Imagine the result

Ford Motor Company

Area C – Comprehensive Site History and Investigation Report

Twin Cities Assembly Plant (TCAP)
966 South Mississippi River Boulevard
St. Paul, Minnesota

April 4, 2014

ARCADIS

Angharad Pagnon
Project Environmental Specialist

Ryan Oesterreich
Environmental Engineer, PG

Robert J. Ellis
Principal in Charge

Area C – Comprehensive Site History and Investigation Report

Twin Cities Assembly Plant (TCAP)
966 South Mississippi River Boulevard
St. Paul, Minnesota 55166

Prepared for:
Ford Motor Company

Prepared by:
ARCADIS U.S., Inc.
430 First Avenue North, Suite 720
Minneapolis
Minnesota 55401
Tel 612.339.9434
Fax 612.336.4538

Our Ref.:
DE000440.0001.00002

Date:
April 4, 2014

This document is intended only for the use of the individual or entity for which it was prepared and may contain information that is privileged, confidential and exempt from disclosure under applicable law. Any dissemination, distribution or copying of this document is strictly prohibited.

ARCADIS

Tables

Figures

Appendices

Executive Summary

This report has been prepared on behalf of Ford Motor Company (Ford) to provide a summary of activities completed to-date relating to Area C, a former waste disposal area (Site). This report was requested by the Minnesota Pollution Control Agency (MPCA) during a telephone conversation between Barbara Rusinowski of Ford and Amy Hadiaris of the MPCA in April 2011. Based on historical document review, between 1945 and 1966 Area C was a former disposal area for industrial waste, such as construction rubble, paint products and wastes, and non-combustible plant waste. In addition, excavated materials from former Main Plant parcel disposal Areas A and B were deposited in 1966 and 1962, respectively. Ford ceased disposal of industrial waste at Area C in 1966 although the Site was utilized by the City of St. Paul for disposal of construction rubble and soil during construction projects in 1975 and 1981. Specifically, construction rubble from reconstruction of the Lock and Dam No. 1 in 1975 and the 1981 Mississippi River Boulevard paving project was placed on top of the industrial waste present. However, exact quantities and composition of the materials disposed over time in Area C are unknown, and due to discrepancies between historical reports on the terminus extent of the industrial waste, only an approximation of the horizontal extent can be made at this time. The extent of the overlaying construction debris was surveyed within the past two years.

The Site was identified to the United States Environmental Protection Agency in 1981 by the MPCA, following receipt of a complaint in October 1980 concerning historical waste disposal practices, as documented in correspondence between the agencies on April 19, 1990. Subsequent to MPCA's receipt of the complaint, a hydrogeologic investigation was commissioned by Ford in 1981. The investigation included the installation of five groundwater monitoring wells and groundwater sample collection for volatile organic compounds (VOCs) and heavy metals. Surface water samples from the Mississippi River were also collected during this initial investigation and analyzed for the same set of constituents. Analytical results from these initial groundwater samples identified exceedances of MPCA Class 2B Surface Water standards for cadmium, copper and lead. Subsequent samples could not duplicate these initial sample results.

In 1987, a supplemental soil, groundwater, and surface water investigation was completed and included the installation of test pits and waste characterization sampling along the southern boundary of the Site. Groundwater and samples were collected from the five monitoring wells previously installed and surface water samples were collected from two locations along the Mississippi River. None of the collected soil, groundwater, or surface water samples exceeded applicable regulatory criteria.

In 1990, the Site was removed from the Superfund list and transferred to the Minnesota Permanent List Priority (PLP). Based on the 1989 and 1990 groundwater and surface water sampling results, Ford submitted a request to the MPCA that no further investigation be required. The MPCA approved this request in a letter dated March 21, 1991. Area C was subsequently delisted from the Minnesota State PLP list on July 8, 1993.

After the completion of the ARCADIS 2007 Phase I Environmental Site Assessment and investigation of abutting Sand Tunnel 1A, two additional monitoring wells were installed within Area C in 2011. These wells were sampled in November 2011 and January 2012. Two metals (cobalt and thallium) exceeded Minnesota Class 2B surface water standards from both sampling events. Based on these observations and historical documents, cross sections of the Site were developed to illustrate the subsurface hydrogeology, geology and industrial waste and construction waste fills. These cross sections illustrate the potential for future flood events to raise groundwater elevations enough to interact with the industrial and construction waste fills. In addition, ARCADIS observed exposed construction concrete, scrap metal, and four 55-gallon storage drums along the western and southern slopes of the Site, as well as soil erosion and slumping during site reconnaissance in April 2011, January 2012, February 2012, and November 2012. The four drums were removed by excavation and disposed off-Site at a licensed facility in February and April 2012.

Although historical groundwater samples identified exceedances of MPCA Class 2B Surface Water standards, an ARCADIS review of collected soil and surface water samples results do not identify exceedances of currently applicable criteria. Additionally, a preliminary screening of potential exposures of human and ecological receptors to constituents which may cause adverse health effects that may potentially be present in the buried industrial waste was conducted. Although there is potential for direct contact exposure with industrial waste if erosion along the Area C incline continues, it is also unlikely for groundwater and surface water to come into contact with the industrial waste during normal seasonal events. Flood events of a 10-year magnitude or greater may result in groundwater and surface water coming in contact with industrial waste, although no data has been collected to support this. Each of these potential exposure pathways can be mitigated with engineering and administrative controls to stop potential current exposure and prevent future exposure to both human and ecological receptors.

1. Introduction

This report was completed by ARCADIS on behalf of Ford Motor Company (Ford) to summarize all information pertaining to disposal of wastes at Disposal Area C (Area C) on the Twin Cities Assembly Plant (TCAP) property and to recap the regulatory actions taken at the site. A comprehensive report of Area C was agreed upon by Ford and by the Minnesota Pollution Control Agency (MPCA) in correspondence from April 8, 2011. This report includes the following sections:

- Area C Disposal History
- Geology and Hydrogeology
- Investigation and Regulatory History
- Risk Pathway Analysis
- Conclusions and Recommendations

2. Area C Disposal History

Area C is located on the Ford TCAP property, within the property fence line, on top of fluvial deposits at the base of a bluff west of South Mississippi River Boulevard, and south of the steam plant (Site, Figure 1). From approximately 1945 to 1966 the area was used as a disposal area for industrial waste, such as construction rubble, paint sludge, and old paints and solvents generated at TCAP (CRA 1988, Ford 1982a). Drums containing industrial waste were also buried, as stated in a 1988 Conestoga-Rovers & Associates (CRA) report, although the number and contents are not known. However, investigation of Sand Tunnel 1A, which terminates within Area C, supports the presence of drums containing solids with a paint-like odor. In addition, historical records identify materials such as cardboard, wood, and scrap metal may have been placed in Area C. Batteries, used light ballasts, and capacitors were specifically excluded from the fill material and were sent to alternate off-site disposal (CRA 1988).

Excavated materials from two former waste disposal areas on the Main Assembly Plant parcel north of South Mississippi Boulevard (Areas A and B), were deposited in Area C in 1966 and 1962, respectively (CRA 1988). Disposal of industrial waste at the Site were discontinued in 1966, prior to enactment of applicable state and federal environmental regulations (i.e., MPCA in 1967, United States Environmental Protection Agency [US EPA] in 1970, Superfund in 1980).

In 1965 and 1966, Ford placed an unknown volume of construction debris (concrete and soil) over the industrial waste materials at the Site.

In 1975, the United States Army Corps of Engineers (USACE) deposited rubble between the Site and the Mississippi River during reconstruction of Lock and Dam No. 1 near the "Ford Bridge".

In 1981, Al Johnson Construction Company General Contractors, placed approximately 19,000 cubic yards (CY) of concrete, 10,000 CY of sandstone and approximately 18,000 CY of sand generated as part of the Mississippi River Boulevard paving project (Appendix A).

Between 1984 and 1986, Ford placed an unknown volume of debris and excavated soil from construction of the Paint Building on the Main Assembly Plant parcel on top of the Site. The location of the Paint Building corresponds to the location of the former test track.

Between 1985 and 1987, the Site was paved with an 8-inch layer of concrete to serve as a parking area for trailers (CRA 1988). The paved area currently exists and is approximately 166,000 square feet (sq ft), or 3.8 acres in size.

Additional details on a portion of the materials described above are in the following Sections.

2.1 Former Waste Disposal Areas A and B

Areas A and B, illustrated on Figure 1.2 from the CRA *Remedial Investigation/Feasibility Study (RI/FS) Work Plan* dated February 15, 1991 (Appendix A), were historical waste disposal sites for industrial wastes generated on the Main Assembly Plant parcel (i.e., paint waste, paint sludge and other plant wastes).

Area A was used as an industrial waste disposal site from 1943 until 1960 and was located at the south end of the former test track east of the main assembly plant. The exact dates and quantities of the disposal events are not known. Based on a file and aerial photo review, a railroad track expansion project required Area A and a portion of the former test track to be excavated. The excavated materials were deposited onto Area C in 1966.

Area B was used for burning waste and burial of industrial waste during early plant operations until 1945, and was located approximately 800 feet south and east of the main assembly building. Buried waste included non-combustible materials such as scrap steel, bricks, concrete block and other solid materials. The exact dates and quantities of these burning and burial events are not known. Excavated materials from Area B were deposited onto Area C during construction of a parking lot expansion in 1962.

2.2 Sand Tunnel 1A

During the initial Phase I site walk in May 2007, ARCADIS discovered open storage drums and storage drums buried under an accumulation of materials at the exit end of sand tunnel 1A (Feature 150) in proximity of Area C. Due to health and safety conditions at the time of the inspection, ARCADIS could not determine the extent of the drum storage in sand tunnel 1A, but did observe black, rust, and turquoise staining on the floor and ceiling surrounding the open drums (ARCADIS, 2007b). The open drums were partially filled with solids with a paint-like odor. During the course of further investigations in 2008, the accumulation of materials was again observed at the far southern end of the tunnel 1A, which terminates directly below the northeast corner of

Area C. The base of sand tunnel 1A is located at an elevation of 711.0 feet above mean sea level (ft amsl). The ground surface above sand tunnel 1A is at an elevation of 772.9 ft amsl and the distance from the ground surface to the ceiling of the tunnel is approximately 56.7 feet as shown on Figure 2 and Figure 3a. As discussed in the ARCADIS 2009 *Tunnel Survey Report, Collapse Area with Buried Drums - Feature 150*, it is believed that the material encountered at the terminus of sand tunnel 1A provides an indication of the industrial waste contained in Area C.

The description of the materials placed in Area C is consistent with that found at the end of the tunnel. The material encountered at the terminus of the tunnel consisted of concrete, wood chunks and solidified paint sludge. Thus, it is believed that the conditions observed at the tunnel terminus is a result of disposal rather than a collapse of the tunnel (ARCADIS 2009). A Remedial Action Plan for sand tunnel 1A was submitted to the MPCA on December 14, 2009 and approved on February 24, 2010. The remedial action consisted of the installation of a barrier wall within the tunnel to isolate the impacted area. ARCADIS completed remedial action on December 15, 2010. Additional details are provided in the *Response Action Implementation Report, 1A Tunnel Barrier Wall, Feature 150*, submitted to MPCA on January 11, 2011 (ARCADIS 2011a).

2.3 Area C

Historical figures and documents (CRA 1988, 1990; Ford 1982b) indicate the industrial waste fill is approximately 25 feet thick. Furthermore, test pits, boring logs (B-2, B-4, and B-6), and site reconnaissance confirm that construction rubble, broken concrete, and soil were subsequently placed over the industrial waste fill, and ranges from approximately 30 to 60 feet thick. The horizontal extent of the industrial waste fill was extrapolated from figures included in CRA and Ford documentation to MPCA (Appendix B). The extent of industrial waste fill as presented by CRA was based on the interpretation of Area C aerial photographs from 1945, 1956, 1958, and 1962 (CRA, 1990). The Ford *Groundwater Monitoring Wells Survey* report (1982b) figure depicts a field drawing of a “filled area” and an “aged dump site” in reference to five monitoring wells present within the area at the time. Each report illustrates a different extent of industrial waste fill at Area C, as the aerial photography interpretation extends the length along the Area C access road to the south while the Ford field documentation extends further south, west, and north in comparison. Due to the discrepancy between the two reports, approximate industrial waste terminus extents from both reports have been indicated on the Site layout map (Figure 2) and translated onto cross-section figures and incorporated within a three dimensional model of the area. Additional details on the cross-sections and three-dimensional model are discussed in greater detail later in this report. The terminus extent of industrial waste fill extends from the edge of a bluff on the west side of Mississippi River Boulevard to approximately 490 feet west of Mississippi River Road Boulevard.

3. Geology and Hydrogeology

3.1 Geology

Area C is located on a point bar east of the Mississippi River (Figure 2), between the river and Mississippi River Boulevard. Cross-sections of the Site are shown on Figures 3A, 3B, and 3C.

The unconsolidated sands and gravels below Area C are approximately 35 feet thick and overlay the St. Peter Sandstone, which was encountered at approximately 734 ft amsl at soil boring B-6 (Figure 3A) (CRA 1998) and at approximately 695 ft amsl at AMW-07 (Figure 3C). Both borings are near the bluff on the east side of Area C. The elevation of the St. Peter Sandstone appears to decrease moving west towards the Mississippi River and was not encountered in any additional borings of depths down to 676 ft amsl. The Platteville Limestone overlies the St. Peter Sandstone and is present in the river bluff located directly east of Area C on the Main Assembly Plant parcel.

3.2 Hydrogeology

Groundwater elevation around Area C is approximately 686 to 690 ft amsl and groundwater flow is generally to the west-northwest towards the Mississippi River (CRA 1990). Groundwater elevation and flow direction is influenced by the river stage and seasonal control of the river elevation at Lock Dam No. 1. Seasonal control allows the potential for temporary reversal of flow direction during high water level events due to the direct connection between groundwater and the Mississippi River.

A hydraulic conductivity of 9×10^{-2} to 5×10^{-3} centimeters per second (cm/s) for groundwater in the vicinity of the Site was estimated by inputting the results of a grain size analysis of flood plain sediments, performed by Soil Testing Services in January 1982, into Hazen's equation. Hazen's equation is an empirical formula for estimating hydraulic conductivity using the d_{10} value returned from a grain size analysis (CRA 1988). With a geometric mean hydraulic gradient of 0.002 taken from these grain size analyses and a porosity of 30%, average groundwater velocity can be estimated at 0.1 to 1.7 feet per day (ft/day). Based on this average groundwater velocity, and a distance of approximately 915 feet between the river and the edge of the bluff, it is estimated groundwater travel time to the river would range from 1.5 to 25 years between the east side of Area C (Sand Tunnel 1A) and the Mississippi River (river edge directly west).

