Los Angeles Regional Water Quality Control Board

TO: All Interested Parties and Persons

FROM: Renee Purdy, Executive Officer R Purdy Digitally signed by R Purdy Date: 2020.08.10 08:24:00 -07'00'
LOS ANGELES REGIONAL WATER QUALITY CONTROL BOARD

DATE: August 10, 2020

SUBJECT: AMENDMENTS TO ATTACHMENT A, LIST OF AUTHORIZED INJECTION MATERIAL AMENDMENTS IN ORDER NO. R4-2014-0187, GENERAL WASTE DISCHARGE REQUIREMENTS FOR IN-SITU GROUNDWATER REMEDIATION AND GROUNDWATER RE-INJECTION

On September 11, 2014, pursuant to the Porter-Cologne Water Quality Control Act (Cal. Water Code §§ 13000 et seq.), the California Regional Water Quality Control Board, Los Angeles Region (Regional Board) adopted General Waste Discharge Requirements (General WDRs) (Order No. R4-2014-0187) (Order) for In-situ Groundwater Remediation and Groundwater Re-injection. The General WDRs are available at https://www.waterboards.ca.gov/losangeles/board_decisions/adopted_orders/docs/GeneralWDRR4-2014-0187.pdf.

The General WDRs authorize the use of materials for in-situ soil/groundwater remediation that have been shown to effectively remediate wastes in groundwater and soil. Attachment A of the Order includes a list of materials that can be used for in-situ soil/groundwater remediation purposes. Since 2014, new technologies have been evolving in the in-situ remediation field. In 2019, Regional Board staff formed a technical work group (Work Group), with representatives from other regulatory agencies, water agencies, water purveyors, environmental consultants, chemical manufacturers, and academia to identify and evaluate new materials available for in-situ soil/groundwater remediation. The Work Group has recommended that Attachment A be updated to add these new materials.

Order No. R4-2014-0187, A. Eligibility, No. 3, states that:

> "The Executive Officer is delegated the authority to revise and update the list periodically to add materials that meet the following criteria:
> a. Effective to remediate targeted constituents;

b. Minimum degradation of water quality (including toxicity and by-product evaluation) that will not cause or contribute to exceedance of WQOs [water quality objectives];
c. Protective of human health and safety (including prohibition of human/animal pathogens);
d. Availability on the market for a minimum of three years."

The Work Group has determined that the materials proposed for inclusion in Attachment A meet the criteria (a through d) listed above.

Pursuant to the authority delegated to the Executive Officer by the Regional Board, and based on the Work Group's evaluation and recommendation, Attachment A is hereby revised as proposed. No other part of the Order is changed.

This memorandum provides information regarding the authorized injection materials added to Attachment A of the Order. The following in-situ injection materials are added to Attachment A:

- Potassium Persulfate
- Ammonium Bicarbonate
- Ammonium Phosphate
- Ammonium Sulfate
- Ammonium Nitrate
- Potassium Chloride
- Red yeast rice extract and garlic oils
- Sodium Ascorbate
- Sodium Sulfite
- Sodium Sulfate
- Calcium Ascorbate
- Ferric Chloride
- Ferrous Sulfide
- Iron (III) Oxide & Iron Pyrite
- Zeolite
- Alcohol Ethoxylate
- Activated Carbon with Reactive Iron
- Activated Carbon with Hydrocarbon Degrading Bacterial Consortium
- Colloidal Activated Carbon
- Micron-Scale Activated Carbon

For a complete list of additional authorized injection materials see the amended Attachment A of the Order on our website: https://www.waterboards.ca.gov/losangeles/board_decisions/adopted_orders/docs/AttachmentA.pdf

Please direct any communications and/or questions regarding this matter to Dr. Yue Rong, Chief of the Underground Storage Tank Program Section, at (213) 576-

6710 or Yue.Rong@waterboards.ca.gov or Dr. Ann Chang of the Groundwater Permitting and Land Disposal Section at (213) 620-6122 or Ann.Chang@waterboards.ca.gov.

