TRANSMITTAL LETTER

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Copies:

Date:
December 13, 2017

Subject:
Livonia Transmission Plant
Response Activity Plan –
Remedial Investigation

Arcadis Project No.:
MI001322.0001

We are sending you hard copies:

☒ **Attached** ☐ **Under Separate Cover Via ________ the Following Items:**

☐ Shop Drawings ☐ Plans ☐ Specifications ☐ Change Order
☐ Prints ☐ Samples ☐ Copy of Letter ☒ Reports
☐ Other:

Copies	Date	Drawing No.	Rev.	Description	Action*
1	12/13/2017			Response Activity Plan – Remedial Investigation	

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RESPONSE ACTIVITY PLAN – REMEDIAL INVESTIGATION

Livonia Transmission Plant Area of Concern
Court Case: No. 2:1712372-GAD-RSW

Prepared for:

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ACRONYMS AND ABBREVIATIONS

ATNPC	Automatic Transmission New Product Center
CSM	conceptual site model
CCTV	closed-circuit television
cDCE	cis-1,2-dichloroethene
COC	constituent of concern
DCA	dichloroethane
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquid
ELAP	Environmental Laboratory Accreditation Program
ft amsl	feet above mean sea level
ft bgs	feet below ground surface
GWIC	groundwater in contact
HCS	hydraulic control system
HPT	hydraulic profiling tool
LIF-HP	laser-induced fluorescence-hydraulic profile
LNAPL	light non-aqueous phase liquid
LTP	Livonia Transmission Plant
MDEQ	Michigan Department of Environmental Quality
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PID	photoionization detector
PS	potential source
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RespAP	Response Activity Plan
RI	Remedial Investigation
RIASL	residential imterim action screening level
RRD	Remediation and Redevelopment Division

SSMP	sub-slab monitoring point
SVMP	soil vapor monitoring point
TCA	trichloroethane
TCE	trichloroethene
tDCE	trans-1,2-dichloroethene
TDL	target detection limit
USEPA	United States Environmental Protection Agency
VAP	vertical aquifer profiling
VC	vinyl chloride
VI	vapor intrusion
VOC	volatile organic compound
WCSS	whole core soil sampling
WWTP	waste water treatment plant

1 INTRODUCTION

Arcadis of Michigan LLC (Arcadis) has prepared the following Remedial Investigation (RI) Response Activity Plan (RespAP) on behalf of Ford Motor Company (Ford) for the Livonia Transmission Plant (LTP) site (the site). The site layout is included as **Figure 1**. This document describes the RI activities that will be used to comprehensively assess the nature and extent of environmental releases and impacts and further evaluate potential exposure pathways at the LTP in accordance with the Consent Decree effective July 27, 2017 (No: 2:1712372-GAD-RSW) and satisfies both section 6.6(b)(i) detailed vapor assessment and mitigation plan and section 6.7a response activity plan for conducting an RI.

The proposed response activities will address the data gaps identified in the conceptual site model (CSM; Arcadis 2017a), address the MDEQ's comments provided in the approval letter for the CSM received on November 13, 2017, and complete other activities required for a comprehensive RI report. The proposed response activities will be completed systematically in phases to provide the appropriate data for decision making. Additional phases might be required to address data gaps that evolve with the changes in the CSM, or to collect additional information deemed vital to the RI and site remedy evaluation.

This RespAP is organized to describe on-site and off-site RI activities. On-site activities will include:

- Source area characterization
- Delineation of light non-aqueous phase liquid (LNAPL)
- Evaluation of potential pathways created by utility corridors
- Continued evaluation of the vapor intrusion (VI) pathway within the LTP, the Automatic Transmission New Product Center (ATNPC), and other on-site buildings.

Additional off-site RI activities include:

- Delineation of groundwater impacts to the north and northeast of the site
- Continued evaluation of potential VI pathways on residential and commercial properties.

In addition, groundwater and soil vapor will be monitored routinely to establish and evaluate spatial and temporal trends on and off site.

The constituents of concern (COCs) for the site, as defined by the Consent Decree, include:

- Trichloroethene (TCE)
- Tetrachloroethene (PCE)
- 1,1-dichloroethene (DCE)
- Cis-1,2-dichloroethene (cDCE)
- Trans-1,2-dichoroethene (tDCE)
- Vinyl chloride (VC)
- 1,4-Dioxane.

The target detection limits (TDLs) for COCs in soil, groundwater, and vapor are also defined in the Consent Decree. Due to analytical limitations, a separate RespAP requesting a TDL change for TCE and VC in residential groundwater was submitted to the MDEQ on November 21, 2017. Therefore, pending MDEQ approval, the goal of off-site groundwater delineation is to define TCE and VC to a TDL of 1.0 microgram per liter (µg/L).

This document provides a framework for the proposed RI activities. Investigation sampling, routine monitoring, and laboratory analyses methodology to be employed during the RI are presented in two Quality Assurance Project Plans (QAPPs; Arcadis 2017b, Arcadis 2017c), prepared and submitted to the MDEQ in August 2017. QAPP addendums may be prepared and submitted to MDEQ for review and approval should an investigation method require additional description.

Schedule

The activities proposed herein will begin upon approval from the MDEQ and pending access to applicable off-site properties. The activities proposed below will be discussed with the MDEQ in a meeting before the approval of the RespAP. A schedule is provided below to show the approximate duration of the proposed response activities. The schedule is not linear, and various tasks may be completed in parallel. Upon approval of the RespAP, a more detailed schedule will be provided to the MDEQ for review.

Scope Define Below	Duration
Source Area Characterization	6 months
Utility Corridor Evaluation	6 months
Additional Vapor Intrusion Characterization	4 months
Groundwater Delineation On Site	2 months
Groundwater Delineation Off Site*	7 months
Offsite VI Evaluation^	unknown
Groundwater sampling On and Off Site	quarterly
Soil Vapor Monitoring Point Sampling Off Site	quarterly

* Dependent on obtaining access agreements from property owners

^ Dependent on obtaining access agreements and communication with the MDEQ

2 ON-SITE REMEDIAL INVESTIGATIONS

The on-site RI activities completed to date have been focused on characterizing the nature and extent of groundwater impacts on site and evaluating mass flux of COCs emanating from previously identified potential source areas. As a result of the early findings and before issuance of the Consent Decree, Ford installed and began operating a hydraulic control system (HCS) as an interim measure in spring 2017 to capture the vast majority of the mass flux from the potential source areas and prevent off-site migration of groundwater impacts to the east, as documented in the CSM (Arcadis 2017a). In addition, preliminary soil vapor analytical results indicated the potential for VI below the footprint of the LTP. Consequently, Ford has designed and is constructing a focused sub-slab depressurization system to address VI concerns as an interim measure, which will become operational during the first quarter 2018.

The focus of the RI going forward will be to address on-site data gaps, which are primarily associated with additional source area characterization, and further evaluate the potential for VI within the LTP, ATNPC, and other buildings located on site. The response activities include:

- **Potential Source Area Characterization** - As an initial step, the six potential source areas (PS-1 through PS-6) identified in the CSM (Arcadis 2017a) will be further evaluated beneath or adjacent to the LTP building. The results of the sampling data, summarized as part of the CSM, suggest that these six areas may have historically contributed to soil, groundwater, and/or vapor impacts at the site.
- **Site Use History Desktop Review -** Ford will complete a desktop review of documents describing historical site use (e.g., equipment, processes), tank closure records, construction records, and other documentation, and will conduct interviews with site personnel to help locate other potential sources of COCs at the site. If additional potential sources are identified, they will be characterized as part of the RI activities.
- **Vapor Intrusion Evaluation -** Delineation of vapor impacts beneath the LTP building will continue, as well as evaluation of the potential for vapor impacts beneath the ATNPC and other on-site outbuildings.
- **LNAPL Delineation -** Delineation of LNAPL beneath the northwest portion of the building will continue.
- **Northwest Corner -** Impacts to groundwater identified in the northwestern portion of the site, potentially associated with the storm sewer system, will be evaluated.

Potential Source Area Characterization

The identification of potential source areas and the response activities described below are based on the available soil, groundwater, LNAPL, and soil vapor data, as well as the known historical operations documented to date as part of the site review and initial CSM development. To date, six potential source (PS) areas have been identified based on impacts observed in soil, groundwater, LNAPL, and/or soil vapor. The approximate locations of the potential source areas are shown on **Figure 2**. For reference, the source investigation figures include the TCE sub-slab soil vapor impacts and the approximate extent of the LNAPL plume. Details regarding sub-slab soil vapor impacts, as well as soil and groundwater data, are provided in the CSM. Potential source areas include:

- PS-1 - Located in the southeastern portion of the LTP near several PS areas including the former broach machine pit. Downgradient impacts are well characterized; however, the lateral extents of source impacts have not been delineated.
- PS-2 - Soil vapor results identified concentrations of COCs beneath the northwestern portion of the LTP building near the former rail lines. The lack of high concentrations of COCs in downgradient groundwater samples suggests that impacts in the area of PS-2 are not contributing significant mass

to groundwater; however, additional sampling is required to verify that impacts are confined to the vadose zone or entrained within the LNAPL.

- PS-3 - Soil vapor results suggest a source of volatile organic compounds (VOCs) in this area. Soil samples collected from below the water table at one location (LMW-15-02) indicate concentrations of DCE and VC in groundwater at depths between 13 and 20 feet below ground surface (ft bgs). However, the LNAPL samples from this area indicate only nominal concentrations of VOCs. These results suggest that a potential upgradient source of dissolved-phase VOCs may be present.
- PS-4 - Sampling at one location (LMW-15-05) has indicated concentrations of VOCs (1,1,1-trichloroethane [1,1,1-TCA], TCA, 1,1-dichloroethane [1,1-DCA], and DCE) in soil vapor and in LNAPL. Saturated soil sampling indicates high concentrations of DCE at 9 to 10 ft bgs, representing LNAPL-impacted soils. Additional sampling is required to verify that impacts are limited to the LNAPL smear zone and are not contributing to groundwater impacts at the site.
- PS-5 - Soil vapor results suggest a potential source of VOCs (mainly TCE) beneath the northeast portion of the building; however, downgradient groundwater sampling does not suggest impacted groundwater in this area. Additional sampling is required to determine if the source of VOCs is the LNAPL or is potentially associated with shallow soil impacts within the vadose zone
- PS-6 – This area is located north and west of the wastewater pretreatment plant (WWTP). To date, characterization has suggested low levels of VOCs in groundwater east to the property boundary and at the northern site boundary, but no hotspot or specific source of the VOC impacts has been identified.

Source characterization has been and will continue to be hindered by the presence of subsurface utilities, large equipment, and ongoing manufacturing operations within the LTP facility. Access to the subsurface will be limited to existing walkways within and around each PS area. Therefore, the source area RI will rely on transects of borings and sample collection where access is available. The locations of walkways within the LTP facility are included on **Figure 2**, as well as on the other source area figures.

PS area characterization will be completed as one continuous mobilization with samples evaluated on site for COCs (including 1,4-dioxane) with an Environmental Laboratory Accreditation Program (ELAP) certified mobile laboratory using gas chromatography/mass spectrometry and United States Environmental Protection Agency (USEPA) Method 8260 for VOC analysis. The mobile lab will be calibrated to meet the TDLs specified by the Consent Decree, as modified and agreed upon with the MDEQ. The near real-time results will be used to adapt the source investigation to focus on areas most likely to contribute to VI or groundwater impacts at the site. Five percent of the samples collected during the source characterization will be split to TestAmerica located in North Canton, OH for comparison and validation of the mobile laboratory results. All soil, vapor, and groundwater samples will be collected and analyzed in accordance with the methodology specified in the QAPPs (Arcadis 2017b).

Potential Source Area 1

In addition to elevated soil vapor results in the area, high concentrations of COCs (primarily TCE, cDCE and VC) were identified in groundwater under the LNAPL. A downgradient transect consisting of Dakota Technologies® laser-induced fluorescence - hydraulic profile (LIF-HP) borings coupled with high-resolution whole core soil sampling (WCSS) has indicated that this PS area contributes 95% or more of the COC mass flux observed in groundwater at the site. The source area is thought to be associated with the former broach machine pit or other former degreasers in the area. During recent renovations, all sub-slab pits were backfilled and the floor brought to grade. The former broach machine pit is currently located below the clean room use for valve body assembly. Access to the clean room is limited.

The response activities proposed for the initial PS-1 source characterization are shown on **Figure 3** along with the LNAPL footprint, TCE sub-slab vapor results, and TCE results for groundwater. The goal of the PS-1 characterization is to identify and delineate the source(s) of the TCE contributing the majority of COC mass flux observed at the site. The scope of work will be completed around three former structures (broach machine pit, former degreaser pit, and a backfilled pit) that may contain residual impacts, as well as two other areas with elevated soil gas detections.

The scope of work will be completed adaptively, with up to 19 primary borings complete around the PS areas as access allows. At each primary boring, the Geoprobe® Hydraulic Profiling Tool (HPT) or Dakota Technologies LIF-HP will be advanced to a depth of 30 feet to provide a continuous hydraulic conductivity profile of the soil. Following completion of the HPT boring, the hole will be grouted to grade. In an adjacent borehole, up to five soil samples will be collected through the vadose zone and LNAPL impacts. Once below the LNAPL impacts, up to three vertical aquifer profile (VAP) groundwater samples will be collected at nominal 5-foot intervals to a maximum depth of approximately 30 feet below grade. Additional soil samples may be collected from low-permeability zones and the lower confining unit to evaluate stored COC mass. The continuous soil core will be screened with a photoionization detector (PID), and intervals suspected to be impacted by potential dense non-aqueous phase liquids (DNAPLs) will be tested with an Oil-In-Soil shake test kit, the results of which will be recorded on the soil boring log. Additional saturated soil samples may be collected from less permeable saturated zones, or intervals identified as potentially impacted with DNAPL, and submitted to the mobile lab for analysis.

Based on the mobile laboratory results, up to 18 adaptive soil borings will be completed as necessary to fill in data gaps, delineate, or otherwise provide sufficient resolution to isolate the source (**Figure 3**). Adaptive borings will not include hydraulic profiling, but rather will focus on the collection of additional soil and VAP groundwater samples.

Potential Source Area 2 through 5

As indicated above, PS-2 through PS-5 have been primarily identified via sub-slab soil gas sampling or through limited saturated soil samples collected during LNAPL monitoring well installation. Although groundwater data collection in the central and northern portion of the LTP has been limited to date, downgradient groundwater samples suggest that dissolved-phase impacts associated with these source areas are relatively limited compared to PS-1. Nonetheless, the goal of the PS-2 through PS-5 characterizations will be to evaluate the vadose and LNAPL-impacted zones and identify potential sources of the elevated COCs observed in sub-slab vapor samples to fill the identified data gaps.

Similar to the approach for investigating PS-1, the RI work will be completed within walkways in areas of elevated VOC soil gas impacts. The proposed borings for PS-2 through PS-5 are shown on **Figure 4**. The RI work will be completed adaptively with five to seven primary borings completed in each area that include hydraulic profiling with the HPT, vadose and LNAPL soil sampling, and then VAP groundwater sampling below the LNAPL impacts. Based on the results of the primary boring locations, adaptive step-outs will be added, as appropriate, to expand the characterization or isolate the VOC-impacted area.

Adaptive borings will not include HPT soundings, but will focus on the soil and groundwater sample collection. At each boring location, up to five soil samples will be collected through the vadose zone and LNAPL impacts. Once below the LNAPL impacts, up to three VAP groundwater samples will be collected at nominal 5-foot intervals up to a maximum depth of approximately 30 feet below grade.

Potential Source Area 6

A preliminary investigation completed around the WWTP in 2016 suggests a potential source of TCE associated with groundwater impacts present along the northern property boundary at boring HPT-1, as well as the northern impacted area that extends off site to the east. HPT and VAP borings were completed both east and west of the WWTP, as well as between the WWTP and northern property boundary (borings HPT-120 to HPT-130). Previous soil boring locations, along with the maximum TCE and VC results, are summarized on **Figure 5**. Between the WWTP and the LTP building (HPT-128 to HPT-130), only low concentrations of VC were observed at the southernmost location (HPT-130), suggesting limited contribution from impacts beneath the LTP building. Before construction of the WWTP, the area was used for waste storage (1960s and 70s). The area of waste storage included the current WWTP footprint and the areas to the north and south of the WWTP. An outline of the waste storage area based on the 1967 aerial photo is included on **Figure 5**. The goal of the PS-6 RI activities is to evaluate if a source of COCs (potentially TCE) exists in the area that may continue to contribute to low-level dissolved-phase TCE and VC groundwater impacts in the area.

The investigation at PS-6 will focus on the shallow soils and groundwater with maximum boring depths of 15 feet below grade and will include a grid of soil borings around the WWTP in areas potentially impacted by waste storage. The scope of work will be completed adaptively with up to 32 primary borings followed by up to 19 adaptive borings based on the sampling results. The locations of the proposed borings are included on **Figure 5**. At each boring location, up to five soil samples will be collected through the vadose zone, and one groundwater sample will be collected at the water table and evaluated for COCs using the mobile laboratory.

