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RE: Technical Assistance - Tarheel Army Missile Plant Site Evaluation of Potential Surface, Groundwater, Soil Contamination and Vapor Intrusion (VI).

SUMMARY

The purpose of this Technical Assistance (TA) document is to provide technical recommendations for the consideration of entities directly involved with remediation activities pertaining to the TAMP site and the surrounding community.

The North Carolina Department of Health and Human Services (NCDHHS) Health Assessment Consultation and Education Program (HACE) has reviewed publicly available reports and data regarding the Tarheel Army Missile Plant (TAMP) site in Burlington, NC and is providing the following technical recommendations to help inform future public health actions.

1. Physical Hazards. HACE recommends reviewing the 2017 Letter of Health Consultation (LHC)[1] for recommendations regarding physical hazards at the TAMP site and executing those recommendations as quickly as possible. If a prolonged remediation of the site is anticipated, **HACE recommends more effective physical barriers be put in place to prevent unauthorized persons from gaining access to the site until the surface and all the known and unknown underground structures are better understood and remediated.**

2. Ongoing Site Contamination. Numerous data sets confirm that the TAMP site is clearly contaminated with several volatile organic compounds (VOCs) including, but not limited to, trichloroethylene (TCE), benzene, 1,1-dichloroethene, tetrachloroethene and 1,4-dioxane. Per- and polyfluoroalkyl substances (PFAS) were also reported in ground water and soil. **HACE recommends that a comprehensive site remediation plan be developed that addresses the cleanup and disposal of contaminated soil, water and other contaminated material on the site itself, with special consideration given to the secondary public health effects to the public, such as aerosolization of contaminated soil and dust, that cleanup efforts may contribute to downgradient contamination outside of the physical boundaries of the TAMP facility.**

3. Offsite Surface Water Contamination**.** Data collected shows that downgradient surface water impacts from VOCs and PFAS chemicals have exceeded the NCAC 02B.0202 Water Quality Standards for Surface Waters (2B Standards)[17] and the USEPA Nationally Recommended Water Quality Criteria for Aquatic Life and Human Health.[18] VOCs and other contaminants have likely been moving off site via the northwest surface water for years[16]. This is likely due to either surface water/stormwater runoff from the site and/or movement of contaminated groundwater from the site to nearby downgradient surface water. **HACE recommends that a comprehensive remediation plan be developed that addresses the removal of the source of contaminated soil and other materials contributing to downgradient surface water contamination.**

4. Offsite Groundwater Contamination**.** HACE is most concerned about the offsite groundwater contamination that may cause public health concern with vapor intrusion (VI) issues in homes outside of the TAMP site. While the offsite data is minimal, the few monitoring wells that are there indicate the presence of VOCs that exceed the NC 2L groundwater standards, with some homes within 100 feet of these wells. It is suggestive but not conclusive that VI may be an issue in homes around the site, and seems more likely for properties to the north, northwest and west of the site boundaries. In addition, there is enough data to warrant a more in-depth investigation of PFAS chemicals in groundwater offsite of the TAMP facility because groundwater may eventually migrate to local surface water and eventually to the Haw River. **HACE specifically recommends the following:**

   a. **A monitoring well (MW) plan should be developed that will delineate the extent of a potential VOC plume from the nearest TAMP property line. These additional MWs should at least be placed on properties to the north, northwest and west of the site boundaries to determine if groundwater contamination of volatile organics and PFAS chemicals can be detected. The data can be used to demonstrate any chemical contamination above the NC 2L limits and assess any potential public health impacts.**
   b. **If subsurface VOC concentrations are found to exceed applicable 2L standards, VI in the surrounding homes should be considered and evaluated. HACE recommends that the ATSDR guidance[14] and DEQ guidance[13] be followed.**
   c. **Should monitoring well VI and/or PFAS chemicals be found as an issue in areas surrounding the site, a monitoring and remediation plan and engineering controls (i.e. subsurface/sub slab depressurization system for VOCs) should be developed and implemented (per ATSDR and DEQ VI guidance) in conjunction with a health communication plan to inform residents on these properties of the health risks**

associated with VI in their homes and the strategies necessary to mitigate risks until fully remediated.

5. Comprehensive Delineation of Nature and Extent of Known and Unknown Subsurface Structures and Preferential Pathways On and Offsite**.** The known underground tunnel on the TAMP site is potentially contaminated with VOCs (and likely PFAS chemicals) because of contaminated ground water migrating through contaminated soil and water above or adjacent to the one known underground tunnel on the site. **HACE recommends that this known tunnel be remediated, and the surrounding soil and groundwater be remediated as part of a comprehensive site remediation plan.**

   HACE also recommends that further investigations be conducted to conclusively determine if a second and longer tunnel that runs north to south from the TAMP site to properties to the south of the TAMP site exists today. This investigation should also include other possible preferential pathways including sewer lines, underground utilities, etc. If a tunnel or other preferential pathways exist, their specific location needs to be identified; and the contents in and around them should be analyzed to determine if further investigation of offsite contamination to the south of the TAMP site and if a public health impact is present. The public health impacts of VI in homes and businesses to the south of the TAMP site cannot be known until the second tunnel and other preferential pathways, if they exist, are better characterized.

6. Unknown Chemicals Potentially Present. It is HACE's conclusion that it is extremely unlikely that a full chemical contamination characterization in and around the TAMP site is possible because of its age, multiple owners, multiple uses, lack of information regarding chemicals used at the site and how chemicals were historically disposed. However, we recognize that it is important to correctly characterize what we can to ensure worker and surrounding residents' health at and around the site and that the remediation waste is disposed of properly, to the extent possible. It is also recognized that uncharacterized chemicals have likely moved from the TAMP site to offsite properties over the past several decades and may or may not be present outside of the TAMP site. From this perspective, **HACE recommends the following chemicals be screened in both soil and groundwater within and around the TAMP site and remediation plans be developed if found to be an issue:**
   a. **Heavy metals, including lead.**
   b. **PFAS chemicals, with particular emphasis on perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) at other sites within the TAMP site and surrounding neighborhoods and businesses.**
   c. **VOCs (including, but not limited to, benzene, 1,1-dichloroethene, tetrachloroethene and 1,4-dioxane) that are representative of constituents of petroleum products and solvent cleaning agents. See also Figure 2 and 3.**
   d. **During onsite remediation activities, air monitoring for all the above constituents, in addition to asbestos, radiation, and aerosol/particulate matter, be monitored for potential public health risks for both workers onsite and residents surrounding the site.**

BACKGROUND

The TAMP site (CERCLIS ID: NC7210020544) is located at 204 North Graham Hopedale Road in Burlington, Alamance County, North Carolina. The property has 22 buildings on approximately 32 acres. North Graham Hopedale Road borders the site to the east. Businesses are located immediately across the road to the east and back up to the property on the south and west sides. Residential properties are adjacent to the property on the north side.

Central Park Burlington LLC is the current owner and operator of the site as of May 2018, however it has had multiple owners and multiple uses over the past 100 years. For example, the Defense Plant Corporation acquired the property in 1942, and then leased the property to Fairchild Engines and Airplane Corporation from 1942 through 1944 to manufacture and test training aircraft for the U.S. Army Air Corp. In 1944, Fairchild divested from the facility, and then Firestone Tire and Rubber Company began operating the site. The specific operations of Firestone are not known and in 1945, the facility was identified as surplus property. From 1946-1954, the Western Electric Company (WEC) manufactured electronic equipment for commercial uses and in 1951, WEC shifted to manufacturing ground-based guidance systems, components, and the assembly of the U.S. Army's Nike missile systems. After the Nike missile systems went into obsolescence, Lucent Technologies took over operations during the 1990s at the facility until Saucier Inc. acquired the property in 2013. There are currently no activities on-site; the site has been without electrical power for several years. Former operations and leaking underground storage tanks on site have contaminated soil and groundwater, particularly under the Waste Accumulation Pad located toward the center of the site, with various volatile organic compounds (VOCs) including petroleum hydrocarbons, chlorinated solvents. Some remediation activities were conducted within the site boundaries from 1993-2004.

