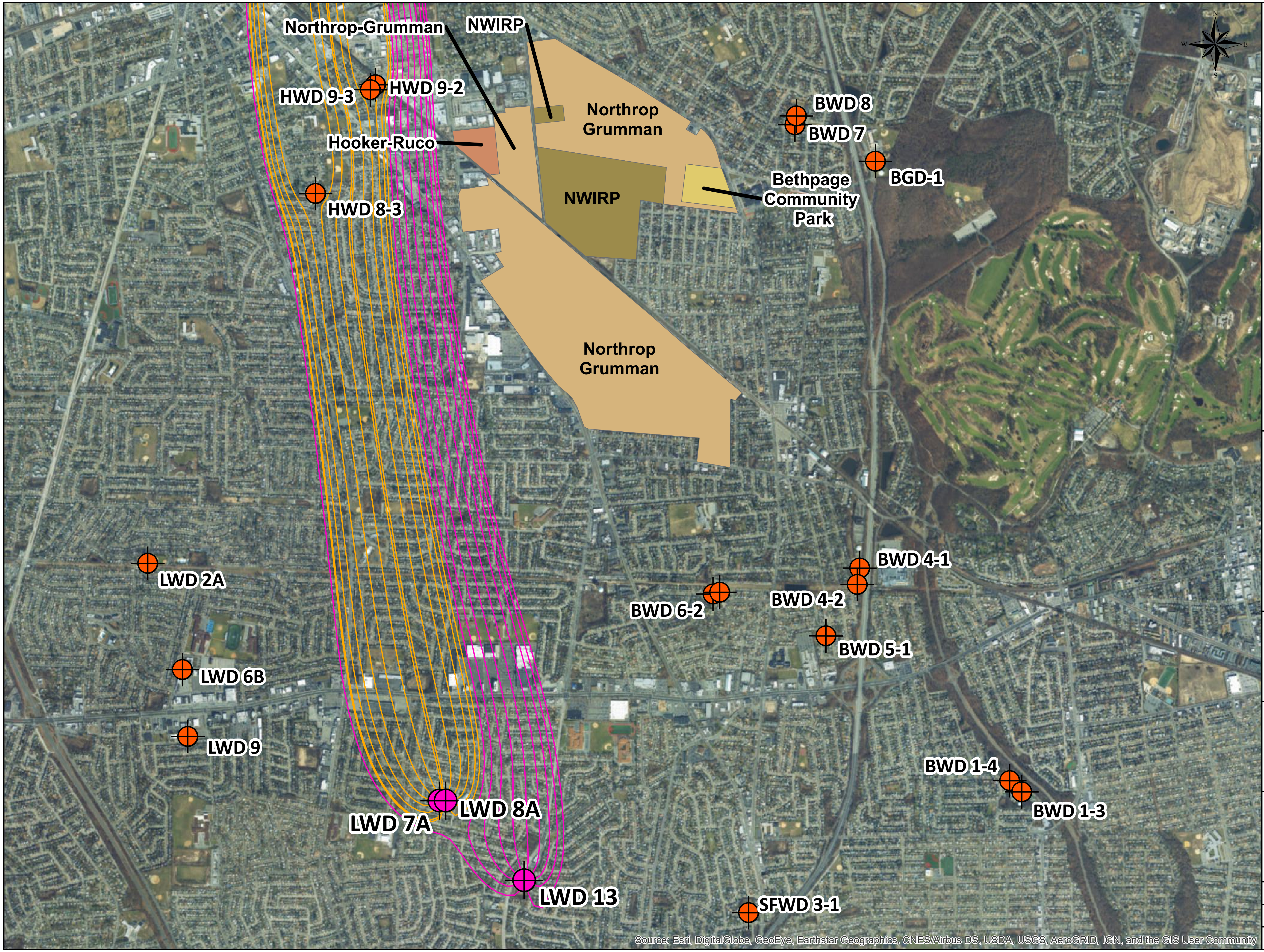
Town of Hempstead, New York

McLane Environmental LLC
Consulting Scientists & Engineers

Author: KL

McLane Environmental, LLC

Date: 1/17/2020



Pathlines

- LWD-13
- LWD-7A and 8A
- Northrop-Grumman
- NWIRP
- Bethpage Community Park
- Hooker-Ruco
- Public Wells in H2M Model
- Pumped LWD Wells in H2M Model

Notes:

Sources: ESRI Basemap

Pathlines were generated using the maximum monthly pumping rate for each well between 2009 and 2014

0 1,000 2,000 4,000
Feet

Figure 9
LWD Capture Zones Generated by H2M Groundwater Model - Maximum Observed Monthly PWS Well Pumping

