



**FMC Corporation
Middleport, New York**

**RCRA Facility Investigation (RFI)
Report**

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**

September 2009 FINAL



**RCRA Facility Investigation (RFI) Report
Volume II –
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(South of the Erie Canal and West of the
Niagara/Orleans County Line)
and
Culvert 105 Study Area South of the Erie Canal**

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Appendices (included on attached CD-ROM)

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Appendix C	Summary of Arsenic Soil Analytical Data (By Property)
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Appendix E	Summary Report for 2004/2005 RFI Work Plans and Supplemental Soil Sampling and Analysis in Air Deposition Study Area 1
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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
ESI	Eastern Surface Impoundment
ETU	ethylene thiourea
FMC	FMC Corporation
GMX	Geomatrix
ICM	Interim Corrective Measure
IRM	Interim Remedial Measure
mg/kg	milligrams per kilogram
MVS	Mining Visualization System
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
ROW	right-of-way
Roy-Hart	Royalton-Hartland
SCOs	Soil Cleanup Objectives
SSLs	Soil Screening Levels
UCL	Upper Confidence Level
ug/kg	microgram per kilogram
USEPA	United States Environmental Protection Agency
VOCs	volatile organic compounds

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 an 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 from 1993 to 2005 under the direction of the Agencies and the New York State Department of Health (NYSDOH). 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 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
- Volume III Former FMC Research and Development (R&D) Property
- Volume IV Culvert 105 and Flood Zone
- Volume V Tributary One and Flood Plain South of Pearson/Stone Roads
- Volume VI Tributary One and Flood Plain East of Stone Road to Confluence with Jeddo Creek
- Volume VII Jeddo Creek, Johnson Creek, and Associated Flood Plains
- Volume VIII Groundwater Investigations and Remediation Results

- Volume IX On-Site Soil, Surface Water, and Sediments
- Volume X Suspected Air Deposition Study Area 2 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 II of the RFI Report and presents the RFI soil investigation results for the off-site areas potentially affected by historical air deposition south of the Erie Canal and west of the Niagara/Orleans county line (referred to herein as “Air Deposition Study Area 1”). This document also presents the RFI investigation results for soil adjacent to and sediment within the section of the Village of Middleport Culvert 105 buried storm sewer system that passes through Air Deposition Study Area 1 (i.e., south of the Erie Canal) (referred to herein as the “Culvert 105 South Study Area”). Although the areal extent of the Culvert 105 South Study Area is within the bounds of Air Deposition Study Area 1, the two study areas encompass two distinct potential migration pathways (i.e., historical air deposition onto surface soils and historical surface water discharges via a buried sewer pipe). The results of investigations of groundwater beneath the Facility and off-site areas, including Air Deposition Study Area 1, will be discussed in Volume VIII of the RFI Report.

1.2 Objectives and Scope of the RFI Report for Volume II Study Areas

The locations of Air Deposition Study Area 1, the Culvert 105 South Study Area, the Facility, and the former FMC R&D property are depicted on Figure 1.1. The areas that are included within Air Deposition Study Area 1 for purposes of the RFI are indicated by yellow color shading on Figure 1.2. The Culvert 105 South Study Area is situated within Air Deposition Study Area 1 and is shaded pink on Figure 1.2. Properties that are traversed by Culvert 105 south of the Erie Canal are indicated by cross-hatching on Figure 1.2. Air Deposition Study Area 1 does not include the Facility (including the FMC-owned North Railroad Property), the former FMC R&D property, or three properties that abut the Facility to the southeast (a National Grid electrical sub-station, a tractor repair shop, and an auto salvage yard). The former FMC R&D property will be evaluated in RFI Report Volume III, and the Facility and the three properties that abut the Facility to the southeast will be evaluated in RFI Report Volume IX. Accordingly, the strip of land between the fence line on the former FMC R&D property, the Facility, and the three properties that abut the Facility and the northern edge of the Route 31 roadway will be evaluated in RFI Report Volumes III and IX. The properties and areas included in Air

Deposition Study Area 1 and the Culvert 105 South Study Area are further discussed in Section 2.

The objectives of the RFI investigations for Air Deposition Study Area 1 and the Culvert 105 South Study Area were to:

- Characterize the nature and extent of Site-related constituents that may be present in soil within Air Deposition Study Area 1 as a result of potential historical air deposition from the FMC Facility.
- Characterize the nature and extent of Site-related constituents that may be present in soil and sediment within the Culvert 105 South 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 Corrective Measures Study (CMS).
- 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 from 1985 through 2007. The sampling and analysis of soil in Air Deposition Study Area 1 and the Culvert 105 South Study Area was primarily for arsenic, with limited testing for other constituents. The associated sampling and analysis activities are discussed in Section 3 of this Volume II of the RFI Report.

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 zone 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) 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 soil arsenic.
- 2) Prepare and submit this Volume II of the RFI Report to the Agencies for their review.

FMC and the Agencies agreed 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 mean that this soil will be required to be remediated in the future. The need for 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 II of the RFI Report is organized as follows:

Section 2 – Description of RFI Report Volume II Study Areas: Reviews background information for Air Deposition Study Area 1 and the Culvert 105 South Study Area, including the identification of properties and areas, remedial activities that have been previously conducted by FMC, properties for which the Agencies have determined that no further action is needed, current and former land use, previous conceptual site model air deposition modeling efforts, and the construction and alignment of Culvert 105 south of the Erie Canal.

Section 3 – Review of Soil and Sediment Sampling and Analysis: Provides a chronological summary of the soil analytical data collected within Air Deposition Study Area 1 and the soil and sediment analytical data collected within the Culvert 105 South Study Area.

Section 4 – Data Usability: Describes the soil and sediment sample database for Air Deposition Study Area 1 and the Culvert 105 South Study Area, including an assessment of the usability of the data set, and the identification of potential statistical outlier data points.

Section 5 – Discussion of Potential Sources of Arsenic: Discusses studies conducted to estimate the background concentration of arsenic in Middleport soil, and information pertaining to potential non-FMC related anthropogenic sources of arsenic in Air Deposition Study Area 1.

Section 6 – Distribution of Arsenic in Soil in Air Deposition Study Area 1: Presents statistical data on the distribution of arsenic in soil at each property, and provides figures that show the horizontal and vertical extent of arsenic in soil in Air Deposition Study Area 1.

Section 7 – Distribution of Arsenic in Soil/Sediment in the Culvert 105 South Study Area: Discusses the spatial and vertical distribution of arsenic in soil adjacent to, and sediment within, the buried sewer pipe in the Culvert 105 South Study Area.

Section 8 – Evaluation of Other Constituents: Evaluates the analytical data set relative to constituents other than arsenic within Air Deposition Study Area 1 and within the Culvert 105 South Study Area.

Section 9 – Proposed CMS Area: Provides the rationale for the proposed extent of the CMS for Air Deposition Study Area 1 and the Culvert 105 South Study Area.

Section 10 – Findings: Summarizes the findings of the investigations and data evaluations described in this RFI Report Volume II for both Air Deposition Study Area 1 and the Culvert 105 South Study Area.

Section 11 – References: Lists the references cited in this RFI Report Volume II.

1.4 Revisions to RFI Report Volume II After Public Comment Period

A public comment period for draft RFI Report Volumes I, II and IV occurred from May 18, 2009 to July 2, 2009. By letter to FMC dated September 1, 2009, the Agencies, in consultation with the NYSDOH, provided responses to written comments received from the public and FMC in a document entitled “Public Comment Responsiveness Summary” and granted final approval of RFI Report Volumes I and IV and conditional approval of RFI Report Volume II.

The Agencies’ approval of RFI Report Volume II was conditioned upon the making of the following modifications to the volume: 1) include text in Section 1 indicating revisions were made to Figure 9.1 per the Agencies’ September 1st conditional approval and that an addendum was added to the report; 2) revise Figure 9.1 to address a public comment regarding the figure; and 3) add an addendum to the report that includes figures and a table with arsenic data for samples collected from Properties B3, E8 and I10 in April 2009, which information was not available at the time of the submittal of the draft RFI Report Volume II in May 2009. As requested in the Agencies’ September 1, 2009 letter (see Appendix G), Figure 9.1 was revised as follows: 1) show an identifying symbol on properties that were sampled as part of the RFI study area for Tributary One and are addressed in RFI Report Volume V; 2) reflect that Properties B3, E8 and I10 have been sampled; and 3) show Property E8 as yellow (i.e., excluded from evaluation in the CMS) because the Agencies decided to send the owner of Property E8 a “No Further Action” letter. In addition, as requested in the Agencies’ September 1, 2009 letter, figures showing the locations of the April 2009 soil samples collected from Properties B3, E8 and I10 and a table presenting the FMC, NYSDOH and combined (arithmetic average including duplicate and split samples) arsenic results from the 2009 sampling event are provided in Appendix H of this RFI Report Volume II. The Agencies approved the quality of the data for these three properties by letter dated August 24, 2009.

2. Description of RFI Report Volume II Study Areas

This section presents a review of background information for Air Deposition Study Area 1 and the Culvert 105 South Study Area, including the identification of properties and areas, remedial activities that have been previously conducted by FMC, properties for which the Agencies have determined that no further action is needed, current and former land use, previous conceptual site model air deposition modeling efforts, and the construction and alignment of Culvert 105 south of the Erie Canal.

