ARCADIS

Ford Motor Company

Work Plan for Design Validation Injection Testing

June 22, 2022

Work Plan for Design Validation Injection Testing

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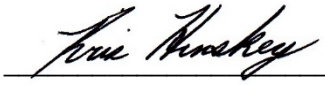

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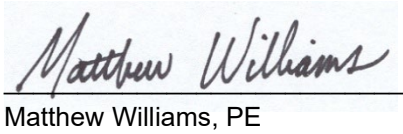

Matthew Williams, PE
Senior Environmental Engineer

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Acronyms and Abbreviations

amsl	above mean sea level
Arcadis	Arcadis of Michigan, LLC.
bgs	below ground surface
COC	constituent of concern
DR	dose response
EGLE	Environment, Great Lakes and Energy
ERD	Enhanced Reductive Dechlorination
Ford	Ford Motor Company
ft	feet
HSA	hollow stem auger
gpm	gallons per minute
LTP	Livonia Transmission Plant
mg/L	milligrams per liter
ml	milliliter
PCE	tetrachloroethene
Plan	Work Plan for Validation Injection Testing
pmw	performance monitoring well
psi	pounds per square inch
pvc	polyvinyl chloride
QAPP	Quality Assurance Project Plan
ROI	radius of influence
TCE	trichloroethene
USEPA	United States Environmental Protection Agency
VOCs	volatile organic compounds

1 Introduction

On behalf of Ford Motor Company (Ford), Arcadis of Michigan, LLC (Arcadis) has prepared this Work Plan for Design Validation Injection Testing (Plan). The Plan outlines the proposed pre-design activities that will be completed to collect site-specific design criteria that will be used to develop the full-scale injection-based design to remediate site-specific constituents of concern (COCs) at Livonia Transmission Plant (LTP).

The objective of this design validation injection testing is to determine site-specific parameters that are required for the design of a full-scale injection-based remediation system. A full-scale injection-based approach for remediation of volatile organic compounds (VOCs) at the LTP is being evaluated with the full-scale remedial objectives of:

- Target source mass beneath the plant,
- Target groundwater impacts outside the plant footprint, and
- Accelerate ongoing degradation of site specific COCs.

The location of the full-scale remediation injections is intended to be implemented at the southern half of the LTP property, refer to **Figure 1** for maximum trichloroethene (TCE) groundwater concentrations depicting the implementation area.

Following completion of the design validation injection testing the effectiveness of a full-scale injection-based remedial system for reducing on-site VOC concentrations in groundwater will be evaluated. Assuming an injection-based remedial strategy would be effective for reaching remedial objectives, a full-scale injection work plan will be developed and submitted to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) for review. The preliminary approach for full-scale remediation is to inject an organic carbon substrate to promote Enhanced Reductive Dechlorination (ERD) of VOCs in groundwater. ERD is a method of in-situ remediation that modifies the biogeochemical environment of the subsurface to enhance conditions suitable for the biological degradation of VOCs such as tetrachloroethene (PCE) and TCE to non-toxic degradation products ethane and ethene.

2 Site Description

The site is located at approximately 670 feet above mean sea level (amsl), has a relatively flat topography with a gentle slope to the east and southeast. The applicable lithology of the site is an interbedded mixture of sands and silts overlying a lacustrine clay, which is approximately 20 feet below ground surface (ft bgs). Depth to groundwater at the site ranges from approximately 7 to 9 ft bgs. Impacted groundwater is flowing through the interbedded sands and silts that overlie the lacustrine clay. **Figure 2** shows the site location.

3 Design Validation Injection Testing

The injection testing proposed at LTP will be performed as a tracer test and will involve the injection of a known volume and concentration of fluorescein dye, which is a non-reactive tracer in the subsurface. The injection testing will be conducted in two phases. The first phase will be completed during the active delivery of the tracer into the injection well and is referred to as the injection phase. During this phase, nearby wells that were installed

within the target radius of influence (ROI) (dose response wells) are monitored frequently for the arrival of tracer. The volume required to reach the dose response wells along with the sustained injection rate and pressure will be used to estimate the following parameters:

- Mobile porosity,
- Maximum sustainable injection rate,
- Optimal injection radius of influence (ROI), and
- Injection duration (time required for each injection event).

The second phase of the test is the drift phase, which begins immediately following the completion of the injection event. During this phase, the injected tracer is allowed to migrate with ambient groundwater flow and is monitored as it moves through the downgradient well network. The drift phase portion of the test is used to estimate the following parameters:

- Direction of groundwater flow,
- Average groundwater velocity, and
- Injection frequency.

4 Well Network Installation

The proposed injection test area is located within the test track near MW-23 (**Figure 3**). To complete the injection testing, the existing monitoring well network will be supplemented with one new injection well and five additional monitoring wells. Details about the monitoring wells and construction are detailed below.

4.1 Injection Well

One new injection well (IW-1) will be installed at the Site, which is provided on **Figure 3**. The injection well (IW-1) will be installed using the hollow stem auger (HSA) drilling method and will be continuously logged during drilling. The injection well (IW-1) will be constructed using 2-inch diameter polyvinyl chloride (PVC) casing with a 10-foot long stainless-steel vee-wire wrapped screen. The well screen will be set on top of the lacustrine clay, which is anticipated to be at a depth of 19 to 20 ft bgs based on the boring log for nearby MW-23 (**Appendix A**). The vee-wire screen is recommended because they have significantly more open surface area than standard slotted screens, facilitating faster injection rates, improved distribution, and allowing for aggressive development. A coarse sand pack will be installed to one foot above the top of the screen. Two feet of fine choker sand will be placed on top of the coarse sand pack to separate the sand pack from the well seal. The remainder of the well annulus will be sealed with a neat cement.

4.2 Dose Response Wells

Four nested dose response wells (DR-1S, DR-1D, DR-2S and DR-2D) will be used during the injection phase of the injection design validation study to monitor the breakthrough of the tracer as it migrates away from the injection well. MW-23 identified a saturated sand unit from 10 to 14 ft bgs and a deeper silty sand unit from 14 to 19 ft bgs, which overlaid the lacustrine clay. Nested dose response wells (DR-1S, DR-1D, DR-2S and DR-2D) will be installed in each of those intervals at two locations that will be approximately 6 and 12 feet from the injection well. The wells will be installed in different directions relative to the injection well in order to evaluate both the heterogeneity of the aquifer in relation to the target ROI and the washout of the tracer after completion of

the injection. Each nested dose response location will have a shallow and deep screen interval that will be screened in the sand and underlying silty sand respectively. The exact screen depth will be determined based on the geologic logs developed during drilling, but it is anticipated that the shallow nested dose response well will be screened from 10 to 13 ft bgs and the deep nested dose response wells will be screened from 16 to 19 ft bgs. The location of the proposed nested dose response monitoring wells are shown on **Figure 3** and monitoring well details are provided on **Table 1**.

