FMC Corporation
1735 Market Street
Philadelphia, PA 19103
USA

215.299.6000
fmc.com

Transmitted Via Email and FedEx

September 10, 2015

Ms. Sally Dewes, PE
NYSDEC Project Coordinator
Division of Environmental Remediation, Remedial Bureau B
New York State Department of Environmental Conservation
625 Broadway, 12th Floor
Albany, NY 12233-7016

Mr. Michael Infurna
USEPA Project Coordinator
Emergency and Environmental Remediation Division
United States Environmental Protection Agency, Region II
290 Broadway, 22nd Floor
New York, NY 10007-1866

Re: *Corrective Measures Study (CMS) Report*
Suspected Air Deposition Study Area 2 – Operable Unit 3 (OU-3)
FMC Corporation, Middleport, NY Facility
Administrative Order on Consent (AOC) Docket No. II-RCRA-90-3008(h)-209
EPA I.D. No. NYD002126845
DER Site No. 932014

Dear Ms. Dewes and Mr. Infurna:

FMC Corporation (FMC) submits the draft *Corrective Measures Study (CMS) Report – Suspected Air Deposition Study Area 2 (North of the Erie Canal and East of the Niagara/Orleans County Line) – Operable Unit 3 (OU-3)* (CMS Report). The CMS Report is submitted under the above referenced AOC.

Please contact me by telephone at (215) 299-6554 or by email at shawn.tollin@fmc.com with any questions.

Sincerely,

Shawn J. Tollin
Manager, Environmental Remediation

cc (by email only):

M. Hinton, NYSDEC, Buffalo
S. Selmer, NYSDOH, Troy
R. Kennedy, Esq., Hodgson Russ
W. Lachell, GEI Consulting
D. Wright, PE, ARCADIS

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Middleport, New York

Corrective Measures Study (CMS) Report

Suspected Air Deposition Study Area 2 (North of the Erie Canal and East of the Niagara/Orleans County Line) – Operable Unit 3 (OU-3)

Draft September 2015

With Contributions By:

GEI Consultants
Consulting Engineers & Scientists

RAMBOLL ENVIRON

Corrective Measures Study (CMS) Report

Suspected Air Deposition Study Area 2 – Operable Unit 3 (OU-3)

FMC Corporation Middleport, New York

Prepared for:
FMC Corporation

Prepared by:
ARCADIS
6723 Towpath Road
P.O. Box 66
Syracuse
New York 13214-0066
Tel 315.446.9120

Reference:
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Date:
Draft September 2015

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Acronyms and Abbreviations

Agencies	NYSDEC and USEPA
AOC	Administrative Order on Consent
CAMU	Corrective Action Management Unit
CAO	Corrective Action Objective
CFR	Code of Federal Regulations
CMA	Corrective Measure Alternative
CMS	Corrective Measures Study
EcoRA	Ecological Risk Assessment
ELCR	Excess Lifetime Cancer Risk
FMC	FMC Corporation
HI	Hazard Index
HHRA	Human Health Risk Assessment
mg/kg	milligrams per kilogram
NFA	No Further Action
NYCRR	Compilation of New York Codes, Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OU	Operable Unit
ppm	part-per-million
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
UCLM	95 percent upper confidence limit on the arithmetic mean
USEPA	United States Environmental Protection Agency

Executive Summary

FMC Corporation (FMC) entered into an Administrative Order on Consent (Docket No. II-RCRA-90-3008(h)-0209) (AOC) with the United States Environmental Protection Agency (USEPA) and the New York State Department of Environmental Conservation (NYSDEC) under the Resource Conservation and Recovery Act (RCRA) with respect to FMC's Middleport, New York Facility (Facility). To facilitate its administration, the parties have agreed to divide the areas to be addressed under the AOC into separate study areas or operable units. This Corrective Measures Study (CMS) Report addresses conditions in Suspected Air Deposition Study Area 2 (Air Deposition Area 2), also known as Operable Unit 3 (OU-3).

Air Deposition Area 2 consists of portions of six undeveloped properties located north of the Erie Canal and east of the Niagara/Orleans county line, beyond Air Deposition Area 1 (OU-2). The properties include agricultural fields, wooded land, the New York State Erie Canalway Trail, and an active railroad right-of-way. During the RCRA Facility Investigation (RFI), soil in the 0- to 12-inch depth interval below surface at these properties was sampled and analyzed for arsenic. Based on those analytical results, NYSDEC and USEPA (jointly "the Agencies") determined no further action was needed at one of the properties (Property R2d) and requested FMC complete a Corrective Measures Study (CMS) for the other five properties.

A site-specific human health risk assessment (HHRA) and screening ecological risk assessment (EcoRA) were developed as part of the CMS process for Air Deposition Area 2. The HHRA estimated current and hypothetical future exposure to Air Deposition Area 2 soil arsenic for current and reasonably anticipated future land uses of the properties. Risk calculations demonstrated that estimated human health risks are within, or below, the acceptable risk range defined in the site-specific Corrective Action Objectives (CAOs) for off-site study areas. The EcoRA identified no adverse impacts to environmental resources. The CAOs were established by the Agencies in 2009, in consultation with the New York State Department of Health (NYSDOH) and based on comments from FMC and community stakeholder groups. CAOs are required by the CMS scope of work attached to the AOC.

Collectively, the HHRA and EcoRA demonstrate that corrective measures are not necessary for soil arsenic in Air Deposition Area 2. Nonetheless, corrective measure alternatives (CMAs) were evaluated, taking into consideration the risk assessment findings. The CMAs included the following: 1) CMA A – no further action; and 2) CMA B – land use based remediation goals and institutional controls, as needed. In accordance with the AOC, the CMAs were evaluated using the following criteria: 1) technical; 2) environmental; 3) human health; 4) institutional; and 5) cost. Among other factors, the criteria evaluated how well each CMA complied with the CAOs.

Based on this evaluation, FMC recommends CMA A as the preferred final corrective measure for Air Deposition Area 2. CMA A satisfies the CAOs and achieves the most favorable evaluation using the applicable criteria. CMAs adopting a universal 20 mg/kg soil arsenic concentration goal or a 20 mg/kg soil arsenic concentration goal with "flexibility" do not produce any measurable or meaningful difference in human health or environmental risk reduction when compared to CMAs A and B, and are not necessary to achieve the human health and environmental risk CAOs established pursuant to the AOC. Those CMAs also necessarily compare very unfavorably to CMAs A and B on every other substantive evaluation criteria. Consequently, those CMAs are not evaluated further in the CMS.

1. Introduction

1.1 Background

FMC Corporation (FMC) owns and operates an agricultural products formulating facility located in the Village of Middleport and the Town of Royalton, New York ("Facility" or "Site"). FMC has entered into an Administrative Order on Consent (AOC; Docket No. II RCRA-90-3008(h)-0209, effective July 2, 1991) with the New York State Department of Environmental Conservation (NYSDEC) and the United States Environmental Protection Agency (USEPA) (jointly, "the Agencies") concerning releases of hazardous waste and hazardous constituents at the Facility. The AOC includes requirements to undertake a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) and, if determined to be necessary by the Agencies, a Corrective Measures Study (CMS). In 2005, FMC and the Agencies agreed that FMC should proceed to implement investigative, monitoring and remedial programs under the AOC using an "operable unit" or "study area" approach, consistent with Section VI.3.d. of the AOC.

The Suspected Air Deposition Study Area 2 (Air Deposition Area 2; Figure 1), also identified by the NYSDEC as Operable Unit 3 (OU-3), is one of the Middleport RCRA Facility study areas, and is the subject of *RCRA Facility Investigation Report Volume X – Suspected Air Deposition Study Area 2* (RFI Report Volume X) (2012). By letters dated December 5, 2012 and May 9, 2013, the Agencies, in consultation with the New York State Department of Health (NYSDOH), accepted RFI Report Volume X and determined that a CMS is necessary to address the presence of FMC-related arsenic in Air Deposition Area 2 soil. The May 9, 2013 letter also requested that FMC submit a CMS work plan. FMC requested, by letter dated May 24, 2013, a meeting to discuss the Agencies' request for a CMS work plan. The meeting did not occur before the Agencies submitted a second request, by letter dated February 18, 2014, to submit a CMS report, or abridged CMS report, for Air Deposition Area 2. In response to FMC's requests, the Agencies subsequently extended the deadline for FMC to respond to the February 18, 2014 letter to April 26, 2014. FMC responded by sending the Agencies a request for a meeting by letter dated April 25, 2014. The meeting was held by teleconference on June 2, 2014, during which FMC and the Agencies agreed that FMC would submit a CMS work plan. FMC submitted the draft *Corrective Measures Study (CMS) Work Plan – Suspected Air Deposition Study Area 2 – Operable Unit 3* (OU-3) (CMS Work Plan) on July 17, 2014.

The Agencies provided comments on the draft CMS Work Plan by letter dated August 14, 2014. FMC requested, by letter dated August 28, 2014, a meeting to discuss the Agencies' comments. On October 10, 2014, FMC submitted written responses to the Agencies' comments and a renewed request for a meeting. The October 10, 2014 submittal also included the draft *Screening Human Health Risk Assessment – Suspected Air Deposition Study Area 2 – Operable Unit 3 (OU-3)* (Screening HHRA), identified as the first task in the draft CMS Work Plan. The Screening HHRA concluded that estimated human health risks associated with arsenic in soil were within the acceptable risk range described in the applicable Corrective Action Objectives (CAOs) for Air Deposition Area 2. Therefore, FMC requested that the Agencies reconsider whether a CMS was necessary for Air Deposition Area 2. A meeting was held between FMC and the Agencies on October 30, 2014, during which it was agreed to temporarily postpone further discussion on a CMS.

By letter dated March 5, 2015, the Agencies directed FMC to "*submit a CMS for OU3 using the outline of Attachment II, Tasks VIII, IX, X and XI.B and C in lieu of submitting a revised Workplan followed by a CMS*." FMC responded on March 13, 2015, requesting a meeting with the Agencies to discuss the March 5th letter. On March 24, 2015 the Agencies sent FMC an email with an attached letter denying FMC's request for a meeting. On April 7, 2015, FMC submitted a Notice of Dispute and Request for Resolution to the USEPA under the terms and conditions of the AOC, requesting that the Agencies' March 5, 2015 request for a CMS report be withdrawn. On June 11, 2015, the USEPA denied FMC's request, and indicated that the Agencies would soon provide comments on the Screening HHRA. By letter dated July 16, 2015, the Agencies' provided comments on the Screening HHRA and requested submittal of the draft CMS Report by September 10, 2015.

This document is the draft CMS Report for Air Deposition Area 2, and includes an updated HHRA addressing the Agencies' July 16, 2015 comments. Copies of the above referenced correspondence are provided in Appendix A.

1.2 Scope of Work for Corrective Measures Study

Attachment II to the AOC identifies four tasks and associated sub-tasks associated with the Scope of Work for a CMS, as follows:

1. Task VIII: Identification and Development of the Corrective Measures Alternative or Alternatives
   a. Description of Current Situation
   b. Establishment of Corrective Action Objectives
   c. Screening of Corrective Measures Technologies
   d. Identification of the Corrective Measure Alternative or Alternatives

2. Task IX: Evaluation of the Corrective Measures Alternative or Alternatives
   a. Technical / Environmental / Human Health / Institutional
   b. Cost Estimate

3. Task X: Justification and Recommendation of the Corrective Measure or Measures
   a. Technical
   b. Environmental
   c. Human Health

4. Task XI: Reports
   a. Progress (not used for Air Deposition Area 2)
   b. Draft
   c. Final

This draft CMS Report (as identified in Task XI.b) provides the findings of the scope of work for Tasks VIII, IX, and X. Supporting information is provided in tables, figures, and appendices referenced in the text.

2. Identification and Development of the Corrective Measures Alternative(s) (Task VIII)

2.1 Description of Current Situation

RFI Report Volume X presents detailed information regarding the investigation of potentially-FMC-related arsenic in Air Deposition Area 2 soil; a summary is provided below.

Air Deposition Area 2 consists of portions of six properties located beyond Air Deposition Area 1 (OU-2), north of the Erie Canal and east of the Niagara/Orleans county line (Figure 2). Each of the six properties is larger in area than its portion within Air Deposition Area 2. The six properties are described as follows:

Property ID	Description
R2a	• National Heritage Corridor-designated New York State Erie Canalway Trail (towpath) owned by New York State Canal Corporation and used as state-wide public recreational trail
R2b	• Agricultural field (e.g., corn, hay)
R2c	• Agricultural field (e.g., corn, hay)
R2d	• Agricultural field (e.g., corn, hay)
R2e	• Active railroad right-of-way (including tracks and wooded land) owned by the County of Orleans Industrial Development Agency and used by Falls Road Railroad
R2f	• Undeveloped open land (woods and brush)

Based on the results of prior soil sampling and analysis in Air Deposition Area 1 (OU-2), Air Deposition Area 2 soil samples were collected from the 0- to 3-inch, 3- to 6-inch, 6- to 9-inch, and 9- to 12-inch depth intervals below surface grade, and analyzed for arsenic (the soil contaminant in off-site air deposition areas). Samples were collected at 54 locations on an approximate 200-foot grid, with two east-west oriented transects north of the Erie Canal and two north-south transects east of the county line (Figure 2).

The RFI data were sufficient to estimate the horizontal and vertical extent of Site-related arsenic in Air Deposition Area 2 soil with respect to a concentration of 20 milligrams per kilogram (mg/kg; equivalent to parts-per-million [ppm]), identified by the Agencies as the weighted 95th percentile concentration calculated in the 2001-2003 Gasport background study. The 2001-2003 Gasport background study was designed by the Agencies to support calculation of background concentrations of arsenic (from both naturally occurring and non-FMC anthropogenic sources) in Middleport soil, weighted by the proportionate areas of different types of historical land use. Appendix B provides summary tables of the data collected during the 2001-2003 Gasport background study and the calculation of background concentrations of arsenic in Middleport soil. The 20 mg/kg concentration is a delineation criterion and not necessarily a remediation criterion; the nature and extent of any remediation is based on the results of a CMS for each study area.

Of the total 216 Air Deposition Area 2 soil arsenic results, 77% (166 samples) are less than 20 mg/kg, 95% (206 samples) are less than 30 mg/kg, and all samples but one are less than 40 mg/kg. In terms of horizontal delineation, soil arsenic concentrations in the east-west transect farthest north of the Erie Canal (13 locations) and the north-south transect farthest east of the county line (14 locations) are below or slightly above 20 mg/kg (with allowance for normal sample variability), except for two samples (of 108 total samples at these locations). In terms of vertical delineation, 96% (52 of 54) of all samples collected in the 9- to 12-inch depth interval throughout Air Deposition Area 2 have soil arsenic concentrations below 20 mg/kg.

By letter dated January 29, 2013 (Appendix A), the Agencies determined that no further action was needed at Property R2d because the soil arsenic concentrations were consistent with expected background concentrations. Therefore, Property R2d is not evaluated in the CMS with regard to further actions, but was included in the HHRA to compare against estimated and hypothetical risks at the other five properties.

In RFI Report Volume X, the draft CMS Work Plan, and the October 10, 2014 response to Agencies' comments, FMC provided multiple lines of evidence supporting the conclusion that soil arsenic concentrations above background on Property R2e are not a result of historical releases from the Facility. Notwithstanding that demonstration, Property R2e is evaluated in the CMS.

The AOC's requirement for a statement of purpose of the CMS (i.e., identification of the actual or potential exposure pathways to be addressed by corrective measures) is described in Section 2.2 below.

2.2 Establishment of Corrective Action Objectives

The AOC specifies that Corrective Measures Alternatives (CMAs) are to be developed based on site-specific CAOs. Accordingly, in 2009 the Agencies established site-specific CAOs for use in all off-site soil and sediment study areas, including Air Deposition Area 2. The CAOs were developed in consultation with the New York State Department of Health (NYSDOH), FMC, and community stakeholder groups, and were based on public health and environmental criteria, information gathered during the RFI, USEPA guidance, and the requirements of applicable federal statutes. The CAOs are:

1. To protect human health and the environment relative to FMC-related contamination, in accordance with, and/or in consideration of, applicable, or relevant and appropriate laws, rules and guidance, using site-specific data and information, supported by multiple lines of evidence, including site-specific risk assessment, and based on current and reasonably anticipated future land use(s). Reasonably anticipated future land uses will be identified in consultation with the community.

    A. Achieve unrestricted use (i.e., without the need for institutional or engineering controls) of current and reasonably anticipated future residential properties within these study areas.

    B. Reduce and manage potential human health risks associated with FMC-related contaminants in soil and sediment, keeping in mind that risk is a function of contaminant concentration and routes, likelihood of exposure, and other factors, such that:

- Excess human health carcinogenic risks are reduced such that the lifetime excess cancer risks fall within the range appropriate for residential communities (i.e., 10^{-4} to 10^{-6});

- Human health non-carcinogenic risks are reduced such that non-cancer risks do not exceed the level appropriate for residential communities (i.e., Hazard Index ≤ 1.0); and

- The "point of departure", or starting point for corrective action risk-management decisions pertaining to arsenic in soil, is the site-specific residential background considering site-specific histories of use for current and reasonably anticipated future residential properties within these study areas.

C. With agreement by the property owner, and based on current and reasonably anticipated future non-residential use of a property, a combination of institutional and/or engineering control methods may be acceptable as corrective measures as long as they are determined to render adequate, long-term protection of human health and the environment.

D. Eliminate, reduce or control existing or potential adverse ecological impacts due to elevated concentrations of FMC-related contaminants in soil and/or sediments, while balancing adverse ecological impacts that may result from the remediation activities themselves.

E. Eliminate, reduce or control the potential for migration of FMC-related contaminants in soil and/or sediment, while balancing adverse ecological impacts that may result from any such measures themselves.

2. Minimize disturbance and disruption of the community so that the character of the neighborhoods can be maintained.

3. Inform and engage affected property owners and local residents in meaningful participation throughout the cleanup process, including the CMS, and corrective measures design and implementation phases.

4. Consistent with the above objective, use best management practices of USEPA 's Green Remediation concepts (i.e., clean diesel technology, waste minimization, resource conservation, reduction of greenhouse gas and other air emissions (e.g., by using alternative energy sources and/or fuel-efficient technology, minimizing truck trips, etc.), ecological and soil preservation) to reduce the demands placed on the environment ("footprint"). In keeping with the Green Remediation strategies site cleanup and reuse can mutually support one another by leveraging infrastructure needs, sharing data, minimizing demolition and earth-moving activities, re-using structures and demolition material, and combining other activities that support timely and cost-effective cleanup and reuse. Early consideration of green remediation opportunities offers the greatest flexibility and likelihood for related practices to be incorporated throughout a project life.

2.3 Reasonably Anticipated Future Land Use

CAO #1 requires that protection of human health and the environment consider current and reasonably anticipated future land uses. Current land uses in Air Deposition Area 2 are discussed in Section 2.1. To identify reasonably anticipated future land uses (subject to public comment by the community), local land use regulatory and planning documents were reviewed.[1] Based on these documents, the reasonably anticipated future land use of Properties R2b, R2c, R2d, and R2f, if redeveloped from their current use, is residential. Property R2a is expected to continue to be used as part of the state-wide Erie Canalway National Heritage recreational trail. Property R2e is expected to continue to be used as a railroad right-of-way.

Current and reasonably anticipated future uses of the six properties in Air Deposition Area 2 are shown on Figure 3 and summarized below:

Property ID	Current Use	Reasonably Anticipated Future Use
R2a	Public/Recreational	Public/Recreational
R2b	Agricultural	Residential
R2c	Agricultural	Residential
R2d	Agricultural	Residential
R2e	Railroad	Railroad
R2f	Open land	Residential

[1] Land use resources:

1. Village of Middleport Zoning Map (updated in January 2002) and associated zoning codes
2. Village of Middleport Local Waterfront Revitalization Program (Adopted by Village of Middleport Trustees, August 19, 2002; Approved by New York State Secretary of State Randy A. Daniels, January 27, 2003), including Map 8 – Proposed Land and Water Uses
3. Town of Royalton Zoning Map (updated in October 2002) and associated zoning codes
4. Town of Royalton Comprehensive Plan (Final Draft, March, 24, 2009)
5. Town of Hartland Zoning Map (updated in January 2008) and associated zoning codes
6. Comprehensive Plan for the Town of Hartland (Adopted August 14, 1998)
7. Town of Shelby Zoning Map (prepared on April 30, 2014) and associated zoning codes
8. Western Orleans Comprehensive Plan: Towns of Shelby, Ridgeway and Yates, Villages of Medina and Lyndonville (Adopted: December 2001 and amended: May 2003)
9. New York State Canal Corporation Standard Operating Procedures - Manual 900-1 (January 2005 - Revised March 2012) (http://www.canals.ny.gov/business/realproperty/add-info.html)
10. Listing the New York State Barge Canal on the National Register of Historic Places and designation as a National Heritage Area (http://www.eriecanalway.org/) to encourage historic preservation and appreciation of the Erie Canal history and heritage.

2.4 Human Health Risk Assessment

CAO #1.B forms the basis for the purpose statement required by Task VIII.A, in that CMAs should be developed in the CMS process to mitigate risks which fall outside of the acceptable risk range (i.e., excess lifetime cancer risk (ELCR) less than 10^{-4} and hazard index (HI) for non-cancer health risks less than 1.0). A site-specific HHRA must be conducted to identify properties or specific areas of those properties where current conditions do not achieve this objective.

The site-specific draft Screening HHRA provided to the Agencies in October 2014 concluded that estimated current and hypothetical future risks associated with current and reasonably anticipated future uses of Properties R2a, R2b, R2c, and R2f (Properties R2d and R2e were not evaluated at that time) were within the acceptable risk range identified in CAO #1.B. The Screening HHRA has been revised as follows: 1) expanded to include Property R2e as discussed in Section 2.1, and also Property R2d for comparison purposes to the other five properties; and 2) updated to address the Agencies' July 16, 2015 comments. The revised site-specific HHRA for Air Deposition Area 2 (Appendix C) was developed using the current and reasonably anticipated future land uses identified in Section 2.3, USEPA guidance, site-specific exposure assumptions, and exposure point concentrations based on the soil arsenic data for each property.

Current Land Use: Considering current land uses, potential receptors are associated with recreational (e.g., walking along the canal towpath on Property R2a, walking through wooded land on Property R2f), trespasser (Property R2e) and agricultural field cultivation (Properties R2b, R2c, and R2d) activities; these activities are associated with surface soil. As summarized in the table below, the HHRA demonstrates that estimated health risks associated with current land uses are within the acceptable risk range, and are also consistent with estimated risks associated with background concentrations.

	Current Land Use		Within Acceptable Risk Range?
	ELCR	HI	
Recreational			
R2a	1e-6	0.002 to 0.01	Yes
R2f	8e-7	0.001 to 0.008	Yes
Background	7e-7	0.001 to 0.007	Yes
Agricultural			
R2b	3e-7	0.002	Yes
R2c	3e-7	0.002	Yes
R2d	2e-7	0.001	Yes
Background	3e-7	0.002	Yes
Trespasser			
R2e	7e-8	0.001	Yes
Background	4e-8	0.001	Yes

Note: HI range reflects values for both adult (lower) and child (higher).

Reasonably Anticipated Future Land Use: As discussed in Section 2.3, in considering reasonably anticipated future land uses, Properties R2b, R2c, R2d, and R2f may be used for residential purposes, and Properties R2a and R2e are expected to continue their respective current land uses. As summarized in the table below, the HHRA indicates that estimated health risks associated with hypothetical future residents are within the acceptable risk range, and are also consistent with estimated risks associated with background concentrations.

	Hypothetical Future Residential Use		Within Acceptable Risk Range?
	ELCR	HI	
R2b	8e-6	0.03 to 0.1	Yes
R2c	9e-6	0.03 to 0.1	Yes
R2d	8e-6	0.03 to 0.08	Yes
R2f	8e-6	0.03 to 0.09	Yes
Background	9e-6	0.03 to 0.1	Yes

Note: See note on prior table

Based on the HHRA results discussed above, CAO #1.B is achieved without corrective measures.

2.5 Ecological Risk Assessment

The NYSDEC on-line Environmental Resource Mapper does not identify any regulated wetlands, rare plants, rare animals, or significant natural communities within Air Deposition Area 2. Water ways in Air Deposition Area 2 (the Erie Canal is not within Air Deposition Area 2) consist of stormwater culverts and ditches. Stormwater Culvert 104 transitions from a buried culvert pipe beneath the Erie Canal to an open ditch at the northern (downstream) boundary of Air Deposition Area 2, and therefore is not expected to support aquatic communities in Air Deposition Area 2. Similarly, a stormwater drainage ditch that runs along the railroad tracks on Property R2e is not expected to support aquatic communities. Properties R2a, R2b, R2c, R2d, and R2e are not expected to support wildlife habitat because these properties: 1) do not contain wetlands; 2) have only isolated strips of trees/woods; and 3) are subject to routine human activities (i.e., public trail on Property R2a, cultivated fields on Properties R2b, R2c, and R2d; and active railroad track right-of-way on Property R2e). Property R2f is overgrown with brush and trees, and may be frequented by various birds and mammals.

Property R2f was further evaluated based on a comparison of the average arsenic concentrations to conservative ecological screening benchmarks (Eco-SSLs). As discussed in more detail in the Ecological Risk Assessment (EcoRA) provided in Appendix D, potential adverse ecological impacts related to soil arsenic are not expected for Property R2f. The avian and mammalian wildlife Eco-SSLs are not exceeded by the mean or 95 percent upper confidence limit of the mean (UCLM) soil arsenic concentration. The mean soil arsenic concentration does not exceed the plant Eco-SSL, but the UCLM does slightly exceed it. The plant Eco-SSL is based on studies of highly soluble arsenic compounds not found in Middleport, as well

as some crops not representative of Middleport vegetation. Mineralogical analysis of site soils indicates that arsenic is present primarily in complexes with limited bioavailability, and therefore low toxicity to plants. When the small exceedance of the plant Eco-SSL (UCLM only) is considered in light of the low arsenic bioavailability and the absence of observed stressed vegetation, it is unlikely that plant resources in Property R2f are being adversely affected.

In sum, there is no meaningful risk to wildlife, mature trees/vegetation, or other ecological resources in Air Deposition Area 2. Consequently, corrective action in Air Deposition Area 2 is not warranted or appropriate on the basis of ecological risk.

2.6 Screening of Corrective Measure Technologies

Notwithstanding the results of the HHRA and EcoRA, as requested by the Agencies, potential corrective measures are evaluated in the CMS. Based on the results of the detailed technology evaluations presented in the *Draft Corrective Measures Study (CMS) Report – Suspected Air Deposition and Culvert 105 Study Areas* (2011) (OUs 2/4/5 CMS Report), six technologies were identified in the draft CMS Work Plan for further screening and/or evaluation in the CMS for Air Deposition Area 2. A discussion of each technology and its potential application in Air Deposition Area 2 is provided below.

1. No Further Action involves no corrective measures and is useful for baseline comparison purposes.

2. Institutional Controls involve the use of administrative measures to prevent or reduce the potential for human exposure to soil. Institutional controls may include: 1) existing governmental controls such as zoning classification specifying allowed land use and existing regulations or codes; 2) deed restrictions (requires property owner consent); 3) property agreements/easements (requires property owner consent); and 4) environmental easements (requires property owner consent and NYSDEC approval). Any of these measures, if needed, may be useful for Air Deposition Area 2 soil, subject to consent/approval by the appropriate parties.

3. Engineering Controls involve the use of physical measures to restrict access to soil or maintain the integrity of another technology, such as: 1) warning signs; 2) fences; 3) engineered covers; and 4) drainage systems. Given the impacts to surface soil, the large areas involved, and the current uses of the properties/areas, engineering controls are not likely to be particularly useful across Air Deposition Area 2, but may be useful in a limited area in concert with another technology.

4. Soil Tilling/Blending involves the tilling or blending of soil to reduce soil arsenic concentrations and recycle land/soil. Soil tilling/blending is an in-situ technology and is considered a “green” technology per USEPA’s and NYSDEC’s green remediation concepts and strategies because it conserves resources (e.g., arsenic-containing topsoil, soil/fill from off-site borrow pits, space within off-site commercial landfills, and fuel for transportation). The OUs 2/4/5 CMS Report included the results of a soil tilling/blending pilot study, which demonstrated the efficacy of this technology for Middleport soil, subject to characteristics of the area to be remediated (e.g., proximity to structures, trees, or physical

constraints; soil arsenic concentrations; extent of soil to be remediated). Air Deposition Area 2 is similar in characteristics to the pilot study areas for OUs 2/4/5 where soil tilling/blending was effective. Specifically, Air Deposition Area 2 comprises large open areas with no or few physical constraints in most areas (e.g., open fields with no buildings or utilities), soil arsenic impacts are generally focused in the 0- to 6-inch depth intervals, and soil arsenic concentrations are within the concentration range addressed in the pilot study. Therefore, based on the expected efficacy of soil tilling/blending and compliance with the green remediation goals of CAO #4, soil tilling/blending is the preferred technology for Air Deposition Area 2 soil that requires remediation.

5. Excavation and On-Site (CAMU) Disposal involves the physical removal of soil and placement of that soil in a Corrective Action Management Unit (CAMU) at the Facility, and backfilling of the excavated area with imported clean soil. A CAMU is defined as "*an area within a facility that is used only for managing remediation wastes and for implementing corrective action or cleanup at the facility*" (6NYCRR 370.2(b)(37) and 40 CFR 260.10). FMC proposed designation of a CAMU at the Facility for the placement of non-hazardous soil excavated from off-site study areas in 2008 and provided an updated conceptual design for the CAMU in the OUs 2/4/5 CMS Report, based on comments by the Agencies and the community. Use of a CAMU at the Facility would require the Agencies' review and approval of a detailed design and revised application (not yet drafted), which would be subject to public comment. Soil excavation and on-site CAMU disposal is retained as a potential remedial technology for Air Deposition Area 2 soil that requires remediation and may not be suitable for soil tilling/blending, assuming that a CAMU is designated.

6. Excavation and Off-Site Disposal/Reuse involves the physical removal of soil and transport of that soil to a permitted commercial off-site landfill for either disposal or beneficial reuse as cover material, and backfilling of the excavated area with imported clean soil. The OUs 2/4/5 CMS Report included a detailed evaluation of this technology, and identified trucking as the preferred transportation method and assumed that approximately 75% of the soil would be disposed with the balance used for daily cover. This technology is also retained as a potential remedial technology, if needed.

2.7 Identification of the Corrective Measures Alternative or Alternatives

The AOC specifies that a workable number of CMAs be developed to address site conditions and the CAOs. Based on the concentration and distribution of arsenic in soil, the established site-specific CAOs, current and reasonably anticipated future land uses, and the identified corrective measure technologies, two CMAs are identified for evaluation in the Air Deposition Area 2 CMS:

- No Further Action Alternative (CMA A)
- Land Use Based Alternative (CMA B)

CMAs adopting a universal 20 mg/kg soil arsenic concentration goal or a 20 mg/kg soil arsenic concentration goal with "flexibility" do not produce any measurable or meaningful difference in human health

or environmental risk reduction when compared to CMAs A and B, and are not necessary to achieve the human health and environmental risk CAOs established pursuant to the AOC. Those CMAs also necessarily compare very unfavorably to CMAs A and B on every other substantive evaluation criteria. Consequently, those CMAs are not evaluated further in the CMS.

2.7.1 No Further Action Alternative (CMA A)

CMA A does not involve any corrective measure. No remedial measures or administrative controls would be implemented, and no costs would be incurred.

2.7.2 Land Use Based Alternative (CMA B)

2.7.2.1 Description of CMA B

CMA B involves soil remediation, as necessary, to achieve a post-remediation average (for both surface soil [0- to 3-inches] and all depths [0- to 12-inches]) and maximum soil arsenic concentration for each property, based on current and reasonably anticipated future land use, as follows:

CMA B Soil Arsenic Concentration Goals		
Land Use	**Average (mg/kg)**	**Maximum (mg/kg)**
Residential	20	40
Public/Institutional/Recreational[1]	30	60
Agricultural/Open Land/ Commercial/Industrial/ Railroad/Utility[1]	40	80

Note:
1. If the residential soil arsenic concentration goals are exceeded, deed restrictions may be imposed (if necessary and subject to property owner consent) to prohibit residential development and use without re-evaluation and, if necessary, corrective action.

Where necessary, remediation would be accomplished through soil tilling/blending, to the extent feasible. For limited areas where soil tilling/blending is not feasible, remediation would be accomplished through excavation and either placement in the Facility CAMU (if designated) or off-site commercial landfill disposal/beneficial reuse. If the soil arsenic concentrations at a non-residential property exceed the residential cleanup goals, then institutional controls may be imposed (if necessary and subject to property owner consent) to prohibit residential development and use without re-evaluation and, if necessary, corrective action.

The post-remediation average and maximum soil arsenic goals for CMA B are based on various estimates of background calculated from the 2001-2003 Gasport study data (see Appendix B for summary of value derivation). The average concentration goal of 20 mg/kg for residential properties is identified by the Agencies as the upper limit concentration (weighted 95th percentile) of local background soil arsenic for residential properties. The maximum concentration goal of 40 mg/kg for residential properties was identified by FMC using the same method to derive the Agencies' value of 20 mg/kg, but incorporating information obtained from additional historical aerial photographs indicating that orchards were historically more extensive in the Middleport area than identified during the 2001-2003 Gasport study. The 40 m/kg concentration is also used as the average concentration goal for agricultural, open land, commercial, industrial, railroad, and utility land uses. The maximum concentration goal of 80 mg/kg for agricultural, open land, commercial, industrial, railroad, and utility land uses is derived using the 98th percentile of weighted background soil data set with the revised Middleport property type/usage weighting factors proposed by FMC. The 30 mg/kg (average) and 60 mg/kg (maximum) concentration goals for public, institutional, and recreational land uses (e.g., canal towpath) are intermediate between the residential and agricultural/open land/commercial/industrial/railroad/utility land use values.

2.7.2.2 CMA B Work Scope

The table below compares the soil arsenic statistics (from RFI Report Volume X) for the Air Deposition Area 2 properties to the respective CMA B remedial goals based on the reasonably anticipated future land use identified for each property in Section 2.3. Property R2d is not included in the table because it has received a No Further Action determination from the Agencies.

	Reasonably Anticipated Future Land Use	Soil Arsenic Concentration (mg/kg)			CMA B Remedial Goal (mg/kg)		Remediation Needed?
		Average (0-3")	Average (0-12")	Maximum	Average	Maximum	
R2a	Public/ Recreational	23	19	49	30	60	No
R2b	Residential	17	14	25	20	40	No
R2c	Residential	16	15	30	20	40	No
R2e	Railroad	33	21	35	40	80	No
R2f	Residential	18	14	36	20	40	No

Based on the soil analytical data and considering the current and reasonably anticipated future land uses, no soil remediation would be required under CMA B. The soil analytical data for Properties R2b, R2c, and R2f already meet the CMA B remedial goals for potential future residential use. Therefore, neither soil remediation nor institutional controls are necessary at Properties R2b, R2c, and R2f. The soil analytical data for Property R2a meet the CMA B remedial goals for public/recreational use, but not the maximum or surface soil average concentration goals for residential use. Property R2a is owned by the New York State Canal Corporation and its non-residential use is dictated by New York State law. Consequently, it is not

reasonable to anticipate that Property R2a will be converted to residential use and, therefore, no additional institutional control is necessary. The soil analytical data for Property R2e meet the CMA B remedial goals for railroad use, but not the average concentration goals (surface and overall) for residential use. Property R2e is owned by the County of Orleans Industrial Development Agency and is operated as an active railroad line. Consequently, it is not reasonable to anticipate that Property R2e will be converted to residential use and, therefore, no additional institutional control is necessary.

3. Evaluation of the Corrective Measures Alternative(s) (Task IX)

This section presents the criteria used to evaluate the CMAs, and the results of the evaluation.

3.1 Criteria

The CMAs were evaluated based on five criteria identified in Task IX of the CMS scope of work: 1) technical; 2) environmental; 3) health; 4) institutional; and 5) cost. These five criteria are described below and summarized in Table 1.

1. **Technical** – The technical criterion involves evaluation of each CMA based on performance, reliability, implementability, and safety.

   A. The performance of the CMA is a function of its effectiveness and its useful life. Effectiveness is the ability of the CMA to reduce unacceptable risks (based on site-specific risk assessment). The useful life is the length of time over which the effectiveness can be maintained.

   B. Reliability is assessed based on the degree to which the technologies employed in the CMA have been demonstrated to be effective under site conditions and uncontrollable changes over time. Reliability also considers the frequency and complexity of any operation and maintenance which may be required to maintain effectiveness of the CMA.