2.1 Description of Air Deposition Study Area 1

The outside geographical boundaries of Air Deposition Study Area 1 extend to the Erie Canal to the north, to the Niagara/Orleans county line to the east, to properties along the south side of Route 31 (Telegraph Road/Rochester Road) to the south, and to properties along Main Street to the west, as shown on Figure 2.1. The 285 properties within these boundaries include:

- 251 residentially-zoned properties, including properties used at least partially for purposes other than residential, such as churches and community meeting space
- Roylton-Hartland (Roy-Hart) School District High School and Middle School property ("Roy-Hart School Property")
- A Village-owned, unimproved parcel adjacent to a bridge on Route 31 (Property S28) and Village-owned right-of-ways between public streets and private properties
- Two agricultural properties northeast and east of the Facility (R1a, R1b)
- One overgrown, undeveloped field that is zoned for residential use (R1d)
- 23 commercially-zoned properties occupied at least partially by businesses
- Six light industrially-zoned properties, including four parcels that are part of the "North Commercial/Industrial Area" and two parcels south of the Facility that include an automobile salvage yard and part of National Grid's utility corridor

Of these 285 properties, samples have not been collected at 30 properties because access permission could not be obtained or due to the presence of extensive pavement or imported fill at the property.

Air Deposition Study Area 1 does not include the Facility (including the FMC-owned North Railroad Property), the former FMC R&D property, or three properties that abut the Facility to the southeast (a National Grid electrical sub-station, a tractor repair shop, and an auto salvage yard). The former FMC R&D property will be evaluated in RFI Report Volume III, and the Facility and the three properties that abut the Facility to the southeast will be evaluated in RFI Report Volume IX. Accordingly, the strip of land between the

fence line on the former FMC R&D property, the Facility, and the three properties that abut the Facility and the northern edge of the Route 31 roadway will be evaluated in RFI Report Volumes III and IX. Other FMC-owned property adjacent to but outside the Facility fence, including a narrow strip of land along the National Grid utility corridor that extends to the north from the North Railroad Property, portions of Niagara Street and its associated right-of-way (ROW), and an approximate 10-foot-wide strip of land that is between the Facility western fence and ten properties along South Vernon Street are included in Air Deposition Study Area 1.

2.2 Areas of Remedial Measures Conducted in Air Deposition Study Area 1

FMC has conducted the following Interim Remedial Measures (IRMs), Interim Corrective Measures (ICMs) and Early Actions involving the excavation of soil and replacement with clean fill/soil within Air Deposition Study Area 1 (refer to tan shading on Figure 2.1):

- South of the southern bleachers at the Roy-Hart School Property in 1996 (Bleacher Area ICM) (Conestoga-Rovers & Associates [CRA] 1997b)
- Athletic fields and adjacent areas in the southern portion of the Roy-Hart School Property in 1999 (Roy-Hart ICM) (CRA 2000)
- 14 residential properties on South Vernon Street and Main Street, ROWs north and south of FMC-owned Niagara Street, and public ROWs adjacent to the residential properties in 2003 (West Properties ICM) (Geomatrix [GMX] 2007)
- Areas, partially extending onto the Roy-Hart School Property and the Wooded Parcel off Elizabeth Street, along a railroad drainage ditch in 2005 (Phase 1 North Railroad ICM) (BBL 2006)
- 12 residential properties along Park Avenue and Maple Avenue (P-Block properties P1 through P9 and P11 through P13) and the Wooded Parcel off Elizabeth Street in 2007 and 2008 (Early Action) (ARCADIS 2009)

In each of these projects, the proposed backfill was tested for arsenic and other constituents to confirm that the soil was “clean,” and was pre-approved by the Agencies for use as backfill.

The NYSDEC issued a Record of Decision for the Bleacher ICM area in February 1999 (NYSDEC 1999). By letter dated May 26, 2000, the Agencies informed the Roy-Hart School District that “the Agencies have determined that the entire school yard is suitable for both athletic and non-athletic uses by all school children, in terms of their exposure to known school yard soil arsenic levels,” with final remedial decisions subject to the completion of the RFI and CMS process. In February 2004, the Agencies issued letters to the owners of the 14 residential properties addressed by the 2003 West Properties ICM and to the Village of Middleport, stating that the arsenic concentrations in soil at the properties and adjacent public ROWs did not require any restriction on the use of the

properties. In December 2008, the Agencies issued letters to the owners of 10 P-Block residential properties that were addressed by the Early Action in 2007, stating that the arsenic levels at the properties were consistent with area residential background concentrations (3.3 to 21.1 mg/kg) determined from the February 2003 Report on the Development of Arsenic Background in Middleport Soils (CRA 2003), that there was no reason to restrict the use of the properties, and that no further sampling or other actions are necessary at this time. The owners of the two P-Block residential properties addressed by the Early Action in 2008 (P11 and P12) are expected to receive similar letters from the Agencies. Copies of the Agencies' May 2000, February 2004, and December 2008 letters are provided in Appendix A.

2.3 Agencies' "No Further Action" Letters

On February 22, 2007, the Agencies issued letters to the owners of 46 residential properties sampled in 2004 to 2005 within the geographical boundaries of Air Deposition Study Area 1. The locations of the 46 properties are shown by yellow shading on Figure 2.1. The letters stated that the concentrations of arsenic in soil at those properties were consistent with residential background concentrations in the area (range of 3.3 to 21.1 mg/kg, and allowing for data variability above this range), and that no further sampling or other actions were required. Copies of the Agencies' February 2007 letters are provided in Appendix A.

2.4 Current and Historical Land Uses

The municipal zoning of land in Air Deposition Study Area 1 is shown on Figure 2.2. Historical uses of land in Air Deposition Study Area 1 are indicated on Figure 2.3, based on information obtained from fire insurance maps and aerial photographs (provided in Appendix 2E of RFI Report Volume I [ARCADIS and AMEC 2008]). This section summarizes the current and historical land uses within Air Deposition Study Area 1; a more detailed discussion is provided in RFI Report Volume I.

Current land uses surrounding the Facility include the following:

- To the east and northeast: Agricultural fields.
- To the north: The Roy-Hart School Property and the "North Commercial/Industrial Area," which includes the Wooded Parcel that was part of the 2007 Early Action activities, a machine shop, vacant buildings, and a former coal shed. Properties farther to the north of these properties consist primarily of single-family residences, extending to the Erie Canal.
- To the west: Residential properties that were part of the 2003 West Properties ICM, and other residential and commercial properties west of South Vernon Street.

- To the southwest: Former FMC R&D property, which currently includes a large vacant building and a smaller building occupied by a trucking company, with residential and commercial properties farther to the southwest.
- To the southeast: An electrical substation, a tractor repair shop, and an automobile salvage yard, with other properties zoned light industrial farther to the southeast.
- To the south: Properties along the south side of Route 31 consist of a drive-in theatre, a church, a wrecking and salvage yard, the Middleport Rotary Park and scout house, residences, and commercial businesses and offices.

Portions of the Roy-Hart School Property, the Wooded Parcel (which is no longer wooded following performance of the 2007 Early Action activities), and agricultural and residential properties to the northeast of the Facility were formerly occupied by orchards in the early 1900s (refer to Figure 2.3). In the same time period, several manufacturing facilities were located in the North Commercial/Industrial Area north of the Facility and to the west along Main Street and Tributary One, lumber yards were located between the Canal and State Street, west of Washington Street, and properties to the south across Route 31 were used as agricultural fields. Further, properties to the northeast and east of the Facility have been used as agricultural fields since the early 1900s.

2.5 Historical Air Deposition Modeling

In 1987, the NYSDEC performed modeling of fugitive air emissions (i.e., wind-blown dust) originating from the ground surface of the entire Facility. In 1996, as part of the RFI, FMC commissioned a review of the NYSDEC 1987 air dispersion modeling efforts and the performance of an updated study, which modeled historical air emissions from arsenic-based operations (primarily stack emissions from three product dryers and an arsenic unloading area) that were conducted at the Facility from approximately 1928 to 1974. The results of this review and study were presented to the Agencies in 1996, and were included in Appendix 2C of the 1999 Draft RFI Report (CRA 1999a). The results are also provided in Appendix 2C of RFI Report Volume I, along with an analysis of uncertainties associated with the modeling that was provided to the Agencies in the Soil Sampling Work Plan – Areas Potentially Affected By Historic Air Deposition (BBL 2004).

Based on the 1996 air modeling study, potential air deposition from pre-1974 arsenic-based product operations at the Facility occurred primarily to the north-northeast of the Facility (refer to wind rose diagram provided in Figure 5.1 of RFI Report Volume I). The scope of subsequent soil sampling and analysis events for Air Deposition Study Area 1 was developed based in part on the results of the 1996 air modeling efforts.

2.6 Description of the Culvert 105 South Study Area

Culvert 105 is a municipal stormwater drainageway. South of the Erie Canal, this drainageway consists entirely of buried pipes. 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 (FMC acquired this property from Conrail in 2002, and it is now part of the “North Railroad Property”). From here it extends north as a buried pipe beneath 16 properties, passes under the Erie Canal, and then continues as a combination of buried pipe and open ditch sections until it discharges to Tributary One of Jeddo Creek, just north of the Village of Middleport wastewater treatment plant.