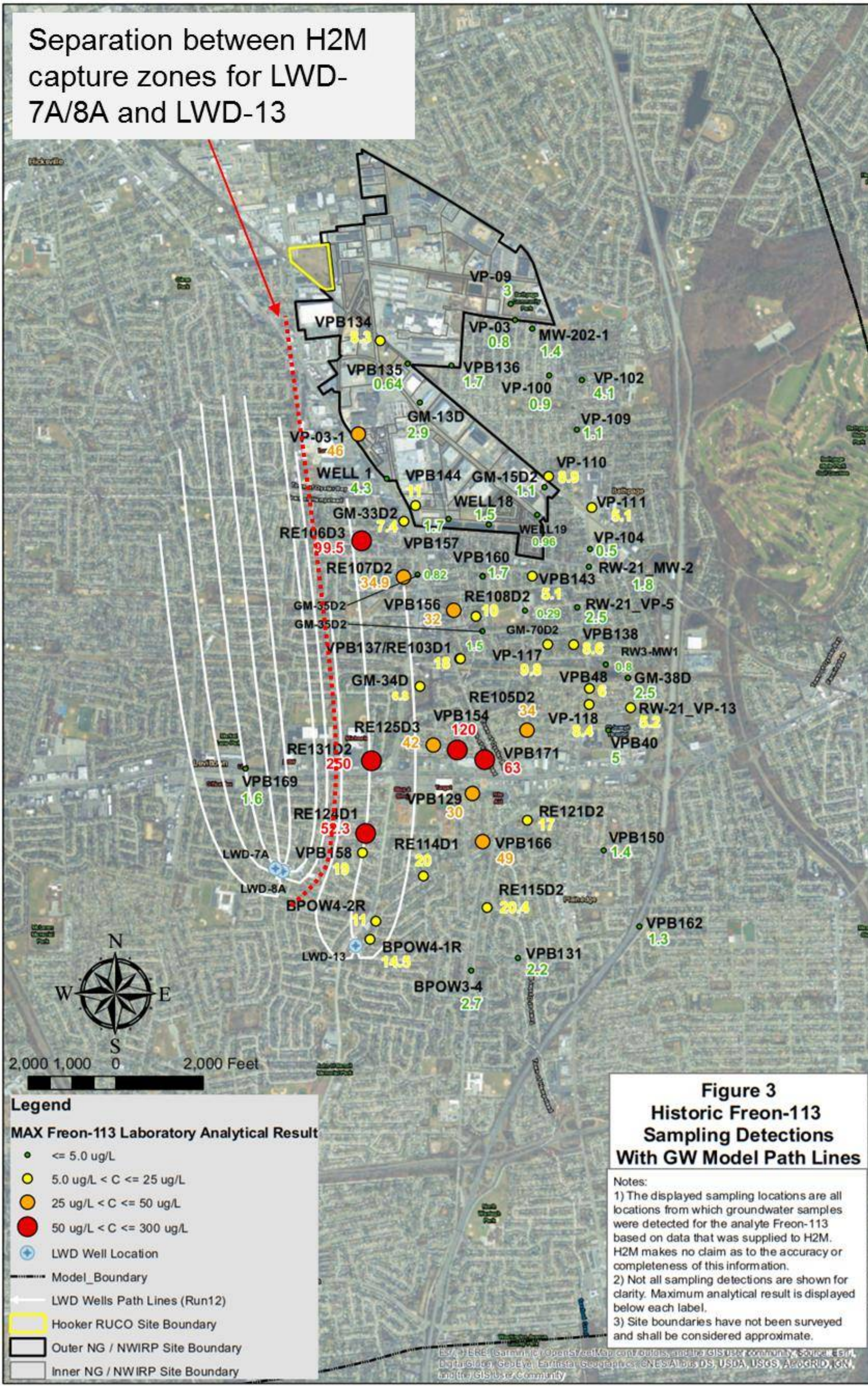
Town of Hempstead, New York

McLane Environmental LLC
Consulting Scientists & Engineers

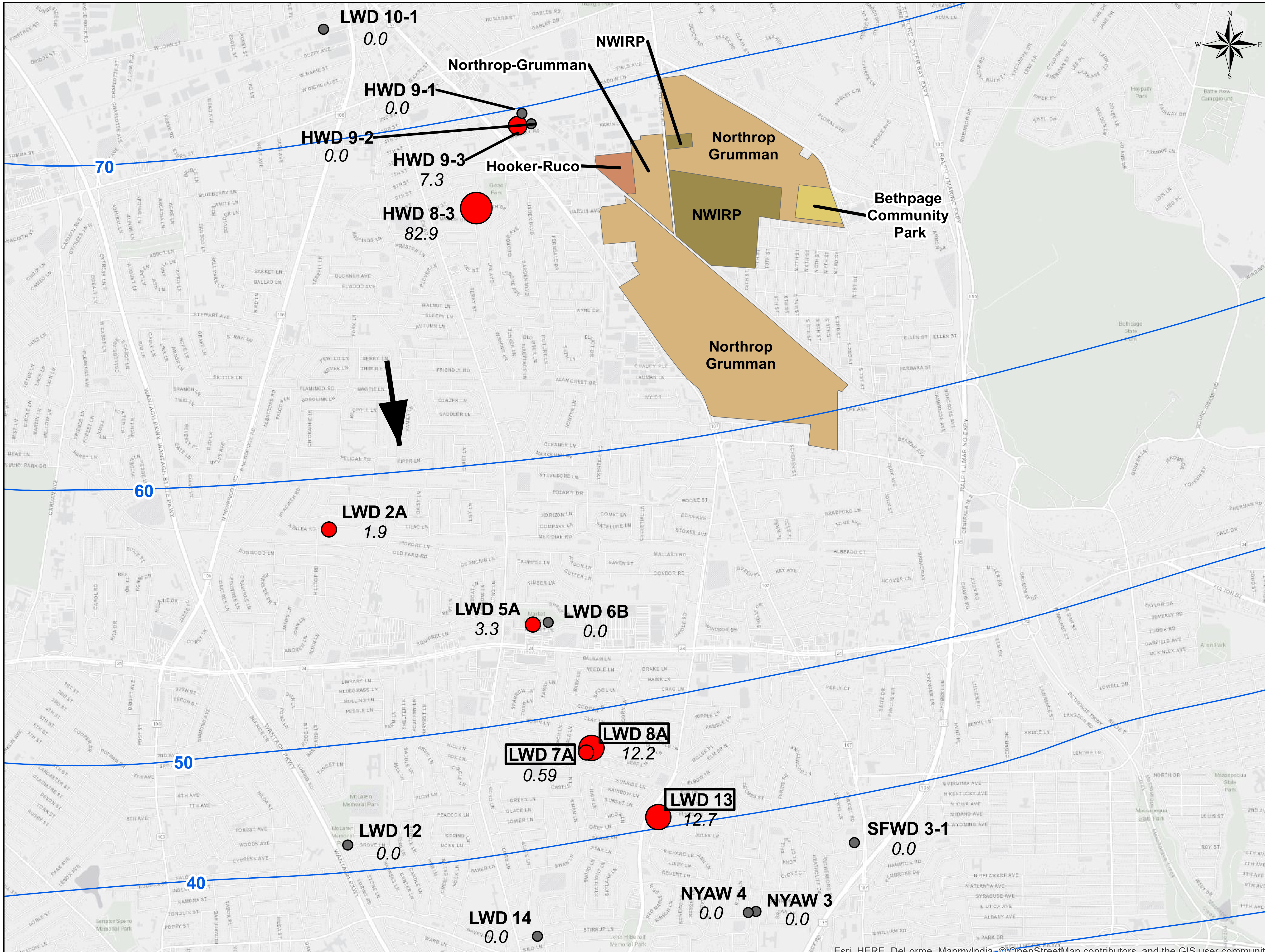
Author: KL

McLane Environmental, LLC

Date: 1/17/2020



1/17/2020	Figure 3 From August 2019 H2M Report - Annotated	McLane Environmental LLC Consulting Scientists & Engineers	Figure 10



Freon-113 Concentration (ug/L)

- ND
- ND - 5.0
- 5.0 - 10
- 10 - 25
- >25
- 2016 Magothy Potentiometric Contours
- GW Flow Direction
- Northrop-Grumman
- NWIRP
- Bethpage Community Park
- Hooker-Ruco

LWD 10-1 Well Name

8.1 Concentration

Levittown Water District Wells of Interest

Notes:

Sources: ESRI Basemap

Note:
The maximum concentration between 2010 and 2018 utilized for each well

0 1,000 2,000 4,000
Feet

Figure 11a
Concentrations of Freon-113 in Regional Monitoring and Public Water Supply Wells

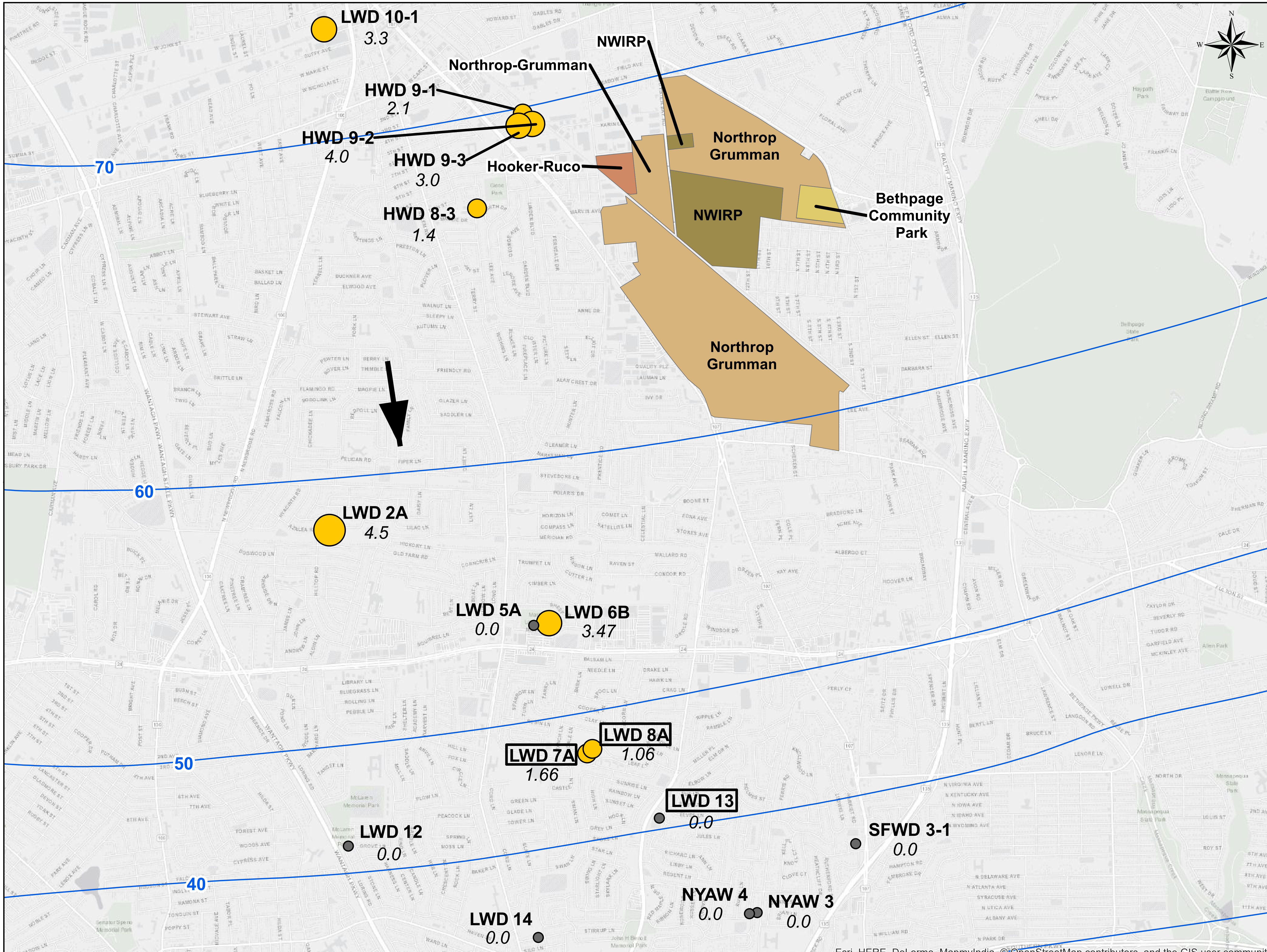
Town of Hempstead, New York

McLane Environmental LLC
Consulting Scientists & Engineers

Author: KL

McLane Environmental, LLC

Date: 1/17/2020



1,1-DCA Concentration (ug/L)

- ND
- ND - 1.0
- 1.0 - 2.5
- 2.5 - 4.0
- >4.0
- 2016 Magothy Potentiometric Contours
- GW Flow Direction
- Northrop-Grumman
- NWIRP
- Bethpage Community Park
- Hooker-Ruco

LWD 10-1 Well Name

8.1 Concentration

Levittown Water District Wells of Interest

Notes:

Sources: ESRI Basemap

Note:
The maximum concentration between 2010 and 2018 utilized for each well

0 1,000 2,000 4,000
Feet

Figure 11b
Concentrations of 1,1-DCA in Regional Monitoring and Public Water Supply Wells

