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RCRA Facility Investigation (RFI) Report

Volume IV –

Culvert 105 and Flood Zone

September 2009 FINAL

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RCRA Facility Investigation Report

Volume IV

Culvert 105 and Flood Zone

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Acronyms, Abbreviations, and Units of Measure

Agencies	NYSDEC and USEPA
AOC	Administrative Order on Consent
BBL	Blasland, Bouck & Lee, Inc.
CMS	Corrective Measures Study
CRA	Conestoga-Rovers & Associates
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
FMC	FMC Corporation
GMX	Geomatrix
GPR	ground penetrating radar
ICM	Interim Corrective Measure
IRM	Interim Remedial Measure
mg/kg	milligrams per kilogram
NYCRR	Compilation of the Rules and Regulations of the State of New York
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OSI	Off-Site Investigation
ppb	parts per billion
ppm	parts per million
R&D	research and development
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SCOs	Soil Cleanup Objectives
SSLs	Soil Screening Levels
TOGS	Technical and Operational Guidance Series
UCL	Upper Confidence Level
ug/kg	micrograms per kilogram
USEPA	United States Environmental Protection Agency

1. Introduction

FMC Corporation (FMC) owns and operates a pesticide formulations facility located in the Village of Middleport and the Town of Royalton, New York (herein the "Facility," "Plant" or "Site"), which has been used for the manufacturing and/or formulation of pesticide products since the 1920s. The location of the Facility is indicated on Figure 1.1.

FMC has been implementing a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) to delineate and evaluate the presence of Site-related constituents in soil, surface water, sediment, soil gas, indoor air and/or groundwater at the Facility and in off-site areas as a result of releases of hazardous waste or hazardous constituents from the Facility into the environment. An additional purpose of the RFI is to gather necessary data to support a Corrective Measures Study (CMS), if one is determined to be necessary. The RFI is one of several related investigative, monitoring, and/or remedial programs being implemented to satisfy the terms and conditions of the Administrative Order on Consent (AOC) [Docket No. II RCRA-90-3008(h)-0209] entered into by FMC, the New York State Department of Environmental Conservation (NYSDEC), and the United States Environmental Protection Agency (USEPA), effective July 2, 1991 (USEPA, NYSDEC, and FMC 1991). The NYSDEC and USEPA are referred to herein collectively as "the Agencies."

1.1 Overview of RFI Report

The RFI sampling and analysis activities were performed in numerous phases at the direction of the Agencies, under the terms and conditions of the AOC. In addition, data generated from relevant investigative and monitoring programs and interim remedial action activities have also been used during performance of the RFI. A Draft RFI Report (Conestoga-Rovers & Associates [CRA] 1997) presenting the RFI sample results was submitted to the Agencies in November 1997, revised based on comments from the Agencies, and then the revised Draft RFI Report was submitted to the Agencies in January 1999 (CRA 1999). FMC subsequently conducted additional investigative and remedial activities that generated data in support of the RFI.

In late 2005, FMC and the Agencies agreed that a revised RFI Report would be prepared to present and summarize the RFI sampling data and results. The Agencies provided FMC with a directive for preparation of the revised RFI Report by letter dated March 10, 2008. The revised RFI Report is organized into the following 11 volumes:

- Volume I — Background and Related Information (ARCADIS and AMEC Geomatrix [AMEC] 2008)
- Volume II — Suspected Air Deposition Study Area 1 (South of the Erie Canal and West of the Niagara/Orleans County Line) and Culvert 105 Study Area South of the Erie Canal (ARCADIS 2009)

- Volume III Former FMC Research and Development (R&D) Property
- Volume IV Culvert 105 and Flood Zone (this volume)
- Volume V Tributary One and Floodplain South of Pearson/Stone Roads
- Volume VI Tributary One and Floodplain North of Pearson/Stone Roads
- Volume VII Jeddo Creek, Johnson Creek, and Floodplains
- Volume VIII Groundwater Investigations and Remediation Results
- Volume IX On-Site Soil, Surface Water, and Sediments
- Volume X Suspected Air Deposition Study Areas North of the Erie Canal and East of the Niagara/Orleans County Line
- Volume ES Comprehensive Executive Summary for all Volumes

RFI Report Volume I (ARCADIS and AMEC 2008) presents detailed information on the RFI study areas, including descriptions of current and historical operations at the Facility, current and historical land use in the area, previous and ongoing environmental investigations and monitoring programs, previous and ongoing remedial activities, regional setting, and the results of Middleport area soil background studies conducted to date.

This document is Volume IV of the RFI Report and presents the RFI soil, sediment, and surface water investigation results for areas along the Village of Middleport's Culvert 105 stormwater conveyance system and its flood zone (referred to herein as "Culvert 105 Study Area"). In the past, Culvert 105 received stormwater from portions of the Plant Site. FMC ceased discharge of stormwater from the Plant Site to Culvert 105 in the mid-1970s. The results of investigations of soil along and above the buried pipe sections of Culvert 105 south of the Erie Canal (also known as Culvert 105 South) are also discussed in RFI Report Volume II (ARCADIS 2009a).

1.2 Scope and Objectives of the RFI in Culvert 105 Study Area

The location of the Culvert 105 Study Area is indicated on Figure 1.1 (colored pink), and the areas that are included within the Culvert 105 Study Area for purposes of the RFI are indicated by pink shading on Figure 1.2. The areas included in the Culvert 105 South Study Area are described in Section 2 of this Volume IV of the RFI Report.

The objectives of the RFI investigations for the Culvert 105 Study Area were to:

- Characterize the nature and extent of Site-related constituents that may be present in soil and sediment within the Culvert 105 Study Area as a result of past stormwater discharges from the Facility.

- Define the horizontal and vertical extent of areas that will be evaluated in a CMS, if determined to be required.

- Provide sufficient data to perform a CMS in accordance with the terms and conditions of the AOC.

To achieve these objectives, FMC used data generated during investigative programs and remedial action activities conducted from 1986 through 2007. Samples collected from the Culvert 105 Study Area were primarily analyzed for arsenic, with some testing for other constituents. The associated sampling and analysis activities are discussed in Section 3 of this Volume IV of the RFI Report. Samples collected from the base of the open ditch sections and within the buried pipe, manholes and catch basins of Culvert 105 were identified as "sediment" during sample collection. As further discussed in Section 6.1, these materials do not meet the regulatory definition of sediment provided in NYSDEC guidance for evaluation of potential ecological impacts. Hence, "sediment" will not be distinguished from soil in this Volume IV of the RFI Report, and samples will be referred to collectively as "soil/sediment."

The Agencies determined (in a letter dated March 10, 2008, with reference to an earlier letter dated September 24, 2007) that "there is currently sufficient data in the above off-site areas [Culvert 105 & flood zone, the portion of Tributary One & flood plain south of Pearson Road, and the off-Site portion of the suspected FMC arsenic air deposition area south of Barge Canal and west of the Niagara/Orleans County Line] to complete RFI characterization and delineation activities with respect to FMC-related soil contamination, and to support the subsequent development of a Corrective Measures Study (CMS) with respect to this soil contamination." FMC agreed (in letter dated March 28, 2008 [FMC 2008]) to:

1) Compare soil arsenic data collected from the three above mentioned study areas to a delineation criterion of 20 parts per million (ppm; equivalent to milligrams per kilogram [mg/kg]), with consideration given to other factors (e.g., historical land use, data variability, wind patterns, ground features and flood zone topography) to delineate potential FMC-related arsenic in soil ("soil arsenic").

2) Prepare and submit this Volume IV of the RFI Report to the Agencies for their review.

In its March 28, 2008 letter, FMC also documented its understanding and the agreement of the Agencies that the soil arsenic "delineation" criterion of 20 mg/kg is not necessarily a "remediation" criterion or standard, and that delineation of soil containing arsenic above 20 mg/kg does not necessarily mean that this soil will be required to be remediated in the future. The need for corrective measures, and the nature and scope of any final corrective measures will be based on the outcome of a CMS.

1.3 Report Organization

The remainder of this Volume IV of the RFI Report is organized as follows:

Section 2 – Description of the Culvert 105 Study Area: Reviews background information for the Culvert 105 Study Area, including a description of the construction, alignment and maintenance of Culvert 105, the location and identification of properties and areas that drain stormwater to Culvert 105, remedial activities and modifications that have been conducted along or upstream of Culvert 105 by FMC, and current and historical land use along Culvert 105.

Section 3 – Review of Sampling and Analysis: Provides a chronological summary of the collection and analysis of the soil, sediment and surface water analytical data collected within the Culvert 105 Study Area.

Section 4 – Presentation of Data Set: Describes the analytical data for the Culvert 105 Study Area, including a description of average or "combined" results and an assessment of the usability of the data.

Section 5 – Discussion of Surface Water Analysis Results: Describes the results of the surface water sampling and analysis efforts within the Culvert 105 Study Area.

Section 6 – Evaluation of Non-Arsenic Constituents in Soil/Sediment: Evaluates the soil/sediment sample data for constituents other than arsenic, including a discussion of background concentrations in soil/sediment, the identification of soil screening values, and a comparison of the soil/sediment data to the soil screening values.

Section 7 – Evaluation of Extent of Arsenic in Soil/Sediment: Discusses the potential non-FMC-related sources of arsenic in soil/sediment, background concentrations of arsenic in soil/sediment, and the spatial and vertical distribution of arsenic in soil/sediment in each reach of the Culvert 105 Study Area.

Section 8 – Proposed Corrective Measures Study Area: Provides the rationale for the proposed extent of the CMS for the Culvert 105 Study Area.

Section 9 – Findings: Summarizes the findings of the investigations and data evaluations described in this Volume IV of the RFI Report.

Section 10 – References: Lists the references cited in this Volume IV of the RFI Report.

2. Description of the Culvert 105 Study Area

This section provides a description of the construction, alignment and maintenance of Culvert 105, a description of the areas from which stormwater drains to Culvert 105, a review of remedial action activities and modifications completed along and upstream of Culvert 105, and a description of current and historical land uses along Culvert 105.

2.1 Description of Construction, Alignment and Maintenance of Culvert 105

Culvert 105 is a municipal stormwater conveyance system (approximately 6,600 feet or 1.25 miles in length) that consists of a combination of buried pipes and open ditches (refer to Figure 2.1). For reference in this Volume IV of the RFI Report, Culvert 105 is divided into four reaches (identified as CS, C1, C2, C3), as shown on Figure 1.2. Photographs of the land along the alignment of Culvert 105 taken in September 2008 are provided in Appendix A (photographs #1 to #18).