It is reported by some local property owners that Culvert 105 was originally 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 Figure 2.4).

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 II of the RFI Report. Table 2.1 and Figure 2.4 summarize the results of the video inspection, GPR, and hand probing efforts regarding the construction and alignment of the buried pipe sections south of the Erie Canal.

Culvert 105 south of the Erie Canal currently receives surface water runoff (e.g., rainfall, snow melt) from private properties (i.e., residential properties, commercial properties, and the North Commercial/Industrial Area), from public streets 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, farm 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 2.7 below) situated north of the mainline railroad track. Following the implementation of the North Railroad Property Phase 1 ICM work in 2005, stormwater runoff from the southern portion of the North Railroad Property does not drain to the North Ditch and Culvert 105.

2.7 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 Facility 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 Facility. These ditches emptied into Culvert 105 (refer to Figure 2.9 of RFI Report Volume I).

In 1976, FMC re-graded the Facility to segregate surface runoff from the north side of the Facility, where manufacturing and formulation activities continued to be conducted, from the south side, and ceased discharge of stormwater runoff from this area to the Northern Ditches. Surface water runoff from the north side of the Facility was originally collected in the lined Western Surface Impoundment, or WSI, prior to treatment at the on-Site Water Treatment Plant and discharge to Tributary One under the terms of a pollutant discharge elimination system permit (initially an 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 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 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/sediments within the invert of the North and South Ditches. Approximately 8 to 12 inches of soil/sediment was removed from the invert of the North and South 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 4.4 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 to enable installation of an engineered cover system, the re-grading 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 discharges to Culvert 105. Refer to Section 4.6.4 and Figure 4.5 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 the Erie Canal (refer to Figure 2.4 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 covering Culvert 105 at the Wooded Parcel and replacement with clean backfill, including a 48-inch thick buffer of clean backfill along the southern and eastern sides of the Wooded Parcel
- Removal and disposal of accumulated sediments in manholes and catch basins along Culvert 105 south of the Erie Canal

Additional remedial actions were conducted along Culvert 105 north of the Erie Canal in 2007. Section 4.11 of RFI Report Volume I presents additional information on the 2007 Early Action activities.

3. Review of Sampling and Analysis

A chronology of the soil sampling programs conducted in Air Deposition Study Area 1 and of the soil and sediment sampling programs conducted in the Culvert 105 South Study Area is presented in Table 3.1, including a summary of the analyses conducted in each program. The sampling and analysis activities conducted within Air Deposition Study Area 1 and the Culvert 105 South Study Area have included the following efforts:

- 1985 Roy-Hart Surface Soil Sampling & Analysis Program
- 1986 NYSDEC Roy-Hart Site Investigation
- 1987 Roy-Hart Supplemental Soil Sampling & Analysis Program
- 1987 Roy-Hart Comprehensive Sampling Program
- 1989 NYSDOH Sampling Program
- 1990 - 1993 Off-Site Investigation (OSI)
- 1995 RFI Phase II Investigations
- 1996 RFI Phase III - Supplemental Sampling
- 1996 Bleacher Area IRM Excavation
- 1996 Under Bleacher Area and Football Field Sampling
- 1996 - 1998 Additional Off-site Arsenic Soil Sampling Programs
- 1998 - 1999 Roy-Hart ICM Sampling & Excavation
- 2002 Sampling Program
- 2003 West Properties ICM Area Sampling & Excavation
- 2003 - 2004 Middleport Environmental Exposures Investigation
- 2004 RFI Tributary One and Culvert 105 Study Area Sampling
- 2004 - 2005 RFI Air Deposition Study Area 1 Sampling
- 2007 Early Action Sampling

Figure 3.1 depicts the locations of the 232 properties where samples were collected during the 2004-2005 RFI sampling program (yellow shading), 2 properties where samples were subsequently collected during the 2007 Early Action activities (green shading), 24 properties where samples were proposed but not collected during the 2004-2005 RFI program because access permission could not be obtained (gray shading), and 7 properties where sampling was not performed due to the presence of extensive pavement or imported fill at the property (orange shading). Sampling locations at these properties as well as other properties where remedial actions were conducted prior to 2004 are shown on Figures 3.2 through 3.34, organized by geographic sub-areas.

The analytical data from these programs are tabulated (organized by individual property) in Appendix C for arsenic and in Appendix D for all other constituents. As referenced in the following sections, descriptions of soil sample collection and validation of the sample results for samples collected from 1985 through 2003 were previously presented in the 1999 Draft RFI Report (CRA 1999a) and in subsequent reports submitted to the Agencies. A comparable description for samples collected from 2004 through 2007 is provided in Appendix E.

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 is 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 (OSI) under an administrative consent order with the NYSDEC. Soil samples were analyzed for constituents on the "Off-Site Parameter List," 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 is provided for reference in Table 3.2 of this Volume II of the RFI Report, and included arsenic, lead, other metals, chlorinated pesticides, chlorinated herbicides, organophosphate pesticides, furans, methyl carbamates, and phenols. Twenty-four of the 52 compounds were detected in soil samples collected within Air Deposition Study Area 1 during the OSI. The constituent that was most frequently detected was arsenic. To a lesser extent, lead and some chlorinated pesticides were also detected. The OSI is discussed in more detail in Section 3.7.

With the concurrence of the Agencies, investigations of soil within Air Deposition Study Area 1 subsequent to the OSI focused on arsenic. Some soil samples in certain areas were also tested for lead and Site-specific chlorinated pesticides, and during some of the programs soil samples were tested for other compounds not on the Off-Site Parameter List. The results of these analyses are included in this Volume II of the RFI Report.

3.2 1985 Roy-Hart Surface Soil Sampling & Analysis Program

In November 1985 soil samples were collected by FMC from the 0- to 6-inch depth interval at eight locations at the Roy-Hart School Property and analyzed for arsenic, mercury, phenol, and carbofuran, with some of the samples also analyzed for other

metals, chlorinated pesticides, volatile organic compounds (VOCs), and semi-volatile organic compounds (SVOCs) (refer to Table 3.1 for specific sample counts). The results were provided in the report titled "Surface Soil Sampling and Analysis Program, Royalton-Hartland and Gasport School Properties" (CRA 1986). Sampling locations associated with this event are identified as "SS-#85" on Figures 3.4 and 3.5. Soil at locations corresponding to three of the eight samples was excavated during the 1999 Roy-Hart ICM, and soil at the location corresponding to one of the samples was removed during construction of a parking lot by the School District in the late 1990s.

3.3 1986 NYSDEC Roy-Hart Site Investigation

In 1986, the NYSDEC collected 27 soil samples from the 0- to 6-inch and 18- to 24-inch depth intervals at 14 locations at the Roy-Hart School Property. These samples were analyzed for arsenic, lead, chlorinated pesticides and furans. 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 1987b). Sampling locations associated with this event are identified as "1" to "14" on Figures 3.4 and 3.5. Soil at locations corresponding to 22 of the 27 samples was excavated during the 1996 Bleacher Area IRM and/or the 1999 Roy-Hart ICM.

3.4 1987 Roy-Hart Supplemental Soil Sampling & Analysis Program

In March 1987, FMC collected soil samples from the 0- to 6-inch depth interval at six locations between the school bleachers and the drainage ditch on the north side of the railroad tracks to supplement the November 1985 program results for arsenic and lead. The results were provided in a report titled "Supplemental Soil Sampling and Analysis Program, Royalton-Hartland School Property, Middleport, New York" (CRA 1987). Sampling locations associated with this event are identified as "SS-#87" on Figure 3.4. Soil at locations corresponding to all of the samples was excavated during the 1996 Bleacher Area IRM.

3.5 1987 Roy-Hart Comprehensive Sampling Program

In December 1987, soil samples were collected by FMC under an administrative consent order with NYSDEC from the 0- to 6-inch depth interval at 78 locations at the Roy-Hart School Property and analyzed for arsenic and lead. The results were provided in the report titled "Comprehensive Sampling Program, Royalton-Hartland School Property, Middleport, New York" (CRA 1988). Sampling locations associated with this event are identified as "RH###" on Figures 3.4 and 3.5. Soil at locations corresponding to 21 of the 78 samples was excavated during the 1996 Bleacher Area IRM and/or the 1999 Roy-Hart ICM, and soil at locations corresponding to two samples was removed during construction of a building addition and parking lot by the School District in the late 1990s.

3.6 1989 NYSDOH Sampling Program

In 1989, the NYSDOH collected 10 soil samples from residential and industrial properties north of the Facility. The samples were all collected from the 0- to 3-inch depth interval and were analyzed for arsenic, lead, and other metals. The NYSDOH documented the results of this sampling event in a report dated March 27, 1989 (NYSDOH 1989). The samples are identified as "DOH-SS#" on the figures. Soil at locations corresponding to 3 of the 10 samples was excavated during the 2007 Early Action activities.