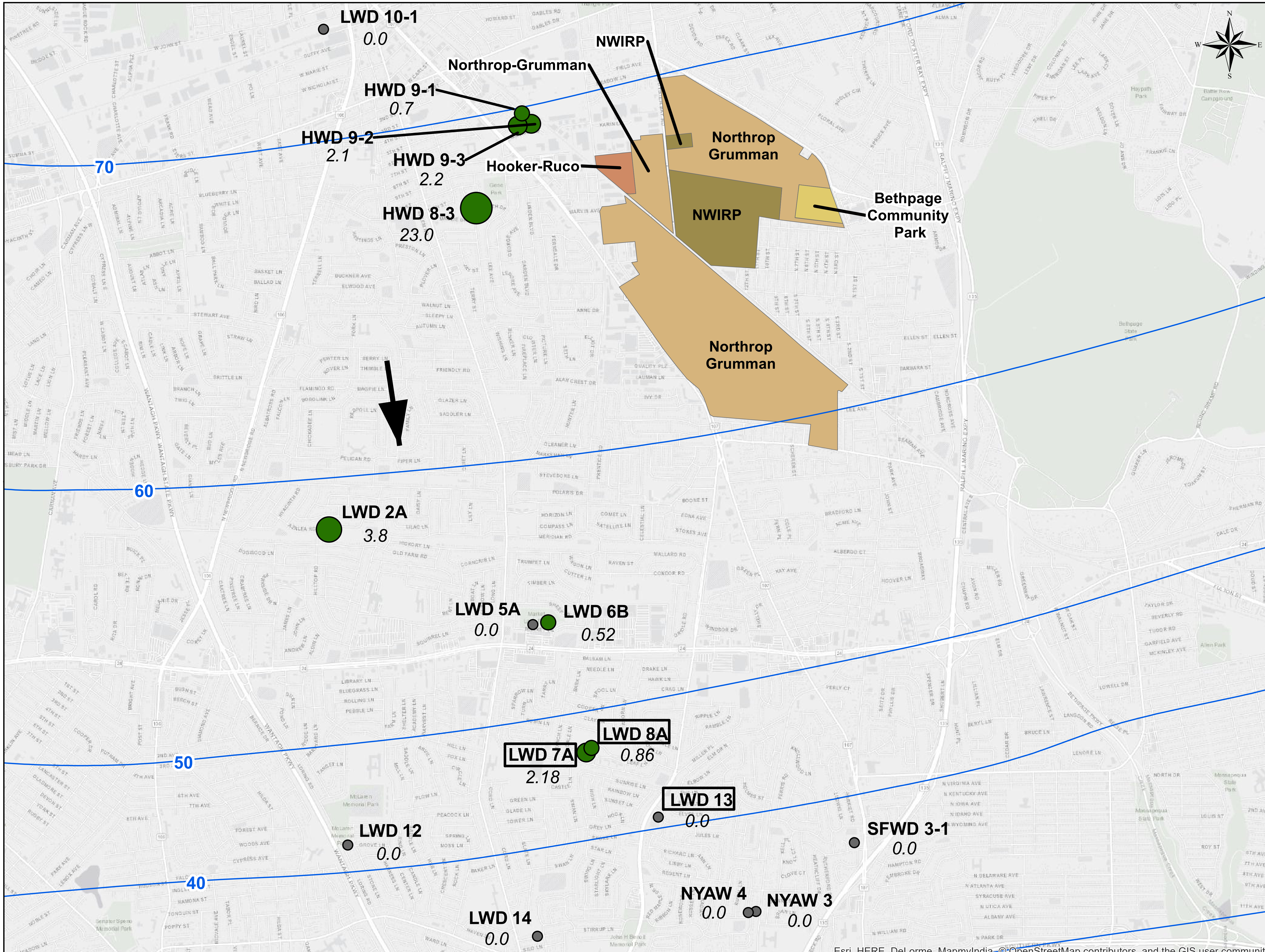
Town of Hempstead, New York

McLane Environmental LLC
Consulting Scientists & Engineers

Author: KL

McLane Environmental, LLC

Date: 1/17/2020



Chloroform Concentration (ug/L)

- ND
- ND - 1.0
- 1.0 - 2.5
- 2.5 - 4.0
- >4.0
- 2016 Magothy Potentiometric Contours
- GW Flow Direction
- Northrop-Grumman
- NWIRP
- Bethpage Community Park
- Hooker-Ruco

LWD 10-1 Well Name

8.1 Concentration

Levittown Water District Wells of Interest

Notes:

Sources: ESRI Basemap

Note:
The maximum concentration between 2010 and 2018 utilized for each well

0 1,000 2,000 4,000
Feet

Figure 11c
Concentrations of Chloroform in Regional Monitoring and Public Water Supply Wells

