VARIANCE REQUEST APPLICATION

MINNESOTA DEPARTMENT OF HEALTH
Well Management Section, 625 North Robert Street
P.O. Box 64502, St. Paul, Minnesota 55164-0502
651-201-4600 or 800-383-9808
Fax 651-201-4599

MDH USE ONLY
Date Received _____
Amount Received _____
TN Number _____
Deposit No. _____
Receipt Codes: General Program - 4921
Disclosure Program - 4932

The party requesting the variance must complete this Variance Request Application and submit to the above-listed address, along with the nonrefundable $235 application fee.

ID No. of Water Well Status Report (if applicable) _____

In counties or governmental units which currently have a well program delegation agreement, the variance request must be submitted to both the Minnesota Department of Health and to the delegated program for review.

The variance request must contain the following information. (Please print or type.)

A. Name of Applicant (i.e. well/boring/sewer/other owner)		Company Name (if applicable)	
Jason Skramstad		Landmark Environmental, LLC	
Street Address: 2042 West 98th Street			
City: Bloomington	State: MN	ZIP: 55431	Telephone No. (including area code):
B. Name of Property Owner (if different from above)		Company Name (if applicable)	
Terry Spaeth		City of Rochester	
Street Address: 201 4th Street SE, Room #108			
City: Rochester	State: MN	ZIP: 55904	Telephone No. (including area code): (507) 328-2000
C. Name of Contractor (if applicable)	Company Name (if applicable)	Company License No.	
Keith Becker	ORIN Technologies, LLC		
Street Address: 405 Investment Court			
City: Verona	State: WI	ZIP: 53593	Telephone No. (including area code): (608) 838-6699 x3

D. Well or Boring Location	Fraction	Section No.	Range No.	Township No.	Township Name	County
	NE ¼ ¼ ¼	2	14 W	106 N		Olmsted

Street Address of Well or Boring				
221 First Avenue S.W.				
City: Rochester	State: MN	ZIP: 55902	Fire No.	MN Unique Well No. (if known)

E. Rule(s) from which variance is requested (cite specific rule[s]).

4725.2050 USE OF WELLS OR BORINGS FOR DISPOSAL OR INJECTION PROHIBITED

F. Reason(s) rule cannot be met (include supporting evidence).

Residual perchloroethene contamination exists in the groundwater on the MN Bio Business Center Property that can no longer be remediated by operating the existing dual phase extraction system. The Minnesota Pollution Control Agency has requested a feasibility study to evaluate other groundwater remediation technologies that are effective at remediating residual PCE contamination. The recommended approach is in-situ chemical oxidation with sodium permanganate. The attached Groundwater Remediation Feasibility Study and Work Plan dated April 8, 2016, provides details associated with injecting the sodium permanganate solution into 8 dual-phase extraction wells located on the Property.

G. Alternative or additional protective measures to be taken to assure a comparable degree of protection to health or the environment.

See the attached sodium permanganate data sheets, the Activity Hazard Analysis and Health and Safety Plan from Orin Technologies, the remediation contractor that will complete the work.

H. Well Information	Estimated Depth	Casing Depth	Casing Diameter	Casing Type	Method of Drilling
	32 ft bgs	20 ft	2 in	Steel	Vibracor/rotasonic
	Depth to Water	Grout Materials			
	24 ft bgs	Neat Cement and Other			

Description of Construction Methods and Anticipated Geologic Conditions.

DPE-1 through DPE-8 are the proposed injection well locations. These wells were installed in fractured bedrock. See attached Feasibility Study/Work Plan.

I. A scaled map showing the location of the well or boring in relation to property lines, structures, utilities, and contamination sources (use additional sheets as necessary and note distances from contamination sources and wells on adjacent properties).

See attached Figures 1 and 2 of the attached Feasibility Study/Work Plan. DPE-1, as shown in Figure 2, is the location of a former basement sump that was the source area where drycleaner sludge was disposed of during past dry cleaning operations at the Property. See attached Feasibility Study/Work Plan for additional information.

Please include the following information for a variance request from isolation distances.

J. Description of the age, design, size, and type of construction of any existing or potential contaminant sources (such as septic system; petroleum storage; unused, unsealed wells; etc.). Include contamination sources on adjacent properties.

See attached Feasibility Study/Work Plan

K. Other relevant information, such as any testing, inspection, or certification data (please attach reports or data).

See attached Feasibility Study/Work Plan

Incomplete applications cannot be processed and will be returned to the applicant. Please submit a complete application including application fees, scaled map, and signatures of well owner and contractor (if applicable). Please include with this request any relevant information necessary to properly evaluate the request and a copy of any review of any contamination sources by a local or state unit of government under other applicable regulations.

The nonrefundable variance fee of $235 along with the variance application, signed by the applicant and the contractor, with supportive information, must be returned to the Well Management Section, Minnesota Department of Health, P.O. Box 64502, St. Paul, Minnesota 55164-0502

This variance is conditioned upon the applicant's acceptance of, and compliance with the conditions of this variance. Failure by the applicant to comply with the conditions prescribed in this variance will result in the immediate expiration of this variance.

If the variance is granted, I agree to comply with any conditions required by the Minnesota Department of Health.

Date	Applicant Name (print)	Applicant Signature
4/14/16	Jason Skramstad	
Date	Property Owner Name (print)	Property Owner Signature
4/14/16	Terry Spaeth	Terry Spaeth on behalf of City of Rochester
Date	Contractor Name (print)	Contractor Representative Signature
4/14/16	Keith Becker	Keith Becker

Attachment 1

Sodium Permanganate Technical and Safety Data Sheets

SAFETY DATA SHEET

1. Identification of the Substance and of the Company **Revised: August 14, 2015**

Product Name: Sodium Permanganate 40% Solution

WC Code: 19-041

Product Use:
Printed Circuit Board Desmearing; Pharmaceutical Synthesis Reactions;
Soil and groundwater remediation by in-situ or ex-situ chemical oxidation;
Active agent in subsurface reactive barriers for treatment of Chlorinated Ethenes-PCE, TCE, Vinyl Chloride, etc

Company
WINTERSUN CHEMICAL
1250 E. Belmont St.
Ontario, CA 91761
Call: 909-930-1688

Information / Emergency Telephone
PERS (Professional Emergency Resource Services)
Domestic Shipments and to Canada: 1-800-633-8253
International Shipments: 1-801-629-0667

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2. Hazard Identification

GHS-US Classification
Oxidizing liquids (Category 2), H272
Acute toxicity, Oral (Category 4), H302
Skin corrosion (Category 1B), H314
Serious eye damage (Category 1), H318
Target Organ Toxicity, **(**Category 3), H335
Chronic aquatic toxicity (Category 1), H410

GHS-US Label elements
Pictogram

Signal word: DANGER

Hazard statement(s)
H272 May intensify fire; oxidizer
H302 Harmful if swallowed
H314 Causes severe skin burns and eye damage
H318 Causes serious eye damage
H335 May cause respiratory irritation
H410 Very toxic to aquatic life with long lasting effects

Precautionary statement(s)
P202: Do not handle until all safety precautions have been read and understood.
P261: Avoid breathing dust/fume/ gas/mist/vapours/spray.
P262: Do not get in eyes, on skin, or on clothing.
P264: Wash hands and other exposed area thoroughly after handling.
P301 + P330 + P331+ P312: IF SWALLOWED: Rinse mouth. Do NOT induce vomiting. Call a POISON CENTER/ doctor/ medical personnel if you feel unwell.
P303 + P361 + P351 + P333 + P313 IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse cautiously with water for several minutes. If skin irritation or rash occurs: Get medical advice/attention.
P304 + P340 + P342 + P311 IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. If experiencing respiratory symptoms: Call a POISON CENTER or doctor/physician.
P305 + P351 + P338 + P337 + P313 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical advice/attention.
P501 Dispose of contents/ container to an approved waste disposal plant.

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3. Composition/ Information on Ingredients

Synonyms: Permanganic acid(HMnO4), sodium salt
CAS No: 10101-50-5
Molecular Formula: $NaMnO_4$
Molecular Weight: 141.93 g/ mol
Appearance: Purple Red Liquid

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4. First-Aid Measures

Eye Contact
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids. Get medical attention if irritation occurs.

Skin Contact
Remove any contaminated clothing. Wipe off excess from skin. Wash skin with soap and flush with plenty of water for at least 15 minutes. Get medical attention if irritation develops or persists.

Inhalation
If inhaled, remove to fresh air immediately and keep at rest in a position comfortable for breathing. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention for any breathing difficulty.

Ingestion
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

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5. Fire Fighting Measures

Special Hazards Arising from the Substance or Mixture

Fire-Fighting Equipment/ Instructions
As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH

(approved or equivalent), and full protective gear. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion.

Extinguishing Media: Suitable extinguishing media such as water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Auto-ignition Temperature: Not data available
Flash Point: Not data available
Explosion Limits, Lower: Not data available
Explosion Limits, Upper: Not data available
Reactivity: Not data available
Flammability of the Product: Not data available
Flammable Limits: Not data available

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6. Accidental Release Measures

Personal precautions, protective equipment and emergency procedures
Use proper personal protective equipment as indicated in Section 8. Keep unnecessary personnel away to safe areas. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Avoid breathing vapors, mist, or gas. Ensure adequate ventilation.

Methods and materials for containment and cleaning up
Handle in accordance with industrial hygiene and safety practices. Contain spills with sand, clay or other inert absorbent material and then place in suitable container. Keep in suitable, closed containers for disposal according to local and regional authority requirements.

Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

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7. Handling and Storage

Personal Precautions
Avoid breathing dust, vapor, mist, or gas. Avoid contact with eyes, skin, and clothing. Do not swallow. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Wash hands and other exposed areas with mild soap and water after handling. Handle in accordance with good industrial hygiene and safety procedures.

Storage
Keep container tightly closed. Keep container in a cool, well-ventilated area. Keep container dry. Keep away from heat. Keep away from sources of ignition. Keep away from combustible material.

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8. Exposure Controls / Personal Protection

Engineering Controls
Use adequate ventilation or other engineering controls to keep airborne concentrations below recommended exposure limits. See **OSHA Regulations state in 29 CFR 1910.151 (c**) for an eyewash facility and safety shower requirement.

Personal Protective Equipment
Eyes: Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin: Wear appropriate protective gloves to prevent skin exposure. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.
Clothing: Wear appropriate protective clothing to prevent skin exposure.
Respirators: Follow the OSHA respirator regulations found in 29 CFR 1910.134. Use a NIOSH/MSHA approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Exposure Limits
ACGIH: TWA 0.2 Mg/m3
US-OSHA: Ceiling 5 Mg/m3

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9. Physical and Chemical Properties

Appearance: Purple Red Liquid
Insoluble Matter in Water (%): 0.01 Max.
Potassium Content (%): 0.22 Max.
Chloride Content (%): 0.02 Max.
Density (g/cm3): 1.36 -1.39
Sodium Permanganate Content (%): 40.0 Min.
PH Value: 6.0 – 8.0
Odour: No data available
Odour Threshold: No data available
pH: No data available
Melting point/freezing point: No data available
Initial boiling point:100 °C (212 °F)
Evaporation rate: No data available
Vapour pressure: No data available
Vapour density: No data available
Relative density: No data available
Water solubility: No data available
Viscosity: No data available
Oxidizing properties: No data available

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10. Stability and Reactivity

Stability: Stable under ordinary conditions
Reactivity: No data available
Conditions to avoid: No data available
Incompatibilities with other materials: Strong oxidizing agents, Strong acids, Organic materials, Strong reducing agents, Powdered metals
Hazardous decomposition products: No data available
Hazardous polymerization: Will Not Occur

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11. Toxicological Information

Acute toxicity
no data available

Skin corrosion/ irritation
No data available

Serious eye damage/ eye irritation
No data available

Respiratory or skin sensitization
No data available

Carcinogenicity
The components of this product are not listed as carcinogen by ACGIH, IARC, NIOSH, NTP, or OSHA

Special Remarks on Toxicity to Animals: No data available
Special Remarks on Chronic Effects on Humans: No data available
Special Remarks on other Toxic Effects on Humans: No data available

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12. Ecological Information

This product has no known eco-toxicological effects

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13. Disposal Information

Waste Code: D001: Waste material with a flash point < 140 F

APPROPRIATE METHOD OF DISPOSAL OF SUBSTANCE OR PREPARATION
Contact a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. Observe all federal, state, and local environmental regulations.

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14. Transport Information

US DOT
UN/NA: 3214
Proper Shipping Name: Permanganates, inorganic, aqueous solution, n.o.s. (Sodium permanganate)
Hazard Class: 5.1
Packing Group: II

Canada TDG
UN/NA: 3214
Proper Shipping Name: Permanganates, inorganic, aqueous solution, n.o.s. (Sodium permanganate)
Hazard Class: 5.1
Packing Group: II

IMDG/ IATA
UN/NA: 3214
Proper Shipping Name: Permanganates, inorganic, aqueous solution, n.o.s. (Sodium permanganate)
Hazard Class: 5.1
Packing Group: II

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15. Regulatory Information

EU ADDITIONAL CLASSIFICATION
Symbol of Danger: O-C
Indication of Danger: Oxidizing. Corrosive.
R: 8-34
Risk Statements: Contact with combustible material may cause fire.Causes burns.
S: 17-26-36/37/39-45

Safety Statements: Keep away from combustible material. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. Wear suitable protective clothing, gloves, and eye/face protection. In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

US CLASSIFICATION AND LABEL TEXT
Indication of Danger: Oxidizing. Corrosive.
Risk Statements: Contact with combustible material may cause fire. Causes burns.
Safety Statements: Keep away from combustible material. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. Wear suitable protective clothing, gloves, and eye/face protection. In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
US Statements: Target organ(s): Nerves. Blood.

UNITED STATES REGULATORY INFORMATION
SARA LISTED: Yes
DEMINIMIS: 1 %
NOTES: This product is subject to SARA section 313 reporting requirements. This product is subject to SARA section 313 reporting requirements.
TSCA INVENTORY ITEM: Yes

CANADA REGULATORY INFORMATION
WHMIS Classification: This product has been classified in accordance with the hazard criteria of the CPR, and the MSDS contains all the information required by the CPR.
DSL: No
NDSL: Yes

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16. Other Information

NFPA RATING
HEALTH: 3
FLAMMABILITY: 1
REACTIVITY: 2

Revision Date: August 14, 2015

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WINTERSUN CHEMICAL

3100 E Cedar Street, #15, Ontario, CA 91761. USA
TEL: 909-93016888 FAX: 909-9471788 Email: sales@wintersunchem.com

Product Name:	**Sodium Permanganate**
WCode:	19-041
CAS No.	10101-50-5
Molecular Formula:	$NaMnO_4$

Sales Specification

Appearance:	Dark, purple solution
Assay:	40% Min as NaMnO4
Ph:	6.0 – 7. 0
Insoluble:	100 ppm Max
Potassium:	1,000 – 2,200 ppm
Chloride Content:	0.04% Max
Specific Gravity:	1.36 - 1.39

Packing

In DOT approved 260KG metal drum with internal HDPE coat.

Drum size:
Weight of drum: 12 KG
Height of drum: 890 cm
Outside diameter of drum: 58 cm

or **In DOT approved 1300kg plastic tote.**

Tote Size :
1200mm (length) x 1000mm (width) x 1150mm (height)

Transportation

Hazard Class	5.1
UN No.:	UN 3214
Packing Group:	II
Label Requirement:	Oxidizer, 5.1

Standard of Metal Residues on Sodium Permanganate

Ag -	0.15 Max mg/kg
Al -	2.0 Max mg/kg
As -	4.0 Max mg/kg
Ba -	5.00 Max mg/kg
Be -	0.5 Max mg/kg
Cd -	0.1 Max mg/kg
Cr -	5.0 Max mg/kg
Cu -	0.1 Max mg/kg
Fe -	2.000 Max mg/kg
Hg -	0.03 Max mg/kg
Ni -	0.100 Max mg/kg
Pb -	0.70 Max mg/kg
Sb -	0.70 Max mg/kg
Se -	0.500 Max mg/kg
Tl -	3.5 Max mg/kg
Zn -	0.400 Max mg/kg

Attachment 2

Orin Technologies Activity Hazard Analysis

Training Requirements:	PPE Requirements
• Site Orientation • Elements of the HASP • Hazard Communication • Emergency Actions and Fire Prevention • Working around forklift • First Aid / CPR (at least 2) • Hazwoper 40 hr. • Hazwoper 8 hr refresher.	• Protective helmets • Eye protection • Safety toed boots • Protective coveralls (where required) • Hand protection (i.e. leather gloves as appropriate) • High visibility vest • Knee pads as appropriate. • Hearing protection

Job Tasks, Hazards, Hazard Control

Job Tasks	Probable Hazards	Prevention / Control
• General initial Mobilization / Demobilization	• Vehicle accident- on / off site	• Journey Management Planning (JMP) must take place prior to beginning operations. PTSP meets requirement • A Pre Task Safety Plan (PTSP) review must be conducted prior to operations. • Stop Work Authority (SWA) shall be reviewed prior to operations. • Coordinate access routes with company personnel, subcontractors as needed. • Review maps, diagrams and photographs with vendors, couriers or company personnel. • Clearly demarcate all travel routes. • Inspect the roadway for hazards. • Check driver identity and certifications prior to entering the interior of the site. • Inspect the load for travel up steep grades, sharp corners and low overhead utility lines.
	• Equipment accidents	• Perform a vehicle inspection before operations. • Wear seat belt. • Obey traffic rules- Maintain safe speed at all times. • Drive defensively. • Use headlights in foggy and or wet conditions. • Use spotters. • Know your JMP. • Watch for low over-heads. • Always leave an exit route. • Keep 4 seconds behind all vehicles. • Avoid having to back out of parking areas. • Focus eyes at 1000 feet ahead of you while driving. • Check mirrors every 3-5 seconds. • Never talk on the phone while driving. • Never eat while driving. • Inspect all loads. • Communicate any changes in route or road conditions to the SSO. • Never drive tired.

		• Turn vehicle radio off when backing or high risk maneuvers. • Get out and look. 360 degree walks around vehicle. • Note: Supervisors and operators will ensure that the equipment manufacturers' instructions and recommendations are followed consistently. • All equipment will be initially inspected to certify safe and undamaged to use onsite and before use. Unsafe equipment will be taken out of service, tagged and not be used until repaired. • Only operators trained, experienced and certified (when feasible) with the specific equipment will operate that equipment. Inspection Forms that may be used are provided in the Field Forms. • Do not operate equipment on grades, which exceed manufacturer's recommendations. • Equipment is to have and maintain manufacturer's guards. • Plan travel route when moving equipment from one site to the next to avoid low over-hangs and power lines. • Ensure work area is assessed for overhead and underground utilities and obstacles prior to the start of operations. • Equipment will not be approached on blind sides and eye contact with operators will be made before approaching equipment. . • Define equipment swing areas with high visibility markings or barriers. • Establish and know hand signals between ground spotters and operators. • All equipment will be equipped with backup alarms. • The use of headphones, cell phones and texting devices for entertainment purposes is prohibited when any exposure to or operation of heavy equipment. • Cell phones may only be used when in a safe zone, clear of points of operation and hazards. • Equipment parked on an incline shall have the wheels chocked or track mechanisms blocked and the parking brake set. Equipment will be shut down before and during fueling operations. • A spotter will be used for backing up equipment in congested areas.
• Working Near Moving Heavy Equipment	• Operator not seeing you-Struck by equipment.	• Proper spotting procedures must be employed. . • High visibility clothing must be worn. • Employ effective communication. • Never turn your back on the equipment. • Use appropriate hand signals. • Watch for low over-heads.
• Vehicle Operations	• Accidents from driving, tailgating, backing, changing lanes.	• Note: Supervisors and operators will ensure that the equipment manufacturers' instructions and recommendations are followed consistently. • All equipment will be initially inspected to certify safe and undamaged to use onsite and before use. Unsafe

		equipment will be taken out of service, tagged and not be used until repaired. • Only operators trained, experienced and certified (when feasible) with the specific equipment will operate that equipment. Inspection Forms that may be used are provided in the Field Forms. • Do not operate equipment on grades, which exceed manufacturer's recommendations. • Equipment is to have and maintain manufacturer's guards. • Plan travel route when moving equipment from one site to the next to avoid low over-hangs and power lines. • Ensure work area is assessed for overhead and underground utilities and obstacles prior to the start of operations. • Equipment will not be approached on blind sides and eye contact with operators will be made before approaching equipment. . • Define equipment swing areas with high visibility markings or barriers. • Establish and know hand signals between ground spotters and operators. • All equipment will be equipped with backup alarms. • The use of headphones, cell phones and texting devices for entertainment purposes is prohibited when any exposure to or operation of heavy equipment. • Cell phones may only be used when in a safe zone, clear of points of operation and hazards. • Equipment parked on an incline shall have the wheels chocked or track mechanisms blocked and the parking brake set. Equipment will be shut down before and during fueling operations. • A spotter will be used for backing up equipment in congested areas.
• Set chemical injection trailer and unload trailer	• Pinch points and hand injuries from lowering trailer jacks	• Identify all pinch points. • Wear appropriate gloves for the task. • Always leave your hands a way out of pinch points. • Use brightly colored gloves where possible. • Identify sharp edges, points and burs. • Never place hands between equipment apparatus. • Keep hands free of gears. • Keep feet away from jacks. • No loose fitting clothing around gears. • Keep hands on outside of wheel chucks.
• Receive and unload chemicals	• Puncture chemical drums with forks	• Check forklift drivers certificates. • Have a spotter present to guide forks. • Check clearance for off loading the skid.
	• Drums falling off pallet during transport	• Verify drums are fully secure on pallet, use safety strap if not. • Have a spotter guide operator into position to avoid road hazards, slick conditions, and sliding. • Avoid hard stops.