Attachment A
List of Authorized Injection Material Amendments

(original September 2014)
(updated August 2020, with new additions in boldface)

The list below does not represent any endorsement of products or materials by the Regional Water Quality Control Board, Los Angeles Region (Regional Board). Many of the products/materials listed are patented. Users of these products/materials shall comply with any regulations and laws applicable to the use of the products/ materials. Some products/materials may contain by-products or impurities that are not authorized to be used by the Regional Board. Compounds listed under one category can also be used under another category.

1. Chemical Oxidants:

- Fenton's reagent (hydrogen peroxide, ferrous iron catalyst, and pH buffer)
- Hydrogen Peroxide
- Ozone
- Potassium or Sodium Permanganate
- Sodium Percarbonate
- Sodium Persulfate
- **Potassium Persulfate**

2. Chemical Oxidant Activators:

- Calcium Hydroxide
- Chelating Agents (ferric ethyldiaminetetraacetic acid (EDTA), sodium citrate, sodium malonate, sodium phytate)
- Silica and Silicates (Silicic Acid, Sodium Silicate, Silica Gel)
- Sodium Hydroxide

3. Aerobic Bioremediation Enhancement Compounds:

- Calcium Oxide/Peroxide
- Calcium hydroxide
- Magnesium (Oxide/Hydroxide/Peroxide)
- Methane (Dissolved Phase)
- Propane (Dissolved Phase)
- **Ammonium Bicarbonate**
- **Ammonium Phosphate**
- **Ammonium Sulfate**

4. Anaerobic Degradation Enhancement Compounds:

- **Ammonium Nitrate**

- Calcium Sulfate (gypsum)
- Cheese Whey
- Complex organic materials (starch, wood chips, yeast extract, grain milling products)
- Complex Sugars
- Corn Syrup
- Emulsified Vegetable Oil
- Ethanol
- Glucose
- Glycerol esters of fatty acids and polylactates
- Glycerol Polylactate/Tripolylactate
- Glycerol, Xylitol, Sorbitol
- Guar
- Hematite
- Lactose
- Lecithin
- Magnesium sulfate
- Milk Whey
- Methanol
- Molasses
- Organic Acids (Acetate, Lactate, Propionate, Benzoate, and Oleate)
- Potassium Sulfate
- **Potassium Chloride**
- Propanol
- **Red yeast rice extract and garlic oils (Antimethanogenic Reagents (AMRs))**
- Sorbitol Cysteinate/Cysteine

5. Reduction Degradation Enhancement Compounds:

- Ferrous Chloride
- Ferrous Gluconate
- Ferrous Sulfate
- Sodium Dithionite
- Zero-Valent Iron
- **Sodium Ascorbate**
- **Sodium Sulfite**
- **Sodium Sulfate**
- **Calcium Ascorbate**

***6. Metals Precipitation / Stabilization*:**

- Calcium Phosphate
- Calcium Polysulfide
- **Ferric Chloride**
- **Ferrous Sulfide**
- Ferrous Sulfate

- Sodium Tripolyphosphate (STPP)
- **Iron (III) Oxide & Iron Pyrite**
- **Zeolite**

7. Surfactants/Co-solvents:

- Benzenesulfonic acid
- Dioctyl Sodium Sulfocuccinate
- D-limonene
- Ethoxylated Castor Oils Surfactants
- Ethoxylated Cocamides Surfactants
- Ethoxylated Coco Fatty Acid Surfactants
- Ethoxylated Octylphenolic Surfactants
- Sorbitan Monooleate
- Xanthan Gum
- **Alcohol Ethoxylate**

8. Bioaugmentation Organisms: *The users shall prove that any bacterial genomes in the original injection form, its degradation form, other impurity or by-product shall not be human/animal pathogens*. Genetically-modified organisms (GMO) should not be used.*

- Dehalococcoides Sp.
- Dehalobactor Sp.
- Geobacter
- Methanomethlovorans
- Desulfovibrio
- Desulfobacterium

* = for any bacteria consortium along with above species, a human/animal pathogen test must be performed for the following species at minimum (table below). If a positive test result is returned for any listed microorganism or group, then additional testing may be required before permission for use is granted.