Town of Hempstead, New York

McLane Environmental LLC
Consulting Scientists & Engineers

Author: KL

McLane Environmental, LLC

Date: 1/17/2020

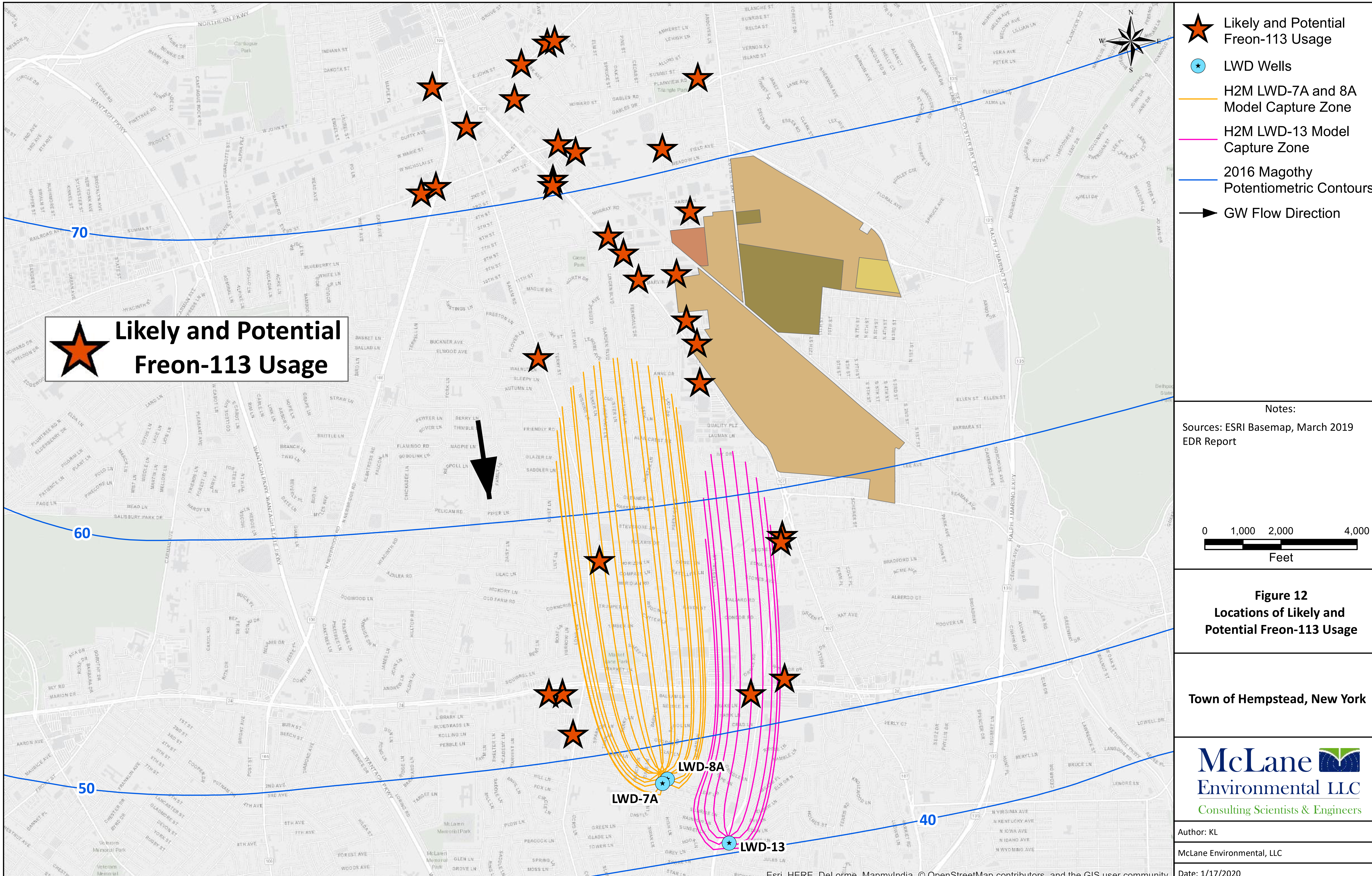


Figure 12
Locations of Likely and Potential Freon-113 Usage

Town of Hempstead, New York

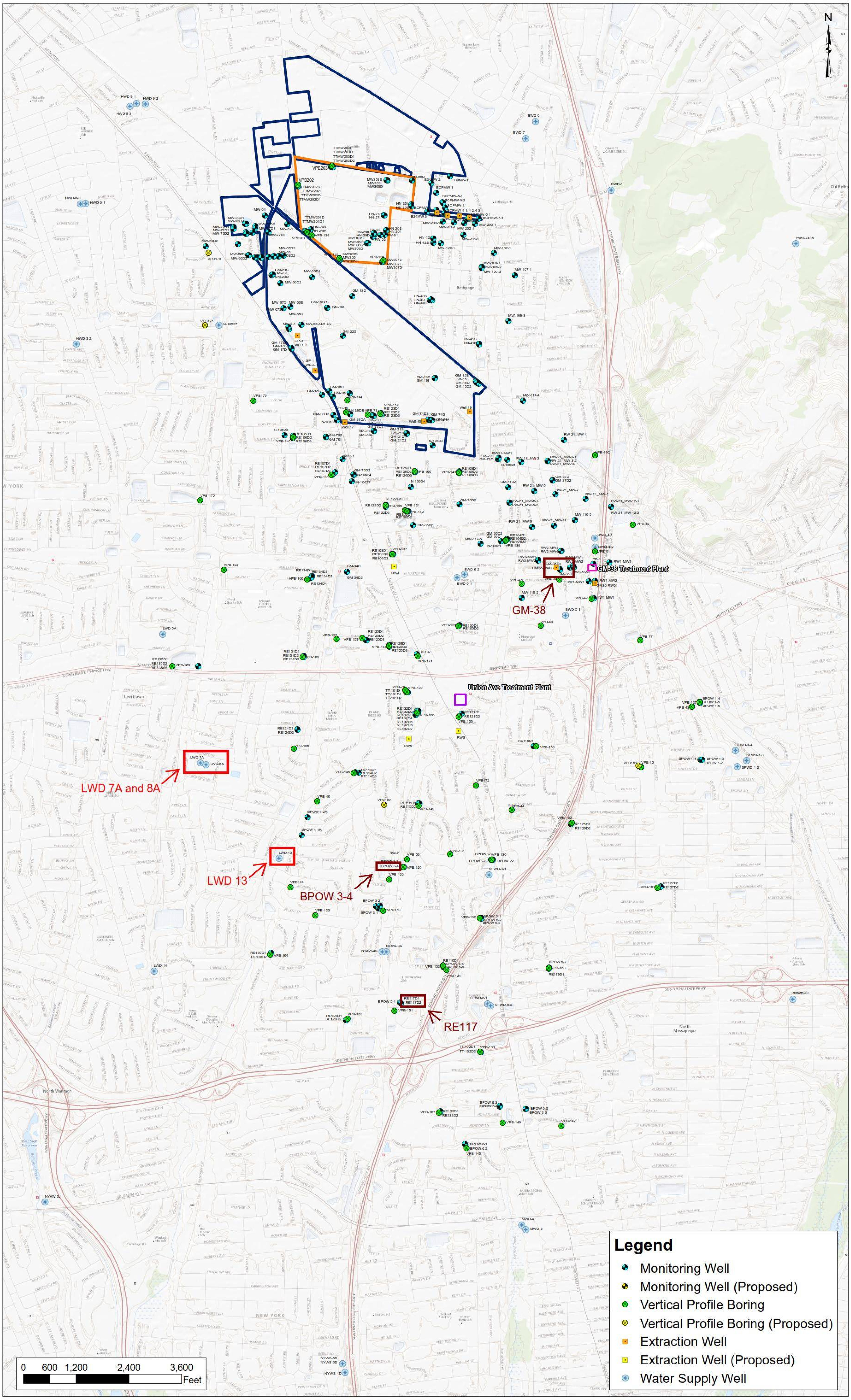
McLane Environmental LLC
Consulting Scientists & Engineers

Author: KL

McLane Environmental, LLC

Date: 1/17/2020

Attachment 1



N
GM-38 Treatment Plant
GM-38
Union Ave Treatment Plant
LWD 7A and 8A
LWD 13
BPOW 3-4
RE117
Levittown
Bethpage
North Wantagh
North Massapequa
HEMPSTEAD TPKE
SOUTHERN STATE PKWY
NEW YORK
Legend
Monitoring Well
Monitoring Well (Proposed)
Vertical Profile Boring
Vertical Profile Boring (Proposed)
Extraction Well
Extraction Well (Proposed)
Water Supply Well
0 600 1,200 2,400 3,600
Feet

APPENDIX A

Curriculum Vitae of Charles F. McLane III, Ph.D.

CHARLES F. McLANE III **MCLANE ENVIRONMENTAL, L.L.C.**
Principal

Education

1984 Ph.D., Environmental Sciences (Hydrogeology), University of Virginia
1978 M.S., Geology (Hydrology), Colorado State University
1974 B.A., Geology, Susquehanna University

Experience

Dr. McLane is a Principal and founder of McLane Environmental, L.L.C. He has over 30 years of diverse experience in environmental regulatory matters, investigations, and analyses. Dr. McLane specializes in groundwater flow system analysis, and in the fate and transport of chemical contaminants in the subsurface, including the use of computer simulation and digital graphic techniques to support risk assessment and remedial engineering investigations. Dr. McLane has assisted numerous corporate clients and their counsel in responding to hazardous waste regulatory program requirements, and in developing the technical portions of complex litigation strategies. He has been called upon to serve as a technical expert in cases involving private party cost recovery, insurance claims, toxic tort, and environmental remediation issues. Examples of Dr. McLane's project and case experience are provided below:

Water Supply, Wastewater Disposal, Regulatory Compliance and Site Assessment Investigations

- Developed technical approach for groundwater contaminant fate and transport analyses to support delineation of a groundwater classification exception area (CEA) for a former waste oil processing facility in central New Jersey. Oversaw plume transport simulations and preparation of materials for submittal to New Jersey Department of Environmental Protection.
- Developed and applied a three-dimensional MODFLOW groundwater flow model for a municipal wellfield in the northeastern US. Guided field investigation efforts to collect hydrologic data to parameterize model. Performed pathline tracing studies to delineate Zone II groundwater protection zones for the individual wells in the system. Performed nitrate loading analyses to examine potential impacts from surrounding sources.
- Provided expert services to a county water coalition to assist them in developing a sustainable water supply plan for the future and, in the short term, preparing scientific positions in response to proposed water supply and treatment options. Compiled and reviewed hydrologic and hydrogeologic data for the county's surface water and groundwater resources, reviewed groundwater modeling studies that had been prepared for the source water aquifer system (river valley fill and deeper bedrock), and evaluated hydrogeologic information and interpretations that had been prepared by the proposing water company. Prepared a technical report and presented findings at a public hearing.
- Served as Principal-in-Charge for a hydrogeologic assessment and contaminant fate and transport study to support delineation of a preliminary groundwater classification exception area (CEA) pursuant to New Jersey Department of Environmental Protection guidelines for a former pigment and polymer plant in northern New Jersey. A BIOSCREEN-AT plume

transport model was calibrated to site groundwater data and was applied to calculate the extent of future migration of dissolved chlorinated compounds in groundwater at the facility.

- Performed groundwater modeling investigation to support permitting of a new wastewater treatment plant for a cranberry processing facility in New England. Reviewed regional and site-specific groundwater studies, evaluated hydrogeologic data, and directed the development and application of an analytic element groundwater model of wastewater infiltration beds to assure proper location of monitoring wells under the permit. Discussed results with regulatory agency and submitted technical report summarizing approach and findings.
- Provided hydrogeologic expertise to a township in northeastern Pennsylvania in reviewing portions of a rock quarry application. The application included plans for groundwater extraction and reinfiltration based on a three-dimensional groundwater flow developed for the proposed quarry site. The review included site geology and hydrogeology reports, the results of bedrock aquifer pumping tests, studies of surface water streams and wetlands, and groundwater modeling analyses performed by the mining company. Findings were presented in an expert report and in testimony presented before the township zoning board.
- Managed groundwater modeling project to evaluate environmental impacts associated with upgrade of an existing wastewater disposal system for a recreational facility in New England. Project included groundwater flow and nitrate transport modeling within the shallow aquifer and to a nearby lake, and preparation of model summary report to accompany project engineering firm's permit application submittal to the State.
- Provided expert witness services on behalf of an industrial client in New Jersey whose facility was named as one of the potential contributors to organic chemical contamination at a small municipal well field. Analyzed site hydrogeologic and contaminant sampling data, well field water testing data, and operational history and sampling data for nearby landfill and other potential sources. Prepared expert report and provided deposition testimony prior to the case settling.
- Served as consulting team leader and groundwater expert for a project designed to support water resource and land use planning decisions for a rapidly growing Florida county. Reviewed existing environmental science and engineering reports, and prepared a 300-page report summarizing key environmental information, and presented findings to Board of County Commissioners.
- Conducted technical peer review of a complex three-dimensional finite-element model to support design of a wastewater disposal system as part of a former defense installation development project in New England. Reviewed site hydrogeologic data, site conceptual model, and groundwater flow and mounding model, and prepared summary report for client.
- Oversaw the development of a groundwater flow model to support a water allocation permit application for an operating industrial facility in New Jersey. The model was designed to explore future configurations of production wells that were to be operated in a complex a multi-layered dipping bedrock aquifer near a major surface water body. Potential future

drawdown was calculated, and particle tracking was employed to examine possible hydraulic effects on nearby facilities and surface water bodies.