		• Keep people clear of drums fall radius.
	• Spills during transport	• Visually check drum conditions and check bung tightness • Have spill kit near work zone
	• Accidents from driving fork lift	• Note: Supervisors and operators will ensure that the equipment manufacturers' instructions and recommendations are followed consistently. • All equipment will be initially inspected to certify safe and undamaged to use onsite and before use. Unsafe equipment will be taken out of service, tagged and not be used until repaired. • Only operators trained, experienced and certified (when feasible) with the specific equipment will operate that equipment. Inspection Forms that may be used are provided in the Field Forms. • Do not operate equipment on grades, which exceed manufacturer's recommendations. • Equipment is to have and maintain manufacturer's guards. • Plan travel route when moving equipment from one site to the next to avoid low over-hangs and power lines. • Ensure work area is assessed for overhead and underground utilities and obstacles prior to the start of operations. • Equipment will not be approached on blind sides and eye contact with operators will be made before approaching equipment. . • Define equipment swing areas with high visibility markings or barriers. • Establish and know hand signals between ground spotters and operators. • All equipment will be equipped with backup alarms. • The use of headphones, cell phones and texting devices for entertainment purposes is prohibited when any exposure to or operation of heavy equipment. • Cell phones may only be used when in a safe zone, clear of points of operation and hazards. • Equipment parked on an incline shall have the wheels chocked or track mechanisms blocked and the parking brake set. Equipment will be shut down before and during fueling operations. • A spotter will be used for backing up equipment in congested areas.
	• Operator not seeing you-Struck by equipment.	• Proper spotting procedures must be employed. • High visibility clothing must be worn. • Employ effective communication. • Never turn your back on the equipment. • Use appropriate hand signals. • Watch for low over-heads.
• Connect injection conveyance system	• Inhalation hazard • Cuts and abrasion	• Work up wind. • Maintain good ventilation. • Inspect and smooth out rough or sharp edges.

	• Exposure to VOC vapors from chemicals of concern • Eye damage	• Wear appropriate gloves. • Work up wind of well. • Perform PID monitoring within the work area. • Refer to Landmark Health and Safety plan for air monitoring. • Wear safety glasses to prevent splashing from chemicals and contaminated well water.
• Connect injection hose via cam lock connection	• Slips, trips, and falls from unwinding injection hose off the reel • Pinch points, cuts and abrasions from cam lock connections • Spills or releases from cam lock or damaged hose	• Keep work area clean and clear. • Wear footwear that is in good condition. • Watch for ice accumulation. Deice where necessary. • No running in work area. • Identify process pipes in the work zone and mark to make visible. • Identify all pinch points. • Wear appropriate gloves for the task. • Always leave your hands a way out of pinch points. • Use brightly colored gloves where possible. • Identify sharp edges, points and burs. • Inspect cam locks to ensure locking mechanisms are properly secured and document in field log. • Inspect all hoses for damage including bulging, cuts, or damaged threading. • Replace any questionable or damaged hose/fittings. • Ensure pressure ratings on hoses/fittings. • Verify 300psi for hosing.
• Pressure check the injection system with water	• Bodily damage from hose failure and whipping	• Tether lines with whip restraints. • Wear required PPE: safety glasses, hard hats, and steel toe boots. • Remove unneeded personnel from area of testing. • Know location of emergency shut off switch in case of failure
	• Noise from running system equipment	• Wear hearing protection around equipment that generates above 85dba of noise. • Minimize exposure whenever possible
• Material Handling – includes movement or transport of materials, supplies and equipment to the work site by manual and/or mechanical means, material receiving, and handling and storage	• Injuries due to storage/handling of $NaMnO_4$	• Pallets/totes of $NaMnO_4$ shall be placed in a cool dry storage area using proper pallet/tote equipment and moving practices. – Train workers on the hazards associated with site chemicals. All employees working with chemicals will review the SDS sheets prior to beginning work. Establish site controls and perform chemical specific training with Landmark Safety coordinator – Review emergency response procedures from the Health and Safety Plan and stage supplies. Verify eyewash stations and safety shower are functional. – Ensure containers are labeled to identify the chemical contents, and the associated hazards.

	• Injuries resulting from manually lifting materials • Injury to head, feet, hands due to crushing, pinching, being caught between, striking against and being struck by objects • Injury to eyes from airborne particulates, flying debris and chemical exposure • Slips, trips, and falls • Traffic	– Ensure that other chemicals and incompatible substances such as wood or debris are removed from the working area. • Required PPE that shall be worn: safety glasses, hard hats, steel toe boots, proper gloves, splash shield, rubber boots, and Tyvek. • Spill containment materials shall be readily available to contain a spill and prevent chemical mixing and/or migration off-site. • Employees should be instructed in safe lifting techniques. Back straight, bend at knees, load close to body, lift smoothly, and do not twist. • Utilize material handling devices such as pallet jack and forklifts only. • Manual lifts of over 55 pounds require two people. Employees are encouraged to get help for any lift that appears excessive. • Remove unnecessary personnel from the location • Wear at all times: steel-toed leather work boots. Leather gloves shall be worn when handling materials with rough, sharp, or slippery surfaces. • Stay out of any sway or tip radius' • Protective eyewear with side shields that meet the ANSI Z-87.1 standard shall be worn at all times. If work conditions warrant during mixing of chemicals or release of chemicals and day lighting, full face shields, goggles, or chemical goggles must be worn. • To the greatest extent possible, keep walking/working surfaces free of clutter, debris, and congestion. Brief personnel on hazards of wet, muddy soil hazards and traversing uneven grades. • Keep work area clean and clear. • Wear footwear that is in good condition. • Watch for ice accumulation. Deice where necessary. • No running in work area. • Exercise caution and obey traffic regulations while transporting materials over facility roadways. • Make sure high visibility tape and cones are present
• Injection of chemicals	• Injury resulting in the use of power tools	• Tools shall be inspected prior to use. • All power tools originally equipped with a safety guard of any type shall be used only with the guard in place and functioning properly. • Defective tools shall be tagged and removed from service. • Tools shall be used only for their intended purpose. • Electric tools shall be unplugged when changing attachments or performing maintenance. • Pneumatic tools and air compressors shall be disconnected and air pressures released before repair of adjustments are made.

		• Sections of air hoses that are not equipped with quick-release fittings shall be secured together with a safety pin and whip checks. • Electric tools with missing ground prongs or cut or frayed cords shall be removed from service. • Electric tools used in highly conductive locations, such as where the employee may contact water, shall be approved for use in those locations. • Power for portable electric tools shall be supplied from a GFCI receptacle. • Electrical tools must be grounded, except tools that are equipped with double insulation. • Electric tools shall not be used in hazardous locations such as flammable or explosive atmospheres unless they are approved for such locations. • Fuel Powered tools (generators, pumps, etc.) shall be turned off during refueling. • Hydraulic powered tools shall use approved fire resistant fluids. • Power operated tools and equipment designed to accommodate guards shall not be used without the guards in place and functioning properly. • All tools and equipment shall be used with the correct guard or attachment as specified by the manufacturer. • All air-powered equipment can be regulated from 0 to 110 psi.
	• Injuries while injecting pressurized $NaMnO_4$	• Verify the competency and integrity of the injection hose. • Verify the quick-connect fittings on the pumps and hoses are structurally sound and free of defects. • When injecting under pressure stand at a distance greater than 2 feet from any injection hose. • Remove all unnecessary equipment and material in the area. • When injecting chemicals, PPE will be properly used. • All air hoses at each connection will be secured with either hose whips or hose grips. • Emergency shut off of system pumps. • Operator control of system monitor injection pressure and adjust as needed. • Leak test equipment prior to initiating application. • Spill containment measures shall be readily available to contain spill and prevent chemical mixing and/or migration off-site.
	• Exposures to chemicals during day lighting	• Constant visual inspection of the injection area. • Inspect area and equipment after significant pressure drop. • Stop work at the first sign of day lighting and evaluate. • Use spill containment and emergency procedure protocol contained in the Health and Safety plan.

	• Exposure to contaminants VOC's	• Perform required air monitoring in Health and Safety plan.
• Rinsing and de-coning by running clean water through injection system	• Refer back to pressure testing injection system with water	• Refer back to pressure testing injection system with water.
• Refueling equipment during operations	• Fires • Spills • Breathing vapors	• Fuel Powered tools (generators, pumps, etc.) shall be turned off during refueling. • Do not refuel near open flames. • No smoking while refueling. • Use only approved fuel containers. • Use drip pans during refueling. • Work up wind of equipment.
• Working in the heat or cold	• Heat Stress • Cold Stress	• Seek shelter/shade to minimize heat stress. • Know your limitations. • Drink fluids to minimize heat stress (1 qt/hr min). • Use the Buddy System. • Stop work at the first sign of heat stress. (SWA) • Refer to the Health and Safety Plan. • Dress for cold conditions. • Stop at the first sign on numbness. • Change clothes if they get wet. • Refer to the Health and Safety Plan.
• Various tasks producing elevated Noise levels	• Noise from heavy and other equipment operation	• Wear hearing protection around equipment that generates above 85dba of noise. • Minimize exposure whenever possible.
• Lifting, moving, carrying	• Strain and Sprain	• Avoid moving heavy awkward objects by you. Get help or equipment to assist in handling materials. • Limit of 55# to be moved by any one person. • Use proper lifting techniques and appropriate PPE. • Use well defined routes for travel. • Keep walkways clear of tools and debris. • Never block your line of vision with the load.
• Various tasks creating potential for Crushing injuries	• Caught between load and fixed object/other loads	• Keep area clear where unloading/loading (coolers). • Locate a clear path and exit in event of load shift. • Make sure equipment operator sees you. • Only trained personnel involved in securing and un-securing heavy loads. Competent persons.
• Biological	Injuries resulting in contact with: – Bees, Insects, – Spiders	• Be aware that the area may have bees, hornets and other insects and small mammals. • If a bee hive or other potentially hazardous biological hazard is found, notify the SSO immediately.

	– Snakes – Small mammals – Ticks	• Listen for strange noises-rattles, buzzing, etc. • Look before placing hands and feet. • Never approach a snake of any kind. • Wear appropriate gloves and inspect all areas where hands / feet are intended to go. • Check for ticks after operations. • Use insect repellant. • Notify supervisor and safety dept. of severe allergic reaction potential.
• Natural Disaster	• Injury resulting from severe weather	• In the event of a natural disaster, all personal will immediately evacuate the area to a safe distance or location depending upon the hazard. When safe proceed to the emergency gathering point for head count and instruction. • Refer to Health and Safety Plan as well as the facilities procedures.

PRINT **SIGNATURE**

Project Manager Name: _____ _____
Date/Time: _____

Field Team Leader Name: _____ _____
Date/Time: _____

Employee Name(s): _____ _____
Date/Time: _____

_____ _____
Date/Time: _____

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Date/Time: _____

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Date/Time: _____

Pre-Task Safety Plan

ORIN Remediation Technologies

Activity Hazard Analysis

PRE-TASK SAFETY PLAN

Project: _____ ___ Location: _____ _____Date:_____ _____

Supervisor: ___ _____ Job Activity:_ _____

_____

Task Personnel:

_____

_____

_____

_____

List Tasks:

_____

_____

_____

_____

Tools/Equipment required for Tasks (ladders, scaffolds, fall protection, cranes/rigging, heavy equipment, power tools):

_____

_____

_____

_____

Potential H&S Hazards, including chemical, physical, safety, biological and environmental (Check all that apply):

__ Chemical burns/contact	__ Trench, excavations, cave-ins	__ Ergonomics
__ Pressurized lines/equipment	__ Overexertion	__ Chemical splash
__ Thermal burns	__ Pinch points	__ Poisonous plants/insects
__ Electrical	__ Cuts/abrasions	__ Eye hazards/flying projectile
__ Weather conditions	__ Spills	__ Inhalation hazard
__ Heights/fall> 6'	__ Overhead Electrical hazards	__ Heat/cold stress
__ Noise	__ Elevated loads	__ Water/drowning hazard
__ Explosion/fire	__ Slips, trip and falls	__ Heavy equipment
__ Radiation	__ Manual lifting	__ Aerial lifts/platforms
__ Confined space entry	__ Welding/cutting	__ Demolition

Other Potential Hazards (Describe): _____

ORIN Remediation Technologies

Activity Hazard Analysis

PRE-TASK SAFETY PLAN

Hazard Control Measures (Check all that apply):

PPE	Protective Systems	Fire Protection	Electrical
__ Thermal/lined	__ Sloping	__ Fire extinguishers	__ Lockout/tag out
__ Eye	__ Shoring	__ Fire watch	__ Grounded
__ Dermal/hand	__ Trench box	__ Non-spark tools	__ Panels covered
__ Hearing	__ Barricades	__ Grounding/bonding	__ GFCI/extension cords
__ Respiratory	__ Competent person	__ Intrinsically safe equipment	__ Power tools/cord inspected
__ Reflective vests	__ Locate buried utilities		
__ Flotation device	__ Daily inspections		
Fall Protection	**Air Monitoring**	**Proper Equipment**	**Welding & Cutting**
__ Harness/lanyards	__ PID/FID	__ Aerial lift/ladders/scaffolds	__ Cylinders secured/capped
__ Adequate anchorage	__ Detector tubes	__ Forklift/ Heavy equipment	__ Cylinders separated/upright
__ Guardrail system	__ Radiation	__ Backup alarms	__ Flash-back arrestors
__ Covered opening	__ Personnel sampling	__ Hand/power tools	__ No cylinders in CSE
__ Fixed barricades	__ LEL/O2	__ Crane w/current inspection	__ Flame retardant clothing
__ Warning system	__ Other	__ Proper rigging	__ Appropriate goggles
		__ Operator qualified	
Confined Space Entry	**Medical/ER**	**Heat/Cold Stress**	**Vehicle/Traffic**
__ Isolation	_ First-aid kit	__ Work/rest regime	__ Traffic control
__ Air monitoring	__ Eye wash	__ Rest area	__ Barricades
__ Trained personnel	__ FA-CPR trained personnel	__ Liquids available	__ Flags
__ Permit completed	__ Route to hospital	__ Monitoring	__ Signs
__ Rescue		__ Training	
Permits	**Demolition**	**Inspections:**	**Training:**
__ Hot work	__ Pre-demolition survey	__ Ladders/aerial lifts	__ Hazwaste
__ Confined space	__ Structure condition	__ Lanyards/harness	__ Construction
__ Lockout/tag out	__ Isolate area/utilities	__ Scaffolds	__ Competent person
__ Excavation	__ Competent person	__ Heavy equipment	__ Task-specific (THA)
__ Demolition	__ Hazmat present	__Cranes and rigging	__ Hazcom
__ Energized work			

FieldNotes:_____

_____

Attachment 3

Orin Technologies Health and Safety Plan

ORIN Technologies

HEALTH AND SAFETY PLAN

FOR:

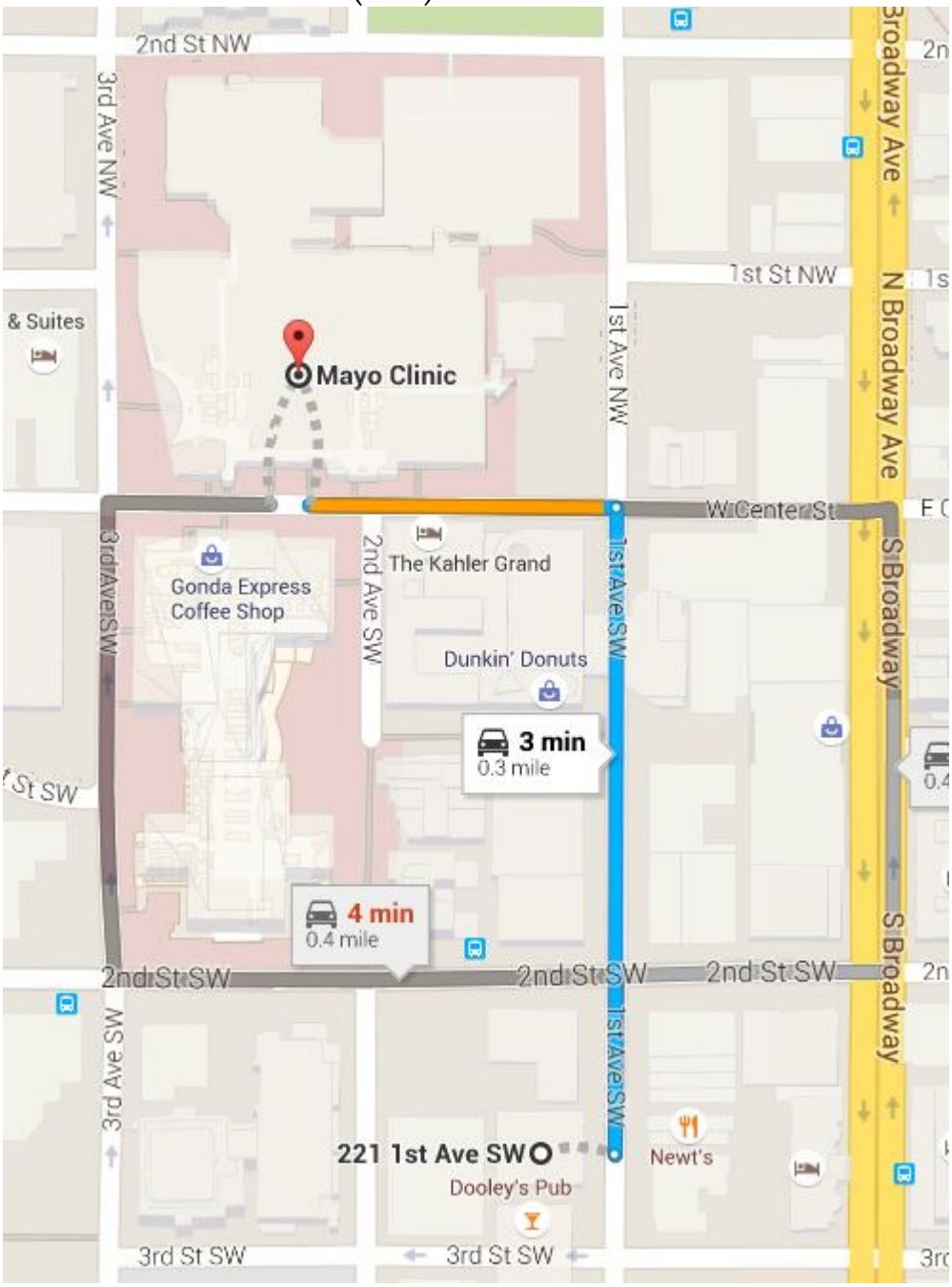
Landmark Environmental, LLC.
MN BioBusiness Center
221 First Ave. SW
Rochester, MN 55902

Site Contacts and Emergency Numbers:

ORIN	**608-838-6699**
Tyler Emerson	608-514-2095
Keith Becker	608-445-8584
James Reece	608-443-7412
Jacob Mirfield	563-468-7645
Landmark	**952-887-9601**
Jason Skramstad	651-717-8885
Hospital	
Mayo Clinic	507-284-2511 or Dial 911

(Map is on the following page)

Mayo Clinic
200 First St. SW
Rochester, MN 55905
(507) 284-2511



from 221 1st Ave SW, Rochester, MN 55902
to Mayo Clinic, 200 1st Street Southwest, Rochester,...