The North Carolina Department of Environmental Quality (NC DEQ) contacted the North Carolina Division of Public Health's (DPH) Health Assessment, Consultation and Education (HACE) program in October 2016 regarding the TAMP site. NC DEQ staff believed there may be potential for VI at homes near the site and requested DPH's assistance in evaluating possible public health impacts from VI. The HACE program responded to this request via a Letter of Health Consultation (LHC) entitled "Evaluation of Groundwater Contamination at the Tarheel Army Missile Plant (TAMP) Site" issued on May 4th, 2017[1]. That LHC concluded that, with the data available at that time, there was not adequate information to determine whether groundwater contaminants from the TAMP site were migrating off the site and entering indoor air at residences neighboring the site via the VI pathway. While the available groundwater data suggested the potential for VI, soil gas and indoor air data were not available to evaluate potential residential exposures to contaminants. The LHC also recommended a complete VI investigation. This could include collecting crawl space air, indoor air and outdoor air samples concurrently at homes where the potential for VI exists (i.e., within 100 feet of locations where groundwater contaminant levels exceed ATSDR VI comparison values (VI CVs)[14]. The LHC also recommended collecting additional data, such as groundwater and soil gas data, off-site to further characterize the extent of contamination and the potential for VI at nearby homes and assessing homes and buildings in multiple seasons (winter and summer) to evaluate seasonal variability.

In addition, another LHC was issued entitled "Evaluation of Physical Hazards at the Tarheel Army Missile Plant (TAMP) Site" on March 15th, 2017[2]. That LHC concluded that trespassers and site workers could be at risk of physical harm from the deteriorating buildings and improperly maintained site areas. Additionally, there was evidence of frequent unauthorized access to this site and that the physical

hazards at the site were an urgent public health issue. The LHC also contained 4 recommendations to remediate the physical hazards present at the site.

In 2023, additional data generated by the Northwind-Jacobs Joint Venture and Terracon Consultants, Inc. was submitted in a Remedial Investigation Report to the U.S. Army Corps of Engineers (USACE) – Savannah District (referred to hereafter as "the report")[3,4]. This report mainly focused on the water and soil samples collected within the confines of the TAMP site property, with limited data generated for contamination outside the boundaries of the site. Specifically, the report generated some data from groundwater monitoring wells, surface water and soil samples outside the boundaries of the TAMP facility itself.

COMMUNITY DEMOGRAPHICS

Relevant community profile information from the U.S. Census Bureau (2023) and the American Community Survey 5-year Estimates for Census Tract 203.01, Alamance, NC: [20,21] is shown below.

- **Population:** The total population within approximately 1-mile of the site is 7,454 people. The total population of the city of Burlington is 60,032 and Alamance County is 171,415.
- **Racial/Ethnic Characteristics:** Twenty-four percent (24%) of the population in the census tract identify themselves as white/Caucasian and thirty percent (30%) are people of color. Forty-six percent (46%) identify themselves as Hispanic or Latino. The percentage of Whites (24%) is significantly lower than the county (61%), state (69%) and the nation (75.5%).
- **Age:** Twenty-six percent (26%) of the population is under 18 years of age which is slightly higher than the county (21%), state (21%) and nation (22%). Nineteen percent (19%) of the population is 65 years or older which is slightly higher than the county (17%), state (17%) and nation (13%).
- **Education Level:** Twenty-seven percent (26%) of residents in the area have less than a high school education. Seventy-four percent (74%) of Alamance County residents have a high school diploma or higher compared to 89% in the state and 89.1% nationally.
- **Housing Characteristics:** The percentage of renter-occupied housing units is 61% in the area, 34% in the county, 34% in the state and 35% in the nation. This area has a significantly higher percentage of renter-occupied housing than the county, state, and nation.
- **Public Transportation:** Link Transit is the local transportation partner in the area, serving Burlington, Elon, Gibsonville, Alamance County offices and Alamance Community College.

DATA LIMITATIONS

1. There is no comprehensive list that provides reliable information regarding chemicals that have been used in the past by former owners of the site and how waste generated from the site was handled.
2. The TAMP site itself has data that shows ongoing contamination issues. However, outside the boundaries of the site, there is insufficient data collected to determine the extent of contamination of soil, groundwater, surface water, and indoor air that may be impacting surrounding residents.
3. The locations of all underground tunnels and/or preferential pathways outside the boundaries of the site have not been sufficiently investigated.

DATA REVIEWED AND RESULTS

HACE reviewed the contents of this 2023 report, in addition to some other publicly available reports and historical documents, and have identified public health concerns in the following 7 categories:

1. **Physical Hazards**. The report[3] noted that the TAMP complex still includes dilapidated buildings with leaking and partially collapsed roofs. Portions of buildings are hazardous and not safe to enter due to the conditions of the structures, and the presence of underground tunnels and basements that do not have interior lighting, some of which are flooded. The exterior ground surfaces are comprised mostly of paved surfaces that limit the infiltration of runoff from precipitation events into the ground immediately underneath the TAMP site but does promote runoff to areas off the TAMP site. The report also noted that there have been land-use controls (referenced on the property deed in 2004) that restrict intrusive activities in areas with chemical impacts to soil, groundwater extraction, tampering with remedial equipment, and residential use without prior approval from NCDEQ. The existing land use controls appear to be ineffective and still poses a public health threat.

   The report[3] confirms that little has changed onsite since HACE issued its LHC on the evaluation of physical hazards in 2017. The LHC did note evidence that people can enter the site and people can at least temporarily inhabit the interior of one or more buildings on the property, with little regard for land use controls.

2. **Ongoing Site Contamination**. The report[3] made it clear that the TAMP site itself contains heavily contaminated water beneath the facility. This is best depicted in **Appendix A, Figure 1**. Monitoring wells from multiple sites within the TAMP site shows a wide range of VOCs present over a wide range of concentrations. These VOCs include 1,2 dichlorethene, MTBE, trichloroethene and vinyl chloride, among others, many of which exceed the NC 2L standards. Other VOCs are also present, including known carcinogens (benzene as one example), that may or may not, depending on the MW location, exceed a 2L standard[17].

   While it is important to recognize that the groundwater located underneath the site is still clearly contaminated, the focus of this document is to obtain more targeted datasets in order to determine the potential public health impact of contaminated runoff surface water and groundwater contamination under the TAMP site boundaries that may move into communities outside of the TAMP site and result in VI issues in nearby homes and businesses. The report stated that both surface and groundwater movements tend to run in a northerly and northwesterly direction from the TAMP site directly in the path of numerous homes located off the TAMP site proper. The impacts of potentially contaminated surface runoff and contaminated groundwater from the TAMP site are discussed below.

   A report prepared for the U.S. Army Corps of Engineers, Baltimore District entitled “Final Preliminary Assessment and Site Inspection of Per- And Polyfluoroalkyl Substances. Former Tarheel Army Missile Plant, North Carolina (2023)” investigated the potential presence for certain PFAS chemicals at the TAMP facility5,[6]. Specific PFAS chemicals, PFOS, PFOA, PFBS, PFNA, and PFHxS, were examined in monitoring well water and soil samples at specific sites within the TAMP facility. GenX was specifically excluded from sample testing. The data from these water and soil samples are shown in **Appendix B, Tables 1 and 2**.