   C. Implementability includes the relative ease of installation or construction (constructability) and the time required to achieve a given level of response (including the time required for implementation and the time it takes to actually obtain beneficial results). It also considers external factors which may affect the feasibility of implementation.

   D. The safety evaluation examines potential safety risks to remediation workers, the surrounding community, and the environment during and after implementation of the CMA.

2. **Environmental** – The environmental criterion involves evaluation of each with respect to: 1) short-term adverse environmental impacts during construction; and 2) short-term and long-term beneficial and adverse impacts of the CMA on the environment, particularly in any environmentally sensitive areas, if present. It considers the balance between potential adverse environmental effects of the remediation itself and benefits to the environment (CAOs # 1.D and 1.E). It also implicates CAO #4, which considers "Green Remediation" concepts in conducting remediation, such as use of alternative fuels and resource conservation).

3. **Human Health** – The human health criterion considers the extent to which short- and long-term exposures to arsenic are mitigated. The assessment includes an examination of how each CMA protects human health during corrective action implementation (short-term) and potential long-term risk reduction, as compared to the acceptable risk ranges identified in CAO #1.B, with a preference to

achieving unrestricted use for residential properties (CAO # 1.A), while allowing for the use of institutional or engineering controls to manage residual impacts at non-residential properties (CAO # 1.C).

4. **Institutional** – The institutional criterion considers the effects of federal, state and local environmental and public health standards, regulations, guidance, advisories, ordinances. It also considers community acceptance of the design, operation, and timing of each CMA, including CAOs # 2 and 3.

5. **Cost** – The cost criterion considers capital costs of each CMA and any long-term costs (e.g., inspection, monitoring, and maintenance). The capital costs include: 1) direct costs for construction equipment, labor and materials to perform the remedial construction; and 2) indirect cost expenditures for engineering, financial, and other services that are not part of the actual construction but required to implement the corrective measure.

3.2 Evaluation of Each CMA

3.2.1 CMA A

CMA A is technically feasible because no remediation would be conducted and no control measures would be implemented beyond what already exists. The HHRA and EcoRA demonstrate that CMA A is protective of human health and the environment. Because no remedial activities would be implemented, no short-term risks to health or safety of human health or the environment would be created by remediation activities. CMA A satisfies the regulatory aspects of the institutional criterion because the standards, criteria, and guidance relevant to setting corrective action goals have been considered in developing and are synthesized in the CAOs issued by the Agencies. The community acceptance aspects of the institutional criterion are satisfied by CMA A because there is no disturbance to the community and the community and property owners will be provided meaningful opportunities for involvement in remedy selection (e.g., an opportunity to provide comments on this draft CMS Report). The estimated cost to implement CMA A is zero.

3.2.2 CMA B

CMA B is technically feasible because no active remediation is involved additional institutional controls are not necessary. The Agencies have already determined that no further action is needed at Property R2d. No further action is required at three other properties (R2b, R2c, R2f) under CMA B because soil arsenic concentrations already meet CMA B residential soil arsenic concentration goals (20 ppm average and 40 ppm maximum soil arsenic). The other two properties (R2a and R2e) already meet CMA B current land use soil arsenic concentration goals and, given their ownership structures and existing limitations on their use, additional institutional controls are not necessary. The HHRA and EcoRA demonstrate that CMA B is protective of human health and the environment. Because no remedial activities would be implemented, no short-term risks to health or safety of human health or the environment would be created. CMA B satisfies the regulatory aspects of the institutional criterion because the standards, criteria, and guidance relevant to

setting corrective action goals have been considered in developing and are synthesized in the CAOs issued by the Agencies. The community acceptance aspects of the institutional criterion are satisfied by CMA B because there is no disturbance to the community and the community and property owners will be continue to be provided meaningful opportunities for involvement in remedy selection. The estimated cost to implement CMA B is zero.

3.3 Comparative Evaluation of CMAs

A comparative evaluation of the CMAs is provided below, and a summary is provided in Table 2.

3.3.1 Technical

Both CMAs are equally favorable under this criterion. Corrective action is not required under either CMA.

3.3.2 Environmental

Both CMAs are equally favorable under this criterion. The HHRA and EcoRA demonstrate that these CMAs are protective of human health and the environment. Because no remedial activities would be implemented, there are no short-term risks to health, safety, or the environment.

3.3.3 Human Health

Both CMAs are equally favorable under this criterion. Estimated risks for current and reasonably anticipated future land uses are within or below the acceptable risk range established by the applicable CAOs for off-site study areas. The estimated risks are also consistent with estimated risks associated with background conditions.

3.3.4 Institutional

Both CMAs are equally favorable under this criterion. No active corrective measures are necessary for soil arsenic in Air Deposition Area 2. Community acceptance for both CMAs is expected to be favorable.

3.3.5 Cost

Both CMAs are equally favorable under this criterion. Neither alternative involves any cost.

4. Justification and Recommendation of the Corrective Measure (Task X)

Based on the evaluation presented in this CMS, CMA A is the recommended alternative because it best satisfies the CAOs and is favorable as measured by the evaluation criteria. The HHRA and EcoRA demonstrate that no further action (CMA A) is needed for Air Deposition Area 2. Implementation of additional corrective measures (i.e., imposition of institutional controls) under CMA B is not necessary.

On the basis of the CMA evaluation and critical comparison of the alternatives, FMC recommends CMA A as the preferred final corrective measure for Air Deposition Area 2.

5. Schedule

Following the Agencies' acceptance of the Draft CMS Report for Air Deposition Area 2, there are several steps in completing the CMS Report, the Agencies' selection of a final corrective measure, and implementation of corrective measures, if needed. Each step has opportunities for public involvement. A description of the steps is provided below.

- Draft CMS Report and RFI Report Volume X Public Comment Period – After the Agencies accept the Draft CMS Report, the Agencies will hold a 30-day public comment period and public meeting on the "final" Draft CMS Report. By letter dated May 9, 2013, in which the Agencies accepted the RFI Report Volume X, the Agencies indicated that the public comment period will include both the RFI and CMS Reports concurrently. In accordance with CAO # 1, the community and property owners will also be able to provide comments on the reasonably anticipated future land uses for Air Deposition Area 2 properties as part of this comment period.

- Agencies' Preliminary Statement of Basis – The Agencies will consider and respond to public comments on the RFI and CMS Reports and will issue a responsiveness summary and "Preliminary Statement of Basis" that identifies the Agencies' preliminary selection of corrective measures.

- Preliminary Statement of Basis Public Comment Period – The Agencies will hold a 30-day public comment period and public meeting on the Agencies' preliminary selection of corrective measures.

- Agencies' Final Selection of Corrective Measures – The Agencies will consider and respond to public comments on the Preliminary Statement of Basis and will select the final corrective measures for Air Deposition Area 2. The Agencies will issue a Final Decision/Statement of Basis and responsiveness summary.

- Corrective Measures Implementation – If the Agencies determine that corrective measures (other than No Further Action) are necessary for Air Deposition Area 2, then planning, designing, and implementation of the corrective measures will proceed, subject to consent of the affected property owner(s). Community involvement and outreach activities will be conducted during implementation.

References

ARCADIS. 2011. Draft Corrective Measures Study (CMS) Report – Suspected Air Deposition and Culvert 105 Study Areas (May).

ARCADIS. 2012. RCRA Facility Investigation Report Volume X – Suspected Air Deposition Study Area 2 (October).

ARCADIS. 2014. Draft Corrective Measures Study (CMS) Work Plan – Suspected Air Deposition Study Area 2 – Operable Unit 3 (OU-3) (July).

ARCADIS and AMEC Geomatrix. 2009. RCRA Facility Investigation Report Volume I – Background and Supporting Information (September).

Conestoga-Rovers Associates. 2003. Development of Arsenic Background in Middleport Soil (February).

ENVIRON International Corp. 2014. Draft Screening Human Health Risk Assessment – Suspected Air Deposition Study Area 2 – Operable Unit 3 (OU-3) (October).

USEPA, NYSDEC and FMC Corporation. 1991. Administrative Order on Consent [Docket No. II RCRA-90-3008(h)-0209] entered into by FMC, NYSDEC and USEPA, effective July 2, 1991.

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Tables

TABLE 1
CORRECTIVE MEASURES ALTERNATIVE (CMA) EVALUATION CRITERIA

CMS REPORT FOR AIR DEPOSITION AREA 2 (OU-3)
FMC CORPORATION – MIDDLEPORT, NEW YORK

Technical	Environmental	Human Health	Institutional	Cost
• Performance of the CMA, based on effectiveness in achieving the remedial goal and useful life in maintaining the remedial goal • Reliability of the CMA, based on dependence on operation, monitoring, and maintenance requirements (frequency and complexity) and past application in similar conditions • Implementability of the CMA, based on constructability (ease of installation) and time (both time to implement and time to observe beneficial results) • Short-term safety of the CMA, for remedial workers, the surrounding population, and the environment during implementation	• Short-term and long-term beneficial and adverse effects of the CMA on the environment, including environmentally sensitive areas • CAOs # 1.D and 1.E – balancing potential adverse ecological impacts resulting from the remediation with benefits of remediation • CAO # 4 – use of Green Remediation concepts (e.g., alternative fuels, resource conservation) to reduce demands placed on the environment during and following remediation	• The extent to which short-term (during remediation) and long-term potential human exposure are mitigated • The extent to which the CMA protects human health both during and after remediation, as measured by site-specific risk assessment and the acceptable risk range identified in CAO # 1.B for current and reasonably anticipated future land uses • CAOs # 1.A and 1.C – achieve unrestricted use for residential properties, with potential use of institutional or engineering controls at non-residential properties (subject to property owner acceptance)	• Federal, State, and local environmental and public health standards, regulations, guidance, advisories, and ordinances • Community acceptance of CMA design, operation, and timing, including but not limited to the following CAOs: o CAO # 2 – minimize community disturbance o CAO #3 – meaningful community involvement in remedy selection, design, and implementation	• Cost to implement the CMA, including: o Direct capital costs (construction, equipment, land/development, buildings, services, utilities) o Indirect capital costs (engineering, legal, permitting, start-up, contingency) o Present worth of future post-remediation costs for operation, monitoring, and maintenance, if needed

Note:
1. Refer to text for complete description of CAOs.

TABLE 2
COMPARATIVE ANALYSIS OF CORRECTIVE MEASURES ALTERNATIVES

CMS REPORT FOR AIR DEPOSITION AREA 2 (OU-3)
FMC CORPORATION - MIDDLEPORT, NEW YORK

Evaluation Criteria	Alternatives	
	A	**B**
Technical	●	●
Environmental	●	●
Human Health	●	●
Institutional	●	●
Cost	$0	$0

● = favorable
◒ = moderate
○ = not favorable

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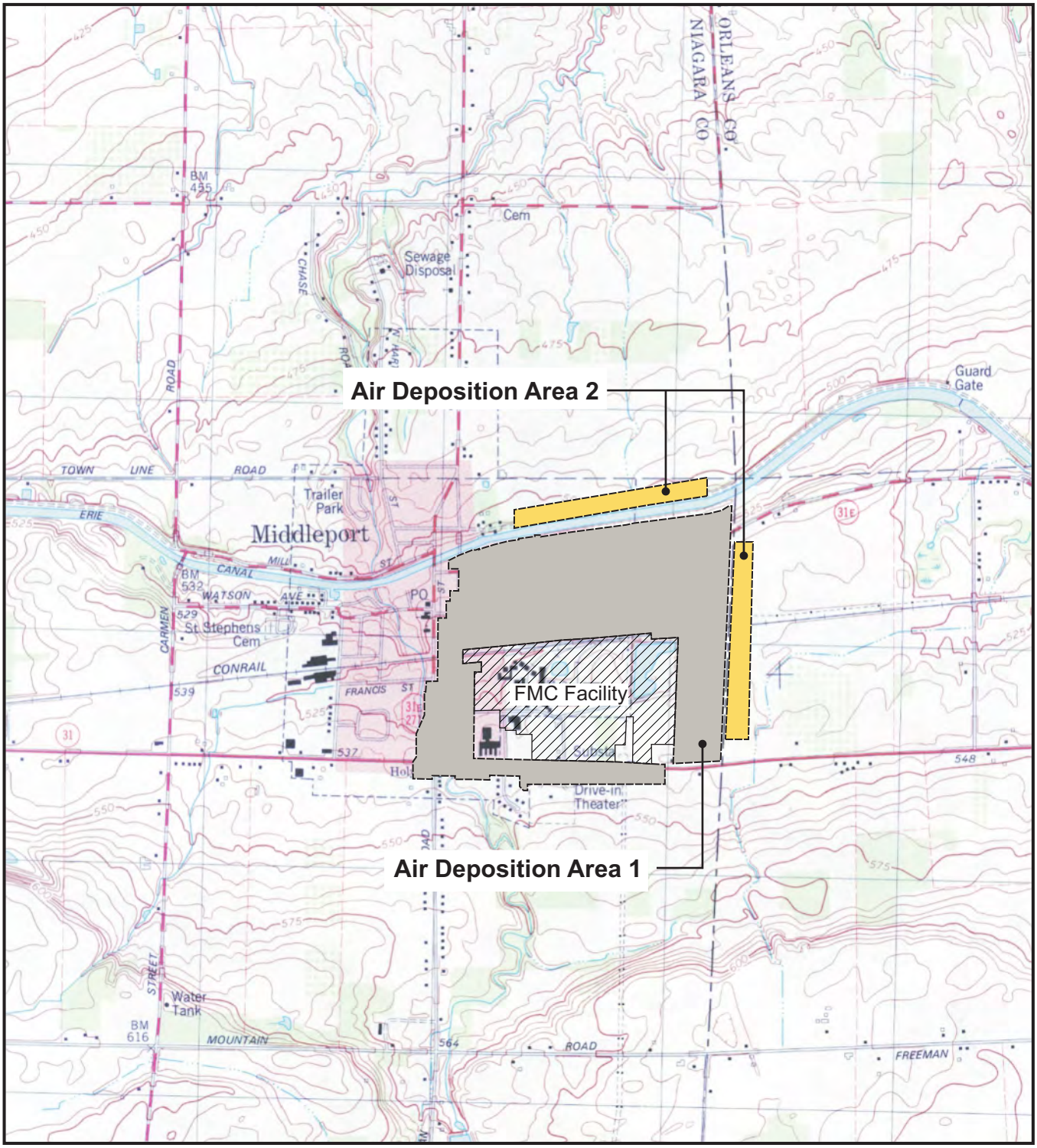
Figures



REFERENCE: BASE MAP USGS 7.5 MIN. QUAD., MEDINA, NY, 1980.

2000' 0 2000'

Approximate Scale: 1" = 2000'

FMC CORPORATION - MIDDLEPORT, NEW YORK

CORRECTIVE MEASURES STUDY REPORT
AIR DEPOSITION AREA 2 (OU-3)

LOCATION MAP

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FIGURE
1

08/28/2015 SYRACUSE,NY-ENV/CAD-KLS, DJHOWES
B0037786/2015/00001/CDR/37786N01.CDR

CITY: SYRACUSE, NY DIV/GROUP: ENV/IM-DV DB: L.POSENAUER PM/TM: T. YOUNG TR: D. WRIGHT LYR:ON=*;OFF=REF; (FRZ)
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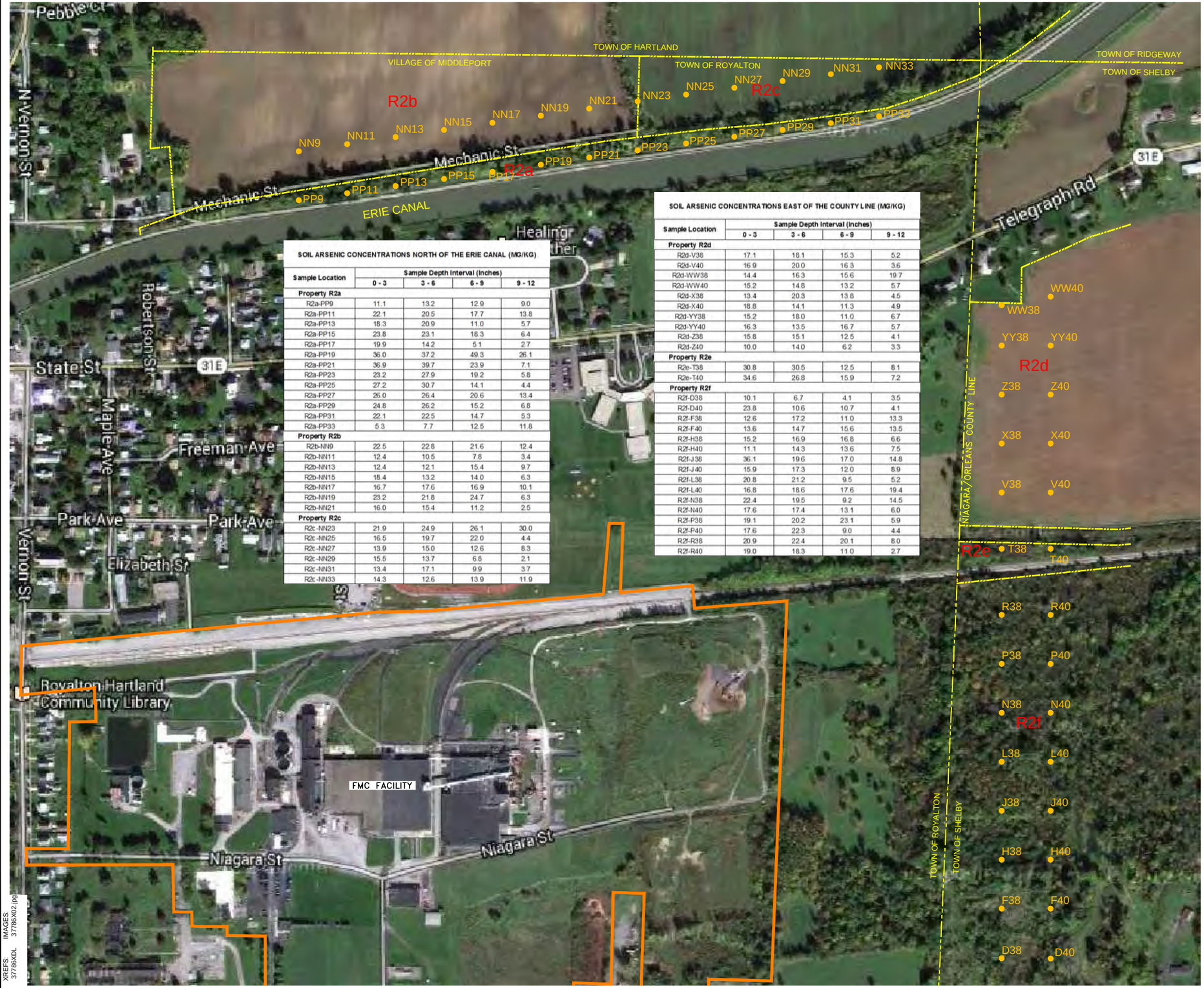
XREFS: IMAGES:
37786XDL 37786X02.jpg



SOIL ARSENIC CONCENTRATIONS NORTH OF THE ERIE CANAL (MG/KG)

Sample Location	Sample Depth Interval (Inches)			
	0 - 3	3 - 6	6 - 9	9 - 12
Property R2a				
R2a-PP9	11.1	13.2	12.9	9.0
R2a-PP11	22.1	20.5	17.7	13.8
R2a-PP13	18.3	20.9	11.0	5.7
R2a-PP15	23.8	23.1	18.3	6.4
R2a-PP17	19.9	14.2	5.1	2.7
R2a-PP19	36.0	37.2	49.3	26.1
R2a-PP21	36.9	39.7	23.9	7.1
R2a-PP23	23.2	27.9	19.2	5.8
R2a-PP25	27.2	30.7	14.1	4.4
R2a-PP27	26.0	26.4	20.6	13.4
R2a-PP29	24.8	26.2	15.2	6.8
R2a-PP31	22.1	22.5	14.7	5.3
R2a-PP33	5.3	7.7	12.5	11.8
Property R2b				
R2b-NN9	22.5	22.8	21.6	12.4
R2b-NN11	12.4	10.5	7.8	3.4
R2b-NN13	12.4	12.1	15.4	9.7
R2b-NN15	18.4	13.2	14.0	6.3
R2b-NN17	16.7	17.6	16.9	10.1
R2b-NN19	23.2	21.8	24.7	6.3
R2b-NN21	16.0	15.4	11.2	2.5
Property R2c				
R2c-NN23	21.9	24.9	26.1	30.0
R2c-NN25	16.5	19.7	22.0	4.4
R2c-NN27	13.9	15.0	12.6	8.3
R2c-NN29	15.6	13.7	6.8	2.1
R2c-NN31	13.4	17.1	9.9	3.7
R2c-NN33	14.3	12.6	13.9	11.9

SOIL ARSENIC CONCENTRATIONS EAST OF THE COUNTY LINE (MG/KG)

Sample Location	Sample Depth Interval (Inches)			
	0 - 3	3 - 6	6 - 9	9 - 12
Property R2d				
R2d-V38	17.1	18.1	15.3	5.2
R2d-V40	16.9	20.0	16.3	3.6
R2d-WW38	14.4	16.3	15.6	19.7
R2d-WW40	15.2	14.8	13.2	5.7
R2d-X38	13.4	20.3	13.8	4.5
R2d-X40	18.8	14.1	11.3	4.9
R2d-YY38	15.2	18.0	11.0	6.7
R2d-YY40	16.3	13.5	16.7	5.7
R2d-Z38	15.8	15.1	12.5	4.1
R2d-Z40	10.0	14.0	6.2	3.3
Property R2e				
R2e-T38	30.8	30.5	12.5	8.1
R2e-T40	34.6	26.8	15.9	7.2
Property R2f				
R2f-D38	10.1	6.7	4.1	3.5
R2f-D40	23.8	10.6	10.7	4.1
R2f-F38	12.6	17.2	11.0	13.3
R2f-F40	13.6	14.7	15.6	13.5
R2f-H38	15.2	16.9	16.8	6.6
R2f-H40	11.1	14.3	13.6	7.5
R2f-J38	36.1	19.6	17.0	14.8
R2f-J40	15.9	17.3	12.0	8.9
R2f-L38	20.8	21.2	9.5	5.2
R2f-L40	16.8	18.6	17.6	19.4
R2f-N38	22.4	19.5	9.2	14.5
R2f-N40	17.6	17.4	13.1	6.0
R2f-P38	19.1	20.2	23.1	5.9
R2f-P40	17.6	22.3	9.0	4.4
R2f-R38	20.9	22.4	20.1	8.0
R2f-R40	19.0	18.3	11.0	2.7

LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- FMC FACILITY
- R2a PROPERTY IDENTIFICATION
- SOIL SAMPLE LOCATION

NOTES:

1. ALL LOCATIONS AND PROPERTY BOUNDARIES SHOWN ARE APPROXIMATE AND SUBJECT TO VERIFICATION.
2. ARSENIC CONCENTRATIONS ARE THE ARITHMETIC AVERAGE OF ALL PRIMARY, DUPLICATE AND SPLIT SAMPLE RESULTS FOR EACH SAMPLE AND ARE PRESENTED IN MILLIGRAMS PER KILOGRAM (MG/KG); EQUIVALENT TO PARTS PER MILLION (PPM).

0 200' 400'
GRAPHIC SCALE

FMC CORPORATION - MIDDLEPORT, NEW YORK
CORRECTIVE MEASURES STUDY REPORT
AIR DEPOSITION AREA 2 (OU-3)

SOIL SAMPLING LOCATIONS AND ARSENIC CONCENTRATIONS

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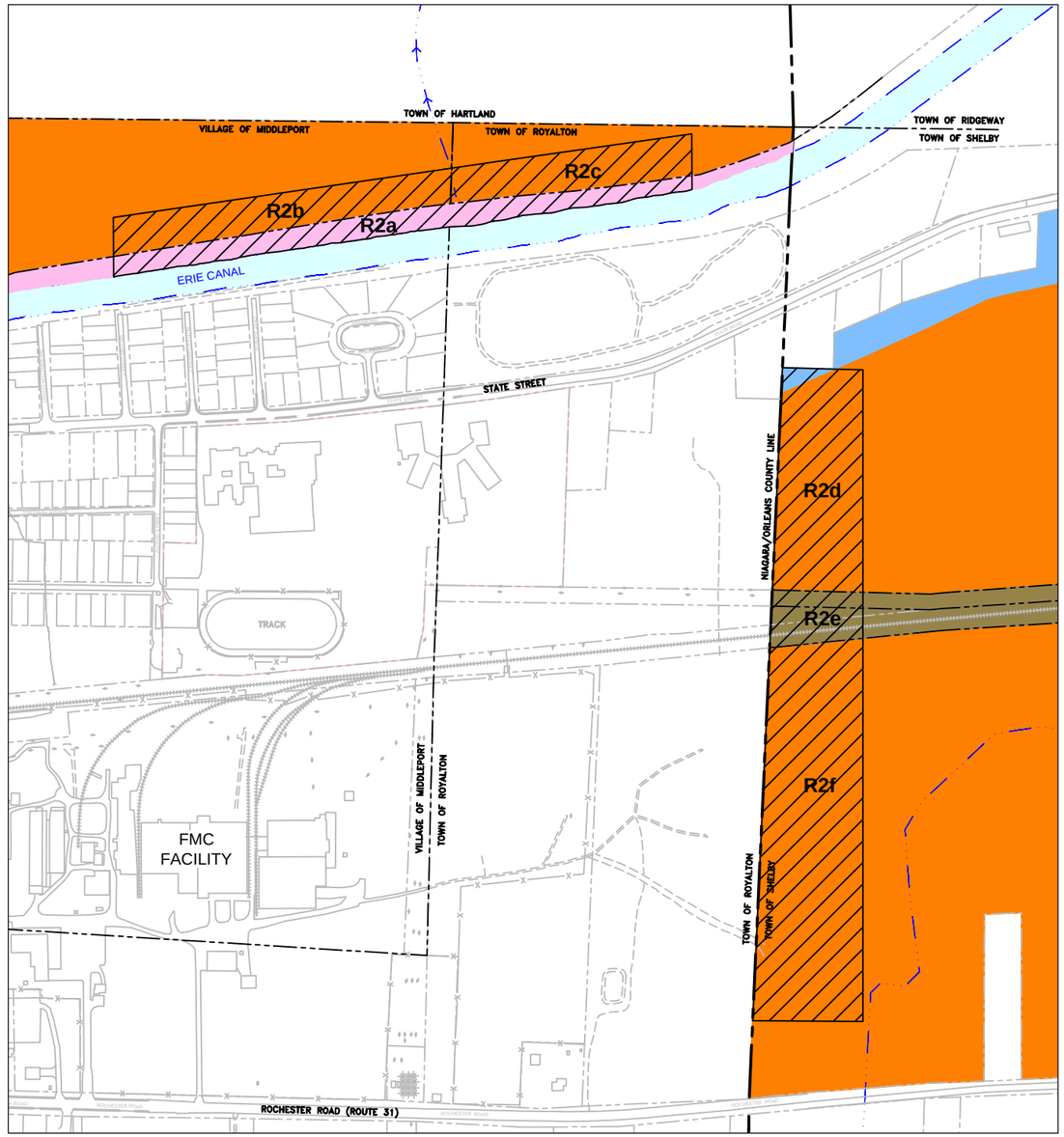
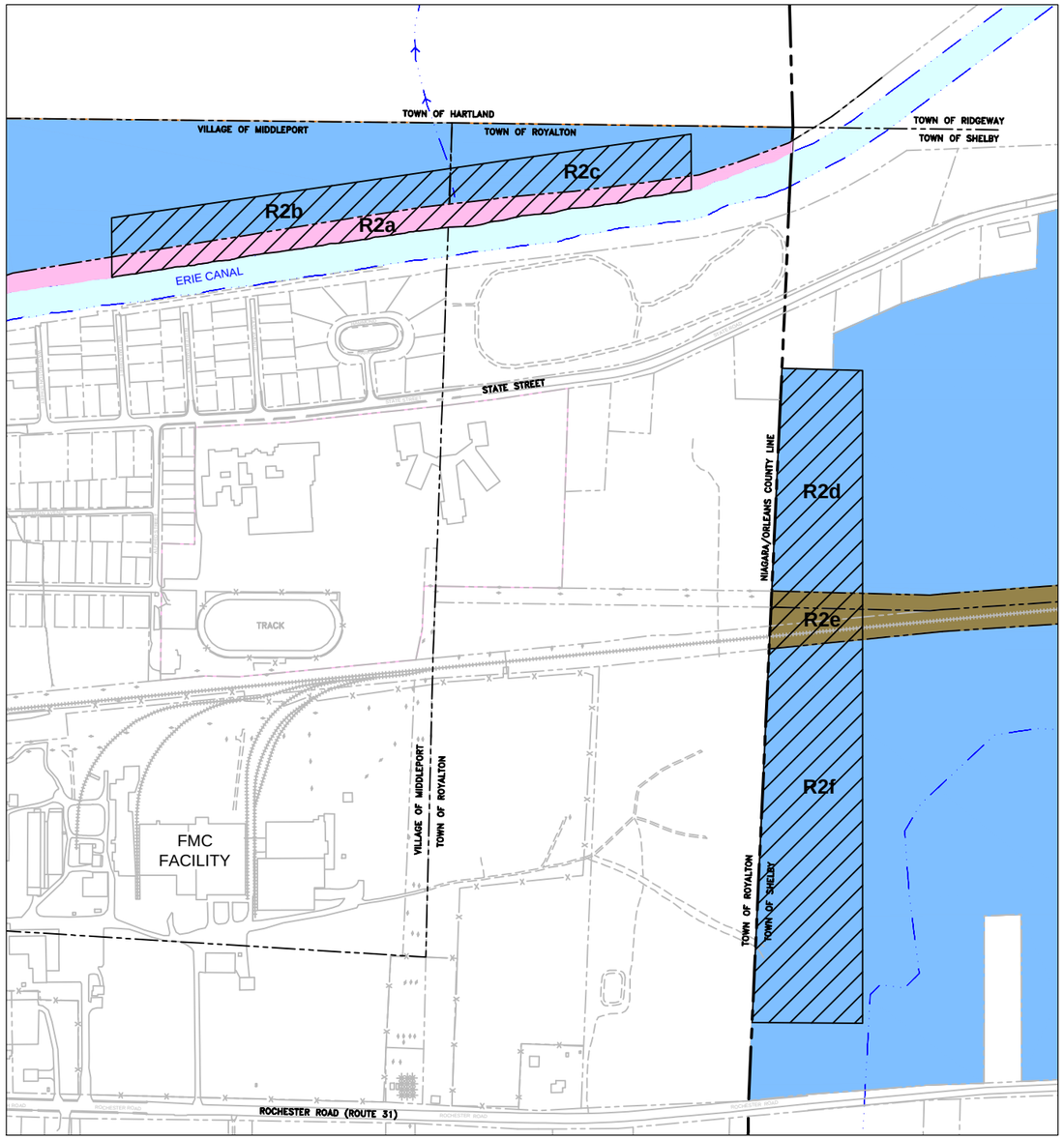
FIGURE
2



CURRENT



REASONABLY ANTICIPATED FUTURE

LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- COUNTY LINE
- R2a PROPERTY IDENTIFICATION
- AIR DEPOSITION AREA 2

LAND USES (SEE NOTE 3)

- AGRICULTURAL/OPEN LAND
- PUBLIC/INSTITUTIONAL/RECREATIONAL
- RAILROAD/UTILITY
- RESIDENTIAL

NOTES:

1. ALL LOCATIONS AND PROPERTY BOUNDARIES SHOWN ARE APPROXIMATE AND SUBJECT TO VERIFICATION.
2. PROPERTY R2d ISSUED NO FURTHER ACTION LETTER BY THE AGENCIES.
3. LAND USES ONLY SHOWN FOR PROPERTIES THAT INCLUDE AIR DEPOSITION AREA 2; IDENTIFICATION OF REASONABLY ANTICIPATED FUTURE LAND USES IS SUBJECT TO REVIEW AND COMMENT BY THE COMMUNITY AND PROPERTY OWNERS.

0 600' 1200'

GRAPHIC SCALE

FMC CORPORATION - MIDDLEPORT, NEW YORK
CORRECTIVE MEASURES STUDY REPORT
AIR DEPOSITION AREA 2 (OU-3)

LAND USES

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FIGURE
3

CITY: SYRACUSE, NY DIV/GROUP: EBC-IM/DV DB: L.POSENAUER PM/TM: T. YOUNG TR: D. WRIGHT LYR:ON=*;OFF=*REF; (FR2)
G:\ENV\CAD\SYRACUSE\ACTIB\003778\2015\000010\DWG\CMSR\37786G03.dwg LAYOUT: 3 SAVED: 9/1/2015 11:55 AM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 9/1/2015 11:57 AM BY: SARTORI, KATHERINE
XREFS:
37786X06
37786X01
37786XBL
IMAGES:

ARCADIS

Appendices

Appendix A

Correspondence

ARCADIS

Appendix A: Correspondence – Corrective Measures Study for Air Deposition Area 2 (OU-3)

Date	From	To	Description
12.05.2012	NYSDEC and USEPA	FMC	RFI Report Volume X for OU-3 (Oct. 2012) deemed complete
01.29.2013	NYSDEC and USEPA	Owner of Property R2d	No Further Action determination for Property R2d
05.09.2013	NYSDEC and USEPA	FMC	Acceptance of RFI Report and request for a Corrective Measures Study (CMS) Work Plan for OU-3
05.24.2013	FMC	NYSDEC and USEPA	Response to 05.09.2013 letter, requesting a meeting
02.18.2014	NYSDEC and USEPA	FMC	Response to 05.24.2013 letter, outlining option to instead submit a CMS Report or an abridged CMS Report
02.27.2014	NYSDEC	FMC	Extension for reply to 02.18.2014 request
03.26.2014	NYSDEC	FMC	Extension for reply to 02.18.2014 request
04.25.2014	FMC	NYSDEC and USEPA	Response to 02.18.2014 letter, requesting a meeting
06.11.2014	FMC	NYSDEC and USEPA	Confirming agreement, reached during 06.02.2014 teleconference meeting, to submit a CMS Work Plan
07.17.2014	FMC	NYSDEC and USEPA	Submittal of CMS Work Plan
08.14.2014	NYSDEC and USEPA	FMC	Comments on CMS Work Plan
08.28.2014	FMC	NYSDEC and USEPA	Response to 08.14.2014 letter, requesting a meeting
10.10.2014	FMC	NYSDEC and USEPA	Submittal of responses to Agencies' 08.14.2014 comments and draft Screening Human Health Risk Assessment
03.05.2015	NYSDEC and USEPA	FMC	Request to submit a CMS Report instead of a revised CMS Work Plan
03.13.2015	FMC	NYSDEC and USEPA	Response to 03.05.2015 letter, requesting a meeting
03.25.2015	NYSDEC and USEPA	FMC	Denial of meeting request
04.07.2015	FMC	USEPA	Notice of Dispute and Request for Resolution
06.11.2015	USEPA	FMC	Ruling on Notice of Dispute and Request for Resolution
07.16.2015	NYSDEC and USEPA	FMC	Comments on Screening Human Health Risk Assessment

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

December 5, 2012

Mr. Shawn J. Tollin
Manager, Environmental Remediation Department
FMC Corporation
1735 Market Street
Philadelphia, Pennsylvania 19103

Dear Mr. Tollin:

Re: FMC Corporation, Middleport, NY
EPA ID No. NYD002126845
AOC Docket No. II-RCRA-90-3008(h)-0209
DER Site No. 932014
RFI Report (Volume X) for Suspected Air Deposition Study Area 2 (OU3)
North of the Erie Canal and East of the Niagara/Orleans County Line

The United States Environmental Protection Agency (USEPA) and the New York State Department of Environmental Conservation (NYSDEC), hereafter referred to as "the Agencies", in consultation with the New York State Department of Health (NYSDOH), have reviewed FMC's RFI Report (Volume X) for the Suspected Air Deposition Area 2 dated October 2012. This Report has been adequately revised, consistent with a number of discussion and e-mails with Agencies staff over the past several months. As a result, the RFI Report Volume X is hereby deemed complete.

Owners of properties that have elevated levels of arsenic associated with historic releases from the FMC Middleport facility, as determined by the RFI Report for Study Area 2, will be so notified. This notification will be sent from the Agencies, via letter, prior to soliciting public comment on the RFI Report. Notification to affected property owners was also done prior to soliciting public comment for Air Deposition Area 1.

If you have any questions concerning this letter or the timing of events moving forward for this study area, you may contact either Michael Infurna (USEPA) at (212) 637-4177 or Ms. Sally Dewes (NYSDEC) at (518) 402-9768 at your earliest convenience.