3 min (0.3 mile)

via 1st Ave SW and W Center St

3 min without traffic

221 1st Ave SW
Rochester, MN 55902

Head north on 1st Ave SW toward 2nd St SW

0.2 mi

Turn left onto W Center St

453 ft

Mayo Clinic
200 1st Street Southwest, Rochester, MN 55905

Site Specific Health And Safety Plan

Table of Contents

Health And Safety Plan

1.0 INTRODUCTION

This health and safety plan provides guidelines and procedures necessary to protect the health and safety of ORIN personnel and is intended to maximize the protection of ORIN field personnel and subcontractors from physical and environmental hazards while performing environmental remediation duties at a site. Incorporated into ORIN's HASP is Landmark's HASP. Both will be diligently followed and the more stringent rules may apply.

SITE SAFETY OFFICER

The site health and safety officer is responsible for field implementation of the Health and Safety Plan and enforcement of safety rules and regulations. The safety officer will handle liaison with subcontractors on matters relating to health and safety. He will be responsible for the implementation of and the conformance with this HSP by all applicable personnel entering the site. The Site Safety Officer is responsible for the following:

- Verify that Site personnel have received proper training. (OSHA training)
- Supervise day-to-day implementation of ORIN Health and Safety Plan by ORIN personnel and ORIN subcontractors.
- Evaluating chemical hazard information.
- Selecting the proper personal protection levels and necessary protective clothing/equipment.
- Conduct daily health and safety meetings prior to the start of each workday.
- Modify Site Health and Safety Plan as needed and notify appropriate personnel.
- Perform or direct ambient air quality monitoring as warranted.
- Stopping work if there is perceived to be an immediate threat to life, health, or safety or if unexplained/unexpected dangerous conditions arise.
- Investigate and report on-site accident/incident reports.

2.0 DESCRIPTION OF SITE SPECIFIC HAZARDS

This section will describe the chemical and physical hazards that a worker may be exposed to the site. Brief emergency procedures are included in this section.

2.1 Chemicals*

Neutralizing Solution:

Hydrogen Peroxide 29-50%

Citric Acid

Treatment Chemical:

Sodium Permanganate 40%

2.1.1 The pathways to worker exposure are as follows:

1. Ingestion
2. Skin and/or Eye Contact
3. Skin Absorption
4. Inhalation of fumes or dusts

2.1.2 Health Effects and Medical Monitoring:

Irritation and chemical burns may result from skin and/or eye contact or skin absorption. Nausea and possibly severe illness may result from ingestion or inhalation.

2.1.3 Emergency Exposure Directions: Please refer to SDS' for more detailed instructions.

EYE EXPOSURE: Hydrogen Peroxide and Sodium Permanganate

• If personnel are splashed in the eye with hydrogen peroxide or sodium permanganate, the following procedures should be followed:

1) Do not allow the victim to rub or keep eyes tightly shut.
2) Gently lift eyelids and flush with eyewash immediately and continuously with flooding amounts of water until transported to Hospital.
3) Consult ophthalmologist immediately.

EYE EXPOSURE: Citric Acid

• If personnel are splashed in the eye, the following procedures should be followed:

1) Do not allow the victim to rub or keep eyes tightly shut.
2) Gently lift eyelids and flush with water immediately and continuously with flooding amounts of water.
3) If irritation persists, consultant ophthalmologist immediately.

SKIN EXPOSURE: Hydrogen Peroxide and Sodium Permanganate

• If personnel are splashed on the skin with hydrogen peroxide, the following procedures should be followed:

1) Immediately flush with plenty of water while removing contaminated clothing and/or shoes.
2) Thoroughly wash with soap and water.
3) If irritation persists, consult a dermatologist immediately.

SKIN EXPOSURE: Citric Acid

• If personnel are splashed on the skin, the following procedures should be followed:

1) Flush skin with plenty of water until cleaned.
2) Thoroughly wash with soap and water.
3) If irritation persists, consult a dermatologist immediately.

There are three available water sources, if applicable. They are as follows:

1) One hose in the injection area

2) One hose in the injection vehicle

3) Two ANSI certified eyewash stations in the control area of injection vehicle

Refer to SDS sheets located in the control area of the injection vehicle for further information.

2.1.4 Emergency Spill Procedures:

PERMANGANATE SPILL

• If a spill of permanganate occurs, the following procedures will be followed:

1) Divert spill from any available conduits. (Storm drains, Sanitary sewer, etc.)
2) Isolate and ventilate the area. Deny entry and stay upwind.
3) Keep combustibles away from spills.
4) Use a mixture of water, citric acid, and hydrogen peroxide to remove stains and neutralize spill.
5) For small spills, take up with earth, sand, vermiculite, or other non-combustible material.

CITRIC ACID SPILL

- If a spill occurs, the following procedures will be followed:

    1) Spilled material will be collected. If applicable, spilled material will be placed in approved DOT container and isolated for disposal.
    2) Isolated material will be monitored for signs of decomposition (fuming/smoking).
    3) If spilled material is wet, dissolve with large quantities of water.
    4) All disposals will be carried out according to regulatory agencies procedures.

HYDROGEN PEROXIDE SPILL

- If a spill occurs, the following procedures will be followed:

    1) Divert spill from any available conduits. (Storm drains, Sanitary sewer, etc.)
    2) Isolate and ventilate the area. Deny entry and stay upwind.
    3) Keep combustibles away from spills.
    4) Use water to reduce the concentrations of hydrogen peroxide.
    5) For small spills, take up with earth, sand, vermiculite, or other non-combustible material.

2.2 Chemical Mixing Procedure

All personnel involved in the chemical mixing and transfer of any chemicals will be in Modified D PPE- chemical resistant apron and shoulder length gloves , steel-toe boots, nitrile gloves, safety goggles and splash shield.

Chemical mixing

1) Chemical mixing will occur within the tank inside the rig.
   Note: not in bulk storage containers.
2) Water is the only constituent to be mixed with the chemicals listed within the tank of the rig.

2.3 Heavy Equipment (Earth Moving Equipment, Drilling rigs, etc.)

Personnel should be cognizant of the operation and movement of heavy equipment at all times. Qualified and experienced personnel should operate heavy equipment. Personnel not operating heavy equipment should stand clear to the extent possible.

2.4 Weather Related Hazards

Seasonal weather changes will occur during the implementation of this HSP. Workers should be cognizant of predicted weather changes and should dress accordingly. Workers wearing protective clothing on warm days will be susceptible to heat stress and will be briefed on the signs, symptoms, and treatment of heat exposure. Further details regarding heat stress hazards are presented in Section 5.4.

2.5 Chemical Transfer Hazards

The risk of spill during the transfer of chemical is low due to the closed transfer process and safety procedures. The material is normally deliver in 275-gallon totes and stored in a trailer, protected location. This protects from spills due to vandalism, collision or other physical harm. Inside the trailer, a worker wearing all necessary personal protective equipment (nitrile gloves, goggles and steal-toe boots) does the transfer of chemical from containers to mixing tanks. Further details regarding PPE are presented in Section 7.0.

A dip-leg attached to the transfer hose is inserted into the tote for transfer. The transfer line, made of chemically rated material, is directly plumbed into the mixing tank in the injection trailer. A water supply is always at arm's length during transfer for dilution. The person in charge of the transfer is in the necessary PPE. Further details regarding PPE are presented in Section 7.0.

3.0 MONITORING EQUIPMENT AND INSTRUMENTS

ORIN may use an ultraviolet Photo ionization Detector ("PID") to screen the site for organic gases and vapors during the fieldwork. If vapors are present, a Combustible Gas Indicator will be used to monitor the lower explosive limit ("LEL") in the atmosphere. These instruments are described as follows:

Instrument:	PID	LEL
Detection Method:	Ionizes molecules using UV radiation; produces a current that is proportional to the number of ions.	A filament usually made of platinum is heated by burning the combustible gas or vapor. The increase in heat is measured.

Limitations:	Does not detect Methane or any compound if the probe used has a lower energy level than the compound's ionization potential. Response may change when gases are mixed. Other volatile sources may interfere with measurements. Reading can only be reported to the calibration standard used. Response is affected by high humidity.	Accuracy depends in part on the difference between calibration and sampling temperatures. Sensitivity is a function of the differences in the chemical and physical property between the calibration gas and the sample gas. Silicones, tetraethyl lead, halides and oxygen enriched atmospheres can damage the filament. Does not provide a valid reading under oxygen deficient conditions.
General Care and Maintenance:	Recharge or replace battery. Regularly clean and maintain the instrument and accesories.	Recharge or replace battery. Calibrate immediately before use.
Operating Times:	10 hours; 5 hours with strip chart recorder.	Life of battery, or for the recommended interval between calibrations.

4.0 TRAINING

All personnel working in areas where hazardous substances or hazardous wastes are present or suspected to be present must be trained in accordance with OSHA requirements set forth in 29 CFR 1910.120(e)(1) and (2), that is a 40 hour training program consistent with job function and responsibilities. The SSO will be additionally trained in accordance with 29 CFR 1910.120(e)(3), that is an additional 8 hours of supervisory training.

The SSO (or project engineer/hydrogeologist after conferring with the SSO) will give briefings daily, when new operations are to be conducted, when changes in work practices must be implemented due to new information made available, or if site or environmental conditions change. Briefings will be given to facilitate conformance with prescribed safety practices, when performance deficiencies are identified during routine daily activities, or as a result of safety audits. Site training and daily briefings will include the following:

° Eating, drinking, chewing tobacco and smoking is prohibited in the contaminated or potentially contaminated area or where the possibility for the transfer of contamination exists.

- Smoking or carrying smoking materials or flame producing devices within restricted areas is prohibited.

- Avoid contact with potentially contaminated substances. Do not walk through puddles, pools, mud, etc. Avoid, whenever possible, kneeling on the ground, leaning or sitting on drums, equipment or ground. Do not place monitoring equipment on potentially contaminated surfaces (i.e., drum, ground, etc.).

- No beard or facial hair, which interferes with a satisfactory qualitative respirator fit test, may be worn.

- Prevent, to the extent possible, spillages. In the event that a spillage occurs, contain liquid if possible and alert the other personnel of the spill. If the spill occurs in the chemical storage area during transfer, stop the transfer and use vermiculite to contain the liquid. If the spill occurs in the treatment vehicle, stop the injection and use the water hose to dilute the chemicals.

- No field personnel will visit the site unaccompanied.

- Locate a decontamination area between site operations and the site exit.

- Protective equipment including, boots, gloves, and splash shields will be washed off before leaving the site and stored on-site in a predetermined location. Boots may be decontaminated at the end of the field effort. Gloves, disposable suits, and splash shields should be thrown away.

5.0 PERSONNEL MONITORING

5.1. Medical Surveillance

Personnel working in hazardous waste areas are required to pass a medical examination in accordance with 29 CFR 1910.120(f). Any worker who has not passed the required physical examination, or refuses to take such examination, will not be permitted to conduct work related to the environmental investigation at this site.

Workers that are part of an annual medical monitoring program will not be required to undergo an additional physical exam prior to site entry.

5.2 Personnel Protective Equipment Monitoring

Skin contact with contaminants and potentially contaminated soils and inhalation of contaminant fumes and potentially contaminated soil dusts are expected to be the primary exposure hazards to workers at the site. The SSO will monitor workers usage of proper personnel protective equipment.

5.3 Routine Monitoring

Air monitoring will be performed during working operations to ensure worker safety and health and to evaluate ambient air conditions at the site, if deemed necessary by the SSO. The primary unit that will be utilized is the photoionization detector. This unit will be calibrated daily in accordance with its operating manual.

5.4. Stress Monitoring

Due to the additional physical and psychological stress of working in respirators and protective clothing, should these be required, all employees shall be monitored for signs of stress during work activity when the ambient temperature in the work area is 80°F or above. Frequency of monitoring for signs of stress shall increase as the ambient temperature increases.

For monitoring the body's recuperating ability to excessive heat, one or more of the following techniques may be used:

- Heart Rate ("HR") should be measured by the radial pulse for 30 seconds as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 110 beats per minute. If the HR is in excess of the above value, the next work period should be shortened by 10 minutes (or 33%) while the length of the rest period stays the same. If the pulse rate is in excess of 100 beats per minute at the beginning of the next rest period, the following work cycle should be further shortened by 33%.
- Body temperature ("BT") should be measured orally with a clinical thermometer as early as possible in the resting period. Oral temperature ("OT") at the beginning of the rest period should not exceed 99°F (corresponding to 100.4°F BT). If OT exceeds 99.7°F, the next work period should be shortened by 10 minutes (or 33%) while the length of the rest period stays the same. If the OT is in excess of 99.7°F at the beginning of the next rest period, the following work cycle should be further shortened by 33%. OT should be measured again at the end of the rest period to make sure that it has decreased below 99.7°F.

- Body Water Loss ("BWL") due to sweating during the work day should be measured by the difference between body weight in the morning before work and body weight in the evening after finishing work. The clothing worn should be similar at both weightings; preferably the

worker should be nude. The scale should be accurate to plus or minus 1/4 lb. BWL should not exceed 1.5% of total body weight. If BWL exceeds 1.5%, the worker will be instructed to increase his daily intake of fluids by the amount of total deficit (morning body weight).

The ideal condition is to maintain the body fluids at a constant level during the whole workday. This requires the replacement of the salt lost in sweat as well. If the body's physiological processes to maintain a normal body temperature fail due to excessive heat exposure, a number of physical reactions can occur. All employees shall be briefed on the most serious heat stress-related problems, heat exhaustion and heat stroke. The following symptoms and first aid treatment will be available to employees at all times.

Heat Exhaustion

Symptoms:

- Pale and clammy skin
- Pulse rapid and weak
- Patient complains of weakness, headache, or nausea
- Patient may have cramps in abdomen or limbs

First Aid:

- Have patient lie down with his head level with or lower than his body.
- Move patient to cool place, but protect him from chilling.
- Give the patient salt water (1 teaspoonful salt to 1 quart water) to drink if he is conscious.
- Loosen tight clothing.
- Call for medical aid.

Heat Stroke

Symptoms:

- Flushed and hot skin.
- Frequently, there is no sigh of perspiration.
- Pulse rapid and strong.
- Patient often is unconscious.

First Aid:

- Call for medical aid.
- Cool body by sponging it with cold water or by cold applications.

In addition to monitoring symptoms of heat stress, liquids will be available at the work site to replace the loss of body fluids (water and electrolytes) due to

sweating. Either a 0.1% salt-water solution, more heavily salted foods, or commercial mixes such as Gatorade will be available.

6.0 RESPIRATORY PROTECTION PROGRAM

6.1 Administration

The SSO (or project engineer/hydrogeologist after conferring with the SSO) has the responsibility of administering the respiratory protection program. The SSO and project engineer/hydrogeologist are trained in identifying and controlling respiratory hazards and choosing respiratory protective equipment. The SSO and project engineer/hydrogeologist are responsible for determining the necessity for respirators, overseeing the use of respirators, and inspecting the condition of respirators. Personnel are informed of the type of respirator required and the appropriate filter cartridge during the review of the site specific HSP.

All personnel must be fit tested to their own personal respirator. Personnel are required to have their half-face respirator and a change of PPE (safety glasses, tyvek, boots, gloves, hard hat, ear plugs) present during all sampling activities in the event of an upgrade from level D to level C equipment.

6.2 Respirator Selection

The respirator selection is made by the SSO (or project engineer/ hydrogeologist after conferring with the SSO). ORIN will supply its employees with the necessary National Institute for Occupational Safety and Health ("NIOSH") approved respiratory protection equipment. Subcontractors are responsible for their own respiratory protective equipment.

6.3 Respirator Type

Level D protection, no respirator needed, is appropriate for the environmental investigation activities at this site.

If an upgrade to Level C becomes necessary based upon photoionization detector readings, a half face respirator with a combination filter cartridge which filters up to 1,000 ppm organic vapors, dusts, mists not less than 0.05 mg/m^3, asbestos, and radionuclides will be used.

6.4 Training

ORIN personnel are trained in the safe use and maintenance of respirators including the various types of respirators available, the hazards, which dictate the choice of respirator type, and the limitations of respirators. Personnel are fit

tested to their own respirator with irritant smoke. Respirators are pressure tested (negative and positive pressure) during the fit test. Personnel are trained in the cleaning, sanitizing and storage of their respirators. Respiratory protection fit test and training are documented in individual personnel files.

Subcontractor personnel are responsible for their own respiratory equipment training.

7.0 LEVELS OF PROTECTION

Equipment used to protect the body against contact with known or anticipated chemical hazards has been divided into four categories according to the degree of protection afforded.

The levels of protection selected should be based primarily on:

- Type(s) and measured concentration(s) of the chemical substance(s) in the ambient atmosphere and its toxicity.

- Potential or measured exposure to substances in the air, splashes or liquids, or other direct contact with material due to work being performed.

In situations where the type(s) of chemical(s), concentration(s), and possibilities of contact are not known, the appropriate level of protection must be selected on the basis of professional experience and judgment until the hazards can be better characterized.

The recommended level of protection worn for each specific task will be determined by the SSO. These are recommended based on the known and suspected hazard characteristics of the site and will be subject to upgrading or downgrading based on changing environmental conditions and different work procedures.

Site personnel will be outfitted as follows:

Task	Level of PPE
Operation of Injectors (Control Room)	Modified Level D
Operation of injectors (Ground Crew)	Modified Level D

Addition and Mixing of Wet Chemical	Modified Level D +
Transfer of Wet Chemical	Modified Level D +

While personnel protective equipment (PPE) reduces the potential for contact with harmful substances, ensuring the health and safety of response personnel requires safe work practices, decontamination, site entry protocols, and other safety considerations. Together, these protocols establish a combined approach for reducing potential harm to workers.

The following outlines the **minimum PPE** for modified Level D for the ORIN Processes:

Modified Level D consists of:

- Safety glasses
- Tyvek suit
- Nitrile Gloves
- Steel-toed boots

Modified Level D + consists of:

- Safety glasses
- Tyvek suit
- Nitrile Gloves
- Steel-toed boots
- Latex booties
- Splash shield (if applicable)

The following brief description of equipment is provided.

7.1 Level C

ORIN has not and does not anticipate the need for Level C protection. If ORIN would experience Level C we would adhere to the following:

Level C is worn when the type(s) of airborne substance(s) is known, the concentration(s) is measured, and the criteria for using air-purifying respirators are met.

When the following criteria are satisfied, Level C protection will be used:

- Measured air concentrations of identified substances will be reduced by the respirator to a level below the substance's exposure limit, and the concentration is within the service limit of the canister.

- Atmospheric contaminant concentrations do not exceed IDLH levels.

- Atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect the small area of skin left unprotected by chemical-resistant clothing.

- Job functions have been determined to not require self-contained breathing apparatus.

- Total vapor readings register between 10 and 200 ppm above background on instruments such as the photoionization detector (PID).

- Oxygen level measures at least 19.5% by volume or 100 mm of total pressure.