- Managed a ground water modeling investigation to examine hydrologic impacts associated with proposed increased withdrawals at an operating municipal well field on Cape Cod. Obtained existing USGS aquifer model to provide for a highly cost-effective analysis of the proposed withdrawals, performed sensitivity analyses and engaged in technical discussions with USGS to guide model modification, simulated impacts of withdrawals on ecologically sensitive nearby surface water bodies, and presented results to client.
- Provided ground water consulting services for landfill Superfund site in New England. Performed ground water flow and plume transport modeling study for two-year remedy performance review, developed recommendations for site data collection, assisted in responding to regulatory agency recommendations contained in five-year review, oversaw data management and analysis tasks including development of a comprehensive site data base and evaluation of monitored natural attenuation parameters for the site, and participated in planning of subsequent phases of site remediation.
- Conducted analyses of aquifer yield and potential saltwater intrusion to assist Cape Cod municipality with water management planning and identification of new source alternatives; engaged in technical exchange with U.S. Geological Survey regarding freshwater aquifer modeling analyses; presented findings to town leadership to support decisions regarding future plans.
- Served as hydrogeology and ground water modeling expert on an external advisory panel for a large southwestern Department of Energy facility. Reviewed technical information; met with installation management, staff and consultants; participated in meetings with regulators and public Stakeholders; prepared reports summarizing findings and recommendations, and performed external peer review for final project Hydrogeologic Synthesis Report.
- Performed analyses to support design and permitting of wastewater treatment facility for Cape Cod town. Developed computer model for Pilgrim Lens aquifer and conducted ground water flow, mounding height, flow path (particle tracking), and nitrogen loading analyses. Participated in meetings with representatives of regulatory, governmental, and environmental oversight agencies, and provided testimony at public hearing.
- Conducted nitrate loading analyses for proposed residential development in sensitive ecological area. Developed analytical model for existing and proposed residential sources, and examined various loading scenarios. Prepared report for submittal to regulatory agency and responded to agency requests for supporting information.
- At the request of a PRP steering committee, reviewed technical documents describing site investigation and remediation activities for ground water contamination at a Superfund site in Pennsylvania resulting from injection well disposal into a fractured bedrock aquifer in the vicinity of a large municipal drinking water source. Prepared and submitted recommendations regarding additional work to be performed to support a proposed modification of the operating ground water remedy.

- Directed ISRA preliminary assessment for former pharmaceutical processing and packaging facility in central New Jersey. Negotiated approach with NJDEP, performed site inspection, and oversaw preparation of report that resulted in No Further Action letter.
- Assisted Cape Cod municipality in developing a comprehensive water management plan. Reviewed previous hydrogeologic investigations, conducted modeling analyses for proposed well fields, summarized information regarding previous saltwater intrusion modeling studies, and analyzed saltwater interface upconing as one of the primary limiting factors in establishing safe yields for the well fields.
- Directed ground water modeling investigation for well field on Cape Cod, Massachusetts to examine potential benefit of switching from central suction pump to distributed submersible pumps. Developed analytical element model of Pamet Lens section of the Cape and simulated effects of selected pumping schemes for various hydrologic conditions. Conducted analysis of potential saltwater upconing for various pumping schemes and saltwater interface depths corresponding to average and drought conditions.
- Served as project manager for a three-dimensional ground water flow simulation and particle-tracking analysis for an abandoned agricultural chemical processing facility in a northern Florida city. Analyzed potential impact of site releases on city water supply wells and nearby surface water to support a petition to exempt the site from listing as a Superfund site on the National Priorities List (NPL).
- Served as technical advisor to a township municipal utilities authority (MUA) in southeast New Jersey regarding ground water modeling conducted by a large energy company in support of a water diversion permit application. Performed review of modeling studies and recommended additional analyses that would lend stronger support to the preliminary finding that large withdrawals for steam generation would not adversely impact the ground water aquifer. Worked with energy company's consultants to modify model and improve analyses, and presented testimony before New Jersey Department of Environmental Protection at public hearing.
- Provided hydrogeologic assistance to engineering firm tasked with siting and permitting a treated wastewater disposal basin for a proposed residential development in New England. Consulted on field data collection program, developed program analyses consistent with state regulations, and performed geologic and computer modeling analyses to support permitting effort.
- Performed groundwater mounding analyses for a proposed municipal wastewater disposal system for a town in Massachusetts. Evaluated field testing results, performed mounding calculations and sensitivity analyses, and prepared report to support permit application.
- Directed Phase I assessments for commercial and industrial facilities and residential properties in New Jersey to identify conditions that may represent an environmental concern. Provided post-assessment assistance in obtaining air permits for a pharmaceutical production, packaging and shipping facility in central New Jersey.

- Managed an Alternate Concentration Limit (ACL) demonstration for a southeastern U.S. Department of Energy (DOE) hazardous waste facility subject to RCRA regulations. Compiled site-specific hydrogeologic, demographic, ecosystem, and waste-disposal history data pursuant to EPA ACL guidelines; prepared and submitted preliminary ACL report to Tennessee Department of Health and Environment.
- For U.S. Department of Energy (DOE), conducted a stochastic (Monte Carlo) modeling study of radionuclide migration from containers in a proposed northwestern US high-level nuclear waste repository in fractured crystalline basalt using finite-element transport code. The simulation technique was based on a statistical failure distribution for population of containers and a statistical assessment of subsequent releases relative to EPA and NRC guidelines.
- Prepared RCRA Part B Post-Closure Permit Applications for hazardous waste management units at a southeastern U.S. Department of Energy (DOE) facility. Compiled required waste disposal and environmental sampling information, and prepared plan for post-closure monitoring and maintenance.
- Assisted a midwestern corporation in evaluating environmental issues at several manufacturing facilities throughout the United States. Reviewed relevant site documents, met with headquarters and plant environmental staff and on-site consultants to review status of investigation and remediation efforts, and prepared reports of findings to support corporate decisions regarding future actions.

Remediation and Risk Assessment

- Performed a technical peer review of a groundwater model that was designed by a consultant for the seller of a commercial property in northern New Jersey to demonstrate the effectiveness of the proposed groundwater remediation system for the property. Identified issues relating to the model's structure, inputs, and results; and conveyed information to the contractor for the prospective buyer.
- Developed a groundwater flow model to assist in site characterization and remedial planning for an industrial facility located along the Delaware River in Salem County, New Jersey. Compiled hydrogeologic data from regional USGS studies and site investigations, developed a site conceptual model, constructed and calibrated a groundwater flow model, and performed flow pathline tracing analyses to examine hydrogeologic connections between aquifer units, and potential flow paths from known and suspected sources on and near the site property.
- Directed development and application of a groundwater flow model to evaluate remedial alternatives for a landfill Super Fund site in Vermont. Analyzed conceptual designs for extraction trench and well array conceptual designs for capturing a mixed chlorinated solvent groundwater plume. Prepared model results and presented to remediation engineering firm.
- Provided groundwater modeling and hydrogeologic technical support services to a New York consulting firm who was assisting a local printing facility in complying with environmental regulations regarding investigation and cleanup of organic chemical contamination in soil and

groundwater beneath and surrounding its property. Performed State-requested modeling analyses; prepared report summarizing data, methods and findings; and participated in conference call with prime consulting firm and State regulators to discuss results of analyses.

- Assisted major engineering contractor with soil remediation program for a portion of US Department of Energy facility in Oak Ridge, Tennessee. Built on system of calculated soil trigger levels by performing soil zone modeling analyses incorporating vertical profile soil sampling results to establish chemical-specific soil cleanup levels. Prepared and submitted modeling analysis reports to project management team to guide remedial decisions.
- Managed the modeling portion of a focused feasibility study to examine likely influent rates and capture effectiveness of several conceptual trench designs for a landfill Superfund site in New England. Modified the existing site model to incorporate a trench design. Calculated flow to the model trenches, and employed particle tracking to examine the effectiveness of the various designs in capturing the known extent of VOC contamination. Worked with the client to redefine and retest selected designs, and prepared modeling report for submittal to EPA as part of overall focused feasibility study.
- Reviewed PRAP, and supporting RI and FS, for a New Jersey Superfund site contaminated with arsenic and VOCs. Examined technical basis for EPA proposed remedy, and performed data analyses to examine estimated ground water cleanup time and effectiveness of natural attenuation processes for VOCs. Assisted PRP committee in preparation of response comments for submittal to EPA prior to ROD issuance.
- Provided oversight and technical peer review for two ground water modeling studies of petroleum refineries located along the Delaware River. Modeling included the development of regional ground water flow models of the Potomac-Raritan-Magothy aquifer system in the vicinity of the sites, and refinement of the models to the site scale to support remedial design analyses.
- Performed technical review of ground water flow and contaminant fate and transport models for New York landfill Superfund site. Reviewed information on background hydrogeology and site conceptual model, examined model design and parameter values, and prepared technical report.
- Assisted the Los Alamos office of DOE, by serving as an independent expert in a review of ongoing and planned ground water modeling studies that were intended to provide support for ground water remediation studies and field data collection and integration activities. Attended a modeling program review meeting with other experts and DOE and LANL staff to receive information on site-specific and regional modeling activities. Prepared recommendations report and submitted to DOE LAOO.
- Directed engineering analyses of remedial alternatives for nitrate and uranium plume at DOE facility in Colorado. Reviewed and assessed adequacy of existing data, prepared conceptual model report and analysis program plan, and presented project plan to regulatory agencies. Reviewed site-specific uranium adsorption test data, and factored into analysis program. Developed ground water flow and transport models, analyzed alternatives including trench

capture and phytoremediation, and assisted in the evaluation of reactive barrier technology to support selection of final ground water remedy.