Sincerely,

Michael Infurna
USEPA Project Coordinator
Emergency & Remedial Response Division

Michael Infurna for S.D.
Sally Dewes, P.E.
NYSDEC Project Coordinator
Division of Environmental Remediation

CC: R.Cozzy/M Komoroske, NYSDEC -DER
M. Hinton, DEC Region 9 Buffalo
N. Freeman, NYSDOH

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

January 29, 2013

[redacted]

Re: FMC Environmental Investigation of Middleport Area Soils
Status of Individual Properties

R2d

Dear [redacted]:

The FMC Corporation has recently (2009) completed an environmental investigation into the levels of arsenic in soil on Middleport area properties located within Air Deposition Area II (North of the Erie Canal and East of the Niagara/Orleans County Line. This includes your property located at Telegraph Road (Sheet 78.00, Block 3-5.1). Your cooperation during this investigation process was instrumental in its performance and we thank you for your patience.

The United States Environmental Protection Agency (USEPA), the New York State Department of Environmental Conservation (NYSDEC), in consultation with the New York State Department of Health (NYSDOH), hereafter referred to as the "governmental agencies", have overseen this FMC environmental investigation and are providing you this letter to summarize its outcome with respect to your property's soil.

A sketch showing the locations of the soil samples previously collected from your property and a table presenting the arsenic results for each sample, are enclosed. The results show that samples obtained from your property contained arsenic levels that are consistent with area "background levels" determined from the February 2003 *Report on the Development of Arsenic Background in Middleport Soils* (the Gasport, NY study). The "background levels" from the Gasport study are being used to represent background arsenic levels in the Middleport area (i.e., arsenic levels that would be expected to be present in Middleport area soils if there were no additional arsenic from a contamination source). The governmental agencies have estimated 20 parts per million (PPM) to generally be the upper limit of these background levels. There may be some arsenic levels on your property that are above 20 ppm and they may represent normal sampling variability but are still considered to be consistent with background levels. Therefore, we believe the levels of arsenic found in your soil samples are generally consistent with what we would expect to find in this area.

Based on our evaluation, we concluded that there is no reason for you to restrict the use of your property because of the levels of arsenic found, and that no further sampling or other actions are necessary at this time. We encourage you to keep this letter and the enclosed arsenic soil data for your records.

If you have any questions or would like to discuss any matters related to your sampling results, you may call Michael Infurna (USEPA) at (212) 637-4177, Sally Dewes (NYSDEC) at (518) 402-9768, or Nathan Freeman (NYSDOH) at 1-(800) 458-1158, ext. 2-7860.

Sincerely,

Michael Infurna for S.D. Michael Infurna

Sally Dewes, P.E.
Project Manager
Div. of Environmental
Remediation
NYSDEC

Michael Infurna
Project Manager
Emergency & Remedial
Response Division
USEPA

Enclosures

New York State Department of Environmental Conservation
Division of Environmental Remediation
Remedial Bureau B, 12th Floor
625 Broadway, Albany, New York 12233-7016
Phone: (518) 402-9768 • **Fax:** (518) 402-9773
Website: www.dec.ny.gov

Joe Martens
Commissioner

May 9, 2013

Mr. Shawn Tollin
FMC Corporation, Remediation Department
1735 Market Street
Philadelphia, Pennsylvania 19103

Dear Mr. Tollin:

Re: FMC Corporation, Middleport, NY
EPA ID No. NYD002126845
AOC Docket No. II-RCRA-90-3008(h)-0209
DER Site No. 932014
FMC Operable Unit #3 (OU3), Air Deposition Area #2

The New York State Department of Environmental Conservation (NYSDEC) and the United States Environmental Protection Agency (USEPA) hereafter referred to as "the Agencies", in consultation with the New York State Department of Health (NYSDOH), have accepted the Remedial Facility Investigation (RFI) for Operable Unit #3.

The next step towards remediating this area is for FMC to complete a Corrective Measures Study (CMS) for this operable unit. The Department envisions a CMS that can rely heavily on the information contained in the CMS for Operable Unit #2 (Air Deposition Area #1) being that both areas are similar in the nature of contamination and the mechanism of contamination. Much of the information and analysis in the CMS for OU2 may not have to be repeated in the CMS for OU3.

With that in mind, please submit a draft work plan for the CMS for Operable Unit #3 within 60 days of the date of this letter.

The RFI must be made available for public review and comment in accordance with the Order. The NYSDEC wishes to public notice the RFI and the CMS at the same time. The NYSDEC will therefore wait on public noticing the RFI until the CMS is acceptable for the purposes of drafting a Statement of Basis.

If you have any questions or wish to discuss these matters further please call or email Sally Dewes.

Sincerely,

Sally Dewes, P.E.
NYSDEC Project Coordinator
Division of Environmental Remediation
NYSDEC

Sally Dewes for Mike Infurna

Michael Infurna
USEPA Project Coordinator
Emergency and Remedial Response Division
USEPA

ec: R. Cozzy/M. Komoroske, DER
M. Hinton/G. Sutton, NYSDEC Region 9 Buffalo
M. Infurna, USEPA
N. Freeman, NYSDOH
W. Lachell, AMEC
D. Watts, MCIG Technical Advisor
W. Arnold, MCIG Chairperson
D. Seaman, Seaman, Jones, Hogan & Brooks

FMC Corporation

FMC Corporation
1735 Market Street
Philadelphia PA 19103

215.299.6000 phone
215.299.6947 fax

www.fmc.com

Transmitted Via Email and FedEx

May 24, 2013

Ms. Sally Dewes, PE
NYSDEC Project Coordinator
Remedial Bureau B
Division of Environmental Remediation
New York State Department of Environmental Conservation
625 Broadway, 12th Floor
Albany, NY 12233-7016

Mr. Michael Infurna
USEPA Project Coordinator
Emergency and Remedial Response Division
United States Environmental Protection Agency, Region II
290 Broadway, 22nd Floor
New York, NY 10007-1866

Re: Suspected Air Deposition Study Area 2 (Operable Unit #3)
Corrective Measures Study Work Plan
RCRA Section 3008(h) Administrative Order on Consent (AOC)
Docket No. II-RCRA-90-3008(h)-209
FMC Corporation, Middleport, NY Facility
EPA I.D. No. NYD002126845

Dear Ms. Dewes and Mr. Infurna:

FMC Corporation (FMC) writes in response to a letter, dated May 9, 2013, from the New York State Department of Environmental Conservation (NYSDEC) and the United States Environmental Protection Agency (USEPA) (jointly, "the Agencies") requesting that FMC submit a draft Corrective Measures Study Work Plan for Operable Unit #3 (Suspected Air Deposition Study Area 2) of FMC's Middleport, New York Facility.

In accordance with Section XI, Item 1, of the above referenced Administrative Order on Consent (AOC), FMC requests a meeting with the Agencies to discuss the Agencies' request provided in the May 9, 2013 letter. FMC proposes that the meeting be held by teleconference at a date and time mutually agreeable with the Agencies.

Please contact me by telephone at (215) 299-6554 or by email at Shawn.Tollin@fmc.com with any questions.

Sincerely,

Shawn J. Tollin
Manager, Environmental Remediation

cc: M. Hinton, NYSDEC, Buffalo
N. Freeman, NYSDOH, Troy
W. Lachell, GEI Consulting
D. Wright, PE, ARCADIS

New York State Department of Environmental Conservation
Division of Environmental Remediation
Remedial Bureau B, 12th Floor
625 Broadway, Albany, New York 12233-7016
Phone: (518) 402-9768 • **Fax:** (518) 402-9773
Website: www.dec.ny.gov

Joe Martens
Commissioner

February 18, 2014

Barbara Ritchie
Associate Director, EHS Governance & Remediation
FMC Corporation
1735 Market Street
Philadelphia, PA 19103

Re: FMC Corporation, Middleport, NY
EPA ID No. NYD002126845
AOC Docket No. II-RCRA-90-3008(h)-0209
DER Site No. 932014
Operable Unit 3 (OU3), Air Deposition Area #2, Letter dated May 24, 2013

Dear Ms. Ritchie:

The United States Environmental Protection Agency (USEPA) and the New York State Department of Environmental Conservation (NYSDEC) have received and reviewed the above-mentioned document.

The FMC letter is a response to the Agencies' letter dated May 9, 2013 requesting that a corrective measures study (CMS) be completed for OU3. As discussed in several conversations between Mr. Tollin and Ms. Dewes, there is an alternative available to FMC for preparing and presenting the information necessary for the selection of an OU3 remedy. This option is available because OU2 and OU3 are similar, both in the nature and origin (air deposition) of the contamination.

If FMC would prefer, instead of developing a complete CMS for OU3 which would necessarily contain much of the same information as the CMS for OU2, FMC can elect to submit an abridged CMS report containing a more limited amount of information. The Agencies would still need sufficient information to analyze the alternatives fully and select a remedy, but we would not need all the background information that typically is contained within a CMS.

With the abridged CMS report FMC would not have to identify nor screen technologies. The Agencies would not require FMC to develop multiple alternatives as was in the OU2 CMS. A review of alternatives similar in extent to OU2's CMA1 and CMA2 and the State's selected remedy (CMA9) would be required at a minimum. For each of those alternatives the Agencies would need to see the properties that would be remediated, the projected extent and volume of soil to be remediated under each alternative, the estimated post-remediation arsenic concentration in the soils, a general discussion of the design and implementation of each alternative, and the cost and timing associated with each alternative. This information should be sufficient for the Agencies to initiate the process of selecting a remedy.

It is FMC's prerogative to choose to forego the formality of an entire CMS and instead submit an abridged CMS report as described above or to choose to submit an entire CMS for Agency review. As you know, the Agencies did not approve the OU2/4/5 HRA contained in the OU2/4/5 CMS because FMC failed to revise the HRA in accordance with our comments. If FMC prepared an HRA for OU3 it is likely the outcome would be the similar. The Agencies do not believe an HRA is necessary for the CMS or abridged CMS report. The State will rely instead on the comprehensive health risk assessments and studies done in determining the statewide Soil Cleanup Objectives (6NYCRR Part 375) and FMC's Gasport Background Study when selecting a remedy for OU3.

The Agencies request that FMC notify us in writing within 15 days of receipt of this letter of its intention to comply with this directive and submit the CMS or abridged CMS report within thirty (30) days thereafter.

The Remedial Facility Investigation (RFI) and CMS must be made available for public review and comment in accordance with the Order. The Agencies wish to public notice the RFI and the CMS at the same time. The NYSDEC will therefore wait on public noticing the RFI until the CMS is ready for public notice as well.

If you have questions or wish to discuss these matters further please contact Ms. Sally Dewes (NYSDEC) at (518)402-9768.

Sincerely,

Sally Dewes

Sally Dewes, P.E.
NYSDEC Project Coordinator
Division of Environmental Remediation

S Dewes for M. Infurna

Michael Infurna
USEPA Project Coordinator
Emergency and Remedial Response Division

ec: R. Schick/M. Ryan, DER
R. Cozzy/M. Komoroske, DER
M. Hinton/G. Sutton, NYSDEC Region 9 Buffalo
M. Infurna/S. Badalementi, USEPA
N. Freeman, NYSDOH
S. Tollin, FMC
W. Lachell, AMEC

New York State Department of Environmental Conservation
Division of Environmental Remediation
Remedial Bureau B, 12th Floor
625 Broadway, Albany, New York 12233-7016
Phone: (518) 402-9768 • **Fax:** (518) 402-9773
Website: www.dec.ny.gov

Joe Martens
Commissioner

February 27, 2014

Barbara Ritchie
Associate Director, EHS Governance & Remediation
FMC Corporation
1735 Market Street
Philadelphia, PA 19103

Re: FMC Corporation, Middleport, NY
EPA ID No. NYD002126845
AOC Docket No. II-RCRA-90-3008(h)-0209
DER Site No. 932014
Operable Unit 3 (OU3), Air Deposition Area #2
Agencies' letter dated February 18, 2014

Dear Ms. Ritchie:

The United States Environmental Protection Agency (USEPA) and the New York State Department of Environmental Conservation (NYSDEC) sent a letter to you dated February 18, 2014 regarding FMC's Operable Unit #3 (Air Deposition Area #2) Corrective Measures Study (CMS).

The letter requested that FMC respond within 15 days (March 5, 2014) with its intention regarding our request to submit a CMS. FMC has requested an extension. The Department will allow an extension until March 26, 2014 for FMC to submit a response with its intentions to our request.

If you have questions or wish to discuss these matters further please contact Ms. Sally Dewes (NYSDEC) at (518)402-9768.

Sincerely,

Sally Dewes, P.E.
NYSDEC Project Coordinator
Division of Environmental Remediation

ec: R. Schick/M. Ryan, DER
R. Cozzy/M. Komoroske, DER
M. Hinton/G. Sutton, NYSDEC Region 9 Buffalo
A. Guglielmi/B. Conlon, OGC
M. Infurna/S. Badalementi, USEPA
N. Freeman, NYSDOH
S. Tollin, FMC
W. Lachell, AMEC

New York State Department of Environmental Conservation
Division of Environmental Remediation
Remedial Bureau B, 12th Floor
625 Broadway, Albany, New York 12233-7016
Phone: (518) 402-9768 • **Fax:** (518) 402-9773
Website: www.dec.ny.gov

Joe Martens
Commissioner

March 26, 2014

Barbara Ritchie
Associate Director, EHS Governance & Remediation
FMC Corporation
1735 Market Street
Philadelphia, PA 19103

Re: FMC Corporation, Middleport, NY
EPA ID No. NYD002126845
AOC Docket No. II-RCRA-90-3008(h)-0209
DER Site No. 932014
Operable Unit 3 (OU3), Air Deposition Area #2
Agencies' letter dated February 18, 2014

Dear Ms. Ritchie:

The United States Environmental Protection Agency (USEPA) and the New York State Department of Environmental Conservation (NYSDEC) sent a letter to you dated February 18, 2014 regarding FMC's Operable Unit #3 (Air Deposition Area #2) Corrective Measures Study (CMS).

The letter requested that FMC respond within 15 days (March 5, 2014) with its intention regarding our request to submit a CMS. FMC requested an extension. The Department extended the deadline until March 26, 2014 for FMC to submit a response with its intentions to our request.

FMC has requested another extension. The Department will extend the deadline for our request until April 26, 2014.

If you have questions or wish to discuss these matters further please contact Ms. Sally Dewes (NYSDEC) at (518)402-9768.

Sincerely,

Sally Dewes, P.E.
NYSDEC Project Coordinator
Division of Environmental Remediation

ec: R. Schick/M. Ryan, DER
R. Cozzy/M. Komoroske, DER
M. Hinton/G. Sutton, NYSDEC Region 9 Buffalo
M. Infurna/S. Badalementi, USEPA
N. Freeman, NYSDOH
S. Tollin, FMC
W. Lachell, AMEC

FMC Corporation
1735 Market Street
Philadelphia, PA 19103
USA

215.299.6000
fmc.com

April 25, 2014

Transmitted Via E-mail

Ms. Sally Dewes, PE
NYSDEC Project Coordinator
Remedial Bureau B
Division of Environmental Remediation
New York State Department of Environmental Conservation
625 Broadway, 12th Floor
Albany, NY 12233-7016

Mr. Michael Infurna
USEPA Project Coordinator
Division of Environmental Planning and Protection
United States Environmental Protection Agency, Region II
290 Broadway, 22nd Floor
New York, NY 10007-1866

Re: FMC Corporation, Middleport, New York
EPA ID No. NYD002126845
AOC Docket No. II-RCRA-90-3008(h)-0209
DER Site No. 932014
Operable Unit 3 (OU3), Air Deposition Area #2, Letter Dated May 24, 2013

Dear Ms. Dewes and Mr. Infurna:

By letter dated May 9, 2013, the New York State Department of Environmental Conservation (NYSDEC) and the United States Environmental Protection Agency (USEPA) (jointly "the Agencies"), requested FMC complete a CMS for Operable Unit 3 under the above referenced AOC. On May 24, 2013, FMC formally requested a meeting pursuant to Section XIX, Item 1 of the AOC. That meeting never occurred.

By letter dated February 18, 2104, the Agencies directed FMC to submit a corrective measures study (CMS) report or abridged CMS report for OU3 and asked that FMC notify the Agencies in writing within fifteen (15) days of receipt of the letter of its intention to comply with that directive. On February 27, NYSDEC agreed to allow FMC until March 26, 2014, to respond to the February 18 letter, and, on March 26, NYSDEC agreed to allow FMC until April 26, 2014, to respond to the February 18 letter.

In accordance with Section XI, Item 1 of the above-referenced AOC, FMC requests a meeting to discuss the Agencies' directive. FMC proposes that the meeting be held in person on a mutually agreed date and at a mutually agreed place.

Please contact me at (215)-299-6700 or at barbara.ritchie@fmc.com with any questions.

Sincerely,

Barbara E. Ritchie
Associate Director, Environment

cc: R. Schick/M. Ryan, DER
R. Cozzy/M. Komoroske, DER
M. Hinton/G. Sutton, NYSDEC Region 9 Buffalo
A. Guglielmi/B. Conlon, OGC
M. Infurna/S. Badalementi, USEPA
N. Freeman, NYSDOH
R. Forbes, FMC
S. Mizrachi, FMC
R. Kennedy, Hodgson Russ
S. Tollin, FMC
W. Lachell, AMEC

FMC Corporation

FMC Corporation
1735 Market Street
Philadelphia PA 19103

215.299.6000 phone
215.299.6947 fax

www.fmc.com

Transmitted Via Email and FedEx

June 11, 2014

Ms. Sally Dewes, PE
NYSDEC Project Coordinator
Remedial Bureau B
Division of Environmental Remediation
New York State Department of Environmental Conservation
625 Broadway, 12th Floor
Albany, NY 12233-7016

Mr. Michael Infurna
USEPA Project Coordinator
Emergency and Remedial Response Division
United States Environmental Protection Agency, Region II
290 Broadway, 22nd Floor
New York, NY 10007-1866

Re: RCRA Corrective Measures Study Work Plans
OU-3 Air Deposition Study Area 2
OU-9 Southwest Commercial (Former R&D) Property
FMC Corporation, Middleport, NY Facility
RCRA Section 3008(h) Administrative Order on Consent (AOC)
Docket No. II-RCRA-90-3008(h)-209
EPA I.D. No. NYD002126845
DER Site No. 932014

Dear Ms. Dewes and Mr. Infurna:

By letter dated May 9, 2013, the New York State Department of Environmental Conservation (NYSDEC) and the United States Environmental Protection Agency (USEPA) (jointly, "the Agencies") requested that FMC Corporation (FMC) submit a RCRA Corrective Measures Study (CMS) work plan for Operable Unit OU-3 (*i.e.*, Air Deposition Study Area 2) of FMC's Facility in Middleport, New York. On May 24, 2013, FMC formally requested a meeting pursuant to Section XI, Item 1, of the above referenced AOC. That meeting did not occur before the Agencies submitted a second request, by letter dated February 18, 2014, to submit a CMS report or abridged CMS report for OU-3. On February 27, 2014, the NYSDEC agreed to allow FMC until March 26, 2014 to respond to the February 18th letter, and on March 26, 2014, the NYSDEC agreed to allow FMC until April 26, 2014 to respond to the February 18th letter. On April 25, 2014, FMC formally requested a meeting pursuant to the AOC.

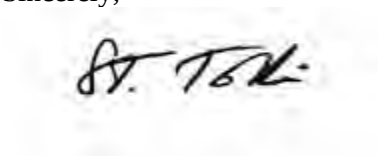
By letter dated April 22, 2014, the Agencies requested that FMC submit a CMS work plan for Operable Unit OU-9 (*i.e.*, Southwest Commercial Property or Former FMC Research and Development Property). On May 6, 2014, FMC formally requested a meeting pursuant to the AOC.

The meetings requested for OU-3 and OU-9 were held jointly by teleconference on June 2, 2014. The teleconference participants included Sally Dewes, Mike Komoroske, Mike Hinton, Jim Strickland, and Andy Guglielmi on behalf of the NYSDEC; Mike Infurna, Amy Chester, and Samantha Stahl on behalf of the USEPA; Nathan Freeman and Deanna Ripstein on behalf of the New York State Department of Health (NYSDOH); and Shawn Tollin, Barb Ritchie, Rick Kennedy, David Wright, and Wai Chin Lachell on behalf of FMC. During the June 2nd teleconference, FMC and the Agencies agreed that FMC will submit CMS work plans as follows:

- Air Deposition Study Area 2 (OU-3) within 45 days (by July 17, 2014)
- Former R&D Property (OU-9) within 60 days (by August 1, 2014)

Please contact me at telephone (215) 299-6554 or email Shawn.Tollin@fmc.com with any questions.

Sincerely,



Shawn J. Tollin
Manager, Environmental Remediation

cc: R. Cozzy, NYSDEC, Albany
M. Komoroske, NYSDEC, Albany
M. Hinton, NYSDEC, Buffalo
N. Freeman, NYSDOH, Troy
B. Ritchie, FMC
R. Forbes, FMC
S. Mizrachi, FMC
R. Kennedy, Hodgson Russ
W. Lachell, GEI Consulting
D. Wright, ARCADIS

FMC Corporation

FMC Corporation
1735 Market Street
Philadelphia PA 19103

215.299.6000 phone
215.299.6947 fax

www.fmc.com

Transmitted Via Email and FedEx

July 17, 2014

Ms. Sally Dewes, PE
NYSDEC Project Coordinator
Remedial Bureau B
Division of Environmental Remediation
New York State Department of Environmental Conservation
625 Broadway, 12th Floor
Albany, NY 12233-7016

Mr. Michael Infurna
USEPA Project Coordinator
Emergency and Remedial Response Division
United States Environmental Protection Agency, Region II
290 Broadway, 22nd Floor
New York, NY 10007-1866

Re: RCRA Corrective Measures Study (CMS) Work Plan
Suspected Air Deposition Study Area 2 (OU-3)
FMC Corporation, Middleport, NY Facility
RCRA Section 3008(h) Administrative Order on Consent (AOC)
Docket No. II-RCRA-90-3008(h)-209
EPA I.D. No. NYD002126845
DER Site No. 932014

Dear Ms. Dewes and Mr. Infurna:

FMC Corporation (FMC) is submitting the enclosed *Corrective Measures Study Work Plan – Suspected Air Deposition Study Area 2 (North of the Erie Canal and East of the Niagara/Orleans County Line) – Operable Unit 3* ("CMS Work Plan") for its Middleport, New York facility. The CMS Work Plan is being submitted under the terms and conditions of the above-referenced AOC, for review and approval by the New York State Department of Environmental Conservation (NYSDEC) and the United States Environmental Protection Agency (USEPA) (jointly, "the Agencies").

By letters dated December 5, 2012 and May 9, 2013, the Agencies, in consultation with the New York State Department of Health (NYSDOH), accepted FMC's *RCRA Facility Investigation Report Volume X – Suspected Air Deposition Study Area 2* (RFI Report Volume X) (October 2012) and determined that a CMS is required to address FMC-related arsenic in Air Deposition Area 2 soil. The May 9, 2013 letter requested that FMC submit a CMS work plan. FMC requested, by letter dated May 24, 2013, a meeting to discuss the Agencies' requested CMS work plan. The meeting did not occur before the Agencies submitted a second request, by letter dated February 18, 2014, to submit a CMS report, or abridged CMS report, for Air Deposition Area 2. The Agencies subsequently extended the deadline for FMC to respond to the February 18, 2014 letter to April 26, 2014. FMC sent the Agencies a request for a meeting by letter

dated April 25, 2014. The meeting was held by teleconference on June 2, 2014. During the June 2nd teleconference, FMC and the Agencies agreed that FMC would submit a CMS work plan within 45 days (by July 17, 2014). Enclosed is the CMS Work Plan for Air Deposition Area 2.

Please contact me at telephone (215) 299-6554 or email Shawn.Tollin@fmc.com with any questions.

Sincerely,

Shawn J. Tollin
Manager, Environmental Remediation

Enclosure
Draft Corrective Measures Study (CMS) Work Plan Suspected Air Deposition Study Area 2 (OU-3)

cc: R. Cozzy, NYSDEC, Albany (w/o enclosure)
M. Komoroske, NYSDEC, Albany (w/o enclosure)
M. Hinton, NYSDEC, Buffalo
N. Freeman, NYSDOH, Troy
B. Ritchie, FMC Philadelphia (w/o enclosure)
R. Forbes, FMC Philadelphia (w/o enclosure)
N. Parker, FMC Middleport
S. Mizrachi, FMC Philadelphia
R. Kennedy, Hodgson Russ
W. Lachell, GEI Consultants
D. Wright, ARCADIS

New York State Department of Environmental Conservation
Division of Environmental Remediation
Remedial Bureau B, 12th Floor
625 Broadway, Albany, New York 12233-7016
Phone: (518) 402-9768 • **Fax:** (518) 402-9773
Website: www.dec.ny.gov

Joe Martens
Commissioner

August 14, 2014

Barbara Ritchie
Associate Director, EHS Governance and Remediation
FMC Corporation
1735 Market Street
Philadelphia, PA 19103

Dear Ms. Ritchie:

Re: FMC Corporation, Middleport, NY
EPA ID No. NYD002126845
AOC Docket No. II-RCRA-90-3008(h)-0209
DER Site No. 932014
Operable Unit No. 3 (Air Deposition Area 2) Corrective Measures Study (CMS)
Work Plan dated July 17, 2014

The United States Environmental Protection Agency (USEPA) and the New York State Department of Environmental Conservation (DEC), hereafter referred to as "the Agencies," in consultation with the New York State Department of Health (NYSDOH), have received and reviewed the above mentioned document. Below are our comments.

1. Section 2.1. Page 4. The Agencies disagree with FMC's request that property R2e be removed from the CMS. FMC claims that the soil arsenic concentrations are not consistent with air deposition. However the data are consistent with all of the properties immediately to the west of R2e. Although a significant portion of the air deposition occurred to the west of the site, air deposition did not exclusively occur in one direction (see wind rose in RFI Volume 1) and this property could have been impacted by run-off from FMC's plant site. This page also states that the two borings on R2e are similar to Gasport's wooded, overgrown, and agricultural properties. The Gasport study divides up the land into five categories; crop field, wooded, commercial/industrial, orchard, and residential/public. The average concentration found on R2e is 460% higher than the levels found in crop fields in Gasport, 411% higher than those found in wooded areas, 190% higher than in commercial/industrial areas, and 216% higher than found in residential/public areas. Also, all crop fields, wooded areas, commercial/industrial, and residential/public property concentrations (excluding outliers) are less than the median R2e concentration. R2e should be included in the CMS.

2. Section 2.3. Page 6. Although corrective action objective 1 mentions a site-specific risk assessment, the State will not require FMC to complete a health risk assessment (HRA) as part of this CMS. As discussed several times, the Agencies previously reviewed a HRA as part of the CMS for OU2/4/5. The Agencies disagreed with many of the risk assessment assumptions made by FMC and requested modifications to that risk

assessment. FMC failed to revise the HRA or take any of the Agencies' comments under consideration. FMC can submit a HRA if they wish, however DEC and the NYSDOH may choose to not review it if the submission does not incorporate our earlier comments. Presently, DEC considers the arsenic risk assessments performed by NYSDOH in conjunction with the NYS Soil Cleanup Objectives (SCOs) to be appropriate for addressing arsenic exposures in the Middleport community and appropriately conservative with regard to the assumptions used to characterize those exposures.

It is also stated on this page that the acceptable risk range is less than 10^{-4} (1 in 10,000). As mandated in the legislation, directing DEC to develop the SCO's, the target risk level is set at 10^{-6} and when background levels exceed this level the SCO is based upon background levels. Risk evaluations prepared by the NYSDOH during the development of the State's SCOs have determined that the soil concentration associated with the 10^{-6} cancer risk level for arsenic is less than 1.0 ppm using a. risk evaluation that DEC and NYSDOH consider applicable and appropriate to the Middleport community. However, since typical background levels of arsenic in soil almost always exceed 10^{-6} cancer risk level, arsenic remedial goals are routinely evaluated in terms of background concentrations, as was true for OU2.

All of the properties where soil concentrations are at or above 20 ppm must be evaluated in the CMS (except R2d).

3. Section 2.4, page 8. In paragraph 4 a tilling alternative is presented that would "achieve an average soil arsenic concentration goal based on land use, or confirmation of post-remediation conditions based on multi-incremental sampling data." Tilling must be evaluated in the CMS against all of the cleanup alternatives based on arsenic concentrations. This will include, as stated in the comment #4 below, the cleanup goal of 20 ppm. Also, please define "multi-incremental sampling data."

4. Section 2.5, page 9. The three alternatives presented in this section are insufficient. FMC must also include an alternative(s) analogous to OU2's CMA2 and/or CMA9.

   Be advised, as discussed in the OU2/4/5 May 2013 Final Statement of Basis (FSOB), FMC's "post-remediation" method of averaging is not acceptable. FMC calculated an average by averaging all samples of a given parcel together (regardless of distribution) and also including in the average projected concentrations of clean fill used to backfill excavated areas.

5. Section 3, Paragraph 2A. The draft work plan states that technical effectiveness is the "ability to reduce risks." Please revise paragraph 2A to reflect the consent order, which states: "Effectiveness shall be evaluated in terms of the ability to perform intended functions, such as containment, diversion, removal, destruction, or treatment. The effectiveness of each corrective measure shall be determined either through design specifications or by performance evaluation. Any specific waste or site characteristics which could potentially impede effectiveness shall be considered. The evaluation should also consider the effectiveness of combinations of technologies".

Section 3, paragraph 4. Please see Comment #2.

6. Section 6 regarding community participation must also specifically discuss actions to be taken at certain steps of the process: public noticing, public meetings/hearings, availability sessions, etc. For example, when the CMS is public noticed, FMC will send out a mailing to announce the public notice.

7. Section 7. The schedule outlined in Section 7 of the draft work, which requires a year to complete this CMS, is unacceptable. Please tighten and shorten the schedule so that it is commensurate to the scope of the work and in conformance with the AOC.

8. Figures 1 and 2. Both figures show a sliver of land bounded by two approximate property boundary lines between R2e and R2f. According to tax maps R2e and R2f are immediately adjacent to one another; there is no small triangular property as shown on the FMC figures. Please correct.

Based on the above comments and requests, please revise the OU 03 CMS work plan in accordance with paragraph XI of the AOC.

If you have questions concerning this letter, you may contact Ms. Sally Dewes (NYSDEC) at (518)402-9768.

Sincerely,

Michael Komoroske

for Sally Dewes, P.E.
NYSDEC Project Coordinator
Division of Environmental Remediation

Michael Komoroske

for Michael Infurna
USEPA Project Coordinator
Emergency and Remedial Response Division

ec: R. Cozzy/M. Komoroske, DER
M. Hinton/G. Sutton, NYSDEC Region 9 Buffalo
D.Garbarini/S. Badalamenti/M. Infurna, USEPA
D. Ripstein/N. Freeman, NYSDOH
B. Ritchie/S. Tollin, FMC
W. Lachell, AMEC

FMC Corporation

FMC Corporation
1735 Market Street
Philadelphia PA 19103

215.299.6000 phone
215.299.6947 fax

www.fmc.com

Transmitted Via Email and FedEx

August 28, 2014

Ms. Sally Dewes, PE
NYSDEC Project Coordinator
Remedial Bureau B
Division of Environmental Remediation
New York State Department of Environmental Conservation
625 Broadway, 12th Floor
Albany, NY 12233-7016

Mr. Michael Infurna
USEPA Project Coordinator
Emergency and Environmental Remediation Division
United States Environmental Protection Agency, Region II
290 Broadway, 22nd Floor
New York, NY 10007-1866

Re: RCRA Corrective Measures Study (CMS) Work Plan
Suspected Air Deposition Study Area 2 (OU-3)
FMC Corporation, Middleport, NY Facility
RCRA Section 3008(h) Administrative Order on Consent (AOC)
Docket No. II-RCRA-90-3008(h)-209
EPA I.D. No. NYD002126845
DER Site No. 932014

Dear Ms. Dewes and Mr. Infurna:

By letter dated August 14, 2014, the New York State Department of Environmental Conservation (NYSDEC) and the United States Environmental Protection Agency (USEPA) (jointly, "the Agencies"), in consultation with the New York State Department of Health (NYSDOH), provided FMC Corporation (FMC) with comments on the *Corrective Measures Study Work Plan – Suspected Air Deposition Study Area 2 (North of the Erie Canal and East of the Niagara/Orleans County Line) – Operable Unit 3* ("CMS Work Plan") (July 2014).

In accordance with Section XI, Item 1, of the above referenced Administrative Order on Consent (AOC), FMC requests a meeting with the Agencies to discuss the Agencies' comments provided in the August 14, 2014 letter. FMC proposes that the meeting be held in person in Albany, at a date and time mutually agreeable with the Agencies. FMC would like to discuss its position on the comments.

Please contact me by telephone at (215) 299-6554 or by email at Shawn.Tollin@fmc.com with any questions.

Sincerely,

Shawn J. Tollin
Manager, Environmental Remediation

cc: M. Hinton, NYSDEC, Buffalo
N. Freeman, NYSDOH, Troy
B. Ritchie, FMC Philadelphia
S. Mizrachi, Esq., FMC Philadelphia
R. Kennedy, Esq., Hodgson Russ
W. Lachell, GEI Consulting
D. Wright, PE, ARCADIS

FMC Corporation

FMC Corporation
1735 Market Street
Philadelphia PA 19103

215.299.6000 phone
215.299.6947 fax

www.fmc.com

Transmitted Via Email and FedEx

October 10, 2014

Ms. Sally Dewes, PE
NYSDEC Project Coordinator
Remedial Bureau B
Division of Environmental Remediation
New York State Department of Environmental Conservation
625 Broadway, 12th Floor
Albany, NY 12233-7016

Mr. Michael Infurna
USEPA Project Coordinator
Emergency and Environmental Remediation Division
United States Environmental Protection Agency, Region II
290 Broadway, 22nd Floor
New York, NY 10007-1866

Re: RCRA Corrective Measures Study (CMS) Work Plan
Suspected Air Deposition Study Area 2 (OU-3)
FMC Corporation, Middleport, NY Facility
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Dear Ms. Dewes and Mr. Infurna:

By letter dated August 14, 2014, the New York State Department of Environmental Conservation ("NYSDEC") and the United States Environmental Protection Agency ("USEPA") (jointly, "the Agencies"), in consultation with the New York State Department of Health ("NYSDOH"), provided FMC Corporation ("FMC") with comments on the *Corrective Measures Study Work Plan – Suspected Air Deposition Study Area 2 (North of the Erie Canal and East of the Niagara/Orleans County Line) – Operable Unit 3* ("CMS Work Plan") (July 2014). In accordance with Section XI, Item 1, of the above-referenced Administrative Order on Consent ("AOC"), on August 28, 2014, FMC requested a meeting with the Agencies to discuss the Agencies' August 14 comments. FMC proposed the meeting be held in person in Albany, at a date and time mutually agreeable with the Agencies, and include legal counsel.

During subsequent email correspondence, NYSDEC indicated that it did not believe lawyers for either side should attend; rather the meeting should be among technical staff only. FMC disagreed, and a meeting has not yet occurred. Nonetheless, FMC submits the attached responses to the August 14 comments provided by the Agencies. Those responses make clear there is a dispute between FMC and NYSDEC on the submitted CMS Work Plan. FMC renews its request for a meeting to discuss the

comments on OU3, to be held in person, and attended by technical and legal representatives from NYSDEC, USEPA, and FMC. FMC reserves all rights to request dispute resolution pursuant to Section XXIX of the AOC.

Additionally, FMC will revise the CMS Work Plan, consistent with the attached responses to Agencies' comments, and anticipates providing a revised draft CMS work plan for review by the Agencies by the end of October.

Finally, Agencies' Comment No. 7 addressed the schedule included in FMC's July 17, 2014, OU3 CMS Work Plan, and FMC's response is included in the attachment. Because we share the Agencies' interest in proceeding with the work, we have commenced work on the first task described in the CMS Work Plan – specifically the screening level risk assessment described in Section 2.3, and described as an interim deliverable in Section 5. A preliminary draft is enclosed (Attachment 2) so as to provide the Agencies opportunity to review it on an expedited schedule, which would facilitate shortening the overall project schedule. As you will note, based on the preliminary draft Screening Human Health Risk Assessment, all the properties considered fall within the acceptable risk range described in the corrective action objectives. Accordingly, FMC requests reconsideration as to whether a CMS is required for OU3.

Please contact me by telephone at (215) 299-6700 or by email at Barbara.Ritchie@FMC.com with any questions.