The average elevation of the Mississippi River is approximately 689 ft amsl, similar to the water table below Area C. Flood elevations for the Mississippi are 707 ft amsl

(10-year), 714 ft amsl (50-year) and 717 ft amsl (100-year), or 18, 21, and 25 feet above the currently observed groundwater table elevation. The river elevation during the flood that occurred in April 1965 was 719.02 ft amsl (Appendix A), or 30 feet above the currently observed groundwater table and two feet higher than the average 100-year flood elevation; the highest recorded elevation since plant operations commenced.

3.3 Geologic Interpretation

The three cross-sections of the Site (Figures 3A, 3B and 3C) also incorporate the interpretation of the vertical and horizontal extent of the industrial waste fill and construction debris fill. However, due to the discrepancy between the locations of the industrial waste fill extents, (as previously discussed in Section 2.3), only the terminus extent of industrial waste fill from each report was utilized for the figures. The cross sections also include the groundwater elevation based on the most recent gauging data in 2011 and 2012 as well as floodwater elevations representative of 10-year, 50-year, and 100-year flood events. There is the potential for the river elevation to rise above the elevation of the bottom of the industrial waste during 10-, 50- and 100-year flood events. However, the potential for groundwater to come into contact with the lower portion of the industrial waste during these flood events is potentially mitigated by the relatively slower response of groundwater to match elevation fluctuations of surface water. Additionally, the portion of Area C where industrial waste has been reported (Section 2.3) is set back approximately 500 feet from the nearest bank of the river, which will further dampen any groundwater response to a flood stage fluctuation in river elevation.

In addition to the cross-sections, information collected from the site from as early as 1945 was utilized to develop a three-dimensional representation of the surficial topography and underlying geological layers noted in Section 3.1. Flood water elevations representative of 10-year, 50-year, and 100-year flood events are also presented within the three-dimensional model. The layers within the model were created by developing a layer framework within Mining Visualization System (MVS), a visualization software package developed by CTech Development Corporation. The convex hull gridding method and Kriging interpolation was utilized within MVS to develop the horizontal and vertical extent of each layer from defined discreet points. The discreet points across the area provide locations of known thickness of material layers for the gridding and interpolation process. These points were formulated from the following sources:

- Geological boring logs of historical and existing groundwater monitoring wells (B-1 through B-6, AMW-19, and AMW-20);
- Historical maps with the horizontal extent of the industrial waste fill developed from aerial images and field observations (Appendix B);
- Field observations noted during the digging of historical test pits (discussed further in Section 4.1);
- Aerial photography for the years 2010-2012;
- Cross-sections (Figures 3A through 3C); and
- Topography and site reconnaissance data (photographs and notes discussed further in Section 4.3.2).

A CD containing a working version of the three dimensional model is presented in Appendix C.

4. Investigation and Regulatory History

Area C was identified to the US EPA by Ford during the Superfund notification process and later moved to the Minnesota Permanent List Priority (PLP) in 1990, as noted in correspondence between the MPCA and US EPA (Appendix A). In 1981, in response to the MPCA's request for the installation of four monitoring wells at the Site, Ford retained Soil Testing Services of Minnesota, Inc. (STS) to complete a hydrogeologic survey (Ford 1982). Following the survey and MPCA approval of the proposed monitoring well locations, STS completed soil borings and monitoring wells installation in December 1981. Ford personnel subsequently completed two groundwater sampling events and collected surface water samples. Investigation activities and results were presented after each event in the *March 3, 1982 Groundwater Monitoring Well Survey* and February 11, 1983 report *Waste Disposal Site – Groundwater Investigation*. A detailed summary of the initial investigation is discussed below in Section 4.1.

Subsequent to the deposit of construction debris between 1984 and 1986, a supplemental investigation was completed by CRA from 1987 through 1990. The supplemental investigation included additional groundwater and surface water sampling, the completion of test pits, and installing one additional groundwater monitoring well. A final report of the investigation and results was submitted in the *Remedial Investigation/Alternatives Analysis Work Plan* dated February 11, 1991. In that report, Ford requested MPCA approval that no further investigation was necessary for Area C. This work plan was approved by the MPCA in a letter dated March 21, 1991 and Area C was delisted from the Minnesota State PLP list on July 8, 1993. A detailed summary of the supplemental investigation is discussed below in Section 4.2.

In anticipation of plant closure, additional investigations were initiated by ARCADIS in November 2010 after Area C was identified as a feature in the ARCADIS 2007 Phase I Environmental Site Assessment. To date, activities include a Site reconnaissance, the installation of monitoring wells, surface water and groundwater sampling, and drum removal. A detailed summary of each of these activities is discussed below in Section 4.3.

As part of this comprehensive historical review of Area C, all data collected at the site was compared to current applicable standards. The Mississippi River is the downgradient receptor for groundwater impacts that are potentially present in Area C. The stretch of the Mississippi River adjacent to Area C is classified as a 2B, 3C, 4A, 5 and 6 water (ARCADIS 2011b). Class 2B (Aquatic Life and Recreation beneficial uses) has the strictest surface water standards of those classes and was therefore utilized as the comparative standard for all water samples. Groundwater analytical results were additionally compared to current Health Risk Limits (HRLs) from the Minnesota Department of Health (MDH).

Well construction details and analytical results of historical and existing monitoring wells are provided in Table 1 and 2, respectively. Samples with exceedances of MDH HRLs and/or Class 2B standards are illustrated on Figure 2. Furthermore, a tabulation of all surface water analytical results is provided in Table 3. Laboratory reports for samples collected in 2011 are presented in Appendix D.

4.1 Initial 1981 Investigation Summary

Six soil borings (B-1 through B-6) were completed around and through the current limits of Area C (Figure 2). Borehole depths ranged from 19.5 to 51 feet below ground surface (ft bgs). Five of the borings (B-1 through B-5) were converted to 2-inch groundwater monitoring wells in 1981 and 1982. Well construction details are provided in Table 1. The wells were sampled twice in 1982 (March and December) for volatile organic compounds (VOCs) and heavy metals (copper, cadmium, zinc, nickel, chromium, and lead). Additionally, surface water samples were collected in December 1982 from three locations and analyzed for VOCs and heavy metals (Ford 1983). The samples were collected along the east bank of the Mississippi River upstream and downstream of Area C and identified as:

- R1 - upstream of the Lock and Dam No. 1;
- R2 - near the TCAP southern property line; and
- R3 - approximately 200 yards south of the Ford TCAP property line.

4.1.1 Groundwater Analytical Results

Four VOCs (cis-1,2-Dichloroethene, trans-1,2-dichloroethene, toluene, and trichloroethene) and five metals (cadmium, copper, lead, nickel and zinc) were detected above their respective reporting limit in at least one sample during the course of the investigation in 1982. All VOC detections were below their respective current Class 2B standards and HRLs. Cadmium concentrations at B-1 (20 µg/L) and B-4 (20 µg/L) in March, and at B-4 (5 µg/L) in December exceeded current Class 2B and HRL standards (2 µg/L and 4 µg/L, respectively). Cadmium concentrations in December at B-1 (3 µg/L), B-2 (3 µg/L), and B-3 (3 µg/L) exceeded current Class 2B standards, but not current HRL standards. Copper concentrations at B-1 (30 µg/L) and B-2 (20 µg/L) in March exceeded current Class 2B standards (14 µg/L), but not current HRL standards (1000 µg/L). Subsequent sampling events either did not detect copper, or detected it below standards. Lead concentrations at B-1 (120 µg/L) and B-4 (60 µg/L) in March exceeded Class 2B and HRL standards (7 µg/L and 15 µg/L, respectively), but did not exceed either standard in subsequent sampling events. No other detected constituent exceeded its corresponding current Class 2B and HRL standards.

4.1.2 Surface Water Analytical Results

None of the surface water samples collected from the Mississippi River in 1982 contained any compounds above the current Class 2B Water Quality Standards.

4.2 Supplemental 1987 Investigation

The supplemental investigation consisted of a file review, hydrogeologic evaluation, test pit investigation, stadia survey and waste characterization sampling.

Test Pit Investigation & Waste Characterization: A backhoe was used to complete 10 test pits along the southern boundary of Area C to a depth of nine ft bgs (Figure 2). Two of the test pits (TP-3 and TP-8) were observed to contain gray-black stained soil and a paint-like odor (CRA 1988). Samples of the stained soil were collected and sent to an off-site laboratory for waste characterization analysis. The remaining eight test pits were not sampled as visual or olfactory indicators of contamination were not observed.

TP-3 samples were analyzed using TCLP for VOCs, metals, flashpoint, reactive sulfide and pH. The flashpoint was reported to be 140 degrees Fahrenheit, reactive sulfide was not detected and the pH was 7.6. Five metals were detected in soil (arsenic, barium, copper, lead and zinc) but were below their respective TCLP standards. Four VOCs were detected in the TP-3 soil (toluene, ethylbenzene, m-xylene and o & p-xylene) but there is no TCLP standard for these constituents.

TP-8 soil samples were analyzed by an extraction procedure (EP) toxicity leachate method for metals. Two metals were detected (barium and zinc) but were below their respective toxicity leachate criteria. Flashpoint was greater than 200 degrees Fahrenheit, reactive sulfide was 61 mg/kg and pH was 7.9 standard units. The TP-8 soil sample was analyzed for total VOCs and there were no detections above laboratory detection limits.

Results of the analyses are shown on Table 4 and analytical reports are included in the October 1988 *Assessment of Fill Areas* report.

Stadia Survey: On February 16, 1988 monitoring locations B-1, B-2, and B-4 were surveyed due to the vertical extension of the wells in response to the expansion of the trailer storage area. Additionally, the northern and southern edges of the fill area were surveyed, although snowfall did not allow for the accurate location of the top of the fill area nor the test pits.

4.3 1989-1993 Monitoring Well Activities

In April 1989, due to the addition of construction debris associated with the Paint Building construction, monitoring wells (B-1 through B-5) were inspected to confirm their integrity. All five monitoring wells were observed to be damaged, and repairs were completed at B-1, B-3 and B-5. Wells B-2 and B-4 could not be salvaged and were subsequently abandoned on May 31, 1989 (CRA 1990a). Copies of the well abandonment records are included in Appendix A. Following repair of the remaining three monitoring wells (B-1, B-3 and B-5), the top of casing and ground surface elevation at that time were resurveyed in September 1989.

Monitoring Well Installation and Sampling:

1989 Sampling: Three groundwater sampling events were completed in June, August, and September 1989 (Table 2).Samples were collected from the repaired monitoring wells (B-1, B-3, and B-5) and submitted for laboratory analysis of halocarbon and aromatic volatile organic compounds (VOCs) and field-filtered metals (arsenic, barium, cadmium, copper, lead, mercury, nickel, selenium, silver, and zinc). Analysis of cis-1,2-dichloroethylene (cis-1,2-DCE) and ethyl acetate was added for the August and September 1989 samples in accordance to the MPCA request (CRA 1990a).

Analytical results from the three groundwater sampling events detected collectively a total of four VOCs (1,1-dichloroethylene, dichlorodifluoromethane, trichloroethene, and vinyl chloride) and six metals (barium, cadmium, chromium, copper, nickel and zinc). When compared to current standards, vinyl chloride was the only VOC detected in exceedance of its corresponding HRL (0.2 µg/L) at B-1 (estimated 5.2 µg/L) in August. However, the result is below the Class 2B standard (9.2 µg/L) and vinyl chloride was not detected in any other samples collected from the three wells during the three sampling events. Copper detected at B-3 (20 µg/L) in August 1989 exceeded the current Class 2B standard (14 µg/L). Copper was also detected at B-1 (10 µg/L) in August, but did not exceed current standards. Zinc detected at B-5 (260 µg/L) in September 1989 exceeded the current Class 2B standard (174 µg/L). Both the copper and zinc exceedances are below the current HRLs (1000 µg/L and 2000 µg/L, respectively).

Three surface water sampling events were completed concurrently with the groundwater sampling events in June, August, and September 1989 (Table 3). Samples were collected from two locations (upstream and downstream) and submitted for laboratory analysis of halocarbon and aromatic volatile organic compounds (VOCs) and field-filtered metals (arsenic, barium, cadmium, copper, lead, mercury, nickel, selenium, silver, and zinc). Analysis of cis-1,2-DCE and ethyl acetate was added for the August and September 1989 samples in accordance to the MPCA request (CRA 1990a).

Analytical results from these three events detected collectively a total of three VOCs (1,1-dichloroethylene, methylene chloride, and trichlorofluoromethane) and three metals (cadmium, copper, and lead). When compared to current standards, no detected constituents exceeded Class 2B standards.

<u>1990 Monitoring Well Installation:</u> On January 31, 1990 the MPCA requested additional field work to be conducted at the Site during a meeting with Ford to review 1989 analytical results. In response, an additional groundwater monitoring well (B-6) was installed to a depth of 47 feet below ground surface on the northwest side of Area C on April 9-10, 1990.

<u>1990 Sampling:</u> Two sampling events were completed in April and June 1990 (CRA 1990b) and included monitoring wells B-1, B-3, B-5, and B-6 and surface water samples (upstream and downstream). All four wells were sampled and sent for laboratory analysis of halocarbon and aromatic volatile organic compounds (VOCs), the metals arsenic, selenium, and mercury via the Atomic Absorption Method, and barium, cadmium, chromium, copper, lead, nickel, silver, and zinc via US EPA Method 6010 (inductively coupled plasma analysis). Analysis of cis-1,2-DCE and ethyl acetate was also conducted per MPCA request in the letter dated April 25, 1989. Analytical results for the monitoring wells detected four VOCs (chloroform, cis-1,2-DCE, methylene chloride, and trichloroethene) and three metals (barium, copper, and zinc). When compared to current standards, no detections of the listed constituents exceeded their respective Class 2B or HRL standards.

Analytical results for the surface water samples detected one VOC (estimated methylene chloride) and one metal (barium). When compared to current standards, no detections of the listed constituents exceeded their respective Class 2B standards.

<u>1993 Monitoring Well Abandonment:</u> B-1, B-3, B-5 and B-6 were abandoned on November 19, 1993 (CRA 1994). Copies of the well abandonment records are included in Appendix A.