Level C personnel protective equipment may include:

- Full-face or half-face, air-purifying, canister-equipped respirator (NIOSH approved).
- Chemical-resistant clothing (coveralls or hooded, two-piece chemical splash suit or chemical-resistant hood and apron or disposable chemical-resistant coveralls).
- Coveralls.
- Gloves (outer), chemical-resistant.
- Gloves (inner), chemical-resistant.
- Boots (outer), chemical-resistant steel toe and shank.
- Boots (outer), chemical-resistant (disposable).
- Hard hat (with face shield).
- Escape mask.

7.2 Level D

Level D is primarily a work uniform. It can be worn in areas where only boots or gloves can be contaminated or there are no inhalable toxic substances. Initially, Level D personal protection (including Tyvek suits) will be worn at the site by all personnel. The SSO, however, may require appropriate upgrading of PPE depending on actual site conditions.

Level D personnel protective equipment will include:

- Tyvek suits.
- Chemical resistant Gloves. (Nitrile)
- Boots/shoes, leather or chemical-resistant, steel toe and shank.
- Safety glasses.

Additional equipment (dependent on actual conditions) may include:

- Boots (outer), chemical-resistant (disposable).
- Chemical splash goggles.
- Hard hat (with face shield).
- Escape mask.

The actual combination of protective equipment worn will be decided by the SSO based on site conditions. Subcontractor personnel are responsible for their own personal protective equipment and any applicable training and certification.

8.0 PROCEDURES FOR DETERMINING PERSONNEL PROTECTION LEVEL

The SSO and/or others who are qualified and trained on that equipment to scan the area for volatile organics will use the PID. The following criteria will define the action levels for the use of respiratory protective gear at the site:

Based on initial Level D: (for non-volatile and non-dust containing atmospheres)

PID READING OF AMBIENT AIR	ACTION
0-10 ppm above background	CONTINUE IN LEVEL D
>10 ppm above background	UPGRADE TO LEVEL C

* These action levels pertain to volatile organic compounds identified at the site. If other acutely toxic compounds are identified, action levels may need to be altered.

Level C will also be required if contaminated soil-dust becomes entrained in the air during field activities. Personnel will don, as a minimum, NIOSH approved respirators with cartridges capable of removing dust particles. The primary concern in this instance is preventing inhalation of contaminating dust particles. Only those workers who are medically certified to work wearing respirator protection will be permitted to continue activities. The soils will be lightly wet down to contain dust.

9.0 EMERGENCY AND FIRST AID EQUIPMENT AND COMMUNICATIONS

Basic emergency and first aid equipment will be available and include a first aid kit, emergency eyewash or drench system, fire extinguisher, and Level C protective equipment.

A telephone may be located at the Response Vehicle for communication with emergency support services/facilities. If not appropriate for this particular project, the nearest public phones shall be identified.

10.0 EMERGENCY PROCEDURES

Personnel on-site will use the "buddy" system (pairs). Buddies will use pre-arranged hand signals or other means of emergency signals for communication in case of radio breakdown.

In emergencies, the following hand signals are to be used:

°	Hand gripping throat:	*Out of air, can't breath.*
°	Grip partner's wrist or Place both hands around waist:	*Leave area immediately, no debate!*
°	Hands on top of head:	*Need assistance.*
°	Thumbs up:	*OK, I'm all right, I understand.*
°	Thumbs down:	*No, negative.*

Site entrance and exit routes will be planned and the Project Manager will delineate emergency escape routes.

Visual contact will be maintained between "buddies" on-site with the team remaining in close proximity in order to assist each other in case of emergencies.

Field crewmembers will inform each other of non-visual effects of possible toxic exposure:

- Headaches
- Dizziness
- Blurred vision
- Cramps
- Irritation of eyes, skin or respiratory tract

In the event that any member of the field crew experiences any adverse effects or symptoms of exposure while on scene, the entire field crew will immediately halt work and act according to the instructions provided by the SSO. **See section 2.1.3 for emergency procedures.**

The discovery of any condition that would suggest the existence of a situation more hazardous than anticipated should result in the evacuation of the field team and a re-evaluation will be conducted by appropriate on-site Health and Safety personnel.

11.0 ON SITE EVACUATION PLAN

Should either a fire or explosion occur on-site, all personnel will proceed to the nearest safe zone. At this time, the local fire and police department will be called for assistance. The acting officer of the fire department and the Project Manager will determine if further evacuation is necessary. This evacuation would include all personnel and inhabitants of any surrounding area, which is in immediate danger.

12.0 PERSONAL INJURY

Emergency first aid shall be applied on site as deemed necessary. Then decontaminate and transport the individual to the nearest medical facility if needed. Decontamination may be waived prior to transport, if the injury or illness is life threatening.

The ambulance/rescue squad shall be contacted for transportation as necessary in an emergency. Directions to the hospital are provided behind the front cover of this report if transportation is required without the assistance of an ambulance. If an accident occurs, the Site Safety Officer will file an accident report.

The phone numbers listed on the first page and the primary hospital route will be posted at the work site.

13.0 DECONTAMINATION PROCEDURES

13.1 Personal Decontamination

The degree of personal decontamination may vary greatly depending on the activity and actual contaminants present at the site. In any case, personnel will be required to follow proper decontamination procedures prior to exiting the work zone. The SSO or his qualified and designated replacement will be responsible for enforcing these procedures.

Should a formal decontamination area be required or desired, the decontamination area will be designed based on the level of protection required at the site. Small tools, and monitoring equipment will be decontaminated in the personal decontamination zone.

13.2 Heavy Equipment and Vehicle Decontamination

All heavy equipment must be properly decontaminated. This will consist of thorough scraping or brushing off gross contamination. These materials will be shoveled up and disposed of in the last disposal truck. Steam or pressure washing may then be accomplished. Decontaminated vehicles will be inspected by the SSO or qualified and designated replacement prior to leaving the site.

13.3 Waste Disposal

Spent decontamination fluids, waste waters, and other wastes will be characterized (as hazardous or non-hazardous wastes) and disposed of in accordance with applicable rules.

14.0 SUBCONTRACTOR DISCLAIMER

This health and safety plan provides guidelines and procedures necessary to protect the health and safety of ORIN personnel and is intended to maximize the protection of ORIN field personnel and subcontractors from physical and environmental hazards while performing environmental remediation duties at a site. However, any ORIN subcontractor is ultimately responsible for his or her own Health and Safety Program.

15.0 Required Signatures of Personnel

Prior to the start of work, this Health and Safety Plan has been reviewed by the following:

Date	Name	Signature	Company

Attachment 4

Groundwater Remediation Feasibility Study and Work Plan,
Prepared by Landmark and dated April 8, 2016

Landmark Environmental, LLC
2042 West 98th Street
Bloomington, MN 55431
Phone: 952-666-2444

www.landmarkenv.com

April 8, 2016
Sent via email

Mr. Allan Timm and Mr. Ed Olson
Minnesota Pollution Control Agency
Voluntary Investigation and Cleanup Program
520 Lafayette Road
St. Paul, MN 55155-4194

Re: **Groundwater Remediation Feasibility Study and Work Plan**
Minnesota Bio Business Center Building
221 First Avenue S.W., Rochester, Minnesota

Dear Mr. Timm and Mr. Olson:

On behalf of the City of Rochester (City), Landmark Environmental, LLC (Landmark) has prepared this Groundwater Remediation Feasibility Study and Work Plan (Feasibility Study/Work Plan) for the above-referenced property (Property) shown in **Figure 1**. The Feasibility Study evaluates the following groundwater remediation technologies for the saturated fractured bedrock at the Property:

Alternative #1.) in situ chemical oxidation (ISCO);
Alternative #2.) enhanced bioremediation;
Alternative #3.) enhanced bioremediation followed by bioaugmentation; and,
Alternative #4.) continued operation of the dual phase extraction (DPE) system.

The Work Plan describes the scope of work to be followed while implementing the recommended groundwater remediation technology. Landmark retained ORIN Remediation Technologies, LLC (ORIN) to provide information and costs included in this Feasibility Study/Work Plan associated with ISCO, enhanced bioremediation, and bioaugmentation.

BACKGROUND

The Property historically consisted of land that historically supported two dry cleaning facilities; historical structures were demolished prior to the construction of a parking lot. The historical activities involved the use of hazardous substances, including the common dry cleaning solvent tetrachoroethylene (PCE). Environmental investigations and response actions (RAs) were previously conducted on Property to address the releases of PCE. The previous RAs at the Property included the installation and operation of an interim DPE system, which was decommissioned prior to redevelopment of the Property for the Minnesota Bio Business Center.

As shown in **Figure 2**, the Minnesota Bio Business Center was built on the entire extent of the Property. Redevelopment of the Property in 2007 required the excavation of approximately 10,000 square feet to the top of bedrock located approximately 13 feet below ground surface (bgs). Approximately 4,350 tons of soil and fill material contaminated with polycyclic aromatic hydrocarbons (PAHs) and Resource Conservation and Recovery Act metals (RCRA metals) was disposed of at the Steele County Landfill as part of soil RAs.

On January 5, 2008, general excavation activities on Property included the removal of the concrete structure from a former elevator pit. During removal of the former elevator pit, solvent odors were detected and a concrete-walled structure (Source Area) was discovered adjacent to the east side of the former elevator pit. This Source Area was located where DPE well, DPE-1, is currently located (**Figure 2**) and was likely the run-shaft for the counterweight of the former elevator and was approximately 3 feet long by 3 feet wide by 4 feet deep. The depth of the Source Area was approximately 17.5 feet bgs. The structure consisted of concrete walls and a concrete cover with a metal pipe extending through the cover. The floor of the structure was native bedrock. The metal pipe and concrete structure contained a dark colored substance with a strong solvent odor. This material had a photoionization detector (PID) reading of 3,500 parts per million. The substance was then sampled (HS-B7) and analyzed by a fixed based laboratory for volatile organic compounds (VOCs) and toxicity characteristic leaching potential (TCLP) VOCs. PCE was detected in the soil from HS-B7 at a concentration of 41,400 mg/kg. No other VOCs were detected in sample HS-B7. The TCLP VOCs results for HS-B7 included a detection of PCE at a concentration of 168 milligrams per liter, which is above the U.S. Environmental protection Agency (EPA) maximum contaminant concentration for toxicity characteristic wastes. No other VOCs were detected in the TCLP analysis. The structure was covered with plastic sheeting until hazardous waste removal could be coordinated.

On January 11, 2008, Stevens Drilling and Environmental removed the hazardous waste discovered at HS-B7 via subcontract with Special Waste Disposal Inc (SWDI), which transported and disposed of the hazardous waste. HS-B7's excavation area was approximately 8 feet long by 8 feet wide by 6 feet in depth. The depth of the excavation was approximately 19 feet below grade. PCE-impacted soil and bedrock was segregated from PCE-impacted concrete structure material and containerized in twenty 55-gallon drums. The impacted concrete sump material was loaded into a 20 cubic yard rolloff box, lined and covered with 10 mil polyethylene sheeting. The 20 drums of hazardous waste from HS-B7 were disposed of by SWDI at Veolia ES Technical Solutions, LLC facility. A total of 10 cubic yards of concrete structure material was disposed of as hazardous waste at the Michigan Disposal Waste Treatment Plant.

Upon discovery of the Source Area, the proposed DPE system was redesigned with the location of extraction well DPE-1 going directly through the center of the Source Area. DPE-2 through DPE-7 were relocated to surround the source area like a "bull's eye." The DPE system operated from June 29, 2009, through August 26, 2013. During approximately 4 years of operation, the DPE system removed a total of 3,698 pounds of total VOCs, including 2,788 pounds of PCE.

When comparing the October 13, 2015, concentrations to the baseline DPE system emissions data from April 9, 2009, the total VOC concentration has decreased from 14,613,880 micrograms per cubic meter (ug/m3) to 5,958 ug/m3, a decrease of 99.9 percent. PCE concentrations decreased from 11,600,000 ug/m3 to 61 ug/m3, a decrease of 99.9 percent from the baseline concentration. The asymptotic mass removal rates, as shown in **Figure 3**, and 99.9% decrease in emissions PCE concentrations are indicative of a system that has reached a point of diminishing returns and is no longer effectively removing contaminant mass from the subsurface.

During the DPE system shut down period starting on August 26, 2013, a rebound in VOCs, including PCE, was observed in the groundwater and soil vapor on the Property after approximately one year. However, the rebound concentrations of PCE in the groundwater were significantly less than baseline concentrations from December 2008, as shown in **Figures 4** and **5**.

FEASIBILITY STUDY

As previously discussed and shown in **Figures 3, 4** and **5**, the DPE system has effectively removed a significant amount of contaminant mass from the source area leaving residual contamination in the fractured bedrock which causes groundwater concentrations to rebound 6 to 12 months after DPE system shutdown. The DPE system groundwater remediation technology is more effective at reducing large amounts of source are contamination and less effective at removing residual contamination.

This Feasibility Study evaluates ISCO, enhanced bioremediation, and enhanced bioremediation with bioaugmentation, which are effective groundwater remediation technologies for removing residual contamination from fractured bedrock, compared to DPE system operation, which is more effective as a source area remediation technology. The residual groundwater remediation technologies will also be compared to continued operation of the DPE system. ORIN has 14 years of experience (over 220 projects) in implementing ISCO, enhanced bioremediation, and bioaugmentation projects. Of these 220 projects, the first injection event has been successful in all but 7 projects. Therefore, for this Feasibility Study, ISCO, enhance bioremediation, or bioaugmentation groundwater remediation technologies will each assume only one injection event would be required to effectively remediate residual contamination in the fractured bedrock.

Treatability Studies

ORIN would normally recommend doing a total oxidant demand (TOD) test and Treatability Study on site soils/fractured bedrock and groundwater. However, the entire footprint of the Property is covered by the MN Bio Business Center building prohibiting any practical methods for collecting soil or fractured bedrock samples for testing. As a result, only site groundwater could be used for treatability study testing. A treatability study on site groundwater would not yield useful TOD information; therefore, is not recommended.

Landmark provided ORIN the latest field parameter data (**Table 1**), and past natural attenuation data (**Table 2**), from previous groundwater samples collected at the Property, which includes the necessary information for evaluating the potential effectiveness of ISCO, enhanced bioremediation, and bioaugmentation. The data provided in **Tables 1** and **2**, in addition to the most recent groundwater analytical results (**Attachment 1**) yield the following information:

1.) not one well currently shows reductive dechlorination conditions;

2.) there are high concentrations of sulfates, but very low concentrations of sulfides, indicating no sulfate bacteria are present;

3.) there is no iron present; therefore, iron bacteria are starving;

4.) there is no methane present; therefore, no methanogenesis is occurring from methanogen bacteria;

5.) there is not a lot of dissolved organic carbon present in the groundwater; and,

6.) the groundwater aquifer is aerobic.

Optimal groundwater conditions for enhanced bioremediation are an oxidation reduction potential of less than -100 and a dissolved oxygen concentration of less than 0.5 milligrams per liter (mg/L). Therefore, the current groundwater conditions are ideal for ISCO. The soluble carbon food source required for enhanced bioremediation would change the groundwater to an anaerobic environment but may be more complicated to maintain for the duration of time necessary.

If bioremediation is the chosen treatment remedy, ORIN would recommend that a microbial analysis be performed to determine if viable populations of dehalogenating bacteria are present in the groundwater. The microbial analysis on site groundwater would analyze for dehalogenating bacteria, specifically dehalococcoides sp. Landmark would collect groundwater samples from various wells and ship to SiREM for analysis. SiREM would then perform analyses to determine which bacterial genes, and quantity, are present in the matrix. This would help determine if bioremediation is an option with the indigenous microorganisms, or if enhanced bioremediation would have to be followed up with bioaugmentation or injecting dehalogenating bacteria.

Pilot Testing

Pilot testing of ISCO, enhanced bioremediation, and bioaugmentation prior to full scale implementation is not recommended for several reasons. First, the presence of the MN Bio Business Center Building and the existing DPE system well locations dictate the locations available for injecting into the groundwater. Second, the fractured bedrock at the Property will require injecting into all 8 DPE wells to for the best chance of connecting the injection solution through fractures between the DPE wells. Lastly, pilot testing would cost over a third of the cost ($20,000 to $25,000) of full scale implementation of these technologies. During full scale

implementation, the first DPE system well tested will essentially act as a pilot test to determine the specific injection pressures and other pertinent information.

Alternative 1 - ISCO

Sodium permanganate (NaMnO4) is the recommended ISCO groundwater remediation technology. As a strong oxidizing agent, NaMnO4 has the ability to add oxygen, remove hydrogen or remove electrons from an element or compound. Permanganate is recognized by its characteristic purple to pink color when made into a solution. NaMnO4 has been successful in the reduction of chlorinated solvents in a wide array of field implementations, including fractured bedrock (**Attachment 2**). NaMnO4 is an inorganic oxidant that performs chemically the same way as potassium permanganate, only in a more concentrated form. The significant advantage to NaMnO4 is its high solubility in water, allowing it to be a more convenient and concentrated form of permanganate when used for organic oxidation of contaminants.

A benefit of a permanganate remediation approach is the complete oxidation of the contaminant without the formation of toxic intermediate compounds commonly found with bioremediation. For example, the breakdown of PCE with NaMnO4 is as follows:

PCE $4NaMnO_4 + 3C_2Cl_4 + 4H_2O \rightarrow 6CO_2 + 4MnO_2 + 4Na^+ + 12Cl^- + 8H^+$

As a result, complete groundwater remediation of contaminants occurs immediately upon contact with NaMnO4 in the subsurface. In addition to visual observation of the purple color of NaMnO4 in groundwater, a bromine tracer will be included to track the migration of the injection solution. A water quality meter will also be used to check the dissolved oxygen and oxidation reduction potential in the groundwater at non-injection wells.

Each and every site has unique characteristics and parameters. There is no one site like another. It is hard to predict how the treatment chemistry will perform. However, given ORIN's experience with oxidation and reductive dechlorination, ORIN predicts the ISCO technology to achieve clean-up goals in approximately 1 to 2 months.

Given the nature of bedrock, such as lots of micro fractures, it is additionally difficult to predict where the contamination is or more importantly, where the treatment chemistry will go once injected into the subsurface. There is no way to know how many injection events will be needed. However, ORIN's experience predicts that only one injection event should be sufficient. As stated, throughout ORIN's 14 years of experience (over 220 projects), ORIN had to re-inject only 7 times.

Disadvantages of using ISCO is the high cost of the NaMnO4 required for this treatment technology and the formation of manganese dioxide as a byproduct of permanganate oxidation. Manganese dioxide has the potential to clog microfractures in bedrock, but ORIN has not had any issues with this to date. ORIN collects pressure and flow rate measurements during injection to determine if the clogging of microfractures in bedrock is occurring.

This Feasibility Study assumes only one full-scale application will be necessary to reduce PCE concentrations in site groundwater to levels acceptable to the MPCA. The full-scale ISCO groundwater injection event is anticipated to take five days to implement. Treatability and pilot testing are not recommended or included in the estimated cost for implementing ISCO. The estimated engineering and contractor cost for implementing ISCO with NaMnO4 is **$93,800**.

Alternative 2 - Enhanced Bioremediation

Enhanced bioremediation requires the injection of a water soluble carbon source into the groundwater to promote anaerobic bioremediation of halogenated solvents, such as PCE. Water soluble carbon sources have historically included lactates, lactate esters (ethyl lactate), fatty acids, and a phosphate buffer. The lactate components serve as the short-term (more quickly consumed) components and the fatty acids serve as long-term releasing components. The phosphate buffer provides phosphates, which are a micronutrient for bioremediation. Also, a proper pH range (5.5 to 8.5) is crucial for complete dechlorination. Anaerobic bioremediation results in the production of metabolic acids, which can lower the pH and adversely affect the results.

There are both water soluble and insoluble oils in most water soluble carbon sources. The insoluble oils are dissolved into ethyl lactate (versus an emulsion). In the environment, triglycerides (soluble oils) are hydrolyzed to glycerol and three fatty acids. The recommended soluble carbon source is a vegetable oil with C-10 to C-20 fatty acids to circumvent the hydrolysis step. This provides a more soluble long lasting carbon source that is more easily distributed in the subsurface environment.