Sincerely,

Barbara Ritchie
Associate Director, EHS Remediation/Governance

Enclosures

Attachment 1 – FMC's Response to Agencies' Comments by Letter Dated August 14, 2014
Attachment 2 – Screening Human Health Risk Assessment – OU3

cc: N. Freeman, NYSDOH, Troy
M. Hinton, NYSDEC, Buffalo
R. Kennedy, Esq., Hodgson Russ
W. Lachell, GEI Consulting
S. Mizrachi, Esq., FMC Philadelphia
S. Tollin, FMC Philadelphia
D. Wright, PE, ARCADIS

Attachment 1

FMC's Response to Agencies' Comments by Letter Dated August 14, 2014

ATTACHMENT 1
FMC'S RESPONSE TO AGENCIES' COMMENTS BY LETTER DATED AUGUST 14, 2014
CORRECTIVE MEASURES STUDY (CMS) WORK PLAN, DRAFT DATED JULY 2014
SUSPECTED AIR DEPOSITION STUDY AREA 2 (OPERABLE UNIT 3)
FMC CORPORATION – MIDDLEPORT, NEW YORK

Agencies Comment #1

Section 2.1. Page 4. The Agencies disagree with FMC's request that property R2e be removed from the CMS. FMC claims that the soil arsenic concentrations are not consistent with air deposition. However the data are consistent with all of the properties immediately to the west of R2e. Although a significant portion of the air deposition occurred to the west of the site, air deposition did not exclusively occur in one direction (see wind rose in RFI Volume 1) and this property could have been impacted by run-off from FMC's plant site. This page also states that the two borings on R2e are similar to Gasport's wooded, overgrown, and agricultural properties. The Gasport study divides up the land into five categories; crop field, wooded, commercial/industrial, orchard, and residential/public. The average concentration found on R2e is 460% higher than the levels found in crop fields in Gasport, 411% higher than those found in wooded areas, 190% higher than in commercial/industrial areas, and 216% higher than found in residential/public areas. Also, all crop fields, wooded areas, commercial/industrial, and residential/public property concentrations (excluding outliers) are less than the median R2e concentration. R2e should be included in the CMS.

FMC's Response

The available information provides multiple lines of evidence indicating that soil arsenic concentrations at Property R2e originate from sources other than the FMC Facility. Discussion of these points, Air Deposition, Surface Water Runoff, and Other Potential Sources, is provided below.

Air Deposition

Soil affected by air deposition of arsenic is expected to exhibit soil arsenic concentrations that: 1) decrease with increasing distance from the Facility; 2) are higher at the surface and decrease with depth below surface grade; and 3) 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). Figure 1 (Location Map) has been revised to include a wind rose, which shows the predominant wind direction is from the southwest, towards the northeast. If wind blowing to the northeast resulted in air deposition from the FMC historical manufacturing units on Property R2e, then, based on distance from the source, the same air deposition would be expected at locations immediately adjacent to the north and south of Property R2e (i.e., on the southern portion of Property R2d and the northern portion of Property R2f), resulting in the same soil arsenic concentrations. However, soil arsenic concentrations in the 0- to 3-inch and 3- to 6-inch depth intervals on Property R2e are higher than on the southern portion of Property R2d and the northern portion of Property R2f:

Property	Sampling Locations	Range of Soil Arsenic Concentrations in 0-3" and 3-6" Depth Intervals (mg/kg)
R2d	V38, V40	16.9 to 20.0
R2e	T38, T40	26.8 to 34.6
R2f	R38, R40	17.4 to 22.4

The pattern shown in the table above, where Property R2e arsenic concentrations are higher than both adjacent properties the same distance downwind from the Facility, clearly suggests that Property R2e has been impacted by a source other than air deposition.

The Agencies' comment asserts that the concentrations on Property R2e are consistent with properties immediately to the west of Property R2e. Please note that properties immediately to the west of Property R2e are closer to the FMC plant than Property R2e and as such, if affected by air deposition, Property R2e would be expected to have lower arsenic concentrations as it is farther away from the FMC plant. Conversely, those properties immediately west of Property R2e would be expected to have higher arsenic concentrations on their eastern edge (bordering R2e), if attributable to air deposition. The closest sampling points on properties immediately to the west of Property R2e (T36 on Property R1a-South and R36 on Property R1b) are not higher than those found on Property R2e (23.7 and 31.7 ppm, respectively, in the 0- to 3-inch depth interval). This pattern is an additional line of evidence which supports a conclusion that Property R2e has been impacted by a source other than air deposition.

Surface Water Runoff

Prior to onsite capture of surface water runoff, stormwater flow from the northeastern portion of the Facility (i.e., portion closest to Property R2e) was historically directed to the drainage ditches along the mainline railroad tracks, which flowed west, away from Property R2e. As seen in the attached Figure A, surface grades on the southern portion of Property R1a do not slope towards Property R2e, but drain to the west. As a result, surface water runoff from the southern portion of Property R1a discharges to the drainage ditch that runs along the north side of the mainline railroad tracks and flows west to Culvert 105. Thus, surface water runoff from the FMC Facility is not a potential source of arsenic on Property R2e.

Other Potential Sources

Property R2e is currently occupied by wooded/overgrown areas and the mainline railroad tracks, and was historically also occupied by a trolley line. During sampling, debris, including railroad ties and wood posts, was observed on the property. An electrical power line corridor adjoins Property R2e, with agricultural land farther to the north and south. Potential anthropogenic sources of arsenic (not related to the FMC Facility) to Property R2e include the historical application of arsenical pesticides along railroad / trolley tracks and electrical power lines, and the deposition of coal ash from rail operations. Given that

the arsenic concentrations are not likely associated with the FMC Facility via air deposition or surface water runoff pathways, a non-FMC anthropogenic source is the most likely cause.

Lastly, the Agencies' refer to the 'average' concentrations on crop fields, wooded areas, commercial industrial areas, and residential/public areas, and compare those to the median Property R2e concentrations. FMC did not understand that the Agencies' supported use of averages / medians in describing arsenic concentrations during RFI/CMS activities. Rather, FMC notes that the 2001-2003 Gasport background study was designed to identify soil arsenic concentrations (as a result of natural and anthropogenic sources) expected at properties, not affected by the FMC Facility, of varying land use types. Soil arsenic concentrations observed at Property R2e (7.2 to 34.6 mg/kg) are within the range of concentrations (3.1 to 56.7 mg/kg) observed in soil at wooded/overgrown/agricultural properties in the Gasport study. Please reference Table B-2 from the October 5, 2012 RFI report on OU3, which shows a 98th percentile arsenic concentration of 51.8 mg/kg for "Wooded or Overgrown Land and Agricultural Crop Field Land." Overall for combined land use types, as shown on Table B-3 in the October 5, 2012 RFI report on OU3, the 98th percentile arsenic concentration would be 75 mg/kg. Consistent with Section 9.1.1 of the New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives Technical Support Document (2006), the 98th percentile of analyte concentrations of the statewide rural surface soil data was used to represent New York State rural soil background concentrations.

In the Agencies' March 10, 2008 letter "Confirmation of Agreements & Resolution of Outstanding Issues" the Agencies made it clear that '…in setting a "delineation" criterion (as opposed to a "remediation" criterion)….we find the 20 ppm arsenic concentration to be an appropriate delineation criterion for the Middleport area, we agree that it should not be employed as an absolute or exclusive criteria …other factors such as data variability, wind patterns, ground features….historic land use may also be considered on a site-specific basis.' Thus, while FMC has delineated to 20 ppm as required by the later adopted CAOs, in consideration of site-specific factors, Property R2e should not be carried into the CMS.

As shown above, multiple lines of evidence support the conclusion that elevated arsenic concentrations on Property R2e are not a result of FMC's operations.

Agencies Comment #2

Section 2.3. Page 6. Although corrective action objective 1 mentions a site-specific risk assessment, the State will not require FMC to complete a health risk assessment (HRA) as part of this CMS. As discussed several times, the Agencies previously reviewed a HRA as part of the CMS for OU2/4/5. The Agencies disagreed with many of the risk assessment assumptions made by FMC and requested modifications to that risk assessment. FMC failed to revise the HRA or take any of the Agencies' comments under consideration. FMC can submit a HRA if they wish, however DEC and the NYSDOH may choose to not review it if the submission does not incorporate our earlier comments. Presently, DEC considers the arsenic risk assessments performed by NYSDOH in conjunction with the NYS Soil Cleanup Objectives (SCOs) to be appropriate for addressing arsenic exposures in the Middleport community and appropriately conservative with regard to the assumptions used to characterize those exposures.

It is also stated on this page that the acceptable risk range is less than 10^{-4} (1 in 10,000). As mandated in the legislation, directing DEC to develop the SCO's, the target risk level is set at 10^{-6} and when background levels exceed this level the SCO is based upon background levels. Risk evaluations prepared by the NYSDOH during the development of the State's SCOs have determined that the soil concentration associated with the 10^{-6} cancer risk level for arsenic is less than 1.0 ppm using a risk evaluation that DEC and NYSDOH consider applicable and appropriate to the Middleport community. However, since typical background levels of arsenic in soil almost always exceed 10-6 cancer risk level, arsenic remedial goals are routinely evaluated in terms of background concentrations, as was true for OU2.

All of the properties where soil concentrations are at or above 20 ppm must be evaluated in the CMS (except R2d).

FMC's Response

The Corrective Action Objectives (CAOs) for this site were issued by the Agencies on March 26, 2009. These CAOs are based on public health and environmental criteria, information gathered during the RFI, USEPA guidance, and the requirements of any applicable federal statutes, include consideration of site specific data, including a risk assessment. CAO 1 states "*to protect human health and the environment relative to FMC-related contamination, in accordance with, and/or in consideration of, applicable, or relevant and appropriate laws, rules and guidance, using* ***site-specific data and information, supported by multiple lines of evidence, including site-specific risk assessment (emphasis added)****, and based on current and reasonably anticipated future land use(s). Reasonably anticipated future land uses will be identified in consultation with the community*." This requirement can only be met by conducting a site-specific HRA with site-specific data.

Regarding the assertion that "*The Agencies disagreed with many of the risk assessment assumptions made by FMC and requested modifications to that risk assessment. FMC failed to revise the HRA or take any of the Agencies' comments under consideration*," it is helpful to review the record of Agencies' comments and responses by FMC. The record is clear that FMC did take the Agencies' comments under consideration and did revise the HRA. The Agencies first commented on the planned approach for the HRA to be conducted as part of the CMS for OU2/4/5 in a letter dated March 23, 2010 (commenting on a document titled "FMC Middleport Risk Management Approach for the Corrective Measures Study, Suspected Air Deposition and Culvert 105 Study Areas" submitted by FMC to the Agencies on October 30, 2009). FMC subsequently provided detailed responses to those comments in Attachment 7 to the July 12, 2010 draft of the HRA for the CMS for OU2/4/5. As indicated in Attachment 7, FMC did incorporate in the HRA changes to address many of the Agency comments. The Agencies subsequently provided comments on the July 12, 2010 draft HRA in a letter dated September 15, 2010 (General Comment number 5). This comment was a subject discussed in a meeting between FMC and the Agencies held on October 28, 2010. Agreements on the disposition of those comments were reached at that meeting and are documented in a letter dated December 2, 2010 from the Agencies to FMC, including the HRA comments.

Regarding the comment that "*DEC considers the arsenic risk assessments performed by NYSDOH in conjunction with the NYS Soil Cleanup Objectives (SCOs) to be appropriate for addressing arsenic exposures in the Middleport community*," FMC has previously explained at length why this assertion is not correct. The risk evaluations prepared by NYSDOH to develop the SCOs are, by definition, *not* site-

specific risk assessments applicable and appropriate to the Middleport community. SCOs are intended to be broadly applied across New York State and do not take into account site-specific information for Middleport, as required by the CAOs. Furthermore, while the SCOs are not directly applicable to the RCRA Corrective Action work being performed pursuant to the AOC, the development of Site-Specific SCOs is provided for in NYSDEC's October 21, 2010 "Soil Cleanup guidance" policy (CP-51) which anticipates a 'flexible framework to develop soil cleanup levels by allowing the remedial party to conduct a more detailed evaluation of site information….the remedial party may…modify the input parameters used in the SCO calculations; use site data to improve or confirm predictions of exposures..." Specifically, the NYSDEC and NYSDOH default assumptions for bioavailability, exposure frequency and duration, and vegetable consumption lack site-specific information and are inconsistent with actual conditions in Middleport. As agreed to in the AOC, site specific data should be used, and that should be followed here to modify the input parameters to improve the prediction of exposures, consistent with USEPA risk assessment guidance, New York State Brownfield Cleanup Program – Development of Soil Cleanup Objectives Technical Support Document (2006), and CP-51.

The Agencies' comment also fails to consider the expressed desire of the community to have an HRA that incorporates site-specific data. As evident throughout the development of the CAOs, and as summarized in the Agencies' March 26, 2009 letter transmitting those CAOs, the Middleport community wants site-specific considerations used in the HRA.

Regarding the comment that "*As mandated in the legislation, directing DEC to develop the SCO's, the target risk level is set at* 10^{-6}", the legislation under which the SCOs were developed is not applicable for developing site-specific clean up goals under RCRA. The CAOs for this site clearly state that protection of human health will be achieved when "*Excess human health carcinogenic risks are reduced such that the lifetime excess cancer risks fall within the range appropriate for residential communities (i.e.,* 10^{-4} *to* 10^{-6}*)*".

Regarding the comment that "… *since typical background levels of arsenic in soil almost always exceed 10-6 cancer risk level, arsenic remedial goals are routinely evaluated in terms of background concentrations, as was true for OU2. All of the properties where soil concentrations are at or above 20 ppm must be evaluated in the CMS (except R2d)",* FMC will revise the draft CMS work plan to include Gasport soil background data comparisons to parcel-specific data based on no action (existing conditions) and anticipated post-corrective action levels for each CMA evaluated.

Thus, there remains a fundamental disagreement over (1) how the risk is calculated to most accurately characterize Middleport's site-specific assumptions, (2) what level of risk is acceptable, and, (3) what arsenic concentrations are reflective of background conditions.

Agencies Comment #3

Section 2.4, page 8. In paragraph 4 a tilling alternative is presented that would "achieve an average soil arsenic concentration goal based on land use, or confirmation of post- remediation conditions based on multi-incremental sampling data." Tilling must be evaluated in the CMS against all of the cleanup alternatives based on arsenic concentrations. This will include, as stated in the comment #4 below, the cleanup goal of 20 ppm. Also, please define "multi-incremental sampling data."

FMC's Response

Section 2.4 of the CMS Work Plan includes a list of technologies that have been identified for further screening and/or evaluation during the CMS. Section 2.5 of the CMS Work Plan includes a preliminary list of Corrective Measures Alternatives (CMA) to be evaluated during the CMS and lists "Soil tilling/blending." The average soil arsenic concentrations are as specified in Section 2.5, Item 2 of the work plan (20 ppm for residential land use, 30 ppm for public/institutional land use and 40 ppm for commercial, industrial, recreational, agricultural, railroad and utility land uses).

Section 3 lists the criteria against which each CMA will be evaluated. These criteria are listed in the AOC. The AOC does not explicitly list an arsenic concentration of 20 ppm as a cleanup goal, or as a criterion for evaluation of CMAs. Rather, as stated in Section 3, each CMA, including tilling, will be evaluated against criteria summarized here:

- How Well Does the CMA Achieve the CAOs
- Technical – performance, reliability, implementability and safety
- Environmental - Short-term and long term potential impacts
- Human Health – extent to which short- and long-term exposures to arsenic are mitigated
- Institutional – effects of federal, state and local environmental and public health standards
- Cost – capital, engineering and any long-term costs

Multi-incremental sampling (MIS) is a sampling methodology allowing for a uniform, representative sample to be generated from multiple discrete samples within a specified area or decision unit. MIS is based on the mathematical theories of Pierre Gy and Francis Pitard and has been used since the mid-1950s in the mining industry to reduce the significance of sampling error. USEPA recognized this methodology in November 2003 (EPA/600/R-03/027) and it was incorporated into SW846 Method 8330B for explosive testing in November 2006. Studies conducted by the US Army Corps of Engineers Cold Regions Research and Engineering Laboratory show, without MIS, sampling error was at least 10 times greater than analytical error and a major source of analytical error was sample processing and sub-processing. Additional information can be found in the September 1, 2014 edition of TechDirect, EPA's Contaminated Site Cleanup Information newsletter. (http://clu-in.org/techdirect)

Agencies Comment #4

Section 2.5, page 9. The three alternatives presented in this section are insufficient. FMC must also include an alternative(s) analogous to OU2's CMA2 and/or CMA9.

Be advised, as discussed in the OU2/4/5 May 2013 Final Statement of Basis (FSOB), FMC's "post-remediation" method of averaging is not acceptable. FMC calculated an average by averaging all samples of a given parcel together (regardless of distribution) and also including in the average projected concentrations of clean fill used to backfill excavated areas.

FMC's Response

The comment appears to be requiring inclusion of two additional CMAs, one analogous to "CMA2" and one analogous to "CMA9." To clarify, a CMA 'analogous to CMA2' would entail excavation of soils

whose RFI results were greater than 20 ppm arsenic, and excavation from that point until the next RFI sample result was less than or equal to 20 ppm, in all directions horizontally and vertically. Properties which had not been sampled would not be included in development of that CMA. FMC can develop a CMA which reflects this end-point, but it will score very poorly against the CMS evaluation criteria listed in FMC's response to comment No. 3, above, when compared to the CMAs currently included in the CMS work plan submitted to the Agencies on July 17, 2014. As such, this effort would not be justified. Further, FMC understands that the Agencies describe CMA9 as CMA2 with some flexibility. Despite much effort, flexibility has never been described in detail sufficient for FMC to fashion a CMA which is 'analogous' to CMA9. Thus, without additional clarification of what CMA9 entails as implemented, FMC cannot delineate the soil excavation parameters which would be 'analogous' to CMA9. Further, developing a CMA based on point-to-point concentrations is inconsistent with generally accepted risk assessment methodology which evaluates risk vs. a representative exposure point concentration, frequently represented by a statistical treatment of the sampling results, not based on the maximum, or even individual, sample results.

With respect to calculation of post-remediation soil arsenic average concentrations, FMC followed the method agreed to with the Agencies after the Agencies reviewed and provided comments on the June/July 2010 preliminary draft CMS Report and after follow-up discussions/meetings with the Agencies. By letter dated December 2, 2010, the Agencies provided agreements and directives on revisions to be made by FMC to the June/July 2010 preliminary draft CMS Report, and in particular, the Agencies' Directive #3.b required:

> *"For CMAs 3 through modified 7B or 8 in the Draft CMS Report, arsenic concentration averages for each property shall be calculated using all arsenic results on the property and separately using only 0-3" / 0-6" arsenic results, except for specific large properties."*

The above directive was an affirmation of the method already used in the June/July 2010 preliminary draft CMS Report, which included post-remediation average arsenic concentrations for both surface soil (i.e., 0-3" and 0-6") and all soil on a property, with a representative concentration for clean backfill included in the averaging (see May 2011 CMS Report, Appendix H, Section II.3 and II.4). The Agencies' comments on the June/July 2010 preliminary draft CMS Report did not take issue with the calculation of averages for both surface soil and all depths, or with inclusion of backfill concentrations. The one exception pertained to averaging (both surface and all depths) over the entire area of specific large properties, where FMC and the Agencies subsequently agreed to divide the properties into 100-foot by 100-foot sub-areas for one alternative to evaluate whether and to what extent the use of sub-areas would result in increased proposed remediation.

The criterion to require that both surface soil and all depths soil meet the post-remediation soil arsenic cleanup levels (average and/or maximum concentration) specified in the CMA was intentional. The soil arsenic data set contains a greater number of results for surface soil than for deeper soil because the sampling plan was focused on the expectation that air deposition of arsenic would result in higher concentrations in surface soil compared to deeper soil. As discussed in RFI Report Volume II (2009), this expectation was reflected in the observed soil arsenic concentrations. Further, exposure to surface soil is more likely to occur than deeper soil.

The approach of using all surface soil within a yard to calculate an exposure point concentration is appropriate, as previously discussed in FMC's comments on the Agencies' Preliminary Statement of Basis [p. 12]:

> *"The nature of the potential risks posed by arsenic in soil is such that it only makes sense to evaluate them by understanding the average concentration or distribution of arsenic in soil over full exposure units; focusing on individual data points is not sound science. Determining a representative soil concentration is essential for understanding the potential for exposure to individuals. For example, because individuals do not spend all their time in one single spot within a yard, it is not reasonable to use a single location within a yard to estimate exposure over time. Instead, a representative concentration for the entire yard that includes both low and high concentration samples (e.g., an average or an upper confidence limit on the mean) is more appropriate for determining the potential for exposure over a period of time."*

Agencies Comment #5

Section 3, Paragraph 2A. The draft work plan states that technical effectiveness is the "ability to reduce risks." Please revise paragraph 2A to reflect the consent order, which states: "Effectiveness shall be evaluated in terms of the ability to perform intended functions, such as containment, diversion, removal, destruction, or treatment. The effectiveness of each corrective measure shall be determined either through design specifications or by performance evaluation. Any specific waste or site characteristics which could potentially impede effectiveness shall be considered. The evaluation should also consider the effectiveness of combinations of technologies".

Section 3, paragraph 4. Please see Comment #2.

FMC's Response

The full text of Paragraph 2A in the draft Work Plan is as follows:

> *"The performance of the CMA is a function of its effectiveness and its useful life. Effectiveness is the ability of the CMA to reduce unacceptable risks (based on site-specific risk assessment). The useful life is the length of time over which the effectiveness can be maintained."*

FMC proposes to replace the second sentence in Paragraph 2A with the above language from the AOC.

The text of Paragraph 4 is as follows:

> *"The human health criterion requires each CMA to be evaluated on the extent to which short- and long-term exposures to arsenic are mitigated. The assessment includes an examination of how each CMA protects human health during corrective action implementation (short-term). Potential long-term risk reduction achievable by each CMA will be evaluated through a site-specific HHRA, as described in Section 2.2. The degree to which different CMAs can reduce risks will be evaluated on the basis of hypothetical incremental human health risks by considering background conditions and post-remediation conditions."*

With respect to Section 3, Paragraph 4, please see FMC's Response to Comment #2.

Agencies Comment #6

Section 6 regarding community participation must also specifically discuss actions to be taken at certain steps of the process: public noticing, public meetings/hearings, availability sessions, etc. For example, when the CMS is public noticed, FMC will send out a mailing to announce the public notice.

FMC's Response

Additional detail regarding community involvement activities has been added to Table 2 (attached).

Agencies Comment #7

Section 7. The schedule outlined in Section 7 of the draft work, which requires a year to complete this CMS, is unacceptable. Please tighten and shorten the schedule so that it is commensurate to the scope of the work and in conformance with the AOC.

FMC's Response

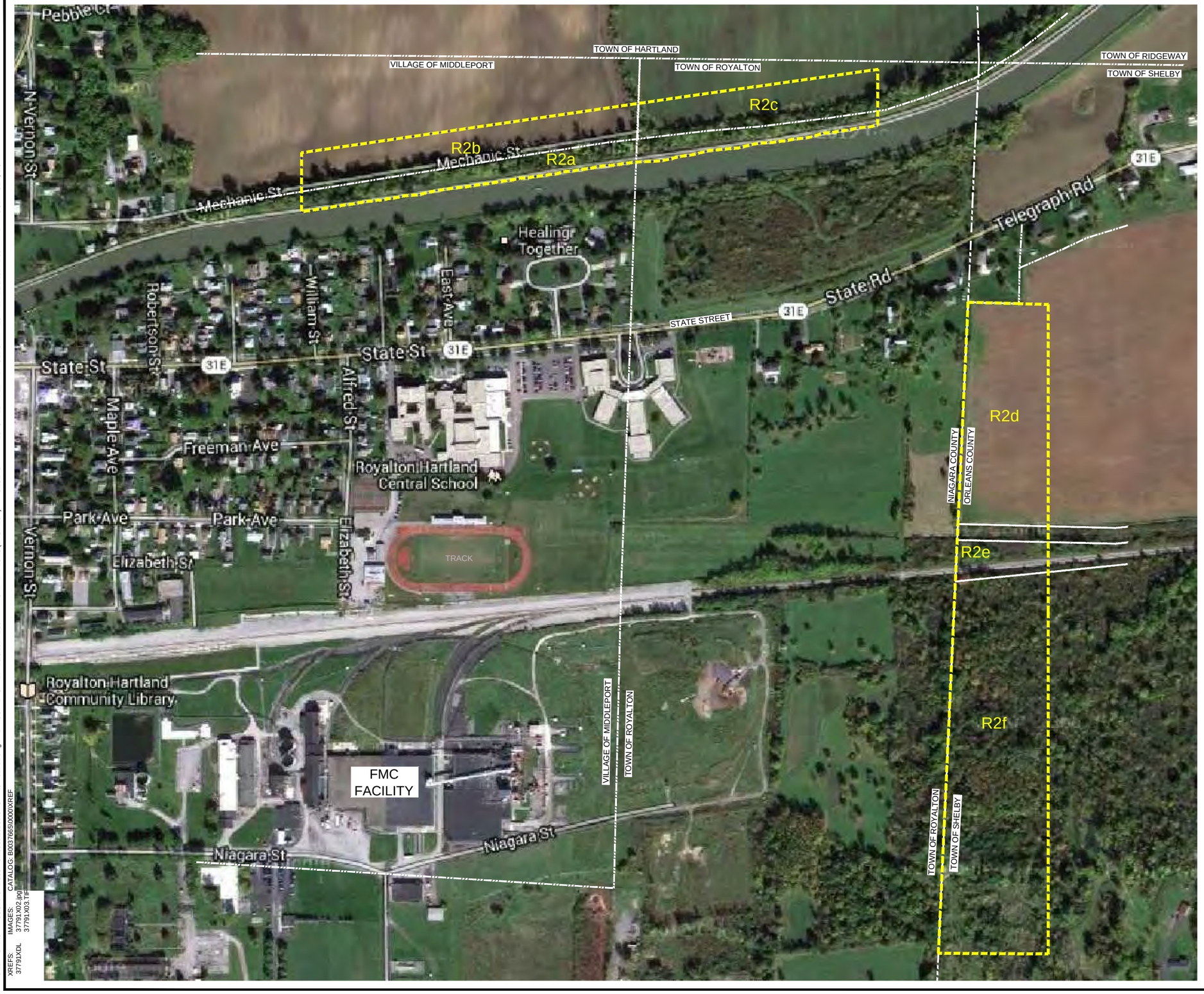
The draft schedule proposed by FMC is commensurate with the effort needed to complete the tasks and the sequence identified in the draft Work Plan. Because we share the Agencies' interest in proceeding with the work, we have commenced work on the first task described in the CMS WP – specifically the Screening Level Risk Assessment described in section 2.3, and described as an interim deliverable in section 5. A preliminary draft is enclosed so as to provide the Agencies opportunity to review it on an expedited schedule, which would facilitate shortening the overall project schedule. As you will note, based on the preliminary draft of the Screening Level Risk Assessment, all the properties considered fall within the acceptable risk range described in the corrective action objectives. Accordingly, FMC requests reconsideration as to whether a CMS is required for OU3.

Agencies Comment #8

Figures 1 and 2. Both figures show a sliver of land bounded by two approximate property boundary lines between R2e and R2f. According to tax maps R2e and R2f are immediately adjacent to one another; there is no small triangular property as shown on the FMC figures. Please correct.

FMC's Response

Acknowledged; revised Figures 1 and 2 are attached.

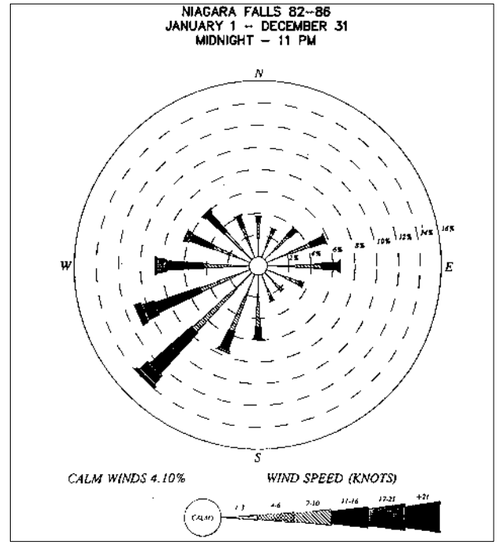


LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- COUNTY LINE
- R2a PROPERTY IDENTIFICATION
- OU3 – SUSPECTED AIR DEPOSITION STUDY AREA 2 (YELLOW)

NOTES:

1. ALL LOCATIONS AND PROPERTY BOUNDARIES SHOWN ARE APPROXIMATE AND SUBJECT TO VERIFICATION.
2. PROPERTY IDENTIFICATION IS NOT RELATED TO STREET ADDRESS OR TAX PARCEL ID.
3. PERCENTAGE SPOKES INDICATE FROM WHICH DIRECTION PREVAILING WIND IS BLOWING. FOR THIS LOCATION THE DIRECTION FROM WHICH THE PREVAILING WIND IS BLOWING IS GENERALLY SOUTHWEST.



FMC CORPORATION - MIDDLEPORT, NEW YORK

CORRECTIVE MEASURES STUDY WORK PLAN
AIR DEPOSITION AREA 2 (OU-3)

LOCATION MAP

ARCADIS

FIGURE
1

CITY: SYRACUSE, NY DIV/GROUP: ENV/M-DV DB: P. LISTER LD: P. LISTER PM/TM: T. YOUNG TR: D. WRIGHT LYR:ON(=*):OFF=REF; (FR2)
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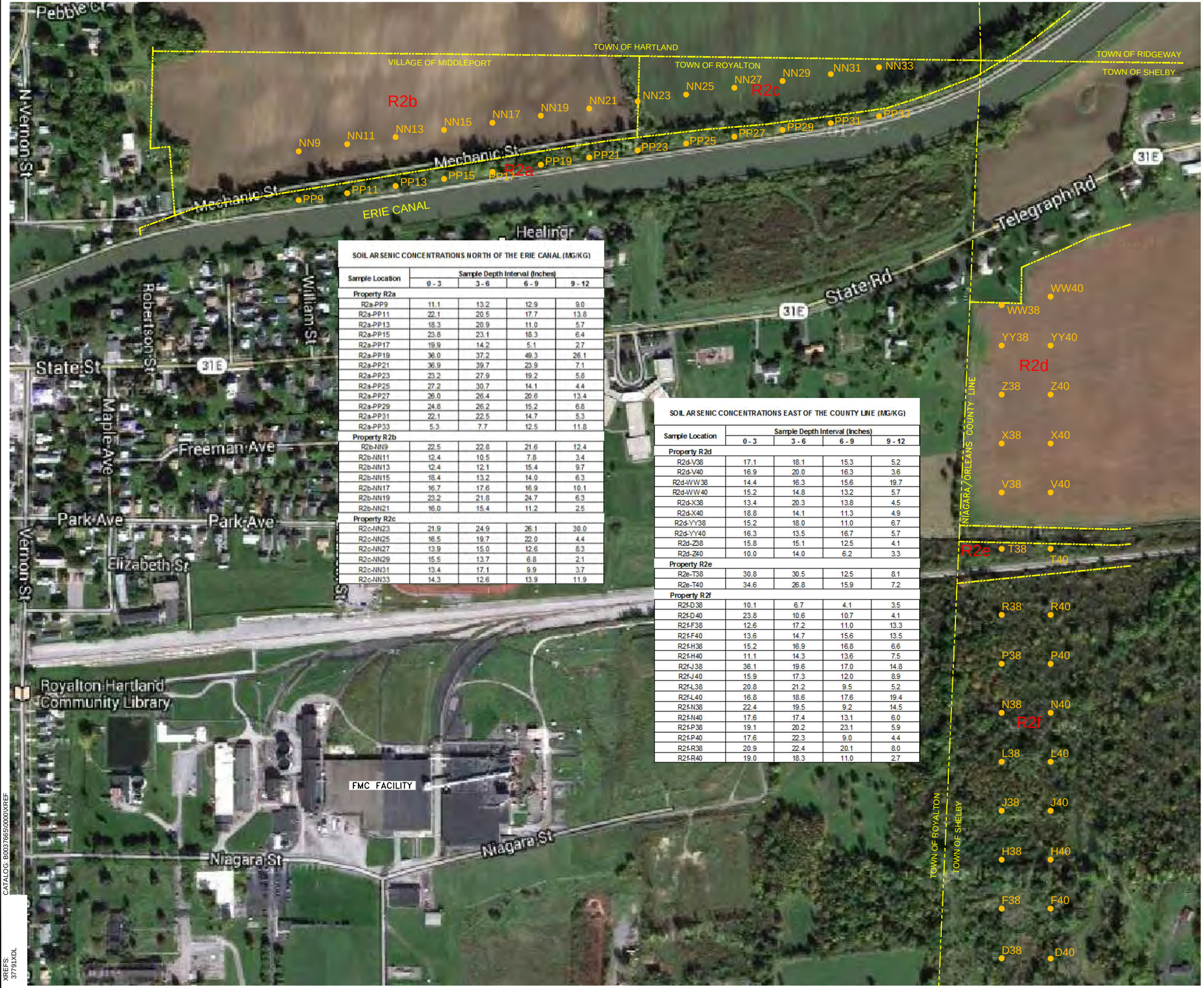

SOIL ARSENIC CONCENTRATIONS NORTH OF THE ERIE CANAL (MG/KG)

Sample Location	Sample Depth Interval (Inches) 0 - 3	3 - 6	6 - 9	9 - 12
Property R2a				
R2a-PP9	11.1	13.2	12.9	9.0
R2a-PP11	22.1	20.5	17.7	13.8
R2a-PP13	18.3	20.9	11.0	5.7
R2a-PP15	23.8	23.1	18.3	6.4
R2a-PP17	19.9	14.2	5.1	2.7
R2a-PP19	36.0	37.2	49.3	26.1
R2a-PP21	36.9	39.7	23.9	7.1
R2a-PP23	23.2	27.9	19.2	5.8
R2a-PP25	27.2	30.7	14.1	4.4
R2a-PP27	26.0	26.4	20.6	13.4
R2a-PP29	24.8	26.2	15.2	6.8
R2a-PP31	22.1	22.5	14.7	5.3
R2a-PP33	5.3	7.7	12.5	11.8
Property R2b				
R2b-NN9	22.5	22.8	21.6	12.4
R2b-NN11	12.4	10.5	7.8	3.4
R2b-NN13	12.4	12.1	15.4	9.7
R2b-NN15	18.4	13.2	14.0	6.3
R2b-NN17	16.7	17.6	16.9	10.1
R2b-NN19	23.2	21.8	24.7	6.3
R2b-NN21	16.0	15.4	11.2	2.5
Property R2c				
R2c-NN23	21.9	24.9	26.1	30.0
R2c-NN25	16.5	19.7	22.0	4.4
R2c-NN27	13.9	15.0	12.6	8.3
R2c-NN29	15.5	13.7	6.8	2.1
R2c-NN31	13.4	17.1	9.9	3.7
R2c-NN33	14.3	12.6	13.9	11.9

SOIL ARSENIC CONCENTRATIONS EAST OF THE COUNTY LINE (MG/KG)

Sample Location	Sample Depth Interval (Inches) 0 - 3	3 - 6	6 - 9	9 - 12
Property R2d				
R2d-V38	17.1	18.1	15.3	5.2
R2d-V40	16.9	20.0	16.3	3.6
R2d-WW38	14.4	16.3	15.6	19.7
R2d-WW40	15.2	14.8	13.2	5.7
R2d-X38	13.4	20.3	13.8	4.5
R2d-X40	18.8	14.1	11.3	4.9
R2d-YY38	15.2	18.0	11.0	6.7
R2d-YY40	16.3	13.5	16.7	5.7
R2d-Z38	15.8	15.1	12.5	4.1
R2d-Z40	10.0	14.0	6.2	3.3
Property R2e				
R2e-T38	30.8	30.5	12.5	8.1
R2e-T40	34.6	26.8	15.9	7.2
Property R2f				
R2f-D38	10.1	6.7	4.1	3.5
R2f-D40	23.8	10.6	10.7	4.1
R2f-F38	12.6	17.2	11.0	13.3
R2f-F40	13.6	14.7	15.6	13.5
R2f-H38	15.2	16.9	16.8	6.6
R2f-H40	11.1	14.3	13.6	7.5
R2f-J38	36.1	19.6	17.0	14.8
R2f-J40	15.9	17.3	12.0	8.9
R2f-L38	20.8	21.2	9.5	5.2
R2f-L40	16.8	18.6	17.6	19.4
R2f-N38	22.4	19.5	9.2	14.5
R2f-N40	17.6	17.4	13.1	6.0
R2f-P38	19.1	20.2	23.1	5.9
R2f-P40	17.6	22.3	9.0	4.4
R2f-R38	20.9	22.4	20.1	8.0
R2f-R40	19.0	18.3	11.0	2.7

LEGEND:

APPROXIMATE PROPERTY BOUNDARY

R2a PROPERTY IDENTIFICATION

2009 SOIL SAMPLE LOCATION

NOTES:

1. ALL LOCATIONS AND PROPERTY BOUNDARIES SHOWN ARE APPROXIMATE AND SUBJECT TO VERIFICATION.
2. PROPERTY IDENTIFICATION NUMBERS SHOWN ARE NOT RELATED TO STREET ADDRESS OR TAX PARCEL ID.
3. ARSENIC CONCENTRATIONS ARE THE ARITHMETIC AVERAGE OF ALL PRIMARY, DUPLICATE AND SPLIT SAMPLE RESULTS FOR EACH SAMPLE AND ARE PRESENTED IN MILLIGRAMS PER KILOGRAM (MG/KG); EQUIVALENT TO PARTS PER MILLION (PPM).