Genus or Group	**Species**
Vibrio	sp.
Campylobacter	sp.
Pseudomonas	*aeruginosa*
Bacillus	*anthracis*
Salmonella	sp.
Listeria	*monocytogenes*
Yersinia	sp.
Clostridium	*perfringens*
Fecal streptococci (Enterococci)	-
Fecal coliforms	-
Escherichia	*coli*
Citrobacter	*freundii*

Klebsiella	*pneumoniae*
Serratia	*marcescens*

9. Tracer Study Compounds: *The tracer compounds shall be highly contrasting and not reactive with current contaminants to be treated. The tracers may be chloride-based, bromide-based, or fluoride-based salts, or similar materials as approved by the Executive Officer.*

- Calcium Bromide
- Calcium Chloride
- Eosin Dyes
- Fluoride Salts
- Iodide
- Potassium Bromide
- Potassium Iodide
- Rhodamine Dyes
- Sodium Bromide
- Sodium Chloride
- Sodium Fluorescein

10. Buffer Solutions and pH Adjusters:

- Calcium Carbonate
- Calcium Magnesium Carbonate
- Potassium Bicarbonate
- Sodium (carbonate/bicarbonate)

11. Inorganics/Nutrients:

- Nitrate
- Ammonia
- Phosphate
- Vitamins

12. Sorption Materials

- Granular Activated Carbon
- **Activated Carbon with Reactive Iron**
- **Activated Carbon with Hydrocarbon Degrading Bacterial Consortium* (Terminal Electron Acceptors (TEA), Nutrients, and Bacteria)**
- **Colloidal Activated Carbon**
- **Micron-Scale Activated Carbon**

*= see note in section 8 above.