Northwest Corner Evaluation

In July 2017, Arcadis collected water samples from 34 storm sewer manholes to determine if COCs were still present in the eastern storm sewer system after storm sewer cleaning and rehabilitation was completed, as described in the CSM (Arcadis 2017a). The evaluation showed TCE impacts within the northwestern portion of the storm system potentially related to infiltration of groundwater in this area of the site. The locations of the TCE detections, as well as the storm sewer layout, are included on **Figure 6**. The goal of the RI activities is to determine if there is a potential source of TCE contributing dissolved-phase impacts to the storm sewer, either on-site or from an upgradient, off-site source.

An investigation will be completed in the northwestern portion of the site to evaluate potential sources of the TCE impacts. Transects of soil borings will be completed both east and west of the storm sewer lines located upgradient of the TCE detections, as well as along the western and northern property boundaries. The interior RI work will be focussed within the accessible walkways inside the LTP. The proposed borings for the northwest corner evaluation are shown on **Figure 6**. The RI work will be completed adaptively with up to 12 primary borings completed that include HPT borings, followed by vadose zone and VAP sampling from an adjacent boring location. Based on the results at the primary boring locations, up to 11 adaptive borings will be added, as appropriate, to focus on areas of interest. Adaptive borings will not include HPT soundings, but rather will focus on the soil and groundwater sample collection. At each boring location, up to five soil samples will be collected through the vadose zone and up to three VAP groundwater samples will be collected from the saturated zone at nominal 5-foot intervals up to a maximum depth of approximately 30 feet below grade.

Source Area Desktop Review

In parallel with the potential source investigations described above, Ford will continue to review available documents and files regarding former site operations, locations of pits, tanks, waste handling areas, and other activities to gather more information regarding known PS areas and identify other PS areas. Response activities will include seeking and reviewing available documents at the LTP, as well as conducting interviews with knowledgeable site personnel. The review will primarily focus on equipment and structures that historically used, stored, and/or transported chlorinated solvents and oils used in the manufacturing process. Based on the results of the desktop review, additional PS areas may be identified that require evaluation. Potential sources identified by the review, as well as data gaps identified as part of the initial source investigation activities, will be addressed as part of a future phase of RI work. Additional RI activities may include establishing a series of data collection transects to identify which former equipment and structures have contributed to LNAPL and COC impacts observed in soil and groundwater.

LNAPL

The LNAPL beneath the LTP was delineated previously using LIF, except in the northwest portion of the LTP, which was noted as a data gap in the CSM (Arcadis 2017a). LNAPL impacts in that area will be delineated as part of the northwest corner investigation and will consist of three to seven LIF borings as illustrated on **Figure 6**. The QAPP (Arcadis 2017b) will be updated to include details on LIF methods.

Utility Corridors

From October 2016 to July 2017, Arcadis oversaw the rehabilitation of more than 95% of the eastern storm sewer system on site, as documented in the CSM (Arcadis 2017a). Water and sediment samples were collected during and after the rehabilitation to evaluate the presence or absence of chlorinated VOCs and polychlorinated biphenyls (PCBs) within the storm system. In addition, water and sediment samples were collected within the sanitary sewers and process waste lines for the same purpose.

In August and September 2017, a portion of the sanitary sewer system and the western diversion chamber were jetted and cleaned as described in the Third Quarter 2017 Progress report. Locations of the cleaned sanitary lines and the western diversion chamber is provided in **Figure 7**.

Evaluation of the eastern storm sewer, western storm sewer, and sanitary sewer systems is ongoing. Additional closed-circuit television (CCTV) survey work and a survey of manhole structures will be completed for the remainder of the eastern storm sewer and sanitary sewer systems where COC impacts have been identified. The CCTV will be used to determine if additional pipe rehabilitation is warranted, and the manhole survey will determine which structures (manhole and inverts) are below the water table.

Sediment samples will be collected from the eastern and western diversion chambers to determine if COCs are present.

Existing monitoring well locations and screened intervals will be compared to the elevation of adjacent sanitary and storm sewer system pipes and manholes to determine if the well screens are constructed at similar elevations to allow use of the existing well network in evaluate potential pathways for migration of COCs along the utility corridors. Following this evaluation, monitoring wells may be proposed for addition to the monitoring network; if needed, this scope of work will be provided in a future RespAP.

Additional Vapor Intrusion Characterization

Initial on-site VI evaluations have successfully delineated most sub-slab impacts inside the LTP. Additional evaluation is needed in some portions of the LTP that have not been sampled, the entirety of the ATNPC, and occupied outbuildings associated with both the LTP and ATNPC. Response activities to fill these on-site VI data gaps will include installation of up to 61 sub-slab monitoring points (SSMPs). Proposed SSMPs include up to 19 locations in the LTP, up to 26 locations in the ATNPC, and up to 16 locations in the outbuildings near the LTP and ATNPC. Proposed sample locations are presented on **Figures 8** and **9**. Field locations are subject to change based on plant approval of each location.

Proposed installation and sampling methods are consistent with those used for the original VI evaluation at LTP and presented in the QAPP (Arcadis 2017b). Arcadis will collect sub-slab VOC samples at the 61 new SSMPs installed during this response activity plus four duplicates for quality assurance/quality control (QA/QC) purposes. Methane will also be screened in the field. Detailed sampling methods are included in the QAPP (Arcadis 2017b).

Sub-slab soil gas samples will be collected from these 61 SSMPs using sorbent tube methods and will be submitted to Eurofins Air Toxics located in Folsom, California. Samples collected from the LTP, ATNPC, and outbuildings will be analyzed for the site COCs by USEPA Method TO-17. USEPA Method TO-17 is proposed instead of USEPA TO-15 (which uses Summa canisters to collect sub-slab soil gas samples) due to the potential presence of elevated methane concentrations which could cause increased canister shipping costs. TO-17 laboratory detection limits are sufficiently low to provide comparison to MDEQ-provided non-residential volatilization to indoor air criteria for soil gas in non-residential slab-on-grade structures. Using sorbent tube sampling methods also provides consistency with past site data and eliminates health and safety concerns associated with shipping samples potentially containing methane. The samples will be analyzed on a standard 10-day turnaround time.

3 OFF-SITE REMEDIAL INVESTIGATIONS

High-resolution site characterization was completed to characterize the nature and extents of impacts in both on-site and off-site groundwater. Most of the VC impacts that migrated to the east have been well characterized and delineated. The exceptions are areas to the northeast of the WWTP (PS-6), where TCE has not been delineated to the north of the site boundary; off site at the northeast corner of the property boundary, where low levels of VC have not been delineated; and in two additional areas of VC impacts east of the site and north of Rosati Drive (one area near the cul-de-sac and one near the north-south bend in the road).

Groundwater Delineation

The goal of the off-site delineation is to define COC impacts to the site-specific Residential Groundwater in Contact Vapor Intrusion Screening Levels. A Response Action Plan requesting a TDL change for TCE and VC in residential groundwater was submitted to the MDEQ on November 21, 2017. Therefore, pending approval, the goal is to delineate the extent of TCE and VC off-site to a TDL of 1.0 µg/L.

North of LTP Property

Response activities to complete delineation to the north include up to four HPT/VAP borings to verify and expand delineation along the northern property boundary as well as installation of up to three monitoring wells to improve the sentinel monitoring well network and verify impacts (HPT-01). The locations of the northern property borings are included on **Figure 10.** Based on the analytical results along the northern boundary, additional step-outs may be completed off site to define the extent of COCs to the north, as necessary. Completion of the off-site borings is access-dependent with the final locations of borings determined by feedback from commercial property owners. Off-site work will consist of up to four additional HPT/VAP borings followed by the installation of a sentinel monitoring well for long-term monitoring. At each VAP boring location, up to three groundwater samples will be collected from the saturated zone at nominal 5-foot intervals to a maximum depth of approximately 30 feet below grade. Monitoring well screens will be installed at a depth consistent with the upgradient groundwater impacts and will consist of a 5-foot-long, 2-inch, 0.010-slot stainless steel wire-wrapped screen with an appropriate sand pack followed by a 2-inch polyvinyl chloride (PVC) riser. The annulus above the screen will be back-filled with bentonite grout to grade. Detailed sampling methods are included in the QAPP (Arcadis 2017b).

Northeast of LTP Property

Similar to the northern property boundary, response activities to the east of the site will consist of HPT/VAP borings to delineate VC to the TDL. Up to eight HPT/VAP borings will be completed north of Rosati Drive. The locations of the proposed borings are included on **Figure 11**. Based on the results of the VAP sampling, up to three monitoring wells will be installed to verify delineation and for long-term monitoring. Completion of the off-site borings is access-dependent, with the final location determined by feedback from the commercial property owners. At each VAP boring location, up to three groundwater samples will be collected from the saturated zone at nominal 5-foot intervals to a maximum depth of approximately 30 feet below grade. Monitoring well screens will be installed at a depth consistent with the upgradient groundwater impacts and will consist of a 5-foot-long, 2-inch, 0.010-slot stainless steel wire-wrapped screen with an appropriate sand pack followed by a 2-inch PVC riser. The annulus above the screen will be back-filled with bentonite grout to grade. Detailed sampling methods are included in the QAPP (Arcadis 2017b).

Continued Off-site VI Evaluation

Multiple rounds of investigation conducted in the off-site area east of the LTP suggest that the potential for VI to occupied buildings remains low.

Lines of evidence used in the evaluation of the VI pathway include:

- Two hundred and fifty VAP groundwater samples from 82 locations
- Twenty permanent groundwater wells that have been sampled three times since installation in May 2017
- Building information in the City of Livonia Building Assessor's database
- Building information from a building owner questionnaire
- Completion of a sensitive receptor survey
- Nine temporary groundwater samples collected beneath soil vapor locations
- Installation of 43 permanent soil vapor sample points, which have each been sampled three times since installation in June 2017 (June 8 through 19, September 18 through 21, and November 17 through 21, 2017).

These lines of evidence continue to suggest that potential for VI to off-site structures is limited due to: (1) the presence of a clean water lens beneath most off-site properties; (2) a lack of VOC detections in soil vapor within the vadose zone, even overlying impacted water; and (3) a lack of VOCs in groundwater beneath buildings with sumps or basements.

Proposed RI activities to further evaluate the potential for VI off-site include:

- The inclusion of additional properties in the off-site VI evaluation
- Gaining access to off-site properties via formal access agreements
- Field verification of building details for all evaluated properties (including collection and evaluation of building-specific property information where an initial building survey was not returned)
- Completion of building surveys to document chemical usage in each building
- Collection of building-specific samples including both sub-slab soil vapor and indoor air.

Each of these response activities is discussed in the sections below.

Additional Properties for Vapor Intrusion Evaluation

As presented on **Figure 12**, in addition to 26 commercial and 38 residential properties identified during development of the CSM, approximately 30 residential properties are located within 100 feet of groundwater where VC is present at concentrations above the MDEQ TDL for vinyl chloride of 1 µg/L that were not originally included for VI evaluation. Additional commercial properties are not being considered at this time, as groundwater concentrations do not exceed the non-residential volatilization to indoor air criteria for slab-on-grade structures where ground is either in contact (VC screening level = 15 µg/L) or not in contact (VC screening level = 160 µg/L) with the structure.

At each property added to the evaluation, items already completed in the off-site properties will be undertaken, and include:

1. Evaluating the presence or absence of a clean water lens
2. Collecting information on building construction from the City of Livonia's online tax assessor database

3. Collecting additional building information via a property survey sent to each owner.

Access Agreements

To enable additional site-specific data collection, formal access agreements will be prepared for all properties included in the off-site VI evaluation (**Figure 12**). Access agreements will be delivered to each property via certified mail. When signed access agreements are returned, additional work on these private properties will be scheduled. At properties where an access agreement is not returned within 4 weeks, Arcadis staff will hand-deliver another copy. MDEQ will be notified of properties that have not returned a signed access agreement. Ford will make every attempt to access properties in a timely manner once access is secured.

Verification and Collection of Additional Building Information

Initial evaluation to understand the construction of properties and buildings located east of the LTP was conducted in late 2016. Initial off-site property investigation included a review of information provided in the City of Livonia's online tax assessor database (https://www.ci.livonia.mi.us/departments/assessorsoffice/onlinepropertyinquiry.aspx) for each property. Information collected from the tax assessor database includes:

- Year built
- Lot size
- Dwelling square footage
- Foundation size
- Number of stories
- Details on garages and outbuildings
- Heating and cooling systems
- Building construction technique (i.e., slab-on-grade, basement, crawl space, combination)
- Size of basement or crawl space
- Photos
- Sketches.

Additionally, a letter was sent to 65 properties care of 54 property owners requesting completion and return of a building construction survey to Arcadis in December 2017. On March 1, 2017, Arcadis went door-to-door to deliver surveys to property owners who had not responded to the originally delivered surveys. The building construction surveys allowed for further assessment of property-specific factors and solicited feedback from individual property owners. Surveys inquired about property construction, foundation condition, drainage, heating, and other information.

To enable decision making, the information on each property will be verified via on-site interviews with each property owner. Sketches of building construction will be prepared documenting the lowest level of each building, the presence of sumps and other sub-grade penetrations, and the condition of the floor slab (if present). Where discrepancies are noted between the initial City of Livonia assessor's database and returned building construction surveys (four residential properties), these discrepancies will be implicitly evaluated during on-site visits.

Additionally, an indoor air quality property owner survey questionnaire will be completed at each property to identify conditions that could affect sub-slab soil vapor or indoor air quality. An MDEQ Indoor Air Building Survey and Sampling Form (MDEQ 2013) will be prepared for each property to document site conditions.

Collection of Building-Specific Samples

Although information collected to date indicates that potential for VI off-site is low, additional samples will be collected to evaluate conditions both below and within each off-site property included in the VI evaluation. To further evaluate the potential for VI, sub-slab soil vapor and indoor air samples will be collected from each property following MDEQ 2013 VI Guidance. Ambient air samples (outside air) will be collected concurrent with all indoor air samples to allow an understanding of background conditions. The general scope of work for building-specific sampling is provided below; detailed sampling methods are included in the QAPP (Arcadis 2017b). Permanent vapor pin sample points will be installed to allow for multiple rounds of sampling if warranted. Permanent sample points will allow for up to four sampling events as required to adequately address potential seasonal and temporal variability per MDEQ 2013 VI guidance. Additionally, water will be collected and sampled from any sumps encountered during the building-specific sampling.

Commercial Properties

- Sub-slab and indoor air sample density will be selected based on Table 5-2 of the MDEQ 2013 VI guidance.
- Indoor air samples will be collected over a 10-hour period representative of a worker.
- If encountered, water from sumps will be collected and sampled.
- All sub-slab and indoor air samples will be analyzed for the site COCs by USEPA Method TO-15.
- Water samples will be analyzed using 8260B and USEPA 8260B-SIM (for 1,4-dioxane).
- Data will be compared to commercial screening values generated by MDEQ for the site.

Residential Properties

- Per MDEQ 2013 Guidance, at least two sub-slab soil vapor samples will be collected from each residence regardless of the building size. In general, one sample will be collected from beneath the center of the structure and the second from between the center of the structure and the wall nearest the source. It is understood that the sample locations may need to be adjusted to accommodate the actual site conditions, building layout, and property owner preference.
- Indoor air samples will be collected from the lowest habitable level of each residence at a rate of one sample per 1,000 square feet (MDEQ 2013).
- Indoor air samples will be collected over a 24-hour period representative of a resident from approximate breathing height.

- If encountered, water from sumps will be collected and sampled.
- Water samples will be analyzed using 8260B and USEPA 8260B-SIM (for 1,4-dioxane).
- All sub-slab and indoor air samples will be analyzed for the site COCs via USEPA Method TO-15.
- Data will be compared to residential screening values generated by MDEQ for the site.

Results of the indoor air, ambient air, sub-slab soil vapor, and groundwater sump sampling will be included in the RI, and a further path forward will be discussed with the MDEQ. If samples cannot be collected from any proposed location, these properties will be discussed with the MDEQ. Off-site data will continue to be evaluated considering multiple lines of evidence to determine the potential for VI.

4 ROUTINE MONITORING

The following sections describe routine monitoring that will be completed in 2018. The monitoring program (i.e., appropriate wells and analytes) will be evaluated annually as new information becomes available and data trends become established.

Groundwater Sampling

Groundwater sampling activities were and will continue to be completed quarterly throughout 2018 as outlined in Arcadis' Technical Guidance (December 2016), included as **Attachment 1**. Additional wells installed as part of the RI will be included in future monitoring events. A list of the current monitoring wells, including associated construction details, is included as **Table 1**. All groundwater samples from on-site and off-site monitoring wells will be collected in pre-cleaned, laboratory-supplied sample containers preserved with hydrochloric acid. Each sample is submitted to TestAmerica Laboratories, Inc. in Canton, Ohio on a standard 10-business day turnaround time. Detailed groundwater sampling methods are presented in the QAPPs (Arcadis 2017b, 2017c).