0 200' 400'
GRAPHIC SCALE

FMC CORPORATION - MIDDLEPORT, NEW YORK
CORRECTIVE MEASURES STUDY WORK PLAN
AIR DEPOSITION AREA 2 (OU-3)

SOIL SAMPLING LOCATIONS AND ARSENIC CONCENTRATIONS

ARCADIS

FIGURE 2

CITY: SYRACUSE, NY DIV/GROUP: ENV/IM-DV DB: P. LISTER LD: P. LISTER PM/TM: T. YOUNG TR: D. WRIGHT LYR:ON=*;OFF=REF; (FR2)
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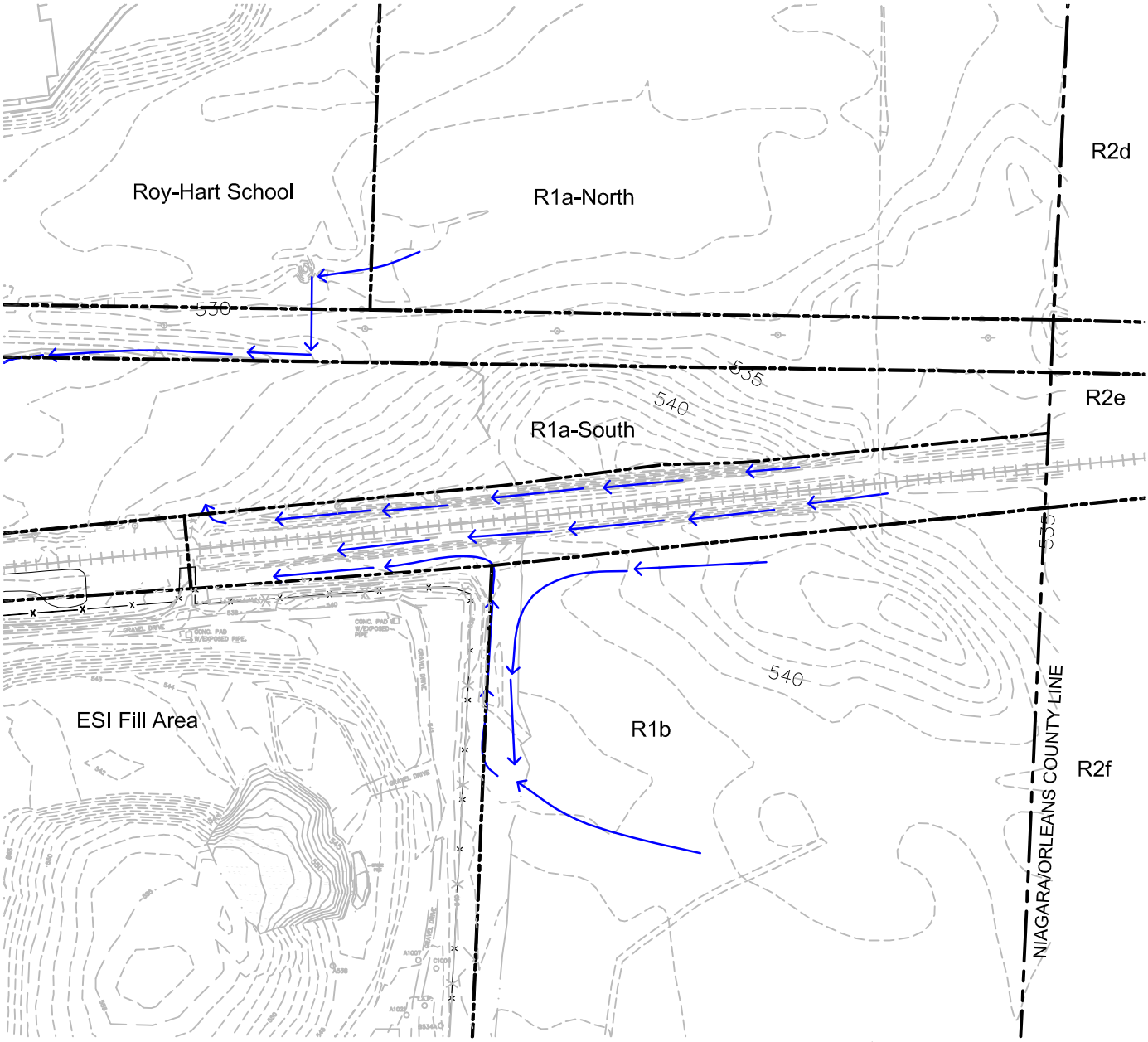

LEGEND:

- PROPERTY LINE
- RAILROAD
- —550— TOPOGRAPHIC ELEVATION (FEET)
- SURFACE WATER FLOW

0 200' 400'

GRAPHIC SCALE

NOTES:

1. TOPOGRAPHIC IMFORMATION FROM SURVEYS BY MCINTOSH AND MCINTOSH, P.C., 1999 TO 2011.
2. PROPERTY LINES ARE APPROXIMATE.

FMC CORPORATION - MIDDLEPORT, NEW YORK
RCRA CORRECTIVE MEASURES STUDY

SURFACE TOPOGRAPHY

ARCADIS

FIGURE
A

CITY: SYRACUSE, NY DIV/GROUP: ENVCAD DB: L.POSENAUER PM: D.WRIGHT LYR:(Opt)ON=*;OFF=*REF*
G:\ENVCAD\SYRACUSE\AVD\2014092\TB0037791\0000000002\DWG\CMSWP\37791P01.dwg LAYOUT: A SAVED: 8/22/2014 8:40 AM ACADVER: 18.1S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 10/9/2014 3:10 PM BY: POSENAUER, LISA
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TABLE 2
PROJECT-SPECIFIC COMMUNITY PARTICIPATION ACTIVITIES
CMS WORK PLAN
AIR DEPOSITION AREA 2
FMC CORPORATION – MIDDLEPORT, NEW YORK

CMS Milestone	Proposed Community Participation Activities (Led by FMC or NYSDEC)
After completion of CMS Work Plan	FMC will place CMS Work Plan in document repository (Royalton Hartland Community Library) and post to project websites (www.fmc-middleport.com and www.middleport-future.com) FMC will notify local officials, FMC's Community Advisory Panel, the Middleport Community Input Group (MCIG), and CMS Area property owners after receipt of Agencies' approval of the CMS Work Plan FMC will meet with local officials, CMS Area property owners, and/or the community to solicit comments/input on reasonably anticipated future land uses in the CMS Area FMC will meet with the MCIG, upon request, to review the CMS activities FMC will hold information session(s)/workshop(s) on the CMS activities FMC will provide updates (e.g., newsletters, fact sheets, visits to property owners, revised schedules), as needed, to project-specific stakeholders
After completion of Draft CMS Report (including FMC's recommended CMA) for public review and comment	FMC will place Draft CMS Report in repository (Royalton Hartland Community Library) and post to project websites (www.fmc-middleport.com and www.middleport-future.com) There will be a public comment period (length of time to be determined by the Agencies), including a public meeting, to solicit comments from the community FMC will place a public notice and send out mailings to local officials, FMC's Community Advisory Panel, the MCIG, and CMS Area property owners to announce the public notice and comment period The Agencies will retain and document public and project-specific stakeholders' comments and responses to comments. If needed, FMC will provide an independent stenographer to record verbatim oral comments made during the public meeting. If needed, FMC and/or the Agencies will meet with local officials, CMS Area property owners, and/or the community to review CMS activities and the Draft CMS Report and/or hold information/availability sessions to solicit comments or answer questions on the Draft CMS Report

TABLE B-2
SUMMARY OF SOIL ARSENIC CONCENTRATIONS BY PROPERTY TYPE/USAGE FROM 2001-2003 GASPORT BACKGROUND STUDY

RCRA FACILITY INVESTIGATION REPORT - VOLUME X
FMC CORPORATION - MIDDLEPORT, NEW YORK

Major Property Type/Usage	Number of Samples	Arsenic Concentrations (mg/kg)				
		Range	Mean	95% UCL	95th Percentile	98th Percentile
Orchard Land (3 Orchards)	12	3.1 to 121.3	33.3	63.5	99.6	112.6
Wooded or Overgrown Land and Agricultural Crop Field Land (2 Wooded, 5 Crop Fields)						
Including 4 potential statistical outliers	56	3.1 to 56.7	7.9	14.2	33.5	51.8
Excluding 4 potential statistical outliers	52	3.1 to 11.9	5.0	5.5	9.1	9.8
Commercial and Industrial Land (2 Business and 2 Industrial Properties)	12	2.2 to 32.8	11.7	18.4	29.1	31.3
Residential and Public Land (7 Residential Properties, 1 School)	23	3.3 to 21.1	10.1	12.0	20.2	20.7

Note: 95% UCL = 95% Upper Confidence Limit on the Mean

The 2001-2003 Gasport Background Study generated total arsenic data for 103 surface soil samples (0 - 3-inch depth interval) collected from four major property types/usage groups. An analysis for potential statistical outliers identified four points in the wooded/overgrown/agricultural crop field land group.

TABLE B-3
SUMMARY OF ESTIMATED MIDDLEPORT SOIL ARSENIC BACKGROUND CONCENTRATIONS

RCRA FACILITY INVESTIGATION REPORT - VOLUME X
FMC CORPORATION - MIDDLEPORT, NEW YORK

Property Type/Usage Weighting Factor Calculation Method[1]	Weighted Mean		95% UCL on Weighted Mean		95th Percentile		98th Percentile	
	Excluding Potential Outliers[2] N=99 (mg/kg)	Including Potential Outliers[3] N=103 (mg/kg)	Excluding Potential Outliers[2] N=99 (mg/kg)	Including Potential Outliers[3] N=103 (mg/kg)	Excluding Potential Outliers[2] N=99 (mg/kg)	Including Potential Outliers[3] N=103 (mg/kg)	Excluding Potential Outliers[2] N=99 (mg/kg)	Including Potential Outliers[3] N=103 (mg/kg)
2001 Gasport Work Plan[4, 5]	**8.1**	**9.7**	**8.7**	**12**	**19**	**22**	**28**	**30**
Updated 2001 Gasport Work Plan[6, 8]	13	14	19	19	39	40	76	75
Time-Weighted Alternative[7, 8]	9.3	11	13	14	23	25	40	41

See Notes on Page 2.

TABLE B-3
SUMMARY OF ESTIMATED MIDDLEPORT SOIL ARSENIC BACKGROUND CONCENTRATIONS

RCRA FACILITY INVESTIGATION REPORT - VOLUME X
FMC CORPORATION - MIDDLEPORT, NEW YORK

Notes:

1. The Middleport background soil arsenic concentrations presented in this table are statistical values that were calculated using property type/usage group weighting factors (i.e., percentages) derived for the Middleport study area. The property type/usage groups are defined in the NYSDEC document entitled "Program to Determine Extent of FMC-Related Arsenic Contamination in Middleport - Part A - Work Plan for Development of Arsenic Background in Middleport Soil" (Agencies, September 2001) [2001 Gasport Work Plan]. The statistical values are calculated based on the soil arsenic data for different property types/usages presented in the report entitled "Development of Arsenic Background in Middleport Soil" [2003 Gasport Background Study Report]; the data are also provided in Appendix B (Table B-1) of this Volume X of the RFI Report.
2. Calculated concentrations in this column are based on the 2003 Gasport Background Study data, excluding 4 potential outliers (total sample size = 99).
3. Calculated concentrations in this column are based on the 2003 Gasport Background Study data, including 4 potential outliers (total sample size = 103).
4. The 2001 Gasport Work Plan arsenic values were calculated using property type/usage group weighting factors specified in the 2001 Gasport Work Plan that are time-weighted, with cumulative orchard areas within two time periods (1931-1958 and 1968-1978), based on aerial photos provided in the Draft RCRA Facility Investigation (RFI) Report (CRA, January 1999) [1999 Draft RFI Report]. The calculated arsenic values are presented in the 2003 Gasport Background Study Report, with the exception of the 98th percentile values, which were subsequently added in early 2011 in response to the Agencies' comments on the Draft CMS Report for the Suspected Air Deposition and Culvert 105 Study Areas.
5. The Agencies selected 20 mg/kg arsenic (based on the weighted 95th percentile of the 2003 Gasport Background Study soil data, using the 2001 Gasport Work Plan calculation method) as the delineation criterion for FMC-related arsenic in Middleport soils for the purposes of the RFI, with consideration given to other factors that could influence potential historical air deposition and stormwater flow.
6. The Updated 2001 Gasport Work Plan arsenic values were calculated using revised property type/usage group weighting factors. The revised property type/usage group weighting factors were calculated as specified in the 2001 Gasport Work Plan and are time-weighted, with cumulative orchard areas within two time periods (1931-1958 and 1968-1978), based on aerial photos provided in the 1999 Draft RFI Report and eight additional aerial photos. The revised property type/usage group weighting factors and the calculated arsenic values are presented in Appendix 6B of RFI Report Volume I – Background and Related Information [RFI Report Volume I].
7. The Time Weighted Alternative arsenic values were calculated using revised property type/usage group weighting factors. The revised property type/usage group weighting factors are time-weighted based on the individual dates of each aerial photo used. The aerial photos used include those provided in the 1999 Draft RFI Report and eight additional photos. The revised property type/usage group weighting factors and the calculated arsenic values are presented in Appendix 6B of RFI Report Volume I.
8. The Agencies have not accepted the statistical values from the Updated 2001 Work Plan or the Time-Weighted Alternative presented in the second and third rows, for reasons explained in their March 10, 2008 letter.

Attachment 2

Screening Human Health Risk Assessment – OU3

New York State Department of Environmental Conservation
Division of Environmental Remediation
Remedial Bureau B, 12th Floor
625 Broadway, Albany, New York 12233-7016
Phone: (518) 402-9768 • **Fax:** (518) 402-9773
Website: www.dec.ny.gov

Joe Martens
Commissioner

March 5, 2015

Shawn J. Tollin
Manager, Environmental Remediation
FMC Corporation
1735 Market Street
Philadelphia, PA 19103

Dear Mr. Tollin:

Re: FMC Corporation, Middleport, NY
EPA ID No. NYD002126845
AOC Docket No. II-RCRA-90-3008(h)-0209
DER Site No. 932014
Operable Unit 3 (OU3) Air Deposition Area #2
Corrective Measures Study (CMS) Work Plan &
FMC Submittal dated October 10, 2014 - FMC's response to
Agencies' August 14, 2014 comments

The United States Environmental Protection Agency (USEPA) and the New York State Department of Environmental Conservation (NYSDEC), hereafter referred to as "the Agencies," in consultation with the New York State Department of Health (NYSDOH), have received and reviewed the above mentioned documents. As you are aware, the Agencies and FMC met on October 30, 2014 to discuss the FMC submittal. The results of our review of these documents are presented below:

There are discrepancies between the AOC requirements (Attachment II – Scope of Work for Corrective Measures Study) and what FMC has proposed in the CMS Work Plan. In order to move forward expeditiously, the Agencies request that FMC submit a CMS for OU3 using the outline of Attachment II, Task VIII, IX, X, and XI.B and C in lieu of submitting a revised work plan followed by a CMS. FMC may present and evaluate multiple alternatives. The CMS must include evaluation of one or more alternatives that achieve the unrestricted use soil cleanup objectives for soil (Part 375-2.8(c) (2) (i) and CP-51 Section V.B.6 (a)) and/or an alternative that is analogous to corrective measures alternative No. 2 (in the OU2/4/5 CMS) and/or an alternative that is analogous to corrective measures alternative No. 9 (in the OU2/4/5 Statement of Basis). With respect to your October 10, 2014 risk assessment submittal, the Agencies intend to review this document concurrent with the preparation and/or review of the CMS.

Please submit a CMS report within 90 days of the date of this letter. If you have questions concerning this letter, you may contact Ms. Sally Dewes (NYSDEC) at (518)402-9768.

Sincerely,

Sally Dewes

Sally Dewes, P.E.
NYSDEC Project Coordinator
Division of Environmental Remediation

S. Dewes for M. Infurna

Michael Infurna
USEPA Project Coordinator
Emergency and Remedial Response Division

ec: R. Cozzy/M. Komoroske, DER
M. Hinton/G. Sutton, NYSDEC Region 9 Buffalo
D. Garbarini, USEPA
S. Badalamenti/M. Infurna, USEPA
S. Selmer, NYSDOH
W. Lachell, AMEC
D. Watts, MCIG Technical Advisor
D. Seaman, Seaman, Jones, Hogan & Brooks

FMC Corporation
1735 Market Street
Philadelphia, PA 19103
USA

215.299.6000
fmc.com

Transmitted Via Email and FedEx

March 13, 2015

Ms. Sally Dewes, PE
NYSDEC Project Coordinator
Remedial Bureau B
Division of Environmental Remediation
New York State Department of Environmental Conservation
625 Broadway, 12th Floor
Albany, NY 12233-7016

Mr. Michael Infurna
USEPA Project Coordinator
Emergency and Environmental Remediation Division
United States Environmental Protection Agency, Region II
290 Broadway, 22nd Floor
New York, NY 10007-1866

Re: RCRA Corrective Measures Study (CMS) Work Plan (July 2014) &
FMC's October 10, 2014 response to the Agencies' August 14, 2014 comments
Suspected Air Deposition Study Area 2 – Operable Unit 3 (OU-3)
FMC Corporation, Middleport, NY Facility
RCRA Section 3008(h) Administrative Order on Consent (AOC)
Docket No. II-RCRA-90-3008(h)-209
EPA I.D. No. NYD002126845
DER Site No. 932014

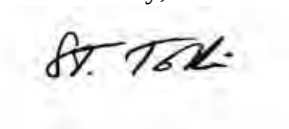
Dear Ms. Dewes and Mr. Infurna:

By letter dated March 5, 2015, the New York State Department of Environmental Conservation (NYSDEC) and the United States Environmental Protection Agency (USEPA) (jointly, "the Agencies"), in consultation with the New York State Department of Health (NYSDOH), provided FMC Corporation (FMC) with a request to submit a Corrective Measures Study (CMS) report for Suspected Air Deposition Study Area 2 (North of the Erie Canal and East of the Niagara/Orleans County Line) – Operable Unit 3 (OU3). The Agencies requested that the CMS report be: 1) prepared using the outline of Attachment II to the above referenced Administrative Order on Consent (AOC); 2) submitted in lieu of a revised CMS Work Plan; and 3) submitted within 90 days of March 5, 2015.

In accordance with Section XI, Item 1, of the AOC, FMC requests a meeting with the Agencies to discuss the Agencies' request provided in the March 5, 2015 letter. FMC proposes that the meeting be held in person in Albany, at a date and time mutually agreeable with the Agencies, and that the meeting include both technical and legal counsel representatives.

Please contact me by telephone at (215) 299-6554 or by email at Shawn.Tollin@fmc.com with any questions.

Sincerely,



Shawn J. Tollin
Manager, Environmental Remediation

cc: M. Hinton, NYSDEC, Buffalo
S. Selmer, NYSDOH, Troy
S. Mizrachi, Esq., FMC Philadelphia
R. Kennedy, Esq., Hodgson Russ
W. Lachell, GEI Consulting
D. Wright, PE, ARCADIS

New York State Department of Environmental Conservation
Division of Environmental Remediation
Remedial Bureau B, 12th Floor
625 Broadway, Albany, New York 12233-7016
Phone: (518) 402-9768 • **Fax:** (518) 402-9773
Website: www.dec.ny.gov

Joe Martens
Commissioner

March 25, 2015

Shawn J. Tollin
Manager, Environmental Remediation
FMC Corporation
1735 Market Street
Philadelphia, PA 19103

Dear Mr. Tollin:

Re: FMC Corporation, Middleport, NY
EPA ID No. NYD002126845
AOC Docket No. II-RCRA-90-3008(h)-0209
DER Site No. 932014
Air Deposition Area #2 Corrective Measures Study (CMS)
Operable Unit #3 (OU3)
FMC letter dated March 13, 2015

The New York State Department of Environmental Conservation (NYSDEC) and the United States Environmental Protection Agency (USEPA), hereafter referred to as "the Agencies", have received and reviewed the above mentioned document.

By letter dated August 14, 2014, the Agencies, in consultation with the New York State Department of Health (NYSDOH), provided FMC with comments on the *Corrective Measures Study Work Plan –Air Deposition Study Area 2 – Operable Unit 3* ("CMS Work Plan") (July 2014).

By letter dated August 28, 2014 FMC requested a meeting with Agency technical and legal staff to discuss its position on the Agencies' comments. DEC staff requested that the meeting only involve only technical staff (i.e., no attorneys) because the CMS is an engineering report. By letter dated October 10, 2014 FMC reiterated its request for a meeting with Agency technical and legal staff to discuss its position on the Agencies' comments. The Agencies granted that request and a meeting was held in Albany with EPA and DEC technical and legal staff on October 30, 2014.

By letter dated March 5, 2015, the NYSDEC and EPA provided FMC with a request to submit a Corrective Measures Study (CMS) report for Air Deposition Study Area #2. FMC has responded in letter dated March 13, 2015 with another request for a meeting with technical and legal staff.

FMC has indicated, through legal counsel, that its preference for the subject of such a meeting would be to discuss proposed elements of a future remedy at properties within OU3, orally presented to the Agencies. This is contrary to the process the Agencies must follow when selecting a remedy. The Agencies must review the engineering report, develop a proposed remedy, present it to the public, receive public comment, and then select the remedy, subsequent to all those other steps. To negotiate and select a remedy *prior to* FMC's draft CMS submittal is untenable. Based on this, the Agencies anticipate that a meeting on OU3 would be duplicative of the meeting previously held in Albany on October 30, 2014.

On page 61 of the AOC it says the following,

"Within fifteen (15) days of Respondent's receipt of EPA's approval/disapproval, determinations, comments, modifications and/or directives, Respondent may request a meeting with EPA to discuss the approval/disapproval, determinations, comments modifications, and/or directives.

Within fifteen (15) days of such meeting, or if no meeting is requested, or if EPA denies Respondent's request, within fifteen (15) days of receipt of EPA's approval/disapproval, determinations, comments, modifications, and/or directives, or EPA's denial of a request for a meeting, whichever is later, Respondent shall either: (1) notify EPA in writing of its intention to comply with EPA's directives or determinations or to amend or modify the submission to incorporate all EPA comments and proposed modifications and submit the amended submission to EPA within thirty (30) days thereafter or according to a mutually agreed schedule; or (2) provide EPA with a written notice of dispute."

The Agencies are denying FMC's request for a second meeting regarding the CMS for OU3. Please respond within 15 days of this letter as required by the AOC. If you have questions concerning this letter, you may contact Ms. Sally Dewes (NYSDEC) at (518)402-9768.

Sincerely,

Sally Dewes

SDewes for M. Infurna

Sally Dewes, P.E.
NYSDEC Project Coordinator
Division of Environmental Remediation

Michael Infurna
USEPA Project Coordinator
Emergency and Remedial Response Division

ec: R. Schick, DER
R. Cozzy/M. Komoroske, DER
M. Hinton/G. Sutton, NYSDEC Region 9 Buffalo
A. Guglielmi, OGC
S. Selmer, NYSDOH
M. Infurna/S. Badalamenti, USEPA
A. Chester, USEPA
W. Lachell, GEI
S. Mizrachi, FMC

FMC Corporation
1735 Market Street
Philadelphia PA 19103

215 299.6000 phone
215 299.6947 fax

www.fmc.com

FMC Corporation

April 7, 2015

Via E-Mail and UPS

Mr. Michael Infurna
USEPA Project Coordinator
United States Environmental Protection Agency, Region II
Environmental Planning and Protection Division
290 Broadway, 20th Floor
New York, NY 10007-1866

Re: FMC Corporation, Middleport, New York:
USEPA ID No. NYD 002126845
AOC Docket No. II-RCRA-90-3008(h)-0209
DER Site No. 932014
Notice of Dispute and Request for Resolution

Dear Mr. Infurna:

Pursuant to Sections XI and XXIX of the Administrative Order on Consent ("AOC"), FMC Corporation submits the enclosed Notice of Dispute and Request for Resolution. As set forth in Section XXIX(1) of the AOC, this is a "major dispute" to be decided by the Director of the Air and Waste Management Division, or his or her equivalent, of the United States Environmental Protection Agency, Region II.

Exhibits to the enclosed Notice of Dispute and Request for Resolution are being sent to you by United Parcel Service (UPS).

Sincerely,

Robert T. Forbes
Director, EHS Remediation/Governance

215-299-6260
robert.forbes@fmc.com

Enclosure

cc: Sal Badalamenti, USEPA
Amy Chester, Esq., USEPA
Robert Cozzy, NYSDEC
Sally Dewes, P.E., NYSDEC
John Filippelli, USEPA
Doug Garbarini, USEPA
Andrew Guglielmi, Esq., NYSDEC
Michael Hinton, NYSDEC
Rick Kennedy, Esq., Hodgson Russ LLP
Michael Komoroske, NYSDEC
David Mandelbaum, Esq., Greenberg Traurig, LLP
Edward McTiernan, Esq., NYSDEC
Sabrina Mizrachi, Esq., FMC Corporation
Walter Mugdan, USEPA
Robert Schick, NYSDEC
Stephanie Selmer, NYSDOH
Greg Sutton, NYSDEC
Shawn Tollin, FMC Corporation
Andrea Utecht, Esq., FMC Corporation

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2
290 BROADWAY
NEW YORK, NEW YORK 10007-1866

JUN 11 2015

Via Electronic and US Mail

Robert T. Forbes
Director, Environment
FMC Corporation
1735 Market Street
Philadelphia, PA 19103
robert.forbes@fmc.com

Re: FMC Corporation Notice of Dispute and Request for Resolution
Administrative Order on Consent – Docket No. II-RCRA-90-3008(h)-0209

Dear Mr. Forbes:

EPA has received FMC Corporation's ("FMC's") April 7, 2015 Notice of Dispute and Request for Resolution ("Dispute Resolution Request") under the Administrative Order on Consent ("AOC") entered into by FMC, the United States Environmental Protection Agency – Region 2 ("EPA") and the New York State Department of Environmental Conservation ("DEC") for FMC's Middleport, New York facility and off-site areas ("the Site").[1] As you know, FMC disputes the "approval/disapproval, determinations, comments, modifications, and directives contained in and incorporated by a letter to FMC dated March 5, 2015" (the "March 5 letter") signed by DEC and EPA (collectively, the "Agencies") representatives, and seeks the withdrawal of the letter. Dispute Resolution Request at 1.

The March 5 letter directs FMC to submit a Corrective Measures Study ("CMS") for Air Deposition Area #2, otherwise known Operable Unit 3 ("OU 3"), within 90 days of FMC's receipt of the letter. The letter further directs FMC to prepare a CMS using the outlines of Attachment II, Tasks VIII, IX, X, and XI.B and C., in lieu of submitting a revised CMS Workplan. Lastly, the Agencies indicate in the letter that they intend to review FMC's October 10, 2014 Screening Human Health Risk Assessment (RA)[2] "concurrent with the preparation and/or review of the CMS." March 5 letter at 1.

[1] Dispute resolution determinations are made by the Director of the Division of Emergency and Remedial Response. The Air and Waste Management Division no longer exists. AOC at 81.

[2] The RA was submitted to the Agencies as part of the draft CMS Workplan correspondence.

FMC argues that the March 5 letter is "both substantially and procedurally contrary to the AOC." Dispute Resolution Request at 1. More specifically, FMC argues that the Agencies' March 5 directives violate the terms of the AOC by: a) requiring FMC to submit a CMS without a Workplan; and b) declining to review the RA which, according to FMC, demonstrates that a CMS is not necessary. See generally, Dispute Resolution Request, Preliminary Section at1- 4. The latter issue, *i.e.*, the Agencies' failure to review and consider the RA before directing FMC to conduct a CMS, is the crux of the Dispute, id. at 9, and will be discussed first.

The Risk Assessment and CMS

FMC argues that the RA must be reviewed prior to the submission of a CMS, and that its RA demonstrates that a CMS is not necessary for OU3. This argument is wrong in several respects. First, the RA is not approvable in its current state, and therefore is not appropriately used in the manner suggested by FMC. (The Agencies will be sending FMC comments on the RA, prepared both by EPA and the DOH, in the near future.) Second, while a site specific RA is one of the factors that may be considered pursuant to the AOC's Corrective Action Objectives ("CAOs"), FMC's argument is inconsistent with the terms of the Order.

The AOC requires FMC to perform the CMS in accordance with Tasks VIII through XI set forth in Attachment II. AOC, Section VI.2 at 40. Significantly, the development of the CAOs is discussed in Task VIII. (Identification and Development of the Corrective Measures Alternative or Alternatives) of Attachment II (Scope of Work for Corrective Measures Study) of the AOC. That is, the CAOs, which are set forth in a March 2009 letter from the Agencies to FMC, see Dispute Resolution Request, Exhibit 4 (March 2009 CAO letter), constitute a task under the Order that is to be addressed by FMC as part of the CMS process. See Attachment II at 2 (the CMS consists of four tasks, including Task VIII) and id. at 3(Respondent shall use Task VIII (including the CAOs) in developing corrective action alternatives). Moreover, the CAOs "shall be used to guide [the Agencies'] review of the CMS Work Plans and Reports so as to insure each CMS is as consistent as possible with these objectives. Each Corrective Measure Alternative (CMA) presented in a CMS will be evaluated by the Agencies on the basis of the CAOs...." March 2009 letter at 2.

In short, the consideration of the CAOs is part of the CMS process and may be relied upon by FMC to support a particular CMA in its CMS. Indeed, the CAOs "will be used [by the Agencies'] as guidance" in the selection of the final CMA. Id. The Order does not, however, provide that RAs are to be used to determine whether or not a CMS is necessary. Consequently, if FMC wishes to revise the RA based on the Agencies' comments, it should submit the revised RA as part of its CMS as contemplated by the Order.

Approval of the CMS Workplan

FMC incorrectly argues that the Agencies violated the AOC by requiring it to submit a CMS without first approving its CMS Workplan. As indicated by FMC, the AOC states that "(i)f EPA determines that a CMS is necessary, EPA will establish a schedule for the submission of a CMS Workplan...." AOC, Section VI.2 (Corrective Measures Study) at 40. This provision, however,

does not indicate that the Agencies[3] *must approve* a CMS Workplan before directing FMC to submit a CMS, and, as discussed below, the Order provides the Agencies' with other response options.

If the Agencies and FMC believed that a CMS should be implemented pursuant to an approved Workplan, they would have expressly included it in the AOC. By comparison, the AOC explicitly requires the Agencies' approval of a RCRA Facility Investigation (RFI) Workplan and then FMC's implementation of that approved RFI Workplan. The Order states, FMC:

> ... shall submit an RFI Workplan for EPA approval.... Following receipt of EPA approval in writing of the RFI Workplan, Respondent shall implement the RFI Workplan according to the schedule in the approved Workplan.

AOC, Section VI.1. (RCRA Facility Investigation (RFI) at 39.

The language differences in the RFI and CMS provisions are not a fluke. Section XI of the AOC, which governs the review process of submittals, indicates that not all plans require Agency approval. This AOC provision states that:

> Unless otherwise specified, *EPA shall review any plan* ... submitted pursuant to or required by this Order, *and promptly provide its written* approval/disapproval, determinations, comments, modifications, *and/or directives* to the Respondent.

AOC, Section XI. (EPA Approvals, Directives and Determinations) at 60-61 (emphasis added).

In this particular instance, the Agencies, after reviewing and commenting on FMC's Workplan,[4] directed FMC to submit a CMS in accordance with provisions of the AOC. This directive is completely consistent with Sections VI.2 and XI. of the AOC which, when read together, require the submission of a CMS Workplan and the Agencies' review (but not necessarily approval of) that Workplan. The language of the Order allows the Agencies' numerous response actions, including the issuance of directives to Respondent. The text of the Order does not support FMC's argument that the Agencies must approve the CMS Workplan.

Sincerely,

Walter Mugdan, Director
Division of Emergency and Remedial Response

cc: Robert Schick, NYDEC

[3] The provisions of the AOC referenced herein, *i.e.*, Sections VI. And XI of the AOC, refer to "EPA" actions or determinations. Because the AOC has been jointly implemented by EPA and DEC, the term "Agencies" is used in lieu of the term "EPA" when not quoting the AOC.

[4] On August 14, 2014, the Agencies provided FMC with comments on its July 2014 CMS Workplan.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Environmental Remediation, Remedial Bureau B
625 Broadway, 12th Floor, Albany, NY 12233-7016
P: (518) 402-9768 I F: (518) 402-9773
www.dec.ny.gov

July 16, 2015

Shawn J. Tollin
Manager, Environmental Remediation
FMC Corporation
1735 Market Street
Philadelphia, PA 19103

Re: Letter dated October 10, 2015, Screening Human Health Risk Assessment - Air Deposition Study Area 2 (OU-3)
FMC Corporation, Middleport NY
EPA ID No. NYD002126845
AOC Docket No. II-RCRA-90-3008(h)-0209
DER Site No. 932014

Dear Mr. Tollin:

The New York State Department of Environmental Conservation (DEC) and the United States Environmental Protection Agency (EPA), in consultation with the New York State Department of Health (DOH), hereafter referred to as "the Agencies," have reviewed the October 2014 Screening Human Health Risk Assessment (RA) referenced above. Based on our review, the RA is not approvable in its current form. Our comments are attached herein.

If FMC wishes to revise the RA based on the agencies comments, it should submit the RA to the Agencies as part of the Corrective Measures Study (CMS) Report being prepared for OU3, consistent with Attachment II of the AOC. As indicated in our letter of March 5, 2015, the CMS must be prepared using the outline of Attachment II, Task VIII, IX, X, and XI.B and C. In addition to the remedial alternative requested in the March 5, 2015 letter, FMC may present and evaluate additional remedies. Please submit a CMS for OU3 by September 10, 2015.

If you have any questions regarding this letter, you may contact either Ms. Sally Dewes (DEC) at (518) 402-9768, or Mr. Michael Infurna (EPA) at (212) 637-4177.

Sincerely,

Sally Dewes, P.E.
NYSDEC Project Coordinator
Division of Environmental Remediation

S. Dewes for M. Infurna

Michael Infurna
USEPA Project Coordinator
Emergency and Remedial Response Division

Attachments

cc: R. Cozzy/M. Komoroske, DER via e-mail
M. Hinton/G. Sutton, DEC Region 9 via e-mail
A. Guglielmi, OGC via email
M. Infurna/M. Maddaloni, EPA
G. Garbarini/ S. Badalamenti, EPA
A. Chester, EPA
S. Selmer/C. Bethoney, DOH via e-mail

Agency Comments on the Screening Human Health Risk Assessment (HHRA)
For Suspected Air Deposition Study Area 2 (Operable Unit 3),
Prepared for the FMC Corporation by ENVIRON International Corporation

Exposure Assessment Parameters

If FMC chooses to revise the HHRA, a more rigorous approach to characterizing the range of potential exposures to children in a residential setting would include an estimate reflecting EPA's generic default exposure parameter values (soil ingestion rate of 200 mg/day and an exposure frequency of 350 days/yr), and would also include exposure parameters used to derive 6 NYCRR Part 375 Soil Cleanup Objectives (SCOs) (DEC/DOH 2006). Further, several parameter values for exposure in the HHRA are inconsistent with methods used to derive the SCOs and/or are not sufficiently justified to support site specific exposure parameters. Below are some examples:

- The exposure duration inputs for adults in the future resident scenario were a central tendency of 9 years and a reasonable maximum exposure (RME) of 20 years. In addition to differing from the lifetime exposure period used to derive the SCOs, it is likely that some current Middleport residents have already exceeded both these values, some by large margins.
- In the agricultural worker scenario, the HHRA assumes this individual only works two days per week over the course of the planting/growing/harvesting season. The document indicates that this input was derived by taking the total number of days of exposure assumed for the adult resident in the SCO technical support document and dividing it by the number of weeks assumed for the season (31). This is an unreasonable approach, given that many farmers are known to work long hours for days on end during the planting/growing/harvesting season. In addition, reference to the SCO technical support document will show that the development of the residential adult exposure scenario that the HHRA links this pathway to, is clearly not intended to represent an agricultural worker.
- The HHRA assumes the inhalation pathway for the worker involves an 8-hour "standard workday" (see page 15), which may not be adequately conservative to represent actual activities during particularly busy times of the season for such workers. Further, the soil ingestion pathway for this worker was evaluated using a value which the HHRA characterizes as the "default" value. However, the HHRA applied this default to the RME component of the scenario, and then arbitrarily used half the default value for the central tendency evaluation

Bioavailability

The HHRA uses a relative arsenic bioavailability factor of 22% based on a study that measured bioavailability of arsenic from three Middleport soil samples fed to cynomolgus monkeys (Roberts et al. 2007), but the text does not indicate whether this is intended to represent a central tendency or upper bound estimate. In addition, the gastrointestinal absorption of arsenic from soil is a complex process that is influenced by a variety of factors, including (but not limited to) soil characteristics, the chemical form of arsenic, the concentration of arsenic in soil, the presence of other contaminants, the fasting and nutritional status of the receptor, and the age of the receptor. A more scientifically valid approach

would be to use a range of values, including the assumption of 100% bioavailability for arsenic in soil, as well as the US EPA default value of 60% (US EPA 2015).