SUMMARY FACT SHEET FOR ADDED INJECTION MATERIALS TO ATTACHMENT A OF GENERAL WASTE DISCHARGE REQUIREMENTS FOR IN-SITU GROUNDWATER REMEDIATION AND GROUNDWATER RE-INJECTION CONTAINED IN ORDER NO. R4-2014-0187				
Compound Name and Description	***COCs Treatability***	***By-Product and Water Quality Effects***	***Human Health and Safety Effects***	***Market Availability***
Activated Carbon with Hydrocarbon Degrading Bacterial Consortium* (Terminal Electron Acceptors (TEA), Nutrients, and Bacteria) **Potassium Chloride**	This is an in-situ remediation technology specifically designed to degrade petroleum hydrocarbons, related solvents, and oils. This compound includes activated carbon, commonly used electron acceptors (sulfate and nitrate), nutrients, and a blend of naturally occurring hydrocarbon degrading bacteria to first “trap” the hydrocarbons, then “treat” them using the aforementioned components.	Minimum degradation of water quality. Reaction end products may include volatile fatty acids and unregulated dissolved hydrocarbon gases typical of aerobic and anaerobic degradation of petroleum hydrocarbons. Outside the treatment footprint, this compound will not exceed water quality objectives (WQOs). Within the treatment footprint, sulfate and nitrate will have elevated concentrations that will decrease over time (similar to other approved technologies such as sodium persulfate).	The activated carbon component does not pose a risk to human health as it is derived from natural virgin carbon.	Since 2002
Activated Carbon with Reactive Iron	This compound targets chlorinated solvents. The food-grade carbon is impregnated with metallic iron formed under reducing conditions at a temperature of roughly 850 degrees C. At this temperature, as the metallic iron is formed it partially dissolves into the carbon forming a new and unique material with properties of both the carbon and iron. The product is typically mixed with water to create a slurry that can be applied using a variety of techniques.	Minimum degradation of water quality. Neither the activated carbon nor the impregnated iron has an impact on water quality such that attainment of WQOs would be affected.	No risk to human health as it is derived from natural virgin carbon.	Since 2004
Alcohol Ethoxylate	This compound targets gasoline, diesel, fuels, and some mixtures with oil sludge. Supports LNAPL removal, solubilization, and temporary mobilization (only under reduced hydraulic controls) for a short period of less than 7 days and supports anaerobic bioremediation of TPH, BTEX, other petroleum hydrocarbons, and some chlorinated hydrocarbons. This compound enhances solubility of LNAPL and residual LNAPL and further improves the biodegradation processes for BTEX, TPH, and other compounds. It also replenishes the electron acceptors within a petroleum spill location where soil and groundwater impacts are present once the surfactants have improved the solubility of those sorbed hydrocarbons and made them more accessible to the native bacteria. The commonly known electron acceptors in anaerobic respiration include sulfate, nitrate, iron, and manganese. Phosphate is also provided at low levels as it is a required nutrient by	Minimum degradation of water quality. Typical application dosages range from 1% to 4% (by weight) of active ingredients depending on the amount of LNAPL or residual LNAPL, soil type, and form of hydraulic control employed. The additional nutrients are intended to replenish preexisting electron acceptors in the hydrocarbon impacted soil and groundwater zone so great care is taken during dosage calculations to ensure that elevated levels of sulfate, phosphate, or other common groundwater monitoring parameters remain within regulatory limits.	The chemistries are non-hazardous and non-toxic to agriculture and ecological environments at the dosages employed. It is provided in concentrated liquid form, so proper material handling is recommended in accordance with OSHA and HAZWOPER safety training dictates until diluted at the site.	Since 2016

	bacteria in the anaerobic respiration process. This compound requires mixture with water at the time of application to inject and/or mix with other injected anaerobic bioremediation products.			
Ammonium Bicarbonate **Ammonium Nitrate** **Ammonium Phosphate** **Ammonium Sulfate**	This compound supports anaerobic bio-stimulation and bioremediation of TPH, BTEX, other petroleum hydrocarbons and some chlorinated hydrocarbons. It replenishes the electron acceptors within a petroleum spill location where soil and groundwater impacts are present. The commonly known electron acceptors in anaerobic respiration include sulfate, nitrate, iron, and manganese. Phosphate is also provided at low levels as it is a required nutrient by bacteria in the anaerobic respiration process. This compound requires mixture with water at time of application to inject and or mix with other injected anaerobic bioremediation products.	Minimum degradation of water quality. Typical application dosages range from 0.25% to 1% wt of soil active ingredients depending on amount of LNAPL or residual LNAPL, soil type, and form of hydraulic control employed. The additional nutrients are intended to replenish preexisting electron acceptors in the hydrocarbon impacted soil and groundwater zone so great care is taken during dosage calculations to ensure that elevated levels of sulfate, phosphate or other common groundwater monitoring parameters remain within regulatory limits.	The chemistries are ecologically safe and nonhazardous and non-toxic to agriculture or other ecological environments at the dosages employed. It is provided in dry powder form or concentrated liquid form, so proper material handling is recommended in accordance with OSHA and HAZWOPER safety training dictates until diluted at the site.	Since 2015
Calcium Ascorbate	This compound supports anaerobic bioremediation applications (e.g., chlorinated solvent degradation). This technology has been in practice for many years, though it is often not mentioned as it is used in small quantities. It is an oxygen scavenger, food-grade, and a common vitamin consumed by humans daily if desired. It requires mixture with water at the time of application to inject and/or mix with other injected anaerobic bioremediation products. Typical dosages range from 2 to 5 g/l of water in the groundwater treatment zone.	Minimum degradation of water quality.	Sodium and calcium ascorbate are salts and common food-grade vitamins (Vitamin C) that are non-hazardous and nontoxic to agriculture and ecological environments at the dosages employed. The chemistries are salts and food-grade minerals that are non-hazardous (compared to oxidants) and nontoxic to agriculture and ecological environments at the dosages employed. It is provided in dry or liquid slurry form, so proper material handling is recommended in accordance with OSHA and HAZWOPER safety training dictates.	Since 2017
Colloidal Activated Carbon **Micron-Scale Activated Carbon**	Both Colloidal Activated Carbon and Micron-Scale Activated Carbon are composed of small size, less than 10 microns, activated carbon. Both of these compounds are used to sorb the target contaminants (VOCs and emergent contaminants such as PFAS and hydrocarbons) out of the aqueous phase and remove the mobile contaminants from the immediate risk pathway. Concentration of the contaminants in this manner in a matrix conducive to degrader colonization and activity results in a direct increase in efficiency of contaminant destruction. Once in place and with contaminants partitioned onto its surface, the compound is colonized by contaminant-degrading bacteria. Enhanced biodegradation of the contaminants within the biomatrix regenerates or frees up sorption	Minimum degradation of water quality. Micron-scale activated carbon has no impact to water quality such that attainment of WQOs would be affected.	No risk to human health as both of these compounds are derived from super fine natural virgin coconut carbon shells milled to less than 10 microns in size. These compounds are also used for drinking water filtration.	Since 2014