The PFAS report[6] concluded that both Areas of Potential Interest (AOPI) within the TAMP site had detections of PFOS, PFOA, PFBS, PFNA, and PFHxS in groundwater and both AOPIs exceeded the Office of the Secretary of Defense (OSD) risk screening levels for groundwater (used interchangeably with tap water) for PFOS and PFOA.

PFOA and PFOS were detected in soil at the IWTP Area (Buildings 23, 29, and 30) AOPI, while only PFOS was detected in soil at the Plating Area (Buildings 11 and 20) AOPI. There were no exceedances of OSD screening levels for soil at either AOPI. It should be noted that this report only addressed specific areas thought to be potentially contaminated with PFAS chemicals; no monitoring wells or soil samples were tested outside of the TAMP property. In addition, water samples from the underground tunnel(s) were not tested for PFAS chemicals.

3. **Offsite Surface Water Contamination**. The report[3] noted that there was one body of surface water, labeled as "Intermittent Tributary to Service Creek" that runs roughly north and south and is located to the west of the TAMP site. This creek had water samples collected and tested for VOCs at time points in the spring, summer and fall of 2022. The report showed the data results from all three timepoints; although the numbers differed somewhat between the time of collection, the results indicate that surface water is contaminated with VOCs. An aerial photo is shown in **Appendix A Figure 2** as representative data for all the time points that were tested and shows this creek relative (shown as a dotted teal line) to the TAMP site (shown in a dotted black line.

   Specifically, this creek was found to contain surface water VOCs during all three seasons of the year, generally highest at the SW-02A collection point, in particular tetrachloroethene and trichloroethene, concentrations of which exceed the 2B water standard, shown in green. The concentrations of VOC tend to decrease in the surface water samples to the north and south of SW-02A but are still present. The report noted that the topography of the land from the western side of the site slopes down from the TAMP site and that groundwater tends to run in both northern and western directions from the TAMP site. The topographic features coupled with the VOC data collected from this creek support the conclusion that surface water runoff from the contaminated TAMP site and/or groundwater moving from the TAMP site are likely sources of the VOC contamination in the creek and reasonably increase the likelihood of potential VI issues on properties near the surface water source with a potential public health impact.

4. **Offsite Groundwater Contamination**. The report[3] shows groundwater monitoring well data from the shallower saprolite aquifer zone and the bedrock aquifer zone. Relevant offsite portions of these zones are shown in **Appendix A, Figures 3 and 4**. It is also noted that residential properties surrounding the TAMP site are all believed to be on the municipal water and that well water is not being used in homes.

   There are two important features to note in **Appendix A, Figures 3 and 4**. First, the well monitoring data points collected north of Hilton Road and west of North Cobb Ave do have some VOCs above the 2L standard from water obtained from the saprolite aquifer layer of the same variety as the VOCs reported in the groundwater sampled on the TAMP site itself. It was also observed that the water samples obtained deeper into the bedrock aquifer also contain several VOCs that exceed a 2L standard. The available data suggests that most of the VOC contamination lies deeper in the bedrock aquifer and is likely to follow the groundwater flow to the north and

northwest of the TAMP site, in addition to potentially rising to the shallower soil saprolite layer and eventually reaching the soil surface and/or surface water.

Second, it should be noted that most of the MWs are located within the TAMP site itself. Relatively few MWs are located to the north and west of Hilton Road and North Cobb Ave, respectively. The lack of MW data north of Hilton Road and west of North Cobb Ave makes it difficult to determine with any certainty that VI is a public health issue in the homes north and west of the TAMP site. The data is suggestive, but not conclusive, that VI may be a public health issue in these homes for an unknown distance from the TAMP site borders.

5. **Offsite Soil Vapor (Soil Gas)**. The report[3] contained data that attempted to discuss chemical vapors exiting the soil into the air above the soil surface. Briefly, the reports stated that passive Beacon soil gas samplers were placed adjacent to building foundations at five off-site properties to evaluate the potential for VI into the buildings from the off-site VOC groundwater plume. The passive soil gas samplers were used to accommodate shallow drilling refusal in the sample locations and the potential for the shallow groundwater to intrude into traditional soil gas points that would need to be set deeper. The property addresses and uses were at 219/221 N. Cobb Ave (residential), 301 N. Cobb Ave (residential), 1612 Hilton Road (commercial), 1615/1617 Hilton Road (residential) and 1707/1709 Hilton Road (residential).

   These passive soil gas samplers (designated PSG-01 through PSG-05) were installed in 1-inch diameter borings advanced using manual DPT methods. Each boring was advanced to an approximate depth of 3 feet bls, where probe rod refusal was encountered. The contractor installed and deployed the passive samplers in accordance with their work plan and Beacon's sampling instructions and the Division of Waste Management Vapor Intrusion Guidance (NCDEQ, 2018). The soil gas samplers were deployed for 6 days. Following the 6-day deployment period, the contractor retrieved the samples and sent them for analysis. **Appendix A, Figure 5** graphically shows the location of each sampler**; Appendix B Table 3** shows the data collected from each sampler.

   Toluene and Total Petroleum Hydrocarbons (TPH) in the C10-C15 chain link length was reported on PSG-1 and PSG-5, respectively. The data suggests that there is little if any VOCs being emitted from the soil at the sample collection points. However, PSGs were not placed further north and west of TAMP facility where residential houses are located, and no samplers were placed in proximity to the Lucent Technologies facility where a plume is thought to exist. In addition, the report noted that if future VI samples are to be collected, summa canisters (in lieu of passive Beacon samplers) be used. This recommendation was based on greater data quality by summa canisters analyzed by Method TO-15, as compared to Beacon samplers analyzed by USEPA Method 8260C. It was also noted that data from the PSGs reported in 2020 saw a greater number of constituents during the soil-gas sampling events in August 2017, February 2019, and April 2019, as compared to the limited number of constituents (i.e., only toluene and TPH C10-C15) detected in July 2022 using Beacon samplers. It was also noted that passive samplers may not be favored according to the North Carolina guidance[13], which states that passive samplers may be used when shallow soil contamination or groundwater is present at less than 5 feet bls and are "limited to field screening only during the investigation of the VI." In summary, the placement and type of the samplers used in the report were likely not sufficient to determine the risk of VI in residences north and east of the TAMP site.

6. **Known and Unknown Subsurface Structures Contamination**. This section pertains to structures beneath the TAMP site itself but excludes surface and groundwater contamination, as discussed above. **Appendix A Figure 6** shows a schematic of the northern and central areas of the TAMP facility. The area highlighted in yellow with red lines on the right side of the figure depicts a roughly "L" shaped underground tunnel beneath the surface of the TAMP site. The report[3] indicates that the tunnel still exists and has standing water on the floor of the tunnel. Water samples were obtained and analyzed for chemical analysis. The results are shown in **Appendix B Table 4**.

   NC DEQ VI Guidance.[13] states that all preferential pathways (utility and sewer beds, stormwater structures, and other unknown links offsite) should be evaluated. As shown in **Appendix B Table 4**, two sites containing free standing water in the tunnel (one on the north side and one on the south side) were sampled (labeled N-01 and S-02) with several VOCs detected. Tetrachloroethene and trichloroethene exceeded the 2B surface water and wetland standards. Air samples in the tunnels were not reported as sampled or reported.