Additional Exposure Pathways

The HHRA does not evaluate some important exposure pathways. The dermal exposure pathway is dismissed in Sections 2.1.1, 2.2.1 and 2.1.3 (recreational, agricultural and future residential scenarios) without an adequate justification. The potential dermal contribution to total exposure and dose in these scenarios should be properly developed and presented, in the absence of a fully documented technical justification to do otherwise. In addition, residential exposures to arsenic in soil through homegrown fruits and vegetables are not evaluated. Fruits and vegetables grown in arsenic-contaminated soil can take up arsenic (Meharg and Hartley-Whitaker 2002; Zhao et al. 2008). Consumption of homegrown fruits and vegetables can contribute to arsenic exposure, and this pathway should be evaluated.

Methods Used to Obtain Exposure Point Concentrations

We do not agree with the methods used in the HHRA to derive exposure point concentrations. The hypothetical exposure point concentrations were generally limited to 20 parts per million (ppm), a value developed by averaging sampling results from different sampling points and from different sampling intervals (depths). Other than listing them in tables, the document does not address the data above 20 ppm from these parcels. This averaging approach does not adequately consider the potential for exposure to the higher concentrations identified by sampling. Such approaches to evaluating the concentration term fail to recognize the influence of human activity patterns and behaviors on human exposure scenarios that incidental soil ingestion is episodic in nature, and that different individuals may use a property in different ways at different life stages. Exposures and risks are more appropriately evaluated using individual sampling results as inputs. In addition, in Section 2.2 (Data Summary and Exposure Point Concentration), surface soil is defined as the 0-6 inch interval after an analysis was performed noting that there was not a statistical difference between the 0-3 interval and 0- 6 inch interval. However, a common risk assessment practice is to define surface soil as the 0-2 inch interval. Moreover, given that contamination is attributable to air deposition, surficial soil may very well have a higher arsenic concentration than samples from deeper cores. In light of these facts, and the high efficiency and computing power of modern personal computers and software packages that make it a simple matter to evaluate data from separate sampling depths as relevant to various hypothetical exposure scenarios, such merging of results from multiple intervals is both arbitrary and unnecessary.

Evaluation of Property R2e

In Section 1.2 (Description of Air Deposition Area), FMC proposes eliminating property R2e from evaluation because the arsenic concentrations "are not consistent with air deposition." The average arsenic concentration in this area is no more than modestly higher than the other areas. No statistical analysis has been performed to support FMC's stance and it should be noted that the average concentration is based on only 8 soil samples compared to sample sizes ranging from 24-64 for the other 5 properties. Property R2e should be carried through the evaluation process.

References

DEC/DOH (New York State Department of Health/New York State Department of Environmental Conservation). 2006. New York State Brownfield Cleanup Program. Development of Soil Cleanup Objectives. Technical Support Document. September 2006. Accessed (June 23, 2015) on-line at http://www.dec.ny.gov/chemical/34189.html.

Meharg, AA, Hartley-Whitaker, J. 2002. Arsenic uptake and metabolism in arsenic resistant and nonresistant plant species. New Phytologist 154: 29-43.

Roberts, SM, JW Munson, YW Lownery et al. 2007. Relative Oral Bioavailability of Arsenic from Contaminated Soils Measured in the Cynomolgus Monkey. Toxicol. Sci. 95: 281-288.

US EPA (United States Environmental Protection Agency). 2015. Arsenic. Relative Bioavailability Of Arsenic In Soils At 11 Hazardous Waste Sites Using An In Vivo Juvenile Swine Method. Accessed (May 20, 2015) on-line at http://www.epa.gov/superfund/bioavailability/guidance.htm.

Zhao, FJ, JF Ma, A A Meharg, et al. 2008. Arsenic uptake and metabolism in plants. New Phytologist 181: 777-794.

ARCADIS

Appendix B

Middleport Background Soil Arsenic Concentrations

Contents (from RFI Report Volume X):

TABLE B-1
SOIL ARSENIC DATA FROM 2001-2003 GASPORT BACKGROUND STUDY

RCRA FACILITY INVESTIGATION REPORT - VOLUME X
FMC CORPORATION - MIDDLEPORT, NEW YORK

Property Group	Land Use Type	Property ID	Sample Location	Depth (inches)	Arsenic Concentration (mg/kg)				
					Primary	Duplicate	Agency Split	Other	Combined
Wooded-Agricultural	Crop Field	Ca	CA-1A	0-3	56.7				56.7
Wooded-Agricultural	Crop Field	Ca	CA-1B	0-3	4.9				4.9
Wooded-Agricultural	Crop Field	Ca	CA-2A	0-3	5.2				5.2
Wooded-Agricultural	Crop Field	Ca	CA-2B	0-3	4.1				4.1
Wooded-Agricultural	Crop Field	Ca	CA-3A	0-3	5	4.6			4.8
Wooded-Agricultural	Crop Field	Ca	CA-3B	0-3	3.5				3.5
Wooded-Agricultural	Crop Field	Ca	CA-4A	0-3	33.5		31.1		32.3
Wooded-Agricultural	Crop Field	Ca	CA-4B	0-3	7.1				7.1
Wooded-Agricultural	Crop Field	Cc	CC-1A	0-3	3.2				3.2
Wooded-Agricultural	Crop Field	Cc	CC-1B	0-3	3 J				3
Wooded-Agricultural	Crop Field	Cc	CC-2A	0-3	3.3		3.1		3.2
Wooded-Agricultural	Crop Field	Cc	CC-2B	0-3	2.9 J				2.9
Wooded-Agricultural	Crop Field	Cc	CC-3A	0-3	3.2				3.2
Wooded-Agricultural	Crop Field	Cc	CC-3B	0-3	2.3 J				2.3
Wooded-Agricultural	Crop Field	Cc	CC-4A	0-3	3.2				3.2
Wooded-Agricultural	Crop Field	Cc	CC-4B	0-3	4.4 J				4.4
Wooded-Agricultural	Crop Field	Cd	CD-1A	0-3	4.1		3.5		3.8
Wooded-Agricultural	Crop Field	Cd	CD-1B	0-3	5.1 J				5.1
Wooded-Agricultural	Crop Field	Cd	CD-2A	0-3	9.8				9.8
Wooded-Agricultural	Crop Field	Cd	CD-2B	0-3	11.9 J				11.9
Wooded-Agricultural	Crop Field	Cd	CD-3A	0-3	3.7				3.7
Wooded-Agricultural	Crop Field	Cd	CD-3B	0-3	4.4 J				4.4
Wooded-Agricultural	Crop Field	Cd	CD-4A	0-3	9.4				9.4
Wooded-Agricultural	Crop Field	Cd	CD-4B	0-3	8.4 J				8.4
Wooded-Agricultural	Crop Field	Ce	CE-1A	0-3	3.4				3.4
Wooded-Agricultural	Crop Field	Ce	CE-1B	0-3	4.7 J				4.7
Wooded-Agricultural	Crop Field	Ce	CE-2A	0-3	4.6				4.6
Wooded-Agricultural	Crop Field	Ce	CE-2B	0-3	3.4 J				3.4
Wooded-Agricultural	Crop Field	Ce	CE-3A	0-3	4.2				4.2
Wooded-Agricultural	Crop Field	Ce	CE-3B	0-3	4.1 J				4.1
Wooded-Agricultural	Crop Field	Ce	CE-4A	0-3	3.7		2.8		3.3
Wooded-Agricultural	Crop Field	Ce	CE-4B	0-3	4 J				4
Wooded-Agricultural	Crop Field	Ch	CH-1A	0-3	3.3				3.3
Wooded-Agricultural	Crop Field	Ch	CH-1B	0-3	5.3 J				5.3
Wooded-Agricultural	Crop Field	Ch	CH-2A	0-3	5.5				5.5
Wooded-Agricultural	Crop Field	Ch	CH-2B	0-3	36.9 J				36.9
Wooded-Agricultural	Crop Field	Ch	CH-3A	0-3	54.4		52.6		53.5
Wooded-Agricultural	Crop Field	Ch	CH-3B	0-3	5.3 J				5.3
Wooded-Agricultural	Crop Field	Ch	CH-4A	0-3	7.7				7.7
Wooded-Agricultural	Crop Field	Ch	CH-4B	0-3	3.3 J				3.3
Wooded-Agricultural	Wooded	Wd	WD-1A	0-3	6.9	6.9			6.9
Wooded-Agricultural	Wooded	Wd	WD-1B	0-3	3.3 J				3.3
Wooded-Agricultural	Wooded	Wd	WD-2A	0-3	7.9		7.3		7.6
Wooded-Agricultural	Wooded	Wd	WD-2B	0-3	6.7 J				6.7
Wooded-Agricultural	Wooded	Wd	WD-3A	0-3	8.8				8.8
Wooded-Agricultural	Wooded	Wd	WD-3B	0-3	8.1 J				8.1
Wooded-Agricultural	Wooded	Wd	WD-4A	0-3	5.1				5.1
Wooded-Agricultural	Wooded	Wd	WD-4B	0-3	7.2 J				7.2
Wooded-Agricultural	Wooded	We	WE-1A	0-3	4.2				4.2
Wooded-Agricultural	Wooded	We	WE-1B	0-3	4.7				4.7
Wooded-Agricultural	Wooded	We	WE-2A	0-3	5.2				5.2
Wooded-Agricultural	Wooded	We	WE-2B	0-3	3.2				3.2
Wooded-Agricultural	Wooded	We	WE-3A	0-3	4.7		3.8		4.3
Wooded-Agricultural	Wooded	We	WE-3B	0-3	4				4
Wooded-Agricultural	Wooded	We	WE-4A	0-3	3.7				3.7
Wooded-Agricultural	Wooded	We	WE-4B	0-3	3.4				3.4
Commercial-Indsutrial	Commercial	Bb	BB-1A	0-3	2.4 J	6.1 J	2.3	2.2	3.3
Commercial-Indsutrial	Commercial	Bb	BB-2A	0-3	4.6				4.6
Commercial-Indsutrial	Commercial	Bb	BB-3A	0-3	5.2				5.2
Commercial-Indsutrial	Commercial	Bf	BF-1A	0-3	7.5				7.5

TABLE B-1
SOIL ARSENIC DATA FROM 2001-2003 GASPORT BACKGROUND STUDY

RCRA FACILITY INVESTIGATION REPORT - VOLUME X
FMC CORPORATION - MIDDLEPORT, NEW YORK

Property Group	Land Use Type	Property ID	Sample Location	Depth (inches)	Arsenic Concentration (mg/kg)				
					Primary	Duplicate	Agency Split	Other	Combined
Commercial-Indsutrial	Commercial	Bf	BF-2A	0-3	9.9		2.9		6.4
Commercial-Indsutrial	Commercial	Bf	BF-3A	0-3	13.2				13.2
Commercial-Indsutrial	Industrial	Ia	IA-1A	0-3	33.5	32.1			32.8
Commercial-Indsutrial	Industrial	Ia	IA-2A	0-3	26.1				26.1
Commercial-Indsutrial	Industrial	Ia	IA-3A	0-3	3.5		3.1		3.3
Commercial-Indsutrial	Industrial	Ib	IB-1A	0-3	12.5				12.5
Commercial-Indsutrial	Industrial	Ib	IB-2A	0-3	20.4		20.8		20.6
Commercial-Indsutrial	Industrial	Ib	IB-3A	0-3	4.9				4.9
Residential-Public	Residential	Ra	RA-1A	0-3	6.3				6.3
Residential-Public	Residential	Ra	RA-2A	0-3	17.4		12.5		15
Residential-Public	Residential	Ra	RA-3A	0-3	4.5				4.5
Residential-Public	Residential	Rb	RB-1A	0-3	16.7		3.5		10.1
Residential-Public	Residential	Rb	RB-2A	0-3	11.6				11.6
Residential-Public	Residential	Rb	RB-3A	0-3	12.8				12.8
Residential-Public	Residential	Rc	RC-1A	0-3	8.7		7.2		8
Residential-Public	Residential	Rc	RC-2A	0-3	9.5				9.5
Residential-Public	Residential	Rc	RC-3A	0-3	9.9				9.9
Residential-Public	Residential	Re	RE-1A	0-3	5.7				5.7
Residential-Public	Residential	Re	RE-2A	0-3	7.7				7.7
Residential-Public	Residential	Re	RE-3A	0-3	18.6		20.3		19.5
Residential-Public	Residential	Rf	RF-1A	0-3	14.7		14.3		14.5
Residential-Public	Residential	Rf	RF-2A	0-3	21.2				21.2
Residential-Public	Residential	Rf	RF-3A	0-3	14.5				14.5
Residential-Public	Residential	Rg	RG-1A	0-3	7.3				7.3
Residential-Public	Residential	Rg	RG-2A	0-3	5.6				5.6
Residential-Public	Residential	Rg	RG-3A	0-3	8		7.3		7.7
Residential-Public	Residential	Rh	RH-1A	0-3	4.6	3.9	4.2		4.2
Residential-Public	Residential	Rh	RH-2A	0-3	20.3 J				20.3
Residential-Public	Residential	Rh	RH-3A	0-3	9.1				9.1
Residential-Public	School	Sa	SA-1A	0-3	4.2	4.3	3.3	3.5	3.8
Residential-Public	School	Sa	SA-2A	0-3	3.3				3.3
Orchard	Orchard	Oa	OA-1A	0-3	14.7				14.7
Orchard	Orchard	Oa	OA-2A	0-3	8.8		8		8.4
Orchard	Orchard	Oa	OA-3A	0-3	27.8				27.8
Orchard	Orchard	Oa	OA-4A	0-3	10.4				10.4
Orchard	Orchard	Ob	OB-1A	0-3	3.8	3.7			3.8
Orchard	Orchard	Ob	OB-2A	0-3	40.4		45.9		43.2
Orchard	Orchard	Ob	OB-3A	0-3	4.6				4.6
Orchard	Orchard	Ob	OB-4A	0-3	3.1				3.1
Orchard	Orchard	Od	OD-1A	0-3	130	129	105		121
Orchard	Orchard	Od	OD-2A	0-3	81.9				81.9
Orchard	Orchard	Od	OD-3A	0-3	24.5				24.5
Orchard	Orchard	Od	OD-4A	0-3	56.3				56.3

Notes:
1. All samples collected in May 2002 during the Gasport Background Study.
2. Approximate locations of properties sampled shown on Figure B-1 of this Volume X of the RFI Report.
3. Results reported in *Development of Arsenic Background in Middleport Soil* (CRA 2003).
4. The combined result is the arithmetic average of all values reported for any primary field sample, field duplicate sample, Agency split sample, and additional other samples collected.
5. J = Associated value is estimated.

TABLE B-2
SUMMARY OF SOIL ARSENIC CONCENTRATIONS BY PROPERTY TYPE/USAGE FROM 2001-2003 GASPORT BACKGROUND STUDY

RCRA FACILITY INVESTIGATION REPORT - VOLUME X
FMC CORPORATION - MIDDLEPORT, NEW YORK

Major Property Type/Usage	Number of Samples	Arsenic Concentrations (mg/kg)				
		Range	Mean	95% UCL	95th Percentile	98th Percentile
Orchard Land (3 Orchards)	12	3.1 to 121.3	33.3	63.5	99.6	112.6
Wooded or Overgrown Land and Agricultural Crop Field Land (2 Wooded, 5 Crop Fields)						
Including 4 potential statistical outliers	56	3.1 to 56.7	7.9	14.2	33.5	51.8
Excluding 4 potential statistical outliers	52	3.1 to 11.9	5.0	5.5	9.1	9.8
Commercial and Industrial Land (2 Business and 2 Industrial Properties)	12	2.2 to 32.8	11.7	18.4	29.1	31.3
Residential and Public Land (7 Residential Properties, 1 School)	23	3.3 to 21.1	10.1	12.0	20.2	20.7

Note: 95% UCL = 95% Upper Confidence Limit on the Mean

The 2001-2003 Gasport Background Study generated total arsenic data for 103 surface soil samples (0 - 3-inch depth interval) collected from four major property types/usage groups. An analysis for potential statistical outliers identified four points in the wooded/overgrown/agricultural crop field land group.

TABLE B-3
SUMMARY OF ESTIMATED MIDDLEPORT SOIL ARSENIC BACKGROUND CONCENTRATIONS

RCRA FACILITY INVESTIGATION REPORT - VOLUME X
FMC CORPORATION - MIDDLEPORT, NEW YORK

Property Type/Usage Weighting Factor Calculation Method[1]	Weighted Mean		95% UCL on Weighted Mean		95th Percentile		98th Percentile	
	Excluding Potential Outliers[2] N=99 (mg/kg)	Including Potential Outliers[3] N=103 (mg/kg)	Excluding Potential Outliers[2] N=99 (mg/kg)	Including Potential Outliers[3] N=103 (mg/kg)	Excluding Potential Outliers[2] N=99 (mg/kg)	Including Potential Outliers[3] N=103 (mg/kg)	Excluding Potential Outliers[2] N=99 (mg/kg)	Including Potential Outliers[3] N=103 (mg/kg)
2001 Gasport Work Plan[4, 5]	**8.1**	**9.7**	**8.7**	**12**	**19**	**22**	**28**	**30**
Updated 2001 Gasport Work Plan[6, 8]	13	14	19	19	39	40	76	75
Time-Weighted Alternative[7, 8]	9.3	11	13	14	23	25	40	41

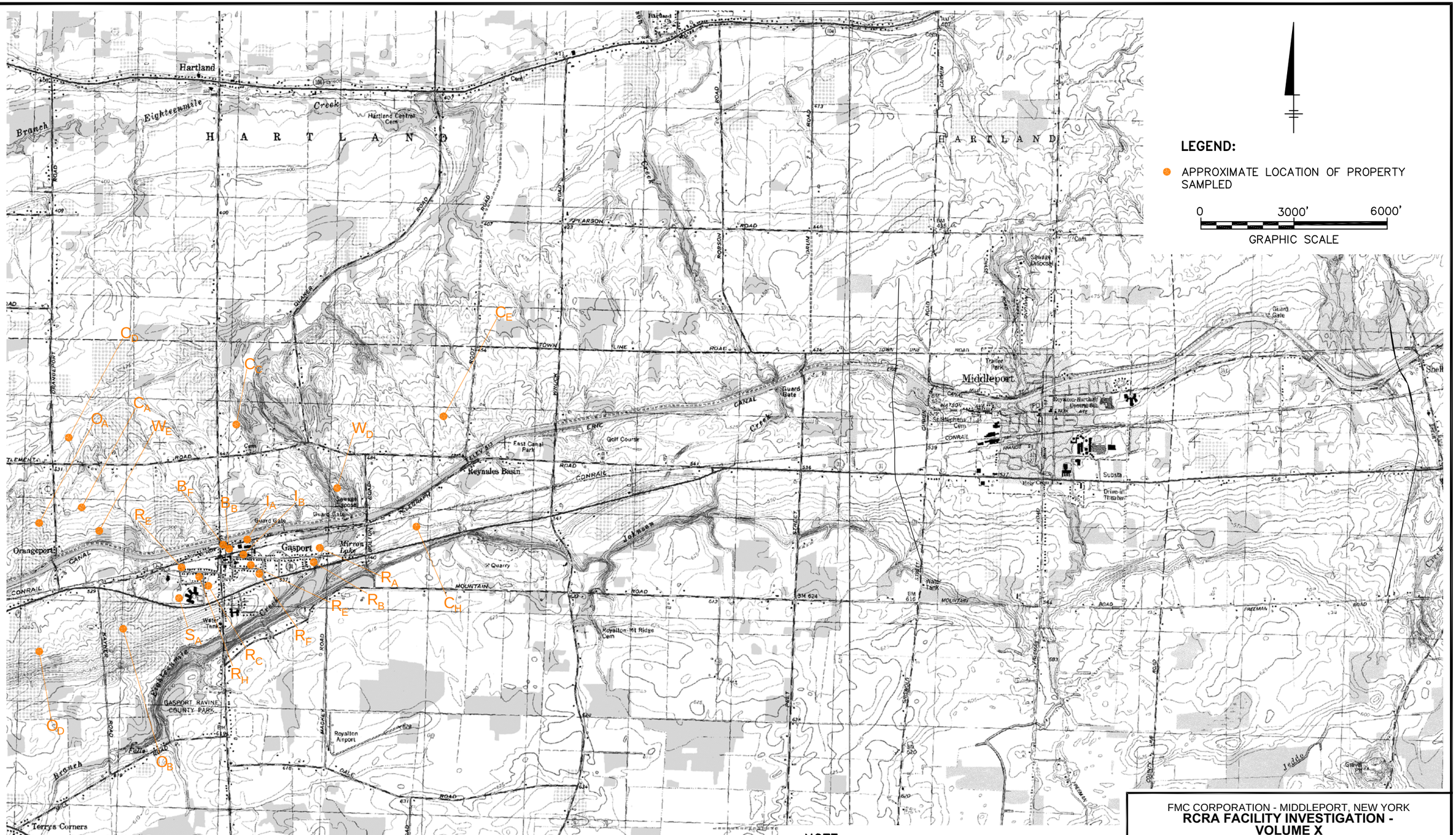
See Notes on Page 2.

TABLE B-3
SUMMARY OF ESTIMATED MIDDLEPORT SOIL ARSENIC BACKGROUND CONCENTRATIONS

RCRA FACILITY INVESTIGATION REPORT - VOLUME X
FMC CORPORATION - MIDDLEPORT, NEW YORK

Notes:

1. The Middleport background soil arsenic concentrations presented in this table are statistical values that were calculated using property type/usage group weighting factors (i.e., percentages) derived for the Middleport study area. The property type/usage groups are defined in the NYSDEC document entitled "Program to Determine Extent of FMC-Related Arsenic Contamination in Middleport - Part A - Work Plan for Development of Arsenic Background in Middleport Soil" (Agencies, September 2001) [2001 Gasport Work Plan]. The statistical values are calculated based on the soil arsenic data for different property types/usages presented in the report entitled "Development of Arsenic Background in Middleport Soil" [2003 Gasport Background Study Report]; the data are also provided in Appendix B (Table B-1) of this Volume X of the RFI Report.
2. Calculated concentrations in this column are based on the 2003 Gasport Background Study data, excluding 4 potential outliers (total sample size = 99).
3. Calculated concentrations in this column are based on the 2003 Gasport Background Study data, including 4 potential outliers (total sample size = 103).
4. The 2001 Gasport Work Plan arsenic values were calculated using property type/usage group weighting factors specified in the 2001 Gasport Work Plan that are time-weighted, with cumulative orchard areas within two time periods (1931-1958 and 1968-1978), based on aerial photos provided in the Draft RCRA Facility Investigation (RFI) Report (CRA, January 1999) [1999 Draft RFI Report]. The calculated arsenic values are presented in the 2003 Gasport Background Study Report, with the exception of the 98th percentile values, which were subsequently added in early 2011 in response to the Agencies' comments on the Draft CMS Report for the Suspected Air Deposition and Culvert 105 Study Areas.
5. The Agencies selected 20 mg/kg arsenic (based on the weighted 95th percentile of the 2003 Gasport Background Study soil data, using the 2001 Gasport Work Plan calculation method) as the delineation criterion for FMC-related arsenic in Middleport soils for the purposes of the RFI, with consideration given to other factors that could influence potential historical air deposition and stormwater flow.
6. The Updated 2001 Gasport Work Plan arsenic values were calculated using revised property type/usage group weighting factors. The revised property type/usage group weighting factors were calculated as specified in the 2001 Gasport Work Plan and are time-weighted, with cumulative orchard areas within two time periods (1931-1958 and 1968-1978), based on aerial photos provided in the 1999 Draft RFI Report and eight additional aerial photos. The revised property type/usage group weighting factors and the calculated arsenic values are presented in Appendix 6B of RFI Report Volume I – Background and Related Information [RFI Report Volume I].
7. The Time Weighted Alternative arsenic values were calculated using revised property type/usage group weighting factors. The revised property type/usage group weighting factors are time-weighted based on the individual dates of each aerial photo used. The aerial photos used include those provided in the 1999 Draft RFI Report and eight additional photos. The revised property type/usage group weighting factors and the calculated arsenic values are presented in Appendix 6B of RFI Report Volume I.
8. The Agencies have not accepted the statistical values from the Updated 2001 Work Plan or the Time-Weighted Alternative presented in the second and third rows, for reasons explained in their March 10, 2008 letter.



LEGEND:

- APPROXIMATE LOCATION OF PROPERTY SAMPLED

0 3000' 6000'

GRAPHIC SCALE

NOTE:

THIS FIGURE WAS PREPARED FROM A DRAWING BY CRA, ENTITLED "SURFACE SOIL BACKGROUND SAMPLE LOCATIONS", FIGURE 7.1, DRAWING NO. 2788 (55) AUG 05/97(NF) REV.0 @ A SCALE OF 1" = 3,000'.

FMC CORPORATION - MIDDLEPORT, NEW YORK
RCRA FACILITY INVESTIGATION - VOLUME X

2002-2003 GASPORT BACKGROUND SOIL SAMPLING LOCATIONS

ARCADIS

FIGURE **B-1**

CITY: SYRACUSE, NY DIV/GROUP: ENV/IM-DV DB: P. LISTER LD: P. LISTER PM/TM: T. YOUNG TR: D. WRIGHT LYR:ON=*:OFF=REF; (FRZ)
G:\ENVCAD\SYRACUSE\ACT\B0037763\000\000004\DWG\377638B5.DWG LAYOUT: B-1 SAVED: 9/18/2012 9:48 AM ACADVER: 18.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 9/18/2012 9:48 AM BY: LISTER, PAUL (LMS TECH)
XREFS: IMAGES: CATALOG: B0037665\0000\XREF
377638XBL 37669X23.TIF

ARCADIS

Appendix C

Human Health Risk Assessment

Intended for
FMC Corporation

Date
Draft September 2015

HUMAN HEALTH RISK ASSESSMENT SUSPECTED AIR DEPOSITION STUDY AREA 2, OPERABLE UNIT 3

RAMBOLL ENVIRON

HUMAN HEALTH RISK ASSESSMENT
OPERABLE UNIT 3

Revision **DRAFT**
Date **September 8, 2015**

Ramboll Environ
901 Fifth Avenue
Suite 2820
Seattle, WA 98164
USA
T +1 206 336 1650
F +1 206 336 1651
www.ramboll-environ.com

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ACRONYMS AND ABBREVIATIONS

95UCLM:	95 percent upper confidence limit of the arithmetic mean
AF:	adherence factor
AOC:	Administrative Order on Consent
FMC:	FMC Corporation
COA:	corrective action objectives
CMS:	corrective measures study
CSM:	conceptual site model
CSF:	cancer slope factor
CTE:	central tendency exposure
DMA:	dimethylarsinic acid
EFSA:	European Food and Safety Authority
EPC:	exposure point concentrations
FDA:	US Food and Drug Administration
HHRA:	human health risk assessment
IUR:	inhalation unit risk
LB:	lower bound
LOD:	limit of detection
NHANES:	National Health and Nutrition Examination Survey
NOAEL:	no-observable-adverse-effect-level
NYSDEC:	New York State Department of Environmental Conservation
NYSDOH:	New York State Department of Health
MMA:	monomethylarsonic acid
OU-3:	Operable Unit 3
PEF:	particulate emission factor
RBA:	relative oral bioavailability
RfC:	reference concentration
RfD:	reference dose
RCRA:	Resource Conservation and Recovery Act
RFI:	RCRA Facility Investigation
RME:	reasonable maximum exposure
SAF:	sampling adjustment factor
SCO:	soil cleanup objectives
UB:	upper bound
USEPA:	United States Environmental Protection Agency
US ATSDR:	US Agency for Toxic Substances and Disease Registry
WHO:	World Health Organization

1. INTRODUCTION

FMC Corporation (FMC) owns and operates an agricultural products formulating facility located in the Village of Middleport and the Town of Royalton, New York ("Facility" or "Site"). FMC has entered into an Administrative Order on Consent (AOC; Docket No. II RCRA-90-3008(h)-0209, effective July 2, 1991) with the New York State Department of Environmental Conservation (NYSDEC) and the United States Environmental Protection Agency (USEPA) (jointly, "the Agencies") concerning releases of hazardous waste and hazardous constituents at the Facility. The AOC includes requirements to undertake a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) and, if determined to be necessary by the Agencies, a Corrective Measures Study (CMS). In 2005, FMC and the Agencies agreed that FMC should proceed to implement investigative, monitoring and remedial programs under the AOC using an "operable unit" or "study area" approach, consistent with Section VI.3.d of the AOC.

The Suspected Air Deposition Study Area 2 (Air Deposition Area 2, Figure 1), also identified by the NYSDEC as Operable Unit 3 (OU-3), is one of the Middleport RCRA Facility study areas. An RFI report for Air Deposition Area 2 submitted in 2012 (ARCADIS 2012) was accepted by the Agencies. The Agencies subsequently requested that a CMS be conducted to address the presence of FMC-related arsenic in Air Deposition Area 2 soil. A draft CMS work plan was submitted to the Agencies on July 17, 2014 (ARCADIS 2014). A screening human health risk assessment (HHRA) for Air Deposition Area 2 was submitted to the Agencies on October 10, 2014 (Attachment A).

This document expands upon the screening HHRA providing a deterministic baseline human health risk assessment for the Air Deposition Area 2 CMS. Agency comments on the screening HHRA dated July 16, 2015 (NYSDEC & USEPA 2015) have been considered in drafting this HHRA and responses to the comments are provided in Attachment B. The HHRA was performed in consideration of relevant USEPA and NYSDEC/New York State Department of Health (NYSDOH) risk assessment guidance and recommendations, including the use of site-specific data for some exposure assumptions, as available and appropriate.

1.1 Corrective Action Objectives (CAOs)

This HHRA has been conducted according to the March 26, 2009 Corrective Action Objectives (CAOs) for public health issued by NYSDEC. The pertinent CAO is quoted below:

> *To protect human health and the environment relative to FMC-related contamination, in accordance with, and/or in consideration of, applicable, or relevant and appropriate laws, rules and guidance, using site-specific data and information, supported by multiple lines of evidence, including site-specific risk assessment, and based on current and reasonably anticipated future land use(s). Reasonably anticipated future land uses will be identified in consultation with the community.*
>
> *A. Achieve unrestricted use (i.e., without the need for institutional or engineering controls) of current and reasonably anticipated future residential properties within these study areas.*
>
> *B. Reduce and manage potential human health risks associated with FMC-related contaminants in soil and sediment, keeping in mind that risk is a function of contaminant concentration and routes, likelihood of exposure, and other factors, such that:*

- *Excess human health carcinogenic risks are reduced such that the lifetime excess cancer risks fall within the range appropriate for residential communities (i.e., 10^{-4} to 10^{-6});*

- *Human health non-carcinogenic risks are reduced such that non-cancer risks do not exceed the level appropriate for residential communities (i.e., Hazard Index ≤ 1.0); and*

- *The "point of departure", or starting point for corrective action risk-management decisions pertaining to arsenic in soil, is the site-specific residential background considering site-specific histories of use for current and reasonably anticipated future residential properties within these study areas.*

1.2 Description of Air Deposition Area 2 (OU-3) Properties Evaluated

As described in detail by Arcadis (2012, 2014), Air Deposition Area 2 includes six properties/areas located farther north and east of Air Deposition Area 1 (OU-2), north of the Erie Canal and east of the Niagara/Orleans county line. Current and historical uses of the six properties/areas are summarized below:

Property ID	Current Use	Historical Use
R2a	Erie Canal towpath trail and strip of trees/brush	Erie Canal towpath trail and strip of trees/brush
R2b	Agricultural field	Agricultural field (orchard in 1930s)
R2c	Agricultural field	Agricultural field
R2d	Agricultural field	Agricultural field
R2e	Wooded land, railroad tracks	Wooded land, railroad tracks
R2f	Wooded land	Agricultural field

Air Deposition Area 2 soil samples were collected and analyzed for arsenic, the only constituent for which site characterization was required (ARCADIS 2012, 2014). Samples were collected from the 0- to 3-inch, 3- to 6-inch, 6- to 9-inch, and 9- to 12-inch depth intervals below surface grade on an approximate 200-foot grid. The RFI data include arsenic results for 216 soil samples collected from 54 locations within the six properties/areas (see Figure 1). The agencies also collected 21 split samples. Table 1 provides a sample inventory of the soil analytical dataset (from Table 3.1 of RFI Report Volume X). The Agencies determined that the available data were sufficient to estimate the horizontal and vertical extent of Site-related arsenic in Air Deposition Area 2 soil with respect to a delineation criterion of 20 mg/kg (weighted 95th percentile concentration calculated in the 2001-2003 Gasport background study).

The Agencies determined that no further action was needed at RFI Property R2d (ARCADIS 2014). FMC has also provided multiple lines of evidence supporting the conclusion that elevated arsenic concentrations on Property R2e are not a result of FMC's operations (ARCADIS 2014, FMC Corporation 2014). The observed arsenic concentrations are not consistent with air deposition from the Facility and are more consistent with other historical uses of this parcel. Nevertheless, for the purposes of this HHRA, all six properties are evaluated.

1.3 Document Organization

In addition to this introduction, this document includes the following sections:

- Section 2 – Problem Formulation
- Section 3 – Exposure Assessment
- Section 4 – Toxicity Assessment
- Section 5 – Risk Characterization
- Section 6 – References

2. PROBLEM FORMULATION

The primary outcome of problem formulation is development of a conceptual model for the Site that characterizes the ways people might be exposed to contaminants of potential concern. As noted above, arsenic is the only Facility-related constituent to be assessed in the Air Deposition Area 2 CMS. This section of the HHRA provides an overview of the exposure media, potentially exposed populations, and potentially complete exposure pathways identified for Air Deposition Area 2 (OU-3). Figure 2 summarizes the updated conceptual site model (CSM) resulting from the problem formulation.

2.1 Exposure Media

As shown in Figure 2, surface soil is the primary exposure medium impacted by dispersion and deposition of air emissions from historical operations of the Facility that may have contained arsenic. Suspended soil particulate in air and shallow subsurface soil represent secondary exposure media that may be impacted by arsenic in surface soil. Soil samples collected from the 0- to 3-inch depth interval are considered surface soil for the purposes of the HHRA.

2.2 Potentially Exposed Populations

Current land uses and activities, as well as possible future uses vary by property. Each property is considered a separate exposure area for the purposes of the HHRA. Current and future uses of Property R2a are limited to recreational activities along the canal towpath. Properties R2b, R2c, and R2d are currently used for agricultural cultivation and could possibly have future residential use. Property R2e is a small triangular overgrown parcel located between mainline railroad tracks and an electrical power line corridor where trespasser use may occur now and in the future. Property R2f is currently open wooded land that could have current passive recreational use and possible future residential use. Thus, potentially exposed populations include recreational users (R2a and R2f), agricultural workers (R2b, R2c, and R2d), trespassers (R2e), and future residents (R2b, R2c, R2d, and R2f). Recreational users along the towpath (Property R2a) may include both adults and children. Recreational users of Property R2f may also include children or adults (either owners or others trespassing on this private property). Agricultural workers at Properties R2b, R2c, and R2d are assumed to be adults. Future residents may include children and adults. Trespassers on Property R2e are assumed to be adolescents.

2.3 Potentially Complete Exposure Pathways

The setting of each property (i.e., exposure area) and the nature of activities in which each potentially exposed population may engage at the property influences the extent to which that population may be exposed to arsenic in the primary and secondary exposure media at each property. Potentially complete exposure pathways identified for each potentially exposed population are described below, first for current land uses, and then for additional potential future land uses.