On Site Sampling

Groundwater sampling will continue to be completed as follows:

- Depth-to-groundwater measurements will be collected from all 69 on-site monitoring wells using an electronic water level meter to within 0.01-foot and measured from the top of casing. Groundwater elevations will be calculated using the monitoring well survey data collected for each respective monitoring well in units of feet above mean sea level (ft amsl). The locations of on-site monitoring wells are shown on **Figure 13**.
- Depth-to-groundwater and LNAPL thickness measurements will be collected from all 10 on-site LNAPL monitoring wells using an interface probe to within 0.01 foot and measured from the top of casing. Groundwater elevations will be calculated using an LNAPL correction factor and the monitoring well survey data collected for each respective monitoring well in units of ft amsl.
- Sixty-nine on-site monitoring wells will be sampled for analysis of COCs via USEPA Method 8260B and via USEPA 8260B-SIM (1,4-dioxane).

On-site groundwater analytical results will be compared to MDEQ Non-Residential Drinking Water Criteria (December 2013).

Off-Site Sampling

Groundwater sampling will continue to be completed off-site as follows:

- Depth-to-groundwater measurements will be collected at the 20 off-site monitoring wells using an electronic water level meter to within 0.01 foot and measured from the top of casing. Groundwater elevations will be calculated using the monitoring well survey data collected for each respective monitoring well in units of ft amsl. The locations of off-site monitoring wells are included as **Figure 14**.
- The 20 off-site monitoring wells will be sampled for analysis of site COCs via USEPA Method 8260B and 1,4-dioxane via USEPA 8260B-SIM.

Off-site sample results will be compared to MDEQ Remediation and Redevelopment Division (RRD) TDLs for TCE and VC (March 2016) as applicable screening levels for potential VI evaluation. All other constituents will be compared to MDEQ site-specific residential interim action screening levels (RIASL) for groundwater in contact (GWIC) with a basement, which were provided within the Consent Decree.

Soil Vapor Monitoring Point Sampling

Arcadis collected initial soil vapor samples in June 2017 and will continue to collect soil vapor samples quarterly from all exterior soil vapor monitoring point (SVMP) locations using 1-liter Summa canisters per the QAPP (Arcadis 2017b). Before sampling, a helium leak test and shut-in test will be conducted to ensure no leakage in the sample points or sample train. Samples will continue to be collected slowly (i.e., over a period of 20 minutes) to ensure that a minimal amount of vacuum is placed on the formation, preventing leakage with ambient air.

Soil vapor samples were and will continue to be submitted under chain-of-custody protocol to Eurofins Air Toxics (Eurofins) laboratory located in Folsom, California for analysis of the site COCs via USEPA Method TO-15. The nine residential SVMP locations (SVMP-29 S/D, SVMP-30 to SVMP-31, SVMP-32 S/D, and SVMP-33 through SVMP-37) were not sampled in the third quarter 2017, and SVMP-11 has been abandoned per the adjacent property owner's request. SVMPs will be sampled quarterly for each of the seven COCs identified in the Consent Decree. Sample results will be compared to Site-Specific Screening Levels for the aforementioned COCs provided by the MDEQ. SVMP locations are presented on **Figure 14,** and constructions details are presented in **Table 2**.

5 WASTE MANAGEMENT

All investigation-derived soil waste was and will be containerized in 55-gallon drums and labelled non-hazardous waste pending disposal off site by Ford's approved waste vendor. All monitoring well purge water will be added to the on-site water treatment system and processed with existing discharge water.

6 REPORTING

Arcadis will communicate progress on activities detailed within the RespRAP within the quarterly progress reports. The information provided in those reports will summarize activities and will not provide detailed data and lab reports. Detailed information will be provided in subsequent RI reports.

7 CLOSING

The goal of the RespAP outlined above is to document how Ford Motor Company will address the data gaps identified in the CSM (Arcadis 2017a), address the MDEQ comments to the CSM, and complete other activities that will be required for a comprehensive RI report in accordance with the Consent Decree. The work will be completed in phases to provide the appropriate data for decision making in accordance with the RI schedule contained herein. Quarterly progress and RI report(s) will be submitted to MDEQ throughout the RI process.

8 REFERENCES

Arcadis of Michigan LLC (Arcadis). 2017a. Conceptual Site Model. Livonia Transmission Plant. August.

Arcadis. 2017b. Quality Assurance Project Plan – On-Site. Livonia Transmission Plant, Livonia, Michigan. August.

Arcadis. 2017c. Quality Assurance Project Plan – Off-Site. Livonia Transmission Plant, Livonia, Michigan. August.

Michigan Department of Environmental Quality (MDEQ). 2013. Guidance Document for the Vapor Intrusion Pathway. Remediation and Redevelopment Division. May.

FIGURES

CITY: Novi DIV: ENV DB: MG PIC: R. ELLIS PM: K. HINSKEY PROJECT NUMBER: MI001322.0001 COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet
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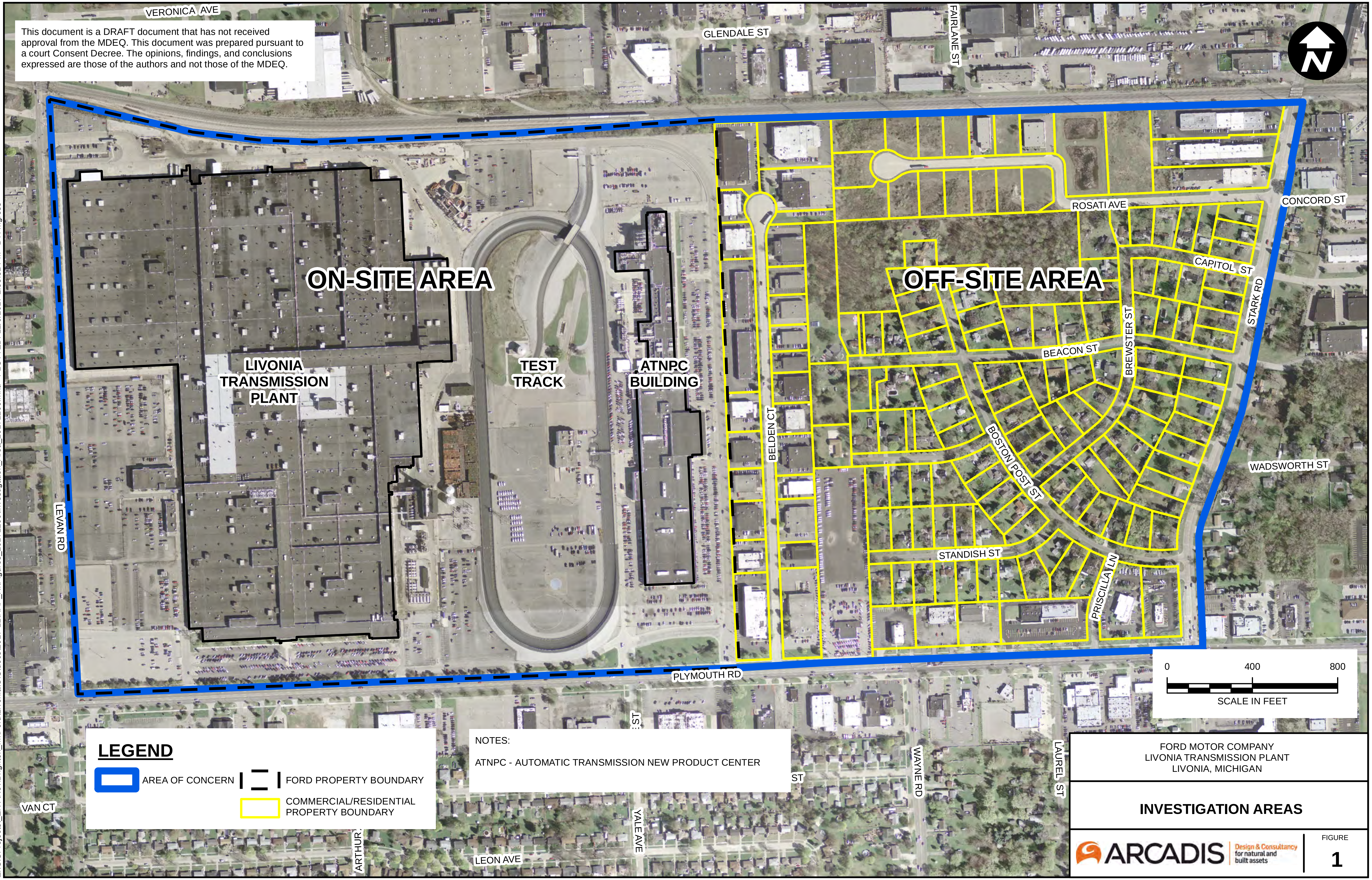

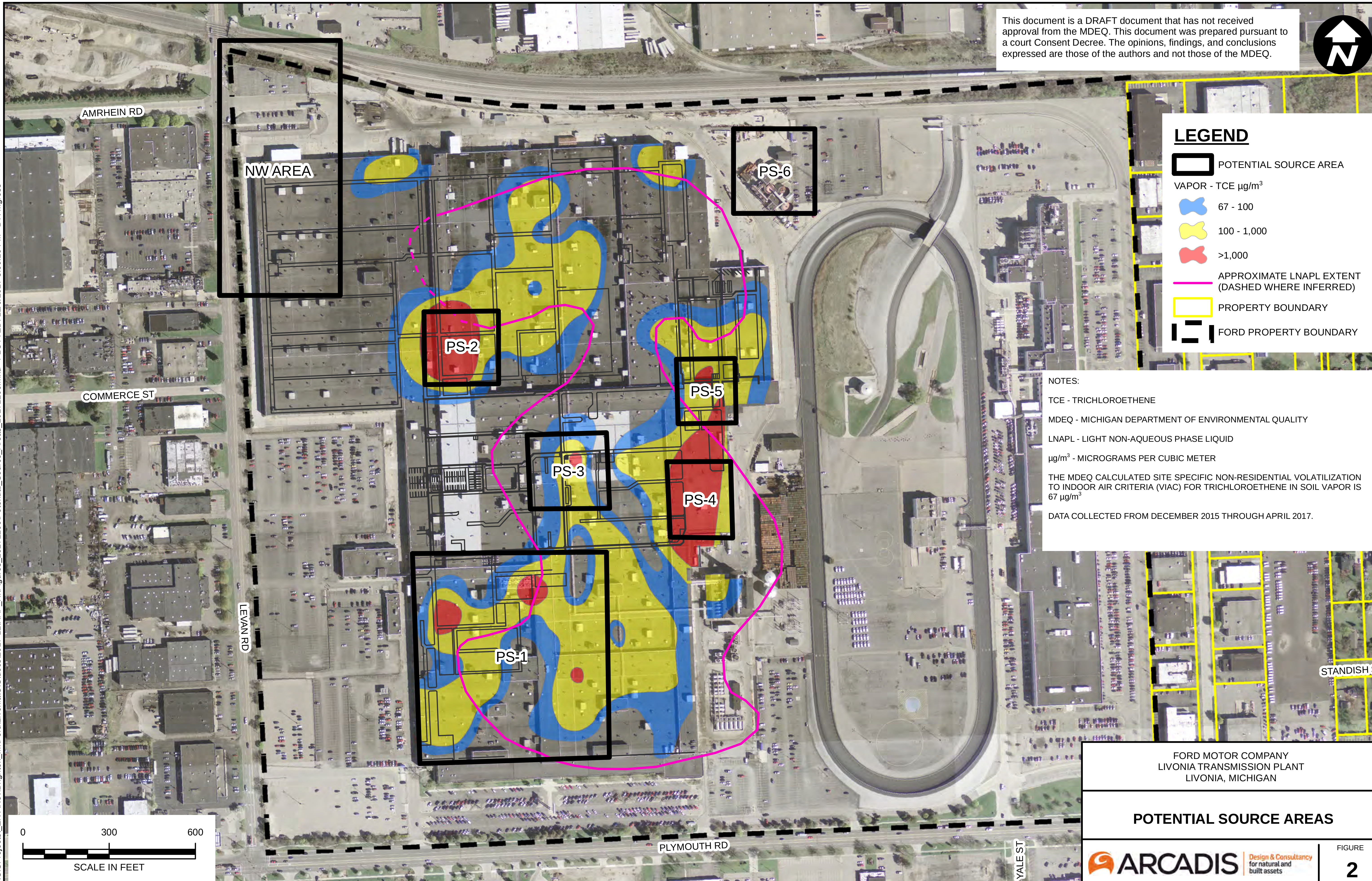

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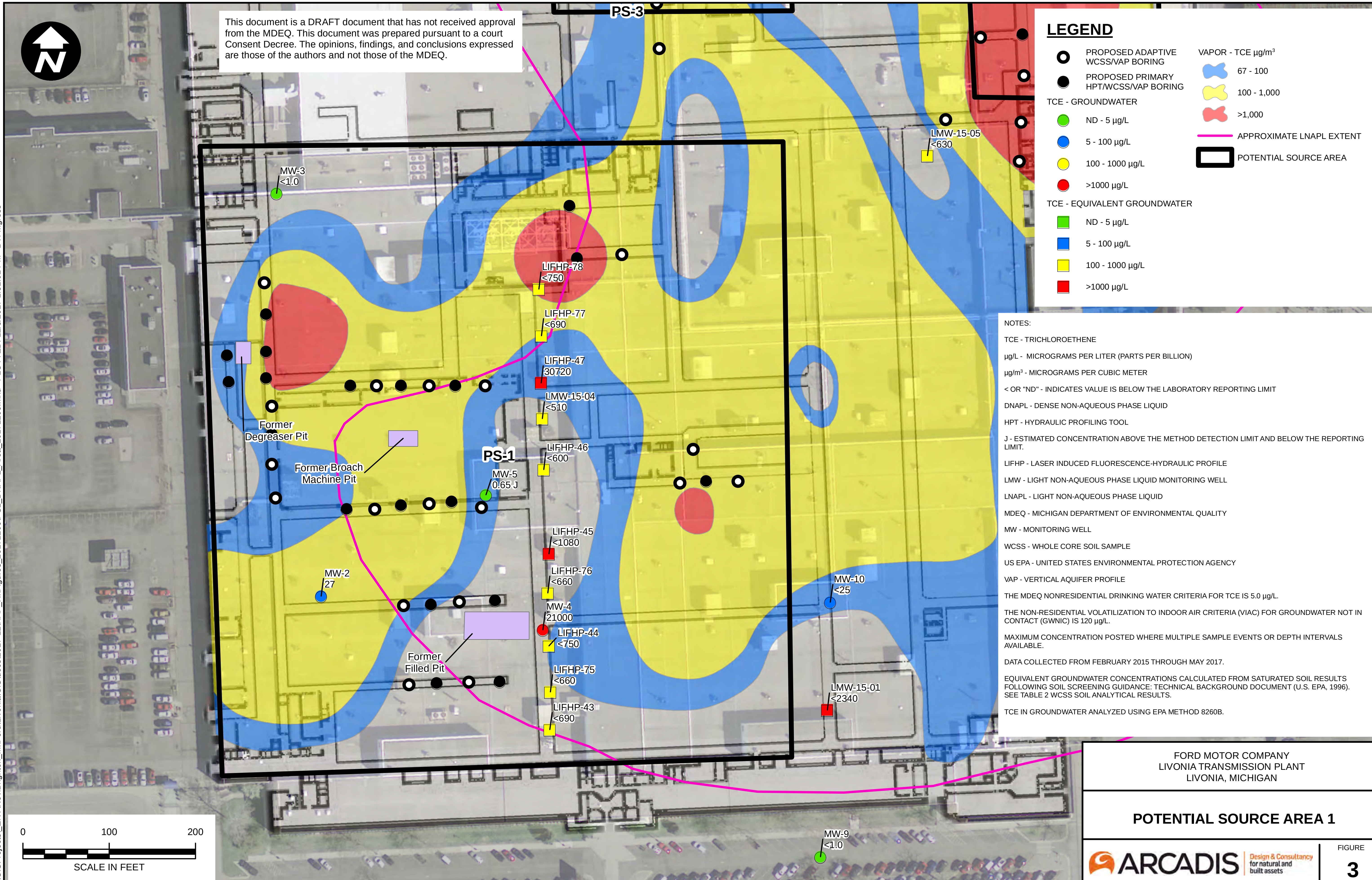

NOTES:

TCE - TRICHLOROETHENE

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

µg/m³ - MICROGRAMS PER CUBIC METER

< OR "ND" - INDICATES VALUE IS BELOW THE LABORATORY REPORTING LIMIT

DNAPL - DENSE NON-AQUEOUS PHASE LIQUID

HPT - HYDRAULIC PROFILING TOOL

J - ESTIMATED CONCENTRATION ABOVE THE METHOD DETECTION LIMIT AND BELOW THE REPORTING LIMIT.

