MEMORANDUM

verdantas

Date: **February 16, 2023- DRAFT**
RE: **Work Plan for Application of Bioremediation Amendment to Soil, Sediment, and Groundwater at Locations Impacted by the Route 44 Gasoline Spill in Norfolk, CT**
Project Title: **November 5, 2022 Gasoline Spill in Norfolk, CT**
Project Number: **16640-000**

Verdantas has developed this Work Plan to provide details regarding proposed bioremediation activities at select locations in the Town of Norfolk, CT. This Work Plan was developed in response to the gasoline release that occurred on Route 44 on November 5, 2022. The following locations are targeted for remediation in this Work Plan:

- Soil and groundwater located beneath a portion of Maple Avenue;
- The open stormwater drainage channel that runs from the release site on Route 44, along Pettibone Lane, and downstream across Maple Avenue to Emerson Street; and,
- Sand bed #2 at the Norfolk Water Pollution Control Facility (WPCF) located at 250 Greenwood Road West.

The proposed activities described in this Work Plan will be implemented starting in March of 2023. The spill response remains under the lead of the Connecticut Department of Energy and Environmental Protection (CTDEEP), and therefore this Work Plan requires approval by CTDEEP. Based on consultation with CTDEEP, the approved Work Plan will satisfy permitting requirements for addition of the bioremediation amendments proposed herein.

This Work Plan proposes a combination of injection and/or surficial application of Petrox® microbes, manufactured by CL Solutions, LLC, for bioaugmentation purposes within the areas described above. The details presented in this Work Plan are based on current conditions. It is noted that this Work Plan may be amended and adjusted as conditions change throughout the Site and additional sampling data is obtained. Any associated revisions to the Work Plan will be presented in a revised version of this document.

Purpose for using Petrox®

This Work Plan presents an *in-situ* and surficial treatment strategy for the remediation of gasoline-related impacts to soil, groundwater, and/or sediment along the flow path of the release. In addition, sand bed #2 at the Norfolk WPCF, which has been impacted by the gasoline spill, will also undergo a surficial application of Petrox®.

The Petrox® treatment program is intended to facilitate bioremediation when the microbes are in contact with gasoline impacts. Petrox® is a commercial product composed of petroleum-degrading microbial strains that are capable of degrading petroleum hydrocarbons resulting in the formation of carbon dioxide and water. The advantages of applying Petrox® are that gasoline impacts can be safely degraded without completing large excavations (i.e., exposing underground utilities, building footings/structural elements, etc.) or creating major disruptions to infrastructure and

surrounding properties. Petrox® relies on microbial degradation of petroleum impacts and does not damage utilities or create an increased vapor intrusion risk.

Injections Along Maple Avenue

It is anticipated that remediation along Maple Avenue will occur in two (2) phases.

Phase 1 – Injections

This first phase is to take place along the perimeter/downstream monitoring wells on Maple Avenue and along the passive venting piping network that is in place between Maple Ave and adjacent properties. The intent of this application is to treat existing petroleum mass and prevent further migration and expansion of the gasoline impacts below the roadway. Directly applying the microbes in areas with known free product may produce an anoxic environment for the Petrox® microbes and can shock the microbes and reduce the effectiveness of the bioremediation process. As such, Verdantas proposes to inject/apply the Petrox® at the perimeter monitoring wells (i.e., the perimeter of the inferred area of hydrocarbon impact) MW-5, MW-17, and MW-23 that are set at a depth of 15 below ground surface (bgs). Please refer to the attached figure for details on the locations of monitoring wells. The wells that are proposed for injections across Maple Avenue have been highlighted in blue on the attached figure.

Petrox® will also be applied along the 40-foot passive venting system that is highlighted with a pink line in the attached figure. The passive venting system piping is slotted and the backfill around the piping has been established as a crushed stone matrix. As such, the application of Petrox® will distribute along the length of the passive venting system.

Liquid vacuum recovery events take place at select recovery wells (e.g., completed by ESI on a weekly basis) along Maple Avenue. These events should continue after the Petrox® is applied. It is anticipated that over time, the Petrox® microbes will be distributed from the injection locations throughout the inferred zone of impact by these vacuum events.

Phase 2 – Application in Maple Avenue Excavation

It is noted that the impacted locations along Maple Avenue are to undergo excavation procedures under the direction of CTDEEP by ESI during the spring of 2023. As part of a post-excavation remediation program, Verdantas proposes an application of Petrox® in the open excavation prior to backfill by ESI. This application of Petrox® will serve as a polishing step following remediation to further treat any residual gasoline impacts.

It may be warranted to combine the use of Petrox® with the use of other remediation technologies/techniques such as Oxygen Release Compound (ORC®), which has already been used in open excavations under CT DEEP direction and oversight. Combining the use of other remediation strategies and/or compounds will be coordinated with CTDEEP prior to these application programs and will be dependent on the conditions encountered during excavations on Maple Avenue.

Application Across Open Storm Water Drainage Channel

As it currently stands, under the direction of CTDEEP, ESI has completed the removal of sections of visibly impacted soil / sediment along the open drainage channel sections that extend the following properties:

- 97 Greenwood Road East;
- 31 Pettibone Lane;
- 51 Maple Avenue; and,
- 26 Emerson.