The wells will be installed using the HSA drilling method and will be completed as a two-inch diameter well with 0.010-inch slotted, schedule 40 PVC screen and solid schedule 40 PVC riser. A coarse sand pack will be installed to 6-inches above the top of the screen and 6 inches of fine sand will be placed on top of the coarse sand pack. A bentonite seal will be installed above the fine sand in the remainder of the well annulus.

4.3 Performance Monitoring Wells

Two performance monitoring wells will be used to track the movement of the tracer as it migrates out of the ROI during the drift phase of the design validation injection test. Existing monitoring well MW-23 (boring log found in **Appendix A**), located approximately 30 ft downgradient (east) of the proposed IW-1, will be utilized as a performance monitoring well during the injection test. An additional performance monitoring well (PMW-1) will be installed outside of the ROI approximately 45 ft east of the injection well.

PMW-1 will be installed using the HSA drilling method and will be completed as a two-inch diameter well with 10 foot long, 0.010-inch slotted, schedule 40 PVC screen set on top of the lacustrine clay, which is anticipated to be at approximately 19 to 20 ft bgs. The well will be completed with a solid schedule 40 PVC riser. A coarse sand pack will be installed to 6-inches above the top of the screen and 6 inches of fine sand will be placed on top of the coarse sand pack. A bentonite seal will be installed above the fine sand in the remainder of the well annulus. The anticipated well construction details are shown on **Table 1**. The final depth of the well will be determined during drilling and will depend on the depth to clay.

4.4 Well Development

The injection and monitoring wells will be developed using intermittent surging and pumping to maximize the hydraulic connection between the well and the aquifer matrix. All wells will be initially pumped to remove sediments from the bottom of the well before surging. Wells will then be surged for approximately 30-minutes and pumped until clear and free of sediments. A maximum of 200 gallons of development water will be generated.

4.5 Investigation Derived Waste

Soil cuttings will be containerized in drums and disposed of at a permitted landfill. Wastewater generated from well development will be containerized and treated through the on-site Hydraulic Control System.

5 Design Validation Injection Test Activities

5.1 Injection Set-up

Injections will be completed using mixing tanks to mix batches of tracer solution to the desired concentration prior to injection. The tracer solution will be injected to the wellhead using a transfer pump. To control flow rates and pressure at the well head, the pump will be capable of adjustable flow rates and/or will be equipped with a recirculation line to direct a portion of the solution back to the mixing tank. The injection line will be equipped with a totalizer for tracking the total volume added to the well. The wellhead will be equipped with a pressure gauge.

5.2 Injection Volume

The estimated injection volume required to distribute the tracer solution to a target ROI is based on the mobile porosity and injection screen interval. The estimated volume of injection solution to obtain the target ROI can be calculated using the following equation:

$$V = \pi * r^2 * h * \theta_m * 7.48$$

For this Plan, the targeted ROI (r) is 15 feet, the assumed mobile porosity (θ_m) is 10%, and the injection screen interval (h) is 10 feet. The target injection volume for the first injection event is approximately 5,290 gallons for the single injection well. The actual injection volume required may vary due to the variability of site-specific mobile porosity and the actual achievable ROI. The actual injected volume may be adjusted in the field to account for any of these observed variations.

5.3 Injection Solution

A 30 milligram per liter (mg/L) solution of fluorescein dye, which is a visual tracer with a bright yellow color, will be utilized for the injection test. A safety data sheet for the proposed dye is included as **Appendix B.** Approximately 11.3 grams of tracer dye will be added for every 100 gallons of batch solution. The total mass of dye required to mix all 5,290 gallons of 30 mg/L dye solution is approximately 1.32 pounds. As noted above, assumptions were made to estimate the achievable ROI and mobile porosity. Extra dye will be available at the Site if the parameters discussed above vary significantly from the assumptions made and the total injected volume required is then larger than anticipated. The solution will be mixed continuously using a submersible sump pump placed inside the potable water poly tank or by using the transfer pump to redirect the recirculated volume of water back into the tank.

5.4 Injection Flow Rate and Pressure

An injection step test will be conducted to establish the relationship between flow rate and injection pressure. The injection will begin with no observed wellhead pressure. The injection rate will then be increased by approximately one gallon per minute (gpm) every 15 minutes until pressure is observed at the well head. The flowrate will be managed to maintain a well head pressure of less than five pounds per square inch (psi) to reduce the potential for the creation of preferential pathways and surfacing of the injected solution. Pressure and flowrate at the injection wellhead will continue to be monitored throughout the injection event.

5.5 Injection Monitoring

The performance of the injection system will be monitored continuously while injections are occurring. Example field logs are provided as **Appendix D**. The following readings will be collected during each day:

- Start time
- Total injection flow rate (approximately every half hour)
- Wellhead pressure reading (approximately every half hour)
- Stop time

In addition to the system performance monitoring readings, a field book will be maintained to record the time on-Site for field personnel and any notable events and issues that occur.

6 Design Validation Injection Test Performance Monitoring

The proposed sampling schedule for both the injection phase and drift phase of the design validation injection test is provided as **Table 2**. Groundwater will be sampled in accordance with established site-specific quality procedures outlined in the January 2021 Quality Assurance Project Plan (QAPP). Results will be reported in units of micrograms per liter (µg/L) and compared to the EGLE site specific criteria.

All fluorescein samples will be collected in 50-mL plastic vials supplied by the selected laboratory and held in a dark space away from ultraviolet light sources. Instructions for storage and shipping of fluorescein dye samples are included in **Appendix C**.

All VOC groundwater samples will be containerized in laboratory supplied sample jars and submitted on ice under chain-of-custody protocols to Eurofins Barberton, Ohio laboratory for analysis on a standard 10-day turnaround time (TAT). Fluorescein groundwater samples will be containerized in laboratory supplied sample jars and submitted under chain-of-custody protocols to Ozark Underground Laboratory in Protem, Missouri on a standard TAT.

6.1 Baseline Sampling

Baseline groundwater samples for fluorescein and VOCs will be collected from all the wells shown in **Table 2** after the well installation and development is complete and prior to the start of the injection test. Samples will be collected in accordance with January 2021 QAPP for low-flow groundwater sampling procedures. VOC samples will be analyzed by USEPA Method 8260. VOC data collected from the well network will be compared to the tracer distribution results to determine if injection wells screened across the heterogeneous silty sand geology are capable of distributing organic carbon to each of the intervals where VOC contamination is present.