- Assisted the US Army by serving as a Subject Matter Expert in the areas of hydrogeology, karst hydrology, and ground water modeling for independent technical reviews of ground water investigation and remediation programs at numerous installations. Participated in site tours and meetings with installation staff, contractors and regulators to discuss pending issues and ongoing and planned activities. Prepared recommendations to assist Army in streamlining investigation, remediation, and closure of installations.
- Conducted ground water to surface water discharge calculations to set safe soil cleanup levels for a lead and tetraethyl lead disposal basin at a waste disposal facility. Presented plans for extending the approach to other on-site SWMUs to the New Jersey Department of Environmental Protection.
- Managed a project for the development of three-dimensional ground water flow and contaminant transport models for RCRA hazardous waste surface impoundment at Department of Energy facility in eastern Tennessee. Utilized MODFLOW and SWIFT and employed grid-refinement approach to move from valley-scale model to site-scale model. Used model results in a risk assessment to establish safe cleanup goals for the site.
- Analyzed data for a mixed petroleum product release from an aboveground tank terminal in Virginia and performed modeling simulations of soil leaching, dissolved plume migration, and sediment desorption to establish ground water, soil and sediment cleanup goals for the facility.
- Developed the soil and ground water portion of a RCRA clean closure strategy for a group of automobile manufacturing facilities in Ohio. Reviewed relevant RCRA regulations, developed an innovative approach for calculating potential soil leaching impacts to ground water, and presented the proposed approach to Ohio EPA.
- Directed the preparation of a preliminary cost estimate for remediating 55 gas pipeline compressor stations at which PCBs, metals, and hazardous substance list (HSL) contaminants have been detected in soils, ground water, and surface water.
- Served as principal investigator for the ground water portion of a multimedia probabilistic (Monte Carlo) risk assessment for the hypothetical release of hazardous materials from a 20,000-drum landfill located near a major eastern river.
- Authored a report comparing the results of a large aquifer testing field program (8 tests, 18 pumping wells, over 200 observation wells) with the predictions of a three-dimensional numerical ground water flow model developed for a Superfund site in New Jersey.
- Conducted a technical review of the contaminant transport modeling portion of a risk assessment performed by consultants for a pesticide production facility in Louisiana. Recommended revisions prior to submittal to State Department of Environmental Resources.
- Served as a member of a joint PRP technical advisory group for a large landfill Superfund site in the mid-west. Assisted in developing technical strategy and served as peer reviewer

for groundwater modeling studies of potential ground water health impacts and remedial alternatives for the site. Assisted in preparing information provided to cognizant regulatory agencies regarding site investigation and remediation activities and findings.

- Reviewed contaminant transport modeling results performed for a California manufacturing facility along with supporting hydrogeologic, water quality, and waste disposal data to provide an opinion regarding the possible presence of DNAPL contamination and to estimate the potential length of remediation. Presented a cleanup time estimate in cumulative probability form for inclusion in statistical analysis of potential cleanup costs.

Litigation Support Activities

- Provided background litigation support and expert witness services to US Department of Justice to assist with a remedial response cost allocation case between a large government defense contractor and the United States for response actions at a complex site in Washington State. Reviewed site hydrogeologic and environmental contamination data, and reviewed past and future remedial response actions and costs. Interpreted and summarized information to support counsel in settlement discussions.
- Provided expert witness and litigation support services to counsel for a petroleum service station owner in New York State to assist with cost allocation litigation related to petroleum releases and resulting groundwater contamination at one of the owners' service stations. Reviewed site historical operations and environmental investigation data, assisted counsel with discovery requests, reviewed documents and data obtained from opposing company, summarized information, and assisted counsel in settlement-directed activities.
- Provided expert witness and litigation support services to counsel for US government regarding contamination contribution claim presented by contractor at former manufacturing site in California. Reviewed site hydrogeology; soil and groundwater sampling data; and site operational history information to examine causes and timing of contamination by chlorinated solvents and perchlorate. Prepared and submitted expert report to assist with settlement of the case.
- Served as expert witness in a groundwater contamination case involving contribution from three service stations to petroleum contamination beneath the stations and in a nearby residential area. Reviewed site hydrogeology and environmental sampling data and site remediation information, and analyzed natural and remedy-influenced groundwater flow patterns at the stations. Prepared expert report, reviewed and rebutted opposing expert's findings, presented testimony in deposition, and provided other assistance to counsel in reaching a settlement.
- Provided background litigation support services to outside counsel for a large telecommunications company with respect to chlorinated solvent contamination associated with a former manufacturing facility on Long Island. Reviewed site area hydrogeology, source information, and commingled plume data to assist counsel in defending against contribution claims from nearby industrial facilities and property owners and related actions from the State

of New York. Reviewed investigation reports and litigation position documents for various sites and advised counsel regarding technical information related to litigation issues.

- Provided expert assistance in an environmental insurance matter involving release of petroleum from a pipeline in the southeastern US. Reviewed site hydrogeology data and information describing the nature of the release to form the basis for analyses of the fate and transport of petroleum compounds from the point of release to groundwater. Developed opinions regarding the timing of the release, prepared an expert report, and presented testimony in mediation proceedings.
- Served as an environmental expert on behalf of a major communications corporation in a dispute regarding allocation of remediation costs for a former electric lighting and uranium processing facility in northern New Jersey. Reviewed information regarding historical operations, nature and extent of contamination, and remediation costs to assist counsel in developing a cost allocation scheme that led to a successful resolution between the parties.
- Provided expert witness services for a generator defendants group seeking to resolve cost allocation litigation with numerous other parties for a large municipal landfill in central New Jersey. Analyzed site hydrogeologic and contaminant sampling data and operational history information, as well as operational history and sampling data for nearby potential sources. Prepared expert report and provided deposition testimony prior to case settling.
- Served as a testifying expert in cost recovery litigation brought by the owner of an industrial facility in northern New Jersey. Reviewed site hydrogeologic and operational information, and assisted counsel for the US Government in preparing technical defenses to claims that war time operations by a small defense contractor contributed to site contamination. Prepared expert report and presented testimony in deposition and at trial.
- Assisted the US Government in complex mediation regarding historical operations and releases, and past and future remedial response actions and costs, for a major automobile and steel manufacturing facility in the Midwest. Compiled and reviewed information regarding site investigation and remediation activities performed and costs claimed by the private party, and participated in mediation sessions with the parties to achieve resolution.
- Assisted an industrial client in evaluating a Natural Resource Damage claim by the State of New Jersey for resources impacted by releases from two former disposal sites in the ecologically sensitive Pine Barrens area of the state. Reviewed data describing the past and current extent of contamination, evaluated the State's calculations regarding damages, and assisted client in preparing for settlement discussions.
- Provided assistance to the US Government in the early discovery stages of Natural Resource Damage litigation brought by the State of New Jersey for chemical releases to the environment at a US Navy installation in central New Jersey. Compiled and reviewed information, met with installation staff and counsel to identify relevant data and information from facility records, and provided advice to counsel for USDOJ regarding case issues.

- Reviewed information regarding environmental contamination and remedial response activities and costs for insurance litigation matter involving a printing facility in northern New Jersey. Prepared expert report regarding the source and timing of soil and groundwater contamination, the portions of the remedy that were associated with off-site soils, and the reasonableness of response costs; assisted in settlement negotiations.
- Served as ground water expert of behalf of the U.S. Government in a case involving perchlorate contamination and response costs at a facility located in the western U.S. Reviewed site hydrogeologic and perchlorate sampling data; reviewed facility process, ownership, and operations information, and developed attribution of released perchlorate mass to support response cost allocation.
- Reviewed BTEX and MtBE soil and ground water sampling data for a gasoline service station in Pennsylvania, examined site operations information and water testing data for surrounding community, and assisted major petroleum company in responding to a legal action filed to attempt to certify a class of impacted residential properties.
- Examined historic releases and response actions at three medical equipment manufacturing facilities and served as expert on behalf of manufacturer in insurance litigation. Identified discharge, spill, and release events from on-site sources at the various facilities, examined the response action in light of the governing state or federal regulatory program, and estimated the nature and timing of impacts to environmental media at the facilities.
- Served as expert in insurance litigation involving response cost claims by a commercial property owner against an on-site dry cleaning facility and nearby food processing facility. Examined site geologic, soil, and ground water data, and evaluated plaintiff's expert's opinions regarding a postulated fate and transport link between the food processing facility and the impacted property.
- Reviewed historic site information and hydrogeologic and environmental sampling data related to gasoline and MtBE groundwater contamination at a former gasoline service station in eastern New Jersey. Prepared expert report describing timing and extent of contamination and evaluating groundwater modeling results and other analyses performed by opposing groundwater expert.
- Served as expert in litigation involving a large Natural Resource Damage claim by the State of New Mexico for impacts associated with releases from multiple facilities at a southwestern Superfund site. Compiled, reviewed and analyzed site data; reviewed analyses including groundwater modeling and kriging performed by Plaintiff's experts to estimate damages; and provided testimony regarding assessment of nature and extent of contamination, potential loss of services, and duration of impacts.
- Served as testifying expert for toxic tort litigation involving historic release of crude oil and gas from a leak in a deep production well in Harris County, Texas. Reviewed ground water flow and chemical transport analyses performed by plaintiffs' expert, conducted rebuttal modeling analyses to examine likelihood of potential impacts to downgradient municipal water supply well, and presented testimony regarding findings.