LIFHP - LASER INDUCED FLUORESCENCE-HYDRAULIC PROFILE

LMW - LIGHT NON-AQUEOUS PHASE LIQUID MONITORING WELL

LNAPL - LIGHT NON-AQUEOUS PHASE LIQUID

MDEQ - MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

MW - MONITORING WELL

WCSS - WHOLE CORE SOIL SAMPLE

US EPA - UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

VAP - VERTICAL AQUIFER PROFILE

THE MDEQ NONRESIDENTIAL DRINKING WATER CRITERIA FOR TCE IS 5.0 µg/L.

THE NON-RESIDENTIAL VOLATILIZATION TO INDOOR AIR CRITERIA (VIAC) FOR GROUNDWATER NOT IN CONTACT (GWNIC) IS 120 µg/L.

MAXIMUM CONCENTRATION POSTED WHERE MULTIPLE SAMPLE EVENTS OR DEPTH INTERVALS AVAILABLE.

DATA COLLECTED FROM FEBRUARY 2015 THROUGH MAY 2017.

EQUIVALENT GROUNDWATER CONCENTRATIONS CALCULATED FROM SATURATED SOIL RESULTS FOLLOWING SOIL SCREENING GUIDANCE: TECHNICAL BACKGROUND DOCUMENT (U.S. EPA, 1996). SEE TABLE 2 WCSS SOIL ANALYTICAL RESULTS.

TCE IN GROUNDWATER ANALYZED USING EPA METHOD 8260B.

FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

POTENTIAL SOURCE AREA 1

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FIGURE
3

CITY: Novi DIV: ENV DB: MG PIC: R. ELLIS PM: K. HINSKEY PROJECT NUMBER: MI001322.0001 COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl
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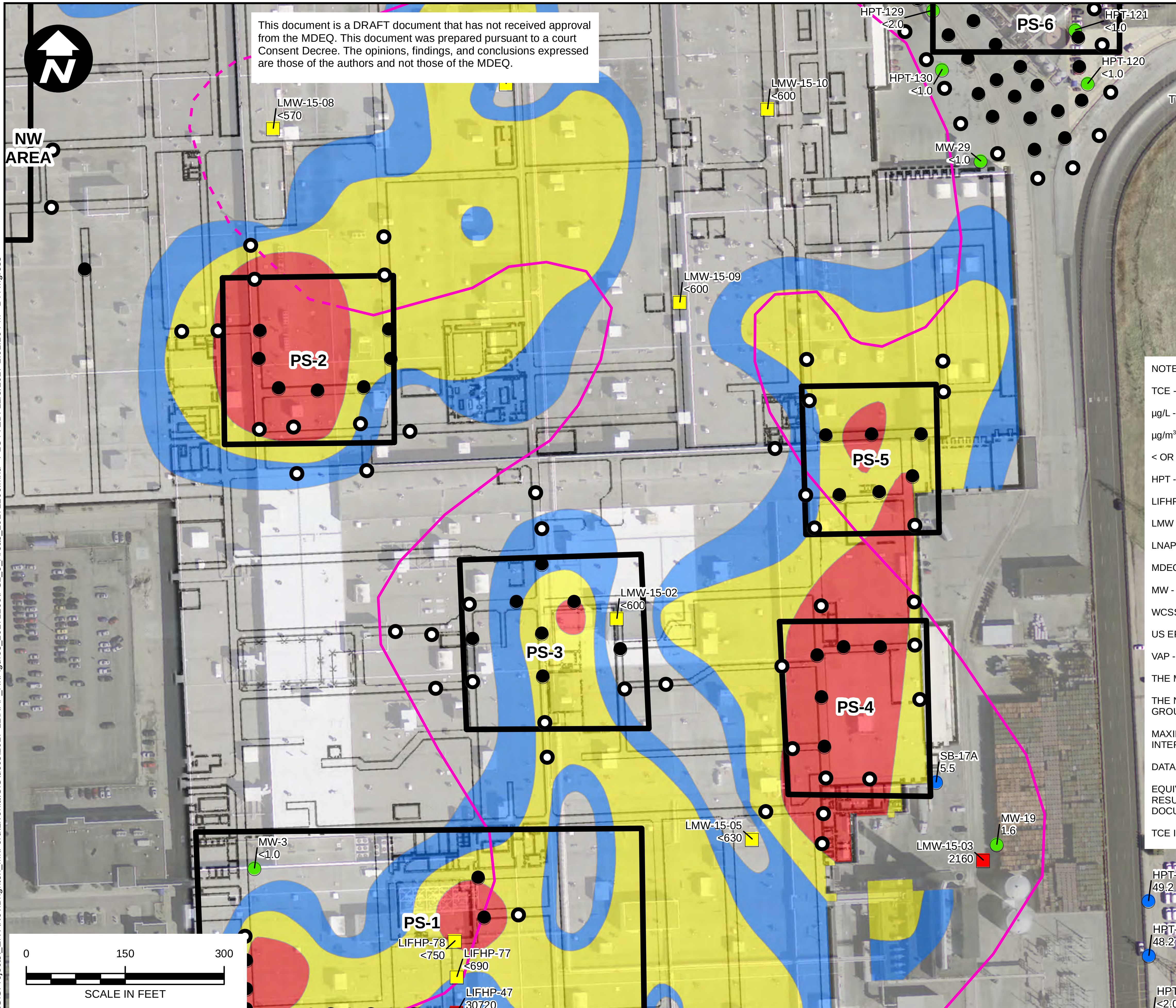

LEGEND

- PROPOSED ADAPTIVE WCSS/VAP BORING
- PROPOSED PRIMARY HPT/WCSS/VAP BORING

TCE - GROUNDWATER
- ND - 5 µg/L
- 5 - 100 µg/L
- 100 - 1000 µg/L
- >1000 µg/L

TCE - EQUIVALENT GROUNDWATER
- ND - 5 µg/L
- 5 - 100 µg/L
- 100 - 1000 µg/L
- >1000 µg/L

VAPOR - TCE µg/m^3
- 67 - 100
- 100 - 1,000
- >1,000
- APPROXIMATE LNAPL EXTENT (DASHED WHERE INFERRED)
- POTENTIAL SOURCE AREA

NOTES:

TCE - TRICHLOROETHENE

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

µg/m^3 - MICROGRAMS PER CUBIC METER

< OR "ND" - INDICATES VALUE IS BELOW THE LABORATORY REPORTING LIMIT

HPT - HYDRAULIC PROFILING TOOL

LIFHP - LASER INDUCED FLUORESCENCE-HYDRAULIC PROFILE

LMW - LIGHT NON-AQUEOUS PHASE LIQUID MONITORING WELL

LNAPL - LIGHT NON-AQUEOUS PHASE LIQUID

MDEQ - MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

MW - MONITORING WELL

WCSS - WHOLE CORE SOIL SAMPLE

US EPA - UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

VAP - VERTICAL AQUIFER PROFILE

THE MDEQ NONRESIDENTIAL DRINKING WATER CRITERIA FOR TCE IS 5.0 µg/L.

THE NON-RESIDENTIAL VOLATILIZATION TO INDOOR AIR CRITERIA (VIAC) FOR GROUNDWATER NOT IN CONTACT (GWNIC) IS 120 µg/L.

MAXIMUM CONCENTRATION POSTED WHERE MULTIPLE SAMPLE EVENTS OR DEPTH INTERVALS AVAILABLE.

DATA COLLECTED FROM FEBRUARY 2015 THROUGH MAY 2017.

EQUIVALENT GROUNDWATER CONCENTRATIONS CALCULATED FROM SATURATED SOIL RESULTS FOLLOWING SOIL SCREENING GUIDANCE: TECHNICAL BACKGROUND DOCUMENT (U.S. EPA, 1996). SEE TABLE 2 WCSS SOIL ANALYTICAL RESULTS.

TCE IN GROUNDWATER ANALYZED USING EPA METHOD 8260B.

FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

POTENTIAL SOURCE AREAS 2, 3, 4 AND 5

ARCADIS Design & Consultancy for natural and built assets

FIGURE 4

CITY: Novi DIV: ENV DB: MG PIC: R. ELLIS PM: K. HINSKEY PROJECT NUMBER: MI001322.0001 COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl

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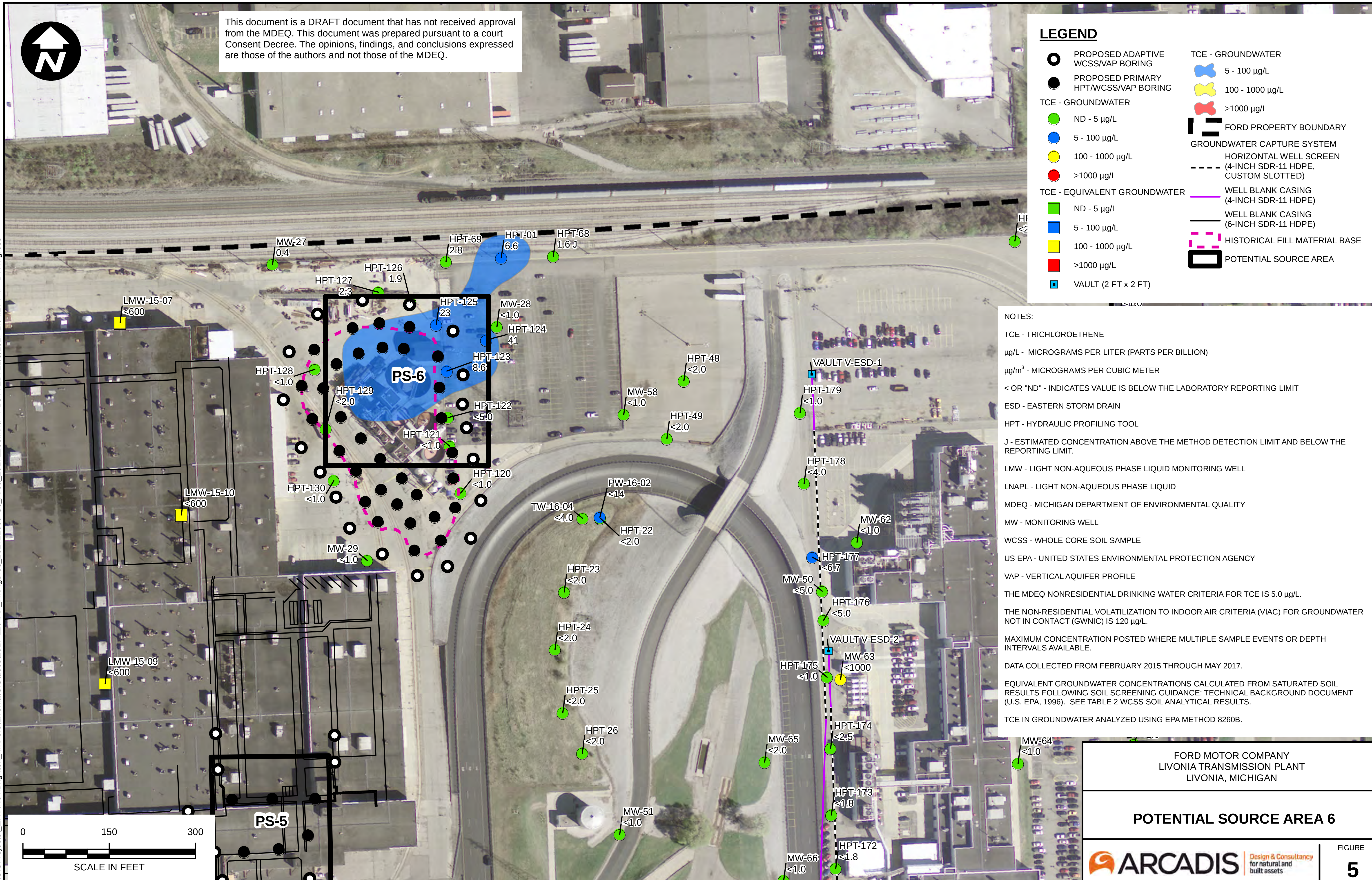

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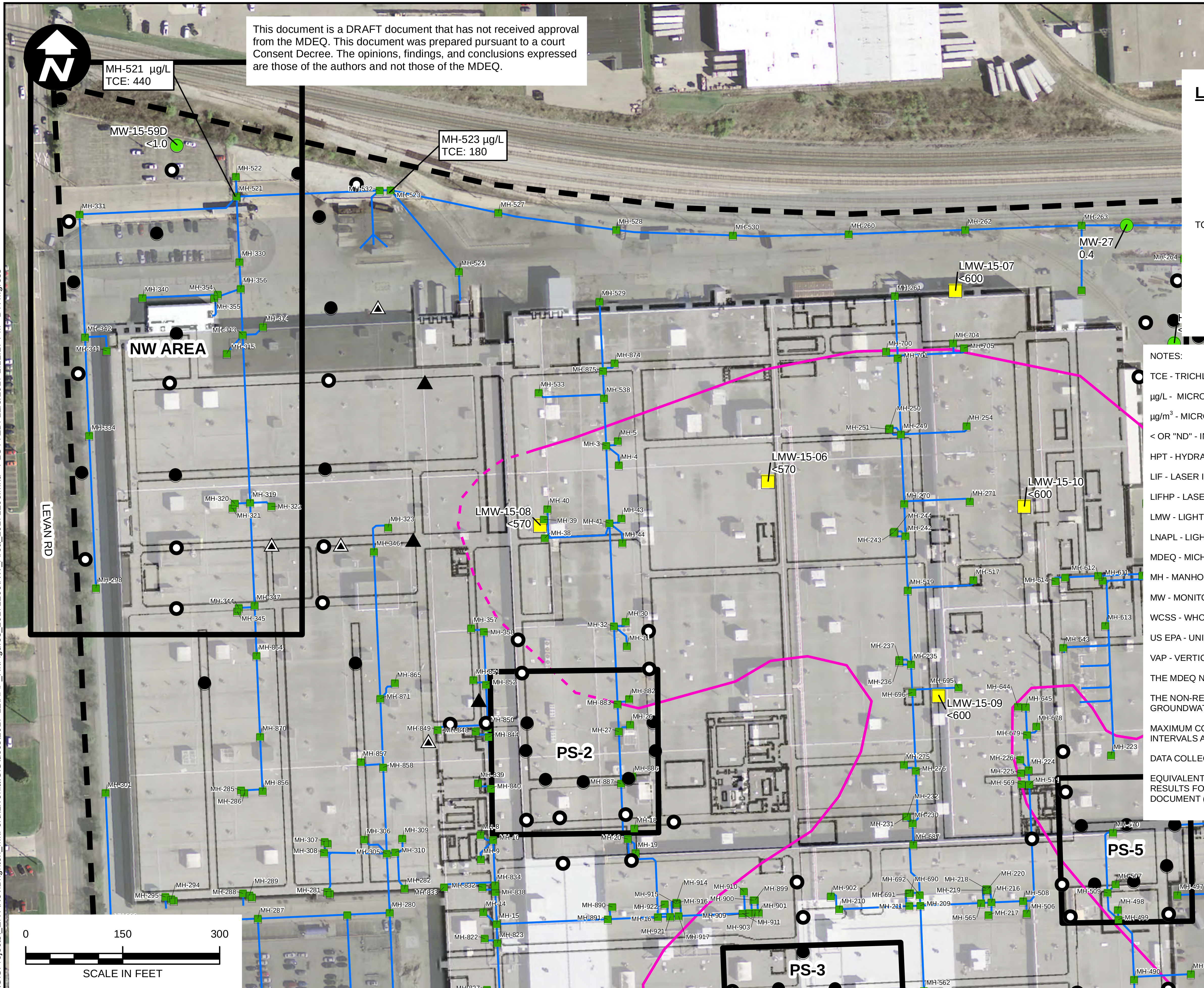


LEGEND

- PROPOSED ADAPTIVE LIF BORING
- PROPOSED ADAPTIVE WCSS/VAP BORING
- PROPOSED PRIMARY HPT/WCSS/VAP BORING
- PROPOSED PRIMARY LIF BORING

TCE - GROUNDWATER
- ND - 5 µg/L
- 5 - 100 µg/L
- 100 - 1000 µg/L
- >1000 µg/L

TCE - EQUIVALENT GROUNDWATER
- ND - 5 µg/L
- 5 - 100 µg/L
- 100 - 1000 µg/L
- >1000 µg/L
- APPROXIMATE LNAPL EXTENT (DASHED WHERE INFERRED)
- FORD PROPERTY BOUNDARY
- MANHOLE
- STORM WATER LINE
- POTENTIAL SOURCE AREA

NOTES:

TCE - TRICHLOROETHENE

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

µg/m^3 - MICROGRAMS PER CUBIC METER

< OR "ND" - INDICATES VALUE IS BELOW THE LABORATORY REPORTING LIMIT

HPT - HYDRAULIC PROFILING TOOL

LIF - LASER INDUCED FLUORESCENCE

LIFHP - LASER INDUCED FLUORESCENCE-HYDRAULIC PROFILE

LMW - LIGHT NON-AQUEOUS PHASE LIQUID MONITORING WELL

LNAPL - LIGHT NON-AQUEOUS PHASE LIQUID

MDEQ - MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

MH - MANHOLE

MW - MONITORING WELL

WCSS - WHOLE CORE SOIL SAMPLE

US EPA - UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

VAP - VERTICAL AQUIFER PROFILE

THE MDEQ NONRESIDENTIAL DRINKING WATER CRITERIA FOR TCE IS 5.0 µg/L.