6.2 Tracer Batch Sampling

Grab samples will be collected from up to four batches of fluorescein dye to confirm the injected concentration. The samples will be collected from the polyethylene mixing tank prior to injection. These sample will be held on-site for the duration of the injection event and will be submitted for laboratory analysis with the samples collected during the injection phase.

6.3 Injection Phase Performance Monitoring

During the injection phase of the test, samples will be collected from dose response wells after every 250-gallons that is injected, and from nearby performance monitoring wells after every 1,000-gallons injected. Sampling frequency may be increased when the tracer is first observed to better characterize the breakthrough curve and may be decreased if visual observations of the samples suggest breakthrough of the tracer is complete. Samples will be visually compared to pre-prepared standards to estimate the tracer concentration (**Appendix C**). When the injection test is complete, four to five samples from each well will be submitted for laboratory analysis to quantitatively analyze the breakthrough strength of the injected solution.

6.4 Drift Phase Performance Monitoring

After the injection phase has been completed, the post-injection drift phase monitoring program will begin. Samples will be collected from the injection well, dose response wells and performance monitoring wells on a weekly basis to track washout from the injection and dose response wells and breakthrough at the downgradient performance monitoring wells (**Table 2**). The duration of the drift phase performance monitoring sampling program is expected to last for an estimated 12 weeks, but the actual duration will be based on washout or the observation of decreasing dye concentrations at the performance monitoring wells. This would indicate the arrival and subsequent departure of the center of mass of the injected solution. Sampling frequency and the sampling network may be adjusted based on field observations. A subset of the samples collected during the drift phase test will be submitted for laboratory analysis.

7 Closing

Following completion of the tracer activities discussed above, a report will be prepared detailing the activities and findings, as well as calculated values for design parameters for a full-scale injection-based remediation system.

If an injection-based remedial strategy would be effective for reaching the full-scale remedial objectives of initiating source zone treatment and accelerating ongoing remediation efforts, then a subsequent remedial design/work plan will be developed for EGLE to review. The work plan will include details on full-scale remedial approach, injection well locations and screen intervals, injection volumes and frequency, proposed remedial amendments and performance monitoring.

Tables

Table 1
Well Network for Performance Monitoring
Ford Motor Company
Livonia Transmission Plant

Monitoring Well	Approximate Well Depth (ft bgs)	Screen Length (ft)	Well Diameter (inches)	Approximate Distance from Injection Wells (ft)	Well Function	Estimated Distance from Injection Well ROI (ft)
IW-1	19.0	10.0	2	NA	Injection	NA
DR-1S	13.0	3.0	2	6	Dose Response	Within
DR-1D	19.0	3.0	2	6	Dose Response	Within
DR-2S	13.0	3.0	2	12	Dose Response	Within
DR-2D	19.0	3.0	2	12	Dose Response	Within
MW-23	20.0	5	2	30	Downgradient Perfomance Monitoring	15
PMW-1	19.0	10.0	2	45	Downgradient Perfomance Monitoring	30

Footnotes:
ft bgs - feet below ground surface
ROI - Radius of Influence
NA - Not Applicable

Table 2
Performance Monitoring Program
Ford Motor Company
Livonia Transmission Plan

Well ID		Location	Baseline Sampling[1]	Injection Phase[2]		Drift Phase[2]
			Pre-Injection	Every 250 gallons	Every 1,000 gallons	Week 1 to 12
Injection Well	IW-1	Injection Well	X			Weekly
Dose Response Wells	DR-1S	Within ROI of IW-1	X	X		Weekly
	DR-1D	Within ROI of IW-1	X	X		Weekly
	DR-2S	Within ROI of IW-1	X	X		Weekly
	DR-2D	Within ROI of IW-1	X	X		Weekly
Performance Monitoring Wells	MW-23	Downgradient	X		X	Weekly
	PMW-1	Downgradient	X		X	Weekly

Footnotes:

1 - Baseline groundwater samples will be analyzed for fluorescein and VOCs (by 8260D).
2 - Injection and Drift Phase groundwater samples will be analyzed for fluorescein only
- Fluorescein samples will be held after collection and a subset will be selected for analysis.
- Proposed sampling plan is preliminary only and will be adapted as necessary based on field observations of tracer.
- Wells may be added or removed from list and sampling duration may be shortened or extended as necessary to capture breakthrough.

Figures

User Name: MSMiller Date Saved: 8/5/2020 10:52:01 AM Project Number: 30050315.601.01
Document Path: D:\Livonia\Docs\2020-05\R\10pt3\Completed\Figure10_NonRes_GW_TCE_Csize1.mxd

Legend

- ND - 1.0 µg/L
- 1.1 - 210 µg/L
- 210.1 - 1,000 µg/L
- >1,000 µg/L
- VAULT (2 FT x 2 FT)
- VAULT (4 FT x 6 FT)

TCE CONCENTRATION > NR VIAC CRITERIA

- 210.1 - 1,000 µg/L
- >1,000 µg/L
- FORD PROPERTY BOUNDARY
- PROPERTY BOUNDARY

N

0 300 600 Feet

NOTES:
J - ESTIMATED VALUE

LIFHP - LASER-INDUCED FLUORESCENCE HYDRAULIC PROFILING

LMW - LNAPL MONITORING WELL

PW - PUMPING WELL

SB - SOIL BORING

TW - TEMPORARY WELL

UB - ANALYTE CONSIDERED NON-DETECT AT THE LISTED VALUE DUE TO ASSOCIATED BLANK CONTAMINATION

TCE - TRICHLOROETHENE

µg/L - MICROGRAMS PER LITER (PARTS PER BILLION)

HPT - HYDRAULIC PROFILING TOOL

MW - MONITORING WELL

VAP - VERTICAL AQUIFER PROFILE

EGLE - MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

THE EGLE RESIDENTIAL VOLATILIZATION TO INDOOR AIR CRITERIA (VIAC) ADJUSTED FOR A 12-HOUR WORK DAY EXPOSURE FOR TRICHLOROETHENE IS 1 µg/L.

MAXIMUM CONCENTRATION POSTED WHERE MULTIPLE SAMPLE EVENTS OR DEPTH INTERVALS AVAILABLE

VOCS ANALYZED USING EPA METHOD 8260 OR 8265.