4.4 2010-2012 Investigation

Since 1993, activities completed at Area C have included the collection of river samples, a Site reconnaissance to document current conditions, a topographic survey, drum removal, and monitoring well installation and sampling. Additional details on each of these activities are described below.

4.4.1 River Sampling

Water samples were collected from the Mississippi River in accordance with the *Groundwater Seep and Mississippi River Sampling Work Plan* (ARCADIS 2008b) in order to evaluate surface water as a potential receptor as required by the Voluntary Investigation and Clean-up (VIC) program and Petroleum Brownfields Program (PBP) under which the TCAP property is enrolled. River water samples SW-01 (located upstream of the dam), SW-02 (located between the wastewater treatment plant and Area C), SW-03 (located downstream of Area C), and SW-04 (located downstream of the TCAP plant) were collected on November 4 and November 10, 2010. In addition to the river water samples, one sample was collected from the Hidden Falls outfall (Outfall-01) on November 4, 2010.

Samples were analyzed for VOCs, semi-volatile organic compounds (SVOCs), Resource Conservation and Recovery Act (RCRA) metals, gasoline range organics (GRO), diesel range organics (DRO) and hardness. Results of the river sampling were initially reported in the *Technical Memorandum to Summarize the Seep and River Sampling Events* (ARCADIS 2011b). From the river water samples, one VOC (estimated chloromethane), one SVOC (bis[2-ethylhexyl]phthalate), and one metal (estimated barium) were collectively detected. None of these constituent detections exceeded its respective current Class 2B standards.

4.4.2 Site Reconnaissance

Ford and ARCADIS conducted a Site reconnaissance of Area C in April 2011, and ARCADIS conducted subsequent Site reconnaissance events in January, February, and November of 2012. Photographs of these Site reconnaissance events are included in Appendix E. ARCADIS observed exposed scrap metal, concrete slabs with and without reinforcement steel bars, and erosion along the western slope base. The four- to eight-foot high erosion cut into the base of the western slope appeared to be the result of flooding events. The southern slope of Area C did not appear to be as heavily eroded as the western slope, but did contain exposed concrete with and without reinforcement steel bars; concrete-filled metal pipes; scrap metal beams, frames and support beams; asphalt, and used insulation. ARCADIS also observed slumping along both the western and southern slopes, and what appeared to be a (now-exposed) geo-membrane barrier placed in an attempt to increase slope stability.

The surface parking lot on top of Area C was observed to be overall intact, with minor surficial cracking. There are precipitation run-off drains along both the southern edge of the concrete lot and northwestern quarter. These drains flow into the retention pond to the north of Area C according to utility figures. The fence surrounding the storage parking lot is in good condition.

The fence line that separates the Site from Hidden Falls Regional Park is in disrepair. The fence has been cut open in two locations, and vegetation, tree growth, and soil erosion has damaged posts, the chain-link, and barbed-wire along the top of the fence. The missing portions of the fence are adjacent to walking paths in Hidden Falls Regional Park, and allow public access to the Site, as evident by a visible foot-pathway onto the Site from the park.

Site reconnaissance conducted in April 2011 and January 2012 resulted in discovery of four exposed 55-gallon steel drums along the base of the western slope and on the southern slope. Details regarding the drum inspection and removal are provided below.

4.4.2.1 Removal of Drums

A visual inspection of Area C was performed by Ford and ARCADIS in April 2011 to determine the pathway for equipment to use during the subsurface investigation (Section 4.4.3). During the inspection, two drums were observed near land surface at the base of the southern and western slope in Area C during this initial visual inspection. One drum did not have a lid, was lying on its side, and appeared to have been filled with soil that washed in from the surrounding area. The second drum was empty and folded in half. Waste characterization samples of the material in the drums were collected by MidAmerica Technical and Environmental Services, Inc. on November 11, 2011, under the supervision of ARCADIS, and analyzed for VOCs, TCLP RCRA metals, mercury, polychlorinated biphenyls (PCBs) and SVOCs. Analytical results of the characterization samples indicated the contents of the drum were non-hazardous. The drums were removed from the Site by MidAmerica and disposed of at the Spruce Ridge Resource Management Facility located in Glencoe, Minnesota on February 3, 2012.

A subsequent visual investigation during the topographic survey conducted by Sunde Land Surveying, LLC, in January 2012 observed two additional drums near the top of the slope on the south side of Area C. One drum was in very poor condition and had been rusted through and broken into several pieces. The drum was empty with the exception of a small amount of soil that appeared to have washed into the drum. The second drum was approximately 75 percent full of a dried blue-gray material, which was believed to be solidified paint sludge. Characterization samples of the material remaining in the drums were collected by MidAmerica on February 3, 2012, under the supervision of ARCADIS, and analyzed for VOCs, TCLP RCRA metals, mercury, PCBs and SVOCs. Analytical results of the characterization samples indicated the contents of the drum were non-hazardous. The drums were removed from the Site by MidAmerica and disposed of at the Spruce Ridge Resource Management Facility on April 11, 2012. The locations, contents, analytical results, and dates of observance and removal of all four removed drums are illustrated on Figure 4.

4.4.2.2 Topographic Survey and Observations

A topographic survey of Area C was completed in January 2012. The survey was centered on the paved portion of Area C and extended east to the asphalt access road, north to approximately the toe of the Area C slope, west to the Mississippi River and south to the property boundary of Hidden Falls Regional Park. The elevation contour lines generated from this survey are shown on Figure 2.

During the survey, scrap metal parts, metal cables, and concrete debris were identified in Area C at land surface in several locations, as illustrated on Figure 4. The scrap metal north and south of the concrete area contained scrap metal strips, sheets, springs/coils and cylinders, some partially buried and all heavily rusted. There was approximately 2 cubic yards of exposed scrap concrete, which appeared to be portions of barricades and pads. The scrap steel cable was approximately one-quarter inch to three-quarters inch thick.

Additional observations during the survey included a general overview of Area C. The industrial waste deposited in Area C between 1945 and 1966 is covered with construction debris and partially capped by an approximately 8 inch-thick concrete parking area (166,000 sq ft, or 3.8 acres), with relatively few minor cracks. The construction debris fill material deposited after 1966 that is not capped with concrete or lies along the shoreline is vegetated with dense underbrush and trees on the slopes and floodplain. As indicated on Figure 2, the toe of the construction debris fill material extends to approximately 50 feet to the river, and on average, is approximately 140 feet from the river. The footprint of Area C encompasses approximately 600,000 sq ft, or approximately 14 acres.

4.4.3 Well Installation and Sampling

In accordance with the *Supplemental Phase II Exterior Work Plan* (ARCADIS 2008a) approved by MPCA on March 15, 2010, ARCADIS oversaw the installation of two additional monitoring wells (AMW-19 and AMW-20) near the toe of the slope on the west side of Area C (Figure 2). After installation, these wells were sampled twice, on November 11, 2011 and January 17, 2012. Complete well construction details are included in Table 1 and on the boring logs included as Appendix F. Groundwater sampling logs are provided in Appendix F.

<u>2011 Monitoring Well Installation:</u> The wells were installed on November 2 and 3, 2011 by Stevens Drilling and Environmental, under the supervision of an ARCADIS Geologist. Prior to well installation, a Geoprobe™ direct push technology rig was used to collect continuous soil samples at each location. Soil was characterized using the United Soil Classification System (USCS) and screened using a photo-ionization detector (PID) with an 11.7 electron-volt (eV) lamp. Observations of groundwater levels, soil type and PID readings collected during the soil boring advancement and macro core soil collection were used to determine where to place the screened interval of each well. The soil encountered during installation of the borings primarily consisted of unconsolidated fine to very coarse sand, with intervals of silty sand and gravelly sand. Neither construction debris fill material nor bedrock was encountered at either of the locations. No soil samples were collected while installing groundwater monitoring wells AMW-19 and AMW-20 because there were no visual or PID indications of impacts during drilling.

Following soil boring advancement, monitoring wells were installed using a 4.25-inch inner diameter hollow-stem auger. The borings were completed to a depth of 26 ft bgs and two-inch diameter, 10 slot polyvinyl chloride (PVC) screens were installed from approximately 14 to 24 ft bgs, with sufficient PVC casing to extend approximately 2 feet above land surface. The wells were subsequently developed using over-pumping techniques with a whale pump. Approximately 25 gallons of water were removed from each well until purge water was clear (i.e., less than 10 nephelometric turbidity units). Purged groundwater from development and subsequent sampling events was placed temporarily within an on-Site polytank until disposal.

Following the installation of the monitoring wells, the locations and elevations of the ground surface and monitoring well top of casings were surveyed by Sunde Land Surveying, LLC.

2011-2012 Monitoring Well Sampling: Groundwater samples were collected from AMW-19 and AMW-20 on November 11, 2011 and January 17, 2012 in accordance with the *Field Sampling Plan* (ARCADIS 2007a) using the standard purge method. Samples were placed into laboratory supplied containers and submitted to TestAmerica in North Canton, Ohio for analysis of VOCs (Method 8260B), SVOCs (8270C), dissolved Target Analyte List (TAL) metals (Method 6010), DRO (Wisconsin Modified Method) and GRO (Wisconsin Modified Method) *per the Supplemental Phase II Exterior Work Plan* (ARCADIS 2008a).

The two sampling events identified detections and estimated detections of seven VOCs (2-butanone, acetone, benzene, methylcyclohexane, p-isopropyltoluene, tetrahydrofuran, and toluene), 13 metals (antimony, barium, cadmium, cobalt, copper, iron, magnesium, manganese, nickel, potassium, sodium, thallium, and vanadium), and DRO were reported for AMW-19 and AMW-20 (Table 2). Cobalt was detected in both groundwater samples collected from AMW-20 at concentrations exceeding the current Class 2B standard of 5 µg/L, but did not exceed the current HRL standard (30 µg/L). Manganese was detected in AMW-19 and AMW-20 at concentrations ranging from 1,700 to 2,800 µg/L which is greater than the HRL of 300 µg/L. There is no Class 2B surface water standard for manganese. Manganese was not analyzed in historical samples collected in Area C. Since the Mississippi River is the only downgradient receptor and there is no surface water standard for manganese, it is not considered a risk to human health or the environment.

Thallium was detected at estimated concentrations during the second of the two sampling events in AMW-19 (9.7 µg/L) and in the duplicate sample collected from AMW-20 (5.9 µg/L). Both concentrations are above the HRL based standard of 0.6 µg/L. Thallium was not analyzed in historic groundwater or surface water samples in Area C. The Class 2B surface water standard for chronic exposure to thallium is 0.56 µg/L for protection of human health. Additional standards of 64 µg/L for maximum exposure and 128 µg/L for the Final Acute Value are published for protection of the aquatic environment.

GRO was not detected in samples collected from groundwater monitoring wells AMW-19 and AMW-20. DRO was detected ranging from 260 µg/L to 1,200 µg/L. There are no HRLs or Class 2B standards for GRO or DRO, but those compounds are generally used as indicator parameters when evaluating redevelopment scenarios at a site. Currently, the type of redevelopment for the site is unknown at this time.

5. Preliminary Screening of Potential Exposure Pathways

A preliminary screening of potential exposures of human and ecological receptors to constituents which may cause adverse health effects that may potentially be present in the buried industrial waste is presented below. This screening considers potential exposure pathways in the context of current and likely future land use scenarios, as well as Site-specific factors. Potential media of concern considered in the screening include groundwater, surface water, soils, and air. Risk calculations associated with potential exposure routes (i.e., ingestion, dermal contact, inhalation,etc.) are beyond the scope of this screening level evaluation, but potential routes are discussed below.

The current land use is undeveloped industrial with low frequency and short duration activity (primarily on the parking lot surface) and occasional trespassers along the river bank. The expected future land use ranges from continuation of the current use to limited recreational, which would be restricted through administrative and engineering controls under future redevelopment scenarios. Commercial and/or residential use are not contemplated for this Site. Development of the site is also unlikely due to the lack of structural integrity necessary to support the construction of a permanent structure. As discussed below, there is limited potential for exposure under current and anticipated future land use. The routes of exposure that may be present can be effectively mitigated and/or controlled to avoid or minimize unacceptable risk to human and ecological receptors.

5.1 Potential Soil Exposure

The majority of the industrial waste fill is covered with up to 60 feet of construction debris and that portion of Area C is capped at land surface by an approximately 8 inch-thick concrete parking area (166,000 sq ft, or 3.8 acres). The portion of the construction debris fill material deposited after 1966 that is not capped with concrete or lies along the shoreline is vegetated with dense underbrush and trees on the slopes and floodplain. As shown in Figure 3B, the only location where industrial waste is near land surface is at the base of the southern slope, in the vicinity of soil boring B-5. Further erosion and slumping of the northern and western slope is not a concern due to large distances between the slope face of the construction debris and the location of the industrial waste (120 to 230 feet behind that slope face). Further erosion at the base of the southern slope could uncover industrial waste. However, both the presence of industrial waste near land surface and the potential for erosion and direct contact exposure can be mitigated with engineering and administrative controls to stop any potential current exposure and prevent future exposure to both human and ecological receptors.

5.2 Potential Groundwater and Surface Water Exposure

Groundwater has the potential to infiltrate the Site only during major flooding events. Due to the discharge of groundwater from the Site to the Mississippi River, surface water may receive groundwater that has come into contact with the industrial waste for short durations of time during those flooding events, as discussed below. In addition, overland erosion and exposure of industrial waste to surface water is possible under major flooding events.

Site groundwater is not currently used as a drinking water source, and it is highly unlikely to be used as a source in the future. Also, as documented in the Phase I ESA by ARCADIS (ARADIS 2007), no public water supply wells were observed within a one-mile radius of the Site. Additionally, the surface water surrounding the Site is classified as Class 2, for aquatic life, recreational, and habitat use, with no nearby intakes for drinking water. Therefore, no current or future exposure to human or ecological receptors is expected to Site groundwater. Comparisons to HRLs, which are protective of human exposure via ingestion of groundwater are not applicable to Site groundwater.

Additionally, all surface water samples collected to date are below Class 2B standards, as previously discussed. Therefore, no unacceptable risk is expected from surface water to either human or ecological receptors under normal site conditions. Potential flooding events which may result in higher concentrations of constituents in surface water are discussed below.