- Served as ground water expert in insurance litigation involving releases, contamination, and cleanup at a large western petroleum refinery; compiled information on the nature and timing of release events and response action costs, and developed program of analyses to estimate impacts of sudden and accidental releases.
- Served as ground water expert in cost allocation litigation involving historic perchlorate releases from a western rocket fuel processing facility. Reviewed data and information pertaining to site hydrogeologic conditions, plant operational data, and locations and timing of perchlorate releases. Evaluated ground water flow and transport modeling analyses and reports prepared by opposing experts.
- Assisted counsel for eastern chemical and plastics manufacturing company by preparing technical portions of insurance litigation relating to chemical release timing, migration, and remediation. Performed data analyses and computer modeling to support testimony of ground water expert, oversaw preparation of complex courtroom graphics including digital animations, and assisted counsel in preparing for trial.
- For a litigation matter involving the release and remediation of gasoline from a transmission pipeline in the mid-west, reviewed and analyzed discharge event data and hydrogeologic information to evaluate the size and location of the proposed class certification area. Examined data describing the migration and distribution of petroleum compounds including MtBE in a fractured bedrock aquifer and evaluated information related to other petroleum sources in the vicinity of the point of release.
- Served as nontestifying ground water expert in toxic tort litigation involving historic organic solvent releases from electronics manufacturing facilities and other industrial sources at a southwestern Superfund site. Reviewed information on solvent handling and disposal practices that had resulted in potential DNAPL sources and deep dissolved phase contamination in a complex alluvial basin aquifer system. Worked with counsel, industrial client, and on-site consultants to compile data, to perform hydrogeologic analyses of ground water flow and contaminant transport, and to oversee development of technical information to support litigation effort.
- Served as ground water expert in insurance litigation involving releases from tanker truck dispatch terminal at a Superfund site in southern New Jersey. Reviewed site documents describing facility operations, site investigation activities, and remedial action program. Analyzed environmental releases, performed lagoon seepage and contaminant plume migration calculations, and presented testimony at trial.
- Assisted a PRP at a Superfund site in California in developing a cost allocation scheme for interim and final ground water remedies aimed at recovering and treating intermingled volatile organic chemical plumes from dozens of PRP facilities in a large valley aquifer system.
- Served as nontestifying consultant on behalf of a private party in a cost recovery suit involving the contamination of a municipal well field by organic solvents and chlorofluorocarbon refrigerants from nearby commercial and industrial facilities.

- For a PRP at a Superfund site in Michigan, developed a cost allocation scheme for investigation and remediation costs that were to be divided among approximately one dozen PRPs. Prepared a matrix of facility-specific and cost-item-specific weighing factors for facilities that had been operated by multiple successive owners over a thirty-year period.
- Assisted PRP group for former lead smelting facility in Pennsylvania in developing information to support a challenge to EPA ROD and proposed remedy. Directed modeling analysis of lead leaching impacts to ground water for various remedial scenarios, including an analysis of the infiltration rate through RCRA cap that addressed EPA concerns regarding minor liner installation defects, and presented findings to regulators.
- Assisted counsel for major U.S. petroleum company in a case involving contamination of a sole source aquifer in the U.S. Virgin Islands. Reviewed opposing experts' computer modeling studies linking contamination of potable wells in a fractured bedrock aquifer to releases from numerous gasoline stations, dry cleaning facilities and other industrial sources of petroleum and chlorinated hydrocarbons. Evaluated opposing experts' calculations, performed production well capture zone analyses, and presented expert testimony.
- Served as nontestifying hydrogeological expert in cost allocation litigation on behalf of the past owner of a manufacturing facility in northern New Jersey. Allocation scheme was developed based on length of ownership, operating practices, known releases, and the fact that activities by current owner's technical consultant had contributed to the contamination problem.
- Provided technical litigation support in a cost recovery case involving contamination by pentachlorophenol and other chemicals at neighboring wood processing facilities in California. Assisted counsel for of one of the wood treating industries in developing a technical position to negotiate with EPA regarding certain response costs, and to develop an allocation scheme to equitably apportion the remaining costs between the two private parties.
- Assisted attorneys for an insurance carrier in reaching a successful settlement with other carriers in a cost recovery case involving multiple releases of degreasing solvents at a southern manufacturing facility.
- Assisted counsel for U.S. Department of Justice in a suit brought by PRP over proposed remedy for zinc smelting wastes and environmental contamination at a Superfund site in eastern Pennsylvania. Reviewed site documents and opposing expert report regarding remediation of leachate from waste slag pile, and worked with counsel and hydrogeologic expert to develop plans for field data collection program to support preparation of response report.
- Presented expert witness testimony on behalf of a southeast Florida city in a cost recovery case involving VOC contamination of municipal water supply wells. Conducted a peer review of ground water flow and transport modeling that was performed by the city's engineering consultant. Prepared preliminary present-cost estimates for remediation, and presented testimony at a trial.

- Provided litigation support, and presented expert testimony in a case involving the release of gasoline product from a northern New Jersey service station. Reviewed information pertaining to facility operation, inventory records, tank and pump upgrades and testing, and BTEX and MTBE environmental sampling data. Performed contaminant transport modeling to support the development of opinions regarding allocation of investigation and remediation costs for past releases.

Professional Communication and Instruction

- From 2014 to present, Dr. McLane has presented the short course "Rapid Design and Analysis of Groundwater Remediation Systems" to environmental professionals and regulators. The course presents lectures on the hydraulics of common groundwater remediation technologies, and incorporates hands-on calculation exercises to explore the functioning of various remediation systems.
- Dr. McLane served as Chairperson for the Hydrogeology I: Water Resources and Water Balances session of the Geological Society of America Annual Meeting, October 9, 2011 in Minneapolis, MN.
- From 2003 to present, Dr. McLane has lectured each May at the "Practical Applications of Hydrogeology" short course for environmental professionals offered by Rutgers - Cook College, where he presents lectures on ground water modeling software and methods, data visualization, analysis of uncertainty, and uses of models in water supply, wastewater engineering, and remedial design.
- In June 2007 and June 2008, Dr. McLane served on the faculty of the ALI-ABA advanced course in Environmental Litigation held each year in Boulder, Colorado. Dr. McLane assisted in the preparation of attorney-expert demonstrations for the course and participated in the environmental litigation mock trial, and various demonstrations and panel discussions.
- From 2004 through 2007 Dr. McLane co-developed and served as one of the primary lecturers for the Environmental Forensics short course offered by the National Ground Water Association. The course explored forensic methods in ground water science and analytical chemistry as they are applied in environmental litigation and regulatory actions; the role of science and the scientific expert in the courtroom; and the nature of specific technical issues associated with the various types of environmental litigation.
- In the Spring of 2004, Dr. McLane served as a lecturer for a series of Navy-sponsored Remediation Innovative Technology Seminars at various installations across the country. The seminar topic was optimization of site characterization and remediation, and Dr. McLane presented information regarding various field equipment and software tools (including statistics, geochemical analyses, ground water flow and transport modeling, Geographic Information Systems, and data visualization to streamline and optimize remedial response activities.
- Dr. McLane was invited to speak at the 1999 Theis Conference sponsored by the National Ground Water Association. The conference assembled presentations and poster sessions on the

topic "Remediation of Subsurface Contaminants: The Meaning and Measures of Success". Dr. McLane's presentation was entitled "Probabilistic Risk Assessment and Uncertainty Analysis in Defining Cleanup Goals."

