



October 7, 2021

Michael T. Hinman, GS-12, WI ANG
Architect, 115th Civil Engineering Squadron
Madison WI

Subject: Summary for Pilot Scale Injection for the Wisconsin Air National Guard in Madison, WI.

Dear Michael,

ORIN Technologies, LLC. (ORIN) is pleased to present this summary for pilot scale injection for the Wisconsin Air National Guard (WI ANG) at Truax Field in Madison, Wisconsin.

Summary of Site Conditions

WI ANG has requested ORIN to provide a cost estimate for treating groundwater contaminated with Per- and Polyfluoroalkyl Substances (PFAS). ORIN will target an area of approximately 1,600 square feet around building 414. The average depth to groundwater is approximately 4-5 feet below ground surface (ft bgs). The lithology within the targeted treatment interval is fine to coarse grained sand overlain by clayey sand with silts.



Figure 1 Monitoring well installation by hollow stem auger. Image courtesy of Geoprobe.com

Installation of monitoring wells will occur through hollow stem auger. The monitoring wells will be constructed of 2-inch schedule 40 PVC.



Figure 2 Flush mount monitoring well.

Monitoring wells can be finished with flush mount vaults and cement pads to protect the well and allow for minimal obstructions.



Figure 3 Enclosed chemical mixing system.



Figure 4 BAM and PFAS Degrading Bacteria batch mixing.

BAM and PFAS degrading bacteria will be mixed inside ORIN's enclosed injection trailers within 200-gallon batch tanks. Multiple tanks will be used to allow for continuous mixing and injecting.



Figure 5 ORIN injection trailer.

ORIN will prepare and mix the treatment remedies inside enclosed trailers.



Figure 6 DPT Direct Push Technology in-situ injection.

BAM and PFAS degrading bacteria will be injected through Geoprobe Direct Push Technology (DPT). ORIN will control the injection process using our custom designed injection head.

Vacuum Extraction



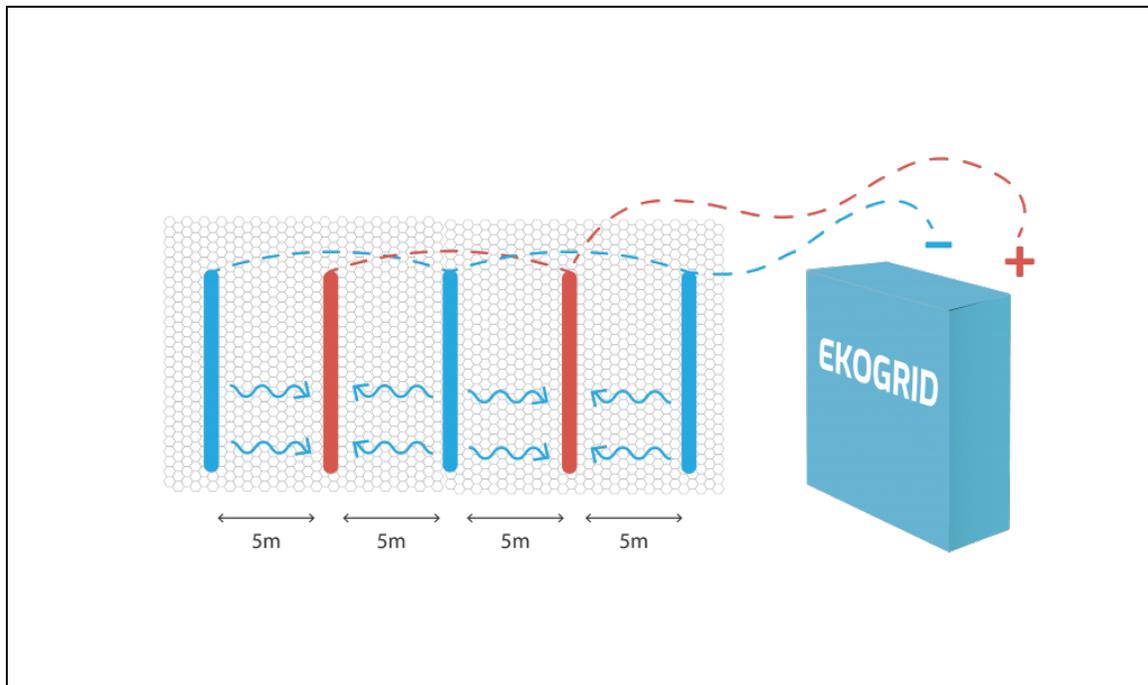
Figure 7 Vacuum extraction truck.