	sites allowing contaminants to further partition out the groundwater.			
Ferric Chloride	This compound targets all forms of heavy metals. Generally, it requires bench-scale testing to verify efficacy and dosage demand to meet local and or federal regulatory screening levels. This technology was specifically designed to sequester many types of heavy metals in soil and groundwater for sustainably long periods (greater than 100 years). It requires mixture with water at the time of application to activate the chemistry. Typical dosages range from 0.5% to 8% (by weight) for soils and groundwater and 5% to 15% (by weight) for industrial slab and waste material.	Minimum degradation of water quality. It is designed to reduce heavy metals in groundwater to meet drinking water standards.	The chemistries are salts and earth minerals that are non-hazardous (compared to oxidants) and non-toxic to agriculture and ecological environments at the dosages employed. It is provided in dry or liquid slurry form, so proper material handling is recommended in accordance with OSHA and HAZWOPER safety training dictates.	Since 2015
Ferrous Sulfide	Ferrous sulfide is highly effective in producing reducing conditions that promote the transformation of hexavalent chromium to trivalent chromium (the less toxic form) in a process known as In-Situ Redox Manipulation (ISRM). Ferrous sulfide (FeS) can be used as either as a powdered reagent or as a liquid solution. Ferrous sulfide has been used for removal of soluble heavy metals (such as hexavalent chromium, antimony, and nickel) in soil and groundwater for over 15 years. In addition, new research has discovered that FeS can also be used to activate sodium persulfate and potassium persulfate in a chemical oxidation remediation process for VOCs and other organics.	As naturally occurring minerals, no exceedance of WQOs would be expected from normal use of this product.	Ferrous sulfide is naturally occurring with low toxicity to humans. The product is not considered harmful to aquatic organisms or to cause long-term adverse effects in the environment. For both the powdered form and the liquid form of the material, users should use caution and wear a dust mask or respirator when mixing with soil or water, as inhalation of dust (or mist) may cause mild irritation of the respiratory system and a dry cough.	Since 2005
Iron (III) Oxide & Iron Pyrite	Iron (III) oxide and iron pyrite are natural iron-bearing minerals and have proven to be effective for removal of soluble heavy metals such as arsenic, chromium, lead, and mercury from soil and groundwater. After injection into the saturated zone, the iron oxide and iron pyrite particles serve as reducing agents and adsorbents for both cationic and anionic heavy metals. As an example, when in contact with iron oxide or iron pyrite surfaces, the soluble and toxic form of chromium (Cr+6) is reduced to the insoluble and non-toxic form (Cr+3) and is then precipitated as a mixed iron chromium-oxyhydroxide that is very stable and highly insoluble. For other major heavy metals, including arsenic, similar reductive and adsorptive chemistry is promoted by iron oxide and iron pyrite to convert soluble heavy metals to stable mineral precipitates. The compounds that include iron oxide and iron pyrite are fine-grained powders that mix with water to form a pumpable slurry with between 20% and 30% (w/w) solids. They are easy to mix and inject using industry standard equipment and moderate injection pressures at most sites.	Minimum degradation of water quality. Iron oxides and iron pyrite do not negatively impact water quality such that attainment of water quality objectives (WQOs) would be affected.	They are both natural minerals and do not pose any risk to human health.	Since 2014
Potassium Persulfate	This compound targets petroleum hydrocarbons, chlorinated solvents, chlorinated benzenes and phenols, pesticides, energetics, and emerging contaminants such as PFAS This compound is high	Minimum degradation of water quality. Leaves potassium and sulfate residual.	Personal protective equipment is required. Avoid breathing dust. Handle product only in closed system or provide appropriate exhaust	Since 2010