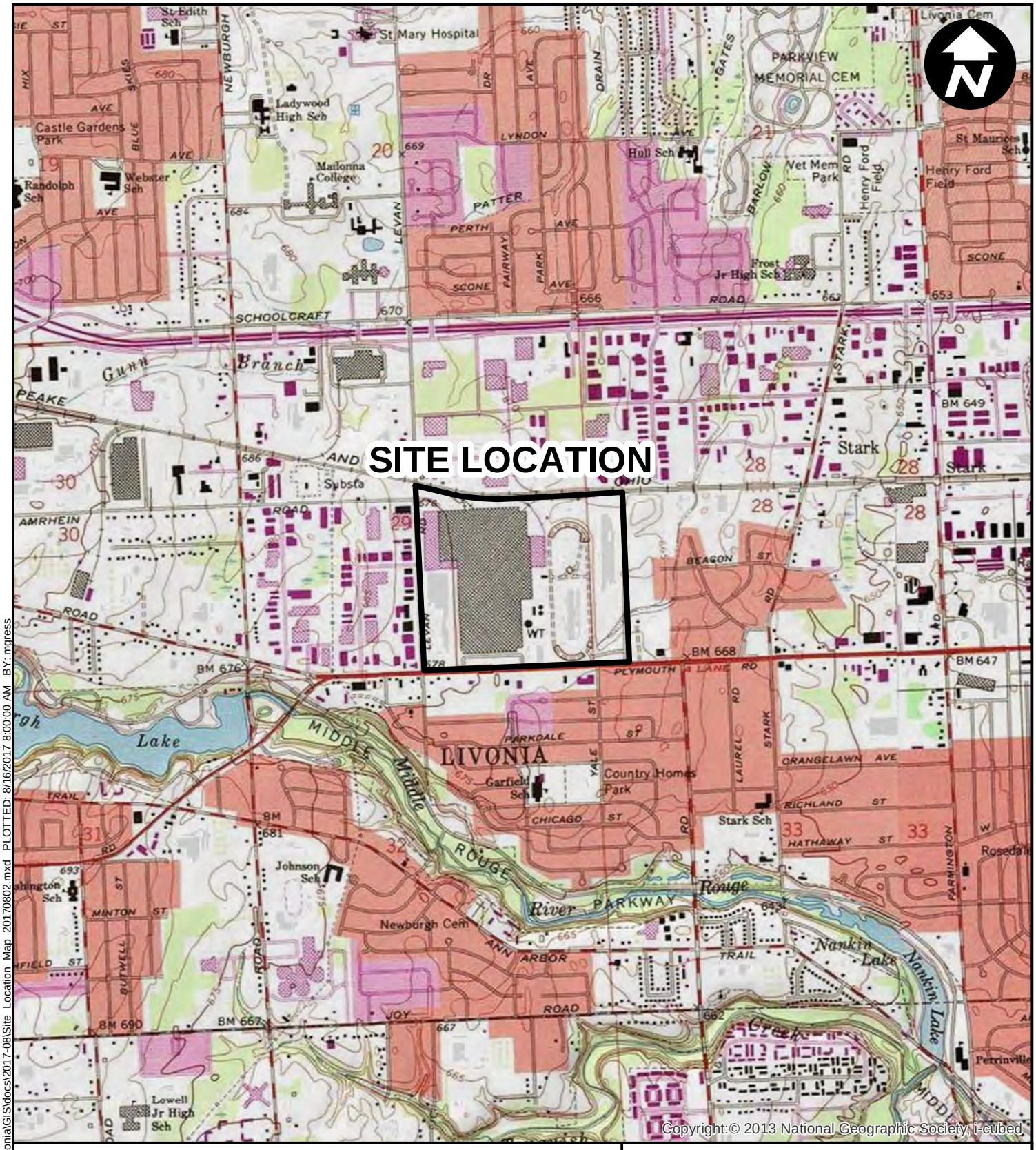
DATA COLLECTED FROM FEBRUARY 2015 THROUGH MARCH 2020.

FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

MAXIMUM TRICHLOROETHENE IN NONRESIDENTIAL GROUNDWATER

ARCADIS

FIGURE 1



0 2,000 4,000

SCALE IN FEET

SOURCE:

USGS 7.5 MINUTE TOPOGRAPHIC MAP
NORTHVILLE AND WAYNE QUADRANGLES

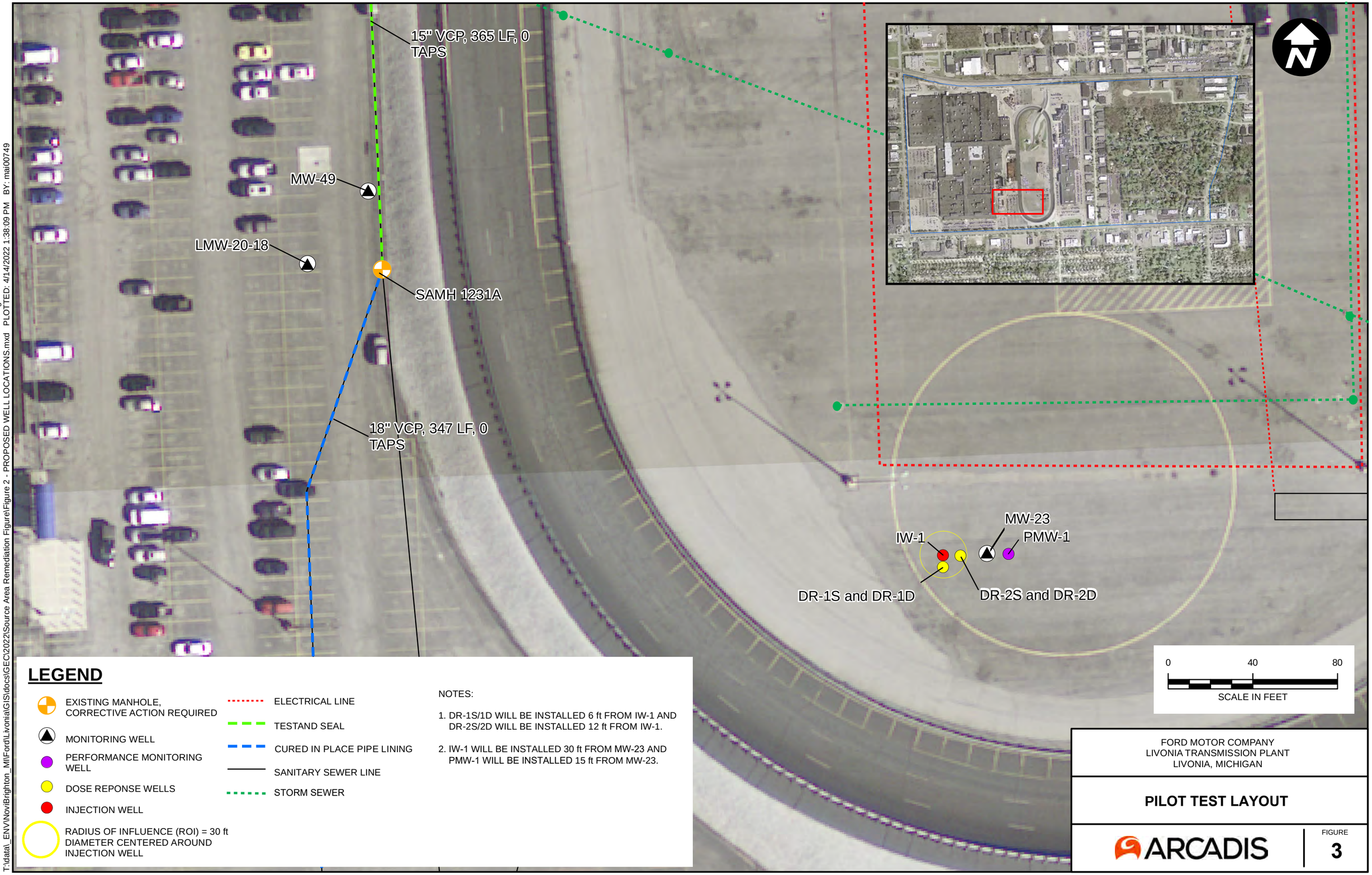
FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