3.7 1990 - 1993 Off-Site Investigation

Soil samples were collected within Air Deposition Study Area 1 as part of the OSI at the Roy-Hart School Property and at six residential properties west of the Facility. The results are presented in the Off-Site Investigation Report (CRA 1993). During this investigation, 10 samples (identified as "S#" on the figures) were collected from the upper 6 to 18 inches at residential properties. Soil at locations corresponding to all of these samples was subsequently excavated during the West Properties ICM. Also, 19 discrete and three composite samples (identified as "BH#") were collected from three borings advanced to depths of 10 to 12 feet at the Roy-Hart School Property, with soil at locations corresponding to 5 of the 19 discrete samples subsequently excavated during the 1996 Bleacher Area IRM and/or the 1999 Roy-Hart ICM. All of these 32 samples were analyzed for arsenic and lead, with some also analyzed for other compounds on the "Off-Site Investigation Parameter List" (Table 3.2 of this Volume II of the RFI Report), including other metals, chlorinated pesticides, phenols, and furans.

3.8 1995 - 1996 RFI Phase II Sampling

As part of the RFI, in September 1995 four soil samples were collected at two locations (identified as "BH-C#" on Figure 3.31) in the field east of the former location of the Eastern Surface Impoundment (ESI). The samples were analyzed for arsenic, lead, other metals, chlorinated pesticides and ethylene thiourea (ETU). Soil samples were collected at two similar locations/depth intervals in July 1996 and analyzed for arsenic, lead, other metals, and chlorinated pesticides.

3.9 1996 RFI Phase III - Supplemental Sampling

In July 1996, the NYSDEC collected samples from the upper 3 inches of soil at 15 locations on residential and commercial properties north, northwest, and west of the Facility, and at three locations in the Rochester Road (Route 31) ROW. All of the samples were split with FMC and were analyzed for arsenic, with two samples also analyzed for chlorinated pesticides. The samples are identified as "NWSS#", "WSS#" or "A#-#" on the figures. Soil at locations corresponding to 6 of the 15 samples was excavated during the 2003 West Properties ICM.

3.10 1996 Bleacher Area IRM Excavation

In 1996, FMC implemented an IRM to remove soil to the south and west of the southern bleachers at the Roy-Hart School Property. Soil was removed to a minimum depth of 2 feet. Twelve soil samples were collected at the limits of the excavation, and two samples were collected from a narrow lens of black soil that was subsequently excavated. These samples were analyzed for arsenic, with some of the samples also analyzed for lead, chlorinated pesticides, other metals, and PCBs. Based on the results for the 14 samples, additional soil was excavated and then another post-excavation sample was collected and analyzed for arsenic and lead. These 15 samples are identified as "BAE-##" or "RBAE-##" on Figure 3.5a.

The IRM was performed in accordance with the provisions of an administrative consent order (Index No. B9-0221-96-06 IRM) between the NYSDEC and FMC, effective July 8, 1996 (NYSDEC and FMC 1996). A summary of the Roy-Hart School Bleacher Area IRM project is presented in the "Bleacher Area Excavation Project, Final Construction Report," dated October 1996 and revised January 1997 (CRA 1997). The NYSDEC approved the report by letter dated February 12, 1997 (NYSDEC 1997) and issued the Record of Decision, FMC Corporation Operable Unit 4, Bleacher Area, Village of Middleport, Niagara County, Site Number 9-32-014 in February 1999 (NYSDEC 1999).

3.11 1996 Under Bleacher Area and Football Field Sampling

In 1996, the NYSDEC collected additional soil samples from beneath the southern bleachers and at the adjacent football field at the Roy-Hart School Property. Split soil samples provided to FMC were analyzed by FMC. A total of 34 soil samples were collected from depths ranging from 3 to 24 inches at 14 locations and were analyzed for arsenic. Select samples were also analyzed for lead and/or chlorinated pesticides. The sampling locations are identified as "UBC-#" or "SB-#" on Figures 3.5a and 3.5b. Soil at locations corresponding to all of these samples was subsequently excavated during the 1999 Roy-Hart ICM (CRA 2000).

3.12 1996 - 1998 Additional Off-site Arsenic Soil Sampling Programs

In November 1996, the NYSDEC collected soil samples from 17 locations on residential properties northwest and west of the Facility, and FMC collected soil samples from seven locations on commercial and agricultural properties south and east of the Facility. In April 1997, the NYSDEC collected soil samples from 16 locations on residential and commercial properties northwest and west of the Facility, and FMC collected soil samples from four locations on agricultural properties east of the Facility. In December 1998, the NYSDEC collected soil samples from six locations on residential properties northwest and west of the Facility. All of these 50 samples were collected from the upper 2 or 3 inches of soil and all were analyzed for arsenic by FMC or the NYSDEC. These sampling locations

are identified as "NWSS#", "WSS#", "C#", "A+#" and "AA+#" on the figures. The 1996 and 1997 results are presented in the 1999 Draft RFI Report (CRA 1999a).

3.13 1998 - 1999 Roy-Hart ICM Sampling & Excavation

In 1998, the Agencies determined that an ICM was required to remove arsenic-containing soil from an area situated in the southern portion of the Roy-Hart School Property, including the football field, track, school bus garage parking lot, and surrounding area (hereafter called the Agencies' Roy-Hart ICM Area). In December 1998, FMC collected approximately 440 surface and subsurface soil samples from 120 locations on a grid pattern within the Agencies' Roy-Hart ICM Area. The samples are identified as "letter-##-98" and were analyzed for arsenic, with 47 samples also analyzed for lead. In April 1999, 139 additional soil samples were collected from 64 locations on the same grid pattern extended farther to the east and to the northeast of the Agencies' Roy-Hart ICM Area. These samples were identified as "letter-1##-99" and were analyzed for arsenic only. Based on these results, the excavation area was extended northeast and east of the Agencies' ICM Area.

In May 1999 a comparison study was conducted by the Agencies to evaluate whether there was a statistical difference in arsenic concentration for samples collected from the 0- to 3-inch depth interval compared to the 0- to 6-inch interval at the Roy-Hart School Property. Samples were collected from both depth intervals at 20 locations (identified as "599-#"). The results are presented in the "ICM Work Plan: Roy-Hart School Football Field Area Excavation Project" (CRA 1999b). As stated in the Agencies' June 24, 1999 letter which approved the 1999 ICM Work Plan, the Agencies concluded that "there was not a significant difference in arsenic levels between soil samples taken from the 0- to 3-inch and 0- to 6-inch depth intervals. The results were also consistent with surface soil arsenic data obtained from previous school yard sampling programs, and did not indicate any single area where arsenic levels in the surface soils were significantly elevated in comparison to the levels found over the entire school yard, outside of the ICM area (i.e. no new "hot spots")."

The ICM area was divided into grid sub-areas based on the planned excavation depth, as determined by the pre-excavation soil data. During soil remedial activities, 216 confirmation samples were collected by the Agencies from 200 locations at the limits of the excavation and analyzed for arsenic and lead, with 22 of the samples also analyzed for chlorinated pesticides. By letter dated May 26, 2000, the Agencies informed the Roy-Hart School District that "the Agencies have determined that the entire school yard is suitable for both athletic and non-athletic uses by all school children, in terms of their exposure to known school yard soil arsenic levels," with final remedial decisions subject to the completion of the RFI and CMS process. Following construction of the new athletic facilities (e.g., football field, all-weather track, bleachers, lighting, concession stand,

fencing), the “ICM Construction Report, Roy-Hart School Football Field Area Excavation Project” (CRA 2000) was submitted to the Agencies in November 2000.

3.14 2002 Sampling Program

In 2002, pursuant to an approved work plan (CRA 2002), FMC collected soil samples from locations at the Facility’s former outfall on the west side of the Facility and along the former storm sewer alignment, the North Commercial/Industrial Area, Tributary One, and properties to the west and northwest of the Facility. A total of 380 soil samples were collected from 116 locations within Air Deposition Study Area 1 and analyzed for arsenic. Fifty-seven of the soil samples were also analyzed for lead and 44 were analyzed for chlorinated pesticides. The data were presented in the report titled “Draft 2002 Sampling Program Report” (CRA and GMX 2003). The sampling locations are identified as “A1-##”, “A2-##” or “TP-#” on Figures 3.6, 3.7 and 3.22. Of these 380 samples, soil at locations corresponding to 164 samples was excavated during the 2003 West Properties ICM and soil at locations corresponding to 45 samples was excavated during the 2007 Early Action activities.

3.15 2003 West Properties ICM Area Sampling & Excavation

In 2003, FMC excavated soil from the West Properties ICM Area (refer to Figures 3.6a and 3.6b) and removed the Facility’s former outfall sewer. The ICM area included 14 residential properties, public ROWs, and adjoining Facility property. The excavation depths ranged from 0.5 to 7 feet below grade. A total of 345 additional samples at 79 locations were collected and analyzed for arsenic, with some samples also analyzed for lead and chlorinated pesticides. Soil at locations corresponding to 178 samples was excavated (refer to tables in Appendix C and Appendix D) during the West Properties ICM. The completed ICM activities are described in the Construction Report for the West Properties Soil and Former Sewer Removal ICM (GMX 2007), which was approved by the Agencies on January 4, 2007.