One of the most effective and environmentally benign food sources are fatty acids. However, care must be taken not to overstimulate the bacteria, because in some instances, the desired bacteria may be overwhelmed by other bacteria (such as methanogens). This is why it is important to use slow- and long-term release compounds. As a precautionary measure ORIN recommends a methane inhibitor be mixed in with the water soluble carbon source.

Given ORIN's experience with oxidation and reductive dechlorination, ORIN predicts the enhanced bioremediation technology to achieve clean-up goals in approximately 12 months.

This Feasibility Study assumes only one full-scale enhanced bioremediation application will be necessary to reduce PCE concentrations in site groundwater to levels acceptable to the MPCA. The full-scale enhanced bioremediation injection event is anticipated to take five days to implement and includes collecting and submitting two groundwater samples to SiREM for bacterial analysis and adding a methane inhibitor. Treatability and pilot testing are not recommended or included in the estimated cost for implementing enhanced bioremediation. The estimated engineering and contractor cost for implementing enhanced bioremediation is **$87,900**.

Alternative 3 - Enhanced Bioremediation with Bioaugmentation

In some instances, the bacteria that are necessary to obtain the desired results are not present. As previously discussed, ORIN recommends that a microbial analysis be performed to determine if viable populations of dehalogenating bacteria are present in the groundwater at the Property, if enhanced bioremediation is the chosen treatment remedy. If the bacteria required for enhanced bioremediation are not present, an enhanced bioremediation water soluble carbon source injection event would have to be followed by a bioaugmentation injection event.

The water soluble carbon source injected into the subsurface during the enhanced bioremediation injection event is required to change the groundwater environment from aerobic to anaerobic, which is required for the new bacteria injected during bioaugmentation to survive.

The additional bioaugmentation event would include injecting RTB-1TM, a mixture of living Dehalococcoides genus bacteria capable of anaerobically degrading chlorinated contaminants such as PCE. Bioaugmentation in groundwater systems with RTB-1TM provides an active microbial community capable of complete reductive dechlorination, ensuring that PCE, TCE, DCE, and VC are completely dechlorinated to ethene, without undue acclimation periods, and at rates that are suitable for achieving remedial goals.

Odor may be an issue while implementing the bioaugmentation injection event. Since the bacterium need anaerobic conditions, there is usually a septic, sewer smell associated with any bioaugmentation. There are odor controls that can be employed at additional expense. However, because of the use of the Property building and the close proximity to other buidlings, if odor is an issue at the Property, this may not be a viable option.

The enhanced bioremediation alternative, with or without bioaugmentation, will take up to 12 months to achieve clean-up goals. Similar to the ISCO remediation technology, it is difficult to know how many injection events will be needed. However, ORIN's experience predicts that only one enhanced bioremediation and bioaugmentation injection event should be sufficient.

This Feasibility Study assumes one full-scale enhanced bioremediation application followed up with one full-scale bioaugmentation application will be necessary to reduce PCE concentrations in site groundwater to levels acceptable to the MPCA. The full-scale enhanced bioremediation injection event is anticipated to take five days to implement and includes collecting and submitting two groundwater samples to SiREM for bacterial analysis and adding a methane inhibitor. The full-scale bioaugmentation event is anticipated to take one day to implement. Treatability and pilot testing are not recommended or included in the estimated cost for implementing ISCO. The estimated engineering and contractor cost for implementing enhanced bioremediation is **$99,800**.

Alternative 4 - DPE System Operation

The final groundwater remediation technology considered for the Feasibility Study includes continued operation of the DPE system. As previously discussed, the asymptotic mass removal

rates and 99.9% decrease in DPE system PCE emissions concentrations are indicative of a system that has reached a point of diminishing returns and is no longer effectively removing contaminant mass from the subsurface.

This Feasibility Study assumes continued operation, maintenance and monitoring of the DPE system on a monthly basis. For comparison with the other remediation technologies considered in this Feasibility Study, the DPE system cost is for one year of operation, maintenance, and monitoring. Unlike Alternatives #1 through #4, the DPE system would remain operational for an unknown number of years. The estimated annual operation, maintenance, and monitoring costs for the DPE system is **$128,500**.

Recommendations

After comparing each of the four alternatives, Landmark recommends implementing Alternative #1, ISCO, as the groundwater remediation technology. ISCO is the preferred technology because it is one of the most cost effective options and it provides the quickest route to meeting the MPCA clean-up goals at the Property. As previously discussed, ORIN predicts that the ISCO route to achieve clean-up goals will take approximately 1 to 2 months, compared to 12 months for enhanced bioremediation with or without bioaugmentation. As previously discussed, it is difficult to know how many injection events will be needed. However, ORIN's experience predicts that only one injection event should be sufficient. Therefore, it is assumed that one ISCO injection event will be sufficient for meeting the MPCA's groundwater cleanup criteria for the Property. Continued operation of the DPE system is not recommended because it has the highest annual cost and it would require annual operation for an unknown number of years.

ISCO WORK PLAN

Prior to ISCO chemical injection activities, the DPE system will be turned off and the active venting systems will be turned on. A $NaMnO_4$ solution with a bromine tracer will be injected into each of the eight DPE system wells by ORIN. **Table 3** includes the well construction summaries of all DPE system and monitoring wells on the Property. **Figure 2** shows the proposed locations of ORIN's treatment trailer and water truck, the nearest fire hydrant for water access, and the basement layout out of the DPE system. The hoses used for transferring the solution used for chemical injection will be routed from ORIN's treatment trailer, along the west alley, and through the DPE system exhaust piping to the basement of the MN Bio Business Center building. Therefore, the DPE system exhaust piping will be disconnected from the DPE system pump in the DPE system room to allow the injection hose through.

After the chemical injection event is completed, the DPE system will remain off indefinitely and the groundwater will be monitored on a quarterly basis to assess the effectiveness of the chemical injection. After one year of post ISCO groundwater monitoring, Landmark will provide recommendations concerning future groundwater remediation options, if necessary, for MPCA approval.

Chemical Injection Summary

- Treatment chemistry injection will utilize 8 drilled DPE wells previously installed.
- Treatment chemistry injection will start at the well with the highest groundwater concentration of PCE (DPE-3) and end at the DPE well with the lowest concentration.
- The vertical extent of remediation shall vary but averages 6 to 18 feet below the basement slab.
- Implementation in the field will take approximately 5 days depending on unforeseen site and matrix conditions.
- Inject an average of 850 gallons of 5% $NaMnO_4$ treatment chemistry into each of the 8 DPE wells (6,800 total gallons).
- Concentration and volume may vary depending on unforeseen conditions and contaminant load at each area.
- ORIN will maintain field notes on the location of the injection points, amount of chemical injected, and any other injection related field observations.
- An implementation report describing the remediation, chemical amount used, other field information, and observations regarding the remedial effort will be submitted to MPCA after all field work is completed.

Injection Methodology

ORIN will inject the ISCO treatment chemistry through the DPE system wells. The injection equipment will be pressure tested with water prior to the beginning of injection activities. The treatment chemistry will be injected into a well slowly to ensure proper flow rates and safe injection pressures. Once safety measures are checked and confirmed, ORIN will inject the treatment chemistry to effectively disperse the treatment chemistry into the subsurface. The pressure, rate, and total volume of treatment chemistry injected would be monitored by ORIN and amended according to field conditions in order to ensure maximum injection effectiveness.

Chemical Mixing and Delivery Methodology

The remedial injection treatment chemistry will be prepared using ORIN's specialized injection equipment which will be set up in the basement of the Minnesota Bio Business Center building in the room adjacent to the DPE system room. The treatment chemistry will be mixed and temporarily staged prior to injection into 200-gallon tanks. The tanks will first be filled with the proper amount of water to achieve the appropriate treatment chemistry solution concentration. The desired amount of $NaMnO_4$ will then be added to the water in each mixing tank. Multiple

mixing tanks will used during the injection, which enables work to proceed steadily and efficiently.

The treatment chemistry will be pumped into the formation using ORIN's air-driven, chemically resistant pumps. The rate, pressure, and volume will be monitored using a chemically resistant inline electronic flow meter. Shut-off valves are present at numerous locations throughout the delivery system for health and safety purposes.

Flow meters, injection pressure gauges, and pressure relief valves are located on ORIN's specially designed "injection heads" which connect the treatment chemistry feed line to the injection location. Each of the injection heads are constructed out of 1-inch schedule 80 PVC pipe fittings for added pressure resistance and durability. The injection head allows for ORIN personnel to monitor real time injection pressures with Ametek 0-100 psi pressure gauges. Flow rates will be measured with GPI industrial grade flow meters (model G2P10N09GMA).

Decontamination and Waste Management

Prior to mobilization, all of ORIN's equipment including pumps, tanks, hoses, injection heads, and rig will be properly decontaminated using specialized chemical treatments and procedures. All waste will be properly disposed of according to standard regulatory protocol. Landmark will properly dispose of all empty chemical containers.

ISCO Treatment Chemistry Descriptions

As a strong oxidizing agent, $NaMnO_4$ has the ability to add oxygen, remove hydrogen or remove electrons from an element or compound. The molecular weight of $NaMnO_4$ is 142 g/mol. Permanganate is recognized by its characteristic purple to pink color when made into a solution.

$NaMnO_4$ has been successful in the reduction of chlorinated solvents in a wide array of field implementations. A benefit of a $NaMnO_4$ remediation approach is the complete oxidation of the contaminant without the formation of intermediate compounds commonly found with bioremediation. For example, the breakdown of common organic solvents with $NaMnO_4$ is as follows:

PCE $4NaMnO_4 + 3C_2Cl_4 + 4H_2O \rightarrow 6CO_2 + 4MnO_2 + 4Na+ + 12Cl^- + 8H^+$

TCE $2NaMnO_4 + C_2HCl_3 \rightarrow 2CO_2 + 2MnO_2 + 2Na^+ + 3Cl^- + H^+$

DCE $8NaMnO_4 + 3C_2H_2Cl_2 \rightarrow 6CO_2 + 8MnO_2 + 8Na^+ + 6Cl^- + 2OH^- + 2H_2O$

VC $10NaMnO_4 + 3C_2H_3Cl \rightarrow 6CO_2 + 10MnO_2 + 10Na^+ + 3Cl^- + 7OH^- + H_2O$

$NaMnO_4$ is an inorganic oxidant that performs chemically the same way as potassium permanganate, only in a more concentrated form. The significant advantage to $NaMnO_4$ and concentrated form of permanganate when used for organic oxidation of contaminants.

The ISCO groundwater remediation event will be scheduled after this Work Plan is approved by the MPCA and a variance for chemical injection into groundwater is procured from the MDH.

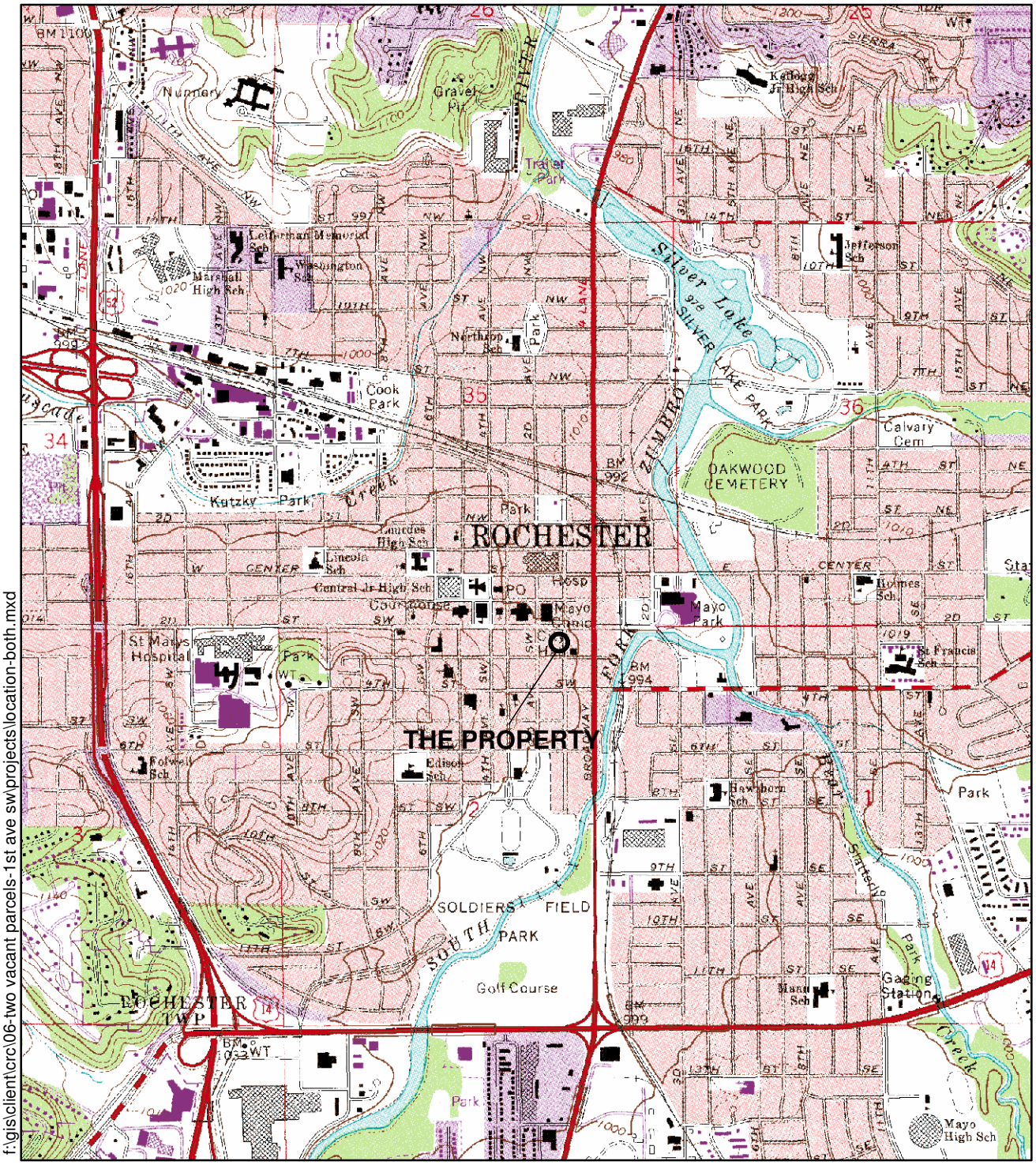
Please contact me with any questions or comments regarding this Feasibility Study/Work Plan at jskramstad@landmarkenv.com or 952-666-2417.

Sincerely,

Jason Skramstad
Vice President/Environmental Engineer
Landmark Environmental, LLC

CC: Terry Spaeth, City of Rochester

Figures



f:\gis\client\crc\06-two vacant parcels-1st ave sw\projects\location-both.mxd

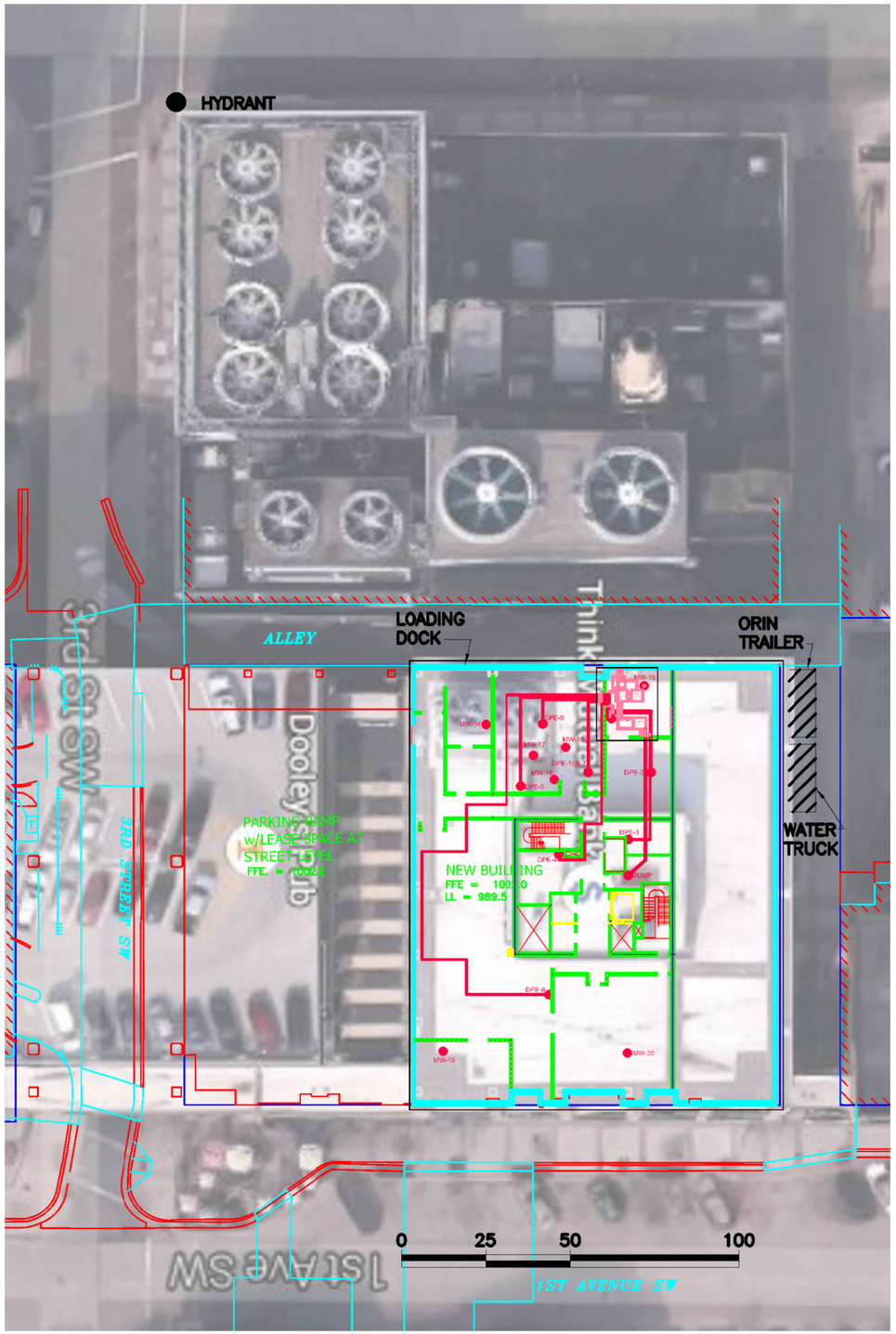
Source: Rochester, Minnesota Topographic Quadrangle, 7.5-Minute Series

