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MEMORANDUM

23 March 2017
File No. 129375-002

TO: NYSDEC, Department of Environmental Remediation
Frank Sowers, P.E.

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Christopher H. Marraro, Esq.
CooperVision, Inc.
Myles Ott

FROM: Haley & Aldrich of New York
Denis Conley
Mark Ramsdell, P.E.

SUBJECT: Results of Biotrap® Sampling - MW-202

This memorandum presents the results from the Biotrap® sampling conducted at monitoring well, MW-202 as part of the groundwater monitoring program at the CooperVision Facility located in Scottsville, New York. The purpose of the testing was to evaluate the effectiveness of the bioamendment, emulsified vegetable oil (EVO) to stimulate the growth of the indigenous microbial population in the groundwater bearing sediments downgradient from the facility.

Background

Soil and groundwater investigations were conducted at the facility between 1998 and 2000 as part of application for and acceptance into a Voluntary Cleanup Agreement (VCA) with the New York State Department of Environmental Conservation (NYSDEC). Following the site investigation, a remedy was selected, which included the injection of hydrogen release compound (HRC) in the overburden soil and groundwater to stimulate enhanced bio-remediation of the volatile organic compounds (VOCs) detected in the soil and groundwater. Periodic groundwater monitoring conducted since the in-situ treatment has indicated that the HRC is continuing to enhance the biodegradation of the groundwater contaminants in that area of the facility but it had not affected the downgradient groundwater near MW-202 along the eastern property line.

At the request of the NYSDEC, CooperVision prepared an Evaluation of Remedial Alternatives, which included an update of the Conceptual Site Model (CSM) and the identification of applicable remedial technologies that may be used to address the downgradient groundwater conditions. The evaluation

concluded that an injection of a biological amendment (emulsified vegetable oil (EVO)) was the most appropriate remedy to address the VOCs detected in the downgradient area groundwater.

The injection of EVO was completed pursuant to the approved Remedial Action Work Plan (RAWP) (Haley & Aldrich, October 2013) and the subsequent post injection groundwater monitoring program prescribed by the RAWP. With the observed increase in total organic carbon (TOC) concentrations within MW-202 indicating the presence of the EVO amendment, a Biotrap[®] was deployed to evaluate the indigenous microbial population and determine if the addition of a bioaugmentation culture would be required to enhance the biodegradation of the VOCs present in the groundwater.

Implementation

Following the collection of the semi-annual groundwater samples in October 2016, an un-baited Biotrap[®] consisting of Biosep[®] beads was installed within the well screen of MW-202. The purpose of the Biotrap is to create a substrate that will enable the growth of the native microorganisms so that identification and quantification of the intrinsic microorganisms can be performed. The Biotrap was retrieved after 2 months of incubation within the well for analysis at Microbial Insights, a biological testing laboratory located in Knoxville, TN. The Biotrap was recovered on 23 December 2016 and shipped to MI for the quantification of dehalococcoides sp. (DHC) and dehalobacter sp.(DHBt); two microorganisms known to biodegrade chlorinated VOCs under anaerobic conditions and the associated enzymes known to facilitate those processes; tceA reductase, BAV1 reductase and vinyl chloride reductase.

Results

The laboratory results provided in the attached Microbial Insights report indicate that DHC and the associated reductase enzymes were not present above the laboratory reporting limits, but DHBt was present at a population density of 2750 cells/bead. DHBt sp. has been identified as a microbial species that can metabolize 1,1,1-trichloroethane under anaerobic conditions. The population density detected is considered a **moderate** level which suggest that intrinsic biodegradation is occurring within the groundwater as a result of the EVO injection program. However, the lack of detectable amounts of DHC or the associated enzymes suggests that the rate of biological activity is down and the complete mineralization of the detected contaminants; 1,1 DCA and 1,1 DCE is less likely without an increase in both the microbial population density and the enzyme activity.