3.16 2003 - 2004 Middleport Environmental Exposures Investigation

From November 2003 through January 2004, FMC collected composite surface soil samples as part of a biomonitoring and exposure study. The locations of the samples collected within Air Deposition Study Area 1 are indicated on Figure 3.34. The data are presented in the report titled “Middleport Environmental Exposure Investigation” (Exponent 2004). A total of 88 composite samples at 40 properties were collected within Air Deposition Study Area 1 and analyzed for arsenic. The data are provided in a separate table in Appendix C. The composite soil sampling and analyses activities performed as part of this study were submitted to but not reviewed or approved by the Agencies.

3.17 2004 RFI Tributary One and Culvert 105 Study Area Sampling

A sampling and analysis effort to further characterize the extent of off-site arsenic in soil and sediment along Tributary One and Culvert 105 was implemented in 2004. Soil and sediment sampling was conducted based on work plans approved by the Agencies, as discussed in Appendix E (there were two phases of work that were relevant to the RFI Volume II study areas). Samples collected as part of this program within the Culvert 105 South Study Area included 137 soil samples from 29 locations along six transects straddling the Culvert 105 buried pipe, 4 sediment samples collected from 4 locations within the base of accessible manholes and catch basins, and 1 sediment sample collected within the buried pipe during repair of a break in the pipe. These sampling locations are shown on Figure 3.3. In addition, 16 soil samples were collected from 4 locations at Property BA1 along Tributary One within Air Deposition Study Area 1 (Figure 3.25). All of these 158 samples were analyzed for arsenic. Two soil samples collected adjacent to the break in the buried pipe on Property J4, 1 sediment sample collected within the buried pipe at this break, and 4 sediment samples collected within the base of a catch basin, and three manholes of Culvert 105 were also analyzed for chlorinated pesticides. Sediment at locations corresponding to the five sediment samples was later removed during either the repair of the break in the pipe by the Village in 2004 or during the Early Action activities in 2007-2008, and soil at locations corresponding to 13 soil samples was excavated from the Wooded Parcel during the Early Actions in 2007-2008 and replaced with clean fill.

3.18 2004-2005 RFI Air Deposition Study Area 1 Sampling

A sampling and analysis effort to further characterize the extent of off-site soil arsenic within Air Deposition Study Area 1 was implemented in 2004. FMC and the Agencies agreed during development of the sampling and analysis scope of work in 2004 that arsenic was the primary constituent of concern in Air Deposition Study Area 1. As a result, soil sampling efforts described in the approved July 2004 Soil Sampling Work Plan (BBL 2004) and in subsequent addenda were limited to the delineation of the horizontal and vertical extent of total arsenic within the study area.

Soil sampling was conducted based on work plans approved by the Agencies, as discussed in Appendix E. Selection of properties for sampling was based on the 1996 FMC air deposition modeling effort, previously collected soil arsenic data in comparison to the 2001-2003 Gasport background soil arsenic data (CRA 2003), and comments from the Agencies. As indicated on Figure 3.1, 232 private properties were sampled as part of this program.

During the 2004 sampling events, 2,684 samples were collected by FMC from 1,240 locations and analyzed for arsenic only by FMC and/or by the Agencies. Based on these

initial results, 522 additional soil samples were collected by FMC from 212 locations in December 2005 and analyzed for arsenic.

3.19 2007 Early Action Sampling

In 2007, additional samples were collected from 11 P-Block residential properties to further define the depths of soil to be excavated as part of the 2007 Early Action activities. Samples were also collected in 2007 from two properties where access was not previously available in 2004 (properties P6 and J10). A total of 324 samples were collected from 55 locations at these 13 properties from May to August 2007 and analyzed for arsenic. Further, eight samples were collected in 2007 from each of two borings at the Wooded Parcel, within the protected root zone of a 24-inch fir tree on the adjoining P10 property for which access was not obtained. Soil at locations corresponding to 93 samples collected in 2004 and 104 samples collected in 2007 was excavated as part of the 2007 Early Action at the Wooded Parcel and the P-Block properties. Refer to Appendix E for a more detailed description of the 2007 sampling and analysis.

4. Presentation of Data Set

From 1985 through 2007, a total of 5,623 soil samples were collected from properties within Air Deposition Study Area 1 and analyzed for arsenic (refer to Table 4.1). Of these soil samples, 137 were collected from transects along Culvert 105 south of the Erie Canal. In addition, five samples of accumulated sediment were collected from within the buried pipe, catch basins or manholes of Culvert 105 south of the Erie Canal. Duplicates and/or split samples were analyzed for approximately 20% of these 5,623 samples for quality assurance and quality control (QA/QC) purposes. Sub-sets of the samples were analyzed for lead, chlorinated pesticides, and/or other constituents.

Soil corresponding to 1,093 of the soil samples was removed and replaced with clean fill (refer to Appendix C for arsenic data for clean fill) as part of remedial actions by FMC (refer to Section 2.2), and soil corresponding to five additional samples is presumed to have been either removed or regraded by others, as discussed in Section 4.2. Further, sediment corresponding to all five sediment samples was removed either during repair of a break in the pipe in 2004 or during the 2007 Early Action activities.

This section discusses the preparation of the data set, an evaluation of the usability of the data set, and the identification of potential statistical outlier data points.

4.1 Combined Results

In this RFI Report, results for samples with duplicate and/or split samples were combined for a given unique sampling location and depth interval 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

The validation and usability of the analytical data for soil samples collected from 1985 through 2003 were variously discussed in the 1999 Draft RFI Report (CRA 1999a) and in the other reports referenced in Section 3 of this Volume II of the RFI Report. The validation and usability of the analytical data for soil and sediment samples collected from 2004 through 2007 are presented in Appendix E. All of the soil analytical data for Air Deposition Study Area 1 and all of the soil and sediment analytical data for the Culvert 105 South Study Area are acceptable to use for the purpose of evaluating the nature and extent of constituents, with the following limitations:

1. The Agencies' data for chlorinated pesticides in two split samples collected in the July 1996 Supplemental Sampling Program (samples "WSS-7" and "WSS-8") were identified in the 1999 Draft RFI Report as rejected during data validation (Section 7 of the 1999 Draft RFI Report [CRA 1999a]) and are not included in the database. However, FMC's data for the analysis of the same samples for chlorinated pesticides are considered usable, and the results for arsenic and lead produced for these samples by both the Agencies and FMC are usable.
2. Samples collected in the 2004 Environmental Exposures Investigation (88 samples designated as "Y0##") and three samples collected during the 1990-1993 OSI ("samples "BH-#" are composites; the data are valid and usable, but are not used in the delineation of the extent of arsenic presented in Section 6 because discrete samples are available in the database that were collected from either the same locations and depths ("BH-#" series) or at the same depths at nearby locations on the same property ("Y0##" series).
3. Sediment corresponding to five locations where samples were collected of sediment within the Culvert 105 buried pipe, manholes, or catch basins south of the Erie Canal was later removed during either the repair of the break in the pipe in 2004 or during implementation of the 2007 Early Action remedial activities. The data for these sediment samples are valid and usable, but are not representative of current conditions.
4. Soil corresponding to 137 locations where soil samples were collected along Culvert 105 south of the Erie Canal was later excavated by FMC during implementation of the 2007 Early Action remedial 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 backfill soil data table in Appendix C). The data for these soil samples are valid and are used in this report, but are not representative of current conditions.

5. Soil corresponding to 956 additional locations where soil samples were collected within Air Deposition Study Area 1 was later excavated by FMC during implementation of the IRM, ICM and Early Action remedial activities (reference Section 2.2) and replaced with clean backfill with arsenic concentrations ranging from 2.6 to 10.5 mg/kg (refer to Figure 2.1 and backfill soil data table in Appendix C). The data for these 956 samples are valid and are used in this report, but are not representative of current conditions.
6. Soil corresponding to the locations of five additional soil samples is believed to have been either removed or regraded by others, so that the sample analytical results no longer represent current conditions. Soil at sample locations SS-3-85, RH-62 and RH-64 is understood to have been removed during construction of an addition to the high school and expansion of a parking lot at the Roy-Hart School Property in the late 1990s. Soil at sample location WSS-26 is believed to have been removed during remediation activities at Property R6, a gasoline station, in 2005. Soil at sample location WSS-27 appears to have been regraded or removed during landscaping at Property T7, since sample WSS-27 had an arsenic concentration of 103 mg/kg but Property T7 was included in the Agencies' group of properties receiving the February 2007 'No Further Action' letters stating that the data were consistent with background.

Table 4.2 summarizes the usable combined analytical results for soil and sediment samples collected within Air Deposition Study Area 1 and the Culvert 105 South Study Area for each constituent, including the number of samples subsequently excavated.

4.3 Identification of Potential Statistical Outlier Data Points

Statistical outlier data points ("outliers") are concentrations that do not conform to the pattern established by the other values in the data set (Gilbert 1987). Outliers deviate from other measurements and, therefore, may introduce bias into estimates of population parameters and summary statistics (USEPA 2006). The arsenic data collected for the upper 12 inches of soil in Air Deposition Study Area 1 were evaluated to identify potential statistical outliers with a value greater than 20 mg/kg (the delineation criterion). The identification of potential statistical outliers in the soil arsenic data set for Air Deposition Study Area 1 is one line of evidence that data points may not be associated with migration from the Facility (discussed further in Section 9). The presence of a potential statistical arsenic data outlier does not necessarily indicate the absence of FMC-related arsenic on the property.