N

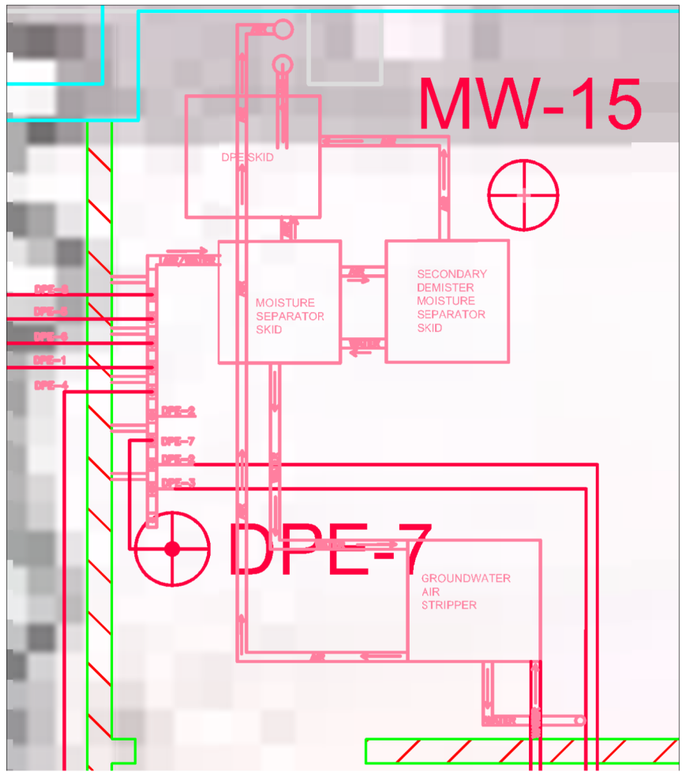
2,000 1,000 0 2,000 Feet

FIGURE 1

PROPERTY LOCATION MAP
221 1st Avenue Southwest
Rochester, Minnesota



BASEMENT FLOOR PLAN



DPE SYSTEM ROOM

Rev	Date	By	Description

LANDMARK ENVIRONMENTAL, LLC
2042 West 98th Street
Bloomington, MN 55431

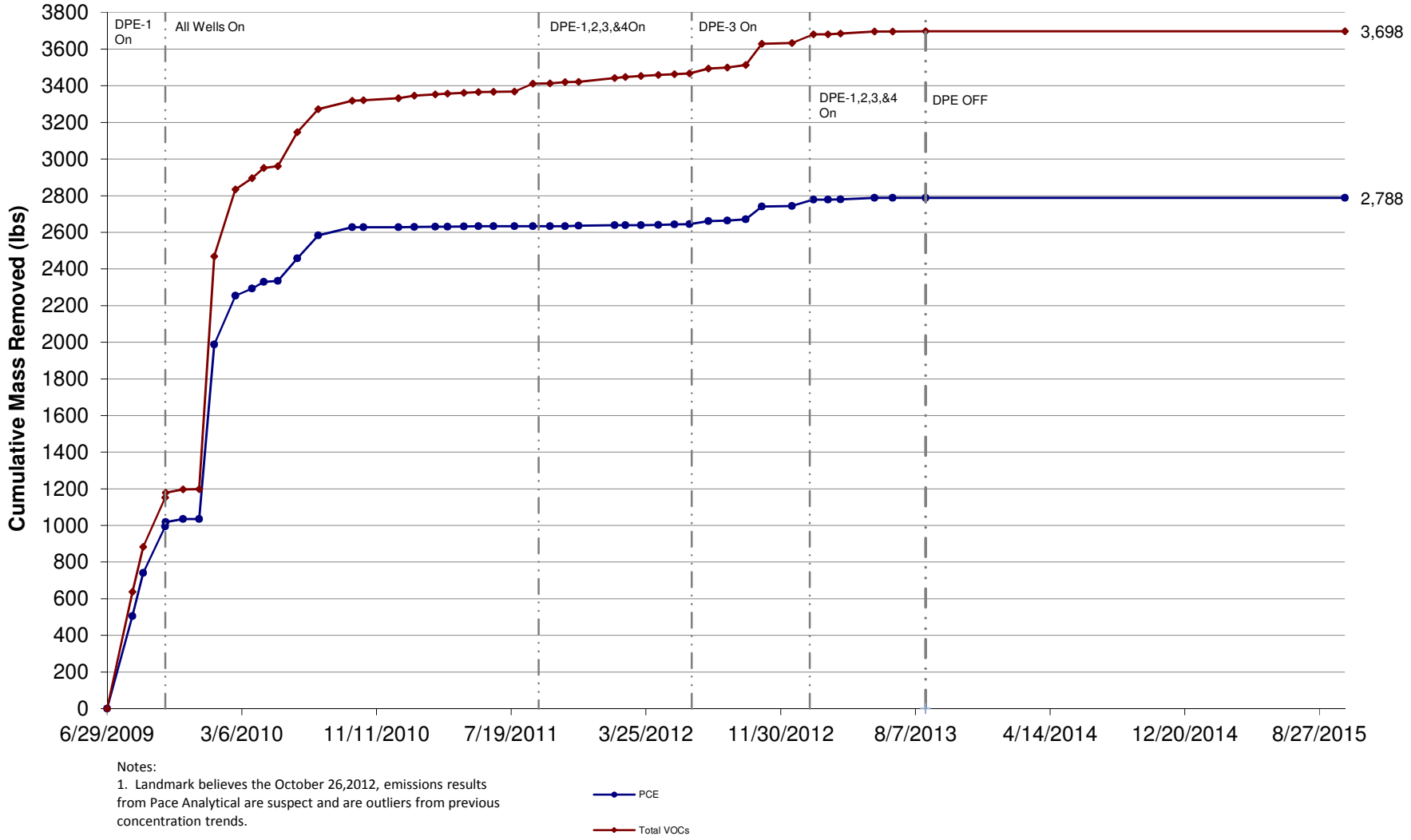
FIGURE 2

SITE LAYOUT MAP
221 FIRST AVENUE S.W.
ROCHESTER, MINNESOTA

Landmark Project Number: CRC		
Drawn: JDS	Checked: JDS	Designed: JDS
Scale: SHOWN	Date: 1/26/2016	Revision:
Drawing Number: .	Sheet . Of .	Sheets .

FIGURE 3

CUMULATIVE MASS REMOVED
MN Bio Business Center
221 1st Avenue SW
Rochester, Minnesota



Notes:
1. Landmark believes the October 26,2012, emissions results from Pace Analytical are suspect and are outliers from previous concentration trends.

FIGURE 4

PCE CONCENTRATIONS IN GROUNDWATER
December 2008 to Present
MN Bio Business Center
221 1st Avenue SW
Rochester, Minnesota

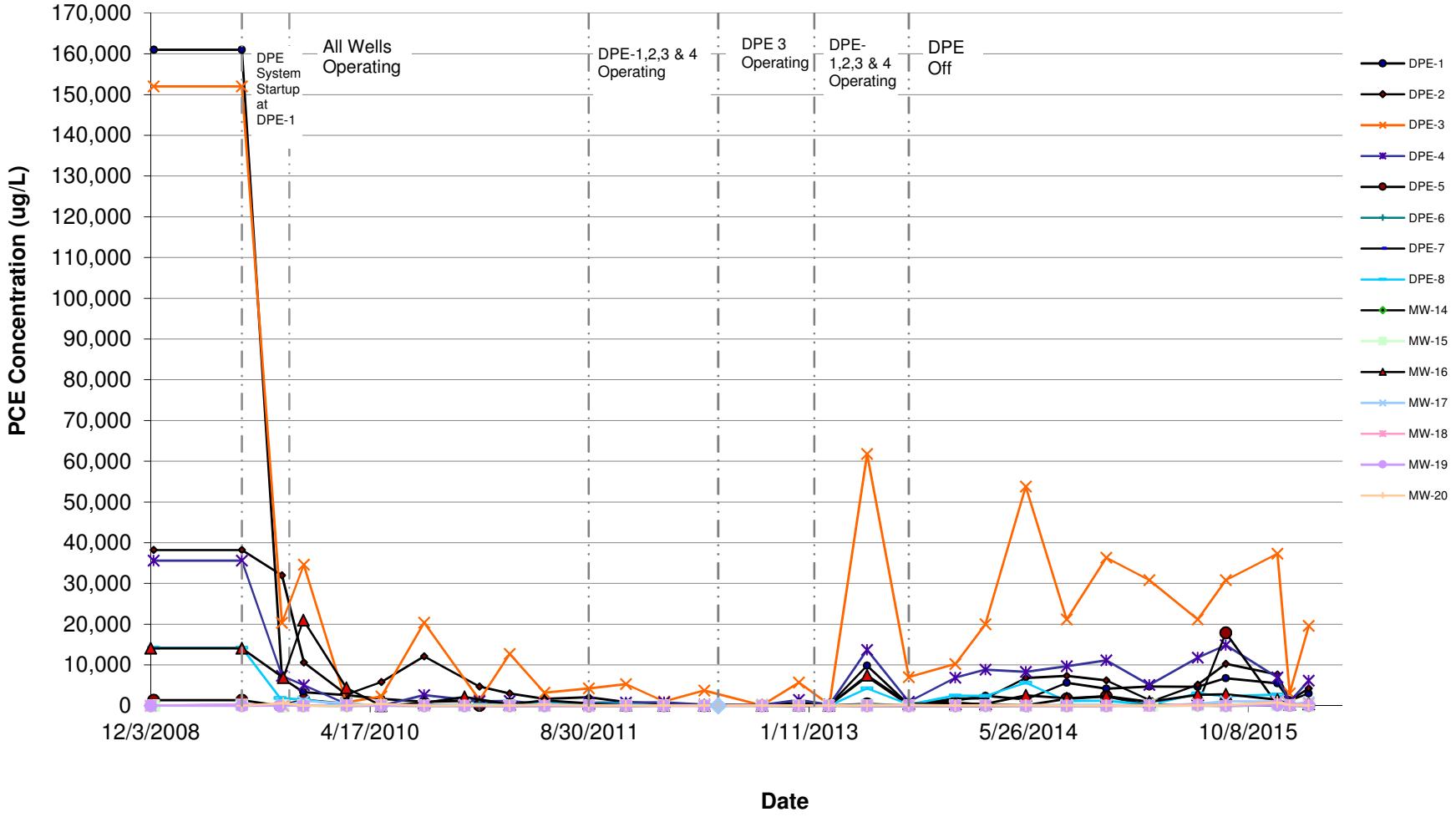
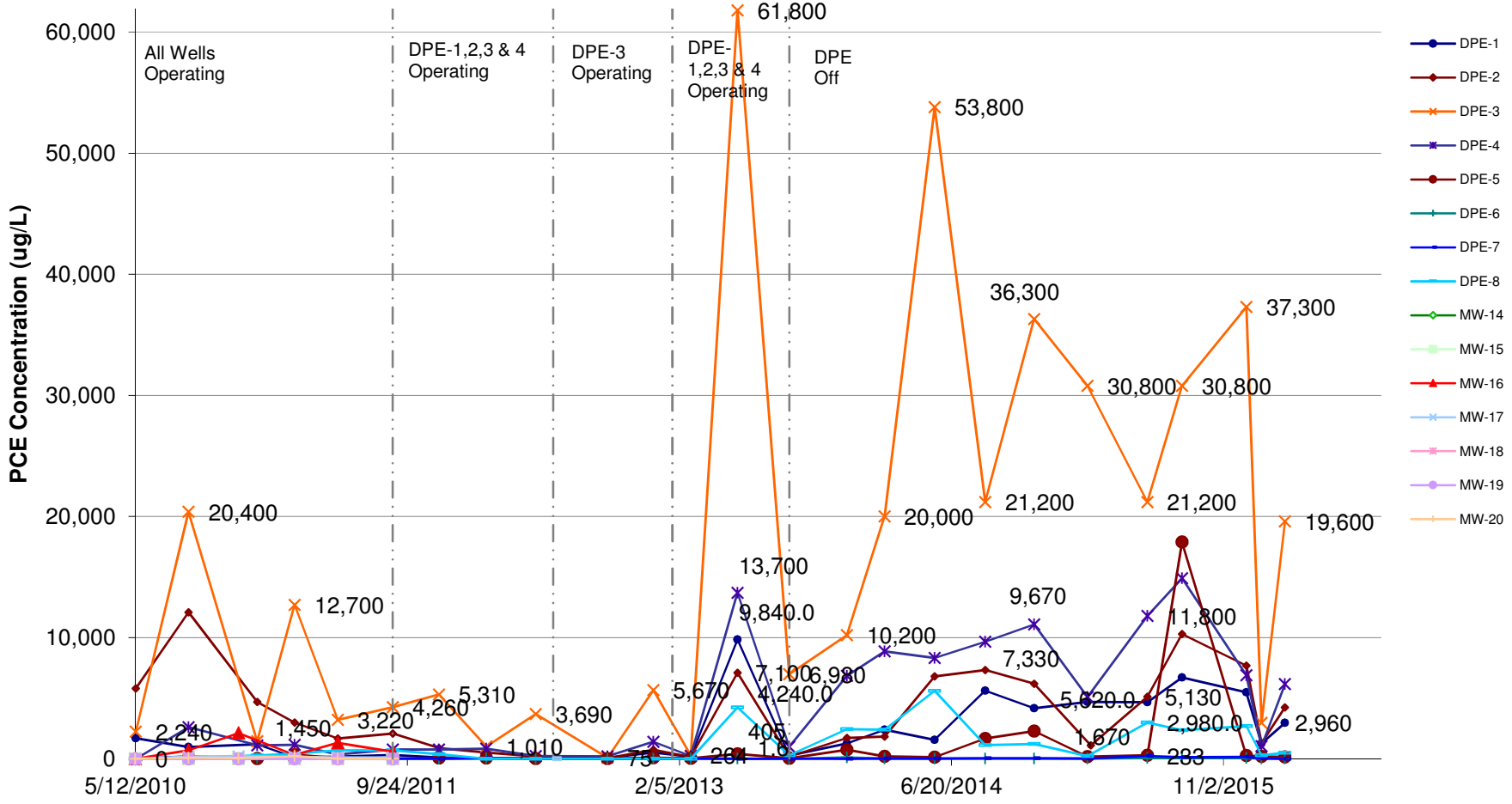


FIGURE 5

PCE CONCENTRATIONS IN GROUNDWATER
May 2010 to Present
MN Bio Business Center
221 1st Avenue SW
Rochester, Minnesota



Note:
The Minnesota Department of Health's Health Risk Limit for PCE is 5 ug/L.

Tables

TABLE 1

GROUNDWATER FIELD DATA
MN Bio Business Center
221 First Avenue SW
Rochester, Minnesota

Monitoring Well	Date Measured	Temp (Deg. C)	Conductivity @ 25 deg. C (uS/cm)	pH	Redox Potential (Eh)	Dissolved Oxygen	Head Space (ppm)
MW-14	12/3/2008	15.1	735	7.41	228	2.6	1.752
MW-14	10/1/2009	18.8	1825	7.84	181	3.6	NR
MW-14	11/16/2009	19.22	1747	6.74	47.5	3.48	NR
MW-14	2/23/2010	18.51	1693	7.54	186	2.8	NR
MW-14	5/12/2010	18.65	1539	7.5	379	5.2	NR
MW-14	8/18/2010	19.16	1088	8.24	285	5.51	NR
MW-14	11/18/2010	19.54	1137	6.95	-42	3.49	NR
MW-14	3/1/2011	18.9	996	6.2	4.3	1.34	NR
MW-14	5/19/2011	19.38	984	7.61	-19.1	2.57	NR
MW-14	8/28/2011	19.5	1711	5.59	148	3.21	NR
MW-14	11/21/2011	19.7	1123	6.92	-14.2	3.99	NR
MW-14	2/15/2012	19.3	1174	7.44	-44.9	4.58	NR
MW-14	5/17/2012	9.9	1062	7.07	-17	1.9	NR
MW-14	9/26/2012	19.4	1043	7.53	-23	6.36	NR
MW-14	12/19/2012	19.8	1119	7.42	-36	1.33	NR
MW-14	2/25/2013	19.4	1324	7.17	-11.6	4.4	NR
MW-14	5/23/2013	19.2	701	7.92	-61	4.4	NR
MW-14	8/26/2013	19.41	1266	7.54	58.2	1.59	NR
MW-14	12/10/2013	20	1507	6.99	-25	4.08	NR
MW-14	2/17/2014	19.51	1596	7.74	-20.8	1.88	NR
MW-14	4/20/2014	19.34	1411	7.78	-36.6	1.95	NR
MW-14	8/21/2014	19.9	1009	6.92	-1	4.56	NR
MW-14	11/19/2014	19.8	1129	7.57	-30	2.83	NR
MW-14	2/25/2015	19.25	1328	7.7	-54	1.6	NR
MW-14	6/15/2015	19.48	1118	7.84	-80.1	2.49	NR
MW-14	8/17/2015	19.62	1652	7.23	147.4	2.11	NR
MW-14	12/14/2015	19.76	987	7.77	218.9	4.47	NR
MW-14	1/11/2016	19.51	1313	7.34	3.9	3.94	NR
MW-15	12/3/2008	13.4	735	8.18	87	3.8	279
MW-15	10/1/2009	18.4	920	8.08	167	5.22	NR
MW-15	11/16/2009	19.6	1155	7.35	200	4.53	NR
MW-15	2/22/2010	19.5	1506	7.82	916	4.27	NR
MW-15	5/12/2010	18.56	1708	7.37	84.9	6.97	NR
MW-15	8/18/2010	21.3	1593	10.6	166	6.04	NR
MW-15	11/18/2010	19.7	1446	6.14	25.8	4.86	NR
MW-15	3/1/2011	19.6	936	7.41	16.3	2.19	NR
MW-15	5/19/2011	15.4	1314	8.08	-42	2.91	NR
MW-15	8/28/2011	19.9	2051	6.65	121	5.15	NR
MW-15	11/21/2011	18.5	14	7.38	-37	97.3	NR
MW-15	2/15/2012	18.4	841	7.61	-53	4.21	NR
MW-15	5/17/2012	9.9	1223	7.49	-20	1.9	NR
MW-15	9/26/2012	19.2	1295	7.67	-30	6.3	NR
MW-15	12/19/2012	20.4	1130	7.49	-40	1.97	NR
MW-15	2/25/2013	20.7	1416	7.4	-23	1.46	NR
MW-15	5/23/2013	20.1	5007	7.53	-41	3.36	NR
MW-15	8/26/2013	20.31	3002	7.48	33.4	2.39	NR
MW-15	12/10/2013	20.31	1322	7.47	-51	4.63	NR
MW-15	2/17/2014	20.14	967	7.95	-32.3	2.26	NR
MW-15	4/20/2014	19.83	2281	7.74	-35.7	2.82	NR
MW-15	8/21/2014	20.2	2451	7.15	63.9	3.03	NR
MW-15	11/19/2014	20.5	1805	7.02	-33	2.04	NR
MW-15	2/25/2015	19.69	1560	7.72	-56	2	NR
MW-15	6/15/2015	20.17	2766	7.79	-45.5	3.7	NR
MW-15	8/18/2015	20.41	2465	7.5	241.3	3.5	NR
MW-15	12/14/2015	20.62	2249	7.39	235.4	3.27	NR
MW-15	1/11/2016	20.27	3590	7.46	101.8	3.65	NR

TABLE 1

GROUNDWATER FIELD DATA
MN Bio Business Center
221 First Avenue SW
Rochester, Minnesota