Recommendations

Based on the results of the Biotrap[®] sampling conducted at MW-202 following the fall 2016 groundwater sampling event, we recommend the placement of a consortium of microorganisms demonstrated to metabolize chlorinated VOCs within the bioaugmentation points (BAP-1 and BAP-2) installed between the injection points and MW-202. This consortium should include both DHC sp. and DHBt sp. Attached to this memorandum are product specifications for several consortia that could be utilized.



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Phone:

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Identifier: 088NL

Date Rec: 12/22/2016

Report Date: 12/23/2016

Client Project #: 129375-002

Client Project Name: Cooper Vision

Purchase Order #: 129375-002-1.1

Analysis Requested: CENSUS, Standard Bio-Trap

Reviewed By:

NOTICE: This report is intended only for the addressee shown above and may contain confidential or privileged information. If the recipient of this material is not the intended recipient or if you have received this in error, please notify Microbial Insights, Inc. immediately. The data and other information in this report represent only the sample(s) analyzed and are rendered upon condition that it is not to be reproduced without approval from Microbial Insights, Inc. Thank you for your cooperation.

Client: Haley & Aldrich, Inc.
Project: Cooper Vision

MI Project Number: 088NL
Date Received: 12/22/2016

Sample Information

Client Sample ID: ET-MW202-1221
16
Sample Date: 12/21/2016
Units: cells/bead
Analyst: JS

Dechlorinating Bacteria

<i>Dehalococcoides</i>	<i>DHC</i>	<2.50E+01
tceA Reductase	TCE	<2.50E+01
BAV1 Vinyl Chloride Reductase	BVC	<2.50E+01
Vinyl Chloride Reductase	VCR	<2.50E+01
<i>Dehalobacter spp.</i>	<i>DHBt</i>	2.76E+03

Legend:

NA = Not Analyzed NS = Not Sampled J = Estimated gene copies below PQL but above LQL I = Inhibited
 < = Result not detected

Quality Assurance/Quality Control Data

Samples Received 12/22/2016

Component	Date Prepared	Date Analyzed	Arrival Temperature	Positive Control	Extraction Blank	Negative Control
DHC	12/22/2016	12/23/2016	1 °C	101%	non-detect	non-detect
DHBt	12/22/2016	12/23/2016	1 °C	107%	non-detect	non-detect
BVC	12/22/2016	12/23/2016	1 °C	119%	non-detect	non-detect
TCE	12/22/2016	12/23/2016	1 °C	104%	non-detect	non-detect
VCR	12/22/2016	12/23/2016	1 °C	100%	non-detect	non-detect



**TERRA SYSTEMS, INC. DEHALOCOCCOIDES
MCCARTYI/DEHALOBACTER BIOAUGMENTATION
CULTURES (TSI-DC AND TSI-TCA) SAFETY DATA SHEET**

>1 x 10¹¹ Dehalococcoides/Dehalobacter cells/L

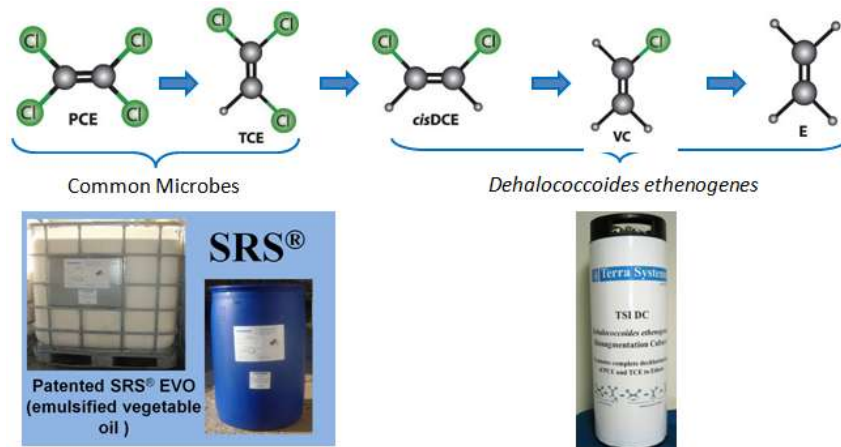
50/50 mix of TSI DC and TSI-TCA *Dehalococcoides mccartyi/Dehalobacter* Bioaugmentation Cultures[®] is an enriched natural bacteria culture that contains *Dehalococcoides* and *Dehalobacter* species for bioaugmentation. This culture dechlorinates tetrachloroethene (PCE) and trichloroethene (TCE) to the non-toxic product ethene. The culture also biodegrades 1,1,1-trichloroethane to 1,1-dichloroethene, 1,1-dichloroethane, and chloroethane. It also can biodegrade carbon tetrachloride and chloroform to methylene chloride and innocuous products. It can be used at sites where bacteria capable of complete reductive dechlorination are not present or there is a need to decrease the remediation time frame. It is estimated that *Dehalococcoides* and *Dehalobacter* are not present in 10 to 40 percent of chlorinated solvent contaminated sites.