Potential statistical outliers were identified by the "Moran's Index" method, which is a common method used to statistically analyze the spatial pattern of data. Use of the Moran's Index method for this purpose is discussed in the USEPA's Risk Assessment Guidance for Superfund (USEPA 2001). Moran's Index was calculated using ArcGIS 9.2

(ESRI 2008), a two-dimensional analysis program. All of the arsenic soil data in each of the 0- to 3-inch, 3- to 6-inch, 6- to 9-inch and 9- to 12-inch layers were evaluated separately. A discussion of the analysis is provided in Appendix F.

This analysis identified 23 soil samples at 18 locations in the upper 12 inches of soil within Air Deposition Study Area 1 as potential statistical outliers (refer to Table 4.3). The locations of the samples are shown on Figure 4.1.

5. Discussion of Potential Sources of Arsenic in Soil

Arsenic is a naturally occurring element in soil, and is also present in soil 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 sample collected in Air Deposition Study Area 1 and the Culvert 105 South Study Area is derived from a combination of several sources, as follows:

- Natural geologic conditions
- Potential non-Site-related anthropogenic sources
- Potential historical air deposition from past operations at the FMC Facility
- Potential historical surface water migration from the FMC Facility via Culvert 105

To evaluate the extent of arsenic in soil in Air Deposition Study Area 1 and the Culvert 105 South Study Area that is potentially derived from historical releases from operations at the FMC Facility, the amount of arsenic present in soil 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.

5.1 Potential Non-Site-Related Anthropogenic Sources

Potential anthropogenic sources of arsenic within Air Deposition Study Area 1 not related to past Facility operations include:

- Applying arsenic-containing pesticides at historical orchards (refer to Figure 2.3) and in the treatment of trees
- Applying 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
- Using 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 some of the properties within Air Deposition Study Area 1 and 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 Air Deposition Study Area 1, including the former locations of orchards, agricultural land, the handling of coal, and manufacturing operations were presented in Figure 2.3, based on historical aerial photographs, Sanborn fire insurance maps, and information from property owners. Information regarding the potential for these sources to have existed at each property sampled in Air Deposition Study Area 1 and the Culvert 105 South Study Area based on information provided by the property owner and observations during the 2004-2005 RFI sampling events is summarized in Table 5.1. For properties that are within the area to be evaluated in the CMS (refer to Section 9 of this Volume II of the RFI Report), 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 (reference Merwin et al 1994, Bishop et al 1961, Peryea 2004, Dragan et al 1991, Woolson 1975, Gianessi et al 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). 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 Air Deposition Study Area 1 and Culvert 105 South Study Area soils. 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 the following section 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.

5.2 Background Levels of Arsenic in Middleport 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 5.2a, and are summarized by property type/usage (e.g., orchard, residential) in Table 5.2b.

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 5.3).

In 2004 additional historical aerial photographs of the Middleport Study Area 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. 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.

5.3 Arsenic Soil Screening Level

In letters dated March 10, 2008 (Agencies 2008) and September 24, 2007 (Agencies 2007), the Agencies advised that the appropriate criterion for delineation of FMC-related arsenic in the Middleport area soil should be 20 mg/kg (based on the weighted 95th percentile calculated in the 2001-2003 Gasport background study), with consideration given to other factors (e.g., data variability, flood zone topography, wind patterns, ground features, etc.) that could influence air deposition. By letter dated March 28, 2008 (FMC 2008) FMC agreed to the Agencies' directive, and stated that the information concerning the new aerial photographs, revised historical land use percentages and weighting factors, and associated statistical values of the calculated arsenic soil background concentrations would be included in the appropriate RFI and CMS Report volumes (refer to Table 5.3). In addition, in this letter FMC confirmed that the soil arsenic "delineation" criterion is fundamentally different from a "remediation" criterion. In other words, soil containing arsenic above 20 mg/kg may or may not be required to be remediated in the future. The nature and scope of any final corrective measures will be based on the outcome of a Corrective Measures Study.

6. Distribution of Arsenic in Soil in Air Deposition Study Area 1

This section presents the statistics of the soil arsenic data set for Air Deposition Study Area 1 (including soil samples collected within the Culvert 105 South Study Area) by property, and the horizontal and vertical distribution of the data set. A weight-of-evidence evaluation of the potential source(s) of arsenic observed at specific locations is provided in Section 9.

6.1 Statistics of the Soil Arsenic Data by Property

The statistics of the soil arsenic data set (collected at all depths), organized by individual property are presented in Table 6.1, with the exception that the 46 properties that received the February 2007 'No Further Action' letters from the Agencies are presented in Table 6.2. Both of these tables are based on data for samples collected at all depths and corresponding to soil that remains in Air Deposition Study Area 1 following the IRM/ICM/Early Action remedial activities and other construction and landscaping activities (refer to Section 4.2 of this Volume II of the RFI Report). The statistics include the arithmetic mean, maximum, and 95% upper confidence level (UCL) of the soil arsenic data for the respective property.

A frequency plot of the number of properties exhibiting a particular arithmetic mean, 95% UCL and maximum soil arsenic concentration is presented in Figure 6.1 for both the 46 properties that received the Agencies' "No Further Action" letters and for the other 173 properties in Air Deposition Study Area 1 that were sampled during the RFI program (excepting grid sampling areas R1a, R1b, R1c, and R1d), and that have not been the subject of the IRM/ICM/Early Action remedial activities.

6.2 Horizontal Extent of Soil Arsenic

The spatial distribution of arsenic in soil in Air Deposition Study Area 1 prior to the implementation of any of the IRM, ICM, and Early Action remedial activities is depicted on Figures 6.2 through 6.5 for the 0- to 3-inch, 3- to 6-inch, 6- to 9-inch and 9- to 12-inch depth intervals, respectively. Figures 6.2 through 6.4 were generated using Mining Visualization System (MVS) (C Tech Development Corporation 2007), a two-dimensional model that interpolates between data points, independently for each depth interval. In each figure, if a sample result is available in that depth interval, then the sample location is shown. Then, the sample locations and intermediate areas between locations are color-coded, based on concentration. In Figure 6.5, only the sample location is color-coded. Sample locations with concentrations less than 20 mg/kg are not shaded (areas of white), while locations with concentrations greater than 20 mg/kg are assigned colors ranging from gray (20 to 25 mg/kg) to purple (greater than 60 mg/kg).

Comparable figures depicting current conditions, following implementation of the remedial activities, are provided in Figures 6.6 through 6.9 for each depth interval, respectively. The IRM/ICM/Early Action remedial areas (white areas surrounded by a dark brown border outline) have been replaced with clean backfill with arsenic concentrations ranging from 2.6 to 10.5 mg/kg.

The spatial distribution of arsenic in soil remaining in Air Deposition Study Area 1, with the potential statistical outliers that were identified in Section 4.3 removed, is presented in Figures 6.10 through 6.13 for each depth interval, respectively. These figures represent the horizontal distribution of soil arsenic in the absence of the data points identified as potential statistical outliers.

6.3 Vertical Extent of Soil Arsenic

A frequency plot of the number of samples exhibiting a particular soil arsenic concentration is presented in Figure 6.14 for each of the 0- to 3-inch, 3- to 6-inch, 6- to 9-inch, 9- to 12-inch and 12- to 18-inch depth intervals for all data collected during the 2004 to 2007 sampling events. The frequency distributions for the three layers in the upper 9 inches of soil are nearly coincident, while the distributions for the two deeper layers contain significantly more data points with lower concentrations.

Figures color-coded based on the concentration ranges of arsenic in soil at each of the 0- to 3-inch, 3- to 6-inch, 6- to 9-inch and 9- to 12-inch depth intervals are provided in Figures 6.2 through 6.13 (refer to Section 6.2).

In some areas, soil samples were collected from depths greater than 12 inches below surface grade, and were analyzed for arsenic. These areas include the IRM/ICM/Early Action remedial areas, and along Culvert 105. For these areas, the maximum arsenic concentration in any soil sample collected at a location from a depth greater than 12 inches, prior to implementation of the remedial activities, is shown on Figure 6.15. A comparable figure depicting current conditions, following implementation of the remedial activities, is provided on Figure 6.16. These figures use the same concentration range colors that were used for the MVS figures. Hence, sampling locations that are shown on the figures but not assigned a color have a maximum soil arsenic concentration less than 20 mg/kg. The IRM/ICM/Early Action remedial areas (surrounded by a dark brown border outline) have been replaced with clean backfill with arsenic concentrations ranging from 2.6 to 10.5 mg/kg.

7. Distribution of Arsenic in Soil and Sediment in Culvert 105 South Study Area

Table 7.1 presents the statistics of the soil/sediment arsenic data set for the Culvert 105 South Study Area, 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 upper 12 inches of soil, and arithmetic mean for samples collected deeper than 12 inches.

Cross-sections depicting the vertical distribution of the soil arsenic data at sampling transects along Culvert 105 south of the Erie Canal are provided on Figure 7.1, with concentrations greater than 20.0 mg/kg colored pink. Sample results with an asterisk indicate that soil corresponding to that location was removed during the 2007 Early Action remedial activities and replaced with clean backfill (refer to Figures 2.1 and 2.4 for information depicting the extent of the 2007 Early Action activities along Culvert 105).

