July 24, 2019

Kevin McKnight
Wisconsin Department of Natural Resources
625 East County Road Y, Suite 700
Oshkosh, WI 54901-9731

Re: Amendment 2 to the Revised Remediation Injection Request
Appleton Wire (Former)
908 N. Lawe Street
Appleton, Wisconsin 54911
BRRTS# 02-45-000015

Dear Mr. McKnight:

This letter presents the second amendment to the revised Remediation Injection Request submitted to the department on April 30, 2019. This amendment has been prepared to request approval for the use of alternative remedial treatment products. The remedial technology (i.e., chemical reduction of hexavalent chromium to trivalent chromium) remains unchanged; however, the specific products and corresponding amounts that will be injected and blended with contaminated soil to achieve the treatment objectives have changed. The change of injection product from the original ABC+® injection product has resulted because this is a proprietary product provided by our original injection subcontractor who has recently declined to provide the injection services for this project. Specification sheets for all remedial products are attached.

Injection Plan

The injection solution will be a combination of the following products, manufactured by Regenesis:

- 3-D Microemulsion (3DME®) will replace Anaerobic BioChem (ABC®);
- Sulfidated Zero-Valent Iron (S-Micro ZVI), which is a colloidal ZVI product, will replace a powder-based ZVI solution.

The total treatment application will consist of 8,400 pounds of 3DME and 2,600 pounds of S-microZVI. The products will be mixed with potable water to produce a total of 18,474 gallons of solution at the desired concentration. This is equivalent to approximately 5 percent of the treatment volume pore space assuming a porosity of 35 percent. The injection procedures will be performed as described in the revised Remediation Injection Request.

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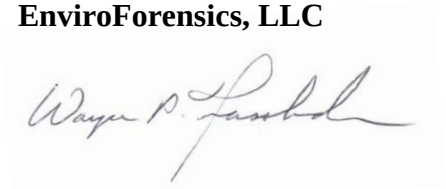
Soil Blending Plan

A bench scale study was performed to identify areas where dosing may be increased or decreased to achieve a reduction of hexavalent chromium to the target cleanup level of 3.84 mg/kg in unsaturated soil. An average dosage (loading rate) of application is 2.0% by weight (i.e. mass of ZVI to mass of soil) is now planned. Using 1,375 total cubic yards to be blended, and a bulk soil density of 128 pounds/cubic foot, we calculate that 88,200 pounds of ZVI will be required. The ZVI powder used for soil blending will have an average particle size of 100 microns rather than 150 microns as initially proposed. The soil blending procedures will be performed as described in the first amendment to the revised Remediation Injection Request dated May 17, 2019.

Please reply with approval of the revised injection and soil blending plans. If you have any questions regarding this submittal, feel free to contact me at 414-982-3988 or by email at wfassbender@enviroforensics.com.

Sincerely,
EnviroForensics, LLC



Wayne Fassbender, PG, PMP
Senior Project Manager

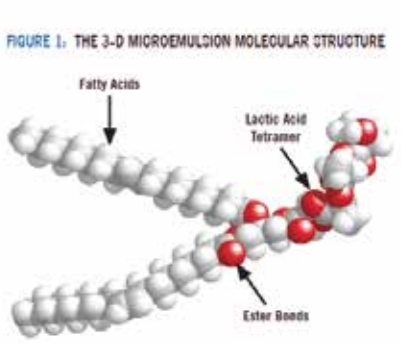
enclosures

cc: Jennifer Borski, Wisconsin Department of Natural Resources

3-D Microemulsion® Factory Emulsified Technical Description

3-D Microemulsion (3DME®) is comprised of a patented molecular structure containing oleic acids (i.e., oil component) and lactates/polylactates, which are molecularly bound to one another (figure 1). The 3DME molecule contains both a soluble (hydrophilic) and in-soluble (lipophilic) region. These two regions of the molecule are designed to be balanced in size and relative strength. The balanced hydrophilic/lipophilic regions of 3DME result in an electron donor with physical properties allowing it to initially adsorb to the aquifer material in the area of application, then slowly redistribute via very small 3DME "bundles" called micelles. These 3DME micelles spontaneously form within sections of the aquifer where concentrations of 3DME reach several hundred parts per million. The micelles' small size and mobility allow it to move with groundwater flow through the aquifer matrix, passing easily through the pore throats in between soil grains resulting in the further redistribution of 3DME within the aquifer. This allows for advective distribution of the oleic acids which are otherwise insoluble and unable to distribute in this manner, allowing for increased persistence of the lactate/polylactates component due to their initial attachment to the oleic acids.