5.2.1 Discharge of Groundwater to Surface Water

Review of recent groundwater concentrations (2012) show thallium as the sole constituent detected at concentrations exceeding Class 2B standards. Cobalt was also detected AMW-20 at concentrations of 3.3 µg/L and 6.4 µg/L; only the estimated duplicate result exceeds the standard (5 µg/L). However, Site groundwater is diluted when it discharges to the surface water and the comparison of Site groundwater concentrations to surface water standards are highly conservative. To estimate the potential concentration of thallium in the Mississippi River from the Site, the potential dilution was calculated using conservative assumptions. The concentration of thallium that could be expected in the Mississippi River as a result of the observed groundwater concentration was estimated through the derivation of the flux of groundwater to the Mississippi River and the use of known groundwater concentration and velocity parameters. The highest observed concentration of thallium (9.7 µg/L at AMW-19) and reported groundwater velocity value (1.7 ft/day) for the Site (CRA 1998) were utilized.

The total area of the river bank downgradient of Area C that could contribute flow to the Mississippi River was calculated to be 15,120 square feet (ft^2) using the following equation:

$$A = L * b$$

Where:

A = Area of the river bank downgradient of Area C that could contribute groundwater flow to the Mississippi River,

L = Length of river bank downgradient of Area C (840 feet, Figure 2),

b = Thickness of saturated unconsolidated aquifer downgradient of Area C (18 feet, Figure 3).

The flux of groundwater to the Mississippi River was estimated to be 25,704 cubic feet per day (ft^3/day) which is equivalent to 8.4 liters per second (L/sec) using the following equation:

$$Q_{GW} = A * v$$

Where:

Q_{GW} = Flux to the Mississippi River (ft^3/day),

A = Area of the river bank downgradient of Area C that could contribute groundwater flow to the Mississippi River (15,120 ft^2),

v = Groundwater velocity (ft/day).

The concentration of thallium that would be created in the surface water of the Mississippi River under these conditions was calculated using the following equation:

$$C_{SW} = \frac{C_{GW} * Q_{GW}}{Q_{river}}$$

Where:

C_{SW} = Concentration of thallium in surface water (µg/L),

C_{GW} = Maximum concentration of thallium in groundwater (9.7 µg/L, Table 2),

Q_{GW} = Flux to the Mississippi River (8.4 L/sec),

Q_{river} = 7Q10 flow of Mississippi River (37,011 L/sec).

The 7Q10 value represents the lowest stream flow for seven consecutive days that would be expected to occur in a 10 year period and is therefore a conservative value representing a minimum amount of dilution. The data was obtained from United States Geological Survey (USGS) gage #05288500 on the Mississippi River near Anoka, MN and was provided by the MPCA. Using the conservative estimates and calculation above, the concentration of thallium that would be present in the Mississippi River would be 0.0022 µg/L, which is below the Class 2B Final Acute Value and Chronic Standards of 128 and 0.56 µg/L, respectively. Therefore, no unacceptable risk is expected to ecological receptors under normal site conditions.

5.2.2 Soil to Surface Water

Surface water contact with industrial waste could also potentially occur during the course of flooding events when rising surface water expands the river inland along the southern slopes of the Site. Erosion from a flooding event along the western edge, approximately 260 feet east of the riverbank, would allow surface water to encounter construction debris (i.e. scrap metal, concrete slabs with and without reinforcement steel bars. However, evidence of industrial waste has not been observed along this edge of the Site and historical depictions of the extent of the industrial waste are more than 380 feet east from the riverbank.

Evidence of industrial waste has been observed near land surface along the southern slope of the Site in historical test pits TP-03 and TP-08 and during drum removal in 2012. Analytical results from soil samples collected during both activities demonstrated solids to be non-hazardous. Furthermore, surface water elevations would need to rise at least 26 feet (from average elevation) and expand the river inland by more than 700 feet east for surface water to encounter this area. Erosion at the base of the southern slope could expose industrial waste, but the potential for erosion and transport of industrial waste to surface water can be mitigated with engineering controls.

5.3 Air Pathway

Soil vapor samples have not been collected to date at the Site, and due to its current and anticipated future use, vapor intrusion is not a concern at this time. However, if development scenarios for the Site include the presence of a building designed for occupancy within 100 feet of the industrial waste, then evaluation of this pathway and potential risk of inhalation exposure would be required. Currently, the majority of observed chemical detections in soil and groundwater are of metals that do not pose vapor concerns and other detections are limited.

6. Conclusions and Recommendations

Industrial waste, consisting of paint sludge and other plant waste from Ford TCAP, was deposited in Area C between 1945 and 1966. In addition, excavated materials from Main Assembly Plant parcel disposal areas A and B were also deposited onto Area C in 1966 and 1962, respectively. The exact volume and contents of the materials buried are not known. Material encountered in recent years during the investigation of sand tunnel 1A at its termination within Area C, is believed to be representative of the buried waste. The material encountered at the terminus of the tunnel consisted of concrete, wood chunks and solidified paint sludge.

As illustrated on Figures 2, 3A, 3B, and 3C, the industrial waste within Area C was placed on top of the floodplain-deposited unconsolidated sands and gravels, which are approximately 25 to 30 feet thick and overlay the St. Peter Sandstone. The waste extends approximately 490 feet west of Mississippi River Boulevard, or approximately 300 feet east of the Mississippi River shoreline. The majority of the industrial waste fill is covered with construction debris deposited after 1965 and that portion of Area C is capped by an approximately 8 inch-thick concrete parking area (166,000 sq ft, or 3.8 acres). The portion of the construction debris fill material deposited after 1966 that is not capped with concrete or lies along the shoreline is vegetated with dense underbrush and trees on the slopes and floodplain. The base of the industrial waste is at approximately 705 to 710 ft amsl and the recently observed static groundwater is at approximately 686 to 690 ft msl). While groundwater adjacent to the Mississippi River temporarily rises during flood events, it is not clear if, or by how much, the groundwater elevation would rise at distance of 300 feet or more inland, in response to a 10-, 50-, or 100-year flood event in the Mississippi River (707, 714 and 717 ft amsl, respectively). During such an event, contact between groundwater and the base of the buried industrial waste, if it occurs, is expected to be short in duration.

Based on the review of available analytical data, potential impacts to the subsurface resulting from the presence of fill material at Area C do not appear to currently migrate to the Mississippi River at concentrations that would pose a risk to human or ecological receptors. However, the calculated groundwater travel time from the east side of the industrial waste, near the bluff along the Mississippi River Boulevard, indicates that if there were impacts to the groundwater, they would be observed at this time. The calculations (Section 5.2), three dimensional model, and cross sections illustrate potential groundwater exposure to the industrial waste fill during the 10-year, 50-year, and 100-year flood events, and it is unclear how the subsurface in Area C would respond to such events. In addition, the three dimensional model, cross sections, and Site reconnaissance also demonstrate there is a potential for the industrial waste to be exposed in the near future due to lack of soil erosion control. Potential future exposure pathways to subsurface soils could occur should erosion or construction activities be performed in the areas of the industrial waste fill. However, the varying degrees of potential for groundwater, surface water, and direct contact exposure with the industrial waste fill can be mitigated with engineering and administrative controls to stop any potential current exposure and prevent future exposure to both human and ecological receptors. Ford will work cooperatively with MPCA on the implementation of engineering/erosion controls for Area C that may be necessary to prevent exposure following completion of any necessary investigation(s).

7. References

ARCADIS. “Field Sampling Plan.” June 2007a.

ARCADIS. “Phase I Environmental Site Assessment, Ford Motor Company, Twin Cities Assembly Plant, St. Paul, Minnesota.” June 2007b.

ARCADIS. “Supplemental Phase II – Exterior Investigation Work Plan.” May 2008a.

ARCADIS. “Groundwater Seep and Mississippi River Sampling Work Plan.” April 2008b.

ARCADIS. Tunnel Survey Report, Collapse Area with Buried Drums – Feature 150 Ford Twin Cities Assembly Plant, St. Paul, Minnesota. March 17, 2009.

ARCADIS. “Response Action Implementation Report, 1A Tunnel Barrier Wall, Feature 150.” January 2011a.

ARCADIS. “Technical Memorandum to Summarize the Seep and River Sampling Events.” February 2011b.

CRA. “Assessment of Fill Areas, Ford Motor Company Twin Cities Assembly Plant.” October 1988.

CRA “Groundwater Monitoring Report and Evaluation – Site C” January 1990a.

CRA “Supplemental Groundwater Monitoring Report and Evaluation – Site C” August 1990b.

CRA “Abandonment of Wells, Ford Motor Company, Twin Cities Assembly Plant, St. Paul, Minnesota.” January 1994.

Ford Motor Company. “Twin Cities Assembly Facility Groundwater Monitoring Wells Survey.” March 1982a.

Ford Motor Company. “Twin Cities Assembly Facility Groundwater Monitoring Wells Survey.” December 1982b.

Tables

Table 1. Well Construction Details
Area C - Twin Cities Assembly Plant, St. Paul, Minnesota

Well ID	Unique Well Number	Date Installed	Surface Elevation (ft msl)	Top Of Casing Elevation (ft msl)	Bottom of Well Elevation (ft msl)	Screen Interval (Elev. - Elev.) (ft bgs)	Surface Completion Type
B-1	Unknown	12/31/1981	729.52	738.06	681.62	41-51	Abandoned
B-2	Unknown	11/18/1981	715.77	718.96	671.27	34.5-44.5	Abandoned
B-3	Unknown	11/17/1981	701.99	704.18	679.68	14.5-24.5	Abandoned
B-4	Unknown	11/19/1981	705.47	708.63	675.97	19.5-29.5	Abandoned
B-5	Unknown	11/30/1982	701.5	703.9	678.5	15.4-25.4	Abandoned
B-6/MW-6	Unknown	04/10/1990	759.93	730.85	681.9	37-47	Abandoned
AMW-19	784743	11/03/2011	705.6	707.84	681.29	14.3-24.3	Above Ground
AMW-20	784744	11/03/2011	707.58	710.02	684.09	13.5-23.5	Above Ground

Notes:
Elev. = elevation
ft msl = feet above mean sea level
ft bgs = feet below ground surface

ARCADIS

Table 2. **Summary of Detected Constituents in Groundwater Samples**
Twin Cities Assembly Plant, St. Paul, Minnesota

Location ID							**B-1**	**B-1**	**B-1**	**B-1**	**B-1**	**B-1**	**B-1**	**B-2**	**B-2**	**B-3**	**B-3**	**B-3**	**B-3**	**B-3**	**B-3**	**B-3**	**B-4**
Sample Matrix							**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**
Sample ID		**Class 2B Waters**			**MDH Derived Value**		**B-1**	**B-1**	**B-1**	**B-1**	**B-1**	**B-1**	**B-1**	**B-2**	**B-2**	**B-3**	**B-3**	**B-3**	**B-3**	**B-3**	**B-3**	**B-3**	**B-4**
Sample Date	**Unit**	**CS**	**MS**	**FAV**	**Value**	**Basis**	**03/03/1982**	**12/01/1982**	**06/01/1989**	**08/01/1989**	**09/01/1989**	**04/01/1990**	**06/01/1990**	**03/03/1982**	**12/01/1982**	**03/03/1982**	**12/01/1982**	**06/01/1989**	**08/01/1989**	**09/01/1989**	**04/01/1990**	**06/01/1990**	**03/03/1982**
VOCs																							
1,1-Dichloroethene	µg/L	NS	NS	NS	200	2009 HBV	NR	NR	1.5	ND R	ND	ND	ND	NR	NR	NR	NR	ND	ND	ND	ND	ND	NR
2-Butanone (MEK)	µg/L	NS	NS	NS	4000	1993/94 HRL	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Acetone	µg/L	NS	NS	NS	4000	2010 HRL	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Benzene	µg/L	114	4487	8974	2	2009 HRL	NR	<1	NR	NR	NR	NR	NR	NR	<1	NR	<1	NR	NR	NR	NR	NR	NR
Chloroform	µg/L	155	1392	2784	30	2009 HRL	NR	NR	ND	ND	ND	ND	ND	NR	NR	NR	NR	ND	ND	ND	ND	ND	NR
cis-1,2-Dichloroethene	µg/L	NS	NS	NS	50	2009 HRL	<2	ND	ND	ND	ND	ND	ND	15	22	<2	<2	ND	ND	ND	ND	ND	<2
Dichlorodifluoromethane (CFC-12)	µg/L	NS	NS	NS	700	2009 HBV	NR	NR	ND	14 J	ND	ND	ND	NR	NR	NR	NR	ND	ND	ND	ND	ND	NR
Methylcyclohexane	µg/L	NS	NS	NS	NS	NS	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Methylene chloride	µg/L	1940	13875	27749	5	2009 HRL/MCL	NR	NR	ND	ND R	ND	ND	ND					ND	ND	ND	ND	ND	
p-Isopropyltoluene	µg/L	NS	NS	NS	NS	NS	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tetrahydrofuran	µg/L	NS	NS	NS	100	1995 HBV	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Toluene	µg/L	253	1352	2703	200	2009 HBV	1	2.1	NR	NR	NR	NR	NR	1	<1	<1	<1	NR	NR	NR	NR	NR	1
trans-1,2-Dichloroethene	µg/L	NS	NS	NS	100	1993/94 HRL	NR	NR	NR	NR	NR	NR	NR	15	NR	<2	NR	NR	NR	NR	NR	NR	<2
Trichloroethene	µg/L	120	6988	13976	5	2009 HRL/MCL	4	NR	ND	ND R	2.1	ND	ND	5	NR	<2	NR	ND	ND	ND	ND	ND	<2
Vinyl chloride	µg/L	9.2	None*	None*	0.2	2009 HRL	NR	NR	ND	5.2 J	ND	ND	ND	NR	NR	NR	NR	ND	ND	ND	ND	ND	NR
Metals																							
Antimony	µg/L	31	90	180	6	1993/94 HRL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barium	µg/L	NS	NS	NS	2000	1993/94 HRL	NA	NA	ND	ND	ND	ND	60	NA	NA	NA	NA	300	ND	ND	200	180	NA
Cadmium	µg/L	2*	65*	130*	4	1993/94 HRL	20	3	ND	ND	ND	ND	ND	<10**	3	<10**	3	0.2	ND	ND	ND	ND	20
Calcium	µg/L	NS	NS	NS	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	µg/L	11*	16*	32*	100/20000	1993/94 HRL	<50**	<50**	ND	ND	ND	ND	ND	<50**	<50**	<50**	<50**	ND	ND	ND	ND	ND	<50**
Cobalt	µg/L	5	436	872	30	1995 HBV	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	µg/L	14*	31*	62*	1000	1995 HBV	30	<5	ND	10	ND	ND	ND	20	<5	10	<5	ND	20	ND	10 U	ND	10
Iron	µg/L	NS	NS	NS	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	µg/L	7*	173*	346*	15	No Basis[1]	120	5	ND	ND	ND	ND	ND	<50**	5	<50**	4	ND	ND	ND	ND	ND	60
Magnesium	µg/L	NS	NS	NS	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	µg/L	NS	NS	NS	300	2008 RAA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	µg/L	259*	2332*	4664*	100	1993/94 HRL	70	60	ND	ND	ND	ND	ND	40	<20	20	<20	ND	50	ND	ND	ND	50
Potassium	µg/L	NS	NS	NS	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	µg/L	NS	NS	NS	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	µg/L	0.56	64	128	0.6	1993/94 HRL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	µg/L	NS	NS	NS	50	1993/94 HRL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	µg/L	174*	193*	385*	2000	1993/94 HRL	60	<50	ND	ND	ND	ND	ND	40	<5	<20	<5	30	ND	20	ND	ND	90
Other																							
Diesel Range Organics	µg/L	NS	NS	NS	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
Results are reported in micrograms per liter (µg/L).