SITE LOCATION MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2

CITY: Novi DIV: ENV DB: MG PROJECT NUMBER: MI001322.0001 COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet
Z:\GISProjects\ ENV\Novi\Brighton MI\Ford\Livonia\GIS\docs\2017-08\Site Location Map 20170802.mxd PLOTTED: 8/16/2017 8:00:00 AM BY: mgress



LEGEND

- EXISTING MANHOLE, CORRECTIVE ACTION REQUIRED
- MONITORING WELL
- PERFORMANCE MONITORING WELL
- DOSE REPONSE WELLS
- INJECTION WELL
- RADIUS OF INFLUENCE (ROI) = 30 ft DIAMETER CENTERED AROUND INJECTION WELL
- ELECTRICAL LINE
- TESTAND SEAL
- CURED IN PLACE PIPE LINING
- SANITARY SEWER LINE
- STORM SEWER

NOTES:

1. DR-1S/1D WILL BE INSTALLED 6 ft FROM IW-1 AND DR-2S/2D WILL BE INSTALLED 12 ft FROM IW-1.
2. IW-1 WILL BE INSTALLED 30 ft FROM MW-23 AND PMW-1 WILL BE INSTALLED 15 ft FROM MW-23.

FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

PILOT TEST LAYOUT

ARCADIS

FIGURE
3

CITY: Novi DIV: ENV DB: MG PIC: R. ELLIS PM: K. HINSKEY PROJECT NUMBER: 30080642 COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet
T:\data_ENV\Novi\Brighton_MI\Ford\Livonia\GIS\docs\GEC\2022\Source Area Remediation Figure\Figure 2 - PROPOSED WELL LOCATIONS.mxd PLOTTED: 4/14/2022 1:38:09 PM BY: mal00749

Appendices

Appendix A

Monitoring Well- 23 Boring Log

PROJECT No.: 1412419 / 0002

CLIENT: Ford - Livonia
PROJECT: Ford
LOCATION: Livonia, MI

RECORD OF BOREHOLE MW-23

BORING DATE: March 19, 2015 - March 19, 2015
DRILLING CONTRACTOR: Terra Probe

SHEET 1 OF 1
DATUM: Local

DEPTH SCALE FEET	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	RECOVERY %	BLOWS/ft	ELEVATION FEET	PID ppm	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
0	Ground Surface										
	(SP) SAND, fine to medium, trace gravel		0.00	1		50		670			Flush mount
				2		50			ND		
5				3		100		665	ND		
	(SM) SILTY SAND, trace organics (7.8 feet to 8 feet)		7.00	4		100					Soil sample
											Water level observed in open hole during drilling
10	**(SP)** SAND, coarse, trace gravel		10.00					660			
	(SM) SILTY SAND		14.00								
15								655			
	(CL) SILTY CLAY										
20	End of .		20.00					650			
25								645			
30											

PID ppm: 2 4 6 8

PID ppm: 2 4 6 8

DOWN HOLE DEPTH SCALE

1 inch to 3.8 feet

Golder Associates

SOIL CLASSIFICATION SYSTEM: USCS

LOGGED: Stephen Tatum

CHECKED: DRAFT

REV:

Appendix B

Safety Data Sheet – Fluorescein Dye

SAFETY DATA SHEET (SDS)
REVISION DATE: 03/03/2016

HUE CORPORATION

Color your everything, may your Hue come true

SECTION I. IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

PRODUCT IDENTIFIER:

PRODUCT NAME ..... **HUE URANINE CONC** (Also known as Fluorescein)
PRODUCT NUMBER 1-C8-073PC
COLOR INDEX NAME ..... ACID YELLOW 073
COLOR INDEX NO 45350
C. A. S. # 518-47-8
CHEMICAL FAMILY..... XANTHENE

INTENDED USE OF THE PRODUCT:

FELT TIP, MARKER INKS, WATER BASED COATINGS AND LEAK DETECTION

NAME, ADDRESS AND TELEPHONE OF RESPONSIBLE PARTY:

HUE CORPORATION	TELEPHONE	714-389-3130
P.O. BOX 509	FAX	714-389-9731
TUSTIN, CA 92781	EMAIL	SUPPORT@HUECORPORATION.COM

EMERGENCY TELEPHONE NUMBER:

CHEMTREC (USA)	1-800-424-9300
CHEMTREC (OUTSIDE USA)	1-703-527-3887

SECTION 2. HAZARD(S) IDENTIFICATION

CLASSIFICATION OF THE SUBSTANCE OR MIXTURE:

GHS-US
ACUTE TOX. - INHALATION (CATEGORY 5)
EYE DAM./IRRITATION (CATEGORY 2B)
SKIN CORR./IRRITATION (CATEGORY 3)

GHS LABELING:

HAZARD PICTOGRAMS (GHS-US):	NO SYMBOL
SIGNAL WORD	WARNING
HAZARD STATEMENT(S)	H333 - MAY BE HARMFUL IF INHALED H320 - CAUSES EYE IRRITATION H316 - CAUSES MILD SKIN IRRITATION
PRECAUTIONARY STATEMENTS	P305 + 351 + P338 - IF IN EYES: RINSE CAUTIOUSLY WITH WATER FOR SEVERAL MINUTES. REMOVE CONTACT LENSES IF PRESENT AND EASY

TO DO. CONTINUE RINSING.
P337 + P313 - IF EYE IRRITATION OCCURS/PERSISTS:
GET MEDICAL ADVICE AND ATTENTION.
P261 - AVOID BREATHING DUST/FUMES/GAS/MIST/VAPORS/SPRAY
P264 - WASH FACE THOROUGHLY AFTER HANDLING.
P322 + P313 - IF SKIN IRRITATION OCCURS: GET MEDICAL ADVICE/ ATTENTION.
P304 + 312 - IF INHALED: CALL A POISON CENTER/DOCTOR/PHYSICIAN IF YOU FEEL UNWELL

OTHER HAZARDS NO DATA AVAILABLE
UNKNOWN ACUTE TOXICITY NO DATA AVAILABLE

SECTION 3. COMPOSITION / INFORMATION ON INGREDIENTS

DESCRIPTION OF MIXTURE: PROPRIETARY MIXTURE OF DYES.