THE NON-RESIDENTIAL VOLATILIZATION TO INDOOR AIR CRITERIA (VIAC) FOR GROUNDWATER NOT IN CONTACT (GWNIC) IS 120 µg/L.

MAXIMUM CONCENTRATION POSTED WHERE MULTIPLE SAMPLE EVENTS OR DEPTH INTERVALS AVAILABLE.

DATA COLLECTED FROM FEBRUARY 2015 THROUGH JULY 2017.

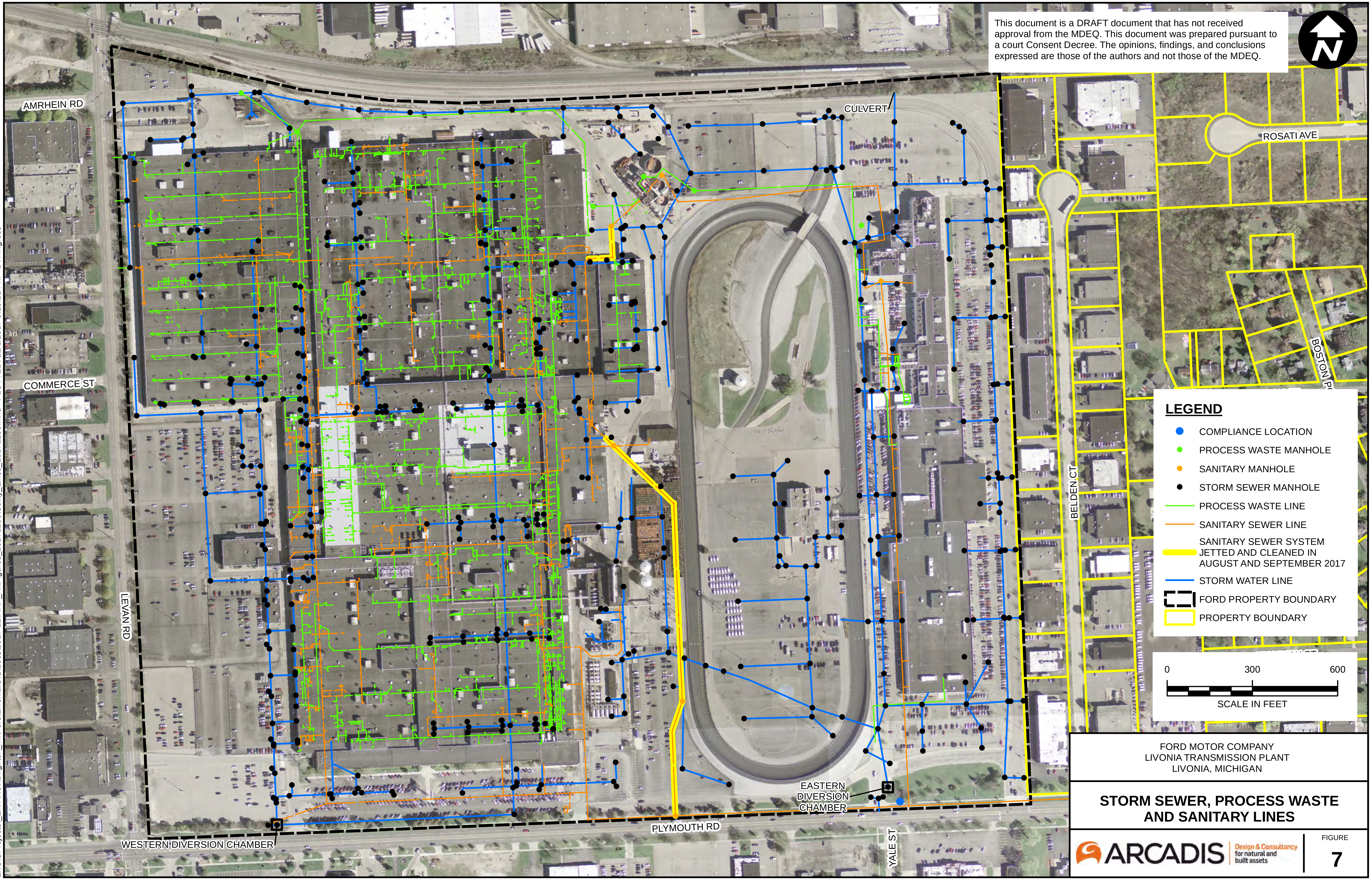
EQUIVALENT GROUNDWATER CONCENTRATIONS CALCULATED FROM SATURATED SOIL RESULTS FOLLOWING SOIL SCREENING GUIDANCE: TECHNICAL BACKGROUND DOCUMENT (U.S. EPA, 1996). SEE TABLE 2 WCSS SOIL ANALYTICAL RESULTS.

FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

POTENTIAL NORTHWEST SOURCE AREA

ARCADIS Design & Consultancy for natural and built assets

FIGURE
6



FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

STORM SEWER, PROCESS WASTE AND SANITARY LINES

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FIGURE
7

CITY: Novi DIV: ENV DB: MG PIC: R. ELLIS PM: K. HINSKEY PROJECT NUMBER: MI001322.0001 COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet
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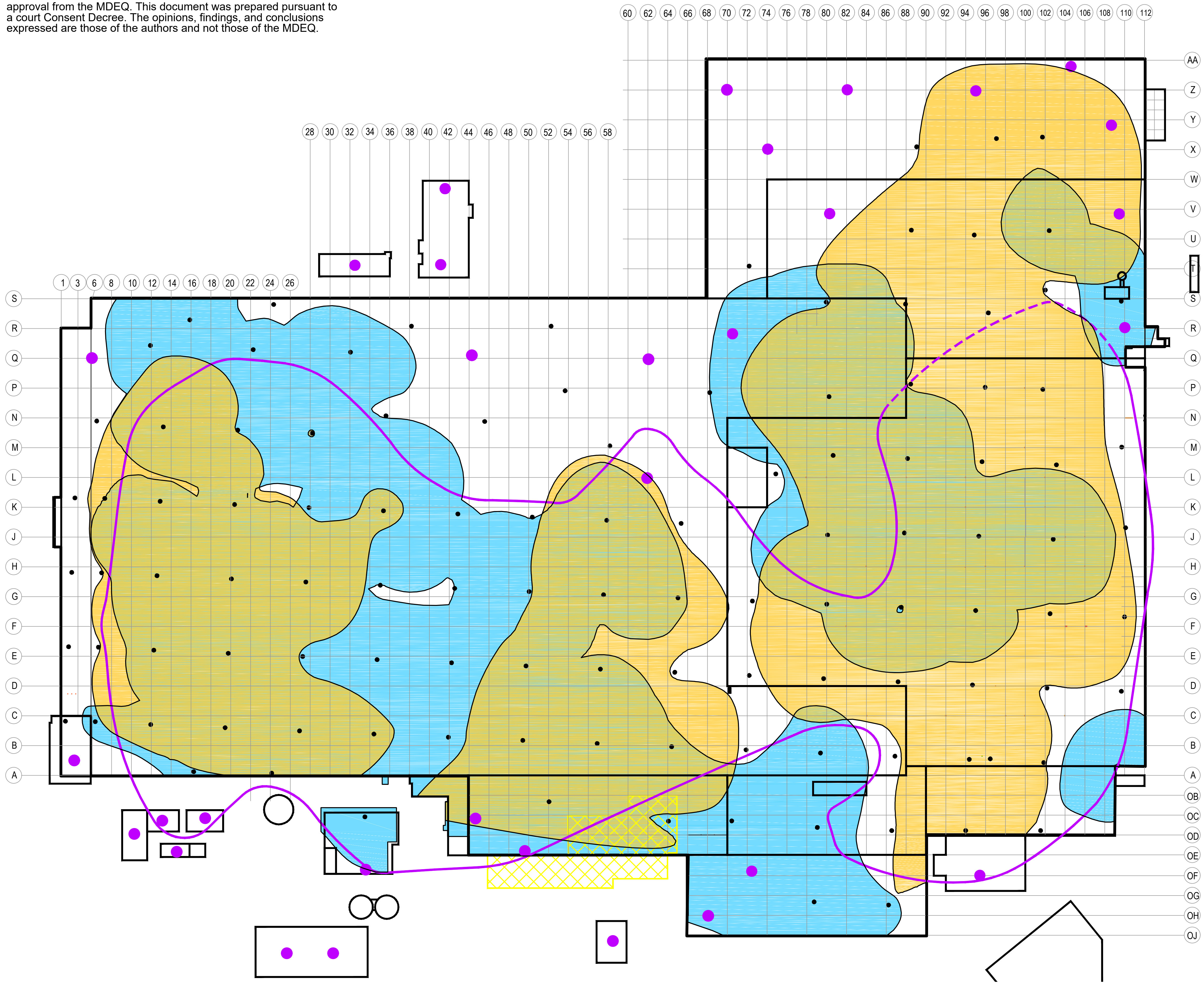

LEGEND:

- VAPOR POINTS
- METHANE CONCENTRATION ABOVE SCREENING LEVEL OF 1.25%
- VAPOR BARRIER
- APPROXIMATE LNAPL EXTENT (DASHED WHERE INFERRED)
- VOC CONCENTRATION ABOVE MDEQ VAPOR INTRUSION GUIDANCE SCREENING LEVEL FOR SHALLOW SOIL GAS, MAY 2013 (RESCINDED JUNE 2017)
- PROPOSED SUB-SLAB DELINEATION POINT

NOTES:

1. ALL METHANE CONCENTRATIONS ARE IN UNITS OF % AIR.
2. METHANE CONCENTRATIONS FIELD SCREENED USING GEM 2000 IN JULY 2016.
3. INITIAL METHANE CONCENTRATIONS BELOW THE SCREENING LEVEL WERE FIELD VERIFIED USING A GEM 2000 IN DECEMBER, 2016. THE HIGHEST CONCENTRATION IS REPORTED.
4. TCVOC = TOTAL CHLORINATED VOC (cis-DCE, TCE AND VINYL CHLORIDE). ANY EXCEEDANCE RESULTS IN SUM OF ALL DETECTIONS.
5. R-38-17 RESULTS EXCEED XYLENE SCREENING LEVELS, BUT ONLY TCVOC PRESENTED.
6. VOC = VOLATILE ORGANIC COMPOUND
7. MDEQ = MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
8. LNAPL = LIGHT NON-AQUEOUS PHASE LIQUID

0 200' 400'

GRAPHIC SCALE

FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

SUB-SLAB VAPOR SAMPLING LOCATIONS - LTP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
8

CITY:(Reqd) DIV/GROUP:(Reqd) DB:(Reqd) LD:(Opt) PIC: R.ELLIS PM: K.HINSKEY TM: A. DEGRANDIS LYR:(Opt)ON=*;OFF=*REF*
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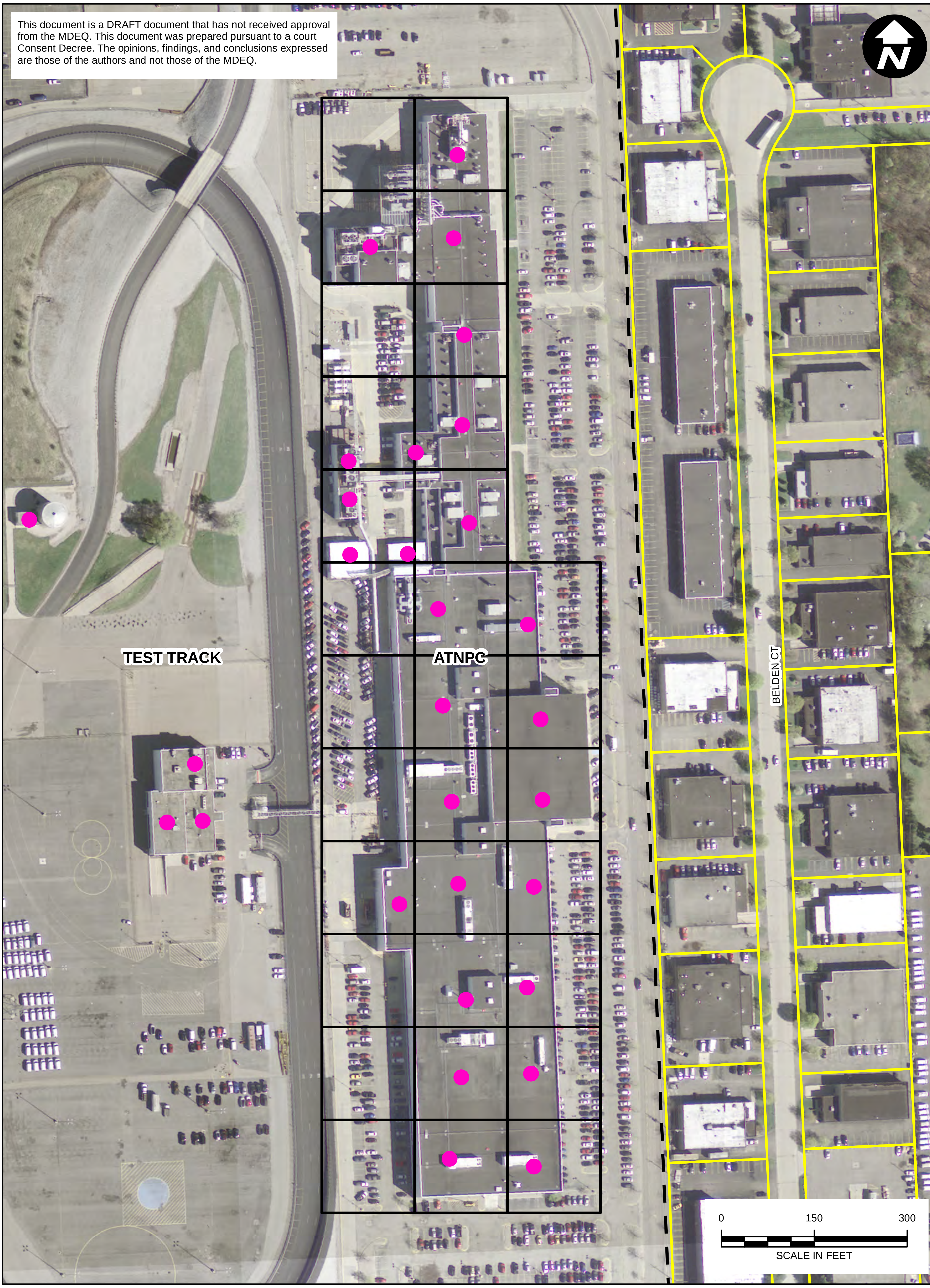

LEGEND:

- PROPOSED SUB-SLAB MONITORING POINT LOCATION
- 150 FT GRID FOR ATNPC
- FORD PROPERTY BOUNDARY
- PROPERTY BOUNDARY

NOTES:

ATNPC - AUTOMATIC TRANSMISSION NEW PRODUCT CENTER

FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

SUB-SLAB VAPOR SAMPLING LOCATIONS - TEST TRACK AND ATNPC

ARCADIS Design & Consultancy for natural and built assets

FIGURE
9

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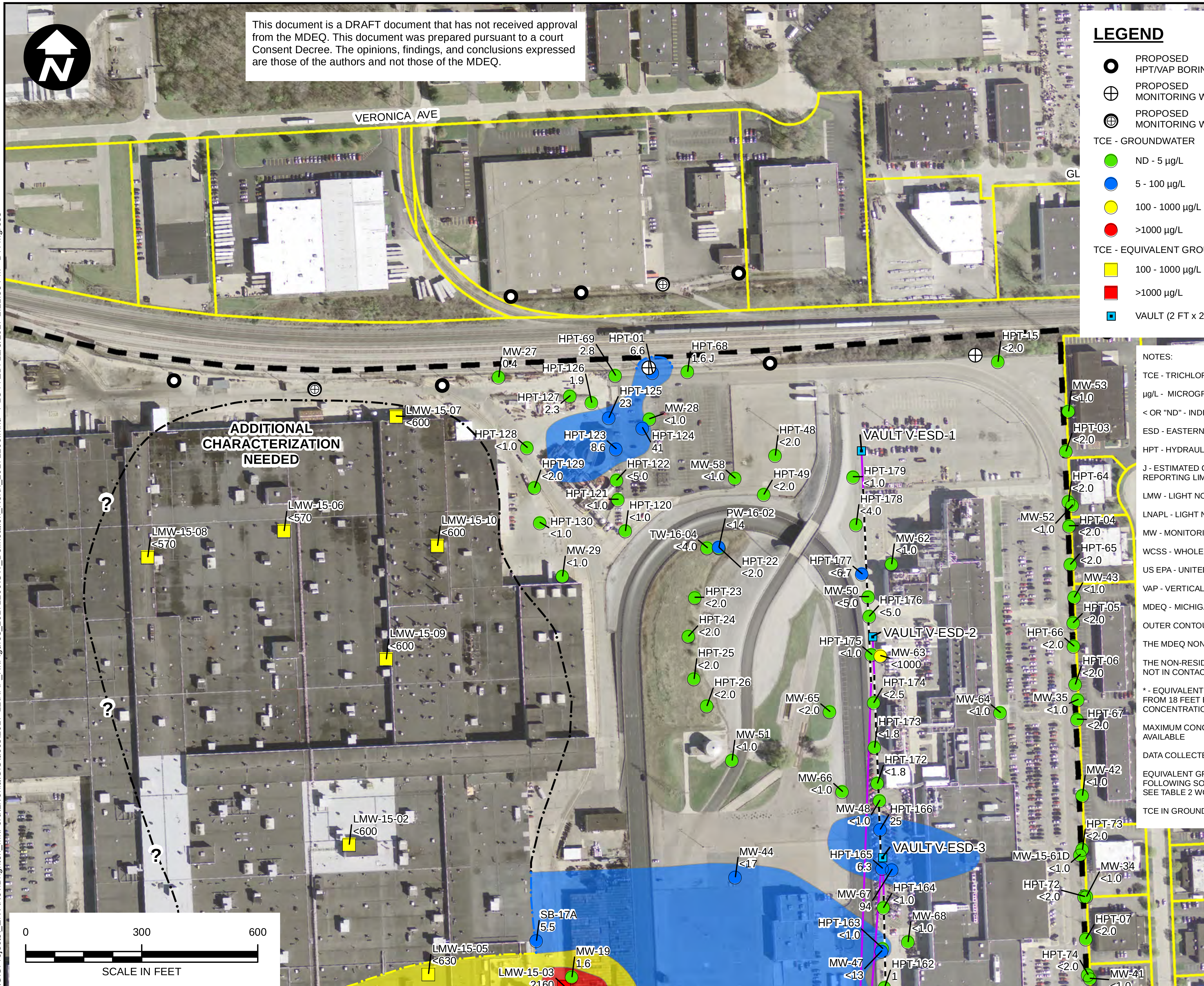