AMW	ARCADIS Monitoring Well.
NS	No standard.
NR	Not reported.
NA	Not analyzed.
ND	Not detected.
<	Not detected (reporting limit included).
J	Estimated result.
U	Value qualified as non-detect based on method blank.
R	Value unusable based on holding time exceedence.
Shade	Value is above Minnesota Administrative Rules, Chapter 7050 Waters of the State, Minnesota Pollution Control Agency, Part 7050.0223, Class 2B Water Quality Standard.
Boxed	Value is above the MDH Derived Value
GW	Groundwater
MDH	Minnesota Department of Health
HBV	Health Based Values.
HRL	Health Risk Limit.
MCL	Maximum Contaminant Level.
RAA	Risk Assessment Advice.
VOCs	Volatile organic compounds.
1	Lead MDH Health Based Water Guidance Action Level at Tap.
CS	Chronic Standard.
MS	Maximum Standard.
FAV	Final Acute Value.
µg/L	Micrograms per liter.
SVOCs	Semi-volatile organic compounds.
VOCs	Volatile organic compounds.
*	Standards vary with Total Hardness (TH). A hardness value of 180 mg/l was used to be conservative in calculating these values using MPCA published equations.
**	Reporting limit exceeds standard

ARCADIS

Table 2. **Summary of Detected Constituents in Groundwater Samples**
Twin Cities Assembly Plant, St. Paul, Minnesota

Location ID							**B-4**	**B-5**	**B-5**	**B-5**	**B-5**	**B-6**	**B-6**	**AMW-19**	**AMW-19**	**AMW-20**	**AMW-20**	**AMW-20**	**AMW-20**
Sample Matrix							**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**
Sample ID		**Class 2B Waters**			**MDH Derived Value**		**B-4**	**B-5**	**B-5**	**B-5**	**B-5**	**B-6**	**B-6**	**AMW-19(20111111)**	**AMW-19(20120117)**	**AMW-20(20111111)**	**DUP-01(20111111)**	**AMW-20(20120117)**	**DUP-02(20120117)**
Sample Date	**Unit**	**CS**	**MS**	**FAV**	**Value**	**Basis**	**12/01/1982**	**12/01/1982**	**06/01/1989**	**08/01/1989**	**09/01/1989**	**04/01/1990**	**06/01/1990**	**11/11/2011**	**1/17/2012**	**11/11/2011**	**11/11/2011**	**1/17/2012**	**1/17/2012**
VOCs																			
1,1-Dichloroethene	µg/L	NS	NS	NS	200	2009 HBV	NR	NR	ND	0.8 J	ND	ND	ND	< 1	< 1	< 1	< 1	< 1	< 1
2-Butanone (MEK)	µg/L	NS	NS	NS	4000	1993/94 HRL	NR	NR	NR	NR	NR	NR	NR	< 10	< 10	0.88 J	< 10	< 10	< 10
Acetone	µg/L	NS	NS	NS	4000	2010 HRL	NR	NR	NR	NR	NR	NR	NR	< 10	< 10	5.4 J	1.9 J	< 10	< 10
Benzene	µg/L	114	4487	8974	2	2009 HRL	<1	<1	NR	NR	NR	NR	NR	< 1	< 1	0.14 J	< 1	< 1	< 1
Chloroform	µg/L	155	1392	2784	30	2009 HRL	NR	NR	ND	ND	ND	3.9	ND	< 1	< 1	< 1	< 1	< 1	< 1
cis-1,2-Dichloroethene	µg/L	NS	NS	NS	50	2009 HRL	6.7	ND	ND	ND	ND	ND	5.5	< 1	< 1	< 1	< 1	< 1	< 1
Dichlorodifluoromethane (CFC-12)	µg/L	NS	NS	NS	700	2009 HBV	NR	NR	ND	ND	ND	ND	ND	< 1	< 1	< 1	< 1	< 1	< 1
Methylcyclohexane	µg/L	NS	NS	NS	NS	NS	NR	NR	NR	NR	NR	NR	NR	< 1	< 1	0.15 J	< 1	< 1	< 1
Methylene chloride	µg/L	1940	13875	27749	5	2009 HRL/MCL			ND	ND	ND	1.4 U	ND	< 1	< 1	< 1	< 1	< 1	< 1
p-Isopropyltoluene	µg/L	NS	NS	NS	NS	NS	NR	NR	NR	NR	NR	NR	NR	< 1	< 1	< 1	< 1	< 1	0.45 J
Tetrahydrofuran	µg/L	NS	NS	NS	100	1995 HBV	NR	NR	NR	NR	NR	NR	NR	< 5	< 5	0.51 J	< 5	< 5	< 5
Toluene	µg/L	253	1352	2703	200	2009 HBV	<1	<1	NR	NR	NR	NR	NR	< 1	< 1	0.19 J	0.14 J	< 1	< 1
trans-1,2-Dichloroethene	µg/L	NS	NS	NS	100	1993/94 HRL	NR	NR	NR	NR	NR	NR	NR	< 1	< 1	< 1	< 1	< 1	< 1
Trichloroethene	µg/L	120	6988	13976	5	2009 HRL/MCL	NR	NR	ND	ND	ND	ND	0.5	< 1	< 1	< 1	< 1	< 1	< 1
Vinyl chloride	µg/L	9.2	None*	None*	0.2	2009 HRL	NR	NR	ND	ND	ND	ND	ND	< 1**	< 1**	< 1**	< 1**	< 1**	< 1**
Metals																			
Antimony	µg/L	31	90	180	6	1993/94 HRL	NA	NA	NA	NA	NA	NA	NA	2.9 J	< 10**	3.3 J	< 10**	< 10**	< 10**
Barium	µg/L	NS	NS	NS	2000	1993/94 HRL	NA		ND	ND	ND	ND	73	240	220	200	200	160 J	160 J
Cadmium	µg/L	2*	65*	130*	4	1993/94 HRL	5	1	0.4	ND	0.2	ND	ND	< 5**	< 5**	< 5**	< 5**	< 5**	< 5**
Calcium	µg/L	NS	NS	NS	NS	NS	NA	NA	NA	NA	NA	NA	NA	150000	150000	180000	190000	180000	180000
Chromium	µg/L	11*	16*	32*	100/20000	1993/94 HRL	<50**	<50**	2	ND	ND	ND	ND	< 10	< 10	< 10	< 10	< 10	< 10
Cobalt	µg/L	5	436	872	30	1995 HBV	NA	NA	NA	NA	NA	NA	NA	4.9 J	3.1 J	5.3 J	9.9	3.3 J	6.4 J
Copper	µg/L	14*	31*	62*	1000	1995 HBV	<5	<5	ND	ND	ND	ND	ND	< 25**	< 25**	< 25**	< 25**	< 25**	< 25**
Iron	µg/L	NS	NS	NS	NS	NS	NA	NA	NA	NA	NA	NA	NA	170	< 100	< 100	< 100	550	700
Lead	µg/L	7*	173*	346*	15	No Basis[1]	6	3	ND	ND	ND	ND	ND	< 3	< 3	< 3	< 3	< 3	< 3
Magnesium	µg/L	NS	NS	NS	NS	NS	NA	NA	NA	NA	NA	NA	NA	41000	41000	49000	51000	48000	48000
Manganese	µg/L	NS	NS	NS	300	2008 RAA	NA	NA	NA	NA	NA	NA	NA	2800	1700	1800	1900	1700	1700
Nickel	µg/L	259*	2332*	4664*	100	1993/94 HRL	<20	<20	80	50	ND	ND	ND	3.4 J	< 40	6.9 J	7.6 J	4.5 J	4.8 J
Potassium	µg/L	NS	NS	NS	NS	NS	NA	NA	NA	NA	NA	NA	NA	4300 J	3900 J	3500 J	3600 J	3300 J	3300 J
Sodium	µg/L	NS	NS	NS	NS	NS	NA	NA	NA	NA	NA	NA	NA	55000	51000	66000	69000	58000	58000
Thallium	µg/L	0.56	64	128	0.6	1993/94 HRL	NA	NA	NA	NA	NA	NA	NA	< 10**	9.7 J	< 10**	< 10**	< 10**	5.9 J
Vanadium	µg/L	NS	NS	NS	50	1993/94 HRL	NA	NA	NA	NA	NA	NA	NA	< 7	< 7	0.64 J	< 7	< 7	< 7
Zinc	µg/L	174*	193*	385*	2000	1993/94 HRL	60	<5	70	ND	260	ND	7 U	< 50	< 50	< 50	< 50	< 50	< 50
Other																			
Diesel Range Organics	µg/L	NS	NS	NS	NS	NS	NA	NA	NA	NA	NA	NA	NA	260	< 100	630	280	460	1200

Notes:
Results are reported in micrograms per liter (µg/L).

AMW	ARCADIS Monitoring Well.
NS	No standard.
NR	Not reported.
NA	Not analyzed.
ND	Not detected.
<	Not detected (reporting limit included).
J	Estimated result.
U	Value qualified as non-detect based on method blank.
R	Value unusable based on holding time exceedence.
Shade	Value is above Minnesota Administrative Rules, Chapter 7050 Waters of the State, Minnesota Pollution Control Agency, Part 7050.0223, Class 2B Water Quality Standard.
Boxed	Value is above the MDH Derived Value
GW	Groundwater
MDH	Minnesota Department of Health
HBV	Health Based Values.
HRL	Health Risk Limit.
MCL	Maximum Contaminant Level.
RAA	Risk Assessment Advice.
VOCs	Volatile organic compounds.
1	Lead MDH Health Based Water Guidance Action Level at Tap.
CS	Chronic Standard.
MS	Maximum Standard.
FAV	Final Acute Value.
µg/L	Micrograms per liter.
SVOCs	Semi-volatile organic compounds.
VOCs	Volatile organic compounds.
*	Standards vary with Total Hardness (TH). A hardness value of 180 mg/l was used to be conservative in calculating these values using MPCA published equations.
**	Reporting limit exceeds standard

ARCADIS

Table 3. **Summary of Detected Constituents in River Samples**
Twin Cities Assembly Plant, St. Paul, Minnesota

Location ID:		Class 2B Waters			Mississippi River	Mississippi River	Mississippi River	Mississippi River	Mississippi River	Mississippi River	Mississippi River	Mississippi River
Sample ID:		CS	MS	FAV	R1	R2	R3	Upstream	Upstream	Upstream	Upstream	Upstream
Sample Date:					12/01/1982	12/01/1982	12/01/1982	06/1989	08/1989	09/1989	04/1990	06/1990
VOCs												
1,1-Dichloroethene	µg/L	NS	NS	NS	NR	NR	NR	1.3	ND	ND	ND	ND
2-Butanone (MEK)	µg/L	NS	NS	NS	NR	NR	NR	NR	NR	NR	NR	NR
Acetone	µg/L	NS	NS	NS	NR	NR	NR	NR	NR	NR	NR	NR
Chloromethane	µg/L	NS	NS	NS	NR	NR	NR	NR	NR	NR	NR	NR
Methylene chloride	µg/L	1940	13875	27749	NR	NR	NR	ND	ND	ND	1.3 J	1
Toluene	µg/L	253	1352	2703	3	<1	<1	NR	NR	NR	NR	NR
Trichlorofluoromethane (CFC-11)	µg/L	NS	NS	NS	NR	NR	NR	ND	ND	ND	ND	ND
SVOCs												
bis(2-Ethylhexyl)phthalate	µg/L	NS	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA
Butyl benzyl phthalate	µg/L	NS	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA
Metals												
Barium	µg/L	NS	NS	NS	NA	NA	NA	ND	ND	ND	ND	58
Cadmium	µg/L	2*	65*	130*	<1	<1	NA	ND	0.5	ND	ND	ND
Chromium	µg/L	11*	16*	32*	<50	<50	<50	ND	ND	ND	ND	ND
Copper	µg/L	14*	31*	62*	<5	<5	<5	ND	ND	ND	ND	ND
Lead	µg/L	7*	173*	346*	<2	<2	<2	ND	ND	1	ND	ND
Nickel	µg/L	259*	2332*	4664*	<20	<20	NA	ND	ND	ND	ND	ND
Zinc	µg/L	174*	193*	385*	<50	<50	<51	ND	ND	ND	ND	9 U
Other												
Diesel Range Organics	mg/L	NS	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA
Hardness, as CaCO3	mg/L	NS	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

<	Not detected.
ND	Not detected.
NR	Not reported.
NA	Not analyzed.
NS	No standard.
R1	Mississippi River upstream of Ford Power Plant.
R2	Mississippi River near southern property boundary.
R3	Mississippi River in park approximately 200 yds South of Ford property.
Upstream	No map or description of location provided in historical reports.
Downstream	No map or description of location provided in historical reports.
OUTFALL-01	South of railroad access on south side of property, along the inside curve of Mississippi River Boulevard in Hidden Falls Park.
SW-01	Upgradient of lock and dam approximately 270 feet.
SW-02	Location shown on Figure 2.
SW-03	Location shown on Figure 2.
SW-04	Downgradient of southern boundary with Hidden Falls Park approximately 1600 feet.
Shade	Value is above Minnesota Administrative Rules, Chapter 7050 Waters of the State, Minnesota Pollution Control Agency, Part 7050.0223, Class 3C Water Quality Standard.
CS	Chronic Standard.
MS	Maximum Standard.
FAV	Final Acute Value.
J	Estimated result.
mg/L	Milligrams per liter.
µg/L	Micrograms per liter.
SVOCs	Semi-volatile organic compounds.
VOCs	Volatile organic compounds.
*	Standards vary with Total Hardness (TH). A hardness value of 180 mg/l was used to be conservative in calculating these values using MPCA published equations.