	purity environmental grade product used as an in situ chemical oxidation (ISCO) technology to treat a wide variety of contaminants of concern in soil and groundwater by forming a powerful oxidative and reductive radical that aggressively treats targeted contaminants. This technology is well established having been successfully applied in thousands of field applications and scientifically validated in hundreds of independent peer-reviewed journal articles and conference presentations.		ventilation at machinery. Avoid contact with skin and eyes. Remove and wash contaminated clothing before re-use.	
Red yeast rice extract and garlic oils (Antimethanogenic Reagents [AMRs])	This compound is a food-grade, natural source of statin typically used with other established remedial technologies such as chemical reduction and anaerobic bioremediation. This technology was specifically designed to control methane production and reduce methane concentrations in groundwater, soil gas/vapor, and indoor air. AMRs can also be used in landfill management. It does not directly remediate targeted constituents (e.g., chlorinated volatile organic compounds) but improves the performance of other remedial technologies such as chemical reduction and bioremediation by inhibiting the growth of methanogens in the subsurface. The methanogen inhibition will allow the applied hydrogen donor substrate (e.g., chemical reductants, emulsified vegetable oils, etc.) to be used for reductive de-chlorination instead of methane production.	Minimum degradation of water quality. AMRs have no impact to water quality such that attainment of WQOs would be affected, and they are biodegradable.	No risk to human health as it is a food-grade product that is also prescribed to and used by humans to lower cholesterol (e.g., Lovastatin). AMRs are manufactured with no hazardous or toxic components. A dust mask should be used if handling the powdered product (red yeast rice extract).	Since 2015
Sodium Ascorbate	This compound supports anaerobic bioremediation applications (e.g., chlorinated solvent degradation). This technology has been in practice for many years, though it is not often mentioned as it is used in small quantities. It is an oxygen scavenger, food-grade, and a common vitamin consumed by humans daily if desired. It requires mixture with water at the time of application to inject and/or mix with other injected anaerobic bioremediation products. Typical dosages range from 2 to 5 g/l of water in the groundwater treatment zone.	Minimum degradation of water quality.	Sodium and calcium ascorbate are salts and common food-grade vitamins (Vitamin C) that are non-hazardous and nontoxic to agriculture and ecological environments at the dosages employed. The chemistries are salts and food-grade minerals that are non-hazardous (compared to oxidants) and non-toxic to agriculture and ecological environments at the dosages employed. It is provided in dry or liquid slurry form so proper material handling is recommended in accordance with OSHA and HAZWOPER safety training dictates.	Since 2017
Sodium Sulfate	This compound supports anaerobic bio-stimulation and bioremediation of TPH, BTEX, other petroleum hydrocarbons, and some chlorinated hydrocarbons. This technology replenishes the electron acceptors within a petroleum spill location where soil and groundwater impacts are present. The commonly known electron acceptors in anaerobic respiration include sulfate, nitrate, iron, and manganese.	Minimum degradation of water quality. Typical application dosages range from 0.25% to 1% wt of soil active ingredients depending on the amount of LNAPL or residual LNAPL, soil type, and form of hydraulic control employed. The additional nutrients are intended to replenish preexisting	The chemistries are non-hazardous and non-toxic to agriculture and ecological environments at the dosages employed. It is provided in dry powder form or concentrated liquid form, so proper material handling is recommended in accordance with OSHA and	Since 2015