LEGEND

- PROPOSED HPT/VAP BORING
- PROPOSED MONITORING WELL
- PROPOSED MONITORING WELL/HPT/VAP BORING

TCE - GROUNDWATER
- ND - 5 µg/L
- 5 - 100 µg/L
- 100 - 1000 µg/L
- >1000 µg/L

TCE - EQUIVALENT GROUNDWATER
- 100 - 1000 µg/L
- >1000 µg/L
- VAULT (2 FT x 2 FT)

TCE - GROUNDWATER
- 5 - 100 µg/L
- 100 - 1000 µg/L
- >1000 µg/L
- INFERRED/UNKNOWN TCE CONTOUR
- PROPERTY BOUNDARY
- FORD PROPERTY BOUNDARY

GROUNDWATER CAPTURE SYSTEM
- HORIZONTAL WELL SCREEN (4-INCH SDR-11 HDPE, CUSTOM SLOTTED)
- WELL BLANK CASING (4-INCH SDR-11 HDPE)
- WELL BLANK CASING (6-INCH SDR-11 HDPE)

NOTES:

TCE - TRICHLOROETHENE

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

< OR "ND" - INDICATES VALUE IS BELOW THE LABORATORY REPORTING LIMIT

ESD - EASTERN STORM DRAIN

HPT - HYDRAULIC PROFILING TOOL

J - ESTIMATED CONCENTRATION ABOVE THE METHOD DETECTION LIMIT AND BELOW THE REPORTING LIMIT.

LMW - LIGHT NON-AQUEOUS PHASE LIQUID MONITORING WELL

LNAPL - LIGHT NON-AQUEOUS PHASE LIQUID

MW - MONITORING WELL

WCSS - WHOLE CORE SOIL SAMPLE

US EPA - UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

VAP - VERTICAL AQUIFER PROFILE

MDEQ - MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

OUTER CONTOUR IS DASHED WHERE THE EXTENT IS INFERRED OR UNKNOWN.

THE MDEQ NONRESIDENTIAL DRINKING WATER CRITERIA FOR TRICHLOROETHENE IS 5.0 µg/L.

THE NON-RESIDENTIAL VOLATILIZATION TO INDOOR AIR CRITERIA (VIAC) FOR GROUNDWATER NOT IN CONTACT (GWNIC) IS 120 µg/L.

* - EQUIVALENT GROUNDWATER CONCENTRATION BASED ON LNAPL IMPACTED SOIL SAMPLE FROM 18 FEET BELOW GRADE. THEREFORE TCE CONCENTRATION REPRESENTS LNAPL TCE CONCENTRATION, NOT DISSOLVED PHASE IMPACTS (SEE TABLE 3 [LNAPL ANALYTICAL])

MAXIMUM CONCENTRATION POSTED WHERE MULTIPLE SAMPLE EVENTS OR DEPTH INTERVALS AVAILABLE

DATA COLLECTED FROM FEBRUARY 2015 THROUGH MAY 2017.

EQUIVALENT GROUNDWATER CONCENTRATIONS CALCULATED FROM SATURATED SOIL RESULTS FOLLOWING SOIL SCREENING GUIDANCE: TECHNICAL BACKGROUND DOCUMENT (U.S. EPA, 1996). SEE TABLE 2 WCSS SOIL ANALYTICAL RESULTS.

TCE IN GROUNDWATER ANALYZED USING EPA METHOD 8260B.

FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

OFF-SITE GROUNDWATER DELINEATION - NORTH

ARCADIS Design & Consultancy for natural and built assets

FIGURE 10

CITY: Novi DIV: ENV DB: MG PIC: R. ELLIS PM: K. HINSKEY PROJECT NUMBER: MI001322.0001 COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl
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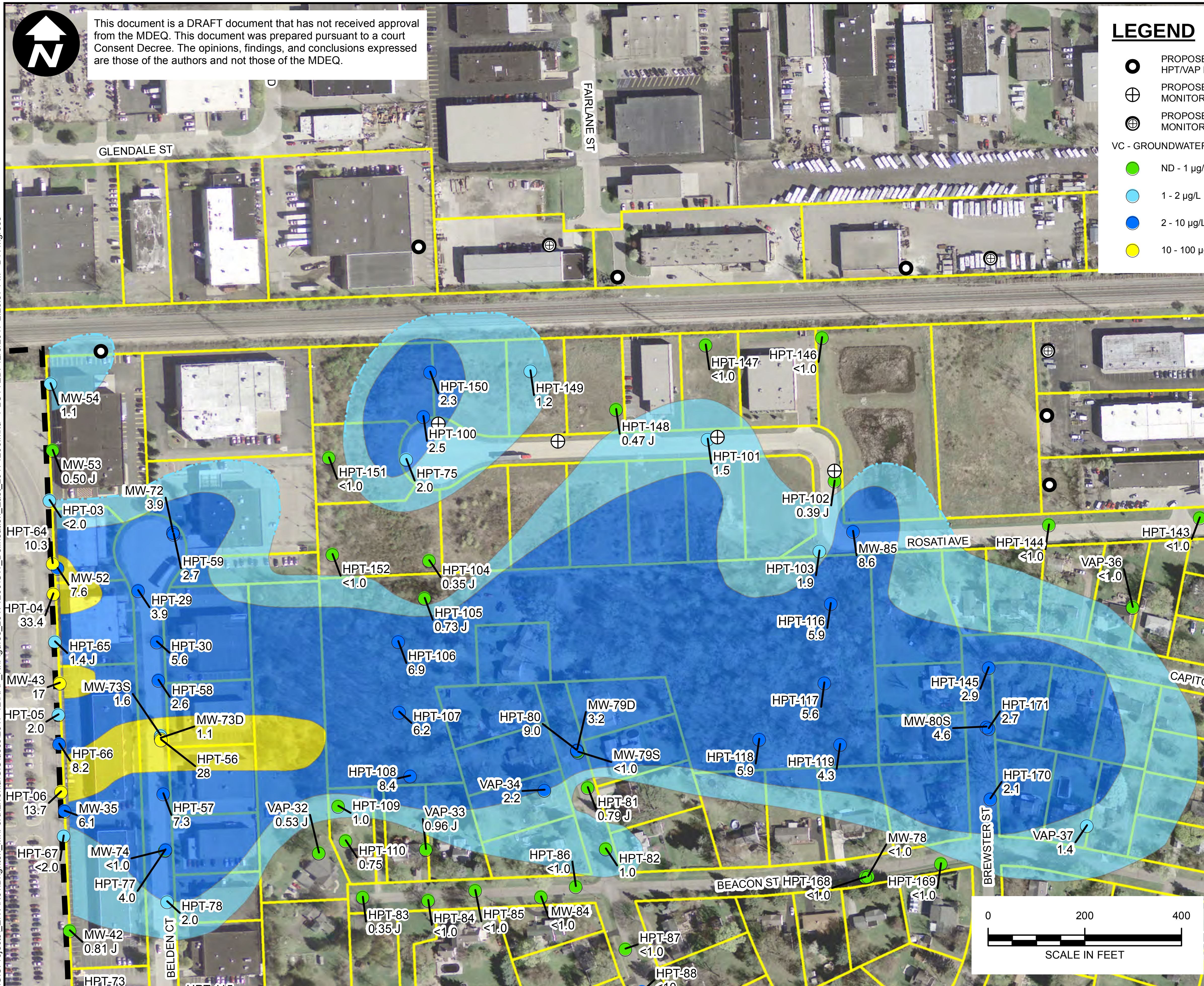

LEGEND

- PROPOSED HPT/VAP BORING
- PROPOSED MONITORING WELL
- PROPOSED MONITORING WELL/HPT/VAP BORING

VC - GROUNDWATER
- ND - 1 µg/L
- 1 - 2 µg/L
- 2 - 10 µg/L
- 10 - 100 µg/L

VC - GROUNDWATER
- 1 - 2 µg/L
- 2 - 10 µg/L
- 10 - 100 µg/L
- PROPERTY BOUNDARY
- FORD PROPERTY BOUNDARY

NOTES:

< OR "ND" - INDICATES VALUE IS BELOW THE LABORATORY REPORTING LIMIT

VC - VINYL CHLORIDE

HPT - HYDRAULIC PROFILING TOOL

MW - MONITORING WELL

US EPA - UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

VAP - VERTICAL AQUIFER PROFILE

VOCS - VOLATILE ORGANIC COMPOUNDS

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

J - ESTIMATED CONCENTRATION ABOVE THE METHOD DETECTION LIMIT AND BELOW THE REPORTING LIMIT.

OUTER CONTOUR IS DASHED WHERE THE EXTENT IS INFERRED OR UNKNOWN.

THE RESIDENTIAL AND NONRESIDENTIAL DRINKING WATER CRITERIA FOR VINYL CHLORIDE IS 2.0 µg/L.

THE SITE-SPECIFIC NON-RESIDENTIAL VOLATILIZATION TO INDOOR AIR CRITERIA (VIAC) FOR GROUNDWATER NOT IN CONTACT (GWNIC) FOR VINYL CHLORIDE IS 160 µg/L.

THE SITE-SPECIFIC RESIDENTIAL VOLATILIZATION TO INDOOR AIR CRITERIA (VIAC) FOR GROUNDWATER IN CONTACT (GWIC) FOR VINYL CHLORIDE IS 0.12 UG/L. THIS SCREENING LEVEL IS BELOW THE TARGET DETECTION LIMIT FOR VINYL CHLORIDE OF 1 µg/L. A TARGET DETECTION LIMIT OF 1 µg/L HAS BEEN USED

MAXIMUM CONCENTRATION POSTED WHERE MULTIPLE SAMPLE EVENTS OR DEPTH INTERVALS AVAILABLE.

DATA COLLECTED FROM OCTOBER 2015 THROUGH MAY 2017.

ALL NON-DETECT GROUNDWATER VALUES WERE ASSUMED TO BE 1/2 THE DETECTION LIMIT FOR CONTOURING.

VOCS ANALYZED USING EPA METHOD 8260 OR 8265. EPA 8265 RESULTS REPORTED AS SUM OF VINYL CHLORIDE + 1,2-DICHLOROETHANE. POSTED EPA 8265 RESULTS ASSUME CONCENTRATION IS ENTIRELY VINYL CHLORIDE.

FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

OFF-SITE GROUNDWATER DELINEATION - NORTHEAST

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FIGURE 11

CITY: Novi DIV: ENV DB: MG PIC: R. ELLIS PM: K. HINSKEY PROJECT NUMBER: MI001322.0001 COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl
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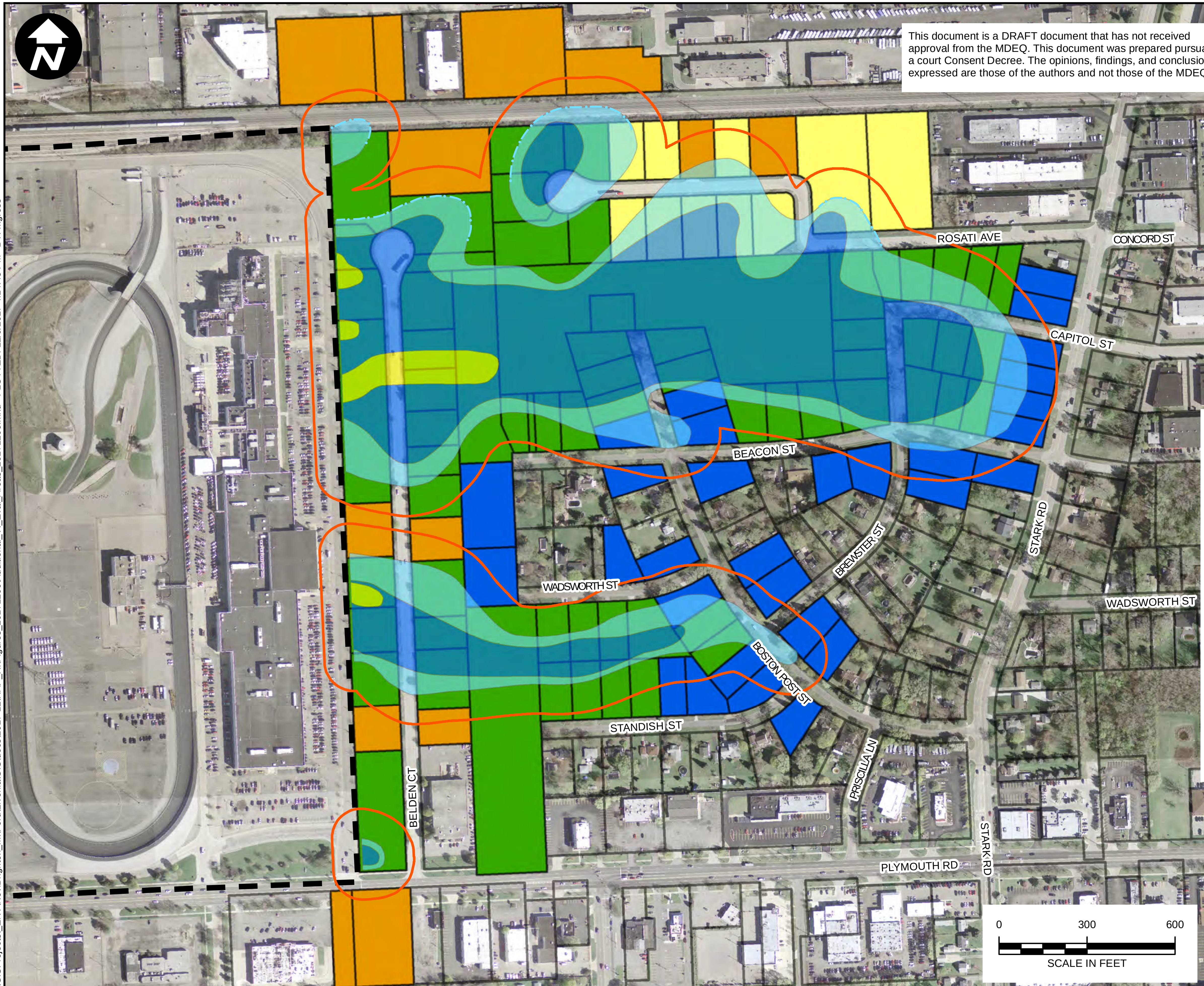

LEGEND

- CURRENTLY UNDER EVALUATION

ADDITIONAL EVALUATION NEEDED

- RESIDENTIAL DEVELOPED
- COMMERCIAL DEVELOPED
- UNDEVELOPED
- PROPERTY BOUNDARY
- FORD PROPERTY BOUNDARY

VC - GROUNDWATER

- 1 - 2 µg/L
- 2 - 10 µg/L
- 10 - 100 µg/L
- >100 µg/L
- 100' PLUME OFFSET

NOTES:

VC - VINYL CHLORIDE

US EPA - UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

VOCS - VOLATILE ORGANIC COMPOUNDS

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

OUTER CONTOUR IS DASHED WHERE THE EXTENT IS INFERRED OR UNKNOWN.

THE RESIDENTIAL AND NONRESIDENTIAL DRINKING WATER CRITERIA FOR VINYL CHLORIDE IS 2.0 µg/L.