The gasoline-related impacts were remediated by shallow excavations to remove/skim impacted soil/sediment and transfer the impacts into containers for transport off Site.

However, it is noted that there may be inaccessible sections of impacted soils (i.e., not accessible by heavy machinery and site personnel) and/or where access would undermine/hinder the drainage channel features (disturb flow path, etc.). As such, this Work Plan proposes the application of Petrox® along the stormwater drainage channel as a remedial measure. The surficial application of Petrox® will promote bioremediation of residually impacted soil/sediment along the length of the open channel.

It is proposed that Petrox® be applied directly to the soils and sediments located along the sides of the open channel using a backpack sprayer. Verdantas will coordinate with CTDEEP to determine the portions of the open stream channel where Petrox® will be applied.

Application at sand bed #2 at WPCF

This Work Plan proposes that a surficial application of Petrox® be applied to the surface of sand bed #2 located in the Norfolk WPCF. The intent is to continue the bioaugmentation/bioremediation of residual gasoline-impacted sand in this sand bed.

Planned Petrox® Injections and Surficial Procedures

The Petrox® that is to be applied via injection and/or surficial application will be mixed with water at a ratio of approximately 55 gallons of water for every 4.5 pounds of Petrox®. ESI will mix and apply the Petrox® mixture as needed. The application activities will be monitored by Verdantas throughout. Supplements or amendments other than those provided by CL Solutions are not anticipated to be used during the injection and surficial applications.

Injection Procedures

Based on our current understanding of the hydrogeological conditions at the locations to undergo injections (MW-5, MW-17, MW-23 and via the passive venting system), the remediation strategy is not anticipated to have adverse effects on the soil or groundwater conditions. Application of Petrox® via injections will be conducted via low-pressure pumps and/or pouring techniques into the respective injection points.

It is anticipated that the total amount of Petrox® to be applied via injection is approximately 385 gallons over two (2) injection events.

A flexible hose will be connected via a submersible pump from the 55-gallon drums to the injection points. The low-pressure injections will not significantly alter groundwater elevations. To avoid mounding at the localized areas during the injection program, an alternating injection sequence shall be applied, meaning that the adjacent injection points will not be injected without lag between the injections. The low-pressure injection program is anticipated to treat impacted soil within the source soil remediation area (the treatment zone). The proposed treatment zones have been selected based upon soil analytical results and an understanding of the release mechanism.

Surficial Application Procedures

It is anticipated that applying Petrox® along the impacted drainage channel sections, the open excavation on Maple Avenue (i.e., to be completed in the Spring of 2023) and the sand bed at the WPCF will be completed by Site personnel via backpack sprayers or directly poured from the 55-gallon drums to the impacted areas. The total amount of Petrox® to be applied will be based on conditions encountered in the field and will be coordinated with CTDEEP. The timing of Petrox® application for these surficial applications will be weather dependent (i.e., ideally Petrox® is to be applied via surficial applications of air temperatures above 55°F) and the number of applications may vary (depending on the level of impacted areas, etc.).

Post-Remediation Soil Sampling

Once Petrox® application procedures are completed, Verdantas will collect representative confirmatory samples in coordination with CTDEEP along the drainage channel and excavations that are to take place. It is expected that samples will be collected after approximately 3 months to allow the Petrox® to work. Confirmatory soil samples will be analyzed for AVOCs and the pertinent gasoline oxygenates using US EPA Method 8260.

Groundwater Monitoring

Verdantas personnel currently conduct periodic groundwater monitoring programs for the monitoring wells that are installed across the Site. Monitoring wells in the vicinity of locations that undergo Petrox® applications will be monitored and sampled quarterly under coordination with CTDEEP. The sampling will be completed in accordance with the CTDEEP guidance document "Low Flow Sampling Procedures" dated June 12, 2000, for the laboratory analysis of AVOCs and gasoline oxygenates using USEPA Method 8260.

Material Handling, Storage and Spill Management

Petrox® is expected to be delivered to Verdantas by the supplier, CL Solution, LLC. The product will be transported to the ESI warehouse to initiate the Petrox® hydration process when needed. Petrox® can be stored in freeze-dried powder form when in a frozen state.

The freeze-dried microbes must be kept frozen until the product is transported to the Site for the varying application programs. The product will be hydrated with clean tap water by ESI personnel in 55-gallon drums prior to use on Site. According to the manufacturer, if spilled in its dry state. Petrox® can simply be swept up and containerized. If spilled in solution, Petrox® can be allowed to dry, swept up and containerized. A copy of the SDS for this product is attached at the end of this work plan.

Safety Procedures for Material Handling

The manufacturer's safety recommendations will be followed. Personal protective equipment includes:

- Eye protection – well-sealed goggles or a face shield (recommended for full face protection).
- Respiratory – dust respirator approved by NIOSH/MSA. Hands – neoprene gloves.
- Feet-steel-toed shoes with chemical-resistant soles or neoprene boots.
- Clothing – long sleeve shirts and long pants, considered a laminated Tyvek body suit coveralls.

Attachments

- Proposed Injection / Application Locations
- Petrox® SDS