Table 3. Summary of Detected Constituents in River Samples
Twin Cities Assembly Plant, St. Paul, Minnesota

Location ID:		Class 2B Waters			Mississippi River	Mississippi River	Mississippi River	Mississippi River	Mississippi River	OUTFALL-01	SW-01	SW-02
Sample ID:		**CS**	**MS**	**FAV**	**Down Stream**	**Down Stream**	**Down Stream**	**Down Stream**	**Down Stream**	**OUTFALL-01 (11/4/2010)**	**SW-01 (11/4/2010)**	**SW-02 (20101110)**
Sample Date:					**06/1989**	**08/1989**	**09/1989**	**04/1990**	**06/1990**	**11/04/2010**	**11/04/2010**	**11/10/2010**
VOCs												
1,1-Dichloroethene	µg/L	NS	NS	NS	ND	1.1 J	ND	ND	ND	NA	ND	ND
2-Butanone (MEK)	µg/L	NS	NS	NS	NR	NR	NR	NR	NR	<10	<10	<10
Acetone	µg/L	NS	NS	NS	NR	NR	NR	NR	NR	<10	<10	<10
Chloromethane	µg/L	NS	NS	NS	NR	NR	NR	NR	NR	<1	0.51J	0.32 J
Methylene chloride	µg/L	1940	13875	27749	1.3	ND	ND	ND	ND	NA	ND	ND
Toluene	µg/L	253	1352	2703	NR	NR	NR	NR	NR	NA	ND	ND
Trichlorofluoromethane (CFC-11)	µg/L	NS	NS	NS	2.1 J	ND	ND	ND	ND	NA	ND	ND
SVOCs												
bis(2-Ethylhexyl)phthalate	µg/L	NS	NS	NS	NA	NA	NA	NA	NA	1.4 J	0.9 J	<10
Butyl benzyl phthalate	µg/L	NS	NS	NS	NA	NA	NA	NA	NA	<10	<10	<10
Metals												
Barium	µg/L	NS	NS	NS	ND	ND	ND	ND	55	132 J	53.4 J	51.3 J
Cadmium	µg/L	2*	65*	130*	ND	0.8	ND	ND	ND	ND	ND	ND
Chromium	µg/L	11*	16*	32*	ND	ND	ND	ND	ND	ND	ND	ND
Copper	µg/L	14*	31*	62*	1	ND	ND	ND	ND	ND	ND	ND
Lead	µg/L	7*	173*	346*	ND	ND	1	ND	ND	ND	ND	ND
Nickel	µg/L	259*	2332*	4664*	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	µg/L	174*	193*	385*	ND	ND	ND	ND	ND	ND	ND	ND
Other												
Diesel Range Organics	mg/L	NS	NS	NS	NA	NA	NA	NA	NA	NA	<0.1	<0.1
Hardness, as CaCO3	mg/L	NS	NS	NS	NA	NA	NA	NA	NA	570	200	190

Notes:

<	Not detected.
ND	Not detected.
NR	Not reported.
NA	Not analyzed.
NS	No standard.
R1	Mississippi River upstream of Ford Power Plant.
R2	Mississippi River near southern property boundary.
R3	Mississippi River in park approximately 200 yds South of Ford property.
Upstream	No map or description of location provided in historical reports.
Downstream	No map or description of location provided in historical reports.
OUTFALL-01	South of railroad access on south side of property, along the inside curve of Mississippi R River Boulevard in Hidden Falls Park.
SW-01	Upgradient of lock and dam approximately 270 feet.
SW-02	Location shown on Figure 2.
SW-03	Location shown on Figure 2.
SW-04	Downgradient of southern boundary with Hidden Falls Park approximately 1600 feet.
Shade	Value is above Minnesota Administrative Rules, Chapter 7050 Waters of the State, Minne esota Pollution Control Agency, Part 7050.0223, Class 3C Water Quality Standard.
CS	Chronic Standard.
MS	Maximum Standard.
FAV	Final Acute Value.
J	Estimated result.
mg/L	Milligrams per liter.
µg/L	Micrograms per liter.
SVOCs	Semi-volatile organic compounds.
VOCs	Volatile organic compounds.
*	Standards vary with Total Hardness (TH). A hardness value of 180 mg/l was used to be cc conservative in calculating these values using MPCA published equations.

ARCADIS

Table 3. Summary of Detected Constituents in River Samples
Twin Cities Assembly Plant, St. Paul, Minnesota

Location ID:		Class 2B Waters			SW-03	SW-04	Trip Blank	Trip Blank
Sample ID:		CS	MS	FAV	SW-03 (20101110)	SW-04 (11/4/2010)	TB-02 (20101104)TB	TB-01 (20101110)TB
Sample Date:					11/10/2010	11/04/2010	11/04/2010	11/10/2010
VOCs								
1,1-Dichloroethene	µg/L	NS	NS	NS	ND	ND	ND	ND
2-Butanone (MEK)	µg/L	NS	NS	NS	<10	<10	0.62 J	0.7 J
Acetone	µg/L	NS	NS	NS	<10	<10	7.5 J	5 J
Chloromethane	µg/L	NS	NS	NS	0.37 J	0.31 J	<1	<1
Methylene chloride	µg/L	1940	13875	27749	ND	ND	ND	ND
Toluene	µg/L	253	1352	2703	ND	ND	ND	ND
Trichlorofluoromethane (CFC-11)	µg/L	NS	NS	NS	ND	ND	ND	ND
SVOCs								
bis(2-Ethylhexyl)phthalate	µg/L	NS	NS	NS	<10	<11	NA	NA
Butyl benzyl phthalate	µg/L	NS	NS	NS	<10	1 J	NA	NA
Metals								
Barium	µg/L	NS	NS	NS	54 J	55 J	ND	ND
Cadmium	µg/L	2*	65*	130*	ND	ND	ND	ND
Chromium	µg/L	11*	16*	32*	ND	ND	ND	ND
Copper	µg/L	14*	31*	62*	ND	ND	ND	ND
Lead	µg/L	7*	173*	346*	ND	ND	ND	ND
Nickel	µg/L	259*	2332*	4664*	ND	ND	ND	ND
Zinc	µg/L	174*	193*	385*	ND	ND	ND	ND
Other								
Diesel Range Organics	mg/L	NS	NS	NS	<0.1	0.086 J	NA	NA
Hardness, as CaCO3	mg/L	NS	NS	NS	180	190	NA	NA

Notes:

<	Not detected.
ND	Not detected.
NR	Not reported.
NA	Not analyzed.
NS	No standard.
R1	Mississippi River upstream of Ford Power Plant.
R2	Mississippi River near southern property boundary.
R3	Mississippi River in park approximately 200 yds South of Ford property.
Upstream	No map or description of location provided in historical reports.
Downstream	No map or description of location provided in historical reports.
OUTFALL-01	South of railroad access on south side of property, along the inside curve of Mississippi R River Boulevard in Hidden Falls Park.
SW-01	Upgradient of lock and dam approximately 270 feet.
SW-02	Location shown on Figure 2.
SW-03	Location shown on Figure 2.
SW-04	Downgradient of southern boundary with Hidden Falls Park approximately 1600 feet.
Shade	Value is above Minnesota Administrative Rules, Chapter 7050 Waters of the State, Minne esota Pollution Control Agency, Part 7050.0223, Class 3C Water Quality Standard.
CS	Chronic Standard.
MS	Maximum Standard.
FAV	Final Acute Value.
J	Estimated result.
mg/L	Milligrams per liter.
µg/L	Micrograms per liter.
SVOCs	Semi-volatile organic compounds.
VOCs	Volatile organic compounds.
*	Standards vary with Total Hardness (TH). A hardness value of 180 mg/l was used to be cc conservative in calculating these values using MPCA published equations.

ARCADIS

Table 4. **Summary of Historical Detected Constituents in Soil Samples**
Area C - Twin Cities Assembly Plant, St. Paul, Minnesota

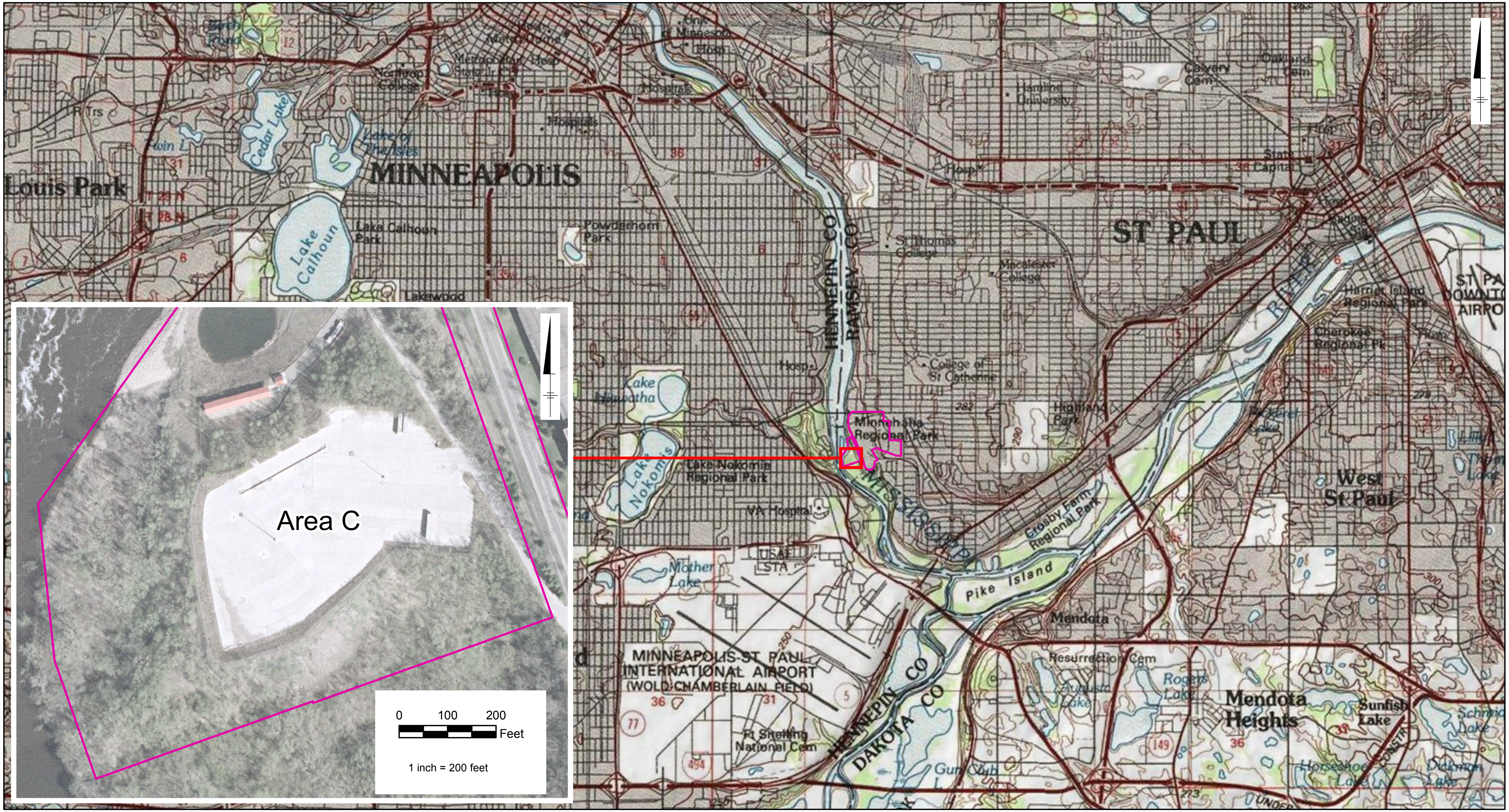
Compound	Test Pit 3*			Test Pit 8**			
	Unit	TCLP Criteria	(TP3) 1/88	Unit	EPA/Minnesota EP Toxicity Leachate Criteria	Tier 2 Industrial SRV	(TP8) 1/88
VOCs							
Toluene	ug/L	NS	180	mg/kg	NA	305	ND
Ethylbenzene	ug/L	NS	85	mg/kg	NA	200	ND
M-xylene	ug/L	NS	2,600	mg/kg	NA	110	ND
O&P xylene	ug/L	NS	3,700	mg/kg	NA	110	ND
Metals							
Arsenic	mg/L	5	0.01	mg/L	5	NA	ND
Barium	mg/L	100	1.5	mg/L	100	NA	0.2
Copper	mg/L	NS	0.02	mg/L	NS	NA	ND
Lead	mg/L	5	0.3	mg/L	5	NA	ND
Zinc	mg/L	NS	0.92	mg/L	NS	NA	0.03
Other							
Flashpoint	ºF	NA	140	ºF	NA	NA	>200
Reactive sulfide	mg/kg	NA	ND	mg/kg	NA	NA	61
pH	SU	NA	7.6	SU	NA	NA	7.9

Notes:

VOCs	Volatile Organic Compounds
NS	No Standard.
NA	Not Analyzed.
ND	Not detected at or above method detection limit.
mg/L	Milligrams per liter.
ºF	Degrees fahrenheit.
mg/kg	Milligrams per kilogram.
SU	Standard units.
TCLP	Toxicity Characteristics Leaching Procedure
EP	Extraction Procedure
SRV	Soil Reference Value
*	TP-3 sample analyzed using TCLP.
**	TP-8 sample was analyzed using EP Toxicity Leachate Procedure for metals and Method 8260 for Total VOCs.