Example of 3-D Microemulsion



Due to its patented molecular structure, 3DME offers far greater transport when compared to blended emulsified vegetable oil (EVO) products, which fail to distribute beyond the limits of pumping. 3DME also provides greater persistence when compared to soluble substrates such as lactates or simple sugars. The 3DME molecular structures capitalize on the best features of the two electron-donor types while at the same time, minimize their limitations. 3DME is delivered to the site as a ready-to-apply emulsion that is simply diluted with water to generate a large volume of a 3DME colloidal suspension.

Suspension of 3DME generated by this mixing range from micelles on the order of .02 microns to .05 microns in diameter, to "swollen" micelles, (termed "microemulsions") which are on the order of .05 to 5 microns in diameter. Once injected into the subsurface in high volumes, the colloidal suspension mixes and dilutes in existing pore waters. The micelles/microemulsions on the injection front will then begin to sorb onto the surfaces of soils as a result of zeta potential attraction and organic matter within the soils themselves. As the sorption continues, the 3DME will "coat" pore surfaces developing a layer of molecules and in some cases a bilayer. This sorption process continues as the micelles/microemulsion moves outward and disassociates into their hydrophilic/hydrophobic components. The specialized chemistry of 3DME results in a staged release of electron donors: free lactate (immediate); polylactate esters (mid-range) and free fatty acids & fatty acid esters (long-term). Material longevity of three years or greater has been seen at most sites as determined from biogeochemical analyses.

For a list of treatable contaminants with the use of 3DME, view the Range of Treatable Contaminants Guide

Chemical Composition

- Hydrogen Release Compound Partitioning Electron Donor – CAS #823190-10-9
- Sodium Lactate – CAS# 72-17-3
- Water – CAS# – 7732-18-5

3-D Microemulsion® Factory Emulsified Technical Description

Properties

- Density – Approximately 1.0 grams per cubic centimeter (relative to water)
- pH – Neutral (approximately 6.5 to 7.5 standard units)
- Solubility – Soluble in Water
- Appearance – White emulsion
- Odor – Not detectable
- Vapor Pressure – None
- Non-hazardous

Storage and Handling Guidelines

Storage
Store in original tightly closed container
Store in a cool, dry, well-ventilated place
Store away from incompatible materials
Recommended storage containers: plastic lined steel, plastic, glass, aluminum, stainless steel, or reinforced fiberglass

Handling
Avoid contact with eyes, skin, and clothing
Provide adequate ventilation
Wear appropriate personal protective equipment
Observe good industrial hygiene practices

Applications

- 3DME is diluted with water prior to application. Resulting emulsion has viscosity similar to water.
- Easily injects into formation through direct push injection points, injection wells or other injection delivery systems.

Application instructions for this product are contained here 3DME FE Application Instructions.

Health and Safety

Material is food grade and relatively safe to handle. We recommend avoiding contact with eyes and prolonged contact with skin. OSHA Level D personal protection equipment including vinyl or rubber gloves, and eye protection are recommended when handling this product. Please review the Material Safety Data Sheet for additional storage, usage, and handling requirements here: SDS-3DME FE.

REGENESIS®

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S-MicroZVI Specification Sheet

S-MicroZVI Technical Description

S-MicroZVI™ is an *In Situ* Chemical Reduction (ISCR) reagent that promotes the destruction of many organic pollutants and is most commonly used with chlorinated hydrocarbons. It is engineered to provide an optimal source of micro-scale zero valent iron (ZVI) that is both easy to use and delivers enhanced reactivity with the target contaminants via multiple pathways. S-MicroZVI can destroy many chlorinated contaminants through a direct chemical reaction (**see Figure 1**). S-MicroZVI will also stimulate anaerobic biological degradation by rapidly creating a reducing environment that is favorable for reductive dechlorination.

Sulfidated ZVI

S-MicroZVI is composed of colloidal, sulfidated zero-valent iron particles suspended in glycerol using proprietary environmentally acceptable dispersants. The passivation technique of sulfidation, completed using proprietary processing methods, provides unparalleled reactivity with chlorinated hydrocarbons like PCE and TCE and increases its stability and longevity by minimizing undesirable side reactions.