2.3.1 Recreational Users (Property R2a and R2f)

Exposures of recreational users are expected to be limited by wooded/vegetative cover associated with these two properties. Contact with exposed surface soils on these properties may include incidental ingestion of surface soil, dermal contact with surface soil, and inhalation of soil particles resuspended in air due to wind. Exposure of recreational users to shallow subsurface soil is not expected to occur.

2.3.2 Agricultural Workers (Property R2b, R2c, and R2d)

Exposures of agricultural workers at Properties R2b, R2c, and R2d are expected to result primarily from contact with soil from 0- to 6-inches below ground surface during routine field activities. Agricultural workers' exposures to 0- to 6-inch soil may occur via incidental ingestion and dermal contact. Surface soils (0- to 3-inch) are most relevant to inhalation of soil particles resuspended in air due to wind. On an infrequent basis, the agricultural worker may also engage in tilling and

digging activities that involve contact with shallow subsurface soil; however, these limited events are expected to contribute negligibly to the worker's overall exposure and are not evaluated quantitatively in the HHRA.

2.3.3 Trespassers (Property R2e)

Exposures of trespassers at Property R2e are expected to be restricted by the small size, limited accessibility, and wooded/vegetative cover associated with most of this property. Contact with exposed surface soils on this property may include incidental ingestion, dermal contact, and inhalation of soil particles resuspended in air due to wind. Exposure of trespassers to shallow subsurface soil is not expected to occur.

2.3.4 Future Residents (Property R2b, R2c, R2d, and R2f)

Future residents are most likely to contact surface soil via incidental ingestion and dermal contact. Inhalation of soil particles resuspended in air due to wind may also occur, but will be limited by the amount of exposed surface soil present on future residential properties after development. While infrequent exposure of the future resident to shallow subsurface soil (3- to 12-inch) may also occur, it is expected to be of low significance relative to exposure to surface soil and is not evaluated quantitatively in the HHRA. However, because development of properties for future residential use is expected to entail significant alteration of existing soil conditions (e.g., due to grading), arsenic concentrations in future surface soils (0- to 3-inch) are likely to be a mixture of current concentrations represented in both surface and shallow subsurface soils. Consumption of homegrown produce from future residential gardens is another potential exposure pathway that will be considered, although biomonitoring previously conducted in Middleport found no correlation between consumption of homegrown produce and urinary arsenic levels (Tsuji et al. 2004).

2.4 CSM Summary

Figure 2 depicts the exposure media, receptors, and exposure routes considered for the HHRA. For recreational users, trespassers, and future residents, contact with surface soil (0- to 3-inch) is expected to occur most frequently while contact with shallow subsurface soil (3- to 12-inch) is expected to be very limited. For the agricultural worker, incidental ingestion and dermal contact with soil expected to be most frequent for soil from 0- to 6-inch below ground surface, while inhalation of soil particulate resuspended in air is most likely to derive from surface soils (0- to 3-inch). Evaluation of the distribution of arsenic across different sample depths for each property (Table 2) shows that mean arsenic soil concentrations tend to be highest for the 0- to 3-inch and 3- to 6-inch depth intervals, with concentrations generally declining with depth below 6 inches.[1] Given the distribution of soil arsenic, focusing the HHRA on contact with soils in the 0- to 3-inch and 0- to 6-inch depths for current potentially exposed populations is expected to be conservative. Although concentrations in surface soil at properties developed for residential use in the future is unknown, assuming that post-development concentrations will represent a mixture of soils from all sample depths over the 0- to 12-inch depth interval is reasonable. This assumption is also expected to be conservative given that post-development soils are also likely to include non-site soils (i.e., at background concentrations) introduced during the development process.

For all potentially exposed populations, exposure to arsenic in soil is expected to be greatest for pathways involving direct contact with soil. The primary intake route for arsenic in soil is expected to result from incidentally ingesting soil particles adhered to skin via hand-to-mouth activities. Direct absorption of soil arsenic through skin is expected to be minimal based on the findings of Lowney et al. (2007). Soil arsenic concentrations in surface soil may also contribute to resuspension of arsenic soil particles in air. Indirect contact with soil arsenic via inhalation of such particles is expected to be limited for recreational users, trespassers, and future residents due to the reduced presence of

[1] Table 2 summary statistics include pre-averaging of duplicate and split samples results with primary samples corresponding to the same locations/depth interval.

exposed surface soils at these properties (i.e., due to increased vegetative cover, landscaping, paving, and buildings that reduce exposed soil surfaces potentially influenced by wind). For agricultural workers, inhalation of soil particles in air may represent a more significant intake route than for other receptors given the increased potential for exposed surface soil at properties used for agriculture. For future residents who may garden, uptake of arsenic from soil to produce is considered.

3. EXPOSURE ASSESSMENT

Population differences will exist in the level of exposure at a specific location due to differences in intake rates, body weights, exposure frequencies, and exposure durations. Because of this, a wide range of average daily intake values usually exist among members of the exposed population. Daily intake calculations must specify which part of the range of doses is being estimated. Values for children (0-6 years of age) and adults are utilized to more accurately portray exposure parameter differences between age groups.

Arsenic exposures are calculated using factors that incorporate scenario- and receptor-specific exposure assumptions. Exposure assumptions used in this HHRA are based primarily on values presented in NYSDEC/NYSDOH guidance for soil cleanup objectives (SCOs) developed for the New York State brownfield cleanup program (as presented in NYSDEC and NYSDOH 2006, NYSDEC 2010) and on data from site-specific studies, with USEPA guidance and professional judgment also applied as needed.

This section of the HHRA summarizes the equations, inputs, assumptions, and approaches used to quantitatively estimate exposure intakes for potentially exposed populations.

3.1 Soil and Dust Exposure Point Concentrations

Consistent with USEPA (1989) guidance, each property within Air Deposition Area 2 is considered a separate exposure area in this HHRA. Per USEPA guidance, exposure point concentrations (EPCs) for each area are intended to provide a representative estimate of the concentration of chemicals of potential concern to which an individual may be exposed within each area (USEPA 1992). USEPA (1992) provides the following scientific rationale for the use of an average concentration for the EPC:

> *(1) carcinogenic and chronic noncarcinogenic toxicity criteria are based on lifetime average exposures; and, (2) Average concentration is most representative of the concentration that would be contacted at a site, over time. For example, if you assume that an exposed individual moves randomly across an exposure area, then the spatially-averaged soil concentration can be used to estimate the true average concentration contacted over time. In this example, the average concentration contacted over time would equal the spatially averaged concentration over the exposure area. While an individual may not actually exhibit a truly random pattern of movement across an exposure area, the assumption of equal time spent in different parts of the area is a simple but reasonable approach.*

USEPA recommends that the 95 percent upper confidence limit of the arithmetic mean (95UCLM) be used to represent the EPC (USEPA 1992). USEPA's software application, ProUCL v5.0 (USEPA 2013) was used to calculate 95UCLM values for this HHRA. A number of factors, including the number of available data points, the shape of the distribution of the values, and the degree of censoring (e.g., samples below the detection limit) are considered in determining which mathematical approach is most appropriate for 95UCLM calculation of a data set (USEPA 2002). The ProUCL software includes several different strategies to calculate a 95UCLM from the data set and recommends a preferred value based on the properties of the input dataset.

3.1.1 Surface Soil EPCs

As summarized in the CSM, recreational user, agricultural worker (inhalation only), trespasser, and future resident exposures to arsenic in surface soil (defined in this HHRA as 0- to 3-inch)[2] are quantitatively assessed by the HHRA. As discussed above, should development of Properties R2b, R2c, R2d, and R2f for residential use occur in the future, the concentrations of arsenic represented in post-development surface soil will not be the same as represented under current (pre-development) conditions. Rather, post-development surface soil concentrations are likely to represent a mixture of current arsenic concentrations from all depths within the 0- to 12-inch sampling horizon. Thus, for future residents, post-development surface soil EPCs represent the mean of samples from the 0- to 3-inch, 3- to 6-inch, 6- to 9-inch, and 9- to 12-inch sample horizons. For the agricultural worker ingestion and dermal exposure routes, EPCs represent the mean of samples from the 0- to 3-inch and 3- to 6-inch sample horizons. For both the future resident and the agricultural worker, soils from the sampled intervals at each sample location were pre-averaged before calculating the scenario-specific EPC. Table 3 summarizes soil EPCs for current and future exposure scenarios.

For residential exposure scenarios, ingestion of soil is assumed to include outdoor soil and house dust originating from outdoor soil. Site-specific house dust arsenic concentration data were collected from 96 homes in Middleport in the summer and fall of 2003 (Tsuji et al. 2004). Soil arsenic concentration data was also available for a majority of the homes for which residents consented to house dust sampling. Arsenic in soil contributed little to arsenic in house dust and house dust arsenic concentrations were not correlated with average or maximum soil arsenic concentrations. Therefore, in the Air Deposition Area 2 HHRA, hypothetical future house dust arsenic concentrations were assumed to be similar to background house dust arsenic concentrations. Tsuji et al. (2004) reported that the geometric mean soil arsenic concentration was higher than the dust arsenic concentration (20.6 and 10.8 mg/kg, respectively). Using the SCO guidance methods, there is no separate concentration term for house dust. Rather, a fraction of ingested soil is assumed to be inside a home.

3.2 Incidental Ingestion of Soil and Dust

Soil exposure occurs primarily from incidental ingestion of soil. The non-cancer average daily dose from incidental ingestion of soil for all receptors is calculated with Equation 1. For future residents, indoor dust ingestion is accounted for in the soil ingestion rate, as specified in the NYSDEC SCO guidance (2006).

[2] Common risk assessment practice varies in the depth interval that is defined as surface soil, with intervals of 0- to 3-inches and 0- to 6-inches having been frequently used in various risk assessments. Characterization of variation of chemical concentrations with soil depth can ensure that the selected depth interval accurately reflects potential surface soil exposures. As was described in the screening HHRA, there is no difference in arsenic concentrations in the 0- to 3-inch and 3- to 6-inch intervals in OU3, whereas, concentrations below 6 inches are generally lower. Consequently, derivation of surface soil EPCs using either 0- to 3-inch or 0- to 6-inch depth data yields the same results and accurately represents potential surface soil exposures.

Equation 1: Average Daily Dose from Ingestion of Soil

$$ADD_{ing} = \frac{C_{soil} \times IR \times RBA \times \frac{1\ kg}{10^6\ mg}}{BW}$$

Where:

ADD_{ing}	= average daily dose from ingestion of soil (mg/kg_{BW}-day)
C_{soil}	= chemical concentration in soil (mg/kg_{soil})
IR	= soil ingestion rate (mg_{soil}/day)
RBA	= relative oral bioavailability of arsenic in soil (unitless)
BW	= body weight (kg_{BW})

For cancer risks to the recreational user and future resident, the average daily dose is quantified over five age classes to represent chronic exposure that occurs over a lifetime (Equation 2). For the agricultural worker and trespasser, only a single age class is quantified (adult and adolescent, respectively). The resulting value is referred to as the lifetime average daily dose.

Equation 2: Lifetime Average Daily Dose from Ingestion of Soil

$$LADD_{ing} = \frac{C_{soil} \times \left[\sum_{i=1}^{5} \frac{ADAF_i \times IR_i \times ED_i}{BW_i}\right] \times RBA \times \frac{1\ kg}{10^6\ mg}}{\frac{AT}{365\ days/year}}$$

Where:

$LADD_{ing}$	= lifetime average daily dose from ingestion of soil (mg/kg_{BW}-day)
C_{soil}	= chemical concentration in soil (mg/kg_{soil})
$ADAF_i$	= age dependent adjustment factor (equal to 1 for arsenic; unitless)
IR_i	= soil ingestion rate for age class i (mg_{soil}/day)
ED_i	= exposure duration for age class i (years)
BW_i	= body weight for age class i (kg_{BW})
RBA	= relative oral bioavailability of arsenic in soil (unitless)
AT	= averaging time (days)

Exposure inputs are provided in Table 4 through Table 8, and the basis for the values is discussed further below. Estimated intakes for this pathway are summarized in Table 9 (non-cancer) and Table 10 (cancer).

3.2.1 Exposure Frequency

Exposure frequency describes how many days per year someone may have contact with soil in a typical one-year period. Following the SCO methodology, the soil ingestion exposure frequency will be combined with the ingestion rate. In developing SCOs, NYSDEC and NYSDOH (2006) considered that

outdoor soil ingestion occurs only during the warmer months of the year. Based on the latest date of the first fall frost (after November 10) and the earliest date of the last spring frost (before April 10) in southern New York State (Long Island) counties, NYSDEC and NYSDOH assumed that outdoor soil ingestion will occur during a 31-week period between early April and early November.

The time spent outside is likely to be more limited in Niagara County than in the southern counties assessed by NYSDEC and NYSDOH. Per NYSDEC (2010) guidance, site-specific SCOs may be derived considering applicable site information. Consequently, a site-specific adjustment was made for the colder climate in the area of Niagara County where Middleport is located, based on data from the Cornell University Cooperative Extension climate maps (2010) that were also used to derive the SCO assumptions for Long Island counties. In Niagara County, the latest date for the first fall frost is October 20 (vs. November 10 on Long Island) and the earliest date of the last spring frost is April 30 (vs. April 10 on Long Island). Thus the soil exposure period in Niagara County is 173 days or 24.7 weeks instead of 217 days or 31 weeks.

For recreational users the exposure frequency is assumed to be two days per week during the 24.7-week soil exposure period, for a total of 49.4 days/year. For the agricultural worker, the exposure frequency is also assumed to be two days per week during the 24.7-week period or 49.4 days/year between late April and late October when agricultural activities might be routinely be conducted. Two days per week is judged to be on the high end of the expected exposure frequency due to the small size of each property relative to the amount of land a full time farmer is expected to manage. The OU-3 portions of R2b and R2c comprise approximately 10 acres of a field, while the entire cultivated field comprises approximately 160 acres, and the same property owner also cultivates an additional approximately 850 acres of contiguous fields. Due to the limited access to Property R2e, the trespasser exposure frequency was assumed to be 10 times per year.

For residents, NYSDEC and NYSDOH assume that residents do not go outside every day due to periods of inclement weather and for time spent away from home. Specifically, children are assumed to contact soil 5 days per week during the soil exposure period, while adults are assumed to contact soil 2 days per week. Based on the 24.7 week exposure period, this results in soil exposure frequencies of 123.5 days/year for children and 49.4 days/year for adults.

3.2.2 Soil Ingestion Rate

Incidental soil ingestion rates for direct exposures to soil vary based on several factors, including the following:

- Frequency of an individual's hand-to-mouth behaviors
- Seasonal climate conditions that affect availability of soil (e.g., snow cover)
- Type of groundcover at the exposure location (e.g., grass versus bare ground)
- Amount and type of outdoor activity
- Individual personal hygiene practices (e.g., frequency of hand washing).

Of these factors, the frequency of an individual's hand-to-mouth behaviors is considered a primary determinant of soil intake. Studies have found that the frequent hand-to mouth behaviors typical of young children increase the potential for ingestion of soil that adheres to hands. Although fewer studies of adult soil ingestion have been published, hand-to-mouth activities in adults are considered much less frequent than in children. For this reason, risk assessment guidance typically recommends

soil ingestion rates that are higher for children than for adults, and young children are evaluated separately in risk assessments.

The SCO soil ingestion assumptions are applied differently than the standard USEPA HHRA approach, with the SCOs incorporating the exposure frequency into the average soil ingestion rate, and also adjusting indoor dust intake to reflect only the portion of dust that is derived from soil. The result is an adjusted soil ingestion rate. Specifically, NYSDEC and NYSDOH (2006) assume that a child ingests 80 mg/day of soil from outdoors on days spent outdoors, and 40 mg/day of soil tracked into the home every day. Based on site-specific climate data (see Section 3.1.2 above), it is assumed that a Middleport child is outside 124 days/year (5 days per week during the 24.7 weeks from late April to late October) yielding an average daily adjusted soil ingestion rate of 67 mg/day. For the SCOs adult residents are assumed to ingest 100 mg/day of soil 2 days/week for 24.7 weeks/year for a daily adjusted ingestion rate of 14 mg/day.

For the resident, the SCO guidance assumes that two thirds of a child's soil ingestion is from outdoor soil (80 mg/day out of 120 mg/day total). Assuming that the child may ingest half of their daily outdoor soil during recreational activities gives a recreational user ingestion rate of 40 mg/day. If the adult resident ingestion rate is also assumed to be two thirds from outdoor soil (approximately 66 mg/day), applying the same assumptions as for the child recreational user results in an adult recreational user ingestion rate of 33 mg/day. Both ingestion rates were modified by the ingestion frequency of 49.4 days per year to result in a daily adjusted soil ingestion rate of 5.4 mg/day for the child recreational user and 4.5 mg/day for the adult recreational user.

The SCO guidance recommends a daily soil ingestion rate of 50 mg/day for an outdoor worker, which was applied to the agricultural worker. The trespasser ingestion rate is 100 mg/day, also as specified in the SCO guidance. Considering exposure frequencies of 49.4 days per year and 10 days per year, respectively, the average daily adjusted soil ingestion rates for the agricultural worker and trespasser are 7 mg/day and 3 mg/day.

3.2.3 Exposure Duration

Exposure duration represents the number of years a person could have contact with the exposure medium. For the SCOs, NYSDEC and NYSDOH assume a 70 year total residential exposure duration for cancer risks over a lifetime. This contrasts with exposure duration of 26 years currently recommended by USEPA (2014). In this HHRA, the exposure duration for the recreational user is assumed to be the same as for a resident, 70 years. For both receptors, exposure durations appropriate to each life stage within the 70 year duration are applied in quantifying cancer risks (see Table 5). For non-cancer risks, the exposure duration and averaging time cancel each other out, so SCO guidance does not specify an exposure duration.

The exposure duration for an outdoor worker in the SCO guidance of 25 years is applied to the agricultural worker. This assumption is the same as the RME assumption used by USEPA (2014). USEPA (2011) reports the median occupational tenure for all workers is 6.6 years. For the trespasser, to Property R2e, an exposure duration of 8 years as an adolescent is applied.

3.2.4 Body Weight

The body weight parameter represents the mass (in kg) of the receptor being evaluated. The values used in this HHRA are from the SCO guidance, i.e., 13.3 kg for a child, 58.1 kg for an adolescent, and 70 kg for an adult (see Table 5 for body weight for each life stage used in estimating cancer risks). These values are lower than USEPA's values updated based on more recent US population data. USEPA (2014) recommends a child body weight value of 15 kg and an adult body weight of 80 kg.

3.2.5 Averaging Time

The averaging time is the period over which an exposure is averaged. When evaluating carcinogenic effects, contaminant intakes are averaged over a full lifetime (70 years or 25,550 days) to be consistent with the way cancer slope factors are derived. When evaluating noncarcinogenic effects, contaminant intakes are averaged over the exposure duration, so the non-cancer averaging time is a function of the exposure duration (exposure duration multiplied by 365 days). As noted above, this factor cancels out and is not specified in the SCO guidance.

3.2.6 Oral Relative Bioavailability

As detailed in the HHRA for Air Deposition Area 1 (Integral 2011) and screening level HHRA for Air Deposition Area 2 (ENVIRON 2014), a site-specific study (Roberts et al. 2007) was used to identify a value of 0.22 or 22 percent for the relative oral bioavailability (RBA) of arsenic ingested in a soil matrix compared with the dosing regimen used in the toxicity study on which the cancer slope factor is based. The same site-specific mean RBA value (0.22) used in deterministic analyses for the 2011 HHRA is applied in this HHRA.

NYSDEC (2015) suggested using a range of relative bioavailability values, including the assumption of 100 percent bioavailability for arsenic in soil, as well as the USEPA default value of 60 percent, claiming this would be a more scientifically valid approach. In contrast, use of applicable site-specific data is more scientifically valid and is supported by USEPA guidance (USEPA 2012). The USEPA default value of 60 percent is based on a comprehensive analysis of the results of many studies. USEPA (2012) concluded that the default of 60 percent is more scientifically valid than an assumption of 100 percent. Specifically:

> *Based on the above considerations, the TRW Bioavailability Committee recommends a default value for RBA of arsenic in soil based on an upper percentile from the data set of arsenic RBAs reported in U.S. EPA... An RBA value of 60% was selected as the default value and is supported by the analysis of soil arsenic RBA estimates which showed that less than 5% of the RBA estimates exceeded 60%. Selection of a default RBA value that is expected to be in the upper percentile range reduces the likelihood that sites are screened out from further evaluation when, in fact, they may present a significant health risk.*

Furthermore, USEPA (2012) specifies that site-specific data should be used in preference to the default value whenever available. Specifically:

> *Agency guidance (U.S. EPA, 2007b) recommends that even in cases where sufficient data exist to support default medium-specific absorption factors for a chemical, site-specific data collection may also be important. Important factors that can affect the bioavailability of arsenic in soil can be expected to vary from site to site, or within a given site. These include the chemical forms of the arsenic, as well as the physical and chemical characteristics arsenic-bearing soil particles. Default values for arsenic RBA may not reflect all of these factors (e.g., chemistry, particle size, matrix effects) at any given site. Therefore, site-specific assessments of bioavailability should still be performed where such assessments are deemed feasible and valuable for improving the characterization of risk at the site.* ***Default RBA values generally should not be used when site-specific assessments are performed.****[emphasis added] In general, the Agency (U.S. EPA, 2007b) recommends that efforts be made to collect data that support site-specific estimates, rather than relying on the default value recommended in this memorandum which may not accurately represent arsenic RBA*

at any specific site. Use of the national default in place of site-specific estimates may underestimate or overestimate risk.

For these reasons the most scientifically valid approach is to use the relative bioavailability estimate from the peer-reviewed, published study using Middleport soil samples.

3.3 Dermal Exposure to Soil

The average daily dose from dermal exposure to arsenic in soil is quantified by Equation 3, and the lifetime average daily dose is quantified by Equation 4.

Equation 3: Average Daily Dose from Dermal Exposure to Soil

$$ADD_{derm} = \frac{C_{soil} \times AF \times ABS \times SSA \times EV \times \frac{EF}{365\ days/year} \times \frac{1\ kg}{10^6\ mg}}{BW}$$

Where:

ADD_{derm}	= average daily dose from dermal contact with soil (mg/kg_{BW}-day)
C_{soil}	= concentration in soil (mg/kg_{soil})
AF	= adherence factor (mg_{soil}/cm^2-event)
ABS	= absorption fraction (unitless)
SSA	= skin surface area (cm^2)
EV	= event frequency (events/day)
EF	= exposure frequency (days/year)
BW	= body weight (kg_{BW})

Equation 4: Lifetime Average Daily Dose from Dermal Exposure to Soil

$$LADD_{derm} = \frac{C_{soil} \times ABS \times \left[\sum_{i=1}^{6} \frac{ADAF_i \times AF_i \times SA_i \times EV \times \frac{EF_i}{365 \text{ days/year}} \times ED_i}{BW}\right] \times \frac{1 \text{ kg}}{10^6 \text{ mg}}}{AT}$$

Where:

$LADD_{derm}$	= average daily dose from dermal contact with soil (mg/kg_{BW}-day)
C_{soil}	= concentration in soil (mg/kg_{soil})
ABS	= absorption fraction (unitless)
$ADAF_i$	= age dependent adjustment factor (equal to 1 for arsenic; unitless)
AF_i	= adherence factor (mg_{soil}/cm^2-event)
SA_i	= skin surface area (cm^2)
EV	= event frequency (events/day)
EF_i	= exposure frequency (days/year)
ED_i	= exposure duration (year)
BW	= body weight (kg_{BW})
AT	= averaging time (years)

Assumptions for exposure frequency, exposure duration, averaging time, and body weight used to assess dermal exposures of each receptor are the same as those applied to the soil ingestion pathway. The basis for additional parameters used only in the dermal pathway are described below. Estimated intakes for this pathway are summarized in Table 9 and Table 10.

3.3.1 Soil Adherence Factor

The adherence factor (AF) is the amount of soil that sticks to the skin on contact. As described in USEPA RAGS E (2004), different activities and body parts are associated with different adherence values. The soil AFs recommended by the SCO guidance were used here. The recreational user AFs were assumed to be equal to those for the resident: for non-cancer, the child AF was 0.2 mg/cm^2-event and the adult AF was 0.07 mg/cm^2-event. The AFs by life stage used for the cancer risks for the recreational user and the future resident are shown in Table 5.

The outdoor worker AF of 0.2 mg/cm^2-event was applied to the agricultural worker, and the adolescent AF of 0.07 mg/cm^2-event was applied to the trespasser.

3.3.2 Dermal Absorption Fraction

A peer-reviewed, published study with site-specific data is also the most scientifically valid source of an arsenic dermal absorption fraction estimate for Middleport. The site-specific arsenic dermal absorption fraction selected for this HHRA (0.5 percent or 0.005) is based on Lowney et al. (2007), which measured dermal absorption of arsenic from Middleport soil in Rhesus monkeys.

The USEPA arsenic absorption fraction of three percent (0.03) cited in USEPA dermal risk assessment guidance (2004) was published by Wester et al. (1993). This study exposed Rhesus monkeys to constructed substrates of soil freshly mixed with radiolabeled arsenic. However, research has shown

that dermal absorption of arsenic from environmental soils differs from absorption of soluble forms of arsenic freshly mixed into soil. Arsenic in environmental soils may not be exclusively in soluble forms, a characteristic which varies with soil-specific factors (water and organic carbon content, metal oxides available in the soil, etc.) and with the source and concentration of the arsenic.

Lowney et al. (2007) builds on the previous research from Wester et al. (1993), using the same laboratories, sample size, and animal model, but updating the substrate to be more relevant to environmental exposures to soil arsenic. The 2007 study uses soil samples collected through a previous sampling effort at Middleport, which contained arsenic concentrations of 1400 µg/g and 1230 µg/g respectively. Of the trials (3 animals, wet and dry soil application), the highest absorption percentage was 0.5 percent, an order of magnitude lower than the 5 percent average absorption from soluble arsenic mixed with soil that the study found. Based on the methodological updates in Lowney et al. (2007) and the use of site soil samples, the absorption fraction of 0.5 percent is more relevant to human exposures at historically contaminated sites than the 3 percent recommended by the 2004 USEPA guidance.

3.3.3 Skin Surface Area

Skin surface area is calculated for all body parts that are exposed for a given receptor and is dependent on assumptions about the type of clothing worn during different activities. For the recreational user and future resident, the value recommended in the SCO guidance is used, i.e., 1870 cm^2 for a child and 4850 cm^2 for an adult. It assumes the child's face, forearms, hands, lower legs and feet are exposed. For the adult, the face, forearms, hands, and lower legs are assumed to be exposed; the adult is assumed to be wearing shoes. For estimating cancer risks for the recreational user and future resident, Table 5 provides the NYSDEC recommended skin surface area by age class (NYSDEC and NYSDOH 2006).

The adult worker is assumed to be wearing long pants and shoes, where exposures may occur to the face, forearms, and hands, for a surface area of 2480 cm^2. For the trespasser, the SCO guidance assumes the face, forearms, hands, and lower legs of a 15-year old are exposed, for a value of 4530 cm^2.

3.3.4 Event Frequency

The event frequency, or number of dermal exposure events per day, is assumed to be one, based on USEPA guidance (2004).

3.4 Consumption of Homegrown Produce

For future residents who garden, uptake of arsenic from soil to homegrown produce is possible. The average daily dose of arsenic from consumption of homegrown produce is calculated using Equation 5. For cancer risks (lifetime average daily dose), the child and adult exposure duration is added together (6 years for child and 20 years for adult) and a cancer averaging time of 25550 days is used.

Equation 5: Average Daily Dose from Consumption of Homegrown Produce

$$(L)ADD_{produce} = \frac{C_{veg} \times FI \times IR \times EF \times ED}{AT}$$

Where:

$(L)ADD_{produce}$	= average daily dose from consumption of homegrown produce (mg/kg_{BW}-day)
C_{veg}	= concentration in vegetables (mg/g_{veg})
FI	= fraction inorganic arsenic (unitless)
IR	= ingestion rate (g_{veg}/kg_{BW}-day)
EF	= exposure frequency (days/year)
ED	= exposure duration (years)
AT	= averaging time (days)

Although consumption of homegrown produce does not occur every day, it is customary to calculate produce ingestion rates by dividing total annual consumption by 365 days to yield an annualized daily average ingestion rate. Therefore, the exposure frequency assumed for the homegrown produce consumer is 365 days per year. The basis for the produce concentrations, fraction of arsenic in produce that is inorganic, and produce intake rates are detailed below. Estimated intakes for this pathway are summarized in Table 9 and Table 10.

3.4.1 Produce Concentrations

The produce arsenic concentration (C_{veg}) used in the HHRA is based on arsenic measured in homegrown produce samples collected from Middleport residents in 2003 as part of a site-specific urine arsenic biomonitoring study (Exponent 2004, Tsuji et al. 2005), which also included collection of soil samples from a subset of participating households' yards, child play areas, and vegetable gardens. Garden soil was sampled at 23 of the 41 households providing produce samples. Garden soil arsenic concentrations averaged 19 mg/kg. This concentration is higher than the mean soil arsenic concentrations for the properties with future potential residential use, i.e., properties R2b, R2c, R2d and R2f. The highest mean concentration for any depth interval in these properties is 18 mg/kg and overall averages are much lower. For that reason, use of produce arsenic concentrations from Air Deposition Area 1 in the OU-3 HHRA is judged to be protective, i.e., likely to over predict concentrations that could occur in produce in future residential use of the properties.

Upon request of participants, homegrown produce was sampled and analyzed during August and September 2003. When analysis was requested, vegetables were sampled from each of the following categories present in a garden: fruiting vegetables, root vegetables, leafy vegetables, cucurbits, brassicas, legumes, bulb vegetables, and herbs. Originally the sampling plan specified that samples would be washed by the analytical laboratory with tap water similarly to if they were being prepared for consumption. Due to field logistics, the sampled vegetables had to be frozen before shipping to the laboratory, at which point they could not be washed without compromising sample integrity. The protocol was later adjusted so that samples were washed by field staff before being frozen, resulting in approximately the first half of the samples being analyzed without washing, while the other half were washed.

A variety of homegrown produce (n=100) was collected from 41 households. Of these, 67 percent were flagged as estimated concentrations and two percent were below the detection limit. Unwashed

produce samples generally had higher arsenic concentrations than washed samples (as shown in the summary table in Exponent 2004); however, the data table we obtained does not specify which samples were washed and which were not. For that reason, and to increase the number and kinds of produce data considered, we calculated mean concentrations including both washed and unwashed samples. The one exception is for lettuce, where the three unwashed samples had concentrations above the range of concentrations in the three washed samples. We excluded those three unwashed samples because they were able to be identified. The concentrations for the resulting 97 samples are described below. All concentrations are noted in wet weight.

The Solanaceae family made up the largest category at 40 percent of the samples (38 out of 39 samples were tomatoes). All other vegetables had very small sample sizes. The highest arsenic concentration was found in sage (Lamiaceae family) at 0.575 mg/kg (see Table 11). This family also had the highest overall mean of all the plant families included (0.162 mg/kg), excluding Apiaceae, which included a single unpeeled carrot sample at 0.174 mg/kg. Amaryllidaceae (onions and garlic) had the second highest average concentration (0.0445 mg/kg). The plant family with the lowest average arsenic concentration was Solanaceae at 0.0041 mg/kg. The mean arsenic concentration in all Middleport samples of homegrown produce is 0.03 mg/kg. This value is used to represent the concentration in vegetables for quantitative evaluation of this pathway.

3.4.2 Fraction Inorganic Arsenic in Produce

Studies of arsenic in food most commonly report total arsenic. For some foods, such as fish and shellfish, most of the arsenic is present as nontoxic organic arsenicals (Schoof and Yager 2007). In rice, the relative proportion of organic and inorganic arsenic is variable (Fontcuberta et al. 2011, FDA 2013, Lynch et al. 2014). Few studies have reported both total and inorganic arsenic concentrations in vegetables and fruit other than rice, with the most frequently cited study being Schoof et al. (1999a, b), who found an average of 51 percent of arsenic in vegetables purchased at US markets was inorganic arsenic, with a range from 9 percent to 104 percent for different kinds of vegetables. For fruits, the mean and range were 47 percent and 21 percent to 103 percent (Table 12).

Fontcuberta et al. (2011) reported a mean estimate that 23 percent of arsenic in market vegetables and fruits from Spain was inorganic arsenic, with 13 percent of spinach arsenic inorganic and 44 percent of cabbage arsenic inorganic. A World Health Organization committee reports the proportion of inorganic to total arsenic in 36 vegetable samples to vary from 33 percent to 74 percent (JECFA 2011). Higher proportions of inorganic arsenic have been reported in other studies, frequently reflecting very high soil and water arsenic concentrations (Diaz et al. 2004, Muñoz et al. 2002, Helgesson and Larsen 1998, Smith et al. 2006). The European Food Safety Authority concluded that 70 percent reflected the best overall average inorganic arsenic content for food communities other than fish and seafood (EFSA 2009).

A small subset of the Middleport vegetable samples were analyzed for inorganic arsenic concentrations (Table 13). Among the 17 samples tested, the proportion of total arsenic that was inorganic ranged from 40 to over 100 percent, with a mean value of 73 percent. Considering the site-specific data, as well as the EFSA conclusion, the assumption that 70 percent total arsenic in produce consumed by a future resident is inorganic is considered reasonable and not likely to over- or under- estimate exposures to inorganic arsenic in vegetables.

It is important to note that evidence is accumulating that cooking may, in many cases, reduce both total and inorganic concentrations in rice and produce. It is apparent from these data that such cooking losses may be significant from leafy greens such as kale, chard and spinach (Table 14). However, recognizing that much of the garden produce may not be cooked, no adjustments were made in the exposure estimates for reduction of arsenic in produce due to cooking losses.

3.4.3 Homegrown Vegetable Ingestion Rate

The most recent national survey of consumption of home-produced goods was the USDA 1987-1988 Nationwide Food Consumption Survey. Data from this survey were reanalyzed by Moya and Phillips (2001) and presented in the Exposure Factors Handbook (EFH; USEPA 2011). This was a 7 day survey that generated consumption rates for those who consumed homegrown produce during the survey period, i.e., "consumers only". As recommended by the EFH and Phillips and Moya (2012), additional analysis was done on the consumer only data from EFH Tables 13-58 through 13-62 to derive long-term average per capita ingestion rates for gardening populations. Specifically, we estimated rates for populations that garden in the Northeast, as well as adjusting for losses in quantities of foods due to preparation and cooking.[3] Relevant homegrown produce types included exposed fruits and vegetables, protected fruits and vegetables, and root vegetables; however, in the Northeast, the sample size for intake of homegrown protected fruits was too small to calculate a mean ingestion rate and this group was therefore excluded.

First, mean per capita ingestion rates were calculated as the product of the percent consuming and the mean unadjusted ingestion rate for the total population across all regions, the total population that gardens, and the population in the Northeast. For each homegrown produce type (e.g., exposed vegetables), the consumer per capita ingestion rate for the population that gardens was then multiplied by the ratio of the consumer per capita intake for the total population in the Northeast to the consumer per capita ingestion for the total population from all regions. This provided the unadjusted mean per capita consumption rate for the Northeastern population that gardens. Equation 13-3 and mean losses in Table 13-69 of the EFH were then used to adjust the ingestion rate for losses from preparation and cooking.

For example, EFH Table 13-58 summarizes mean intakes (based on wet weight produce measurements) and percent consuming for different population groups consuming home-produced, exposed fruit. These data are unadjusted for losses due to preparation or cooking. For each population group (e.g., total population, Northeast population, total population that gardens), mean intake rates can be converted to per capita rates by multiplying the percent consuming and the mean unadjusted intake. For example, the mean consumer-only per capita intake rate for the Northeast region is 0.02 g/kg-day (i.e., 2.96 percent x 0.76 g/kg-day). To calculate the consumer-only per capita intake for the Northeast population of households that garden, the per capita rate for the population that gardens (0.23 g/kg-day) was then multiplied by the ratio of the per capita intake for the total population in the Northeast (0.02 g/kg-day) to the per capita intake for the total population from all regions (0.09 g/kg-day). This provided the mean per capita consumption rate for the Northeastern population that gardens (0.06 g/kg-day) prior to adjusting for cooking losses. The EFH data for percent weight losses from food preparation (EFH Table 13-69) were then applied (using EFH equation 13-3) to the unadjusted mean per capita rate for Northeast gardener/consumers of exposed fruit (i.e., 0.06 g/kg-day x [1- 0.254] x [1-0.305]). The resulting consumption rates, adjusted for preparation and cooking losses, are shown in Table 15 by produce type, along with the representation of each type in the Middleport dataset.