Culvert 105 begins at the western end of the North Ditch that runs along the north side of the mainline railroad tracks, north of the Facility (this inlet section was re-configured in 2007 – refer to Section 2.3). From here, the buried pipe extends north through 16 properties, passes under the Erie Canal, and then continues as a buried pipe (prior to implementation of the 2007 Early Action activities, as discussed in Section 2.3, Culvert 105 consisted of both buried pipe and open ditch sections) through 13 other properties until just north of Sleeper Street. North of this location, Culvert 105 is an open ditch (with the exception of three short lengths of buried pipe) that passes through 10 additional properties and then joins Tributary One of Jeddo Creek, north of the Village of Middleport wastewater treatment plant.

The open ditch sections of Culvert 105 (north of Sleeper Street) are approximately 2 to 4 feet in width, and on average 2 to 4 feet deep compared to the adjacent land. These sections pass through wooded and open field areas, with the ditch overgrown with vegetation (refer to photographs in Appendix A). Surface water is intermittently present in the open ditch sections, which receive runoff during and immediately after major rain events and during thaws. Local property owners have reported that the open ditch sections have been periodically cleared of vegetation and/or excavated to improve flow (e.g., the section next to the Village's wastewater treatment plant).

Some local property owners report an understanding that in the early to mid-1900s, Culvert 105 was an open ditch for its entire length, except for the portion that passes beneath the Erie Canal. The open ditch was converted to buried pipe sections over time, with mostly 24-inch to 36-inch diameter sewer pipes of various materials (i.e., tile, metal, plastic, stone, and concrete). Records of the historical (prior to circa 2000) construction of the Culvert 105 storm sewer are not available. Sections constructed of plastic materials (e.g., PVC) were likely installed since the 1960s, when those materials became available (refer to Figures 2.2a and 2.2b). Three sections of open ditch

between the Erie Canal and Sleeper Street were replaced with buried pipe in 2007 (refer to Section 2.3).

In 2004, FMC commissioned a video inspection and mapping of the buried pipe sections of Culvert 105, and also conducted a ground-penetrating radar (GPR) survey and probing effort to attempt to locate sections of the buried pipe that could not be accessed by the video camera. The results of the video inspection activities are presented in a report entitled “Culvert 105 Video Inspection Results” (BBL and GMX 2004a), which was submitted to the Agencies, and is provided in Appendix B of this Volume IV of the RFI Report. Table 2.1 and Figures 2.2a and 2.2b summarize the results of the video inspection, GPR survey, and hand probing efforts regarding the construction and alignment of the buried pipe sections.

Most of the buried pipe sections of Culvert 105 are owned and maintained by the Village of Middleport, and are part of the Village’s storm sewer system. The New York State Canal Corporation owns and maintains the section of Culvert 105 that passes under the Erie Canal. Buried pipe sections have been historically (prior to 2007) cleaned out “on a few occasions” according to representatives of the Canal Corporation and Village officials; records of the clean-outs are not available.

2.2 Review of Stormwater Drainage to Culvert 105

Culvert 105 south of the Erie Canal receives stormwater runoff from private properties (i.e., residential properties, the North Commercial/Industrial Area, and commercial properties), from public streets south of the Erie Canal, east of Main Street and west of Alfred Street, and from the North Ditch. The North Ditch currently receives stormwater from the Roy-Hart School Property, agricultural fields east and northeast of the Facility, Alfred Street, the North Commercial/Industrial Area properties, and any stormwater that falls on the portion of the remediated North Railroad Property (refer to Section 2.3 below) situated north of the mainline railroad track. Following the implementation of the North Railroad Property Phase 1 ICM in 2005, stormwater runoff from the southern portion of the North Railroad Property does not drain to the North Ditch and Culvert 105. In the past, orchards were located within areas that drained to Culvert 105 South, including the Wooded Parcel portion of the North Commercial/Industrial Area and in the current location of the Roy-Hart School Property (refer to Figure 2.5).

North of the Erie Canal, Culvert 105 receives stormwater runoff from residential and commercial properties, vacant land, a park, public streets, and farm fields. In the past, runoff from former orchards, agricultural fields, and a commercial greenhouse operation drained into Culvert 105 north of the Erie Canal (refer to Figure 2.5).

2.3 Review of Remediation/Modification to Culvert 105 Completed by FMC

Prior to the construction of a surface water collection and treatment system in 1976-1977, stormwater runoff from a portion of the Plant Site discharged to the drainage ditches (North Ditch and South Ditch, collectively the "Northern Ditches") that ran along the north and south sides of the mainline railroad tracks, respectively, north of the Plant Site. These ditches emptied into Culvert 105 (refer to Figure I2.9 of RFI Report Volume I).

In 1976, FMC re-graded the Plant Site to segregate surface runoff from the north side of the Plant Site, where manufacturing and formulation activities had continued to be conducted, from the south side, and ceased discharge of stormwater runoff to the Northern Ditches. Surface water runoff from the north side of the Plant Site was collected in the lined Western Surface Impoundment, or WSI, prior to treatment at the on-Site Water Treatment Plant, and then discharged to Tributary One under the terms of a pollutant discharge elimination system permit (initially a NPDES permit, but later a State Pollutant Discharge Elimination System, or SPDES permit). Two additional surface water impoundments, the Central Surface Impoundment (CSI) and the Eastern Surface Impoundment (ESI), were constructed in 1978 to provide retention capability and to control the flow of surface water runoff to the WSI.

In 1987-1988, FMC constructed an engineered clay and asphalt cover (North Site Cover) over the open areas of the northern portion of the Facility, installed sub-drain collection systems, discontinued use of the CSI and ESI, and conducted other pre-closure activities (refer to Section 4.2 of RFI Report Volume I for a detailed description of these activities) that further reduced the potential for any migration of contaminated surface water runoff from the Facility to the Northern Ditches and the Culvert 105 storm sewer drainage system.

FMC has conducted three remedial actions involving Culvert 105 and/or the North Ditch immediately upstream of the inlet of Culvert 105, as follows:

- 1987-1988 Northern Ditches Interim Remedial Measure [IRM] (CRA 1988)
- 2005 Phase 1 North Railroad Interim Corrective Measure [ICM] (BBL 2006)
- 2007 Early Action (ARCADIS 2009)

In 1987-1988, FMC performed the Northern Ditches Restoration IRM program to address elevated arsenic concentrations in surface soil/sediment within the invert of the Northern Ditches. Approximately 8 to 12 inches of soil/sediment was removed from the invert of the Northern Ditches, a geotextile liner was installed, and clay and stone were placed on top of the geotextile liner. Refer to Section 4.6.1 and Figure I4.4 of RFI Report Volume I for additional information on the Northern Ditches Restoration IRM.

In 2005, FMC completed the Phase 1 ICM project for the North Railroad Property. The work activities included the excavation of soils, the regrading and re-direction of drainage areas to the Culvert 105 inlet, and the construction of an engineered cover system over the Phase 1 ICM area. Following completion of this work, only water collected within the North Ditch portion of the North Railroad Property drains to Culvert 105. Refer to Section 4.6.4 and Figure I4.5 of RFI Report Volume I for additional information on the North Railroad Property Phase 1 ICM.

In 2007, as part of the remedial work under the 2007 Early Action activities, FMC performed the following work relative to Culvert 105 between the North Ditch and Sleeper Street (refer to Figure 2.3 for work locations):

- Abandonment of a section of Culvert 105 on the Wooded Parcel portion of the North Commercial/Industrial Area, extension of the North Ditch and installation of a new inlet section of Culvert 105 from the North Ditch, as extended, to a point approximately 5 feet from catch basin CB-6, including replacement of catch basin CB-2
- Excavation of a minimum of 24 inches of soil at the Wooded Parcel and replacement with clean backfill, including excavation of 48 inches of soil from an approximately 20-foot wide strip along the southern and eastern property lines of the Wooded Parcel
- Removal and disposal of soil/sediment within manholes and catch basins of Culvert 105 south of the Erie Canal
- Flushing of the Culvert 105 buried pipe sections north of the Erie Canal to Sleeper Street and removal of soil/sediment from these sections
- Excavation of 12 to 24 inches of soil/sediment from and along the three existing open ditch sections of Culvert 105 between the Erie Canal and Sleeper Street (refer to photographs #19 to #22 in Appendix A)
- Installation of new buried storm sewer pipes and manholes to replace the three open ditch sections between the Erie Canal and Sleeper Street, with clean backfill approved by the Agencies placed over the buried pipes (resulting in no open ditch sections remaining south of Sleeper Street)

Section 4.11 of RFI Report Volume I presents additional information on the 2007 Early Action activities.

2.4 Current and Historical Land Uses

The municipal zoning of land in the Culvert 105 Study Area is shown on Figure 2.4, based on the zoning maps for the Village of Middleport, Town of Royalton and Town of Hartland, as updated through December 2008.

Historical uses of land in the Culvert 105 Study Area are shown on Figure 2.5, based on information obtained from fire insurance maps and aerial photographs (provided in Appendix 2E of RFI Report Volume I). Historical commercial land uses of note along Culvert 105 included the former Niagara Sprayer facility, Norco Corporation (metal fabrication), and American Sigma (pump manufacturer) in the North Commercial/Industrial Area, orchards at the Wooded Parcel and adjoining land to the east, lumber yards between State Street and the Erie Canal (the preceding uses all in Reach CS), the former Gould florist and greenhouses south of Sleeper Street (in Reach C1), and several orchards extending between Sleeper Street and the Village's wastewater treatment plant (in Reaches C2 and C3).

3. Review of Sampling and Analysis

A chronology of the sampling and analysis programs conducted in the Culvert 105 Study Area is presented in Table 3.1, including a summary of the analyses conducted in each program for soil, sediment and surface water samples. The sampling and analysis activities conducted within the Culvert 105 Study Area have included the following efforts:

- 1986 NYSDEC Investigation
- 1990-1993 Off-Site Investigation (OSI)
- 2002 RFI Sampling Program
- 2004 RFI Sampling Program for Tributary One & Culvert 105 – Phase I
- 2004 RFI Sampling Program for Tributary One & Culvert 105 – Phase II
- 2005 RFI Sampling Program for Tributary One & Culvert 105 – Phase III
- 2004-2005 RFI Air Deposition Study Area Sampling (for properties south of the Erie Canal within the Culvert 105 Study Area)
- 2007 Early Action Sampling

Figure 3.1 depicts the locations and identification of the 39 properties where samples were collected within the Culvert 105 Study Area (either for the Culvert 105 study or the Air Deposition study) and the two properties (AE2, AK1) where samples were not collected during the 2004 and 2005 RFI Culvert 105 sampling events because access permission could not be obtained. Sampling locations are shown on Figures 3.2 through 3.6, organized by reach of the Culvert 105 Study Area.