	Phosphate is also provided at low levels as it is a required nutrient by bacteria in the anaerobic respiration process. It requires mixture with water at time of application to inject and/or mix with other injected anaerobic bioremediation products.	electron acceptors in the hydrocarbon impacted soil and groundwater zone so great care is taken during dosage calculations to ensure that elevated levels of sulfate, phosphate, or other common groundwater monitoring parameters remain within regulatory limits.	HAZWOPER safety training dictates until diluted at the site.	
Sodium Sulfite	Sodium sulfite is a food-grade oxygen scavenger that serves as a cost-effective reagent for rapid creation of anaerobic water used during injection of zero valent iron as well as anaerobic microbial cultures (e.g., Dehalococcoides sp.) used during enhanced reductive de-chlorination projects. Such use of sodium sulfite ensures that the reactivity of iron is maintained, and microbial cultures are not damaged by exposure to dissolved oxygen during the injection process. Sodium sulfite has proven effective as an oxygen scavenger for removal of dissolved oxygen in groundwater as part of remediation projects that employ zero valent iron (ZVI) or anaerobic bacteria in treatment of chlorinated solvents. The removal of dissolved oxygen from groundwater during preparation of ZVI and/or injection of bacterial cultures can prevent loss of ZVI reactivity and ensure maintenance of enzyme systems in de-halogenations.	Minimum degradation of water quality. Sodium sulfite does not negatively impact water quality such that attainment of WQOs would be affected.	Sodium sulfite does not pose any risk to human health. It is widely used as an antioxidant in dried fruit prepared for human consumption (i.e., dried apples, mangoes, coconut). It is also used as a preservative in many types of seafood.	More than 10 years
Zeolite	This compound targets all forms of heavy metals. Generally, it requires bench-scale testing to verify efficacy and dosage demand to meet local and or federal regulatory screening levels. This technology was specifically designed to sequester many types of heavy metals in soil and groundwater for sustainably long periods (greater than 100 years). It requires mixture with water at the time of application to activate the chemistry. Typical dosages range from 0.5% to 8% (by weight) for soils and groundwater and 5% to 15% (by weight) for industrial slab and waste material.	Minimum degradation of water quality. It is designed to reduce heavy metals in groundwater to meet drinking water standards.	The chemistries are salts and earth minerals that are non-hazardous (compared to oxidants) and non-toxic to agriculture and ecological environments at the dosages employed. It is provided in dry or liquid slurry form, so proper material handling is recommended in accordance with OSHA and HAZWOPER safety training dictates.	Since 2011

* = for any bacteria consortium containing the species below, a human/animal pathogen test must be performed for the following species at minimum (table below). If a positive test result is returned for any listed microorganism or group, then additional testing may be required before permission for use is granted.

Genus or Group	Species
Vibrio	sp.
Campylobacter	sp.
Pseudomonas	*aeruginosa*
Bacillus	*anthracis*
Salmonella	sp.
Listeria	*monocytogenes*
Yersinia	sp.
Clostridium	*perfringens*
Fecal streptococci (Enterococci)	-

Fecal coliforms	-
Escherichia	*coli*
Citrobacter	*freundii*
Klebsiella	*pneumoniae*
Serratia	*marcescens*