THE SITE-SPECIFIC NON-RESIDENTIAL VOLATILIZATION TO INDOOR AIR CRITERIA (VIAC) FOR GROUNDWATER NOT IN CONTACT (GWNIC) FOR VINYL CHLORIDE IS 160 µg/L.

THE SITE-SPECIFIC RESIDENTIAL VOLATILIZATION TO INDOOR AIR CRITERIA (VIAC) FOR GROUNDWATER IN CONTACT (GWIC) FOR VINYL CHLORIDE IS 0.12 UG/L. THIS SCREENING LEVEL IS BELOW THE TARGET DETECTION LIMIT FOR VINYL CHLORIDE OF 1 µg/L. A TARGET DETECTION LIMIT OF 1 µg/L HAS BEEN USED

DATA COLLECTED FROM OCTOBER 2015 THROUGH MAY 2017.

VOCS ANALYZED USING EPA METHOD 8260 OR 8265. EPA 8265 RESULTS REPORTED AS SUM OF VINYL CHLORIDE + 1,2-DICHLOROETHANE. POSTED EPA 8265 RESULTS ASSUME CONCENTRATION IS ENTIRELY VINYL CHLORIDE.

FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

OFF-SITE PROPERTIES FOR VAPOR INTRUSION EVALUATION

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FIGURE **12**

CITY: Novi DIV: ENV DB: MG PIC: R. ELLIS PM: K. HINSKEY PROJECT NUMBER: MI001322.0001 COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl
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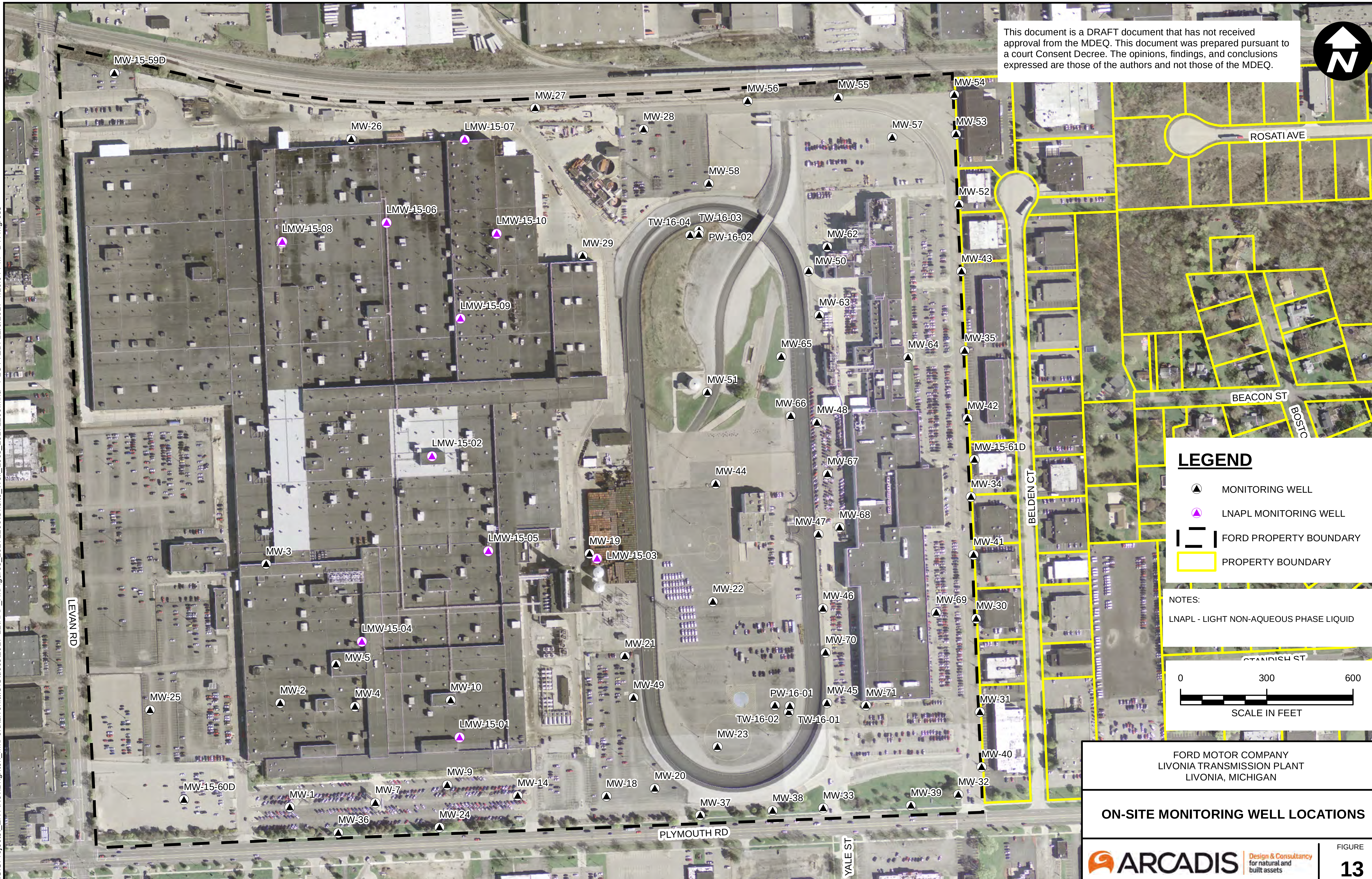

FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

ON-SITE MONITORING WELL LOCATIONS

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FIGURE
13

CITY: Novi DIV: ENV DB: MG PIC: R. ELLIS PM: K. HINSKEY PROJECT NUMBER: MI001322.0001 COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet
Z:\GISProjects_ENV\Novi\Brighton_MI\Ford\Livonia\GIS\docs\2017-12\RAP_RIFigures_20171206\Onsite_Well_Locs_20171206.mxd PLOTTED: 12/6/2017 4:16:04 PM BY: mgress

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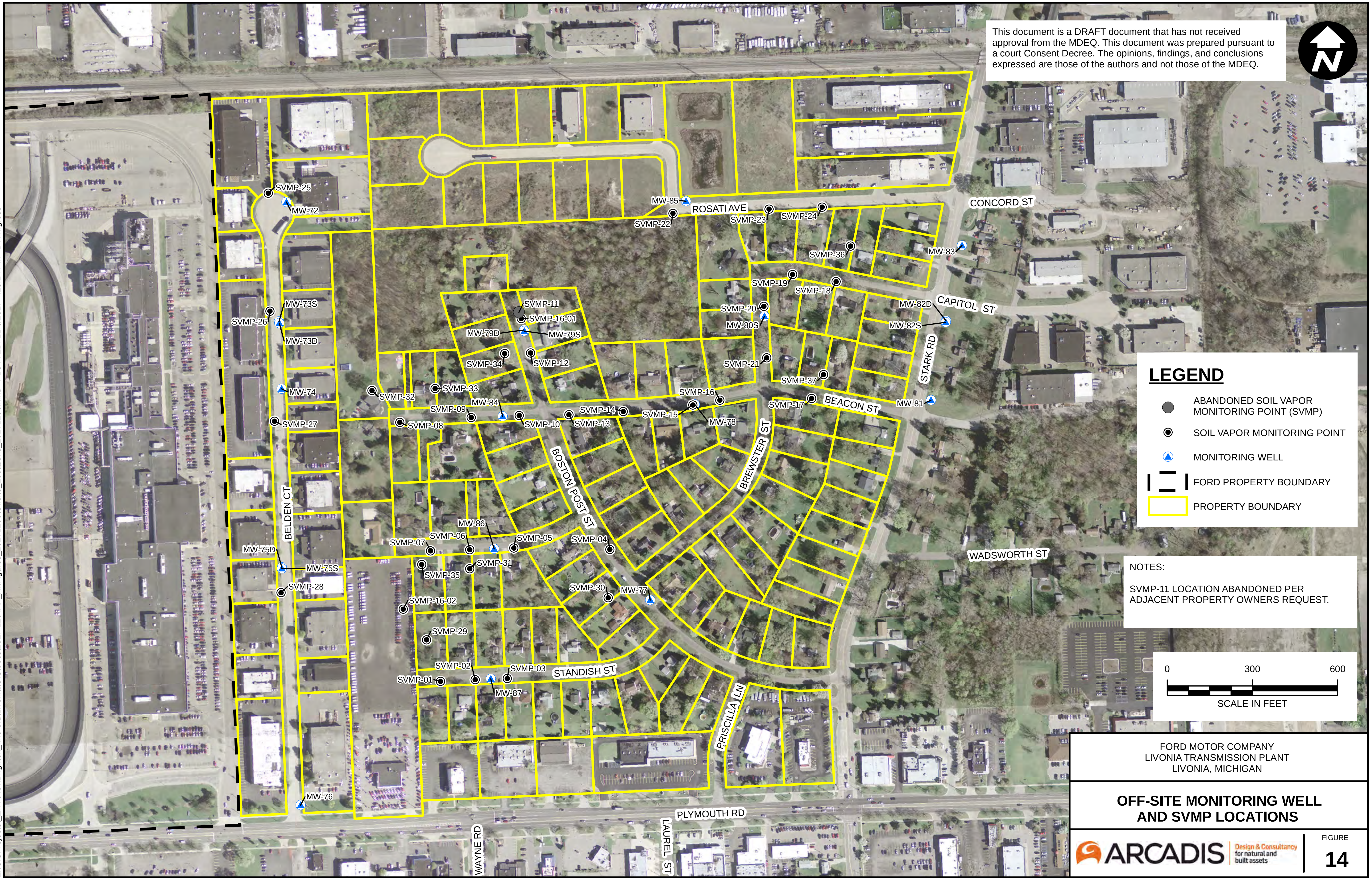

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LEGEND

- ABANDONED SOIL VAPOR MONITORING POINT (SVMP)
- SOIL VAPOR MONITORING POINT
- MONITORING WELL
- FORD PROPERTY BOUNDARY
- PROPERTY BOUNDARY

NOTES:

SVMP-11 LOCATION ABANDONED PER ADJACENT PROPERTY OWNERS REQUEST.

0 300 600

SCALE IN FEET

FORD MOTOR COMPANY
LIVONIA TRANSMISSION PLANT
LIVONIA, MICHIGAN

OFF-SITE MONITORING WELL AND SVMP LOCATIONS

ARCADIS Design & Consultancy for natural and built assets

FIGURE 14

TABLES

Table 1
Site-Wide Well Construction Details
Ford Livonia Transmission Plant
36200 Plymouth Road
Livonia, Michigan

Well ID	Well Diameter (inches)	Screen Interval (ft. bgs)	Total Well Depth (ft.)
On-Site Wells			
LMW-15-01	2	7-12	12
LMW-15-02	2	7-12	12
LMW-15-03	2	7-12	12
LMW-15-04	2	6-11	11
LMW-15-05	2	7-12	12
LMW-15-06	2	7-12	12
LMW-15-07	2	7-12	12
LMW-15-08	2	7.5-12.5	12.5
LMW-15-09	2	7-12	12
LMW-15-10	2	7-12	12
MW-15-59D	2	94-99	99
MW-15-60D	2	93-98	98
MW-15-61D	2	88-93	93
MW-1	2	14-19	19
MW-2	2	15.5-20.5	20.5
MW-3	2	14-19	19
MW-4	2	15.5-20.5	20.5
MW-5	2	15.5-20.5	20.5
MW-7	2	18-23	23.0
MW-9	2	19.5-24.5	24.5
MW-10	2	16.5-21.5	21.5
MW-14	2	15-20	20
MW-18	2	13-18	18
MW-19	2	15-20	20
MW-20	2	13.5-18.5	18.5
MW-21	2	13.5-18.5	18.5
MW-22	2	16.5-21.5	21.5
MW-23	2	15-20	20
MW-24	2	19-24	24
MW-25	2	16-21	21
MW-26	2	4.5-14.5	14.5
MW-27	2	4-14	14
MW-28	2	2-12	12
MW-29	2	5-15	15
MW-30	2	19-24	24
MW-31	2	17-22	22
MW-32	2	18-23	23
MW-33	2	14-19	19
MW-34	2	16.5-21.5	21.5
MW-35	2	19.5-24.5	24.5
MW-36	2	20-25	25
MW-37	2	18-23	23
MW-38	2	15-20	20
MW-39	2	19.5-24.5	24.5

See Notes on Last Page.

Table 1
Site-Wide Well Construction Details
Ford Livonia Transmission Plant
36200 Plymouth Road
Livonia, Michigan

Well ID	Well Diameter (inches)	Screen Interval (ft. bgs)	Total Well Depth (ft.)
MW-40	2	15-20	20
MW-41	2	16-21	21
MW-42	2	16-21	21
MW-43	2	17-22	22
MW-44	2	16-21	21
MW-45	2	15-20	20
MW-46	2	16-21	21
MW-47	2	16-21	21
MW-48	2	17-22	22
MW-49	2	12.5-17.5	17.5
MW-50	2	16-21	21
MW-51	2	15-20	20
MW-52	2	15-20	20
MW-53	2	16-21	21
MW-54	2	16-21	21
MW-55	2	15-20	20
MW-56	2	16-21	21
MW-57	2	17-22	22
MW-58	2	15-20	20
MW-62	2	16.3-21.3	21.3
MW-63	2	7-12	12
MW-64	2	15-20	20
MW-65	2	16-21	21
MW-66	2	15-20	20
MW-67	2	9-14	14
MW-68	2	15-20	20
MW-69	2	15-20	20
MW-70	2	15-20	20
MW-71	2	15-20	20
PW-16-01	6	9.7-19.7	21.7
PW-16-02	6	6-21	23
TW-16-01	2	12-17	17
TW-16-02	2	12-17	17
TW-16-03	2	9-19	19
TW-16-04	2	9-19	19
Off-Site Wells			
MW-72	2	15-20	20
MW-73S	2	7-12	12
MW-73D	2	13.5-18.5	18.5
MW-74	2	14-19	19
MW-75S	2	5-10	10
MW-75D	2	12-17	17
MW-76	2	15-20	20
MW-77	2	9-14	14
MW-78	2	7-12	12

See Notes on Last Page.

Well ID	Well Diameter (inches)	Screen Interval (ft. bgs)	Total Well Depth (ft.)
MW-79S	2	5-10	10
MW-79D	2	10-15	15
MW-80S	2	7-12	12
MW-81	2	8-13	13
MW-82S	2	9-14	14
MW-82D	2	18-23	23
MW-83	2	8-13	13
MW-84	2	8-13	13
MW-85	2	8-13	13
MW-86	2	12-17	17
MW-87	2	14-19	19

Notes:

D Deep well
ft. Feet
ft. bgs Feet below ground surface
LMW LNAPL Monitoring Well
LNAPL Light non-aqueous phase liquid
MW Monitoring Well
PW Pumping Well
S Shallow well
TW Test Well

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Table 2
Off-site Soil Vapor Monitoring Point Construction Details
Ford Livonia Transmission Plant
36200 Plymouth Road
Livonia, Michigan

Location ID	Depth to Water During Installation (ft. bgs)	Screen Depth (ft. bgs)	Screen Length (inches)
SVMP-01S	8.0	3.5	1.0
SVMP-01D	8.0	7.0	1.0
SVMP-02S	10.0	4.5	1.0
SVMP-02D	10.0	8.5	1.0
SVMP-03S	9.0	3.5	1.0
SVMP-03D	9.0	7.0	1.0
SVMP-04	5.0	3.5	1.0
SVMP-05	5.0	4.5	1.0
SVMP-06	5.5	4.5	1.0
SVMP-07	4.5	3.5	1.0
SVMP-08	5.5	3.5	1.0
SVMP-09	6.0	4.0	1.0
SVMP-10	4.0	3.0	1.0
SVMP-11	5.0	3.5	1.0
SVMP-12	5.0	3.5	1.0
SVMP-13	3.0	2.0	1.0
SVMP-14	3.0	2.0	1.0
SVMP-15	3.0	2.0	1.0
SVMP-16	3.0	2.0	1.0
SVMP-17	3.5	2.0	1.0
SVMP-18	4.5	3.0	1.0
SVMP-19	4.5	3.0	1.0
SVMP-20	4.5	3.0	1.0
SVMP-21	3.5	2.0	1.0
SVMP-22	4.5	3.0	1.0
SVMP-23	4.5	3.0	1.0
SVMP-24	5.5	4.0	1.0
SVMP-25S	8.5	3.0	1.0
SVMP-25D	8.5	6.0	1.0
SVMP-26	5.5	4.0	1.0
SVMP-27	6.5	4.5	1.0
SVMP-28	5.5	3.0	1.0
SVMP-29S	9.0	3.5	1.0
SVMP-29D	9.0	7.5	1.0
SVMP-30	6.0	4.0	1.0
SVMP-31	7.0	5.5	1.0
SVMP-32S	8.0	3.0	1.0
SVMP-32D	8.0	6.0	1.0
SVMP-33	7.0	4.0	1.0
SVMP-34	7.0	4.0	1.0
SVMP-35	7.0	4.0	1.0
SVMP-36	7.0	4.0	1.0
SVMP-37	4.0	2.5	1.0

Notes:

1" Stainless Steel Screen Implant, 1/4" fitting. Part #SVPT92-SW14 from Environmental Service Products.