The analytical data from these programs are tabulated in Appendix C for arsenic in soil/sediment samples (organized by reach) and in Appendix D for all other constituents in soil/sediment samples and for arsenic and all other constituents in surface water. As referenced in Sections 3.2 to 3.4 of this Volume IV of the RFI Report, descriptions of sample collection and validation of the analytical results for samples collected from 1986 through 2002 were previously presented in reports submitted to the Agencies. A comparable description for samples collected from 2004 through 2007 is provided in Sections 3.5 to 3.9 of this Volume IV of the RFI Report (validated results were previously provided to the Agencies).

3.1 FMC Master Compound List and Site-Specific Parameter Lists

A list of materials used and/or produced at the Facility prior to 1988, including known degradation products and impurities, is presented in a document titled “Master Compound List and Various Related Lists for Environmental Studies, FMC Corporation, Middleport, New York,” dated December 19, 1988 (hereafter called the Master Compound List) (FMC 1988). The Master Compound List was submitted to the NYSDEC in December 1988

together with site specific parameter lists for sampling program purposes and was included for reference in Appendix 2A of RFI Report Volume I.

From 1990 to 1993, FMC conducted an investigation of specific off-Site areas located around the Facility (Off-Site Investigation or OSI), including the Culvert 105 Study Area, under an administrative consent order with the NYSDEC (NYSDEC and FMC 1990). Soil, sediment and surface water samples were analyzed for constituents on the "Off-Site Parameter List" (provided for reference as Table 3.2 of this Volume IV of the RFI Report), which was developed as a sub-set of the Master Compound List based on criteria that included the quantity of a compound handled at the Facility, and its persistence and mobility in the environment. The list of 52 compounds on the Off-Site Parameter List included arsenic, lead, other metals, chlorinated pesticides, chlorinated herbicides, organophosphate pesticides, phenolic compounds, furans and methyl carbamates.

Compounds detected in soil, sediment and/or surface water samples collected within the Culvert 105 Study Area during the OSI included arsenic, lead and five chlorinated pesticide constituents, as well as other metals at levels consistent with background levels. The constituent that was most frequently detected was arsenic. To a lesser extent, lead and some chlorinated pesticides were also detected. The OSI sampling and analysis within the Culvert 105 Study Area are discussed in more detail in Section 3.3.

Based on the results of the OSI, investigations of soil/sediment within the Culvert 105 Study Area subsequent to the OSI focused on the delineation of the horizontal and vertical extent of total arsenic within the study area. Some soil/sediment samples were also tested for lead and Site-related chlorinated pesticides. The results of these analyses are included in this Volume IV of the RFI Report.

3.2 1986 NYSDEC Investigation

The Niagara County Health Department collected soil/sediment samples from the 0- to 6-inch depth interval at four locations along Culvert 105 open ditch sections north of the Erie Canal in 1986. These samples were analyzed by the NYSDOH for arsenic, lead, chlorinated pesticides, manganese and zinc. The results were provided in the NYSDEC report titled "Surface and Subsurface Soil/Sediment Investigations at Royalton-Hartland Schoolyard, Jeddo Creek, Culvert 105 Extension" (NYSDEC 1987). Sampling locations associated with this event are identified as "DEC-26" to "DEC-29" on Figures 3.4 (Reach C1) and 3.5 (Reach C2).

Soil/sediment corresponding to sampling locations DEC-26, DEC-27, and DEC-28 in Reach C1 was excavated and replaced with clean backfill during the 2007 Early Action activities.

3.3 1990-1993 Off-Site Investigation

Soil/sediment samples were collected at the 0- to 6-inch and 6- to 12-inch depth intervals at each of four locations along Culvert 105 open ditch sections north of the Erie Canal as part of the OSI in 1990. These samples were analyzed for constituents on the "Off-Site Investigation Parameter List" (Table 3.2 of this Volume IV of the RFI Report), including arsenic, lead, ten other metals, chlorinated pesticides, chlorinated herbicides, organophosphate pesticides, phenolic compounds, furans and methyl carbamates. In addition, surface water samples were collected at three of these same four locations (the fourth [C7] was dry and could not be sampled) and analyzed for the same constituents as the soil/sediment samples. The results are presented in the "Off-Site Investigation Report" (OSI Report) (CRA 1993). Sampling locations associated with this event are identified as "C4" to "C7" on Figures 3.4 to 3.6. Soil/sediment corresponding to four of the eight samples (all in Reach C1) was excavated and replaced with clean backfill during the 2007 Early Action activities.

3.4 2002 RFI Sampling Program

In 2002, in accordance with an approved work plan, FMC collected soil/sediment samples from boreholes installed along 10 transects across Culvert 105 north of the Erie Canal. A total of 220 soil/sediment samples were collected from 70 locations on 14 properties and analyzed for arsenic, including samples from the 0- to 3-inch, 3- to 6-inch, and 6- to 12-inch depth intervals at each location, and from the 12- to 18-inch depth interval at 10 of the locations. In addition, 12 of the samples were analyzed for lead and seven were analyzed for chlorinated pesticides. The data were presented in the report titled "Draft 2002 Sampling Program Report" (CRA and GMX 2003a). The sampling locations are identified as "C#S," "C#W#," or "C#E#" on Figures 3.4 to 3.6. Soil/sediment in Reach CS and Reach C1 corresponding to 70 of the 220 samples was excavated and replaced with clean backfill during the 2007 Early Action activities.

3.5 2004 RFI Sampling Program for Tributary One & Culvert 105 – Phase I

By letter dated November 14, 2003 the Agencies approved the sampling and analysis portions of the October 2003 document titled "Tributary One South of Pearson/Stone Roads & Culvert 105 North of the Erie Canal RFI/CMS Work Plan" (CRA and GMX 2003b), and directed FMC to implement the approved work. Implementation of the approved work began in December 2003, with sample collection conducted in March and April 2004.

A total of 489 soil/sediment samples were collected at 102 locations on 20 properties within the Culvert 105 Study Area north of the Erie Canal and analyzed for arsenic. The sampling locations were oriented along 16 transects across Culvert 105 and at 21 "remote borehole" locations beyond the transects in Reach C1. The boring log information is summarized in Appendix E. The validated data were provided to the Agencies on June

22, 2004 and July 8, 2004, and were approved by the Agencies on October 27, 2004. Soil/sediment corresponding to 32 of the 489 samples was excavated and replaced with clean backfill as part of the 2007 Early Action activities.

By cover letter dated March 9, 2004 FMC submitted to the Agencies Addendum No. 1 to the RFI/CMS Work Plan (GMX 2004), which proposed additional evaluation of Culvert 105. By letter dated March 29, 2004 the Agencies approved specific pre-sampling inspections and survey portions identified in Addendum No.1 and directed FMC to implement the approved portions. The findings of this work were documented in the Culvert 105 Video Inspection Results report.

In April 2004 a video inspection was conducted of buried pipe sections of the Culvert 105 storm sewer beginning at the inlet on the Wooded Parcel and extending downstream to just north of Sleeper Street (excludes three open ditch sections between the Erie Canal and Sleeper Street that existed at that time). The video camera was used to visually record the construction (e.g., material, diameter) and condition of the buried pipe, and was also equipped with a locating device to identify the alignment of the buried pipe. Some of the buried pipe sections could not be recorded due to obstructions or access limitations. The findings of the survey are summarized in Table 2.1 and on Figures 2.2a and 2.2b for buried pipe sections south and north of the Erie Canal, respectively. A copy of the video inspection report is provided in Appendix B.

3.6 2004 RFI Sampling Program for Tributary One & Culvert 105 – Phase II

Based on the preliminary findings of the investigation activities conducted through May 2004, FMC submitted Addendum No. 2 to the RFI/CMS Work Plan (BBL and GMX 2004b) to the Agencies. This Addendum proposed additional sampling and analysis intended to:

- Collect soil samples for arsenic analysis outward from previously sampled locations along transects north of the Erie Canal.
- Where possible, collect soil samples for arsenic analysis near previously proposed sample locations where access permission was not granted.
- Evaluate soil adjoining the buried pipe sections south of the Erie Canal.

As part of development of this sampling plan, additional attempts were made to identify the location and alignment of buried pipe sections of Culvert 105 that were not ascertained by the video inspection, using ground penetrating radar (GPR) and probing with hand tools. Some sections of the buried storm sewer pipe could still not be located. The approximate depth of the buried pipe in several locations, as identified by this effort, is shown on Figure 2.2a.

South of the Erie Canal, soil samples were collected from boreholes on 1- to 2-foot centers along six transects (identified as “CS1” to “CS6”) across the buried pipe sections of Culvert 105. Soil/sediment samples were collected from five manholes or catch basins within Culvert 105, and samples of soil/sediment (1 sample) within the pipe and soil beneath the pipe (2 samples) were collected at the location of a break in the pipe on property J4, as described in Addendum No. 2 to the RFI/CMS Work Plan (BBL and GMX 2004b). North of the Erie Canal, additional boreholes were extended outward on approximate 20-foot centers along 10 prior transects. The boring log information is summarized in Appendix E.

A total of 384 samples collected at 81 locations on 18 properties were analyzed for arsenic, with eight of the samples also analyzed for chlorinated pesticides. The validated data were provided to the Agencies on July 12, 2005, and were approved by the Agencies on August 25, 2005. Soil/sediment corresponding to 13 of these 384 samples was excavated and replaced with clean fill as part of the 2007 Early Action activities, and soil/sediment corresponding to 6 samples of soil/sediment collected within the buried pipe, catch basins, and manholes was removed during the repair of the pipe in 2004 (soil adjacent to the pipe was returned to its trench during the repair) or during the 2007 Early Action activities.

3.7 2005 RFI Sampling Program for Tributary One & Culvert 105 – Phase III

By letter dated September 21, 2005 the Agencies determined that additional investigation was needed along some of the transects north of Sleeper Street, outward from the culvert, and requested additional sampling and analysis. By cover letter dated October 27, 2005, FMC submitted Addendum No. 3 to the RFI/CMS Work Plan (BBL 2005) to the Agencies. By letter dated November 2, 2005 the Agencies approved Addendum No. 3, and directed FMC to implement the approved work. Implementation of the approved work began in November 2005, with sample collection conducted in November and December 2005.