Composition

Ingredient	Synonyms	CAS #	Percent	Hazardous
Non-hazardous ingredients	DHC	Not applicable	50%	No
Non-hazardous ingredients	DHB	Not applicable	50%	No

Key Benefits of the 50/50 mix of TSI DC and TSI-TCA *Dehalococcoides mccartyi/Dehalobacter* Bioaugmentation Cultures[®]

The 50/50 mix of TSI DC and TSI-TCA *Dehalococcoides mccartyi/Dehalobacter* Bioaugmentation Cultures[®] has been proven to be effective with a growing body of laboratory and field data demonstrating that the *Dehalococcoides* group of microorganisms is solely responsible for the complete dechlorination of PCE and TCE to ethene. At sites where *Dehalococcoides* microorganisms are not present or are found at low numbers, the process will often "stall" at cis-1,2-dichloroethene. The TSI-DC[®] Bioaugmentation Culture will promote the complete dechlorination of PCE or TCE. The TSI-DC[®] Bioaugmentation Culture contains greater than **1 x 10¹¹ *Dehalococcoides*/L**. The *Dehalobacter* culture biodegrades 1,1,1-trichloroethane to 1,1-dichloroethene, 1,1-dichloroethane, and chloroethane.



The TSI DC and TSI-TCA Bioaugmentation Culture is cost effective and is typically a minor component of the total remediation project cost. At sites where the *Dehalococcoides* and *Dehalobacter* are present, but at low numbers or poorly distributed, bioaugmentation can be used to reduce the treatment time. Bioaugmentation can also reduce the time required to grow the *Dehalococcoides* and *Dehalobacter* population to effective cell densities. Therefore, future costs can be reduced.

- The Bioaugmentation Culture is competitively priced at less than \$150 per liter of culture plus shipping depending on volume ordered.
- The Bioaugmentation Culture works with all commonly used electron donors.
- The Bioaugmentation Culture is not genetically modified or engineered.
- The Bioaugmentation Culture is certified to be free of known human pathogens.
- The Bioaugmentation Culture has rigorous quality control procedures in place to ensure that each shipment is of the highest quality, stable, safe, effective and free of chlorinated volatile organic compounds.
- The Bioaugmentation Culture is shipped overnight in specially designed stainless steel containers that prevent exposure to air and are safe & easy to handle.



Each purchase comes with free technical phone support from an experienced Terra Systems microbiologist. A senior level microbiologist is also available to be on-site to support the successful application at \$1,200 per day.

130 Hickman Road, Suite 1
Claymont, Delaware 19703
Phone: 302-798-9553 • Email: mfree@terrasystems.net
On the Web: www.terrasystems.net



**TERRA SYSTEMS, INC DECHLORINATING
BIOAUGMENTATION CULTURES (TSI-DC AND TSI-TCA)
SAFETY DATA SHEET**

1. Product Identification

Synonyms: *Dehalococcoides* or DHC Microbial Consortium (TSI-DC) and *Dehalobacter* (DHB)

Recommended Use: Bioremediation of groundwater contaminated with chlorinated solvents such as tetrachloroethene and trichloroethene and trichloroethene and their daughter products.