Monitoring Well	Date Measured	Temp (Deg. C)	Conductivity @ 25 deg. C (uS/cm)	pH	Redox Potential (Eh)	Dissolved Oxygen	Head Space (ppm)
MW-16	12/3/2008	14.5	735	8.21	-45	1.9	40
MW-16	10/1/2009	18.27	1182	7.46	214	9.68	NR
MW-16	11/16/2009	18.82	4048	6.91	170	3.67	NR
MW-16	2/22/2010	18.54	3238	7.31	115	4.17	NR
MW-16	5/12/2010	18.52	3240	7.46	209	6.29	NR
MW-16	8/18/2010	19.21	2695	10.3	49	6.26	NR
MW-16	11/18/2010	19.19	2935	7.61	-71	3.54	NR
MW-16	3/1/2011	18.93	1862	7.22	-23	1.94	NR
MW-16	5/19/2011	19.2	2476	7.76	-26	2.54	NR
MW-16	8/28/2011	19.4	3357	6.96	117	4.16	NR
MW-16	11/21/2011	19.7	2535	7.17	-26	3.35	NR
MW-16	2/15/2012	18.9	1492	7.68	-57	4.25	NR
MW-16	5/17/2012	9.9	1129	7.54	-24	1.9	NR
MW-16	9/26/2012	18.9	1126	7.4	-16	6.21	NR
MW-16	12/19/2012	19.6	2177	7.39	-10	3.61	NR
MW-16	2/25/2013	19.4	1338	7.48	-27	4.7	NR
MW-16	5/23/2013	19.1	2161	7.02	-19	1.92	NR
MW-16	8/26/2013	19.69	2058	7.29	-2.5	2.37	NR
MW-16	12/10/2013	19.88	2319	7.45	-50.7	6.12	NR
MW-16	2/17/2014	19.76	2391	7.71	-19.2	4.19	NR
MW-16	4/20/2014	19.24	9599	7.01	1.9	3.43	NR
MW-16	8/21/2014	19.89	3415	7.1	92.6	3.7	NR
MW-16	11/19/2014	20.3	3437	7.43	63	3.56	NR
MW-16	2/25/2015	19.5	2559	7.45	-41	2.57	NR
MW-16	6/15/2015	19.75	4532	7.62	-33.6	3.55	NR
MW-16	8/18/2015	19.94	3952	7.39	412.4	2.43	NR
MW-16	12/14/2015	19.89	4269	7.49	111.4	2.55	NR
MW-16	1/11/2016	19.7	2876	7.28	83.5	3.19	NR
MW-17	12/3/2008	14.8	735	8.99	-99	2.6	1.3
MW-17	10/1/2009	17.8	1428	8.6	175	1.99	NR
MW-17	11/16/2009	17.62	1761	7.34	29	1.62	NR
MW-17	2/22/2010	18.25	16.08	7.66	-163	2.02	NR
MW-17	5/12/2010	18.05	1707	7.21	-82	1.96	NR
MW-17	8/18/2010	18.29	1759	10.4	15	3.51	NR
MW-17	11/18/2010	18.47	2102	7.43	-62	2.23	NR
MW-17	3/1/2011	18.5	1425	7.21	-76	1.21	NR
MW-17	5/19/2011	18.6	1371	7.87	-31	0.77	NR
MW-17	8/28/2011	19.1	2206	6.96	-116	4.1	NR
MW-17	11/21/2011	19.81	1927	7.26	-31	0.83	NR
MW-17	2/15/2012	19.04	1349	7.45	-45	0.42	NR
MW-17	5/17/2012	9.9	1000	7.54	-39	1.09	NR
MW-17	9/26/2012	18.2	753	7.03	2.1	3.02	NR
MW-17	12/19/2012	19.5	727	7.48	-40	0.43	NR
MW-17	2/25/2013	19.2	1361	7.32	-19.3	1.6	NR
MW-17	5/23/2013	19.2	1396	7.92	-58	1.62	NR
MW-17	8/26/2013	19.29	1594	7.32	-51.2	1.02	NR
MW-17	12/10/2013	20.15	1480	7.41	-48	2.77	NR
MW-17	2/17/2014	19.59	1311	7.79	-23.5	0.97	NR
MW-17	4/20/2014	19.46	1861	7.56	-26.3	1.54	NR
MW-17	8/21/2014	19.65	640	7.5	22.3	1.28	NR
MW-17	11/19/2014	19.9	1436	7.76	6.9	1.62	NR
MW-17	2/25/2015	19.44	1509	7.56	-84.1	0.57	NR
MW-17	6/15/2015	19.8	1123	9.5	-450	0.33	NR
MW-17	8/18/2015	19.73	1813	8.37	226.1	0.8	NR
MW-17	12/14/2015	19.68	1952	8.65	-78.3	0.81	NR
MW-17	1/11/2016	19.59	1817	7.67	-89.3	0.73	NR

TABLE 1

GROUNDWATER FIELD DATA
MN Bio Business Center
221 First Avenue SW
Rochester, Minnesota

Monitoring Well	Date Measured	Temp (Deg. C)	Conductivity @ 25 deg. C (uS/cm)	pH	Redox Potential (Eh)	Dissolved Oxygen	Head Space (ppm)
MW-18	12/3/2008	14.9	735	8.06	-137	3.1	1.2
MW-18	10/1/2009	17.8	1497	7.75	176	1.47	NR
MW-18	11/16/2009	16.46	2588	6.6	54.7	1.09	NR
MW-18	2/22/2010	17.7	2061	7.41	-244	1.19	NR
MW-18	5/12/2010	18.11	1992	6.98	-122	2.21	NR
MW-18	8/18/2010	17.3	1876	10.3	-69	0.69	NR
MW-18	11/18/2010	17.34	1640	7.51	-66	2.7	NR
MW-18	3/1/2011	17.4	1845	6.94	-46	0.61	NR
MW-18	5/19/2011	17.5	1949	7.41	-8.5	0.91	NR
MW-18	8/28/2011	18.9	2149	6.71	2.7	1.1	NR
MW-18	11/21/2011	19.8	1840	7.31	-34	1.03	NR
MW-18	2/15/2012	18.76	1937	7.5	-86	0.71	NR
MW-18	5/17/2012	9.9	2361	6.68	-46	5.6	NR
MW-18	9/26/2012	19.3	1680	6.98	4.9	2.9	NR
MW-18	12/19/2012	19.5	1738	7.08	-18	0.6	NR
MW-18	2/25/2013	19.9	2076	7.11	-85	0.5	NR
MW-18	5/23/2013	19.6	2121	7.67	-16	1.06	NR
MW-18	8/26/2013	19.39	2441	7.03	-65.9	0.28	NR
MW-18	12/10/2013	18.59	2655	7.22	-36.5	1.52	NR
MW-18	2/17/2014	19.58	2669	7.41	-3.4	0.62	NR
MW-18	4/20/2014	19.36	2280	7.46	-21	0.3	NR
MW-18	8/21/2014	19.59	2341	7.47	-224	0.68	NR
MW-18	11/19/2014	19.8	2198	7.36	-190	0.4	NR
MW-18	2/25/2015	19.46	2507	7.19	-116.7	0.57	NR
MW-18	6/15/2015	19.57	2113	8.23	-450	0.75	NR
MW-18	8/18/2015	19.71	2105	7.92	-164.2	2.47	NR
MW-18	12/14/2015	19.78	1392	11.01	68.1	1.93	NR
MW-18	1/11/2016	19.64	2180	7.37	-83.8	2.08	NR
MW-19	12/3/2008	13.7	735	7.20	219	2.2	0.13
MW-19	10/1/2009	15.6	3667	7.03	163	225	NR
MW-19	11/16/2009	15.96	3482	6.13	226	3.03	NR
MW-19	2/23/2010	15.81	4277	6.88	130	5.42	NR
MW-19	5/12/2010	6.4	8955	6.25	332.2	43.55	NR
MW-19	8/18/2010	17.28	3147	6.44	157	6.61	NR
MW-19	11/18/2010	16.99	4653	6.74	-25	3.71	NR
MW-19	3/1/2011	17.8	3992	6.77	30.8	2.81	NR
MW-19	5/19/2011	16.9	3750	7.05	14	2.61	NR
MW-19	8/28/2011	17.4	4618	6.59	47	4.7	NR
MW-19	11/21/2011	17.1	64	5.18	300	5.93	NR
MW-19	2/15/2012	17.33	3772	6.23	19.7	4.25	NR
MW-19	5/17/2012	9.9	4425	7.30	-3.4	7	NR
MW-19	9/26/2012	18.14	4655	6.71	17.3	8.16	NR
MW-19	12/19/2012	17	5054	6.71	-24	2.39	NR
MW-19	2/25/2013	17.9	6006	7.15	-10.3	2.12	NR
MW-19	5/23/2013	17.2	4673	6.63	-40	0.63	NR
MW-19	8/26/2013	17.54	5499	6.93	77.8	2.46	NR
MW-19	12/10/2013	17.89	5095	6.90	79.8	5.89	NR
MW-19	2/17/2014	17.38	6328	7.17	9.2	2.1	NR
MW-19	4/20/2014	17.63	5684	6.89	7.9	2.53	NR
MW-19	8/21/2014	17.6	6939	6.44	111.2	3.69	NR
MW-19	11/19/2014	17.9	6174	6.97	-4.5	2.95	NR
MW-19	2/25/2015	17.62	6298	6.87	74.5	2.41	NR
MW-19	6/15/2015	17.49	6233	6.94	-6.2	2.51	NR
MW-19	8/18/2015	17.42	7015	6.34	204.3	2.45	NR
MW-19	12/14/2015	17.99	7173	6.47	69.8	2.48	NR
MW-19	1/11/2016	17.87	6853	6.53	82.7	2.94	NR

TABLE 1

GROUNDWATER FIELD DATA
MN Bio Business Center
221 First Avenue SW
Rochester, Minnesota

Monitoring Well	Date Measured	Temp (Deg. C)	Conductivity @ 25 deg. C (uS/cm)	pH	Redox Potential (Eh)	Dissolved Oxygen	Head Space (ppm)
MW-20	12/3/2008	13.1	753	7.47	139	1.8	3.279
MW-20	10/1/2009	17.5	4008	7.31	317	6.19	NR
MW-20	11/16/2009	17.31	3760	6.8	288	3.85	NR
MW-20	2/23/2010	16.82	4720	7.23	322	5.22	NR
MW-20	5/12/2010	17.96	2410	7.16	276	7.83	NR
MW-20	8/18/2010	18.3	4559	10.1	182	8	NR
MW-20	11/18/2010	18.39	4497	7.44	-62	3.88	NR
MW-20	3/1/2011	16.6	3505	6.42	9.6	2.43	NR
MW-20	5/19/2011	18.5	3788	7.27	7.2	2.17	NR
MW-20	8/28/2011	18.7	5102	7.12	82	6.24	NR
MW-20	11/21/2011	18.45	5491	5.19	253	1.89	NR
MW-20	2/15/2012	17.95	5192	6.99	-22	4.42	NR
MW-20	5/17/2012	9.9	726	7.02	-21	1.06	NR
MW-20	9/26/2012	18.4	4277	6.99	3.6	3.9	NR
MW-20	12/19/2012	18.4	4868	6.78	-3	0.33	NR
MW-20	2/25/2013	18.9	5812	7.04	-4.8	1.3	NR
MW-20	5/23/2013	19.35	6325	6.96	-12	2.83	NR
MW-20	8/26/2013	19.13	7554	6.88	63.6	4.04	NR
MW-20	12/10/2013	19.35	6735	7.93	-32	4.93	NR
MW-20	2/17/2014	18.72	6617	7.14	10.9	0.6	NR
MW-20	4/20/2014	19.24	9599	7.01	1.9	3.43	NR
MW-20	8/21/2014	19.5	93.61	6.68	252	4.26	NR
MW-20	11/19/2014	19.6	8514	7.15	-10	4.3	NR
MW-20	2/25/2015	18.98	6510	6.96	108.1	0.76	NR
MW-20	6/15/2015	19.76	9394	7.11	-13.6	5.6	NR
MW-20	8/18/2015	20.02	1006	7.08	111.6	3.58	NR
MW-20	12/14/2015	19.38	1006	6.93	137.3	3.65	NR
MW-20	1/11/2016	19.23	9861	7.24	143.2	4.12	NR
DPE-1	12/3/2008	14.5	735	8.02	-4.9	0.9	10.5
DPE-1	9/28/2009	18.1	2584	7.64	170	4.8	NR
DPE-1	11/16/2009	18.18	2595	7.52	173	4.98	NR
DPE-1	2/22/2010	17.9	1152	6.23	255.6	8.16	NR
DPE-1	5/13/2010	18.4	2428	6.41	248	8.05	NR
DPE-1	8/18/2010	19.3	2242	10.4	286	5.54	NR
DPE-1	12/23/2010	18.61	1982	5.96	-4.7	12.57	10.1
DPE-1	3/1/2011	18.2	990	7.6	14.2	4.02	6.4
DPE-1	5/19/2011	18.9	1677	8.42	-59	4.17	NR
DPE-1	8/28/2011	18.1	2162	7.01	3	4	NR
DPE-1	11/21/2011	18.4	16.21	7.69	-53	5.89	NR
DPE-1	2/16/2012	18.14	1381	7.08	-26	5.04	NR
DPE-1	5/17/2012	9.9	1023	7.83	-57	1.09	NR
DPE-1	9/26/2012	19.1	1170	8.5	-74	5.7	NR
DPE-1	12/19/2012	18.9	1205	7.95	-64	4.24	NR
DPE-1	2/26/2013	17.1	1321	7.09	-6	5.1	NR
DPE-1	5/23/2013	19.2	4945	7.69	-49	3.63	NR
DPE-1	8/26/2013	19.97	1858	7.49	168	4.11	NR
DPE-1	12/10/2013	19.19	1176	7.9	-75.8	6.3	NR
DPE-1	2/17/2014	18.88	1910	8.3	-49.9	3.39	NR
DPE-1	4/20/2014	18.86	4150	7.89	-43.1	3.62	NR
DPE-1	8/21/2014	19.23	6093	7.69	138.2	4.41	NR
DPE-1	11/19/2014	19.02	4194	8.15	133	4.37	NR
DPE-1	2/25/2015	17.3	3570	7.83	-61	2.2	NR
DPE-1	6/15/2015	20.28	4422	7.91	-51.1	3.05	NR
DPE-1	8/17/2015	19.78	5025	7.83	162.8	3.05	NR
DPE-1	12/14/2015	19.56	4053	7.53	218.1	1.44	NR
DPE-1	1/11/2016	18.52	2309	7.54	292.7	3.56	NR

TABLE 1

GROUNDWATER FIELD DATA
MN Bio Business Center
221 First Avenue SW
Rochester, Minnesota

Monitoring Well	Date Measured	Temp (Deg. C)	Conductivity @ 25 deg. C (uS/cm)	pH	Redox Potential (Eh)	Dissolved Oxygen	Head Space (ppm)
DPE-2	12/3/2008	14.4	735	7.83	109	1.9	**2000**
DPE-2	9/28/2009	18.2	2440	8	81	7.82	NR
DPE-2	11/17/2009	18.15	4523	6.86	114	5.43	NR
DPE-2	2/22/2010	17.5	2751	7.75	283	4.57	NR
DPE-2	5/13/2010	18.1	2900	7.25	268	5.59	NR
DPE-2	8/18/2010	18.7	4401	10.4	258	5.07	NR
DPE-2	12/23/2010	17.6	962	7.09	-42	11.6	2.8
DPE-2	3/1/2011	18.6	1986	7.21	118	3.16	15.1
DPE-2	5/19/2011	18.4	1972	8	-38	2.75	NR
DPE-2	8/28/2011	18.2	3408	7.04	-62	3.6	NR
DPE-2	11/21/2011	18.5	2767	7.56	-46	2.02	NR
DPE-2	2/16/2012	18.6	1931	7.56	-51	2.37	NR
DPE-2	5/17/2012	18.9	2156	7.74	-61	4.37	NR
DPE-2	9/26/2012	19.2	943	7.9	-42	3.8	NR
DPE-2	12/19/2012	18.7	2440	7.7	-51	5.03	NR
DPE-2	2/26/2013	16.4	1062	7.10	-62	4.2	NR
DPE-2	5/23/2013	18.8	5181	7.52	-40	4.87	NR
DPE-2	8/26/2013	20.24	2245	7.49	134	4.41	NR
DPE-2	12/10/2013	19.66	5387	7.56	-57.2	6.2	NR
DPE-2	2/17/2014	19.09	4705	8.13	-41.4	3.66	NR
DPE-2	4/20/2014	19.03	6497	7.72	-34.4	4.09	NR
DPE-2	8/21/2014	19.48	7389	7.76	138.2	4.13	NR
DPE-2	11/19/2014	19.17	6329	8.1	-56	3.79	NR
DPE-2	2/25/2015	18.92	4769	7.53	-39	3.98	NR
DPE-2	6/15/2015	19.7	5018	8.06	-52.9	3	NR
DPE-2	8/17/2015	19.83	6552	8.1	180.2	3.85	NR
DPE-2	12/14/2015	19.8	5137	7.7	78.8	3.65	NR
DPE-2	1/11/2016	18.22	3076	7.63	279.1	3.88	NR
DPE-3	12/3/2008	13.4	735	7.96	127	2.5	1684
DPE-3	9/28/2009	17.3	7799	7.95	158	7.05	NR
DPE-3	11/17/2009	17.43	4442	7.1	208	3.32	NR
DPE-3	2/22/2010	15.4	4707	7.9	310	7.59	NR
DPE-3	5/13/2010	17.1	4484	7.62	270	7.36	NR
DPE-3	8/18/2010	18.4	4992	10.5	277	6.31	NR
DPE-3	12/23/2010	16.2	5922	7.15	17	16.23	28.2
DPE-3	3/1/2011	18.8	6621	7.19	-0.6	2.01	23.5
DPE-3	5/19/2011	17.2	4847	8.12	-44	5.76	NR
DPE-3	8/28/2011	NR	5894	7.61	-41	5.3	NR
DPE-3	11/21/2011	17.6	3012	7.54	-45	2.7	NR
DPE-3	2/16/2012	17.92	4634	7.07	-25	4.85	NR
DPE-3	5/17/2012	9.9	4383	7.45	-40	1.09	NR
DPE-3	9/26/2012	17	2777	8.3	-63	7.1	NR
DPE-3	12/19/2012	18.2	4487	7.14	-21	2.07	NR
DPE-3	2/26/2013	18.3	1114	7.11	-51	3.9	NR
DPE-3	5/23/2013	18.4	7742	7.02	-47	3.12	NR
DPE-3	8/26/2013	19.39	5878	6.98	156	3.47	NR
DPE-3	12/10/2013	NR*	NR*	NR*	NR*	NR*	NR
DPE-3	2/17/2014	18.58	6875	7.35	0	1.11	NR
DPE-3	4/20/2014	19.23	7780	7.07	-1.2	2.26	NR
DPE-3	8/21/2014	19.47	7917	7.14	103.7	2.97	NR
DPE-3	11/19/2014	19.07	7193	7.48	-20	2.54	NR
DPE-3	2/25/2015	17.16	6630	7.27	-32	1.59	NR
DPE-3	6/15/2015	19.87	6953	7.43	-28.7	2.2	NR
DPE-3	8/17/2015	19.98	7990	7.29	119.2	1.52	NR
DPE-3	12/14/2015	19.31	8178	7.36	153.3	3.67	NR
DPE-3	1/11/2016	18.07	7280	7.53	286.7	4.54	NR

TABLE 1

GROUNDWATER FIELD DATA
MN Bio Business Center
221 First Avenue SW
Rochester, Minnesota

Monitoring Well	Date Measured	Temp (Deg. C)	Conductivity @ 25 deg. C (uS/cm)	pH	Redox Potential (Eh)	Dissolved Oxygen	Head Space (ppm)
DPE-4	12/3/2008	13.5	735	7.84	114	1.9	**2000**
DPE-4	9/28/2009	17.14	3230	8.25	87.4	8.22	NR
DPE-4	11/17/2009	17.49	4057	7.16	285	5.2	NR
DPE-4	2/22/2010	17.4	2899	7.11	198	7.64	NR
DPE-4	5/13/2010	17.6	3362	7.88	242	8.61	NR
DPE-4	8/18/2010	18.3	3296	10.6	252	6.9	NR
DPE-4	12/23/2010	17.1	3227	7.46	3.9	NR	23.1
DPE-4	3/1/2011	18.8	874	7.18	144	1.9	11.5
DPE-4	5/19/2011	18.8	2168	8.21	-49	4.37	NR
DPE-4	8/28/2011	18.6	3318	7.63	-48	5.4	NR
DPE-4	11/21/2011	17.8	2265	7.38	-42	2.09	NR
DPE-4	2/16/2012	18.2	2692	7.5	-47	4.18	NR
DPE-4	5/17/2012	19.2	2579	7.45	-18	6.33	NR
DPE-4	9/26/2012	18.5	1891	8.1	-56	5.9	NR
DPE-4	12/19/2012	19.6	3637	6.62	-158	2.76	NR
DPE-4	2/26/2013	18.4	951	7.62	-46	4.4	NR
DPE-4	5/23/2013	19	4272	6.34	-73	1.78	NR
DPE-4	8/26/2013	20.05	3719	7.01	135	3.12	NR
DPE-4	12/10/2013	19.93	4120	6.75	-11.5	3.86	NR
DPE-4	2/17/2014	19.79	4102	6.98	19.2	1.76	NR
DPE-4	4/20/2014	19.32	4794	6.52	26.8	1.21	NR
DPE-4	8/21/2014	19.77	5364	7.05	11.3	3.11	NR
DPE-4	11/19/2014	19.4	4684	7.35	-81	2.88	NR
DPE-4	2/25/2015	20.1	4562	6.89	-93	1.45	NR
DPE-4	6/15/2015	19.93	4474	7.06	-11.9	2.27	NR
DPE-4	8/17/2015	20.21	5609	7.23	65	1.74	NR
DPE-4	12/14/2015	19.88	5983	6.69	-64.3	2.14	NR
DPE-4	1/11/2016	18.61	3878	7.65	268.1	5.28	NR
DPE-5	12/3/2008	14.3	735	9.26	13	0.5	1.3
DPE-5	9/28/2009	17.06	2264	7.94	181	0.2	NR
DPE-5	11/17/2009	18.02	2921	7.58	204	4.15	NR
DPE-5	2/22/2010	16.7	3271	7.48	231	6.3	NR
DPE-5	5/13/2010	17.1	3115	7.92	274	7.54	NR
DPE-5	8/18/2010	18.3	2997	10.5	241	3.65	NR
DPE-5	12/23/2010	17.4	2216	7.12	-13	10.3	17.7
DPE-5	3/1/2011	18.5	776	7.21	22	2.87	0
DPE-5	5/19/2011	18.6	1008	8.15	-36	2.91	NR
DPE-5	8/28/2011	18.6	3219	6.69	-44	5.9	NR
DPE-5	11/21/2011	18.5	2939	7.76	-56	4.77	NR
DPE-5	2/16/2012	18.19	2280	7.95	-72	5.11	NR
DPE-5	5/17/2012	9.9	1767	7.85	-15	1.09	NR
DPE-5	9/26/2012	18.3	1972	8.5	-73	7.2	NR
DPE-5	12/19/2012	18.9	1886	9.28	-134	0.91	NR
DPE-5	2/26/2013	19.2	1801	7.21	-44	4.6	NR
DPE-5	5/23/2013	18.85	1528	7.91	-60	1.57	NR
DPE-5	8/26/2013	19.99	2163	7.07	174	2.93	NR
DPE-5	12/10/2013	19.56	1468	8.14	-89	2.79	NR
DPE-5	2/17/2014	19.12	1508	8.26	-49.2	0.92	NR
DPE-5	4/20/2014	19.05	2290	7.92	-45.2	1.44	NR
DPE-5	8/21/2014	19.34	3428	8.37	85.9	2.21	NR
DPE-5	11/19/2014	18.5	3111	8.64	-82	0.98	NR
DPE-5	2/25/2015	19.5	2818	9.8	85.6	2.48	NR
DPE-5	6/15/2015	19.89	3738	7.08	-105.8	2.3	NR
DPE-5	8/17/2015	19.92	4832	8.53	62.5	1.57	NR
DPE-5	12/14/2015	19.87	4175	8.01	162.4	2.7	NR
DPE-5	1/11/2016	17.95	3497	7.88	179.5	5.81	NR