Soil samples were collected from 56 locations on an approximate 100-foot grid across portions of properties AD1, AD2, AD3, AE1, AE3, and AF1, and from three additional locations along transect C8.5. Samples were collected at the 0- to 3-inch, 3- to 6-inch, 6- to 12-inch, 12- to 18-inch, and 18- to 24-inch depth intervals. The boring log information is summarized in Appendix E. A total of 293 samples were collected and analyzed for arsenic, with 69 of the samples also analyzed for lead and for chlorinated pesticides. The validated data were provided to the Agencies on March 9, 2006, and were approved by the Agencies on May 31, 2006.

3.8 2004-2005 RFI Air Deposition Study Area Sampling

South of the Erie Canal, the Culvert 105 buried pipe sections pass through 16 properties. The top of the pipe is buried between approximately 10 to 30 inches below grade as it

passes through these properties. Samples of the upper 12 inches of soil (from surface grade) were collected at 14 of these properties for arsenic analysis during the RFI sampling program for the Air Deposition Study Area in 2004-2005, with additional samples collected at some of the properties during earlier sampling efforts. A detailed description of these sampling and analysis efforts is presented in RFI Report Volume II. For reference, the soil sampling locations and arsenic analytical results for samples collected at the properties situated along Culvert 105 within the Air Deposition Study Area (south of the Erie Canal) are provided on Figure 3.3a for samples collected in the 0- to 12-inch depth intervals and on Figure 3.3b for samples collected deeper than 12 inches below grade.

3.9 2007 Early Action Sampling

In 2007, additional soil samples were collected along the open ditch sections of Culvert 105 between the Erie Canal and Sleeper Street to further define the areas and depths of soil/sediment to be excavated as part of the 2007 Early Actions. A total of 47 soil samples were collected at 12 locations on four properties and analyzed for arsenic. The boring log information is summarized in Appendix E. The validated data were provided to the Agencies on July 11, 2007 and August 24, 2007, and were approved by the Agencies based on conditional approval of the “2007 Early Action Work Plan” (ARCADIS BBL 2007) on September 5, 2007. Soil corresponding to 10 of the 47 samples was excavated and replaced with clean backfill as part of the 2007 Early Action activities. The extent of excavation conducted in Reach C1 during the 2007 Early Action activities is shown on Figure 3.4.

4. Presentation of Data Set

From 1986 through 2007, a total of 1,445 "combined" (refer to Section 4.1 below for explanation of the term "combined") analytical results were obtained for arsenic in soil/sediment samples collected by FMC and/or the Agencies (in some cases both FMC and the Agencies sampled the same location) within the Culvert 105 Study Area. Duplicates and/or split samples were analyzed for approximately 5% of these samples for quality assurance/quality control (QA/QC) purposes. Sub-sets of the samples were analyzed for lead, chlorinated pesticides, other metals, chlorinated herbicides, organophosphate pesticides, phenolic compounds, furans and methyl carbamates.

Table 4.1 summarizes the number of primary, split and duplicate soil/sediment samples collected by FMC and the Agencies within the Culvert 105 Study Area and analyzed for each group of constituents. Table 4.1 also indicates the number of samples in each category corresponding to soil/sediment that was subsequently excavated or removed and to soil/sediment that remains in the Culvert 105 Study Area. Table 4.2 summarizes the number of primary, split and duplicate soil/sediment samples collected by FMC and the Agencies and analyzed for arsenic during each sampling program. Table D.3 presents the analytical results that were obtained for three unfiltered surface water samples collected from Culvert 105 north of the Erie Canal during the OSI in 1990.

This section discusses the preparation of the data set and an evaluation of the usability of the data set.

4.1 Combined Results

In this and other volumes of the RFI Report, analytical results for soil/sediment samples at a given unique sampling location and depth interval with more than one primary result (e.g., splits, duplicates) were combined to produce a single "combined" result for that sampling location/depth interval. The approach used to present the data and produce the combined results is as follows:

- If a single analytical result was present for a sampling location/depth interval, that value was used as the combined result.
- If multiple analytical results (e.g., splits, duplicates) were reported for a sampling location/depth interval, the arithmetic average of all results for that sample was used as the combined result.
- If an analytical result was reported as not detected (ND), then a value of one-half the reported laboratory detection limit was used as the combined result.
- For the few cases where a sampling location/depth interval was later re-sampled, the later results were treated as a separate sample, except as described in specific cases presented in Section 4.2.

4.2 Usability of Data

All of the soil/sediment and surface water analytical data for the Culvert 105 Study Area are acceptable to use for the purpose of evaluating the nature and extent of constituents, with the following limitations:

1. The arsenic soil/sediment analytical results reported for five samples (0- to 3-inch, 3- to 6-inch, 6- to 12-inch, 12- to 18-inch and 18- to 24-inch depth intervals) collected at location C8.5W4 on December 12, 2005 are used in place of results for samples collected at the same location and depth intervals on October 27, 2004. The basis for this treatment of the data is that three of the 2004 results were reported as non-detect and were considered suspect. Addendum No. 3 (BBL 2005) to the RFI/CMS Work Plan specified the collection of soil samples next to the 2004 location of C8.5W4. The 2005 sampling results for this location consisted of detectable levels of arsenic (ranging from 2.4 to 17.5 mg/kg) identified in each sample.

2. The result reported for beta-BHC in soil/sediment sample C-6 (0- to 6-inch interval, collected during the OSI in 1990) is used in the evaluation of constituents presented in Section 6 of this Volume IV of the RFI Report, but is considered suspect for the following reasons:

    - Sample C-6 (0- to 6-inch) was reported in Table 5.20 of the OSI Report (CRA 1993) to contain beta-BHC at a concentration of 51 mg/kg, and no detectable levels of the other three (alpha, delta, gamma) target BHC isomers, with a reporting limit three orders of magnitude lower (0.02 mg/kg).
    - Elevated levels of beta-BHC are not expected to be found in the absence of other isomers because technical-grade BHC contains a mixture of isomers, with a composition of approximately 5 to 12% beta-BHC, 10 to 15% gamma-BHC, 60 to 70% alpha-BHC, and the balance as other isomers (Agency for Toxic Substances and Disease Registry [ATSDR] 2005).
    - Upstream, downstream, and other nearby samples do not exhibit elevated levels of beta-BHC, including sample C-6 (6- to 12-inch interval), with no detectable levels at a reporting limit of 0.083 mg/kg. A total of 82 other soil/sediment samples were analyzed for beta-BHC, and the next highest reported concentration was 0.14 mg/kg, approximately 360 times lower than the value reported for sample C-6 (0- to 6-inch).

3. The surface water analytical results for samples collected during the OSI are considered upper limits of the actual amount of each constituent dissolved in the surface water because the samples were reported to be turbid, and hence are likely to have included constituents adsorbed to suspended particles in the samples and

not actually dissolved in the water (refer to discussion in Section 5 of this Volume IV of the RFI Report).

4. Soil/sediment corresponding to six locations where samples were collected within the Culvert 105 buried pipe, manholes, or catch basins was subsequently removed during either the repair of the break in the pipe in 2004 or pipe flushing as part of the 2007 Early Action activities. The data for these samples are valid and usable, but are not representative of current conditions.

5. Soil/sediment corresponding to 132 other locations/depths where samples were collected within Reach CS or Reach C1 was subsequently excavated during implementation of the 2007 Early Action removal activities (discussed in Section 2.3) and replaced with clean backfill with arsenic concentrations ranging from 2.6 to 10.5 mg/kg (refer to Table C.5 in Appendix C). The data for these samples are valid and usable, but are not representative of current conditions.

5. Discussion of Surface Water Analysis Results

Surface water is intermittently present in the open ditch sections of Culvert 105, which receive runoff during and immediately after major rain events and during thaws. During the OSI, surface water samples were collected at three of four soil/sediment sampling locations (identified as “C4” to “C7” on Figures 3.4 to 3.6) along open ditch sections of Culvert 105 north of the Erie Canal in August and November 1990. The fourth location (C7) could not be sampled because it was dry. These samples were analyzed for the same constituents as the soil/sediment samples, including the constituents on the Off-Site Investigation Parameter List (refer to Table 3.2). The results were presented in the OSI Report, and are summarized in Table D.3 of Appendix D of this Volume IV of the RFI Report.

Eight metals (arsenic, lead, aluminum, copper, iron, manganese, sodium, and zinc) and the chlorinated pesticide constituent beta-BHC were the only compounds identified at detectable levels in the surface water samples. Metals occur naturally in surface water as well as in soil, and were identified in background samples collected from nearby surface waters during the OSI. The detectable surface water results for Culvert 105 are compared in Table D.3 to the NYS Class D surface water quality standards and guidance values provided in 6NYCRR Part 703 and in the NYSDEC Division of Water Technical and Operational Guidance Series (TOGS) 1.1.1, and where no value is available, the maximum concentration observed in the background samples of Tributary One or Jeddo Creek during the OSI.

The concentrations of arsenic in the surface water samples were less than the applicable surface water quality screening value in all three samples, including samples that were noted to be turbid. Hence, even in areas where elevated arsenic levels are found in soil/sediment within the invert of open ditch sections of Culvert 105, no significant adverse impact to surface water was identified in the same location. This finding also applies for dieldrin and other chlorinated pesticide constituents (except for one suspect measurement of beta-BHC discussed below).

The concentrations of the other eight compounds (seven metals and beta-BHC) detected in samples C5 and/or C6 exceeded either the Class D Surface Water Quality Standard, where available, or the maximum concentration in the background samples. However, the Surface Water Quality Standards for arsenic, lead, and several other metals apply to dissolved, not total concentrations. Samples C5 and C6 were noted during sampling to be turbid, and hence likely reflect the presence of constituents adsorbed to suspended particles in the samples, rather than concentrations dissolved in surface water (refer to p. 57 of the OSI Report). The concentration of each constituent in sample C4, which was not noted to be turbid, was lower than in samples C5 and C6. Metals and chlorinated pesticides exhibit low solubility in water and a high affinity to adsorb to particles.

6. Evaluation of Non-Arsenic Constituents in Soil/Sediment

This section presents and evaluates the analytical data for constituents other than arsenic that are potentially FMC-related in soil and sediment samples collected within the Culvert 105 Study Area. The data are compared to background concentrations of metals in soil in the Middleport area, to the soil screening levels (SSLs) previously presented in the 1999 Draft RFI Report (CRA 1999a), and to the NYSDEC Soil Cleanup Objectives (SCOs) identified in 6 NYCRR Subpart 375-6.8(b).