S-MicroZVI is Best in Class For

- ☑ Longevity
- ☑ Reactivity
- ☑ Transport

In addition to superior reactivity, S-MicroZVI is designed for easy handling that is unmatched by any ZVI product on the market. Shipped as a liquid suspension, S-MicroZVI requires no powder feeders, no thickening with guar, and pneumatic or hydraulic fracturing is not mandatory. When diluted with water prior to application, the resulting suspension is easy to inject using either direct push or permanent injection wells.

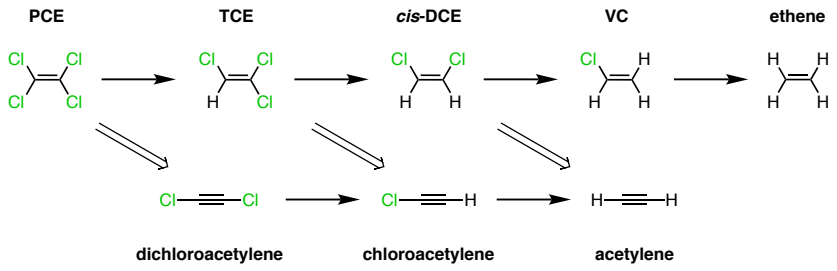

Figure 1: *Chlorinated ethene degradation pathways and products. The top pathway with single line arrows represent the reductive dechlorination (hydrogenolysis) pathway. The lower pathway with downward facing double line arrows represent the beta-elimination pathway.*

To see a list of treatable contaminants, view the S-MicroZVI treatable contaminants guide.

S-MicroZVI Specification Sheet

Chemical Composition

Iron, powders CAS 7439-89-6

Iron (II) sulfide CAS 1317-37-9

Glycerol CAS 56-81-8

Properties

Physical State: Liquid

Form: Viscous metallic suspension

Color: Dark gray

Odor: Slight

pH: Typically 7-9 as applied

Density: 15 lb/gal

Storage and Handling Guidelines

Storage:

- Use within four weeks of delivery
- Store in original containers
- Store at temperatures below 95F°
- Store away from incompatible materials

Handling:

- Never mix with oxidants or acids
- Wear appropriate personal protective equipment
- Do not taste or swallow
- Observe good industrial hygiene practices

Applications

S-MicroZVI is diluted with water on site and easily applied into the subsurface through low-pressure injections. S-MicroZVI can also be mixed with products like 3-D Microemulsion® or PlumeStop® prior to injection.

Health and Safety

The material is relatively safe to handle; however, avoid contact with eyes, skin and clothing. OSHA Level D personal protection equipment including: vinyl or rubber gloves and eye protection are recommended when handling this product. Please review the Safety Data Sheet for additional storage, and handling requirements here: S-MicroZVI SDS.

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CERTIFICATE OF ANALYSIS

Product Name: Cleanit ® SI.100S
Item Number: 132923
Lot Number: 2736633
Delivery:
Shipment:
Quantity: 33 MTs

Generated by:
HOGANAS ENVIRONMENT SOLUTIONS, LLC
3000 Weston Parkway
Cary, NC 27513
USA

Production Date: July 17, 2018
Reference:

CHEMICAL PROPERTIES				
Parameters	**Unit**	**Value**	**StDev**	**Method**
Iron (Fe)	%	97.75	0.94	Modified EPA 3050B (SW-846); ICP-MS
Aluminum (Al)	%	<0.0032	0.00	
Arsenic (As)	%	<0.0054	0.00	
Calcium (Ca)	%	<0.001	0.00	
Cadmium (Cd)	%	0.00001	0.00	
Colbalt (Co)	%	0.004	0.00	
Chromium (Cr)	%	0.036	0.001	
Copper (Cu)	%	0.062	0.001	
Magnesium (Mg)	%	0.001	0.00	
Manganese (Mn)	%	0.167	0.00	
Molybdenum (Mo)	%	0.006	0.00	
Nickel	%	0.022	0.40	
Lead	%	<0.001	<0.001	
A.D. (Carney)	g/cc	2.99		
PARTICLE SIZE DISTRIBUTION				
+ 212	Micron	0.00%	1.0% Max	ISO 22412:2017 Dynamic light scattering using Microtrac S3500 & ASTM C136
212 - 150	Micron	11.6%	12.0% Max	
149 - 44	Micron	58.1%		
- 44	Micron	30.3%	10.0 - 45%	

Höganäs manufacturing facilities across the globe are certified with ISO/TS 16949 standard.

Approved by:

Title: VP, Technology

Date of Release: August 13, 2018

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