Supplier: Terra Systems, Inc.
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Claymont, Delaware 19703
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www.terrasystems.net

2. Hazards Identification

The available data indicates no known hazards associated with exposure to this product. Nevertheless, individuals who are allergic to enzymes or other related proteins should avoid exposure and handling. Health effects associated with exposure to similar organisms are listed below.

Emergency Overview

Caution: May cause eye irritation or discomfort if ingested or inhaled or allergic reaction to sensitive individuals.

Health Rating: 1 - Slight

Flammability Rating: 0 - None

Reactivity Rating: 0 - None

Contact Rating: 1 - Slight

Protective Equipment: Goggles; Proper Gloves

Storage Color Code: Green (General Storage)

Potential Health Effects

Inhalation: Not expected to be a health hazard. Hypersensitive individuals may experience breathing difficulties after inhalation of aerosols.

Ingestion: Not expected to be a health hazard via ingestion. Ingestion of large quantities may result in abdominal discomfort including nausea, vomiting, cramps, diarrhea, and fever.

Skin Contact: No adverse effects expected. May cause irritation or sensitization in sensitive individuals upon prolonged contact.



Eye Contact: May cause mild irritation, possible reddening unless immediately rinsed.

Chronic Exposure: No information found.

Aggravation of Pre-existing Conditions: No information found.

3. Composition/Information on Ingredients

Ingredient	Synonyms	CAS #	Percent	Hazardous
Non-hazardous ingredients	DHC	Not applicable	50%	No
Non-hazardous ingredients	DHB	Not applicable	50%	No

4. First Aid Measures

Inhalation: Not expected to require first aid measures. Remove to fresh air. Get medical attention for any breathing difficulty or if allergic symptoms develop.

Ingestion: Thoroughly rinse mouth with water. Do not induce vomiting unless directed to do so by medical personnel. Get immediate medical attention. Never give anything by mouth to an unconscious or convulsing person.

Skin Contact: Not expected to require first aid measures. Wash exposed area with soap and water. Get medical advice if irritation develops.

Eye Contact: Immediately flush eyes with plenty of water for at least 15 minutes, lifting upper and lower eyelids occasionally. Get medical attention if irritation persists.

Note to Physicians: All treatments should be based on observed signs and symptoms of distress in the patient. Consideration should be given to the possibility that overexposure to materials other than this material may have occurred.

5. Fire Fighting Measures

Fire: Non-flammable. Flash point and flammable limits are not available.

Explosion: Not considered to be an explosion hazard.

Fire Extinguishing Media: Dry chemical, foam, carbon dioxide, or water.

Special Information: In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full face piece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Clean-up personnel may require protective clothing and avoid skin contact. Absorb in sand, paper towels, or other inert material. Scoop up and containerize for disposal. Flush trace residues to sewer with soap and water. Containerized waste may be sent to an approved waste disposal facility. After clean-up, disinfect all cleaning materials and storage containers that come in contact with the spilled liquid.

7. Handling and Storage

Avoid breathing breathe aerosol. Avoid contact with skin. Use personal protective equipment recommended in Section 8. Keep containers tightly closed in a cool, well-ventilated area. The DHC/DHB microbial consortium (TSI-DC and TSI-TCA) can be supplied in stainless steel kegs designed for maximum working pressure of 130 psi and equipped with pressure relief valves. The kegs are pressurized with nitrogen gas up to the pressure of 15 psi. Do not exceed pressure of 15 psi during transfer of DHC/DHB microbial consortium (TSI-DC and TSI-TCA) from kegs. Don't open keg if content of the keg is under pressure. DHC/DHB microbial consortium (TSI-DC and TSI-TCA) may be stored for up to 3 weeks at temperature 2-4°C without aeration. Avoid freezing.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:	None established.
Ventilation System:	Not expected to require any special ventilation. Provide adequate ventilation to remove odors.
Personal Respirators (NIOSH Approved):	Not expected to require personal respirator usage. If aerosols might be generated, use N95 respirator.
Skin Protection:	Wear protective rubber, nitrile, or vinyl gloves and clean body-covering clothing.
Eye Protection:	Use chemical safety goggles and/or a full face shield where splashing is possible. Provide readily accessible eye wash stations and safety showers.