6.1 Applicability of Ecological-Based Sediment Criteria

According to the NYSDEC "Technical Guidance for Screening Contaminated Sediment" (NYSDEC 1999), "sediments can be loosely defined as a collection of fine-, medium-, and coarse-grain minerals and organic particles that are found at the bottom of lakes [and ponds], rivers [and streams], bays, estuaries, and oceans. Sediments are essential components of aquatic [and marine] ecosystems. They provide habitat for a wide variety of benthic organisms as well as juvenile forms of pelagic organisms."

Samples collected within the open ditch sections of Culvert 105 were referred to as "sediment" in the 1986 DEC, 1993 OSI and 2002 RFI reports discussed in Sections 3.2 to 3.4 of this Volume IV of the RFI Report. In addition, samples were collected of the accumulated "sediment" material within the Culvert 105 buried pipe sections, manholes and catch basins in 2004. Notwithstanding, as discussed in the 1999 Draft RFI Report (CRA 1999), neither the samples from the open ditch sections nor those from the culvert structures meet the regulatory definition of sediment provided in the NYSDEC guidance for evaluation of potential ecological impacts, and will not be described as such in this Volume IV of the RFI Report for the following reasons:

- Culvert 105 is a man-made drainage ditch comprising a combination of buried sewer pipes and open ditch sections that intermittently contain water during and following precipitation events and thaws.
- Neither federal nor New York State agencies have identified a wetland area or a habitat belonging to a species of special environmental concern along Culvert 105.

Sediment may be present in the area where Culvert 105 discharges to Tributary One (i.e., downstream of sample location C7 on Figure 3.6), and is addressed in RFI Report Volume V – Tributary One and Flood Plain South of Pearson/Stone Roads. Because the samples were previously referred to as sediment as a descriptor, all soil and sediment samples collected in the Culvert 105 Study Area are referred to collectively in this Volume IV of the RFI Report as "soil/sediment" samples. For purposes of comparison to regulatory screening criteria, all soil/sediment samples in the Culvert 105 Study Area are

treated as soil and not "sediment" (as defined in the NYSDEC "Technical Guidance for Screening Contaminated Sediment" [NYSDEC 1999]) in this Volume IV of the RFI Report.

6.2 Background Levels of Metals in Soil/Sediment

Metals are present in soil/sediment in the Culvert 105 Study Area as a result of both natural conditions and a range of anthropogenic sources, such as the use of lead-based paint, use of coal and depositing of coal ash, disposal of household wastes, use of pesticides and fertilizers, vehicle exhaust emissions, the use of fill of unknown origin for excavation projects and grading, and possible releases from the Facility.

Sampling programs have been conducted by FMC and the Agencies to evaluate background concentrations of arsenic from natural and non-FMC-related anthropogenic sources in soil in the Middleport area (refer to discussion in Section 7.2). During these studies, soil samples were tested for other metals on the Off-Site Parameter List (Table 3.2) as well as other metals. Table 6.1 provides the combined results for each metal in 13 soil samples collected at 11 locations between 1985 to 1993, where the locations were identified by the Agencies in a letter to FMC dated January 24, 1996 (Agencies 1996). More comprehensive studies of the background arsenic soil concentrations were later conducted (refer to Section 7.2), but did not include analysis for other metals. The 11 sampling locations are variously located approximately 0.5 to 2.0 miles east of the Facility and approximately 2.5 to 5.0 miles west of the Facility (refer to Figure 6.1a).

6.3 Soil Screening Values

In 1996, the USEPA published a document entitled "USEPA Soil Screening Guidance: Technical Background Document," which included Soil Screening Levels (SSLs) for some constituents and a health-based methodology for determining SSLs for other constituents. For each constituent, there is a SSL for residential property and a SSL for industrial property. SSLs applicable to FMC-related constituents were used in comparison to site data to develop soil sampling programs, and were presented in the 1999 Draft RFI Report (CRA 1999a).

In 2006, the NYSDEC promulgated regulations which included Soil Cleanup Objectives (SCOs) for a wide variety of constituents, with each constituent having a number of SCOs in consideration of property type/usage. The SCOs were developed from ecological and human health-based criteria, and in some cases, from a state-wide background database. The Agencies have indicated that the SCOs, presented in 6 NYCRR Subpart 375-6.8(b) of the NYSDEC regulations, are appropriate for use as comparison criteria in the RFI for the non-arsenic constituents.

The residential and industrial SSL and SCO values applicable to this Volume IV of the RFI Report are provided in Tables 6.2a and 6.2b, respectively.

6.4 Comparison to the SSLs and SCOs

None of the concentrations of any of the non-arsenic constituents in any of the soil/sediment samples collected in the Culvert 105 Study Area are greater than the respective industrial SSL or industrial SCO (refer to tables in Appendix D), with the exception of the one suspect result for beta-BHC. Therefore, the following discussion of the non-arsenic analytical data is limited to a comparison of data to the residential SSLs and residential SCOs. A comparison of the non-arsenic analytical data is provided in Table 6.3 for the residential SSLs and in Table 6.4 for the residential SCOs. The following sections provide a discussion of the non-arsenic soil/sediment analytical data compared to the soil screening values.

6.4.1 Chlorinated Pesticides

A total of 84 soil/sediment samples collected within the Culvert 105 Study Area were analyzed for chlorinated pesticides (refer to Table D.1 in Appendix D). By reach, the analyses included seven samples in Reach CS, 13 samples in Reach C1, 57 samples in Reach C2, and seven samples in Reach C3. Soil/sediment corresponding to all of the samples collected in Reach C1 and all but two of the samples collected in Reach CS has been excavated or removed.

Twenty-three chlorinated pesticide constituents (including isomers) were included in the analytical suite. Prior to remediation under the 2007 Early Action, seven of these constituents were non-detect in all samples, nine constituents were detected in a few samples each and the other seven constituents (dichlorodiphenyldichloroethane [DDD], dichlorodiphenyldichloroethylene [DDE], dichlorodiphenyltrichloroethane [DDT], dieldrin, chlordane, endrin aldehyde and endosulfan II) were identified in 10% or more of the samples. One or more chlorinated pesticide constituents (dieldrin, chlordane, and/or BHC isomers) were detected above the residential SSL or SCO value in 10 of the 84 samples (approximately 12%). Soil at locations corresponding to five of those 10 samples was excavated or removed during the 2007 Early Action activities.

Five of the 69 samples that were analyzed for chlorinated pesticides and that were not excavated as part of the 2007 Early Action activities were reported to contain a chlorinated pesticide constituent at a concentration above its respective residential SSL or SCO value. As listed below, all of these locations are within the open ditch sections of Culvert 105 north of Sleeper Street.

Sample	Compound	Result (ug/kg)	SSL (ug/kg)	SCO (ug/kg)
DEC-29 (0-6")	Chlordane (total)	750	493	n.a.
	Dieldrin	290	40	39
C5S (0-3")	Dieldrin	48	40	39
C6 (0-6")	beta-BHC	51,000	356	72
	Dieldrin	84	40	39
C6 (6-12")	Dieldrin	240	40	39
C9S (6-12")	Dieldrin	51	40	39

Note: ug/kg = micrograms per kilogram, equivalent to parts per billion (ppb)

There were single exceedances of chlordane and beta-BHC. In both cases, other samples collected in the immediate vicinity were reported to contain no detectable concentrations. Further, as discussed in Section 4.2, the result for beta-BHC is considered suspect.

Four of the five exceedances for dieldrin are located within an approximate 150-foot length of open ditch on property AD1, north of Sleeper Street, and the fifth exceedance is located approximately 2,000 feet farther downstream. Seventeen soil/sediment samples (including samples representing soil/sediment in open ditch sections that was subsequently removed) were collected within or along Culvert 105 at locations upstream of Sleeper Street (a distance of approximately 3,600 feet). Dieldrin was detected in nine of these samples, with a maximum concentration of 150 ug/kg. This distribution of inconsistent detections at lower concentrations in samples collected in upstream samples (south of Sleeper Street) is not consistent with a source solely originating from FMC. Property AD1 and nearby properties were formerly used for agricultural purposes. Dieldrin was formerly used as a pesticide on crops such as corn.

Based on the low frequency of observations above the residential soil screening values and the occurrence of these results within the areal extent of soil/sediment arsenic concentrations above 20 mg/kg (refer to Section 7), chlorinated pesticides in soil/sediment in the Culvert 105 Study Area have been delineated.

6.4.2 Lead

A total of 81 soil/sediment samples collected within the Culvert 105 Study Area were analyzed for lead (refer to Table D.1 in Appendix D). By reach, the analyses included 12 samples in Reach C1, 62 samples in Reach C2, and seven samples in Reach C3. Soil/sediment corresponding to all of the samples that were collected in Reach C1 and analyzed for lead has been excavated or removed.

Lead is naturally occurring in soil/sediment and is also ubiquitous in soil/sediment in developed areas due to many common anthropogenic sources (e.g., historically in lead-based paint and used as gasoline additive, etc.). Prior to remediation, approximately 77% of the 81 samples had lead concentrations within the range of concentrations (9 to 114 mg/kg) in the 11 background sampling locations (refer to Section 6.2).

Both the residential SSL and the residential SCO for lead use a value of 400 mg/kg. Soil/sediment corresponding to two of the 81 samples that were analyzed for lead was reported to contain lead at a concentration greater than 400 mg/kg, as follows:

(1) At 492 mg/kg at a depth of 0 to 6 inches at sampling location “DEC-29” within an open ditch section on property AD1

(2) At 541 mg/kg at sampling location AE1-I5 at a depth of 6 to 12 inches in a field in the eastern portion of property AE1

Based on the low frequency of concentrations above the residential soil screening value and the occurrence of these results within the areal extent of soil/sediment arsenic concentrations above 20 mg/kg (refer to Section 7), lead in soil/sediment in the Culvert 105 Study Area has been delineated.

6.4.3 Other Metals

A total of 12 soil/sediment samples collected within the Culvert 105 Study Area were analyzed for metals other than arsenic and lead (refer to Table D.2 in Appendix D). By reach, the analyses included seven samples in Reach C1, three samples in Reach C2, and two samples in Reach C3. Soil/sediment corresponding to all of the samples collected in Reach C1 that were tested for other metals has been excavated or removed.

Prior to remediation, of the metals on the Off-Site Parameter List other than arsenic and lead, iron and cadmium were detected above the residential soil screening values. Iron was detected in two samples above its residential SSL (no SCO value available) in open ditch sections of Reaches C2 and C3. Cadmium was detected in one of these two samples above its residential SCO but less than its residential SSL value. These two sample locations were not affected by the 2007 Early Action activities. None of the detected concentrations of metals (other than arsenic and lead) in any of the samples exceeds its respective residential soil screening criterion, with the exception of two results for iron (a natural component of soil). The results for iron are within the range of concentrations observed in the background data set.