The approximate diameter and depth of the Culvert 105 buried pipe, where known, are indicated on Figure 7.1 and Figure 2.4. 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 observations below regarding the distribution of arsenic in soil along the buried pipe and sediment within the pipe and associated structures in the Culvert 105 South Study Area are based on Table 7.1 and Figures 2.1, 2.4, 3.3a, 3.3b and 7.1.

- 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 in 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.
- South of the Erie Canal, where Culvert 105 consists solely of buried pipe sections, soil in sampled locations at depths greater than 12 inches have arsenic concentrations above 20 mg/kg in two sampled areas along Culvert 105 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 remedial 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 7.1. Review of Figure 7.1 indicates that subsurface soil arsenic concentrations decrease with 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 (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 7.1). Figure 7.1 indicates that subsurface soil arsenic concentrations decrease with distance from the buried pipe. Subsurface soil arsenic concentrations at locations approximately three feet laterally outward from the buried 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 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. Sediment corresponding to these samples was removed during the Early Action activities in 2007.

8. Evaluation of Other Constituents

This section presents and evaluates the analytical data for constituents other than arsenic that are potentially FMC-related in soil samples collected within Air Deposition Study Area 1 and in soil and sediment samples collected within the Culvert 105 South 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).

8.1 Background Levels of Metals in Soil

Metals are present in soil in Air Deposition Study Area 1 and in soil and sediment in the Culvert 105 South Study Area as a result of both natural conditions and a range of anthropogenic sources, including possible releases from the Facility.

During the studies that were conducted to evaluate the background concentration of arsenic in soil in the Middleport area prior to the 2001-2003 Gasport Study (refer to Section 5.2), soil samples were tested for other metals on the Off-Site Parameter List (Table 3.2) as well as other metals. Table 8.1 provides the combined results for each metal in 13 soil samples collected at 11 locations between 1985 and 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 5.2), but did not include analysis for other metals. The 11 sampling locations are variously located approximately 0.5 to 2 miles east of the Facility and approximately 2.5 to 5 miles west of the Facility (refer to Figure 8.1a).

8.2 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 SSL and SCO values and the industrial SSL and SCO values applicable to this Volume II of the RFI Report are provided in Tables 8.2a and 8.2b, respectively.

8.3 Comparison to the SSLs and SCOs

None of the concentrations of any of the non-arsenic constituents in any of the soil samples collected in Air Deposition Study Area 1 or in any of the soil or sediment samples collected in the Culvert 105 South Study Area are greater than the respective industrial SSL or industrial SCO (refer to tables in Appendix D). Therefore, the following discussion of the non-arsenic analytical data is limited to a comparison of data to the residential SSL and SCO values. A comparison of the non-arsenic analytical data is provided in Table 8.3 for the residential SSLs and in Table 8.4 for the residential SCOs.

The following sections provide a discussion of the non-arsenic soil analytical data compared to the soil screening values.

8.3.1 Lead

A total of 530 soil samples collected within Air Deposition Study Area 1 were analyzed for lead (refer to Tables D.1 to D.3 in Appendix D). The locations of the samples are shown on Figure 8.2 (in some locations, samples were collected at more than one depth interval). Samples were collected at the Roy-Hart School Property (400 samples), land owned by FMC next to the school yard (8 samples), the 14 west residential properties (89 samples), the North Commercial/Industrial Area (10 samples), the eastern agricultural field R1b (6 samples), 13 residential properties north of the Facility (13 samples), and within public street right-of-ways (4 samples).

Lead is naturally occurring in soil and is also ubiquitous in soil in developed areas due to many common anthropogenic sources (e.g., lead paint, gasoline additive, etc.). FMC produced lead arsenate at the FMC Plant Site and lead potentially may have been historically released to off-site areas via air migration and surface water pathways. Prior to remediation, approximately 80% of the 530 soil samples had lead concentrations within the range of concentrations (9 to 114 milligrams per kilogram [mg/kg]) identified in the 11 background soil sampling locations (refer to Section 8.1).

Both the residential SSL and the residential SCO for lead use a value of 400 mg/kg. Prior to remediation, the concentration of lead in 508 of the 530 soil samples (approximately 96%) was below 400 mg/kg. Sample locations where the maximum lead concentration at any sample depth was greater than 400 mg/kg, prior to remediation, are highlighted pink/purple on Figure 8.2.

Soil at locations corresponding to 324 samples remains following implementation of the IRM, ICM and Early Action remedial activities and construction activities at the Roy-Hart School Property. The locations of the samples corresponding to soil that remains are shown on Figure 8.3. The concentration of lead in 321 of the 324 samples (approximately 99%) is below 400 mg/kg. Soil corresponding to the three samples with a lead concentration greater than 400 mg/kg (highlighted pink/purple on Figure 8.3) includes:

- at a depth of 18 to 24 inches at sampling location "1" in the grass area north of the athletic track at the Roy-Hart School Property. (The sample collected in the 0- to 6-inch depth interval at this location contained less than 400 mg/kg of lead).
- at a depth of 48 inches at sampling location K-17B beneath the Alfred Street right-of-way. (This location is immediately adjacent to the layer of clean backfill placed during the Roy-Hart School Property ICM).
- at a depth of 12 to 15 inches at sampling location A1N10 next to the existing house at Property A1N in the West Residential Properties ICM Area. (This location is covered with clean backfill as a result of implementation of the ICM work).

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 arsenic concentrations above 20 mg/kg (compare Figure 8.2 to Figure 6.2), lead in soil in Air Deposition Study Area 1 has been delineated.

8.3.2 Chlorinated Pesticides

A total of 140 soil samples collected within Air Deposition Study Area 1 were analyzed for chlorinated pesticides. In addition, two soil samples and five sediment samples collected within the Culvert 105 South Study Area were analyzed for chlorinated pesticides. The analytical results are provided in Tables D.4 to D.8 in Appendix D. The locations of the samples are shown on Figure 8.4 (samples were collected at more than one depth interval at some locations). Samples were collected at the Roy-Hart School Property (63 samples), the 14 west residential properties (61 samples), the North Commercial/Industrial Area (9 samples), the eastern agricultural field R1b (6 samples), two other residential properties located north of the Facility (3 samples), and within the buried pipe, manholes or catch basins of Culvert 105 (5 samples). The locations of soil samples in Air Deposition Study Area 1 where a chlorinated pesticide was detected at a concentration above its residential SSL or residential SCO are highlighted pink/purple on Figure 8.4. None of the chlorinated pesticide concentrations in soil or sediment samples collected within the Culvert 105 South Study Area was above a residential SSL or residential SCO.

Soil at locations corresponding to 54 samples in Air Deposition Study Area 1 or the Culvert 105 South Study Area remains following implementation of the IRM, ICM and Early Action remedial activities. All of the sediment corresponding to the five sediment samples within Culvert 105 was removed. The locations of the samples corresponding to soil that remains are shown on Figure 8.5. The concentrations of chlorinated pesticides in 52 of the 54 samples (approximately 96%) are below the residential SSLs and residential SCOs. The locations of the two samples remaining in Air Deposition Study Area 1 that have a chlorinated pesticide concentration greater than its residential SSL or residential SCO are highlighted pink/purple on Figure 8.5. The constituents include DDT at sampling location "1" (0 to 3 inches) in the grass area north of the athletic track at the Roy-Hart School Property, and dieldrin and isodrin at sampling location TP-3 (6 to 12 inches) in the yard of a church on Vernon Street (Property O7).

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 (compare Figure 8.4 to Figure 6.2), chlorinated pesticides in soil in Air Deposition Study Area 1 and the Culvert 105 South Study Area have been delineated.

8.3.3 Other Metals

A total of 39 soil samples collected within Air Deposition Study Area 1 were analyzed for metals other than arsenic and lead, including metals on the Off-Site Parameter List (Table 3.2). The results are provided in Table D.9 in Appendix D. The samples were collected at the Roy-Hart School Property (19 samples), the 14 west residential properties (7 samples), the North Commercial/Industrial Area (1 sample), and 12 residential properties north of the Facility (12 samples). Soil at locations corresponding to 21 of the samples remains following the implementation of the IRM, ICM, and Early Action remedial activities and following other construction projects.

Of the metals on the Off-Site Parameter List other than arsenic and lead, only iron was detected in soil at a concentration above its residential SSL or residential SCO (five samples above the SSL, two of which correspond to locations that were excavated). Iron is a natural component of soil, and the maximum concentration in the samples is within the range observed in the background samples. With respect to other metals that are not on the Off-Site Parameter List, chromium was detected in soil above its residential SCO but not its residential SSL (four samples, two of which correspond to locations that were excavated). Chromium is not a potential FMC-related constituent.

Based on the low frequency of concentrations above the residential soil screening values within the areal extent of soil arsenic concentrations above 20 mg/kg, with all such results within the range of background concentrations, metals on the Off-Site Parameter List other than arsenic in soil in Air Deposition Study Area 1 have been delineated.

8.3.4 Other Synthetic Organic Constituents

A total of 47 soil samples collected at the Roy-Hart School Property and at the 14 west residential properties were analyzed for carbofuran. Soil corresponding to 13 of these samples remains following the implementation of the IRM and ICM remedial activities. Sub-sets of these 47 samples were also analyzed for other synthetic organic compounds, including 39 for 7-hydroxybenzofuran, 20 for phenol or other phenolic compounds, 12 for methyl carbamates, 12 for chlorinated herbicides, 12 for organophosphate pesticides, 3 for VOCs, and 3 for SVOCs.