- For a period of over ten years from the early 1990s to the early 2000s, Dr. McLane lectured twice each year at a short course sponsored by the National Ground Water Association to introduce environmental professionals to computer software designed for use in ground water modeling, remediation, and risk assessment. Dr. McLane lectured on ground water modeling and risk assessment, and directed a computer laboratory exercise on the application of Monte Carlo statistical techniques to environmental risk assessment calculations.
- For several years in the early 1990s Dr. McLane chaired and lectured at a short course offered under the auspices of Government Institutes to provide environmental professionals a broad overview of ground water flow, contaminant fate and transport, site investigation, risk assessment, ground water modeling, and site remediation.
- In 1990 and 1991, Dr. McLane served as project manager and co-instructor for a national series of Wellhead Protection training workshops sponsored by EPA Office of Ground Water Protection (OGWP). The first three-day course presented an overview of wellhead protection policy and guidelines, and focused on the prescribed half dozen or so technical methods and hydrogeologic bases for delineating Wellhead Protection Areas. The second course was aimed at getting computer modeling technology into the hands of environmental professionals involved in water management issues. The course provided instruction in basic hydrogeology and ground water modeling and provided course participants with hands-on experience in the use of the EPA WHPA computer model for delineating Wellhead Protection Areas.
- In the late 1980s, while a Principal Hydrogeologist with Geraghty & Miller Ground Water Consultants, Dr. McLane lectured at a ground water seminar presented to Bureau of Reclamation personnel in Denver, Colorado, presenting portions of the course dealing with ground water flow modeling, transport modeling, and uses of models in artificial recharge system design and management. Also, as part of G&M's "Fundamentals of Ground Water Contamination" seminar for attorneys, environmental managers, and hydrogeologists he presented an overview of ground water modeling technology and methodology, and discussed potential applications to ground water supply and contamination problems.
- Other presentations, seminars and workshops include a two-day course on ground water hydrology and hydraulics to representatives of the Virginia State Office of Surface Mining. The course introduced hydrogeologic terminology and concepts relating to ground water recharge and discharge, flow in aquifer systems, and effects of pumping.

Prior to forming McLane Environmental, L.L.C., Dr. McLane was a Manager and Senior Science Advisor with ENVIRON International Corporation. In addition, Dr. McLane has practiced environmental consulting as a Principal Hydrogeologist with Geraghty & Miller Ground Water Consultants, and served as a Senior Engineer with Rockwell International Corporation.

Professional Memberships

Member, American Geophysical Union (AGU).
Member, National Ground Water Association (NGWA).
Member, Geological Society of America (GSA).

Publications and Presentations

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Walton, W.C. and C.F. McLane. 2013. Aspects of Groundwater Supply Sustainable Yield. *Ground Water* Vol. 51 No. 2: 158-160.

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Luchette, J., G. Nelson, C. F. McLane and L. Cecan. 2009. Unlimited Virtual Computing Capacity using the Cloud for Automated Parameter Estimation. Presented at the PEST Conference, November 2 – 4, 2009, Potomac, MD.

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McLane, C. F. and L. Cecan. 2009. Discussion of Paper - ''MODALL: A Practical Tool for Designing and Optimizing Capture Systems.'' *Ground Water*, March-April 2009, Vol. 47, No.2: 172-175.

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McLane, C.F., R.A. Magelky, and D.R. Sieling. 2002. Effect of withdrawals from a simulated island freshwater lens aquifer system: An analytic element modeling approach (Poster). GSA 2002 Annual Meeting, October 27 – 30, 2002, Denver, CO.

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APPENDIX B

Summary of Prior Testimony

Charles F. McLane III, PhD
Principal
McLane Environmental LLC
Matters in Which I Have Testified in the Last Four Years

Year	Type Testimony	Matter	For
2019	Admin Hearing	New Hanover Township v Commonwealth of Pennsylvania Department of Environmental Protection and Gibraltar Rock No. 2018-072-L / 2018-075-L	Plaintiff
2019	Deposition	New Hanover Township v Commonwealth of Pennsylvania Department of Environmental Protection and Gibraltar Rock No. 2018-072-L / 2018-075-L	Plaintiff
2018	Deposition	Penna v United States et al. Case 16-1545-L (Court of Federal Claims)	Defendant
2018	Deposition	City of Lincoln v United States et al. Case 2:16-cv-01164-KJM-AC	Defendant
2017	Trial	Strong Oil Company v Zurich American Ins. Corp. – Index No.: 62714/2014	Plaintiff
2017	Deposition	Cranbury Brick Yard v United States et al. – Civil Action No. 3:15-CV-02789-PGS-LHG	Defendant
2017	Deposition	Peconic Baykeeper Inc. and Soundkeeper Inc. v Rose Harvey – Case No. 13-cv-06261-(JMA)(SIL)	Defendant
2017	Deposition	Hexcel Corporation v Allianz Underwriters Ins. Co., et al. – Superior Court of NJ Docket No. L-7918-12	Plaintiff

APPENDIX C

Documents Considered

Appendix C: Documents Considered and Relied Upon

No.	Author	Title	Date
1	R. Allan Freeze and John A. Cherry	Groundwater	1979
2	Rogers, Golden & Halpern	Initial Assessment Study; Naval Weapons Industrial Reserve Plant, Bethpage and Calverton, New York. UIC: N6095/N0845	December-1986
3	US EPA	Potential Hazardous Waste Site Preliminary Assessment, Servo Corporation of America, EPA ID No. NYD002418911	1987
4	James. F. Pankow and John A. Cherry	Dense Chlorinated Solvents and other DNAPLs in Groundwater	1996
5	C. W. Fetter	Contaminant Hydrogeology, Second Edition	1999
6	ARCADIS Geraghty & Miller	Groundwater Feasibility Study, Grumman Aerospace-Bethpage, NY Site # 130003A and Naval Weapons Industrial Reserve Plant Bethpage, NY Site #130003B	October-2000
7	NYSDEC	Record of Decision Operable Unit 2 Groundwater, Northrup Grumman and Naval Weapons Industrial Reserve Plant Sites Nassau County Site Number 1-30-003A & B	March-2001
8	NAVFAC	Record of Decision Naval Weapons Industrial Reserve Plant Bethpage, New York, Operable Unit 2 - Groundwater. NYS Registry: 1-30-003B. Revision 1.	April-2003
9	ARCADIS	Public Water Supply Contingency Plan	July-2003
10	Levittown Water District	Monthly Pumpage Reports - 2009-2017	2009-2017
11	Bethpage Water District	Monthly Pumpage Reports - 2009-2017	2009-2017
12	Farmingdale Water Department	Monthly Pumpage Reports - 2009-2017	2009-2017
13	Hicksville Water District	Monthly Pumpage Reports - 2009-2017	2009-2017
14	Massapequa Water District	Monthly Pumpage Reports - 2009-2016	2009-2017
15	Plainview Water District	Monthly Pumpage Reports - 2009-2017	2009-2017
16	South Farmingdale Water District	Monthly Pumpage Reports - 2009-2017	2009-2017
17	Paul Misut, USGS	Simulation of Groundwater Flow in a Volatile Organic Compound-Contaminated Area near Bethpage, Nassau County, New York - A discussion of Modeling Considerations	2011
18	Robert D. Morrison and Brian L. Murphy	Chlorinated Solvents: A Forensic Evaluation	2013
19	William Merklin, D&B Engineers and Architects	Email RE: TOH LWD Wells 7A, 8A and 13 (also 2A, 5A, 6A &6B) - 3402	August-2013
20	ARCADIS	2013 Periodic Review Report, On-Site Groundwater Remedy Operable Unit 2	October-2014
21	ARCADIS	Interpretive Report for the On-Site Containment System Hydraulic Effectiveness Program. Operable Unit 2, Northrup Grumman Systems Corporation (NYSDEC Site #1-30-003A) and Naval Weapons Industrial Reserve Plant (NYSDEC Site #1-30-003B)	May-2015
22	D&B Engineers and Architects	Design Report, Packed Tower Aeration System Wells 7A & 8A. Town of Hemstead Department of Water, Levittown Water District	February-2016
23	D&B Engineers and Architects	Design Report, Packed Tower Aeration System Well 13. Town of Hemstead Department of Water, Levittown Water District	February-2016
24	NAVFAC	2018 Annual Report for Groundwater Impacts at Naval Weapons Industrial Reserve Plant, Bethpage, New York	June-2018
25	NYSDEC	Comprehensive Water Quality Database (Data_Export_20190214.xlsx)	February-19
26	EDR	The EDR GeoCheck Report, Bethpage Source, Inquiry Number 5604728.5s	March-2019
27	N/A	Oral Deposition of Edward Hannon	June-2019
28	Richard Humann and Timothy Hazlett, H2M	Expert Report of Richard Humann and Timothy Hazlett	August-2019
29	Timothy Hazlett, H2M	AnAqSim Groundwater Modeling Files (model012.anaq)	August-2019
30	N/A	Oral Deposition of Lora Fly	August-2019
31	William Merklin, D&B Engineers and Architects	Expert Report of William Merklin	August-2019
32	US EPA	Regional Screening Level (RSL) Chemical-specific Parameters Supporting Table November 2019	November-2019
33	N/A	Oral Deposition of Richard Humann, Part 1	December-2019
34	N/A	Oral Deposition of Richard Humann, Part 2	December-2019
35	N/A	Oral Deposition of Timothy J Hazlett, Ph.D.	December-2019
36	N/A	Oral Deposition of William Merklin	December-2019