Based on the low frequency of concentrations above the residential soil screening values and the occurrence of these results within the areal extent of soil arsenic concentrations above 20 mg/kg (refer to Section 7), metals other than arsenic in soil/sediment in the Culvert 105 Study Area have been delineated.

6.4.4 Other Synthetic Organic Constituents

A total of eight soil/sediment samples collected within the open ditch sections of Culvert 105 north of the Erie Canal were tested for other synthetic organic compounds, including chlorinated herbicides, organophosphate pesticides, phenolic compounds, furans, and

methyl carbamates. No detectable levels of any of these compounds were identified in any of these samples (refer to Table D.2 in Appendix D). Based on the non-detectable concentrations, these other synthetic organic compounds have been delineated for soil/sediment in the Culvert 105 Study Area.

7. Evaluation of Extent of Arsenic in Soil/Sediment

Arsenic is a naturally occurring element in soil/sediment, and is also present in soil/sediment as a result of the use of a variety of man-made products and activities (also referred to as “anthropogenic sources”). The amount of arsenic in each soil/sediment sample collected in the Culvert 105 Study Area is derived from a combination of three sources:

- Natural geologic conditions
- Potential non-Site-related anthropogenic sources
- Potential historical releases from past operations at the Facility

To evaluate the extent of arsenic in soil/sediment in the Culvert 105 Study Area that is potentially derived from historical releases from operations at the Facility, the amount of arsenic present in soil/sediment due to natural geologic conditions and potential non-Site-related anthropogenic sources must be identified. This evaluation is complicated by the use of many products containing arsenic for both commercial purposes and in everyday life beginning in the late 1800s. To assist in this evaluation, FMC and the Agencies attempted to estimate the background levels of arsenic (from both natural conditions and non-FMC-related anthropogenic sources) in soil representative of the Middleport area.

This section presents an evaluation of the horizontal and vertical extent of potentially Site-related arsenic in soil/sediment in the Culvert 105 Study Area and demonstrates that the extent of arsenic has been sufficiently characterized for the purposes of the RFI in accordance with the terms and conditions of the AOC and Attachment 1 to the AOC. This evaluation consists of:

- Presentation of the horizontal and vertical distribution of the soil/sediment arsenic data set for the Culvert 105 Study Area (refer to Section 7.1)
- Discussion of studies conducted to evaluate the background levels of arsenic in soil in the Middleport area (refer to Section 7.2)
- Discussion of potential non-Site-related sources of arsenic in the Culvert 105 Study Area and discussion of the distribution characteristics consistent with stormwater migration from the Facility (refer to Section 7.3)

Based on this evaluation, a summary of observations regarding the horizontal and vertical distribution of arsenic in soil/sediment in Reaches CS, C1, C2 and C3 is provided in Sections 7.4 to 7.7, respectively.

7.1 Presentation of the Soil/Sediment Arsenic Distribution

A frequency distribution plot (graph) of the percent of soil/sediment samples within specified soil arsenic concentration ranges is provided in Figure 7.1 for the 0- to 3-inch, 3- to 6-inch, 6- to 12-inch, 12- to 18-inch and 18- to 24-inch depth intervals. The frequency distributions for the 0- to 3-inch and 3- to 6-inch depth intervals are nearly the same. The frequency distributions for the 12- to 18-inch and 18- to 24-inch depth intervals are nearly the same, and are substantially different from the distributions of the 0- to 3-inch and 3- to 6-inch depth intervals, with approximately 90% of samples containing less than 20 mg/kg arsenic. The frequency distribution for the 6- to 12-inch depth interval is intermediate between the distributions for the two shallower and two deeper intervals, indicating that arsenic concentrations are generally more prevalent in the upper 12 inches of soil/sediment in the Culvert 105 Study Area.

Table 7.1 presents the statistics of the soil/sediment arsenic data set, organized by transect and remote borehole (non-transect) locations within each reach, both before and following implementation of the 2007 Early Action activities. The statistics include the number of samples, minimum concentration, maximum concentration, arithmetic mean for all samples, arithmetic mean for samples collected from the 0- to 12-inch depth interval, and arithmetic mean for samples collected deeper than 12 inches.

The arithmetic mean concentrations that are provided in Table 7.1 are shown on Figures 7.2a and 7.3a for each transect versus distance downstream from the inlet of Culvert 105 at the North Ditch. Figure 7.2a shows the arithmetic mean concentrations for both the 0- to 12-inch depth interval of soil/sediment and for samples collected deeper than 12 inches. Figure 7.3a shows the arithmetic mean concentrations for all sample depths both before and after implementation of the 2007 Early Action activities. The arithmetic mean concentration for samples collected deeper than 12 inches is consistently substantially lower than the arithmetic mean concentration for samples collected in the 0- to 12-inch depth interval. Following the 2007 Early Action activities, the arithmetic mean concentration for samples collected deeper than 12 inches is at or less than 20 mg/kg for 21 of 24 transects of Culvert 105. Figures 7.2b and 7.3b present the maximum concentrations for each transect versus distance downstream.

Cross-sections depicting the vertical distribution of the soil/sediment arsenic data are provided in Figure 7.4 for each transect south of the Erie Canal, and in Figures 7.5 to 7.16 for each transect north of the Erie Canal, with arsenic concentrations greater than 20.0 mg/kg colored pink. Sample results with an asterisk indicate that soil/sediment corresponding to that location was removed during the 2007 Early Action activities and replaced with clean backfill (refer to Figure 2.3 for information depicting the extent of the 2007 Early Action activities along Culvert 105). For transects south of the Erie Canal, the approximate diameter and depth of the buried pipe, where known, are indicated. The buried pipe ranges in diameter from 24 to 36 inches, and the top of the pipe is situated approximately 10 to 30 inches below surface grade.

The areal extent of soil removed from Reach CS and Reach C1 during the 2007 Early Action activities and the concentration of arsenic in soil/sediment remaining at each sampling location beyond the excavated areas following the 2007 Early Action activities are depicted on Figures 3.3 and 3.4, respectively.

The horizontal distribution of arsenic in soil/sediment in Reaches C1, C2 and C3 is depicted on Figures 7.17 through 7.19, respectively, using isocontours of the 0- to 12-inch average arsenic concentration in the upper 12 inches of soil/sediment. The locations of soil/sediment samples collected deeper than 12 inches are shown on Figures 3.3b, 7.20, 7.21 and 7.22 for Reaches CS, C1, C2 and C3, respectively, with arsenic concentrations greater than 20 mg/kg color-coded.

7.2 Background Levels of Arsenic in Soil

From 1985 to 2003, several sampling and analysis studies were conducted by FMC and/or the Agencies to characterize background arsenic concentrations in Middleport soil (refer to Section 6 of RFI Report Volume I for a more detailed review of these studies). The most recent and comprehensive study was the 2001-2003 Gasport background study, proposed by the Agencies in the Background Study Work Plan (Agencies 2001). This program was designed to provide a database of local area soil arsenic concentrations to support the calculation of background levels of arsenic in Middleport soil, weighted by the proportionate areas of different types of historical land uses.

To implement this program, FMC collected surface soil samples from orchards, agricultural fields, undeveloped wooded properties, public properties, and residential properties in the nearby Village of Gasport, which was selected based on its similar soil geology and similar pattern of historical land uses to those found in Middleport, and the fact that properties in Gasport would not have been impacted by releases from the FMC Plant in Middleport. The results of the 2001-2003 Gasport background study were presented in the report titled Development of Arsenic Background in Middleport Soils (CRA 2003), which was approved by the Agencies in June 2003 and is provided in Appendix 6A of RFI Report Volume I. The data collected in the 2001-2003 Gasport background study are provided in Table 7.2a, and are summarized by property type/usage (e.g., orchard, residential) in Table 7.2b. The 2001-2003 Gasport data were then used in conjunction with the proportionate total area of historical land use types within a defined study area in the Village of Middleport (called the “Middleport Study Area”) to calculate an overall background level of arsenic in soil weighted by property type/usage (refer to Table 7.3).

In 2004, additional historical aerial photographs were identified. In 2007, FMC used these additional aerial photographs to revise the land use weighting factors (primarily those attributable to orchard land), and proposed re-calculated arsenic background levels based on the revised weighting factors and other changes in methodology (refer to Table 7.3). The Agencies reviewed the FMC proposal along with the additional aerial photographs,

and determined that there was not a significant change in the amount of historical orchard land when considering the entire 1931-1978 time period, and as a result the original 2003 arsenic background levels remain appropriate for use as arsenic comparison criteria. FMC reserves the ability to propose the use of the re-calculated soil arsenic levels in the future in the CMS or for the purposes of Corrective Measures Implementation.

7.3 Potential Non-Site Related Anthropogenic Arsenic Sources

Potential anthropogenic sources of arsenic other than the FMC Facility with respect to the Culvert 105 Study Area include:

- Application of arsenic-containing pesticides at historical orchards (refer to Figure 2.5) and in the treatment of trees
- Application of arsenic-containing pesticides, fertilizers, and lawn care and horticultural products (e.g., lime, potting soil, chicken manure) at agricultural fields, along railroad tracks, and landscaping activities
- Use of arsenic-containing wood treatment products and/or pressure-treated lumber for decks, play sets, docks, sheds, utility poles, fences, and other structures
- Burning and storing coal and depositing coal ash (it is reported that many homes in Middleport were formerly heated by coal and train engines formerly burned coal)
- Placement of arsenic-containing fill materials

References for these sources include http://pubs.usgs.gov/fs/2005/3152/, http://www.atsdr.cdc.gov/csem/arsenic/exposure_pathways.html, and http://www.dnrec.state.de.us/dnrec2000/Divisions/AWM/SIRB/Arsenic/. One or more of these sources may have been associated with properties that contributed surface water runoff to Culvert 105 prior to commencement of investigation activities in the mid- to late 1980s. Historical land uses at properties in the Culvert 105 Study Area, including former orchards, agricultural land, coal-handling locations, and manufacturing operations, are presented on Figure 2.5, based on historical aerial photographs, Sanborn fire insurance maps, and information from property owners. This information is summarized in Table 7.4 for each property within the Culvert 105 Study Area. The presence of a potential non-FMC related source of contamination or arsenic source does not necessarily indicate the absence of FMC-related arsenic at these properties.