   Other tunnel(s) may be present onsite and/or offsite from the TAMP site[4]. In a publicly available report entitled "Remedial Investigation for Tarheel Army Missile Plant Burlington, NC Stakeholders Meeting and Site Visit", dated Wednesday, August 25th (no year reported, but assumed to be the year 2021, based on the context of the report), it was stated that "Jeff Ballsieper with Progress Environmental, representing the property owner, noted that the tunnels present beneath the site are mostly flooded. Some of the tunnels are approximately 20-feet deep" and "One [tunnel] that potentially extends from Building 13 in a southwesterly direction or approximately 3/8 mile to a nearby airstrip." If this statement regarding a second tunnel that extends underground and far off the TAMP site is correct, tunnel flooding and contamination with VOCs and/or other chemicals may be present. There is no offsite data reported for air, soil or water to the south and east of the TAMP site. The ventilation status of the tunnel is also unknown.

   Historical records indicate an airstrip near the TAMP facility did exist. What remains of this airstrip is not easily identified today using Google Maps. However, publicly accessible websites have some useful information regarding what was likely the Huffman Field/Fairchild Field in Burlington, NC[7,8]. Figure 7 shows what this airfield looked like circa 11/18/1950 on a USGS aerial view. The photo depicts Fairchild Field as having a single paved northeast/southwest runway, with a ramp & some small buildings on the northeast side, and the former Fairchild aircraft factory (now known as the TAMP site) across the street to the northwest (upper left portion of the photograph) from the airfield. It is possible that an underground tunnel existed or still exists and that was likely used to move equipment and/or personnel from the TAMP site to the airfield in a secure manner and not having to interfere with the flow of traffic to access either site. This area now appears to have several businesses built over where this airstrip used to be located. The potential public health impact of these tunnels and/or the chemical contents of this tunnel is unknown.

7. **Unknown Chemicals Potentially Present**. The report[3], in addition to the other publicly available documents examined, does not provide information regarding a comprehensive list of chemicals that have been used in the past by any of the former owners of the site. Chemicals used by the US Army to manufacture and test training aircraft for the U.S. Army Air Force, Firestone, or by

Western Electric Company to manufacture electronic equipment for commercial uses, and manufacturing of ground-based guidance systems, components, and the assembly of the U.S. Army's Nike missile systems is unknown[9,10]. Similarly, American Telephone and Telegraph Company (AT&T) used the property for the production and maintenance of defense-related electronic systems, until 1999 when Lucent Technologies, a divestiture of the former AT&T, took over operations at the facility. There is no available information regarding what was specifically manufactured, or the processes and chemicals used to manufacture this equipment, or how disposal of used equipment and chemicals was handled.

Given this data gap, one can only speculate on what could have potentially been used when the site was active and how waste disposal was dealt with at the time. The report clearly indicates that a variety of volatile organic chemicals (VOCs) such as tetrachloroethene, trichloroethene and vinyl chloride, 1,1-dichloroethane, 1,2-dichloroethane, benzene, carbon tetrachloride, cis-1,2-dichloroethene, methyl tert-butyl ether (MTBE) is present above the 2L Standard on and under the TAMP site proper. Some of these VOCs have been detected from surface water and ground water monitoring wells offsite as well, generally and directionally north and west of the site.

The presence of heavy metals in soil and water within the TAMP was also reported (data not shown). Section 4.8.4.4 of the report stated that barium, cadmium, chromium and selenium exceeded the 2L Standards in one or more of the MWs sampled. The report went on to state that the detections above the 2L Standards were scattered across the TAMP site and observed no trends based on the sample locations. The report states that the exceedances could be due to natural conditions and/or metals that were mobilized (solubilized) due to the anaerobic conditions established in many areas of the site. Arsenic, lead, mercury, and silver were not detected above the 2L Standards in the MWs.

Considering the data available in the report, the age of the property when it was constructed and possible chemicals used, HACE has public health concerns regarding possible asbestos within walls and ceilings of the physical structures, lead-based paint, metals such as chromium, lead, and zinc (used in electronics manufacturing), as well as any number of petroleum hydrocarbons in the soil and runoff water off the site into residential and businesses surrounding the site. Regarding petroleum hydrocarbons, it is known that the early versions of the NIKE missiles initially used a combination of solid and liquid petroleum-based fuel; later versions of these missiles (aka Nike-B or Nike Hercules) exclusively used solid rocket fuel propellants, including various versions of Thiokol [9,10]. The composition of either of these fuel types (liquid or solid), the fueling and refueling procedures, as well as how these fuels may have been handled and disposed of, is unknown. In addition, PFAS contamination cannot be ruled out as a potential onsite and offsite public health concern.

A recent news article[11] reported that "… in 1999, radiation 20 times above background levels were detected in one of the buildings. Contractors removed all the contaminated flooring, but within a year found more radioactivity in the air ducts and in drain systems throughout several other buildings." The report (an email sent only between military email addresses)[12] noted that there was a Cs-137 spill reported at the TAMP site in the 1970s and mentioned that NC DEQ was

made aware of the radiation issues. There was no information in this 1999 communication regarding the building it was found in, the doorway location, the amount of radiation found in the ductwork and drain, disposal (if any) of removed materials, how much radioactive material is still on site, or how remediation of the radiological contamination was addressed. Further investigations documented that the site was remediated shortly after the email was issued and that there was no evidence of further radiological contamination at the site. The fact that this contamination occurred underscores the concern that there may be multiple types of chemical contamination present at this site that may not be known prior to site remediation and their impact to public health to people living or working around the site.

TECHNICAL RECOMMENDATIONS

1. Physical Hazards. HACE recommends reviewing the 2017 Letter of Health Consultation (LHC)[1] for recommendations regarding physical hazards at the TAMP site and executing those recommendations as quickly as possible. If a prolonged remediation of the site is anticipated, **HACE recommends more effective physical barriers be put in place to prevent unauthorized persons from gaining access to the site until the surface and all the known and unknown underground structures are better understood and remediated.**

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3. Offsite Surface Water Contamination**.** Data collected shows that downgradient surface water impacts from VOCs and PFAS chemicals have exceeded the NCAC 02B.0202 Water Quality Standards for Surface Waters (2B Standards)[17] and the USEPA Nationally Recommended Water Quality Criteria for Aquatic Life and Human Health.[18] VOCs and other contaminants have likely been moving off site via the northwest surface water for years[16]. This is likely due to either surface water/stormwater runoff from the site and/or movement of contaminated groundwater from the site to nearby downgradient surface water. **HACE recommends that a comprehensive remediation plan be developed that addresses the removal of the source of contaminated soil and other materials contributing to downgradient surface water contamination.**

4. Offsite Groundwater Contamination**.** HACE is most concerned about the offsite groundwater contamination that may cause public health concern with vapor intrusion (VI) issues in homes outside of the TAMP site. While the offsite data is minimal, the few monitoring wells that are there indicate the presence of VOCs that exceed the NC 2L groundwater standards, with some homes within 100 feet horizontally of these wells. Per EPA guidance, a buffer zone of 100 feet vertically and 100 feet horizontally from an occupied structure should be used to rule out concerns of groundwater indoor air contamination when groundwater concentrations are above

applicable standards[19]. It is suggestive but not conclusive that VI may be an issue in homes around the site, and seems more likely for properties to the north, northwest and west of the site boundaries. In addition, there is enough data to warrant a more in-depth investigation of PFAS chemical contamination in groundwater offsite of the TAMP facility. In addition, there is enough data to warrant a more in-depth investigation of PFAS chemicals in groundwater offsite of the TAMP facility because groundwater may eventually migrate to local surface water and eventually to the Haw River. **HACE specifically recommends the following:**

a. **A monitoring well (MW) plan should be developed that will delineate the extent of a potential VOC plume from the nearest TAMP property line. These additional MWs should at least be placed on properties to the north, northwest and west of the site boundaries to determine if groundwater contamination of volatile organics and PFAS chemicals can be detected. The data can be used to demonstrate any chemical contamination above the NC 2L limits and assess any potential public health impacts.**
b. **If subsurface VOC concentrations are found to exceed applicable 2L standards, VI in the surrounding homes should be considered and evaluated. HACE recommends that the ATSDR guidance[14] and DEQ guidance[13] be followed.**
c. **Should monitoring well VI and/or PFAS chemicals be found as an issue in areas surrounding the site, a monitoring and remediation plan and engineering controls (i.e. subsurface/sub slab depressurization system for VOCs) should be developed and implemented (per ATSDR and DEQ VI guidance) in conjunction with a health communication plan to inform residents on these properties of the health risks associated with VI in their homes and the strategies necessary to mitigate risks until fully remediated.**