ARCADIS

Figures



LEGEND:

Ford Property Boundary

NOTES:

Imagery Source: United States Geological Survey
High Resolution Orthoimagery for the Minneapolis-St. Paul, Minnesota Urban Area

Topographic Map Source:
© 2007 National Geographic Society

0 1 2
Miles

1 inch = 1 miles

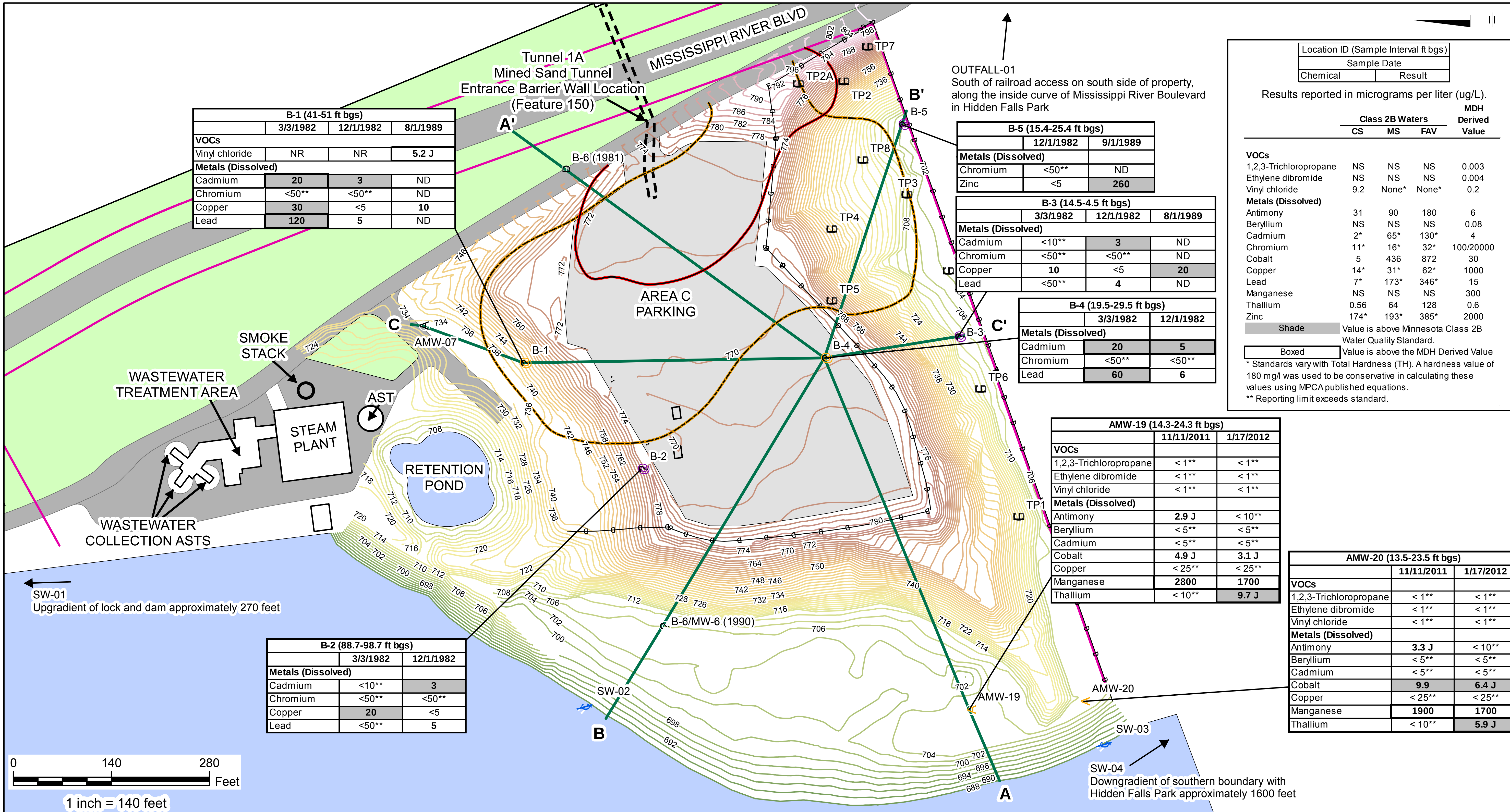
Twin Cities Assembly Plant
Ford Motor Company
St. Paul, Minnesota

Area C
Site Location / Property Layout

ARCADIS

FIGURE
1

CITY: MPLS DB: MG LD: TW PM: BZ
FORD ST. PAUL
G:\GIS\Projects\Ford Ranger\ArcMap\2012\2012-02\Fig1_Site_Location_Area_C_20120228.mxd



B-1 (41-51 ft bgs)			
	3/3/1982	12/1/1982	8/1/1989
VOCs			
Vinyl chloride	NR	NR	**5.2 J**
Metals (Dissolved)			
Cadmium	**20**	**3**	ND
Chromium	<50**	<50**	ND
Copper	**30**	<5	**10**
Lead	**120**	**5**	ND

B-2 (88.7-98.7 ft bgs)		
	3/3/1982	12/1/1982
Metals (Dissolved)		
Cadmium	<10**	**3**
Chromium	<50**	<50**
Copper	**20**	<5
Lead	<50**	**5**

B-5 (15.4-25.4 ft bgs)		
	12/1/1982	9/1/1989
Metals (Dissolved)		
Chromium	<50**	ND
Zinc	<5	**260**

B-3 (14.5-4.5 ft bgs)			
	3/3/1982	12/1/1982	8/1/1989
Metals (Dissolved)			
Cadmium	<10**	**3**	ND
Chromium	<50**	<50**	ND
Copper	**10**	<5	**20**
Lead	<50**	**4**	ND

B-4 (19.5-29.5 ft bgs)		
	3/3/1982	12/1/1982
Metals (Dissolved)		
Cadmium	**20**	**5**
Chromium	<50**	<50**
Lead	**60**	**6**

AMW-19 (14.3-24.3 ft bgs)		
	11/11/2011	1/17/2012
VOCs		
1,2,3-Trichloropropane	< 1**	< 1**
Ethylene dibromide	< 1**	< 1**
Vinyl chloride	< 1**	< 1**
Metals (Dissolved)		
Antimony	**2.9 J**	< 10**
Beryllium	< 5**	< 5**
Cadmium	< 5**	< 5**
Cobalt	**4.9 J**	**3.1 J**
Copper	< 25**	< 25**
Manganese	**2800**	**1700**
Thallium	< 10**	**9.7 J**

AMW-20 (13.5-23.5 ft bgs)		
	11/11/2011	1/17/2012
VOCs		
1,2,3-Trichloropropane	< 1**	< 1**
Ethylene dibromide	< 1**	< 1**
Vinyl chloride	< 1**	< 1**
Metals (Dissolved)		
Antimony	**3.3 J**	< 10**
Beryllium	< 5**	< 5**
Cadmium	< 5**	< 5**
Cobalt	**9.9**	**6.4 J**
Copper	< 25**	< 25**
Manganese	**1900**	**1700**
Thallium	< 10**	**5.9 J**

Location ID (Sample Interval ft bgs)	
Sample Date	
Chemical	Result

Results reported in micrograms per liter (ug/L).

	Class 2B Waters CS	Class 2B Waters MS	Class 2B Waters FAV	MDH Derived Value
VOCs				
1,2,3-Trichloropropane	NS	NS	NS	0.003
Ethylene dibromide	NS	NS	NS	0.004
Vinyl chloride	9.2	None*	None*	0.2
Metals (Dissolved)				
Antimony	31	90	180	6
Beryllium	NS	NS	NS	0.08
Cadmium	2*	65*	130*	4
Chromium	11*	16*	32*	100/20000
Cobalt	5	436	872	30
Copper	14*	31*	62*	1000
Lead	7*	173*	346*	15
Manganese	NS	NS	NS	300
Thallium	0.56	64	128	0.6
Zinc	174*	193*	385*	2000

Shade — Value is above Minnesota Class 2B Water Quality Standard.

Boxed — Value is above the MDH Derived Value

* Standards vary with Total Hardness (TH). A hardness value of 180 mg/l was used to be conservative in calculating these values using MPCA published equations.

** Reporting limit exceeds standard.

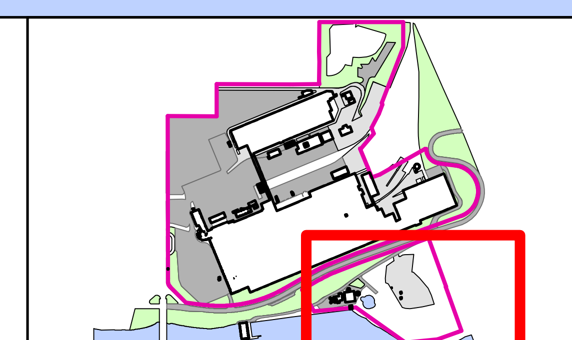
LEGEND:

- Existing Monitoring Well
- Historic Locations
- Abandoned Monitoring Well
- Soil Boring
- Test Pit
- Mississippi River Sampling Location
- Cross Section Location
- Ford Property Boundary
- Fence
- Tunnel 1A
- No Exceedance
- Class 2B Exceedance
- MDH HRL/HBV/RAA and Class 2B Exceedance
- Buildings
- Asphalt
- Concrete
- Grass
- Mississippi River/Retention Pond
- Elevation Contours (Feet Mean Sea Level)
- Approximate Extent of Industrial Waste Fill Inferred from CRA Report, 1990
- Approximate Extent of Industrial Waste Fill Inferred from Ford Report, 1982

NOTES:

AMW	ARCADIS Monitoring Well
<	< Reporting Limit of Lab
ND	Not Detected
NR	Not Reported
NS	No Standard
J	Estimated Result
ft bgs	Feet Below Ground Surface

Topographic survey for Area C completed January 2012, Sunde Land Surveying



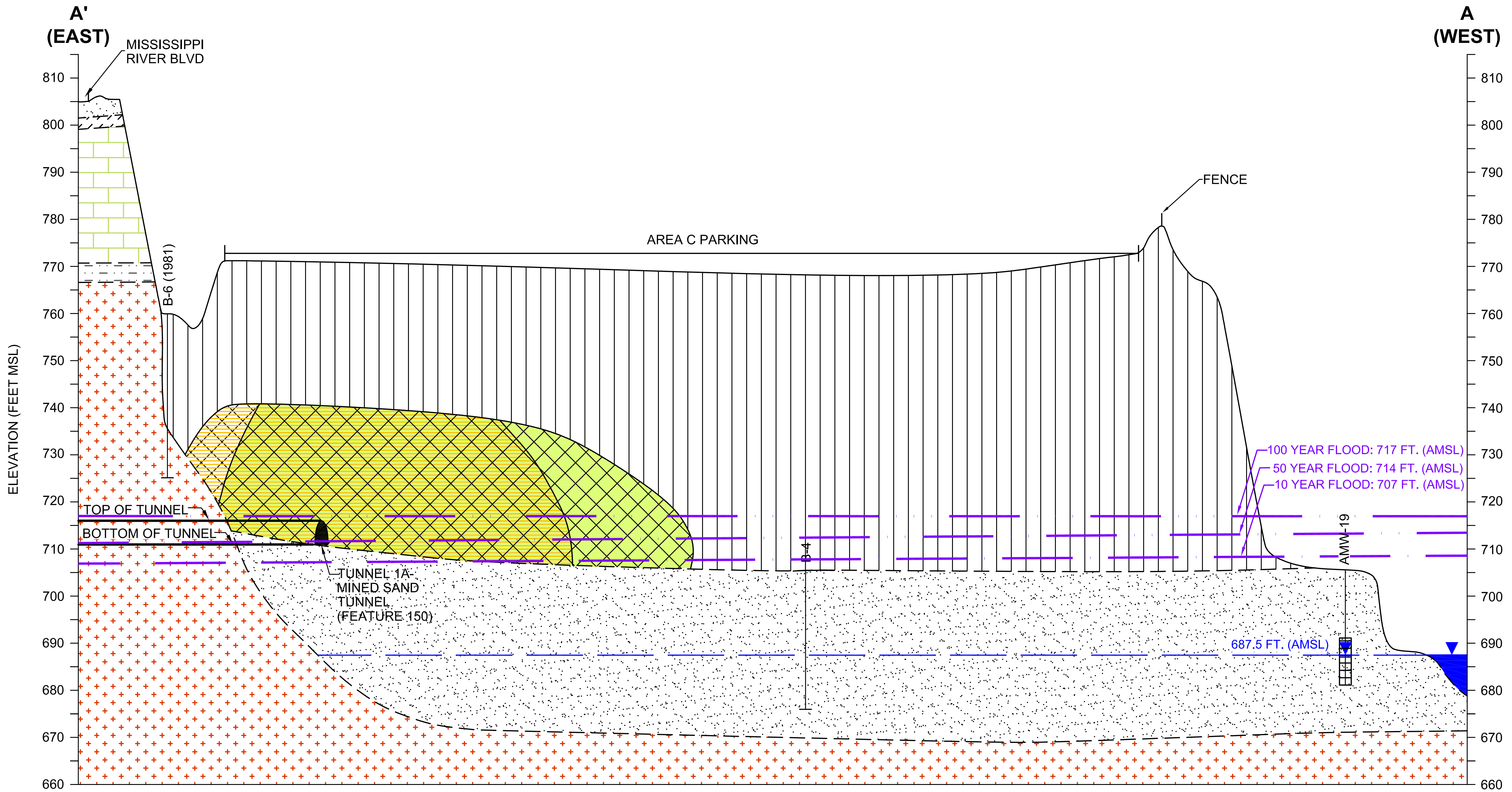
Twin Cities Assembly Plant
Ford Motor Company
St. Paul, Minnesota

Area C - Site Layout Map and Groundwater Exceedences

ARCADIS

FIGURE 2

CITY: MPLS, MN DB: MG LD: RO
FORD ST. PAUL
Path: G:\GIS\Projects\Ford Ranger\ArcMap\2013\2013-04\Area_C_Layout_20130412.mxd



NOTE:

1. AMW–19 ELEVATION AND LAND SURFACE TOPOGRAPHY THROUGHOUT AREA C MEASURED ON JANUARY 17, 2012.
2. MISSISSIPPI RIVER ELEVATION IS APPROXIMATE (BASED ON AVERAGE ANNUAL ELEVATION).
3. GROUNDWATER ELEVATION DATA IS BASED ON 2011/2012 DATA COLLECTED FROM AMW–19/AMW–20.
4. LOCATION B–4 IS A HISTORICAL BORING DRILLED PRIOR TO ADDING FILL IN AREA C.
5. ELEVATION OF TUNNEL BOTTOM IS 711 FT. AMSL. ELEVATION OF TUNNEL ROOF IS 716 FT. AMSL. PROJECTION IS APPROXIMATELY 70 FEET SOUTH OF A–A' SECTION LINE.