Figure 8 Vacuum extraction and in-situ injection.

Vacuum extraction will be applied through adjacent monitoring wells. The extraction process will assist in distributing treatment solution through the impacted soil and groundwater. ORIN will utilize a vacuum extraction truck during implementation.

EKOGRID



The EKOGRID system will generate oxygen through low voltage currents that are transferred between conductive rods within the treatment area. The oxygen will be used by PFAS degrading bacteria in their metabolic process.

Treatment Chemistry Descriptions

Bioavailable Absorbent Media

BAM is a sustainable, pyrolyzed, recycled cellulosic bio-mass product (>80% fixed carbon) derived from a proprietary blend of recycled organic materials with a high cation exchange. BAM has diverse pore sizes with a minimum total surface area of up to 1,133 square meters per gram or 127 acres/lb.

BAM has numerous synergistic qualities and is relatively affordable in large quantities for remediation purposes. BAM has the ability to provide ample



usable surface area for maximizing microbial colonization and thereby an active microbial community. Due to its unique 'honeycomb' structure, BAM has the ability to provide increased pore space for the different strains of microbes. Most importantly, BAM's affinity for organic and inorganic compounds supports maximum contact (bioavailability through high sorbency) with microbes allowing for complete degradation.

The unique absorption capability of BAM prevents exterior surface microfilm buildup providing long term remediation capabilities. This allows BAM to absorb contaminants for more productive bio-attenuation of contaminants over a longer period of time. Granular Activated Carbon (GAC) primarily adsorbs contamination to the surface of the media, which then is subject to bio-film development, preventing further adsorption. As a result, BAM has been proven to supply long term maintenance free remedial abilities over GAC. Laboratory tests have also shown that BAM has a significantly higher absorptive capacity than commercially available GAC products.

BAM's absorption ability or sponge like effect, comes from its unique and diverse honeycomb- structure. The shape creates pores or openings within the structure that allows for contaminants to be drawn in and retained within the pores. This unique ability prevents exterior surface microfilm buildup that allows BAM to continually absorb contaminants. Advantages include:

- Rapid absorption of contaminants.
- Pores provide extremely high surface area per gram of material creating a high Cation Exchange Capacity (CEC).
- Promotes microbial colonization's that biodegrade contaminants.

Calcium Peroxide

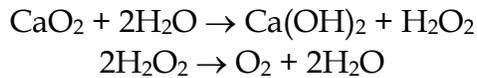
Calcium peroxide releases oxygen over an extended time period to enhance the biodegradation of petroleum hydrocarbons and other biodegradable contaminants in soil and groundwater.

It is well documented that the release of oxygen in the subsurface environment enhances the biodegradation of contaminants. Based on extensive laboratory studies, the releases of oxygen can provide a useful and cost-effective mechanism for enhancing aerobic bioremediation.

Successful bioremediation of contamination via aerobic microbial respiration depends on a number of factors including the presence of appropriate microbes,



nutrients, electron donors and terminal electron acceptors. In the aerobic metabolism of contaminants, oxygen acts as a terminal electron acceptor and contaminants act as electron donors, which are oxidized. Often, the limiting factor in aerobic bioremediation of contaminants is oxygen. Calcium peroxide provides oxygen by reacting with water. The reaction is:



PFAS Degrading Bacteria

The carbon-fluorine (C-F) bond is one of the strongest single covalent bonds known. The presence of numerous C-F bonds in any given PFAS molecule makes these compounds very difficult to degrade. As a result of their resilience, PFAS compounds have commonly become known as “forever chemicals” due to their persistence in the environment. PFAS compounds are generally considered to be resistant to biodegradation due to their chemical stability, although some limited biotransformations of PFAS are known in wastewater systems that typically lead to the formation of PFOS from other fluorinated compounds. ORIN/Fixed Earth Innovations has developed a method to obtain microbes that are capable of degrading PFAS substances in a timely manner that are native to the impacted site. The microbes are aerobic, which utilize low levels of oxygen for survival and their metabolic process.