5. Comprehensive Delineation of Nature and Extent of Known and Unknown Subsurface Structures and Preferential Pathways On and Offsite**.** The known underground tunnel on the TAMP site is potentially contaminated with VOCs (and likely PFAS chemicals) because of contaminated ground water migrating through contaminated soil and water above or adjacent to the one known underground tunnel on the site. **HACE recommends that this known tunnel be remediated, and the surrounding soil and groundwater be remediated as part of a comprehensive site remediation plan.**

   HACE also recommends that further investigations be conducted to conclusively determine if a second and longer tunnel that runs north to south from the TAMP site to properties to the south of the TAMP site exists today. This investigation should also include other possible preferential pathways including sewer lines, underground utilities, etc. If a tunnel or other preferential pathways exist, their specific location needs to be identified; and the contents in and around them should be analyzed to determine if further investigation of offsite contamination to the south of the TAMP site and if a public health impact is present. The public health impacts of VI in homes and businesses to the south of the TAMP site cannot be known until the second tunnel and other preferential pathways, if they exist, are better characterized.

6. Unknown Chemicals Potentially Present. It is HACE's conclusion that it is extremely unlikely that a full chemical contamination characterization in and around the TAMP site is possible because of its age, multiple owners, multiple uses, lack of information regarding chemicals used at the site and how chemicals were historically disposed. However, we recognize that it is important to

correctly characterize what we can to ensure worker and surrounding residents' health at and around the site and that the remediation waste is disposed of properly, to the extent possible. It is also recognized that uncharacterized chemicals have likely moved from the TAMP site to offsite properties over the past several decades and may or may not be present outside of the TAMP site. From this perspective, **HACE recommends the following chemicals be screened in both soil and groundwater within and around the TAMP site and remediation plans be developed if found to be an issue:**

a. **Heavy metals, including lead.**
b. **PFAS chemicals, with particular emphasis on perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) at other sites within the TAMP site and surrounding neighborhoods and businesses.**
c. **VOCs (including, but not limited to, benzene, 1,1-dichloroethene, tetrachloroethene and 1,4-dioxane) that are representative of constituents of petroleum products and solvent cleaning agents. See also Figure 2 and 3.**
d. **During onsite remediation activities, air monitoring for all the above constituents, in addition to asbestos, radiation, and aerosol/particulate matter, be monitored for potential public health risks for both workers onsite and residents surrounding the site.**

References used to prepare this technical assistance document can be found in **Appendix C**.

If you have any questions or concerns about this evaluation, please reach out by calling NC HACE at (919) 707-5900 or by email at nchace@dhhs.nc.gov. HACE staff are available to discuss these results and any associated health concerns that residents may have about this site if needed.

Thank you,

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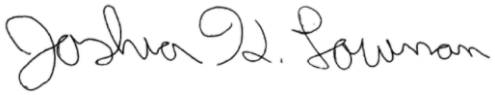

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REPORT PREPARATION

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APPENDIX A: FIGURES

Figure 1. Monitoring well VOC measurements obtained from selected sites within the TAMP.

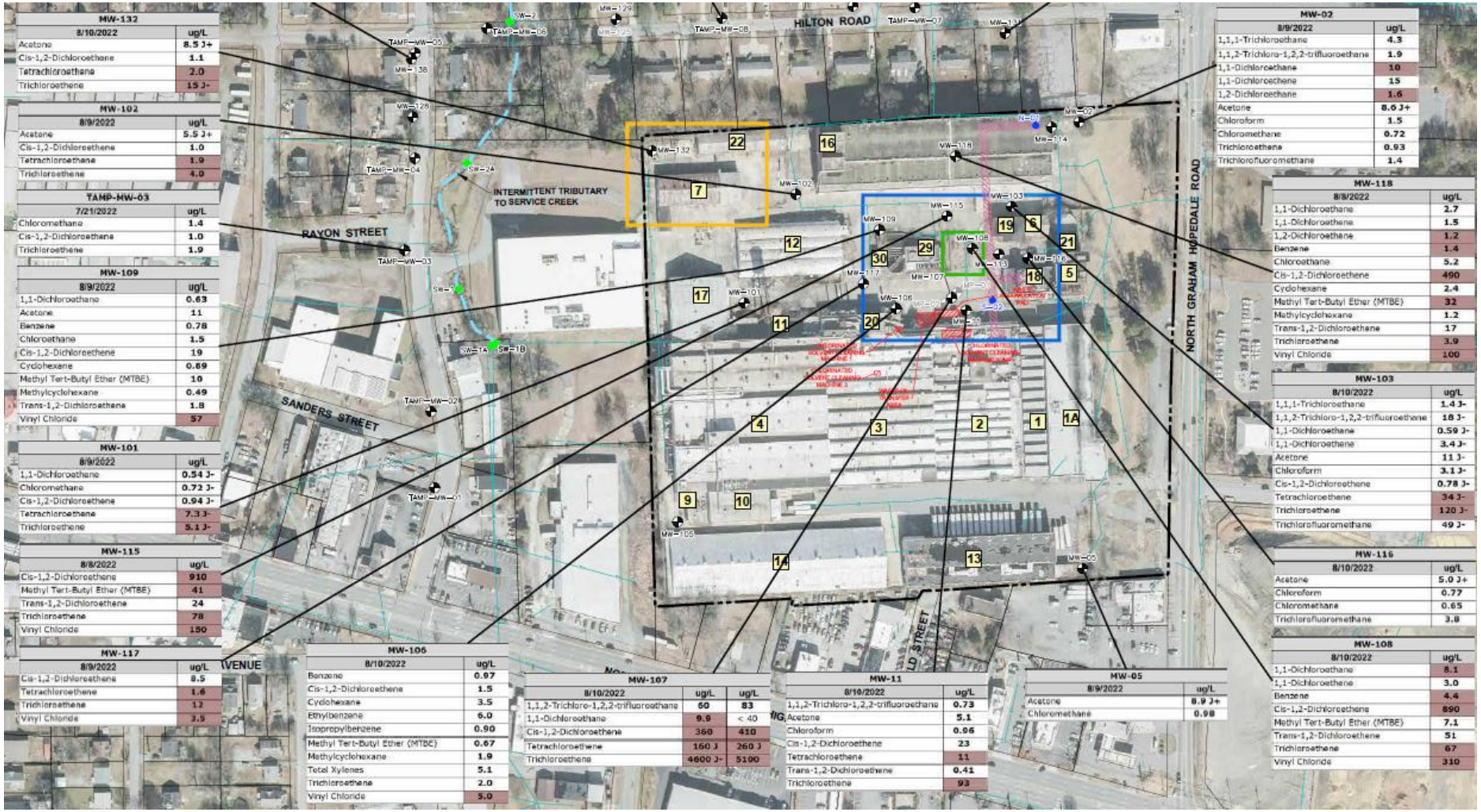

Figure 2. Representative VOC data collected from the Intermittent Tributary to Service Creek surface water source. Green indicates the exceedance of the NC 2B water standard.