Arsenical pesticides were commonly used in Western New York in fruit orchards and for other agricultural purposes (Merwin et al 1994, Bishop and Chisholm 1961, Peryea 2004, Dragun and Chiasson 1991, Woolson 1975, Gianessi and Phillips 1994, Woolson et al 1971). FMC and its predecessor companies (e.g., Niagara Sprayer) manufactured and managed common arsenical pesticides (e.g., calcium arsenate and lead arsenate) at the

FMC Facility from approximately 1928 to 1974. Some of the arsenical pesticide products produced at the Facility could well have been used by others in the Middleport area for agricultural purposes (e.g., orchards, crop land) and other non-agricultural purposes (e.g., treatment of trees, weed control along railroad and power lines, other historical uses by local industries/businesses). Extensive areas along Culvert 105 north of Sleeper Street were historically used as orchards. The presence of an historical orchard does not necessarily indicate that arsenic-based pesticides were used, and that, if used at an orchard or other area, any impact on soil arsenic concentrations would depend on a number of factors including amounts applied, methods of application, concentrations of arsenic within the pesticide product, and the number of applications.

The varied and generally undocumented possible use of these materials from potential sources other than past FMC Plant releases makes it difficult, if not impossible, to determine the specific contribution to the arsenic in the Culvert 105 Study Area soil/sediment. The potential non-FMC related anthropogenic sources of arsenic discussed in this section are not unique to the Middleport area. The 2003 Gasport Background Study discussed in Section 7.2 was designed to investigate non-FMC related anthropogenic sources of arsenic in a soil environment similar to Middleport, and the resultant background data set is expected to generally account for typical arsenic concentrations associated with non-FMC related anthropogenic sources.

A second line of evidence supporting contribution to soil arsenic conditions in the Culvert 105 Study Area by non-Site anthropogenic sources is the distribution of arsenic. Soil/sediment affected by historical surface water from the Facility would be expected to exhibit the following characteristics (in the absence of subsequent activity that would alter the soil profile, such as soil/sediment excavation for maintenance or re-alignment of the ditch):

- Arsenic concentrations within and along Culvert 105 would decrease with increasing distance downstream from the Facility.
- Concentrations would be higher at an elevation near the invert (bottom) of the culvert and decrease with increasing depth below this elevation.
- Concentrations would be higher within or immediately adjacent to Culvert 105 and would decrease with distance laterally outward from Culvert 105.
- Arsenic concentrations would be higher in open ditch sections between buried pipe sections due to settlement associated with slower flow velocities in the open ditches as compared to the pipe flow.

It is reported that the Culvert 105 ditch has been subject to excavation for maintenance and to possible re-alignment in the past; these activities complicate interpretation of the distribution of arsenic in soil/sediment.

The information provided in Sections 7.1 to 7.3 is considered in the discussion of the extent of arsenic presented in Sections 7.4 to 7.7 for each reach, in upstream to downstream order.

7.4 Summary of Extent of Arsenic – Reach CS

The observations below regarding the distribution of arsenic in soil/sediment along the Culvert 105 buried pipe and within the pipe and associated structures in Reach CS (south of the Erie Canal, where Culvert 105 consists solely of buried pipe) are based on Table 7.1 and Figures 3.3a, 3.3b and 7.4.

- Many of the samples collected in the upper 3 inches of surface soil above the alignment of the Culvert 105 buried pipe south of the Erie Canal contain more than 20 mg/kg arsenic. However, many of the samples collected between the 3- to 12-inch depth intervals (i.e., above the height of the buried pipe sections) indicate arsenic concentrations below 20 mg/kg. Potential sources of the arsenic in surface soil along Culvert 105 in Reach CS include: 1) historical air deposition; 2) historical stormwater flooding from Culvert 105; and 3) other non-FMC related sources.

- Soil in sampled locations at depths greater than 12 inches have arsenic concentrations above 20 mg/kg in two areas of Reach CS following implementation of the 2007 Early Action activities: 1) at depth at the Wooded Parcel, which is covered with a minimum of 24 inches of clean backfill; and 2) at a depth of approximately 24 to 54 inches adjacent to sections of the buried pipe in the J-Block residential properties. The Agencies believe that FMC-related contamination may have potentially impacted subsurface soil surrounding the buried pipe at locations along the length of Culvert 105 due to historical pipe leakage and/or from deposits in the open ditch which may have pre-dated pipe installation along sections of Culvert 105. Arsenic in the subsurface soil in these locations may also be attributable to non-FMC related sources.

- Following implementation of the 2007 Early Action activities at the Wooded Parcel, soil with arsenic concentrations ranging up to 79.1 mg/kg remains at depth in Transect CS-1 at the Wooded Parcel. The section of pipe at Transect CS1 was removed and replaced during the 2007 Early Action activities, resulting in the excavation of soil and replacement with clean fill to depths up to approximately 54 inches in certain boring locations of Transect CS1. Beyond the trench for replacement of the buried pipe, soil at the Wooded Parcel was excavated and replaced with clean fill with a minimum thickness of 24 inches. The pre-remedial and post-remedial soil arsenic conditions are shown on Figures 3.3a, 3.3b, and 7.4. Review of Figure 7.4 indicates that subsurface soil arsenic concentrations decrease with lateral distance from the buried pipe. At the

transect locations (CS1W3 and CS1E3) farthest from the buried pipe, soil arsenic concentrations ranged from 3.6 mg/kg to 56.1 mg/kg.

- Soil at depths greater than 3 inches along Transect CS2, the first transect downstream of the Wooded Parcel, contains arsenic concentrations less than 20 mg/kg. All soil collected at the next downstream transect, CS3, also contains less than 20 mg/kg arsenic.

- Soil with arsenic concentrations above 20 mg/kg was found at a depth greater than 3 inches along the buried pipe at three locations in the J-Block residential properties – namely, Transect CS4, borehole J4BSP1 (at the former pipe break that was repaired), and Transect CS5. In upstream to downstream order, arsenic concentrations above 20 mg/kg were found at depths ranging from 36 to 54 inches below grade in Transect CS4 (maximum concentration 28.2 mg/kg), at 36 to 39 inches below grade at borehole J4BSP1 (maximum concentration 35.6 mg/kg), and from 24 to 39 inches below grade in Transect CS5 (maximum concentration 142 mg/kg). Soil arsenic concentrations were less than 20 mg/kg both above and below these depth intervals (refer to Figure 7.4). Figure 7.4 indicates that subsurface soil arsenic concentrations decrease with lateral distance from the buried pipe. Subsurface soil arsenic concentrations at locations approximately three feet laterally outward from the pipe at Transect CS4 ranged from 3.4 mg/kg to 24.1 mg/kg. Subsurface soil arsenic concentrations at Transect CS5, where the pipe was in fair to poor condition, were less than 20 mg/kg at locations approximately one to two feet in both lateral directions outward from the pipe.

- All soil samples collected at depths greater than 3 inches along Transect CS6, on Property B1 just south of the Erie Canal, contain less than 20 mg/kg arsenic.

- Samples of soil/sediment collected within the buried pipe, catch basins and manholes of Culvert 105 south of the Erie Canal were reported in 2004 to contain 26 to 114 mg/kg of arsenic. Soil/sediment corresponding to these samples was removed during the Early Action activities in 2007.

7.5 Summary of Extent of Arsenic – Reach C1

The observations below regarding the distribution of arsenic in soil/sediment of Culvert 105 Reach C1 (between the Erie Canal and Sleeper Street) are based on Table 7.1 and Figures 3.4, 7.1 to 7.3, 7.5 to 7.7, 7.17 and 7.20.

- Prior to performance of the 2007 Early Action activities, the soil/sediment arsenic concentrations detected in Reach C1 ranged from 1.8 to 217 mg/kg, with an average of 15.8 mg/kg. The concentration of arsenic in accumulated soil/sediment in the base of sediment chamber MH-N9, based on analysis in

2004, was 63 mg/kg (soil/sediment in MH-N9 was removed during the Early Action activities in 2007).

- Prior to the 2007 Early Action activities, approximately 60% of the length of Culvert 105 in Reach C1 was comprised of buried pipe. The Agencies believe that FMC-related contamination may have potentially impacted subsurface soil surrounding the buried pipe at locations along the length of Culvert 105 due to historical pipe leakage and/or from deposits in the open ditch which may have pre-dated pipe installation along sections of Culvert 105. Arsenic in the subsurface soil in these locations may also be attributable to non-FMC related sources.

- Prior to the 2007 Early Action activities, soil/sediment with arsenic concentrations above 20 mg/kg was present within the open ditch section just south of Mechanic Street (at Margaret Droman Park, also known as Property AA1), to depths ranging from 12 to 24 inches below surface grade (refer to Figures 7.5 and 7.17a). Following the removal of the upper 12 to 24 inches of soil/sediment along this former open ditch section during the 2007 Early Action activities, the remaining soil/sediment arsenic data at Margaret Droman Park are less than 20 mg/kg (refer to Figure 7.17b).

- Prior to the 2007 Early Action activities, soil/sediment with arsenic concentrations above 20 mg/kg was present within the open ditch section just west of North Vernon Street (on Properties AB4, AB5, and AB6), to depths ranging from 12 to 24 inches below surface grade (refer to Figures 7.5, 7.6 and 7.17a). Following the removal of the upper 12 to 24 inches of soil/sediment along this former open ditch section during the 2007 Early Action activities, the remaining soil/sediment arsenic data on Properties AB5 and AB6 are less than 20 mg/kg. Property AB4 contains soil with arsenic concentrations above 20 mg/kg at locations that were not excavated during the 2007 Early Action activities, including the 20-foot diameter protected root zone of a tree.

- Soil at three boring locations (AB4-1, C2E4, and C2E5) within the protected root zone of a tree on Property AB4 contains arsenic at concentrations above 20 mg/kg from the ground surface to depths ranging from 12- to 18-inches below grade (maximum concentration 98.7 mg/kg). A phytoremediation pilot study designed to reduce these soil arsenic concentrations through uptake into plants was conducted in 2008; the results of which are being discussed with the Agencies.

- Soil/sediment at three boring locations (CNBSB2, CNBSB3, and CNBSB5) within approximately 20 feet laterally to either side along a pre-existing buried pipe section on Property AB2, east of North Main Street, contains arsenic with maximum concentrations ranging from 32 to 217 mg/kg. The depth interval of the

maximum concentration in each boring location varies from 0 to 3 inches below grade to 18 to 24 inches below grade. At least a portion of this buried pipe section was installed since the mid-1980s, and this work may have resulted in the displacement of soil/sediment from the former open ditch section. Soil at other boring locations situated more distant from the Culvert 105 alignment on Property AB2 contains less than 20 mg/kg arsenic.