LEGEND:

AMW-19 BORING ID
GROUND SURFACE
INFERRED BOUNDARY
GROUNDWATER TABLE
SCREEN INTERVAL
END OF BORING

APPROXIMATE LOCATION OF INDUSTRIAL WASTE FILL INFERRED FROM CRA REPORT, 1990
APPROXIMATE LOCATION OF INDUSTRIAL WASTE FILL INFERRED FROM FORD REPORT, 1982.
CONSTRUCTION DEBRIS FILL
UNCONSOLIDATED/FLOODPLAIN
DECORAH SHALE
PLATTEVILLE LIMESTONE
GLENWOOD SHALE
ST. PETER SANDSTONE

0 25' 50'
VERTICAL SCALE
0 100' 200'
HORIZONTAL SCALE
VERTICAL EXAGGERATION 4X

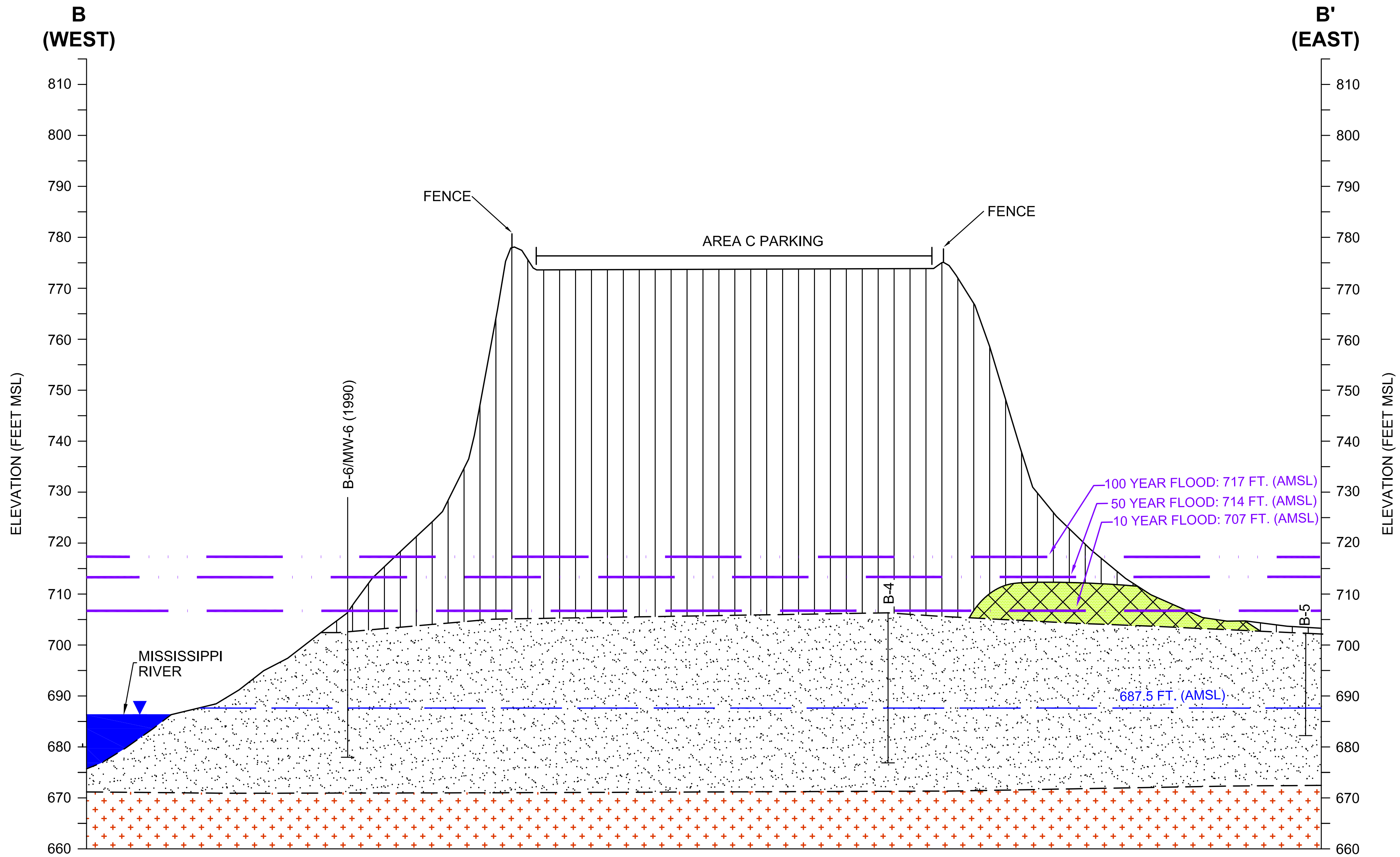
TWIN CITIES ASSEMBLY PLANT
FORD MOTOR COMPANY
ST. PAUL, MINNESOTA

CROSS SECTION A'-A (EAST - WEST)

ARCADIS

FIGURE
3A

CITY:Syracuse DIV/GROUP:EnvCAD DB:A.Schilling, R. BASSETT LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
G:\ENVCAD\SYRACUSE\ACT\DE000440\0001\00002\DWG\00440V01.dwg LAYOUT: 3A SAVED: 3/5/2013 2:36 PM ACADVER: 18.1S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 3/5/2013 2:37 PM BY: BASSETT, RICHARD
XREFS: IMAGES: 00440X02.JPG PROJECTNAME: ---



LEGEND:

B-4	BORING ID
	GROUND SURFACE
	INFERRED BOUNDARY
	GROUNDWATER TABLE
	END OF BORING
	APPROXIMATE LOCATION OF INDUSTRIAL WASTE FILL INFERRED FROM FORD REPORT, 1982
	CONSTRUCTION DEBRIS FILL
	UNCONSOLIDATED/FLOODPLAIN
	ST. PETER SANDSTONE

NOTE:

1. AMW–19 ELEVATION AND LAND SURFACE TOPOGRAPHY THROUGHOUT AREA C MEASURED ON JANUARY 17, 2012.
2. MISSISSIPPI RIVER ELEVATION IS APPROXIMATE (BASED ON AVERAGE ANNUAL ELEVATION).
3. GROUNDWATER ELEVATION DATA IS BASED ON 2011/2012 DATA COLLECTED FROM AMW–19/AMW–20.
4. LOCATION B–4 IS A HISTORICAL BORING DRILLED PRIOR TO ADDING FILL IN AREA C.

0 25' 50'
VERTICAL SCALE
0 100' 200'
HORIZONTAL SCALE
VERTICAL EXAGGERATION 4X

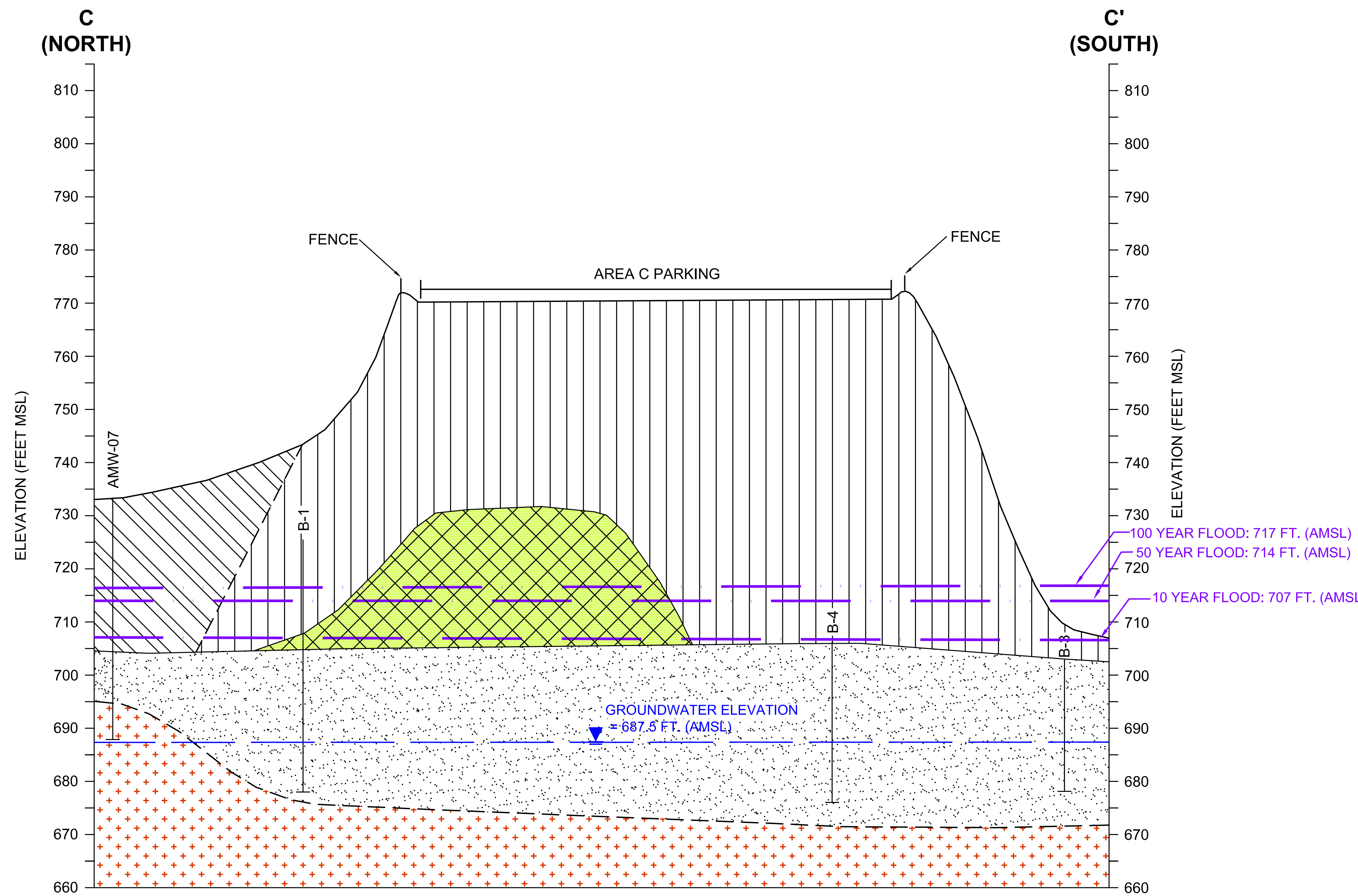
TWIN CITIES ASSEMBLY PLANT
FORD MOTOR COMPANY
ST. PAUL, MINNESOTA

CROSS SECTION B-B' (WEST - EAST)

ARCADIS

FIGURE
3B

CITY:Syracuse DIV/GROUP:EnvCAD DB:A.Schilling, R.BASSETT LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF* G:\ENVCAD\SYRACUSE\ACT\DE000440\0001\00002\DWG\00440V02.dwg LAYOUT: 3B SAVED: 3/5/2013 2:39 PM ACADVER: 18.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 3/5/2013 2:39 PM BY: BASSETT, RICHARD
XREFS: IMAGES: 00440X02.JPG PROJECTNAME: ---



LEGEND:

B-4	BORING ID
	GROUND SURFACE
	INFERRED BOUNDARY
	GROUNDWATER TABLE
	END OF BORING

	APPROXIMATE LOCATION OF INDUSTRIAL WASTE FILL INFERRED FROM FORD REPORT, 1982
	CONSTRUCTION DEBRIS FILL
	SAND AND GRAVEL FILL (WITH BRICK FRAGMENTS)
	UNCONSOLIDATED/FLOODPLAIN
	ST. PETER SANDSTONE

NOTE:

1. AMW–19 ELEVATION AND LAND SURFACE TOPOGRAPHY THROUGHOUT AREA C MEASURED ON JANUARY 17, 2012.
2. GROUNDWATER ELEVATION DATA IS BASED ON 2011/2012 DATA COLLECTED FROM AMW–19/AMW–20.
3. LOCATION B–4 IS A HISTORICAL BORING DRILLED PRIOR TO ADDING FILL IN AREA C.

0 25' 50'
VERTICAL SCALE
0 100' 200'
HORIZONTAL SCALE
VERTICAL EXAGGERATION 4X

TWIN CITIES ASSEMBLY PLANT
FORD MOTOR COMPANY
ST. PAUL, MINNESOTA

CROSS SECTION C-C' (NORTH - SOUTH)

ARCADIS

FIGURE
3C

CITY:Syracuse DIV/GROUP:EnvCAD DB:A.Schilling, R. BASSETT LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
G:\ENVCAD\SYRACUSE\ACT\DE000440\0001\00002\DWG\00440V03.dwg LAYOUT: 3C SAVED: 3/5/2013 2:40 PM ACADVER: 18.1S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 3/5/2013 2:40 PM BY: BASSETT, RICHARD
XREFS: IMAGES: PROJECTNAME: ---
00440X02.JPG

LEGEND:

- Former Drum Location
- Field Observation (2011-2012)
- Ford Property Boundary
- Fence
- Tunnel 1A
- Buildings
- Asphalt
- Concrete
- Grass
- Mississippi River/Retention Pond
- Elevation Contours (Feet Mean Sea Level)

Drum	
Content	Detected Constituents
Date Observed	Date Removed

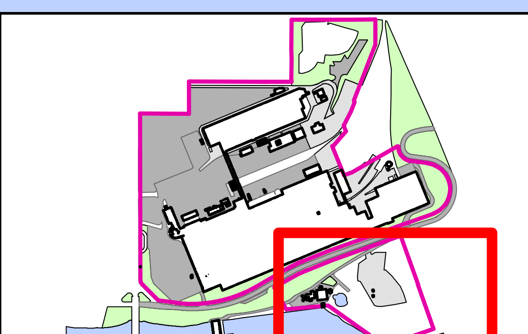
*All detected constituents were detected below Tier I Residential SRV standards.

0 140 280 Feet

1 inch = 140 feet

NOTES:

Topographic survey for Area C completed January 2012, Sunde Land Surveying



Twin Cities Assembly Plant
Ford Motor Company
St. Paul, Minnesota

Area C - Site Reconnaissance (2011-2012)

ARCADIS

FIGURE 4

CITY: MPLS, MN DB: MG LD: RO
FORD ST. PAUL
Path: G:\GIS\Projects\Ford Ranger\ArcMap\2013\2013-04\Area_C_Site_Insp_20130412.mxd

ARCADIS

Appendix A

Historical Documentation and Reports

ARCADIS

Appendix B

Historical Figures

ARCADIS

Appendix C

Area C – Three-Dimensional Model

ARCADIS

Appendix D

2011 Laboratory Analytical Reports

ARCADIS

Appendix E

Site Reconnaissance Photographic Log

ARCADIS

Appendix F

2011 Soil Boring, Well Construction, and Sampling Logs