9. Physical and Chemical Properties

Appearance:	Light greenish, murky liquid.
Odor:	Musty.
Solubility:	Soluble in water.
Specific Gravity (water=1):	1.0. 8.34 pounds per gallon.
pH:	6-8
% Volatiles by volume @ 21C (70F):	Negligible.
Boiling Point:	100C (212F)
Melting Point:	0C (32F)
Flash Point (F):	No information found.

Autoignition Temperature:	No information found.
Decomposition Temperature:	No information found.
Vapor Density (Air=1):	No information found.
Vapor Pressure (mm Hg):	24 mm @ 25C (77F).
Evaporation Rate (BuAc=1):	No information found.
Viscosity @23 C (73 F):	1 centipoises
Partition Coefficient (octanol/water):	No information found.

10. Stability and Reactivity

Stability:	Stable under ordinary conditions of use and storage.
Reactivity:	Not reactive under ordinary conditions.
Hazardous Decomposition Products:	None.
Hazardous Polymerization:	Will not occur.
Incompatibilities:	Strong oxidizers, acids, water reactive materials.
Conditions to Avoid:	Incompatibles. Isolate from heat and open flame.

11. Toxicological Information

TSI-DC and TSI-TCA	No information found on toxicology. It is not a carcinogen listed by IARC, NTP, NIOSH, OSHA, or ACGIH. It has tested negative for pathogenic microorganisms such as <i>Bacillus cereus</i> , <i>Listeria monocytogens</i> , <i>Salmonella</i> sp., <i>Pseudomonas</i> sp., fecal coliform, total coliform, yeast, and mold.
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12. Ecological Information

Environmental Fate:	No information found.
Environmental Toxicity:	No information found.
Degradability:	This product is completely biodegradable under both aerobic and anaerobic conditions.
Soil Mobility:	This compound will move with groundwater until it attaches onto the soil.
Bioaccumulation Potential:	No information found.

13. Disposal Considerations

Waste Disposal Method: No special disposal methods are required. The material is compatible with all known biological treatment methods. To reduce odors and permanently inactivate microorganisms, mix 100 parts (by volume) of TSI-DC/TSI-TCA consortium with 1 part (by volume) of bleach. Dispose of in accordance with local, state and federal regulations.

14. Transport Information

DOT Classification:	N/A
Labeling:	NA



Shipping Name: Not regulated

15. Regulatory Information

OSHA STATUS: This product is not hazardous under the criteria of the Federal OSHA hazard Communication Standard 29 CFR 1910.1200.

TSCA STATUS: No component of this product is listed on the TSCA inventory.

CERCLA (Comprehensive Response Compensation, and Liability Act): Not reportable.

SARA TITLE III (Superfund Amendments and Reauthorization Act)

Section 312 Extremely Hazardous Substances: None

Section 311/312 Hazard Categories: Non-hazardous Under Section 311/312

Section 313 Toxic Chemicals: None

RCRA STATUS: If discarded in its purchased form, this product would not be a hazardous waste either by listing or by characteristic. However, under RCRA, it is the responsibility of the product user to determine at the time of disposal, whether a material containing the product or derived from the product should be classified as a hazardous waste. (40 CFR 261.20-24)

CALIFORNIA PROPOSITION 65: The following statement is made in order to comply with the California safe Drinking Water and Toxic Enforcement Act of 1986. The product contains no chemicals known to the State of California to cause cancer.

16. Other Information

NFPA Ratings: Health: 1 Flammability: 0 Reactivity: 0

Date Prepared: February 10, 2016

Revision Information: SDS Section(s) changed since last revision of document include: None.

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