The performance of the PFAS degrading microbes has been previously validated in multiple laboratory studies and in an in-situ field demonstration. The available data from these studies suggests that cleavage of the C-F bond occurs, resulting in complete mineralization of PFAS.

EKOGRID™

EKOGRID Electrokinetic Remediation solution utilizes certain electrokinetic and electrochemical reactions to enhance bioremediation and break down organic pollutants in soil, groundwater, and sediment (in situ or ex situ). Optimized pulsed voltage patterns, essential for the proper functioning of this method, are transmitted by EKOGRID control unit, which programming is optimized to each site.

EKOGRID is an advanced in situ remediation technology which enhances natural processes and supports complementary remediation methods. EKOGRID utilizes electrochemical phenomena to generate chemical radicals on soil particle



surfaces and electrokinetic and electro osmotic phenomena to increase availability of organic contaminants for bioremediation, chemical degradation, or mechanical removal.

EKOGRID is both cost-effective and simple to install. The system utilizes the capacitive nature of the soil matrix. Reactions will occur at the surface of each soil particle and everywhere between the electrodes – not just at the installed electrodes. The effect can be quickly seen in the form of reduced pollutant concentrations in the soil and groundwater as well as stabilized ORP and dissolved oxygen levels.

Two electrodes will be hooked together to act as one set and the other two will be hooked together to act as the second set of electrodes. Both get wired back to the control box using heavy gauge cable and the control box is plugged into a standard outlet for power. The EKOGRID technician then can interface with the system to observe the electrical response of the soil and optimize the pulsing (voltages, timing, etc) to maximize oxygen production in situ.

Scope of Services

DPT Injection

- Remedial treatment will utilize in-situ DPT.
- The targeted remedial area has a total footprint of approximately 1,600 ft².
- Approximately 17 injection points will be utilized with the vertical extent of remediation extending from approximately 4 to 24 ft bgs.
- Injection points will be arranged in a barrier wall pattern on the upgradient side of the newly installed targeted well, and a grid like pattern down gradient.
- Inject an average of 200 gallons of 12.7% BAM Ultra and 1% calcium peroxide solution into each of the 17 DPT locations. A minimum of 2 gallons of microbial culture will be injected at each DPT location.
- Approximately 4-6 EKOGRID electrodes will be installed following the DPT injection.
- Injection will take approximately 1-2 days depending on unforeseen site and matrix conditions.
- Concentration and volume may vary depending on site conditions and targeted COC concentrations.



- ORIN will maintain field notes on the amount and concentration of chemical applied and any other related field observations.
- Demobilize field personnel and equipment from the site.
- A brief report describing the remediation, chemical amount used, other field information and observations regarding the remedial effort will be submitted to WI ANG after all field work is completed.

Health and Safety

To ORIN, health and safety is not just a priority, it's a value. By being proactive instead of reactive, ORIN has learned to identify and listen to health and safety triggers, such as fatigue, emotion and rushing. ORIN reports near misses and lessons learned to help facilitate open discussions with clients and vendors alike about health and safety on our projects.

ORIN is ISN certified. ISN is a certification that ensures all members are up to date and compliant with safety standards and training in some of the most safety conscious industries. We pursued ISN certification to show our commitment to health and safety, and to ensure we meet even the most stringent requirements for companies we work with.

ORIN subscribes to Occupational Safety and Health Administration (OSHA)- and United States Environmental Protection Agency (USEPA)-mandated Health and Safety standards for protection of hazardous waste workers. Because of the wide range of potential exposures for our employees, ORIN must make conservative judgments as to potential health risks. The services outlined in this proposal are offered on the basis of providing Level D health and safety protection (Tyvek[®], steel-toed boots, hard hats, nitrile gloves, hearing protection, eye protection, and air-purifying respirators). ORIN personnel will abide by the applicable OSHA guidelines for personal safety outlined in 29 CFR 1910.

Prior to daily commencement of injection activities, ORIN will conduct health and safety tailgate meetings with all applicable onsite personnel. The meetings will include but will not be limited to discussion of the work planned for the day and any potential hazards, changes in work assignment, any problems encountered during past operations, and any other pertinent health and safety issues.



We look forward to working with you on this project. If you have additional questions or comments, please feel free call our office at (608) 838-6699 or my cell at (608) 514-2095.

Sincerely,

Tyler Emerson
Project Manager
ORIN Technologies, LLC.

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