SUBSTANCE:

NAME	C.A.S.#	WEIGHT 100%	GHS-US CLASSIFICATION
ACID YELLOW 073	518-47-8	100%	ACUTE TOX. - INHALATION (CATEGORY 5) EYE DAM./IRRITATION (CATEGORY 2B) SKIN CORR./IRRITATION (CATEGORY 3)

SECTION 4. FIRST AID MEASURES

FIRST AID MEASURES GENERAL:

INHALATION: REMOVE TO FRESH AIR. IF BREATHING IS DIFFICULT, GIVE OXYGEN AND GET IMMEDIATE MEDICAL ATTENTION.

SKIN: WASH WITH MILD SOAP AND WATER. IF IRRITATION OCCURS GET MEDICAL ATTENTION. IF CLOTHING IS CONTAMINATED, RE-MOVE AND WASH BEFORE REUSE.

EYES: FLUSH EYES WITH WATER FOR AT LEAST 15 MINUTES, HOLDING EYELIDS APART FOR THOROUGH IRRIGATION. GET IMMEDIATE MEDICAL ATTENTION.

INGESTION: INDUCE VOMITING - SEEK IMMEDIATE MEDICAL ATTENTION.

MOST IMPORTANT SYMPTOMS AND EFFECTS, ACUTE AND DELAYED:

THIS PRODUCT IS NOT HAZARDOUS AS DEFINED BY HAZARDOUS COMMUNICATION STANDARD. HOWEVER, AS WITH ALL CHEMICAL; HANDLE WITH CARE, AVOID EYE AND SKIN CONTACT, AVOID INHALATION OF DUSTS OR VAPORS. WASH THOROUGHLY AFTER HANDLING. KEEP CONTAINERS CLOSED.

SECTION 5. FIRE-FIGHTING MEASURES

EXTINGUISHING MEDIA:

WATER, DRY CHEMICAL, CARBON DIOXIDE, FOAM.

SPECIAL HAZARDS ARISING FROM SUBSTANCE OR MEDIA:

FIREFIGHTERS SHOULD BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS TO GUARD AGAINST POTENTIALLY TOXIC AND IRRITATING FUMES. AVOID DUSTING. DUST CAN FORM EXPLOSIVE MIXTURES WITH AIR.

PROTECTION/ADVICE FOR FIREFIGHTER(S):

BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING.

SECTION 6. ACCIDENTAL RELEASE MEASURES

PERSONAL PRECAUTIONS:

REMOVE PERSONS FROM DANGER AREA.

ENVIROMENTAL PRECAUTIONS:

AVOID ANY UNCONTROLLED RELEASE OF MATERIAL. DO NOT EMPTY INTO DRAINS OR THE AQUATIC ENVIRONMENT.

EMERGENCY PROCEDURES:

NO ADDITIONAL INFORMATION

METHODS AND MATERIALS FOR CONTAMINENT AND CLEANING UP:

WHERE SPILLS ARE POSSIBLE, A COMPREHENSIVE SPILL RESPONSE PLAN SHOULD BE DEVELOPED AND IMPLEMENTED. AVOID ANY UNCONTROLLED RELEASE OF MATERIAL.

UTILIZE RECOMMENDED PROTECTIVE CLOTHING AND EQUIPMENT (SEE SECTION 8).
SPILLS SHOULD BE SWEPT UP USING AN ABSORBENT DUST CONTROL PRODUCT AND PLACED IN CONTAINERS. SPILL AREA CAN BE WASHED WITH WATER. COLLECT WATER FOR APPROVED DISPOSAL.
IN THE EVENT OF UNCONTROLLED RELEASE OF THIS MATERIAL, THE USER SHOULD DETERMINE IF THE RELEASE IS REPORTABLE UNDER APPLICABLE LAWS AND REGULATIONS.

SECTION 7. HANDLING AND STORAGE

PRECAUTIONS FOR SAFE HANDLING:

HANDLE WITH CARE. AVOID OVER EXPOSURE. USE NIOSH/OSHA APPROVED RESPIRATOR, WORK GLOVES, AND CLOTHING. WASH AFTER HANDLING. SENSITIVE INDIVIDUALS MAY EXPERIENCE RESPIRATORY ALLERGIES. MAY CAUSE SKIN IRRITATION. USE WITH LOCAL VENTILATION.

CONDITIONS FOR SAFE STORAGE, INCLUDING ANY INCOMPATIBILITIES:

USE PROCESS ENCLOSURES, LOCAL EXHAUST VENTILATION OR OTHER ENGINEERING CONTROLS TO KEEP AIRBORNE LEVELS BELOW RECOMMENDED EXPOSURE LIMITS.

KEEP AWAY FROM HEAT. KEEP AWAY FROM SOURCES OF IGNITION.

KEEP AWAY FROM STRONG OXIDIZING AND REDUSING AGENTS.

SPECIFIC END USES:

FELT TIP, MARKER INKS, WATER BASED COATINGS AND LEAK DETECTION

SECTION 8. EXPOSURE CONTROLS /PERSONAL PROTECTION

CONTROL PARAMETERS:

INGREDIENTS WITH LIMIT VALUES THAT REQUIRE MONITORING AT THE WORKPLACE - NOT REQUIRED

EXPOSURE CONTROLS:

APPROPRIATE ENGINEERING CONTROLS - THE USUAL PRECAUTIONARY MEASURES ARE TO BE ADHERED TO WHEN HANDLING CHEMICALS.