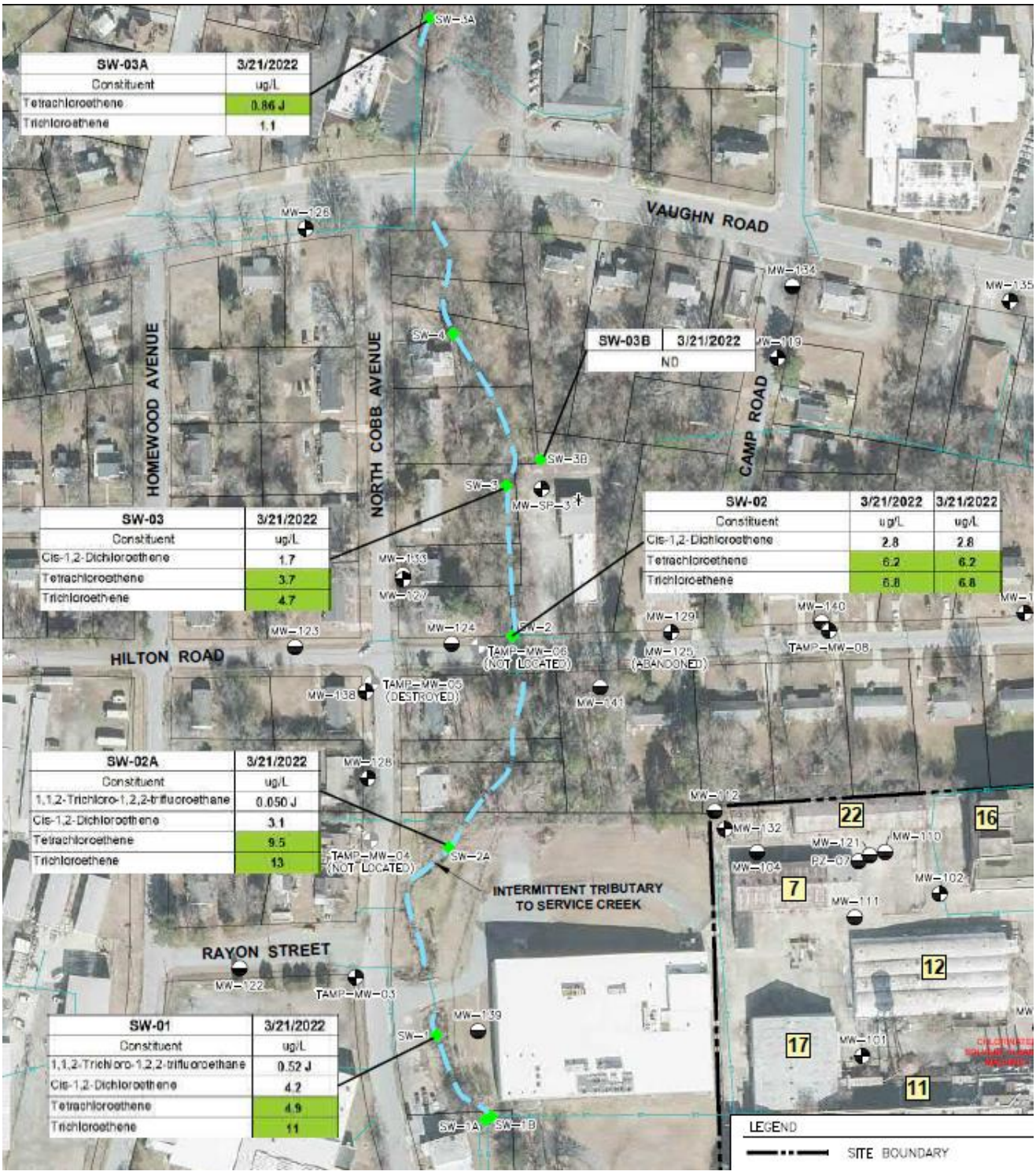

Figure 3. VOC results of groundwater samples in the saprolite aquifer zone. Red indicates the exceedance of the NC 2L water standard.

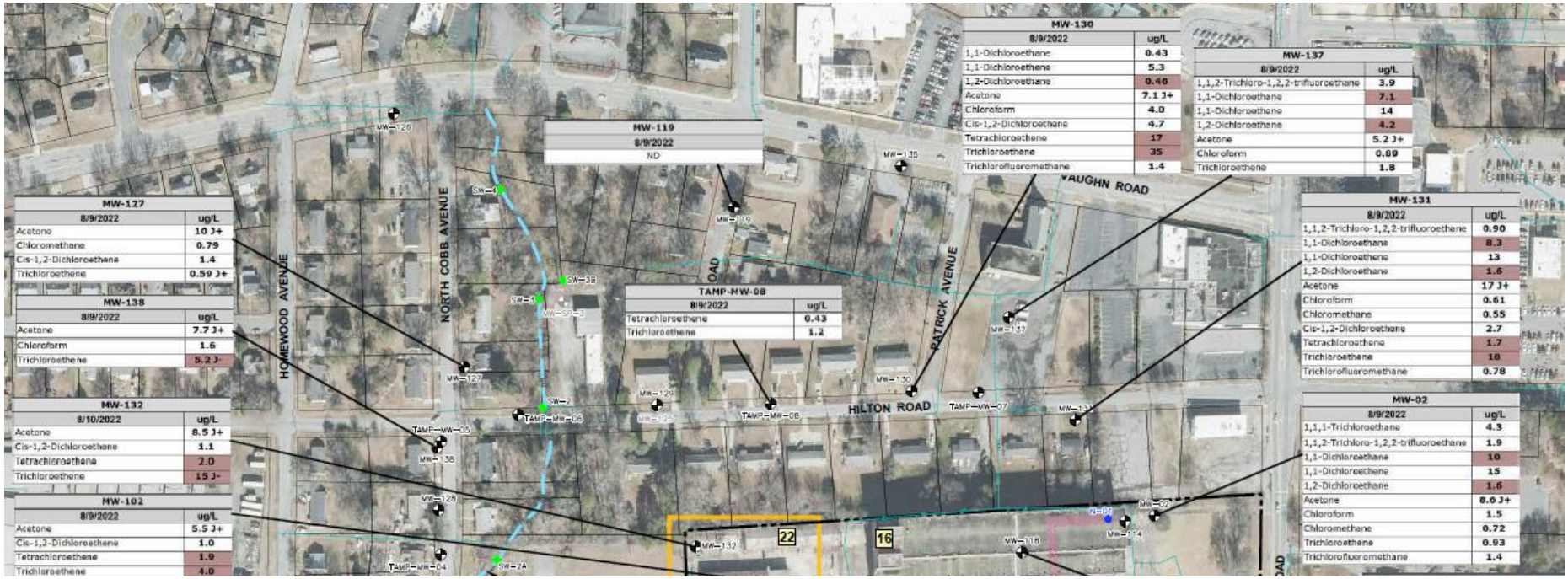

Figure 4. VOC results of groundwater samples in the bedrock aquifer zone. Red indicates the exceedance of the NC 2L water standard.