- Soil/sediment at Property AB1 contains less than 20 mg/kg arsenic with the exception of two locations (CNASB1 and CNASB4). Soil collected at depths of 12 to 24 inches below grade at location CNASB1 contains 31 to 71 mg/kg arsenic. Location CNASB1 is situated near the Culvert 105 buried pipe section that passes through Property AB2. The upper 12 inches of soil at location CNASB4 contains arsenic at concentrations ranging from 40 to 109 mg/kg. The arsenic at this location is not consistent with impact from Culvert 105 stormwater because this location is situated approximately 150 feet laterally outward and uphill from Culvert 105, and because the arsenic concentration is less than 20 mg/kg in all samples collected from three locations (CNASB3, CNCSB1, and CNCSB2) oriented in a line between location CNASB4 and Culvert 105. Therefore, the source of the arsenic at location CNASB4 is not likely attributable to historical FMC-related surface water discharges.

- Soil/sediment at Properties AB3 and AB7 contains less than 20 mg/kg arsenic, with the exception of one location. At Property AB7, the soil/sediment arsenic data for 16 samples are less than 20 mg/kg, with the exception of the 6- to 12-inch depth at location CNESB3 (23.8 mg/kg). The soil sample data at nearby locations C2.1W3 and C2.1W4 on abutting property AB6 are less than 20 mg/kg.

- Prior to the 2007 Early Action activities, soil/sediment with arsenic concentrations above 20 mg/kg was present within the open ditch section just south of Sleeper Street (on Properties AC1, AC2, AC3, and AC4), to depths ranging from 12 to 18 inches below surface grade (refer to Figures 7.7, 7.17a and 7.20a). Following the removal of the upper 12 to 18 inches of soil/sediment along the former open ditch section during the 2007 Early Action activities, the remaining soil/sediment arsenic data on Properties AC1, AC2, AC3, and AC4 are less than 20 mg/kg.

7.6 Summary of Extent of Arsenic – Reach C2

The observations below regarding the distribution of arsenic in soil/sediment of Culvert 105 Reach C2 (north of Sleeper Street through Property AF1) are based on Table 7.1 and Figures 3.5, 7.1 to 7.3, 7.8 to 7.10, 7.18 and 7.21.

- The 0- to 12-inch average soil/sediment arsenic concentration in each of the transects in Reach C2 consistently increases with increasing distance

downstream (refer to Figures 7.2a and 7.3a). This section of Culvert 105 comprises an open ditch of relatively consistent slope and width.

- The average arsenic concentration in soil/sediment samples collected deeper than 12 inches in each of the transects in Reach C2 (refer to Figure 7.2a) is significantly lower than for the upper 12 inches of soil/sediment, and is consistently less than 20 mg/kg.

- The highest arsenic concentrations in soil/sediment of Reach C2 follow the path of Culvert 105 from Sleeper Street through Transect C5.5, but then diverge between 100 to 250 feet to the east and uphill of Culvert 105 between Transects C6 and C7 on Properties AE1 and AF1. The maximum soil arsenic concentrations detected at locations AF1-K5, AE1-J5, AE1-I5, and AE1-H4 are situated along the eastern boundaries of Properties AE1 and AF1, and range from 234 to 380 mg/kg. This distribution has five possible contributing factors:

  1) The path of the ditch through Properties AE1 and AF1 may have been moved over time.

  2) Material may have been removed from the ditch invert and placed elsewhere on the adjoining properties.

  3) Potential past use of pesticides in historical orchards on adjacent Property AE2 (refer to Figure 2.5). Sampling and analysis at abutting Property AE2, where access permission was not previously granted by the owner, could further elucidate the source(s) of arsenic on the eastern portions of Properties AE1 and AF1.

  4) Soil on properties AE1 and AF1 may have been disturbed or regraded in the past.

  5) Historical Culvert 105 flooding events may have transported water or other materials containing arsenic to soil in the flood zone.

- The concentrations of arsenic in soil on the eastern portion of Property AD1, away from the Culvert 105 ditch, are consistent with the concentrations (3.1 to 121.3 mg/kg) observed in the 2001-2003 Gasport background study at properties historically used as orchards. Property AD1 was formerly the location of an orchard.

7.7 Summary of Extent of Arsenic – Reach C3

The observations below regarding the distribution of arsenic in soil/sediment of Culvert 105 Reach C3 (north of Property AF1 to confluence with Tributary One) are based on Table 7.1 and Figures 3.6, 7.1 to 7.3, 7.11 to 7.16, 7.19 and 7.22.

- The average arsenic concentration in soil/sediment samples collected deeper than 12 inches in the eight transects in Reach C3 is significantly lower than for the upper 12 inches of soil/sediment. Further, the average arsenic concentration in the samples collected deeper than 12 inches is consistently less than 20 mg/kg (with the exception of Transect C10).

- Within Reach C3, the highest arsenic concentrations in soil/sediment follow the path of the open ditch, with the exception of the area to the east of Transects C7.5 to C8.2 and at sample location C8.5W5. To the east of Transects C7.5 to C8.2, concentrations above 20 mg/kg extend approximately 100 feet laterally to the east and uphill from the open ditch (but not to the same topographic elevations to the west). Location C8.5W5 is situated approximately 100 feet laterally from the open ditch and contains arsenic at concentrations ranging from 24 to 416 mg/kg, while arsenic concentrations are less than 20 mg/kg in samples collected from three locations closer to the open ditch. These distributions have five possible contributing factors:

    1) The path of the ditch in these areas may have been moved over time.

    2) Material may have been removed from the ditch invert and placed elsewhere on the adjoining properties.

    3) Potential past use of pesticides in historical orchards on properties throughout most of Reach C3 (refer to Figure 2.5).

    4) Soil in these areas may have been disturbed or regraded in the past.

    5) Historical Culvert 105 flooding events may have transported water or other materials containing arsenic to soil in the flood zone.

- The embankments of the open ditch are steep for a length of approximately 700 linear feet north of Transect C9. Samples of soil/sediment collected within the ditch and on its western embankment (access was not available on Property AK1 to the east) in this section have arsenic concentrations less than 20 mg/kg.

8. Proposed Corrective Measures Study Area

This section presents the basis for the selection of the properties and areas described in this Volume IV of the RFI Report to be included in the CMS for the Culvert 105 Study Area. Properties and areas proposed for inclusion in the CMS are highlighted green on Figure 8.1.

As discussed in Section 9.2 of RFI Volume II, all 16 properties that are located south of the Erie Canal and are traversed by the Culvert 105 buried pipe will be included in the Proposed CMS. These properties include B1, B3, B4, B8, J1, J2, J4, J13, J14, J15, J16, M3, M18, M19, M20 and P14 (including the Wooded Parcel). All of the soil/sediment data collected at these properties will be included in the CMS, regardless of whether the arsenic might be present as a result of potential historical migration of storm water along Culvert 105 or potential historical air deposition.

Between the Erie Canal and downstream to the approximate location of Transect C8, all 21 properties that are either traversed by the Culvert 105 buried pipe or open ditch sections or were sampled as part of the RFI study for Culvert 105 will be included in the Proposed CMS. These properties include AA1 (Margaret Droman Park), AB1, AB2, AB3, AB4, AB5, AB6, AB7, AC1, AC2, AC3, AC4, AD1, AD2, AD3, AE1, AE3, AF1, AG1, AH1 and AH2.

The extent of the CMS area to the east of Properties AE1 and AF1 (on Property AE2) cannot be estimated due to the lack of sampling data on Property AE2. Also, the presence of an historical orchard on Property AE2 (refer to Figure 2.5) suggests a non-FMC related contributing source to the arsenic in these soils. Additional sampling on Property AE2 could help clarify this situation if property access can be obtained in the future.

North of Transect C8, the proposed extent of the areas to be included in the CMS (refer to Figure 8.1) is estimated based on the extent of soil/sediment arsenic concentrations above 20 mg/kg along the open ditch on Properties AI1, AJ1, AJ2 and AK2.

9. Findings

A review of the analytical data collected from the Culvert 105 Study Area yields the following findings:

1. Soil/sediment is not an on-going source of significant impact to surface water quality in Culvert 105. Surface water analysis indicates that arsenic is not present at concentrations above the applicable Class D surface water standard, including areas where elevated concentrations of arsenic are found in soil/sediment. Other compounds (seven metals and the chlorinated pesticide constituent beta-BHC) detected at concentrations above the surface water standards and/or background concentrations of nearby surface waters are likely attributable to turbidity (i.e., suspended particles) in the samples, and do not represent actual dissolved concentrations in surface water. These observations are consistent with the low water solubility and high affinity to adsorb to organic matter exhibited by arsenic, other metals, and chlorinated pesticides.

2. Soil/sediment in the Culvert 105 Study Area has been adequately evaluated for constituents that were historically manufactured, formulated, handled, or used at the Facility. The data set includes arsenic results for 1,445 soil/sediment samples, with sub-sets of the samples analyzed for other constituents on the Off-Site Parameter List.

3. Arsenic data define the horizontal and vertical limits of potential Site-related impacts in soil/sediment in the Culvert 105 Study Area. The extent of other constituents at concentrations above the soil screening values is within the extent of soil arsenic above background concentrations.

4. With consideration given to other factors (e.g., data variability, flood zone topography, ground features, historical land use, etc.) that could influence the distribution associated with stormwater migration along Culvert 105, the horizontal and vertical extent of arsenic have been sufficiently delineated to 20 mg/kg (ppm) in soil/sediment in the Culvert 105 Study Area, except for the area east of Properties AE1 and AF1, where access was not obtained for sampling (Property AE2).

5. The Agencies believe that FMC-related contamination may have potentially impacted subsurface soil surrounding the buried pipe sections of Culvert 105 present in Reaches CS, C1, C2 and C3 prior to the 2007 Early Action activities due to historical pipe leakage and/or from deposits in the open ditch which may have pre-dated pipe installation along sections of Culvert 105. Arsenic in the subsurface soil in these locations may also be attributable to non-FMC related sources.

As summarized in the above findings, the nature and extent of releases of hazardous waste or hazardous constituents from the Facility in soil/sediment in the Culvert 105 Study Area have been delineated. The information and data are sufficient to support the development of the CMS. Inclusion in the CMS does not necessarily rule out the possibility that other non-FMC-related sources may be contributing to the soil/sediment concentrations of constituents, particularly arsenic, at some locations. The CMS will evaluate the need for corrective measures and the nature and scope of any final corrective measures consistent with the Corrective Action Objectives established by the Agencies for soil and sediment in off-Site study areas.

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