PERSONAL PROTECTIVE EQUIPMENT:

HAND PROTECTION	WEAR IMPERMEABLE RUBBER OR PLASTIC GLOVES
EYE PROTECTION	TIGHTLY SEALED SAFETY GOGGLES OR FULL FACE SIDE SHIELDS.
SKIN AND BODY	APRON, COVERALLS AND NON-LEATHER SOLED WORK SHOES. WASH DYE CONTAMINATED CLOTHES AND SKIN WITH MILD SOAP AND DETERGENTS.
RESPIRATORY	WEAR OSHA/NIOSH APPROVED DUST MASK/RESPIRATOR
HYGIENE MEASURES	HANDLE IN ACCORDANCE WITH GOOD INDUSTRIAL HYGIENE AND SAFETY PRACTICES. WASH HANDS AFTER HANDLING MATERIAL.
OTHER PROTECTION	DELUGE SAFETY SHOWER AND EYE WASH STATION SHOULD BE LOCATED NEAR WORK AREA.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

INFORMATION ON BASIC PHYSICAL AND CHEMICAL PROPERTIES :

APPEARANCE, COLOR, ODOR	YELLOW POWDER, NO ODOR
pH	8.0 - 9.0
MELTING POINT/FREEZING POINT	ND
INITIAL BOILING POINT/BOILING RANGE	0.00
FLASHPOINT	NORMALLY STABLE, NOT COMBUSTIBLE NOR FLAMMABLE
EVAPORATION RATE	NO DATA
FLAMMABILITY (SOLID,GAS)	NORMALLY STABLE, NOT COMBUSTIBLE NOR FLAMMABLE
UPPER EXPLOSIVE LIMITS	NA
LOWER EXPLOSIVE LIMITS	NA
VAPOR PRESSURE	NA
VAPOR DENSITY	NA
RELATIVE DENSITY	NA
SOLUBILITY IN WATER	SOLUBLE
PARTITION COEFFICIENT N-OCTANOL/WATER	NO DATA

AUTO-IGNITION TEMPERATURE	NO DATA
DECOMPOSITION TEMPERATURE	NO DATA
VISCOSITY, DYNAMIC	NO DATA
VISCOSITY, CINEMATIC	NO DATA
EXPLOSIVE PROPERTIES	N/A
OXIDIZING PROPERTIES	NA
OTHER INFORMATION	NA

SECTION 10. STABILITY AND REACTIVITY

CHEMICAL STABILITY	STABLE UNDER NORMAL STORAGE AND HANDLING CONDITIONS.
CONDITIONS TO AVOID	OXIDIZING & REDUCING AGENTS MAY DESTROY COLOR.
INCOMPATIBLE MATERIALS	OXIDIZING & REDUCING AGENTS MAY DESTROY COLOR.
HAZARDOUS DECOMPOSITION PRODUCTS	CO, CO2, OXIDES OF NITROGEN AND OTHER POTENTIALLY TOXIC FUMES.

SECTION 11. TOXICOLOGICAL INFORMATION

TOXICOLOGICAL EFFECTS :

ORAL (ANIMAL	GREATER THAN 7,000 MG/KG - RAT
DERMAL (ANIMAL)	NA
EFFECTS TO EYES (ANIMAL)	EYES - RABBIT, NOT IRRITATING
SKIN IRRITATION (ANIMAL)	SKIN - RABBIT, SLIGHT IRRITANT

SKIN CORROSION/IRRITATION	NOT CLASSIFIED
SERIOUS EYE DAMAGE/IRRITATION	CAUSES EYE IRRITATION
RESPIRATORY OR SKIN SENSITIZATION	NOT CLASSIFIED
GERM CELL MUTAGENICITY	NOT CLASSIFIED
CARCINOGENICITY	NOT CLASSIFIED
REPRODUCTIVE TOXICITY	NOT CLASSIFIED
SPECIFIC TARGET ORGAN TOXICITY (SINGLE EXPOSURE)	MAY CAUSE DROWSINESS OR DIZZINESS.
ASPIRATION HAZARD	NOT CLASSIFIED
INHALATION	MAY CAUSE DROWSINESS OR DIZZINESS.
EYE CONTACT	CAUSES SERIOUS EYE IRRITATION.
INGESTION	INGESTION MAY CAUSE NAUSEA, VOMITING AND DIARRHEA

SECTION 12. ECOLOGICAL INFORMATION

TOXICITY	NA
PERSISTENCE AND DEGRADABILITY	NA
BIOACCUMULATIVE POTENTIAL	NA
MOBILITY IN SOIL	LC-50 (LETHAL CONCENTRATION) UG = MICROGRAMS/LITER CHANNEL CATFISH - 2,267,000 UG/LITER RAINBOW TROUT - 1,372,000 UG/LITER BLUEGILL - 3,433,000 UG/LITER
OTHER ADVERSE EFFECTS	NA

SECTION 13. DISPOSAL CONSIDERATION

WASTE DISPOSAL RECOMMENDATION :

EMPTY BAGS THOROUGHLY. CARRY OUT THE PROPER RECYLING, REUSAGE OR DISPOSAL.
PLEASE REFER TO THE RELEVANT EU REGULATIONS, IN PARTICULAR THE GUIDELINES/DECISIONS OF THE COUNCIL REGARDING HANDLING OF WASTES (E.G. 75/442/EEC, 91/689/EEC, 94/67/EC, 94/904/EC) AS IMPLEMENTED IN NATIONAL REGULATIONS.

REGIONAL RECOMMENDATION :

BURY OR INCINERATE ACCORDANCE WITH FEDERAL, STATE AND LOCAL REGULATIONS.

CONTAINERS SHOULD NOT BE REUSED WITHOUT PROFESSIONAL CLEANING AND RECONDITIONING.
OBSERVE ALL LABELED SAFEGUARDS UNTIL CLEANED, RECONDITIONED OR DESTROYED.

PLEASE REFER TO SECTION 8 (EXPOSURE CONTROLS /PERSONAL PROTECTION) OF THIS SDS.

SECTION 14. TRANSPORTATION INFORMATION

UN NUMBER	NONE
UN PROPER SHIPPING NAME	NONE

DEPARTMENT OF TRANSPORTATION (DOT) : NOT HAZARDOUS FOR TRANSPORTATION

TRANSPORT HAZARD CLASS(ES)

HAZARD LABLES (DOT) :

PACKING GROUP (DOT)	NA
DOT SPECIAL PROVISIONS	NA

ADDITIONAL INFORMATION:

OVERLAND TRANSPORT	NONE
TRANSPORT BY SEA	NONE
AIR TRANSPORT	NONE
DOT QUANTITY LIMITATIONS PASSENGER AIRCRAFT	NA
DOT QUANTITY LIMITATIONS CARGO AIRCRAFT	NA

SECTION 15. REGULATORY INFORMATION

US FEDERAL REGULATIONS:

THE SUBSTANCES IS LISTED ON UNITED STATES TSCA (TOXIC SUBSTANCE CONTROL ACT) INVENTORY.