D Deep sample depth
ft. bgs Feet below ground surface
S Shallow sample depth
SVMP Soil vapor monitoring point

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ATTACHMENT 1

Technical Guidance Documents

LOW-FLOW GROUNDWATER PURGING AND SAMPLING PROCEDURES FOR MONITORING WELLS

Rev. #: 5

Rev Date: 12/30/2016

TGI VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by

APPROVAL SIGNATURES

Prepared by: Ryan McKinney Date: 12/30/2016

Reviewed by: Eric Killenbeck Date: ________________
(Technical Expert)

I. SCOPE AND APPLICATION

Groundwater samples are collected from monitoring wells to evaluate groundwater quality. The protocol presented in this Technical Guidance Instruction (TGI) describes the procedures recommended to purge monitoring wells and collect groundwater samples. This protocol has been developed in accordance with the United States Environmental Protection Agency (USEPA) Region I Low Stress (Low-Flow) Purging and Sampling Procedures for the Collection of Groundwater Samples from Monitoring Wells (EQASOP-GW001; January 19, 2010). Both filtered and unfiltered groundwater samples may be collected using this low-flow sampling method. Filtered samples should be obtained using a 0.45-micron disposable filter. Project teams should determine the last time the wells were developed and if additional development might be necessary. Groundwater samples should not be collected within 1 week following well development.

II. PERSONNEL QUALIFICATIONS

Arcadis personnel providing assistance to groundwater sample collection and associated activities should have a minimum of 6 months of related experience or an advanced degree in environmental sciences, engineering, hydrogeology, or geology. The supervisor of the groundwater sampling team should have at least 1 year of previous supervised groundwater sampling experience. Prior to mobilizing to the field, the groundwater sampling team should review and be thoroughly familiar with relevant site-specific documents including but not limited to the site work plan, field sampling plan, Quality Assurance Project Plan (QAPP), Health and Safety Plan (HASP), historical information, and site relevant documents.
Additionally, the groundwater sampling team should review and be thoroughly familiar with documentation provided by equipment manufacturers for all equipment that will be used in the field prior to mobilization.

III. EQUIPMENT LIST

Specific to this activity, the following materials (or equivalent) should be available:

- Health and safety documents and equipment (as identified in the site HASP)
- Site Plan, well construction records, prior groundwater sampling records (if available)
- Sampling pump, which may consist of one or more of the following:

  - Submersible pump (e.g., Grundfos Redi-Flo 2)
  - Peristaltic pump (e.g., ISCO Model 150)
  - Bladder pump (e.g., Marschalk System 1, QED Micropurge, Geotech)
- Appropriate controller and power source for pump:

  - Submersible and peristaltic pumps require electric power from either a generator or a deep cell battery.
  - Submersible pumps such as Grundfos require a pump controller to run the pump.

- Bladder pumps require a pump controller and a gas source (e.g., air compressor or compressed N_2 or CO_2 gas cylinders).

- Teflon® tubing or Teflon®-lined polyethylene tubing of an appropriate size for the pump being used. For peristaltic pumps, dedicated Tygon® tubing (or other type as specified by the manufacturer) should also be used through the pump apparatus. When collecting samples for perflourinated compounds (PFCs), Teflon® components or tubing should not be used. Teflon® components or tubing may not be necessary when sampling for metals and/or inorganics.
- Water-level probe (e.g., Solinist Model 101)
- Water-quality (temperature/pH/specific conductivity/oxidation reduction potential [ORP]/turbidity/dissolved oxygen) meter and flow-through measurement cell. Several brands may be used, including:

  - YSI 6-Series Multi-Parameter Instrument
  - Horiba U-22 Multi-Parameter Instrument
  - Hydrolab Series 3 or Series 4a Multiprobe and Display
- Supplemental turbidity meter (e.g., Horiba U-10, Hach 2100P, LaMotte 2020). Turbidity measurements collected with multi-parameter meters have sometimes been shown to be unreliable due to fouling of the optic lens of the turbidity meter within the flow-through cell. A supplemental turbidity meter should be used to verify turbidity data during purging if such fouling is suspected. An in-line tee and valve should allow for collection of water for turbidity measurements before the pump discharge enters the flow-through cell. Note that industry improvements may eliminate the need for these supplemental measurements in the future.
- Appropriate water sample containers (supplied by the laboratory)
- Appropriate blanks (trip blank supplied by the laboratory)
- 0.45-micron disposable filters (if field filtering is required)
- Cleaning equipment
- Groundwater sampling log (attached) or bound field logbook.

Note that, in the future, the client may acquire different makes/models of some of this equipment if the listed makes/models are no longer available, or as a result of general upgrades or additional equipment acquisitions. Note the specific make/model of the equipment used during a sampling event on the groundwater sampling log. The maintenance requirements for the above equipment generally involve decontamination or periodic cleaning, battery charging, and proper storage, as specified by the manufacturer. For operational difficulties, the equipment should be serviced by a qualified technician.

IV. CAUTIONS

Different USEPA regions and/or state regulatory agencies may stipulate deviations from this document. It is the responsibility of the Project Manager or Technical manager to be fully aware of the requirements from the applicable regulatory framework.

If heavy precipitation occurs, and no cover over the sampling area and monitoring well can be erected, sampling may be discontinued until adequate cover is provided. Rain water could contaminate groundwater samples. Do not use permanent marker or felt-tipped pens for labels on sample container or sample coolers; use indelible ink. Permanent markers could introduce volatile constituents into the samples. It may be necessary to field filter some parameters (e.g., metals) prior to collection, depending on preservation, analytical method, and project quality objectives. Store and/or stage empty and full sample containers and coolers out of direct sunlight. To mitigate potential cross-contamination, groundwater samples are to be collected in a pre-determined order from least impacted to impacted based on previous analytical data. If no analytical data are available, collect samples in order of upgradient, then furthest downgradient to source area locations. Be careful not to overtighten lids with Teflon® liners or septa (e.g., 40 mL vials). Overtightening can cause the glass to shatter or impair the integrity of the Teflon® seal.

V. HEALTH AND SAFETY CONSIDERATIONS

Review all site-specific and procedural hazards as they are provided in the HASP, and review Job Safety Analysis (JSA) documents in the field each day prior to beginning work. Generators and cord and plug equipment should employ an overcurrent protection device such as an integrated ground fault circuit interrupter (GFCI) cord. Grundfos pump controllers will not run properly with a GFCI, so the power source should be equipped with other overcurrent protection means.

VI. PROCEDURE

Groundwater should be purged from the wells using an appropriate pump. If the depth to water is below the sampling range of a peristaltic pump (approximately 25 feet), submersible pumps or bladder pumps should be used provided that the well is constructed with a casing diameter greater than or equal to 2 inches (the minimum well diameter capable of accommodating such pumps). Bladder pumps are preferred over peristaltic and submersible pumps if sampling of volatile organic compounds (VOCs) is required to prevent volatilization. For smaller diameter wells, where the depth to water is below the sampling range of a peristaltic pump, alternative sampling methods (i.e., bailing or small diameter bladder pumps) should be used to purge and sample the groundwater. Purge water should be collected and containerized according to the direction of the project team.

1. Calibrate field instruments according to manufacturer procedures for calibration and document.

2. Open the well cover while standing upwind of the well. Remove the well cap and place it on the plastic sheeting. Insert the photoionization detector (PID) probe approximately 4 to 6 inches into the casing or the well headspace and cover it with a gloved hand. Record the PID reading in the field log. Perform air monitoring in the breathing zone according to the HASP and/or JSA. Measure the initial depth to groundwater prior to placing the pumps.
3. Prepare and install the pump in the well: For submersible and non-dedicated bladder pumps, decontaminate the pump according to site decontamination procedures. Non-dedicated bladder pumps will require a new bladder and attachment of an air line, sample discharge line, and safety cable prior to placement in the well. Attach the air line tubing to the air port on the top of the bladder pump. Attach the sample discharge tubing to the water port on the top of the bladder pump. Take care not to reverse the air and discharge tubing lines during bladder pump setup, as this could result in bladder failure or rupture.

   Attach and secure a safety cable to the eyebolt on the top of bladder pump (if present, depending on pump model used). Slowly lower the pump, safety cable, tubing, and electrical lines into the well to a depth corresponding to the approximate center of the saturated screen section of the well. Avoid twisting and tangling of safety cable, tubing, and electrical lines while lowering the pump into the well; twisted and tangled lines could result in the pump becoming stuck in the well casing. Also, make sure to keep tubing and lines from touching the ground or other surfaces while introducing them into the well, as this could lead to well contamination. If a peristaltic pump is being used, slowly lower the sampling tubing into the well to a depth corresponding to the approximate center of the saturated screen section of the well. The pump intake or sampling tube must be kept at least 2 feet above the bottom of the well to prevent mobilization of any sediment present in the bottom of the well.

4. If using a bladder pump, connect the air line to the pump controller output port. The pump controller should then be connected to a supply line from an air compressor or compressed gas cylinder using an appropriate regulator and air hose. Tighten the regulator connector onto the gas cylinder (if used) to prevent leaks. Teflon® tape may be used on the threads of the cylinder to provide a tighter seal. Once the air compressor or gas cylinder is connected to the pump controller, turn on the compressor or open the valve on the cylinder to begin the gas flow. Turn on the pump controller power if an on/off switch is present, and verify that all batteries are charged and fully operating before beginning to pump.

5. Connect the pump discharge water line to the bottom inlet port on the flow-through cell connected to the water quality meter.

6. Measure the water level again with the pump in the well before starting the pump to ensure that it has stabilized. Start pumping the well at 200 to 500 milliliters (mL) per minute (or at lower site-specific rate if specified). Adjust the pump rate to cause little or no water level drawdown in the well (less than 0.3 foot below the initial static depth to water measurement), and the water level should stabilize; however, this is not always possible. The water level should be monitored every 3 to 5 minutes (or as appropriate, lower flow rates may require longer time between readings) during pumping if the well diameter is of sufficient size to

allow such monitoring. Do not break pump suction or cause entrainment of air in the sample. Record pumping rate adjustments and depths to water. If necessary, reduce pumping rates to the minimum capabilities of the pump to avoid pumping the well dry and/or to stabilize indicator parameters. Maintain a steady flow rate to the extent practicable. Review groundwater sampling records from previous sampling events (if available) prior to mobilization to estimate the optimum pumping rate and anticipated drawdown for the well in order to more efficiently reach a stabilized pumping condition. If the recharge rate of the well is very low, use alternative purging techniques, which will vary based on the well construction and screen position. For wells screened across the water table, the well may be pumped dry and sampling can commence as soon as the volume in the well has recovered sufficiently to permit collection of samples. For wells screened entirely below the water table, the well can be pumped until a stabilized level (which may be greater than the maximum displacement goal of 0.3 foot) is maintained, and monitoring for stabilization of field indicator parameters can commence. If a lower stabilization level cannot be maintained, the well may be pumped until the drawdown is at a level slightly higher than top of the well screen. Sampling may commence after one well volume has been removed and the well has recovered sufficiently to permit collection of samples. During purging, monitor the field indicator parameters (e.g., turbidity, temperature, specific conductance, pH, ORP, and dissolved oxygen [DO]) every 3 to 5 minutes (or after each volume of the flow-through cell has been purged). Measure field indicator parameters using a flow-through analytical cell or a clean container such as a glass beaker. Record field indicator parameters on the groundwater sampling log. The well is considered stabilized and ready for sample collection when turbidity values remain within 10% (or within 1 nephelometric turbidity unit [NTU] if the turbidity reading is less than 10 NTU), the specific conductance and temperature values remain within 3%, ORP readings remain within ± 10 mV, DO values remain within 10%, and pH remains within 0.1 unit for three consecutive readings collected at 3- to 5-minute intervals (or other appropriate interval, alternate stabilization goals may exist in different geographic regions, consult the site-specific Work Plan for stabilization criteria). If the field indicator parameters do not stabilize within 1 hour of the start of purging, but the groundwater turbidity is below the goal of 50 NTU and the values for all other parameters are within 10%, the well can be sampled. If the parameters have stabilized but the turbidity is not in the range of the 50 NTU goal, the pump flow rate may be decreased to a minimum rate of 100 mL/min to reduce turbidity levels as low as possible. DO is extremely susceptible to various external influences (including temperature or the presence of bubbles on the DO meter); care should be taken to minimize the agitation or other disturbance of water within the flow-through cell while collecting these measurements. If air bubbles are present on the DO probe or in the discharge tubing, remove them before taking a measurement. If DO values are not within acceptable range for the temperature of groundwater (Attachment 1), then again check for and remove air bubbles on the probe before re-measuring. If the DO value is 0.00 or less, then the meter should be serviced and re-calibrated. If the DO values are above possible results, then the meter should be serviced and re-calibrated.

During extreme weather conditions, stabilization of field indicator parameters may be difficult to attain. Modifications to the sampling procedures to alleviate these conditions (e.g., measuring the water temperature in the well adjacent to the pump intake) should be documented in the field notes. If other field conditions preclude stabilization of certain parameter, an explanation of why the parameters did not stabilize should also be documented in the field logbook.

7. Complete the sample label(s) and cover the label(s) with clear packing tape to secure the label onto the container.

8. After the indicator parameters have stabilized, collect groundwater samples by diverting flow out of the unfiltered discharge tubing into the appropriate labeled sample container. If a flow-through analytical cell is being used to measure field parameters, the flow-through cell should be disconnected after stabilization of the field indicator parameters and prior to groundwater sample collection. Under no circumstances should analytical samples be collected from the discharge of the flow-through cell. When the container is full, tightly screw on the cap. Samples should be collected in the following order: VOCs, total organic carbon (TOC), semi-volatile organic compounds (SVOCs), metals and cyanide, and others (or other order as defined in the site-specific Work Plan).

9. If sampling for total and filtered metals and/or polychlorinated biphenyls (PCBs), a filtered and unfiltered sample should be collected. Install an in-line, disposable 0.45-micron particle filter on the discharge tubing after the appropriate unfiltered groundwater sample has been collected. Continue to run the pump until an initial volume of “flush” water has been run through the filter in accordance with the manufacturer’s directions (generally 100 to 300 mL). Collect the filtered groundwater sample by diverting flow out of the filter into the appropriately labeled sample container. When the container is full, tightly screw on the cap.

10. Secure with packing material and store at 4°C in an insulated transport container provided by the laboratory.

11. Record on the groundwater sampling log or bound field logbook the time at which sampling procedures were completed, any pertinent observations of the sample (e.g., physical appearance and the presence or lack of odors or sheens), and the values of the stabilized field indicator parameters as measured during the final reading during purging (Attachment 2 – Example Sampling Log).

12. Turn off the pump and air compressor or close the gas cylinder valve if using a bladder pump setup. Slowly remove the pump, tubing, lines, and safety cable from the well. Do not allow the tubing or lines to touch the ground or any other surfaces which could contaminate them.

13. If tubing is to be dedicated to a well, it should be folded to a length that will allow the well to be capped and also facilitate retrieval of the tubing during later sampling events. A length of rope or string should be used to tie the tubing to the well cap. Alternatively, if tubing and safety line are to be saved and reused for sampling the well at a later date, they may be coiled neatly and placed in a clean plastic bag that is clearly labeled with the well ID. Make sure the bag is tightly sealed before placing it in storage.

14. Secure the well and properly dispose of personal protective equipment (PPE) and disposable equipment.

15. Complete the procedures for packaging, shipping, and handling with the associated chain of custody.

16. Complete decontamination for flow-through analytical cell and submersible or bladder pump, as appropriate.
17. At the end of the day, perform calibration check of field instruments.

VII. WASTE MANAGEMENT

Materials generated during groundwater sampling activities, including disposable equipment, should be placed in appropriate containers. Containerized waste should be disposed of by the client consistent with the procedures identified in the HASP.

VIII. DATA RECORDING AND MANAGEMENT

Initial field logs and chain-of-custody records should be transmitted to the Arcadis Project Manager at the end of each day unless otherwise directed. The groundwater team leader retains copies of the groundwater sampling logs.

IX. QUALITY ASSURANCE

In addition to the quality control samples to be collected in accordance with this TGI, the following quality control procedures should be observed in the field:

- Collect samples from monitoring wells, in order of increasing concentration, to the extent known based on review of historical site information if available.
- Equipment blanks should include the pump and tubing (if using disposable tubing) or the pump only (if using tubing dedicated to each well).
- Collect equipment blanks after wells with higher concentrations (if known) have been sampled.
- Operate all monitoring instrumentation in accordance with manufacturer's instructions and calibration procedures. Calibrate instruments at the beginning of each day and verify the calibration at the end of each day. Record all calibration activities in the field notebook.
- Clean all groundwater sampling equipment prior to use in the first well and after each subsequent well following procedures for equipment decontamination.

X. REFERENCES

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