No detectable levels of carbofuran, 7-hydroxybenzofuran, methyl carbamates, chlorinated herbicides, or organophosphate pesticides were identified in any of the soil samples. Some constituents were identified at low levels (phenol at 0.2 mg/kg or less, alkylbenzene-based VOCs at less than 1 ug/kg, and polycyclic-based SVOCs at less than 1 ug/kg); regardless, all concentrations were well below (i.e., orders of magnitude) the respective residential SSL or residential SCO (refer to Tables D.10 to D.12 in Appendix D).

Four soil samples were analyzed for ethylene thiourea (ETU). Low concentrations were identified in one sample, well below its residential SSL [no SCO value is available] (refer to Table D.13 in Appendix D). Two soil samples were analyzed for polychlorinated biphenyls (PCBs); no detectable levels of PCBs were identified (refer to Table D.14 in Appendix D).

Based on the non-detectable concentrations or low concentrations detected, these other synthetic organic compounds (carbofuran, 7-hydroxybenzofuran, phenol, other phenolic compounds, methyl carbamates, chlorinated herbicides, organophosphate pesticides, VOCs, SVOCs, ETU, PCBs) have been delineated for soil in Air Deposition Study Area 1.

9. Proposed Corrective Measures Study Areas

This section presents the basis for the selection of the properties and areas described in this Volume II of the RFI Report to be included in the CMS for either the Air Deposition Study Area 1 or the Culvert 105 Study Area. Properties and areas proposed for inclusion in the CMS are highlighted green on Figure 9.1.

9.1 Air Deposition Study Area 1

Soil affected by air deposition of arsenic is expected to exhibit the following characteristics (in the absence of other factors discussed below):

- Concentrations that decrease with increasing distance from the Facility, with the areal extent predominantly to the north and northeast based on historical wind patterns
- Concentrations that do not vary significantly over short distances in the cross-wind direction (i.e., concentrations at locations the same distance and in the same direction from the Facility should be similar)
- Concentrations that are higher at the surface and decrease with increasing depth below grade

A review of Figures 6.2 through 6.13 indicates that soil arsenic concentrations do not always exhibit these patterns throughout Air Deposition Study Area 1, with deviation more pronounced at the outer limits of the study area (e.g., potential statistical outlier data points surrounded by lower concentrations on Properties U4 and R1c, and concentrations along the eastern portion of Property R1b that are higher than locations closer to the Facility).

In some locations it is difficult to conclusively distinguish those soil arsenic conditions that are the result of air deposition from the Facility from those soil arsenic conditions that may be the result of other sources due to a number of uncertainties, including:

- Other anthropogenic sources of arsenic may be present in Air Deposition Study Area 1 based on interviews of the property owners, observations during sampling, and review of historical resources such as aerial photographs and Sanborn maps (refer to Table 5.1 for summary of potential sources)
- The possibility of other historical anthropogenic sources of arsenic that are not currently known
- Activities may have occurred to move the soil after air deposition occurred (such as excavation or re-grading – refer to comments in Table 5.1)

- The modeling of potential air deposition that was conducted in 1996 was subject to a number of uncertainties, including simulation of air movement and the limited data available on historical air emissions from the Facility
- Variable weather conditions (wind direction, wash-out by flooding)

Therefore, a “weight-of-evidence” approach was used to identify properties where the soil arsenic concentrations above 20 mg/kg are not likely to be associated with historical air deposition from the Facility, and hence will not be included in the Proposed CMS for Air Deposition Study Area 1. The approach for identifying the CMS area may result in the inclusion of some locations where the soil arsenic content is not entirely the result of air deposition from the Facility. Areas of soil requiring remediation will be determined based on the final CMS. Factors included in this weight-of-evidence evaluation included:

- The sampling location is distant from the Facility and is situated in the prevailing upwind direction from the Facility (northeast to the southwest¹), and therefore may not be consistent with the areal distribution expected from air deposition
- The sample result is identified as a potential statistical outlier (refer to Table 4.3), and therefore may not be consistent with the areal distribution expected from air deposition
- The sample result is coincident with another result that is identified as a potential statistical outlier, and therefore may not be associated with air deposition
- The sample result is consistent with normal data variability above 20 mg/kg, and therefore may be attributable to background conditions
- Another potential source of arsenic may have been present based on observations during sampling, interviews of the property owners, or review of resources regarding historical land use (refer to Table 5.1)
- Review of the soil arsenic distribution presented in the visualization figures (6.2 to 6.13) for areas that may not be consistent with a pattern of air deposition from the Facility as described in the beginning of this Section 9.1

No one factor alone was used as a basis to exclude a property or area from the Proposed CMS Area. Rather, the total weight of evidence provided by these factors for all of the

¹ Prevailing winds at the Facility blow from the southwest to northeast, as identified by Figure I5.1, Wind Rose Diagram, presented in RFI Report Volume I.

data at a particular property was considered. The basis for excluding a property from the Proposed CMS Area is provided in Table 9.1. Properties that are included in the Proposed CMS Area are highlighted green on Figure 9.1.

9.2 Culvert 105 South Study Area

All sixteen properties that are traversed by Culvert 105 and are located south of the Erie Canal 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 and 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 stormwater along Culvert 105 or potential historical air deposition.

10. Findings

A review of the analytical data collected from Air Deposition Study Area 1 and the Culvert 105 South Study Area results in the following findings:

1. Soil in Air Deposition Study Area 1 and soil and sediment in the Culvert 105 South Study Area have been adequately evaluated for constituents that were historically manufactured, formulated, handled or used at the Facility. This data set includes arsenic results for 5,623 soil samples, including samples collected within the Culvert 105 South Study Area. Sub-sets of the samples were analyzed for other constituents on the Off-Site Parameter List.
2. Arsenic data define the horizontal and vertical limits of potential Site-related impacts in soil in Air Deposition Study Area 1 and in soil and sediment in the Culvert 105 South Study Area. The extent of other constituents at concentrations above soil screening values is within and significantly less than the extent of soil arsenic above background concentrations.
3. With consideration given to other factors (e.g., data variability, wind patterns, ground features, historical land use, etc.) that could influence the distribution associated with potential air deposition from the Facility, the horizontal and vertical extent of arsenic have been delineated to 20 mg/kg in soil in Air Deposition Study Area 1.
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 delineated to 20 mg/kg in soil and sediment in the Culvert 105 South Study Area.
5. A weight-of-evidence approach was used to identify properties/areas that are proposed for exclusion from the CMS for Air Deposition Study Area 1. This approach considered multiple lines of evidence that support the conclusion that soil arsenic is not likely attributable to historical air deposition from the Facility, and erred on the side of inclusion in the CMS. The identified properties and areas will not be included in the CMS for Air Deposition Study Area 1.
6. All 16 properties located south of the Erie Canal that are traversed by Culvert 105 will be included in the Proposed CMS.
7. No further action determinations have been issued by the Agencies for 46 residential properties within Air Deposition Study Area 1 where sampling and analysis was conducted and the arsenic soil concentrations were consistent

with background, with consideration given to normal data variability. These properties will not be evaluated in the CMS.

8. There is some uncertainty associated with the delineation of potential Site-related impacts in the area north of the Erie Canal and east of the Niagara/Orleans county line. As directed by the Agencies, FMC will conduct additional soil sampling and arsenic analysis in the area north of the Erie Canal and east of the Niagara/Orleans county line in the spring of 2009. The results of this additional soil sampling and arsenic analysis will be reported in RFI Report Volume X.

As summarized in the above findings, the nature and extent of releases of hazardous waste or hazardous constituents from the Facility in soil in Air Deposition Study Area 1 and in soil and sediment in the Culvert 105 South Study Area have been delineated. The information and data are sufficient to support the development of the CMS for each area. Inclusion in the CMS does not necessarily rule out the possibility that other non-FMC related sources may be contributing to the soil concentration of constituents, particularly arsenic, at some locations. The CMS will evaluate the need for 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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Tables

Figures

Appendices on attached CD-ROM:

Appendix A

Copies of Letters from the Agencies to Property Owners

Appendix B

Copy of Culvert 105 Video Inspection Results Report

Appendix C

Summary of Arsenic Soil Analytical Data (By Property)

Appendix D

Summary of Non-Arsenic Soil Analytical Data

Appendix E

**Summary Report for 2004/2005 RFI Work Plans and Supplemental Soil
Sampling and Analysis in Air Deposition Study Area 1**

Appendix F

Evaluation for Soil Arsenic Potential Statistical Outliers

Appendix G

Copy of Letter from the Agencies to FMC Dated September 1, 2009

Appendix H

**Results of April 2009 Soil Sampling and Analysis
at Properties B3, E8 and I10**

Appendix A

Copies of Letters from the Agencies to Property Owners

Appendix B

Copy of Culvert 105 Video Inspection Results Report

(BBL and Geomatrix, July 2004)

Appendix C
Summary of Arsenic Soil Analytical Data
(By Property)

Appendix D

Summary of Non-Arsenic Soil Analytical Data

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