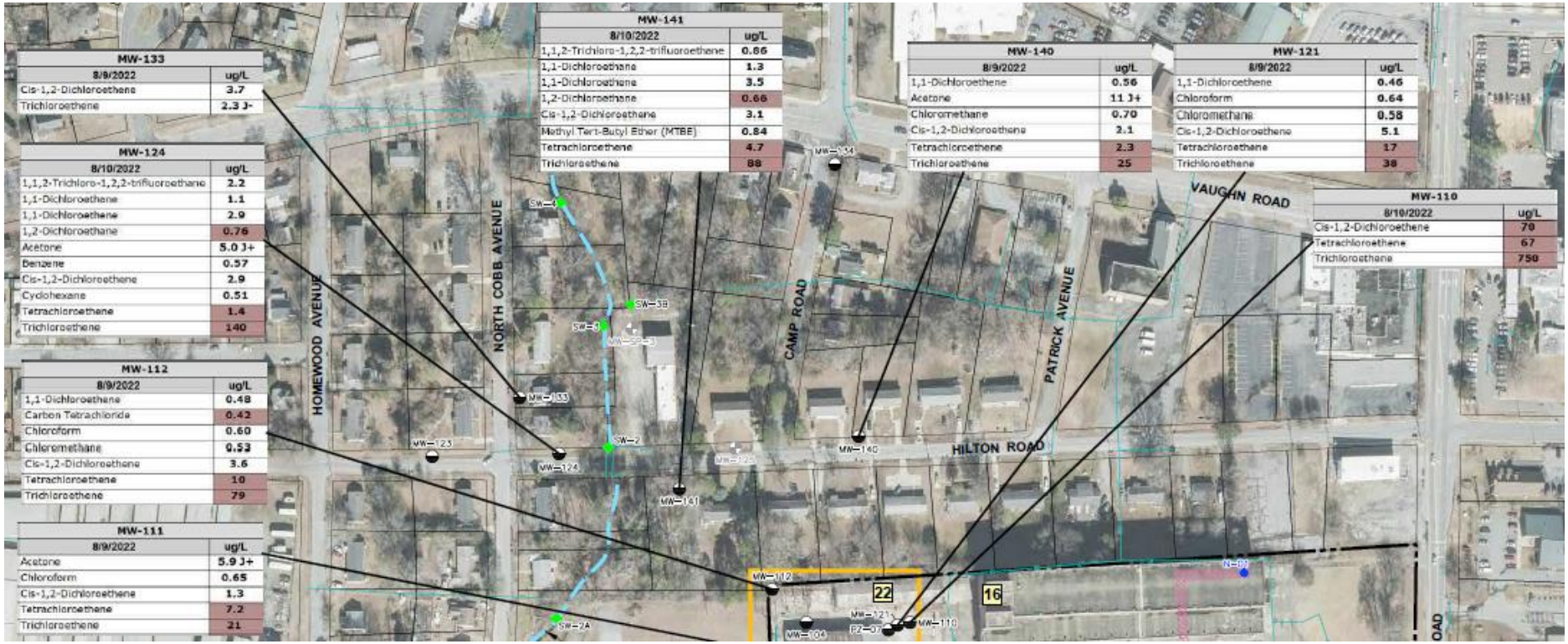

Figure 5. Graphical representation of Passive Soil Gas (PSG) sampler placement (yellow triangles) in relation to the TAMP site northern boundary (dotted black line).

Figure 6. Schematic of the northern and central areas of the TAMP facility showing water samples from On-Site Tunnel.

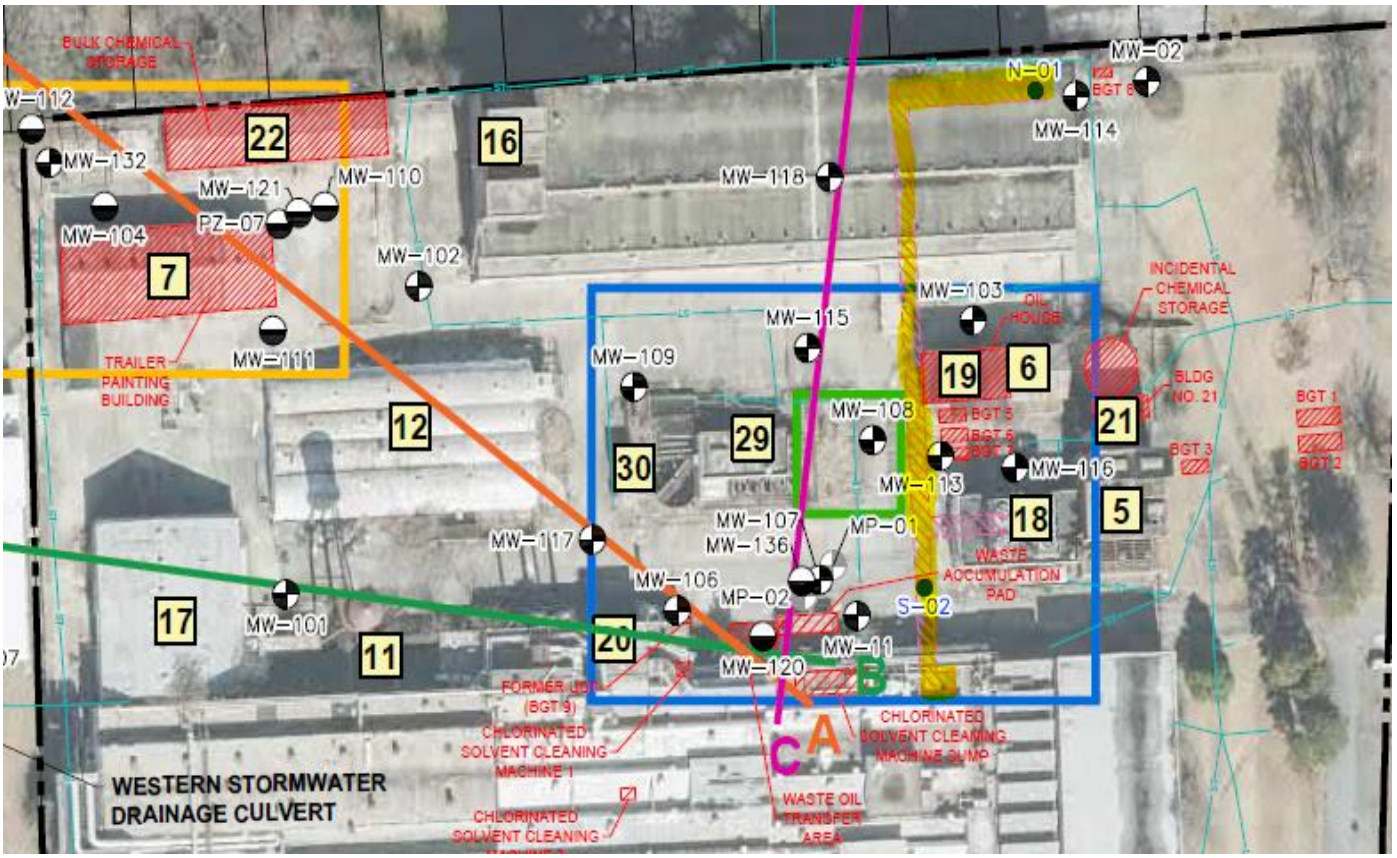

Figure 7. Aerial view of Huffman Field / Fairchild Field in Burlington, NC, circa 1950.