US STATE REGULATIONS:

NONE

CHEMICAL IDENTITY:

518-47-8	TSCA	DSL	NDSL	EINECS	ELINCS	ENCS	CHINA	KECL	PICCS	AICS
	X	-	-	-	-	-	-	-	-	-

TSCA STATUS	IN COMPLIANCE
E C CLASSIFICATION	(67/548/EEC - 88/379/EEC) N/A
EINECS NUMBER	
REACH CLASSIFICATION	
R PHRASES	
ADDITIONAL REGULATORY INFORMATION	

SECTION 16. OTHER INFORMATION

INDICATION OF CHANGES:

NA

OTHER INFORMATION:

NA

GHS FULL TEXT PHRASES:

MAY BE HARMFUL IF INHALED	H333
CAUSES EYE IRRITATION	H320
CASUES MILD SKIN IRRITATION	H316

	HEALTH	FLAMMABILITY	REACTIVITY	PERSONAL PROT
H. M. I. S. CLASSIFICATION:	1	0	0	D

HMIS CODE: **4** - SEVERE HAZARD, **3** - SERIOUS HAZARD, **2** - MODERATE HAZARD, **1** - SLIGHT HAZARD, **0** - MINIMAL HAZARD

SAFETY DATA SHEET (SDS)
REVISION DATE: 03/03/2016

Appendix C

Instructions for Dye Sampling and Shipping

Instructions for Dye Sampling and Shipping

Dye detection limits vary with the type of dye and its matrix, but are routinely in the parts per trillion range. As a result, sampling and sample shipment must be done carefully. Helpful sampling and shipping tips are listed below:

1. Make sure that the caps on all water sample vials are on tightly. It is a good protocol to check the tightness of the cap on every sample vial before shipment.

2. Never, never ship the samples packed in regular ice. The ice melts and the melt water will almost always have at least some dye in it from the outside of sample containers or from a leaky water vial. The melt-water can potentially enter other samples and contaminate them. To keep samples cool in shipment use Blue Ice® or some similar compound. We would rather have unrefrigerated samples than samples packed in ice.

3. Pack the samples so that the blocks of Blue Ice® will not be able to bounce around in the cooler during rough handling and potentially damage a sample and cause leakage.

4. If the Blue Ice® has thick frost or ice on it when removed from the freezer then melt that off with water before placing it in the sample cooler. Keep all samples as dry as possible. A few sheets of white paper towels in the bottom of the cooler is a good approach.

5. Samples containing visible dye should either be shipped separately or placed in a separate sealed container within the shipment.

6. Zip-Lock® bags are good for organizing samples, but they will leak liquids both in and out. Don't view these bags as sealed containers.

7. Try not to get water containing dye on the outside of sample containers. If you believe there may be dye on the outside of containers then place the container in a sealed plastic bag or wash off the outside of the container.

8. Please place the Chain of Custody documents in a Zip-Lock® bag taped to the inside top of the cooler. The ink may run on damp custody sheets.

Dye Visual Standards

Standard Dilution	Estimated Fluorescein Dye (mg/L)	Observations
0	40	strong yellowish-green
2	20	mild yellowish-green
10	4	mild yellowish-green
20	2	light yellowish-green
50	0.8	faint yellowish-green
100	0.4	very faint yellowish-green

Prior to the start of the injection, a batch sample will be collected from the sampling port (with the valve closed) for lab analysis for fluorescein dye.

Collect about one gallon of well water from any monitoring well for the visual dye standards.

- **Batch Sample**: Once the injection setup has been completed, collect a sample in a clean glass vial and label as “Batch1”.
- **2X Dilution:** Using a graduated cylinder, dilute the batch sample by a factor of two, i.e., 50 mL of injection solution diluted to 100 mL by adding 50 mL well water. Fill a clean glass vial with the solution and label the vial as “2X”.
- **10X Dilution**: Using a graduated cylinder, dilute the 2X dilution sample by a factor of 10, i.e., 10 mL of injection solution diluted to 100 mL by adding 90 mL well water. Fill a clean glass vial with the solution and label the vial as “10X”.
- **20X Dilution**: Using a graduated cylinder, dilute the 20X dilution sample by a factor of 20, i.e., 5 mL injection solution diluted to 100 mL by adding 95 mL well water. Fill a clean glass vial with the solution and label the vial as “20X”.
- **50X Dilution**: Using a graduated cylinder, dilute the 50X dilution sample by a factor of 50, i.e., 2 mL injection solution diluted to 100 mL by adding 98 mL well water. Fill a clean glass vial with the solution and label the vial as “50X”.
- **100X Dilution**: Using a graduated cylinder, dilute the 100X dilution sample by a factor of 100, i.e., 1 mL injection solution diluted to 100 mL by adding 99 mL well water. Fill a clean glass vial with the solution and label the vial as “100X”.

Keep the visual dye standards in a cooler when not in use to protect them from the sunlight to prevent spoiling of the oil. These samples will be used to compare the samples collected from the monitoring wells during the injection test.

Appendix D

Injection Pilot Test Field Logs

Injection Pilot Test

Ford Livonia

Step Test Field Log

				Depth-to-Water Readings [ft BTOC]							
Date	Time	Volume Extracted from IW-1 [gallons]	Flowrate [gpm]	IW-1	DR-1S	DR-1D	DR-2S	DR-2D	MW-23	PMW-1	Comments

Notes:
gpm - gallons per minute
ft BTOC - feet below top of casing

Injection Pilot Test

Ford Livonia

Injection Log

Injection Well ____________

Injection Event ____________

Injection Phase ____________

Screened Interval ____________ ft bgs

Target Injection Volume ____________ gallons

Initial Target Injection Rate ____________ gpm

Injection Start Date/Time ____________

Injection Start/Stop Log

Date	Time	Action

Date	Time	Flow Totalizer	Total Gallons Injected	Flow (GPM)	Injection Pressure (psi)	Comments

Injection Pilot Test

Ford Livonia

Dose Response Monitoring Log

Well: DR-1S

Date	Time	Total Gallons Injected	Estimated Dye Concentration	Comments

Well: DR-1D

Date	Time	Total Gallons Injected	Estimated Dye Concentration	Comments

Well: DR-2S

Date	Time	Total Gallons Injected	Estimated Dye Concentration	Comments

Well: DR-2D

Date	Time	Total Gallons Injected	Estimated Dye Concentration	Comments

Injection Pilot Test

Former Climatrol Facility - Cocoa, FL

Performance Monitoring Well Log

Well: MW-23

Date	Time	Total Gallons Injected	Estimated Dye Concentration	Comments

Well: PMW-1

Date	Time	Total Gallons Injected	Estimated Dye Concentration	Comments