TABLE 1

GROUNDWATER FIELD DATA
MN Bio Business Center
221 First Avenue SW
Rochester, Minnesota

Monitoring Well	Date Measured	Temp (Deg. C)	Conductivity @ 25 deg. C (uS/cm)	pH	Redox Potential (Eh)	Dissolved Oxygen	Head Space (ppm)
DPE-6	12/3/2008	14.6	735	8.12	67.1	1.9	1.2
DPE-6	9/28/2009	18.6	1086	8.39	98.6	9.8	NR
DPE-6	11/17/2009	18.7	1400	7.81	249	6.3	NR
DPE-6	2/22/2010	17.9	1248	7.81	213	5.42	NR
DPE-6	5/13/2010	18.4	1022	8.18	272	5.86	NR
DPE-6	8/18/2010	19.1	559	11.1	251	6.67	NR
DPE-6	11/18/2010	18.39	4497	7.44	-62	3.88	NR
DPE-6	12/23/2010	17.2	3341	7.11	-12	10.9	17.7
DPE-6	3/1/2011	17.9	1048	7.09	-16	2.04	6.2
DPE-6	5/19/2011	18.4	1162	8.22	-44	2.61	NR
DPE-6	8/28/2011	18.7	1800	6.82	-3	4.6	NR
DPE-6	11/21/2011	19.3	648	8.15	-76	3.49	NR
DPE-6	2/16/2012	19.07	590	7.9	-69	3.59	NR
DPE-6	5/17/2012	14.9	611	7.93	-23	6.43	NR
DPE-6	9/26/2012	19.6	461	8	50	4.3	NR
DPE-6	12/19/2012	19.6	695	7.49	-40	3.3	NR
DPE-6	2/26/2013	17.6	1726	6.91	-40	5.1	NR
DPE-6	5/23/2013	19.12	1414	7.86	-58	3.96	NR
DPE-6	8/26/2013	20.34	1006	6.97	167	2.73	NR
DPE-6	12/10/2013	19.6	622	7.89	-75	3.17	NR
DPE-6	2/17/2014	19.62	472	7.24	-4.9	2.5	NR
DPE-6	4/20/2014	19.66	706	6.95	4.7	3.28	NR
DPE-6	8/21/2014	19.51	879	7.84	130.1	3.65	NR
DPE-6	11/19/2014	19.6	929	8.02	95	3.11	NR
DPE-6	2/25/2015	18.6	1088	7.6	13.3	3.1	NR
DPE-6	6/15/2015	19.99	882	7.98	-54.2	3.55	NR
DPE-6	8/17/2015	19.68	1132	7.84	412.4	3.14	NR
DPE-6	12/14/2015	19.65	1380	7.5	274.3	3.6	NR
DPE-6	1/11/2016	18.39	1486	7.58	193	3.53	NR
DPE-7	12/3/2008	15.2	735	7.95	92.8	0.4	2.5
DPE-7	9/28/2009	17.15	2216	7.01	196	2.14	NR
DPE-7	11/17/2009	19.01	2095	7.97	193	5.01	NR
DPE-7	2/22/2010	18.1	1354	7.84	209	5.31	NR
DPE-7	5/13/2010	18.5	1240	7.93	272	5.19	NR
DPE-7	8/18/2010	19.7	1012	11.1	276	4.13	NR
DPE-7	11/18/2010	19.19	2535	7.61	-71	3.54	NR
DPE-7	12/23/2010	17.3	5901	7.19	-18	9.6	10.7
DPE-7	3/1/2011	18.5	996	7.01	-8	1.96	0
DPE-7	5/19/2011	18.2	2472	8.09	-43	2.97	NR
DPE-7	8/28/2011	16.9	1602	7.72	-51	9.4	NR
DPE-7	11/21/2011	19.7	727	7.92	-64	3.48	NR
DPE-7	2/16/2012	19.3	1478	7.5	-48	2.5	NR
DPE-7	5/17/2012	19.3	1366	7.68	-22	4.76	NR
DPE-7	9/26/2012	19.9	747	7.8	40	4.3	NR
DPE-7	12/19/2012	20	1045	6.88	-8.6	3.04	NR
DPE-7	2/26/2013	18.4	1500	7.08	-49	3.2	NR
DPE-7	5/23/2013	19.6	2289	7.28	-28	2.98	NR
DPE-7	8/26/2013	19.6	2289	7.28	-28	2.98	NR
DPE-7	12/10/2013	19.7	972	7.9	-76	4.4	NR
DPE-7	2/17/2014	19.11	885	7.95	-31.9	3.45	NR
DPE-7	4/20/2014	19.36	11.33	7.65	-31.3	3.61	NR
DPE-7	8/21/2014	20.33	1655	7.77	95.3	3.51	NR
DPE-7	11/19/2014	19.2	1524	8.26	93	3.61	NR
DPE-7	2/25/2015	18.7	1442	6.31	103	3.36	NR
DPE-7	6/15/2015	19.91	1273	8.1	-58.4	2.65	NR
DPE-7	8/17/2015	19.94	2319	7.98	442.1	2.56	NR
DPE-7	12/14/2015	19.73	2297	7.41	182.7	3.01	NR
DPE-7	1/11/2016	20.17	1845	7.22	191.1	4.51	NR

TABLE 1

GROUNDWATER FIELD DATA
MN Bio Business Center
221 First Avenue SW
Rochester, Minnesota

Monitoring Well	Date Measured	Temp (Deg. C)	Conductivity @ 25 deg. C (uS/cm)	pH	Redox Potential (Eh)	Dissolved Oxygen	Head Space (ppm)
DPE-8	12/3/2008	13.6	753	7.52	165	1.4	1056
DPE-8	9/28/2009	17.31	2826	7.93	460	6.61	NR
DPE-8	11/17/2009	1678	3604	7.2	226	5.19	NR
DPE-8	2/22/2010	16.2	2661	7.82	227	7.15	NR
DPE-8	5/13/2010	17.8	2236	8.03	267	9.06	NR
DPE-8	8/18/2010	17.6	3115	11	262	6.68	NR
DPE-8	11/18/2010	NR	NR	NR	NR	NR	NR
DPE-8	12/23/2010	17.3	4162	NR	NR	NR	11.4
DPE-8	3/1/2011	18.4	872	6.92	21	1.87	0.8
DPE-8	5/19/2011	18.4	3649	7.21	1.7	2.22	NR
DPE-8	8/28/2011	18.7	5345	7.14	-20	4.09	NR
DPE-8	11/21/2011	18.55	5100	7.2	-28	3.38	NR
DPE-8	2/16/2012	NR*	NR*	NR*	NR*	NR*	NR
DPE-8	5/17/2012	NR*	NR*	NR*	NR*	NR*	NR
DPE-8	9/26/2012	NR*	NR*	NR*	NR*	NR*	NR
DPE-8	12/19/2012	NR*	NR*	NR*	NR*	NR*	NR
DPE-8	2/26/2013	NR*	NR*	NR*	NR*	NR*	NR
DPE-8	2/25/2013	19.9	6720	7.35	-32	4.3	NR
DPE-8	8/26/2013	19.98	7601	6.65	186	2.82	NR
DPE-8	12/10/2013	NR*	NR*	NR*	NR*	NR*	NR
DPE-8	2/17/2014	NR*	NR*	NR*	NR*	NR*	NR
DPE-8	4/20/2014	NR*	NR*	NR*	NR*	NR*	NR
DPE-8	8/21/2014	19.37	8741	7.17	165.2	3.48	NR
DPE-8	11/19/2014	NR*	NR*	NR*	NR*	NR*	NR
DPE-8	2/25/2015	20.7	6803	8.45	128	2.3	NR
DPE-8	6/15/2015	19.8	8359	7.41	-27.7	4.05	NR
DPE-8	8/17/2015	20.4	9924	7.38	125.5	2.65	NR
DPE-8	12/14/2015	19.86	9141	7.28	160.3	3.08	NR
DPE-8	1/11/2016	18.17	7311	7.35	239.3	5.57	NR

Notes:
Bold - number has exceeded the range of the instrument
NR - Not Recorded
NR* - Not Recorded, well was dry

TABLE 2

NATURAL ATTENUATION ANALYTICAL RESULTS (ug/L)
MN Bio Business Center
221 First Avenue SW
Rochester, Minnesota

Sample ID	DPE-1	DPE-1	DPE-2	DPE-2	DPE-3	DPE-3	DPE-4	DPE-4
Collected Date	09/28/2009 12:52	12/10/2008 13:50	09/28/2009 14:22	12/10/2008 11:45	09/28/200 9 15:25	12/10/2008 10:57	09/28/2009 10:13	12/10/2008 11:20
Calcium, Dissolved	NA*	**149,000**	NA*	**181,000**	NA*	**556,000**	NA*	**258,000**
Dissolved Organic Carbon	<2000	**4,800**	**2,000**	**2,800**	**3,700**	**6,900**	<2000	2700
Iron, Dissolved	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0
Magnesium, Dissolved	NA*	**33,400**	NA*	**47,600**	NA*	**103,000**	NA*	**73,400**
Methane	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Nitrate as N	**5,900**	**6,400**	**4,900**	**7,800**	**7,100**	**9,800**	**11,000**	**26,800**
Sulfate	**157,000**	**250,000**	**174,000**	**182,000**	**296,000**	**436,000**	**168,000**	**235,000**
Sulfide	<5000	<5000	<5000	<5000	<5000	<5000	<5000	<5000

Sample ID	DPE-5	DPE-5	DPE-6	DPE-6	DPE-7	DPE-7	DPE-8	DPE-8
Collected Date	12/10/2008 16:45	09/24/2009 04:00	12/10/2008 14:29	09/24/2009 04:30	12/10/200 8 13:15	09/24/2009 05:00	12/10/2008 09:30	09/24/2009 05:30
Calcium, Dissolved	**75,400**	NA*	**70,800**	NA*	**123,000**	NA*	**189,000**	NA*
Dissolved Organic Carbon	4700	<2000	2500	<2000	**3,300**	<2000	**4,000**	**3,000**
Iron, Dissolved	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0
Magnesium, Dissolved	**86,200**	NA*	**17,700**	NA*	**23,400**	NA*	**36,800**	NA*
Methane	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Nitrate as N	**5,500**	**5,500**	**3,000**	**1,500**	**7,900**	**1,900**	**9,800**	**4,300**
Sulfate	**468,000**	**281,000**	**159,000**	**67,600**	**275,000**	**85,600**	**262,000**	**149,000**
Sulfide	<5000	<5000	<5000	<5000	<5000	<5000	<5000	<5000

Notes:
Bold: Parameter detected above laboratory reporting limit
NA*: Not Analyzed

TABLE 2

NATURAL ATTENUATION ANALYTICAL RESULTS (ug/L)
MN Bio Business Center
221 First Avenue SW
Rochester, Minnesota

Sample ID	MW14	MW-14	MW15	MW15	MW16	MW-16	MW17	MW-17
Collected Date	10/01/2009 04:00	12/03/2008 16:20	10/01/2009 04:20	12/10/2008 12:15	10/01/2009 04:25	12/03/2008 12:35	10/01/2009 05:20	12/03/2008 13:10
Calcium, Dissolved	NA*	**114,000**	NA*	**67,700**	NA*	**194,000**	NA*	**76,300**
Dissolved Organic Carbon	**69,200**	**2,400**	**15,700**	<2000	**49,100**	**3,500**	**9,100**	**7,500**
Iron, Dissolved	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	**50.1**
Magnesium, Dissolved	NA*	**30,400**	NA*	**18,700**	NA*	**70,200**	NA*	**29,100**
Methane	10.1	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Nitrate as N	**1,600**	**3,700**	**580**	**2,200**	**16,200**	NA*	**3,900**	NA*
Sulfate	**146,000**	**131,000**	**99,900**	**87,500**	**258,000**	**253,000**	**159,000**	**199,000**
Sulfide	<5000	<5000	<5000	<5000	<5000	<5000	<5000	<5000

Sample ID	MW18	MW-18	MW-19	MW-19	MW20	MW20
Collected Date	10/01/2009 05:46	12/03/2008 14:26	09/24/2009 11:40	12/03/2008 16:59	10/01/2009 06:00	12/10/2008 10:30
Calcium, Dissolved	NA*	**99,000**	NA*	**245,000**	NA*	**260,000**
Dissolved Organic Carbon	**5,400**	**8,500**	<2000	**3,100**	**20,300**	**2,700**
Iron, Dissolved	**88.3**	**4,190**	<50.0	<50.0	<50.0	<50.0
Magnesium, Dissolved	NA*	**52,600**	NA*	**71,100**	NA*	**65,900**
Methane	<10.0	<10.0	**10.7**	<10.0	**274**	**17.0**
Nitrate as N	<400	NA*	**16,800**	NA*	**8900**	**10,900**
Sulfate	**110,000**	**115,000**	**156,000**	**187,000**	**139,000**	**203,000**
Sulfide	<5000	<5000	<5000	<5000	<5000	<5000

Notes:
Bold: Parameter detected above laboratory reporting limit
NA*: Not Analyzed

TABLE 3

WELL CONSTRUCTION SUMMARY
(elevations are in feet above mean sea level)

MN Bio Business Center
221 First Avenue SW
Rochester, Minnesota

Monitoring Well	Top of Casing Elevation[1,2]	Basement Floor Elevation	Top of Seal Elevation	Top of Filter Pack Elevation	Top of Well Screen Elevation	Bottom of Well Screen Elevation	Screen Interval (feet)	Depth to Bottom of Well (feet)	Bottom of Well Elevation	Well Completion
MW-14	989.50	989.50	989.50	986.00	984.00	974.00	10	17.5	972.00	flush-mounted
MW-15	991.50	989.50	990.50	987.50	985.50	975.50	10	18.0	973.50	stickup
MW-16	989.44	989.50	989.94	985.44	983.44	973.44	10	18.0	971.44	flush-mounted
MW-17	989.53	989.50	989.03	973.53	971.53	966.53	5	25.0	964.53	flush-mounted
MW-18	989.50	989.50	989.25	938.50	936.50	931.50	5	60.0	929.50	flush-mounted
MW-19	991.13	989.50	990.63	984.13	983.13	973.13	10	20.0	971.13	stickup
MW-20	991.50	989.50	992.80	988.80	986.80	976.80	10	16.7	974.80	stickup
DPE-1	992.40	989.50	989.53	984.53	982.53	970.53	12	21.9	970.53	stickup
DPE-2	992.80	989.50	990.28	986.28	984.28	972.28	12	20.5	972.28	stickup
DPE-3	992.48	989.50	990.42	989.42	987.42	975.42	12	17.1	975.42	stickup
DPE-4	992.40	989.50	990.07	987.07	985.07	973.07	12	19.3	973.07	stickup
DPE-5	992.46	989.50	990.32	987.32	986.32	974.32	12	18.1	974.32	stickup
DPE-6	992.40	989.50	989.87	986.87	984.87	972.87	12	19.5	972.87	stickup
DPE-7	993.48	989.50	990.32	984.32	983.32	971.32	12	22.2	971.32	stickup
DPE-8	992.84	989.50	990.84	989.34	987.34	975.34	12	17.5	975.34	stickup

Notes:

1. Monitoring well top of casing elevations were surveyed by Adolfson and Peterson on 4/22/08.
2. DPE well top of casing elevations changed during DPE well head installation and were estimated from a basement floor elevation of 989.5 ft and include the distance from the floor to the top of the well seal cover and the distance from the well seal cover to the top of the PVC stickup for collecting water level readings.

Attachments

Attachment 1

Attachment 2

Temporary Injection Wells – Chlorinated VOC's

Imbedded Bedrock – Hudson, WI

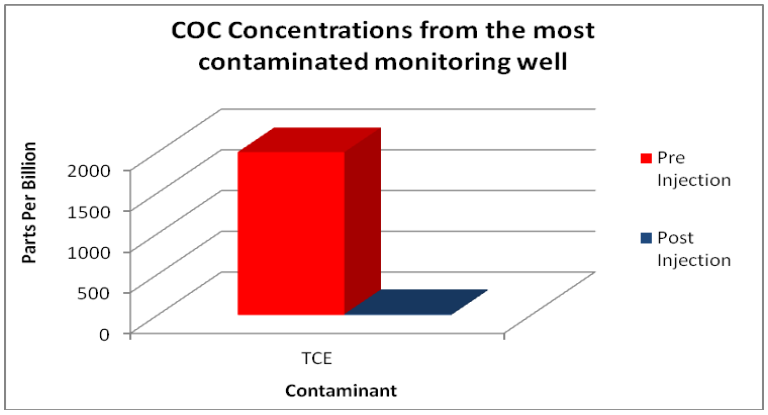
Project Profile: Imbedded Bedrock – Hudson WI

Contaminants: Trichloroethene (TCE): 2,000 ug/L

Treatment Chemistry: Sodium Permanganate

Impacted Matrix: Sandstone w/ limestone bedrock

Project Summary: ORIN successfully treated chlorinated VOC contaminated groundwater utilizing In-situ chemical oxidation. Prior to ORINs mobilization, three nested temporary injection wells were installed. Five injection wells, screened at different intervals, were installed at each of the three locations. Each of the fifteen injection wells received approximately 150 gallons of permanganate treatment chemistry. Evidence of oxidant influence was observed during the injection by the increase of key groundwater parameters such as DO, ORP and conductivity in monitoring wells down and side gradient while color change occurred in wells within the targeted plume area.



Pre and post injection concentrations of targeted contaminants

Project Results: Three months following the injection, monitoring wells were purged and sampled for VOC constituents. Average TCE concentrations were reduced from 2,000 ug/L to 12 ug/L within the pilot test area. Down gradient wells outside of the active injection area also showed a significant reduction.

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