APPENDIX B: TABLES

Table 1. Groundwater PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results

AOPI					PFOS (ng/L)		PFOA (ng/L)		PFBS (ng/L)		PFNA (ng/L)		PFHxS (ng/L)	
OSD Tapwater Risk Screening Level					4		6		601		6		39	
AOPI	Location	Sample/ Duplicate ID	Sample Date	Sample Type	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Industrial Wastewater Treatment Plant Area (Buildings 23, 29, and 30)	TAMP-IWTP-MW-102	TAMP-IWTP-MW-102-01112023	01/11/2023	N	**16**		**16**		3.4	U	**1.9**	J	3.4	U
	TAMP-IWTP-MW-109	TAMP-IWTP-MW-109-01112023	01/11/2023	N	**38**		**43**		**3.0**	J	**3.3**	J	**3.6**	
	TAMP-IWTP-MW-115	TAMP-IWTP-MW-115-01112023	01/11/2023	N	**93**		**25**		**2.1**	J	**1.9**	J	**4.6**	
Plating Area (Buildings 11 and 20)	TAMP-PA-MW-101	TAMP-PA-MW-101-01112023	01/11/2023	N	**42**		**39**		**3.8**		**5.4**		**6.2**	
		TAMP-FD-01-GW-01112023	01/11/2023	FD	**37**		**32**		**3.2**	J	**4.7**		**4.6**	
	TAMP-PA-MW-106	TAMP-PA-MW-106-01112023	01/11/2023	N	**210**		**8.9**		3.5	U	**2.3**	J	**1.9**	J

Notes:

- Bolded values indicate the result was detected greater than the limit of detection.
- Gray shaded values indicate the result was detected greater than the 2022 Office of the Secretary of Defense (OSD) risk screening levels, (OSD. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. July 6, 2022).[16]

Acronyms/Abbreviations:

- AOPI = area of potential interest - FD = field duplicate sample - ID = identification - N = primary sample.
- ng/L = nanograms per liter (parts per trillion) - PFAS = per- and polyfluoroalkyl substances
- PFBS = perfluorobutanesulfonic acid - PFOA = perfluorooctanoic acid
- PFOS = perfluorooctane sulfonate - PFNA = perfluorononanoic acid - PFHxS = perfluorohexane sulfonate Qual = qualifier
- J= The analyte was positively identified; however, the associated numerical value is an estimated concentration only.
- U= The analyte was analyzed for, but the result was not detected above the limit of quantitation (LOQ).

Table 2. Soil PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results

				Analyte	PFOS (mg/kg)		PFOA (mg/kg)		PFBS (mg/kg)		PFNA (mg/kg)		PFHxS (mg/kg)	
				OSD Industrial/Commercial Risk Screening Level	0.16		0.25		25		0.25		1.6	
				OSD Residential Risk Screening Level	0.013		0.019		1.9		0.019		0.13	
AOPI	Location	Sample ID / Duplicate ID	Sample Date	Sample Type	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Industrial Wastewater Treatment Plant Area (Buildings 23, 29, and 30)	TAMP-IWTP-01-SO-2	TAMP-IWTP-01-SO-2-01102023	01/10/2023	N	0.0011	U	0.0011	U	0.0011	U	0.0011	U	0.0011	U
		TAMP-FD-01-SO-01112023	01/10/2023	FD	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U
	TAMP-IWTP-01-SO-5	TAMP-IWTP-01-SO-5-01102023	01/10/2023	N	0.00099	U	0.00099	U	0.00099	U	0.00099	U	0.00099	U
	TAMP-IWTP-02-SO-2	TAMP-IWTP-02-SO-2-01102023	01/10/2023	N	0.0011	U	0.0011	U	0.0011	U	0.0011	U	0.0011	U
	TAMP-IWTP-02-SO-5	TAMP-IWTP-02-SO-5-01102023	01/10/2023	N	0.0012	U	0.0012	U	0.0012	U	0.0012	U	0.0012	U
	TAMP-IWTP-03-SO-2	TAMP-IWTP-03-SO-2-01102023	01/10/2023	N	**0.00084**	J	**0.00077**	J	0.0011	U	0.0011	U	0.0011	U
	TAMP-IWTP-03-SO-5	TAMP-IWTP-03-SO-5-01102023	01/10/2023	N	0.0011	U	0.0011	U	0.0011	U	0.0011	U	0.0011	U
Plating Area (Buildings 11 and 20)	TAMP-PA-01-SO-2	TAMP-PA-01-SO-2-01102023	01/10/2023	N	**0.0072**		0.00099	U	0.00099	U	0.00099	U	0.00099	U
	TAMP-PA-01-SO-5	TAMP-PA-01-SO-5-01112023	01/11/2023	N	**0.0075**		0.0011	U	0.0011	U	0.0011	U	0.0011	U

Acronyms/Abbreviations:

- = not applicable - AOPI = area of potential interest - FD = field duplicate sample
- ID = identification - mg/kg = milligrams per kilogram (parts per million) - N = primary sample
- PFAS = per- and polyfluoroalkyl substances - PFBS = perfluorobutanesulfonic acid
- PFOA = perfluorooctanoic acid - PFOS = perfluorooctane sulfonate
- PFNA = perfluorononanoic acid - PFHxS = perfluorohexane sulfonate
- Qual = qualifier USAEC = United States Army Environmental Command
- J= The analyte was positively identified; however, the associated numerical value is an estimated concentration only.
- U= The analyte was analyzed for, but the result was not detected above the limit of quantitation (LOQ).

Table 3. Summary of data collected from Passive Soil Gas Samplers.

Sample Location				**PSG-01**	**PSG-02**	**PSG-03**	**PSG-04**	**PSG-05**
Sample Date				7/25/2022	7/25/2022	7/27/2022	7/28/2022	7/25/2022
Analyte	**Unit**	**Industrial VISL**	**Residential VISL**					
Toluene	ug/m3	**438,000**	**34,762**	**15.8 J**	< 7.11	< 7.28	< 7.27	< 7.31
TPH C10-C15	ug/m3	**N/A**	**N/A**	< 824	< 824	< 845	< 843	**2,320**

Notes:

Only constituents that were detected above the Laboratory Limit of Quantitation (LoQ) are shown.
TPH C10-C15 = Total Petroleum Hydrocarbons Containing 10 to 15 Carbon Atoms.
VISL = Vapor Intrusion Screening Level developed by the North Carolina Department of Environmental Quality (https://deq.nc.gov/permits-rules/risk-based-remediation/risk-evaluation-resources).
Bold = detected.
Non detects shown as < LoQ.
J = Qualified as estimated.
Shaded values (if present) exceeded the referenced standards.

Table 4. Water samples from On-Site Tunnel.

Sample Location						**TUNNEL N-01**	**TUNNEL S-02**
Analyte	**Unit**	**2B Standard**	**USEPA NRWQC**	**NC ISTV**	**NC 2L**		
SW8260D							
1,1,2-Trichloro-1,2,2-trifluoroethane	ug/l	**NE**	**NE**	**710,000**	**200,000**	**1.1**	< 0.84
Acetone	ug/l	**NE**	**NE**	**3,100**	**6,000**	< 10	< 10
Chloroform	ug/l	**NE**	**60**	**NE**	**70**	**0 0.57 J**	< 0.80
Cis-1,2-Dichloroethene	ug/l	**NE**	**NE**	**60**	**70**	**18**	**5.6**
Tetrachloroethene	**ug/l**	**0.7**	**NE**	**NE**	**0.7**	**19**	**5.0**
Trichloroethene	**ug/l**	**2.5**	**NE**	**NE**	**3**	**120**	**33**
Trichlorofluoromethane	ug/l	**NE**	**NE**	**9,100**	**2,000**	**2.3**	**0 .85 J**
Vinyl Chloride	ug/l	**0.025**	**NE**	**NE**	**0.03**	< 0.80	< 0.80

Table Legend:
NM = Not measured.
2B Standard = Subtitle 15A North Carolina Administrative Code (NCAC) 02B Surface Water and Wetland Standards. Effective Date September 1, 2022. 2L Standard = Subtitle 15A NCAC 02L Groundwater Quality Standards.
Only constituents that were detected above the Laboratory Limit of Quantitation (LoQ) are shown.
ug/L = Microgram per liter.
NE = Standard not established.
J = Qualified as estimated.
Non detects shown as < LoQ.
Bold red = values detected at >LoQ.

APPENDIX C: REFERENCES

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