These ingestion rates are not specific to age, assuming that each age group eats homegrown produce proportional to their body weight. Ingestion rates from all vegetable types were summed for a total homegrown produce ingestion rate of 0.43 g/kg-day. This assumption is expected to be protective considering that the Middleport data does not contain exposed fruits or protected vegetables. If these two groups are omitted, the ingestion rate would be 0.34 g/kg-day from only exposed and root

[3] Note that these "cooking losses" are different than the reductions in arsenic concentrations reported above.

vegetables. However, to be conservative, the higher ingestion rate of 0.43 g/kg-day was used in this analysis.

3.5 Inhalation of Soil Particles Resuspended in Air

Equation 6 is used to estimate the non-cancer inhalation exposure concentration for each potentially exposed population contacting arsenic-containing particulate in air that originates from arsenic in soil. Equation 7 is used to estimate the cancer inhalation exposure concentration.

Equation 6: Non-cancer Exposure Concentration from Inhalation of Soil-Derived Particulate

$$EC_{inh} = \frac{C_{soil} \times ET \times EF \times \frac{1}{PEF} \times \frac{1000\ \mu g}{mg}}{365\ days/year \times 24\ hours/day}$$

Where:

EC_{inh}	= exposure concentration from inhalation of soil ($\mu g/m^3$)
C_{soil}	= concentration in soil (mg/kg) (from Table 3)
ET	= exposure time (hours/day)
EF	= exposure frequency (days/year)
PEF	= particulate emission factor (m^3/kg)

Equation 7: Cancer Exposure Concentration from Inhalation of Soil-Derived Particulate

$$EC_{inh} = \frac{C_{soil} \times ADAF \times ET \times EF \times ED \times \frac{1}{PEF} \times \frac{1000\ \mu g}{mg}}{AT \times 24\ hours/day}$$

Where:

EC_{inh}	= exposure concentration from inhalation of soil ($\mu g/m^3$)
C_{soil}	= concentration in soil (mg/kg) (from Table 3)
ADAF	= age-dependent adjustment factor (equal to 1 for arsenic; unitless)
ET	= exposure time (hours/day)
EF	= exposure frequency (days/year)
ED	= exposure duration (years)
PEF	= particulate emission factor (m^3/kg)
AT	= averaging time (days)

For each potentially exposed population, exposure duration and averaging time inputs for the inhalation pathway were identical to those for the ingestion pathway. The basis for all other inhalation exposure inputs is provided below. Estimated exposure concentrations for this pathway are summarized in Table 9 and Table 10.

3.5.1 Particulate Emission Factor

A particulate emission factor (PEF) is used to relate the concentration of a chemical in soil to that in air resulting from wind-driven resuspension of soil particulate. NYSDEC SCO guidance derived a PEF

(1.21×10^9 m^3/kg) using inputs selected to estimate climate and meteorological conditions of New York State. This PEF was used as a surrogate for a site-specific PEF for Middleport, NY.

3.5.2 Inhalation Exposure Time and Frequency

The exposure time and frequency for inhalation represents the number of hours per day and days per year that a potentially exposed population may breathe soil particulate in air from each of the areas evaluated. The recreational user is assumed to be exposed one and one-half hours per day[4] for two days per week during the 24.7-week soil exposure period, i.e., 49.4 days per year.

The future resident child is assumed to be exposed three hours per day for five days per week (consistent with SCO guidance) during the site-specific exposure period (i.e., 24.7 weeks from late April to late October). SCO guidance assumes the adult resident is also exposed three hours per day during weekdays and six hours per day on weekends during the soil exposure period.

For the agricultural worker, inhalation is assumed to occur for 12 hours per day for two days per week of the soil exposure period (24.7 weeks). Due to limited accessibility, trespasser inhalation is assumed to occur for one hour per day for 10 days per year.

[4] Inhalation time is assumed to be half of the three-hour resident inhalation time specified in the SCO guidance, based on the fraction applied to the outdoor soil ingestion from recreational activities (see Section 3.2.2).

4. TOXICITY ASSESSMENT

The toxicity assessment provides an overview of toxicity values selected for estimating the risk of adverse health effects from chemical exposures and summarizes toxicity information from governmental health authorities and in peer-reviewed publications. Toxicity values for carcinogenic and noncarcinogenic health effects have been developed for many chemicals by government agencies, including USEPA, the US Agency for Toxic Substances and Disease Registry (ATSDR), and some state agencies. These toxicity values are numerical expressions of chemical dose and response, and vary based on factors such as route of exposure (e.g., oral, inhalation, or dermal) and duration of exposure. The toxicity assessment includes a description of procedures used to identify toxicity values and the critical studies that form the basis for them. Some of the key methodological issues, assumptions, and uncertainties that underlie the toxicity information also are provided.

Arsenic is the only chemical of concern in this HHRA. A detailed toxicity assessment was provided in the HHRA for Air Deposition Area 1 (Integral 2011). The arsenic toxicity values have not changed since that HHRA was conducted. USEPA is in the process of conducting an updated toxicity assessment for arsenic, but revised toxicity values are not anticipated to be released until 2016 at the earliest.

4.1 Cancer Effects

Arsenic is classified by the USEPA as a human carcinogen. Sufficient data exist to show that lung cancer mortality increases with arsenic inhalation and skin and internal organ cancers increase in populations exposed to high concentrations of arsenic in drinking water. The oral cancer slope factor (CSF) for arsenic is 1.5 $(mg/kg\text{-}day)^{-1}$ based on skin cancer. The inhalation unit risk factor (IUR) is 0.0043 per $\mu g/m^3$ based on lung cancer.

4.2 Non-Cancer Effects

The non-cancer oral reference dose for arsenic is 0.0003 mg/kg-day. This value was derived from a critical effect based on human chronic oral exposure resulting in hyperpigmentation and keratosis (Tseng et al. 1968, Tseng 1977). An uncertainty factor of three was used due to a lack of reproductive toxicity data and uncertainty in whether the NOAEL is protective of all sensitive individuals. A subchronic oral reference dose (RfD) for arsenic of 0.005 mg/kg-day developed by Tsuji et al. (2004) is applicable for child exposures, but was not used in this HHRA.

USEPA does not provide an inhalation reference concentration (RfC) for arsenic. However, California EPA has derived a reference exposure level of 0.015 $\mu g/m^3$ based on a critical effect of decreased intellectual function in children (Tsai et al. 2003, Wasserman et al. 2004).

5. RISK CHARACTERIZATION

To characterize risks related to arsenic exposure, estimated intakes calculated in the exposure assessment and the toxicity values are combined to yield numerical estimates of potential health risk for both carcinogenic and noncarcinogenic endpoints. This phase of a risk assessment also involves interpreting and qualifying the derived risk estimates and the associated uncertainty.

5.1 Cancer

A cancer risk estimate derived using standard risk assessment methods is characterized as the excess probability that an individual will develop cancer during his or her lifetime due to exposure to site-related chemicals in the specific exposure scenario evaluated. The term "excess" reflects the fact that the calculated risk associated with site-related exposures is in addition to background cancer risk experienced by all individuals in the course of daily life. In this document, this risk is referred to as the "total" excess lifetime cancer risk.

Excess lifetime cancer risks for ingestion and dermal exposure pathways are typically calculated by multiplying the daily contaminant intake by the contaminant-specific oral CSF, as shown in Equation 8. The oral CSF for arsenic is 1.5 $(mg/kg\text{-}day)^{-1}$. For inhalation, the inhalation exposure concentration is multiplied by the IUR of 0.0043 $(\mu g/m^3)^{-1}$ for arsenic (Equation 9).

Equation 8: Ingestion and Dermal Cancer Risk Calculation

$$CR = LADD \times CSF$$

Where:

CR	= excess lifetime cancer risk associated with exposure to contaminant via the specified exposure route (unitless)
LADD	= estimated lifetime average daily dose of contaminant via the specified exposure route ($mg/kg_{BW}\text{-}day$)
CSF	= cancer slope factor ($(mg/kg_{BW}\text{-}day)^{-1}$)

Equation 9: Inhalation Cancer Risk Calculation

$$CR = EC_{inh} \times IUR$$

Where:

CR	= excess lifetime cancer risk associated with exposure to contaminant via inhalation (unitless)
EC_{inh}	= inhalation exposure concentration ($\mu g/m^3$)
IUR	= inhalation unit risk ($m^3/\mu g$)

The discussion of risk results focuses on risk levels specified in the CAOs, i.e., 10^{-4} to 10^{-6}. Because there are risks associated with arsenic in soil due to background conditions in addition to FMC activities, comparison between the contribution from FMC activities and background conditions is a critical issue in understanding the potential risk reduction associated with any remedial actions that might be undertaken at the site. FMC's contributions might be termed the "incremental" risk, reflecting the risks present in the study areas above background conditions. In the HHRA for Air Deposition Area 1, both total and incremental excess lifetime cancer risks for the study areas were calculated. Only total excess lifetime cancer risks are presented in this risk assessment, i.e., the risk estimates reflect both background and site-related contributions. Risks are also presented for the

NYSDEC-specified Middleport background soil arsenic delineation criterion of 20 mg/kg (listed as "Background" in Table 16 through Table 19).

5.1.1 Current Cancer Risks

Recreational users (combined child and adult exposures) at Property R2a and R2f were estimated to have a total cancer risk estimate between 1E-06 and 8E-07, similar to the risks at background (Table 16). Total cancer risk estimates for adult agricultural workers were lower than for the recreational users, and trespasser risk estimates for Property R2e were more than an order of magnitude below risks for the recreational user. Soil ingestion was the primary contributor to estimated risks, followed by dermal contact with soil and then inhalation of particulate originating from soil.

Thus, cancer risks associated with current uses of all properties calculated using approaches and assumptions consistent with the SCOs (including site-specific data) are at or below the lower end of the risk range specified in the CAOs. Furthermore, these risk estimates are very similar to those generated in the screening risk assessment (Attachment A) using USEPA approaches and assumptions (but excluding dermal exposure). Using the USEPA approach recreational user risks were between 5E-07 and 7E-07 (vs. between 1E-06 and 7E-07 using the SCO approach). Agricultural risks were lower using the SCO approach, ranging from 2E-07 to 3E-07 as compared with 5E-07 using the USEPA approach.

5.1.2 Potential Future Cancer Risks

Total excess lifetime cancer risk estimates for the future resident exposure scenarios (combined child and adult exposures) were estimated from 8E-06 to 9E-06, with risks based on background at 9E-06 (Table 17). Risk estimates were driven by the soil/dust ingestion and homegrown produce consumption pathways for all properties. The dermal pathway risk estimates were generally an order of magnitude lower than ingestion, while the inhalation pathway contributed even less to total risk. It is noteworthy that the risk estimates for Properties R2b and R2f are the same as the risk estimate for the "no further action" property, R2d, i.e., 8E-06.

Thus, cancer risks associated with potential future residential use are within the risk range specified in the CAOs. Furthermore, these risk estimates are very similar to those generated in the screening risk assessment (Attachment A) using USEPA approaches and assumptions (but excluding homegrown produce and dermal exposure). Using the USEPA approach future resident risks were 5E-06 for all applicable properties (vs. between 8E-06 and 9E-06 using the SCO approach and adding homegrown produce ingestion, and dermal and inhalation exposure).

5.2 Non-Cancer

A noncarcinogenic health risk is typically calculated as a simple ratio of the intake from site exposures to the level determined to be without any risk of adverse effects, such as the RfD. This ratio is referred to as the hazard quotient. If receptors are exposed to contaminant levels less than or equal to the RfD (hazard quotient less than or equal to 1), no adverse health effects are expected. Exposures above an RfD (hazard quotient greater than 1) do not mean that adverse human health effects are certain to occur, but rather that further evaluation is appropriate. The non-cancer hazard quotients for ingestion and dermal exposure routes are calculated using the average daily dose of the chemical and the RfD (0.0003 mg/kg), as shown in Equation 10. The inhalation hazard quotient is calculated using the inhalation exposure concentration and the RfC (0.015 $\mu g/m^3$; see Equation 11).

Equation 10: Non-Cancer Ingestion and Dermal Hazard Quotient Calculation

$$HQ = \frac{ADD}{RfD}$$

Where:

HQ	= hazard quotient associated with exposure to contaminant via the specified exposure route (unitless)
ADD	= estimated average daily dose of contaminant via the specified exposure route (mg/kg_{BW}-day)
RfD	= reference dose (mg/kg_{BW}-day)

Equation 11: Non-Cancer Inhalation Hazard Quotient Calculation

$$HQ = \frac{EC_{inh}}{RfC}$$

Where:

HQ	= hazard quotient associated with exposure to contaminant via inhalation (unitless)
EC_{inh}	= inhalation exposure concentration ($\mu g/m^3$)
RfC	= inhalation reference concentration ($\mu g/m^3$)

All hazard indices were all well-below one, indicating that adverse noncarcinogenic effects due exposure to arsenic in soil from Properties R2a, R2b, R2c, R2d, R2e, and R2f are not expected (Table 18 and Table 19). Estimates are similar to corresponding background estimates.

5.3 Uncertainty Discussion

Risk assessments predict the likelihood of health effects in a population but do not directly measure the occurrence of health effects. The predicted risks are based on many assumptions about the ways in which people come into contact with chemicals in the environment. Although many of these assumptions are based on general scientific studies or site-specific data, uncertainty remains regarding how well the available data reflect the ways potentially exposed populations are actually exposed to chemicals. The degree of confidence in the results of a risk assessment depends on how closely the data and assumptions used match actual conditions.

It is important that uncertainty be evaluated in the context of the intended scope of the risk assessment. The goals of this HHRA were to evaluate potential human health risks to recreational users, agricultural workers, trespassers, and potential future residents who may contact arsenic in surface soil at six properties that may have been impacted by aerially deposited arsenic related to the Facility. The evaluation focused on quantifying the scenario-specific risks to assess whether predicted risks were within the acceptable range specified in the CAOs to determine whether further action at any of the six properties is needed.

Uncertainty is introduced during various steps in the development of a risk assessment, and the nature of the uncertainty may be different for each of these steps. In general, conservative selections have been made for this HHRA to ensure that risk estimates will be predictive of the higher end of possible risks for each scenario. For example, 95UCLMs are used to estimate soil concentrations for all receptors. Uncertainty has also been reduced by using site-specific data, including studies of the relative oral bioavailability and dermal absorption fraction of arsenic in Middleport soil, exposure frequencies that reflect the climate in Niagara County, and arsenic concentrations in produce collected in Middleport gardens.

Including arsenic exposure from consumption of homegrown produce for future residents likely has resulted in risk estimates that overestimate the contribution this pathway would make to risks beyond the contribution from market purchased produce. Additional discussion of arsenic in produce is provided in the following section.

5.3.1 Arsenic Concentrations in Vegetables

For this HHRA, the concentrations of arsenic in produce were estimated based on site-specific concentrations measured in produce from local gardens as part of a biomonitoring study conducted by Tsuji et al. (2005). Uncertainty with regard to these estimates may reside in the methods used to sample, prepare, and measure arsenic as well as the types of produce collected. The most comprehensive datasets of natural arsenic concentrations in vegetables are from government organizations compiling data on contaminant concentrations in market foods (EFSA 2009, Health Canada 2009, FDA 2014). All of these datasets prepare the foods as they would be consumed, including peeling and/or boiling, which will likely reduce the concentration of arsenic found in the vegetable.

The largest single dataset for arsenic in foods is from the European Food Safety Authority, which published a scientific opinion on arsenic in food based on a database of more than 100,000 arsenic results in food commodities from 15 European countries. The data for the food group "vegetables, nuts, and pulses" is provided as Table 20. A majority of the samples (66 percent) were below limits of detection (LOD). Lower bound (LB) estimates apply a value of zero to all samples below the LOD, and upper bound (UB) estimates apply a value equal to the LOD. The mean arsenic concentration from all samples in this category was 0.0367 mg/kg wet weight (UB) and 0.0262 mg/kg wet weight (LB). These mean values are close to the mean value for Middleport garden produce, providing support that the produce samples collected are likely to realistically reflect potential exposures via this pathway.

5.3.2 Lack of Correlation of Arsenic Exposure with Homegrown Produce Consumption

As shown by several studies, arsenic exposures through consumption of homegrown produce are likely to be far exceeded by arsenic intake from purchased foods unrelated to the site. The biomonitoring study conducted in Middleport found a small but significant negative correlation was noted between residents eating homegrown produce and those who did not (negative correlation between speciated urinary arsenic and ingestion of homegrown produce: $r=-0.097$; $p=0.043$) (Exponent 2004, Tsuji et al. 2005), which is consistent with findings from other studies (Hwang et al. 1997; Polissar et al. 1987; UCDEH 1997). A comprehensive risk assessment conducted by EPA for a Denver, Colorado, site also indicated minimal incremental arsenic exposures via homegrown produce (USEPA 2001).

5.4 Summary and Conclusions

For all properties and all scenarios, non-cancer risks were well below a hazard index of 1.0, indicating an absence of non-cancer health risks. For current uses of all properties, cancer risks are at the low end of or below the range of risks specified by the CAOs. For properties with potential future residential uses (R2b, R2c, R2d, and R2f), cancer risks are also within the range of risks specified by the CAOs. Risk estimates associated with the NYSDEC-specified background soil concentration are similar to estimates for corresponding receptors across all properties evaluated.

Given that the HHRA finds all current and future scenarios evaluated to have estimated risks that are within or below the range of risks specified by the CAOs, no further action is necessary for all six properties.

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TABLES

Table 1: Soil arsenic data summary

Property	Number of Sampling Locations	Number of FMC Samples		Number of Agencies' Split Samples	
		Primary	Duplicate	Primary	Duplicate
R2a	13	52	2	6	0
R2b	7	28	1	3	1
R2c	6	24	2	2	0
R2d	10	40	2	4	0
R2e	2	8	1	1	0
R2f	16	64	3	5	0
Total	54	216	11	21	1

Table 2: Soil arsenic concentrations by depth interval

Property	Depth Interval (inches)	N[a]	Minimum (mg/kg)	Maximum (mg/kg)	Mean (mg/kg)
R2a	0-3	13	5	37	23
	3-6	13	8	40	24
	6-9	13	5	49	18
	9-12	13	3	26	9
R2b	0-3	7	12	23	17
	3-6	7	11	23	16
	6-9	7	8	25	16
	9-12	7	3	12	7
R2c	0-3	6	13	22	16
	3-6	6	13	25	17
	6-9	6	7	26	15
	9-12	6	2	30	10
R2d	0-3	10	10	19	15
	3-6	10	14	20	16
	6-9	10	6	17	13
	9-12	10	3	20	6
R2e	0-3	2	31	35	33
	3-6	2	27	31	29
	6-9	2	13	16	14
	9-12	2	7	8	8
R2f	0-3	16	10	36	18
	3-6	16	7	22	17
	6-9	16	4	23	13
	9-12	16	3	19	9

Notes:
mg/kg = milligrams arsenic per kilogram soil
Available field duplicate and split sample results were averaged with primary sample results prior to calculation of property- and depth-specific summary statistics.
a. Represents the number of individual soil sampling locations.

Table 3: Calculated soil EPCs for each exposure scenario

Exposure Scenario	N	Percent Detected	Minimum (mg/kg)	Maximum (mg/kg)	Mean (mg/kg)	EPC (mg/kg)[a]
Recreational Users (contact with 0- to 3-inch soils, all exposure routes)[b]						
R2a	13	100	5.3	37	23	27
R2f	16	100	10	36	18	21
Agricultural Workers (contact with 0- to 6-inch soils, ingestion and dermal routes)[c]						
R2b	7	100	11	23	17	20
R2c	6	100	13	23	17	20
R2d	10	100	12	18	16	17
Agricultural Workers (contact with 0- to 3-inch soils, inhalation routes)[b]						
R2b	7	100	12	23	17	21
R2c	6	100	13	22	16	19
R2d	10	100	10	19	15	17
Trespasser (contact with 0- to 3-inch soils, all exposure routes)[b]						
R2e	2	100	31	35	33	35
Future Residents (contact with 0- to 12-inch soils, all exposure routes)[d]						
R2b	7	100	8.5	20	14	17
R2c	6	100	9.5	26	15	19
R2d	10	100	8.4	17	13	14
R2f	16	100	6.1	22	14	16

Notes:
mg/kg = milligrams arsenic per kilogram soil
Duplicate and spilt samples are averaged with the primary sample before calculating summary statistics and EPCs.
a. EPC is the 95% Student's-t UCL for all properties, except R2e, which is the maximum concentration.
b. For the recreational user, agricultural worker (inhalation route) and trespasser, only 0- to 3-inch soil data were used to calculate summary statistics and EPC
c. For the agricultural worker ingestion and dermal routes, 0-3 and 3- to 6-inch data for each sampling location were averaged prior to calculating the shown summary statistics and EPC for the property
d. For the future resident, 0-3, 3-6, 6-9, and 9- to 12-inch depth intervals for each sampling location were averaged prior to calculating the shown summary statistics and EPC for the property

Table 4: Recreational user exposure parameters

Exposure Parameter	Units	Child	Adult	Source
Exposure Duration (ED), for cancer	years	70		(NYSDEC and NYSDOH 2006)
Body Weight (BW)	kg	13.3	70	(NYSDEC and NYSDOH 2006)
Averaging Time, Cancer (AT_C)	days	25550	25550	(NYSDEC and NYSDOH 2006)
Ingestion Exposure Parameters				
Adjusted Soil Ingestion Rate (IR)	mg/day	5.4	4.5	Soil ingestion rate multiplied by soil ingestion exposure frequency, divided by 365
Soil Ingestion Rate	mg/day	40	33	Assumed half of the child resident daily outdoor ingestion rate; for adult, assumed two thirds of resident ingestion rate is from outdoor soil, and half of daily outdoor ingestion rate occurs during recreation
Soil Ingestion Exposure Frequency	days/year	49.4	49.4	Site-specific climate data: two days per week for 24.7 weeks
Oral Relative Bioavailability (RBA)	unitless	0.22	0.22	(Roberts et al. 2007)
Dermal Exposure Parameters				
Skin surface area (SA)	cm^2	1870	4850	(NYSDEC and NYSDOH 2006)
Event frequency (EV)	events/day	1	1	(USEPA 2004)
Dermal exposure frequency (EF_{derm})	days/year	49.4	49.4	Assumed equal to ingestion frequency
Adherence factor (AF)	mg/cm^2-event	0.2	0.07	Assumed equal to adherence factor for resident
Dermal absorption fraction (ABSd)	unitless	0.005	0.005	Site-specific data (Lowney et al. 2007)
Inhalation Exposure Parameters				
Inhalation Exposure Time (ET)	hours/day	1.5	1.5	Assumed to be half of the three-hour resident inhalation time specified in the SCO guidance, based on the fraction applied to the outdoor soil ingestion from recreational activities (see Section 3.1.6).
Inhalation Exposure Frequency (EF)	days/year	49.4	49.4	Assumed equal to ingestion frequency

Table 5: Recreational user and future resident cancer exposure parameters

Age Class	Exposure Duration (years)	Body Weight (kg)	Skin Surface Area (cm^2)
Soil Ingestion			
1	1	9.1	NA
2	1	12.3	NA
3	4	16.2	NA
4	10	39.8	NA
5	54	69.3	NA
Soil Dermal Contact			
1	1	9.1	1870
2	1	12.3	1870
3	4	16.2	1870
4	10	39.8	4526
5	2	61.3	4526
6	52	69.6	4850

Source: (NYSDEC and NYSDOH 2006)
NA = Not Applicable

Table 6: Agricultural worker exposure parameters

Exposure Parameter	Units	Value	Source
Exposure Duration (ED), for cancer	years	25	(NYSDEC and NYSDOH 2006)
Body Weight (BW)	kg	70	(NYSDEC and NYSDOH 2006)
Averaging Time, Cancer (AT_C)	days	25550	(NYSDEC and NYSDOH 2006)
Ingestion Exposure Parameters			
Adjusted Soil Ingestion Rate (IR)	mg/day	7	Soil ingestion rate multiplied by soil ingestion exposure frequency, divided by 365
Soil Ingestion Rate	mg/day	50	(NYSDEC and NYSDOH 2006)
Soil Ingestion Exposure Frequency	days/year	49.4	Assumed 2 days per week for 24.7 weeks, based climate data and limited site area
Oral Relative Bioavailability (RBA)	unitless	0.22	(Roberts et al. 2007)
Dermal Exposure Parameters			
Skin surface area (SA)	cm^2	2480	(NYSDEC and NYSDOH 2006)
Event frequency (EV)	events/day	1	(USEPA 2004)
Dermal exposure frequency (EF_{derm})	days/year	49.4	Assumed equal to ingestion frequency
Adherence factor (AF)	mg/cm^2-event	0.2	(NYSDEC and NYSDOH 2006)
Dermal absorption fraction (ABSd)	unitless	0.005	Site-specific data (Lowney et al. 2007)
Inhalation Exposure Parameters			
Inhalation Exposure Time (ET)	hours/day	12	(NYSDEC and NYSDOH 2006)
Inhalation Exposure Frequency (EF)	days/year	49.4	Assumed equal to ingestion frequency

Table 7: Property R2e trespasser exposure parameters

Exposure Parameter	Units	Values	Source
Exposure Duration (ED), for cancer	years	8	Assumed exposure from 11-18 years of age
Body Weight (BW)	kg	58.1	(NYSDEC and NYSDOH 2006)
Averaging Time, Cancer (AT_C)	days	25550	(NYSDEC and NYSDOH 2006)
Ingestion Exposure Parameters			
Adjusted Soil Ingestion Rate (IR_S)	mg/day	3	Soil ingestion rate multiplied by soil ingestion exposure frequency, divided by 365
Soil Ingestion Rate	mg/day	100	(NYSDEC and NYSDOH 2006)
Soil Ingestion Exposure Frequency	days/year	10	Assumed based on limited site size and accessibility, see section 3.2.1
Oral Relative Bioavailability (RBA)	unitless	0.22	(Roberts et al. 2007)
Dermal Exposure Parameters			
Skin surface area (SA)	cm^2	4530	(NYSDEC and NYSDOH 2006)
Event frequency (EV)	events/day	1	(USEPA 2004)
Dermal exposure frequency (EF_{derm})	days/year	10	Assumed equal to ingestion frequency
Adherence factor (AF)	mg/cm^2-event	0.07	(NYSDEC and NYSDOH 2006)
Dermal absorption fraction (ABSd)	unitless	0.005	Site-specific data (Lowney et al. 2007)
Inhalation Exposure Parameters			
Inhalation Exposure Time (ET)	hours/day	1	Assumed based on limited site size and accessibility
Inhalation Exposure Frequency (EF)	days/year	10	Assumed equal to ingestion frequency

Table 8: Future resident exposure parameters

Exposure Parameter	Units	Child Values	Adult Values	Source
Exposure Duration, Cancer (ED)	years	70		(NYSDEC and NYSDOH 2006)
Body Weight (BW)	kg	13.3	70	(NYSDEC and NYSDOH 2006)
Averaging Time, Cancer (AT_C)	days	25550	25550	(NYSDEC and NYSDOH 2006)
Soil Ingestion Exposure Parameters				
Adjusted Soil Ingestion Rate (IR_S)	mg/day	67	14	Soil ingestion rate multiplied by soil ingestion exposure frequency, divided by 365
Soil Ingestion Rate	mg/day	120	100	(NYSDEC and NYSDOH 2006)
Soil Ingestion Exposure Frequency	days/year	123.5	49.4	Adjusted for site-specific climate data, See Section 3.2.1
Oral Relative Bioavailability (RBA)	unitless	0.22	0.22	(Roberts et al. 2007)
Dermal Exposure Parameters				
Skin surface area (SA)	cm^2	1870	4850	(NYSDEC and NYSDOH 2006)
Event frequency (EV)	events/day	1	1	(USEPA 2004)
Dermal exposure frequency (EF_{derm})	days/year	123.5	49.4	Assumed equal to ingestion exposure frequency
Adherence factor (AF)	mg/cm^2-event	0.20	0.07	(NYSDEC and NYSDOH 2006)
Dermal absorption fraction (ABSd)	unitless	0.005	0.005	Site-specific data (Lowney et al. 2007)
Produce Ingestion Exposure Parameters				
Produce Ingestion Rate (IR_{veg})	g/kg-day wet weight	0.43		Adapted from Moya and Phillips 2001, see Section 3.4.3
Fraction Inorganic Arsenic (FI)	unitless	0.7		(EFSA 2009)
Produce Ingestion Frequency (EF)	days/year	365		Assumed daily homegrown produce ingestion
Produce Exposure Duration, Non-cancer (ED)	years	6	20	(USEPA 2014)
Produce Exposure Duration, Cancer (ED)	years	70		(NYSDEC and NYSDOH 2006)
Inhalation Exposure Parameters				
Inhalation Exposure Time (ET)	hours/day	3	3-6	(NYSDEC and NYSDOH 2006)
Inhalation Exposure Frequency (EF)	days/week	5	2-5	(NYSDEC and NYSDOH 2006)

Table 9: Calculated average daily dose for all receptors

Property	Ingestion (mg/kg-day)	Homegrown Produce (mg/kg-day)	Inhalation of Soil Particulate (µg/m³)	Dermal (mg/kg-day)
Recreational User - Child				
R2a	2.4E-06	--	1.9E-10	5.1E-07
R2f	1.9E-06	--	1.5E-10	4.0E-07
Background	1.8E-06	--	1.4E-10	3.8E-07
Recreational User - Adult				
R2a	3.8E-07	--	1.9E-10	8.9E-08
R2f	2.9E-07	--	1.5E-10	6.9E-08
Background	2.8E-07	--	1.4E-10	6.6E-08
Agricultural Worker				
R2b	4.3E-07	--	1.1E-09	9.8E-08
R2c	4.2E-07	--	1.0E-09	9.6E-08
R2d	3.6E-07	--	9.3E-10	8.1E-08
Background	4.3E-07	--	1.1E-09	9.6E-08
Trespasser				
R2e	3.6E-07	--	3.3E-11	2.6E-08
Background	2.1E-07	--	1.9E-11	1.5E-08
Future Resident - Child				
R2b	1.9E-05	9.3E-06	6.0E-10	8.2E-07
R2c	2.2E-05	9.3E-06	6.8E-10	9.2E-07
R2d	1.6E-05	9.3E-06	4.9E-10	6.7E-07
R2f	1.8E-05	9.3E-06	5.6E-10	7.6E-07
Background	2.2E-05	9.3E-06	7.0E-10	9.5E-07
Future Resident - Adult				
R2b	7.3E-07	9.3E-06	1.1E-09	5.6E-08
R2c	8.2E-07	9.3E-06	1.2E-09	6.4E-08
R2d	6.0E-07	9.3E-06	8.8E-10	4.6E-08
R2f	6.8E-07	9.3E-06	1.0E-09	5.2E-08
Background	8.5E-07	9.3E-06	1.3E-09	6.6E-08

Table 10: Calculated lifetime average daily dose for all receptors

Property	Soil Ingestion (mg/kg-day)	Homegrown Produce (mg/kg-day)	Inhalation of Soil Particulate (µg/m^3)	Soil Dermal Contact (mg/kg-day)
Recreational User (combined child and adult)				
R2a	5.4E-07	--	1.9E-07	1.2E-07
R2f	4.2E-07	--	1.5E-07	9.5E-08
Background	4.0E-07	--	1.4E-07	9.0E-08
Agricultural Worker				
R2b	1.5E-07	--	4.1E-07	3.5E-08
R2c	1.5E-07	--	3.7E-07	3.4E-08
R2d	1.3E-07	--	3.3E-07	2.9E-08
Background	1.5E-07	--	4.0E-07	3.4E-08
Trespasser				
R2e	4.1E-08	--	3.7E-09	3.0E-09
Background	2.4E-08	--	2.2E-09	1.7E-09
Future Residents (combined child and adult)				
R2b	1.9E-06	3.4E-06	1.1E-06	1.3E-07
R2c	2.2E-06	3.4E-06	1.2E-06	1.5E-07
R2d	1.6E-06	3.4E-06	8.8E-07	1.1E-07
R2f	1.8E-06	3.4E-06	1.0E-06	1.2E-07
Background	2.3E-06	3.4E-06	1.3E-06	1.5E-07

Table 11: Middleport vegetable arsenic concentrations

Plant Family	N	Minimum (mg/kg wet wt)	Maximum (mg/kg wet wt)	Mean (mg/kg wet wt)
Amaranthaceae (beet, chard)	7	0.0071	0.0545	0.0221
Amaryllidaceae (onion)	7	0.0049	0.1990	0.0445
Apiaceae (carrot)	1	0.1740	0.1740	0.1740
Asteraceae (lettuce)	3	0.0195	0.0511	0.0384
Brassicaceae (turnip, broccoli, kale, cauliflower, etc.)	8	0.0026	0.1250	0.0384
Cucurbitaceae (squash, cucumber)	20	0.0001	0.1030	0.0200
Fabaceae (bean)	4	0.0023	0.0198	0.0082
Lamiaceae (mint, sage, basil)	8	0.0283	0.5750	0.1623
Solanaceae (tomato, pepper)	39	0.0003	0.0189	0.0041
All samples	97	0.0001	0.5750	0.0304

Notes:
N = sample size; mg/kg wet wt = milligrams arsenic per kilogram produce in wet weight
Samples with estimated (J flagged) concentrations or below the detection limit (U flagged) were set equal to the detection limit provided.
Summary statistics include washed and unwashed, however three unwashed lettuce samples that were able to be identified were removed from the dataset.
Source: Exponent 2004 and associated data table

Table 12: Inorganic arsenic as percent of total arsenic in produce

Food Category	Mean Total As (mg/kg wet wt)	Mean Inorganic As (mg/kg wet wt)	Percent Inorganic
Vegetable	**0.0054**	**0.0028**	**51**
Beans (green)	0.0021	0.0012	61
Carrots	0.0073	0.0039	54
Corn (kernel)	0.0016	0.0011	72
Cucumber	0.0096	0.0041	43
Lettuce	0.0014	0.0015	104
Onions	0.0096	0.0033	34
Peas	0.0043	0.0045	103
Potatoes	0.0028	0.00082	29
Spinach	0.0051	0.0061	119
Tomato	0.0099	0.00092	9
Fruit	**0.0062**	**0.0029**	**47**
Apple, raw	0.0048	0.0018	37
Apple, juice	0.0076	0.0028	38
Banana	0.0023	0.00065	28
Grapes	0.01	0.0037	36
Grape juice	0.014	0.0093	66
Orange	0.0016	0.0025	153
Orange juice	0.0048	0.002 U	21
Peaches	0.0034	0.0023	67
Watermelon	0.0067	0.0021	32

Notes:
mg/kg wet wt = milligrams arsenic per kilogram produce in wet weight
Sample size of four for each food
Source: Schoof et al 1999a

Table 13: Subset of Middleport samples analyzed for inorganic arsenic

Vegetable	Total As (mg/kg dry wt)	Inorganic As (mg/kg dry wt)	Percent Inorganic
Broccoli	0.0606	0.0341	56
Carrot	1.96	1.88	96
Cucumbers	1.49	1.05	70
Cucumbers	0.953	0.604	63
Cucumbers	0.632	0.557	88
Cucumbers	0.461	0.442	96
Green Tomato	0.0302	0.0122	40
Lettuce	3.31	2.56	77
Lettuce	1.92	1.51	79
Lettuce	1.61	1.15	71
Onion	0.806	0.507	63
Radish	1.36	0.939	69
Sage	2.93	2.85	97
Sage	2.48	1.31	53
Summer squash	0.967	0.977	101
Tomato	0.0469	0.0263	56
Zucchini	0.149	0.0829	56
Source: Exponent 2004 and associated data table			

Table 14: Comparison of arsenic in raw and cooked vegetables

Vegetable	Preparation	Total (mg/kg wet wt)	Inorganic (mg/kg wet wt)	Percent Inorganic	Ratio of iAs cooked to iAs raw
Exposed					
asparagus	raw	0.081	0.065	80	0.22
	cooked in distilled water (boiling)	0.029	0.014	48	
beans	raw	0.022	0.023	105	0.26
	cooked in distilled water (boiling)	0.007	0.006	86	
cauliflower	raw	0.014	0.01	71	0.40
	cooked in distilled water (boiling)	0.007	0.004	57	
chard	raw	0.266	0.187	70	0.33
	cooked in distilled water (boiling)	0.099	0.061	62	
spinach	raw	0.121	0.087	72	0.44
	cooked in distilled water (boiling)	0.05	0.038	76	
Protected					
maize	raw	0.152	0.11	72	0.64
	cooked in distilled water (boiling)	0.089	0.07	79	
pumpkin	raw	0.004	0.003	75	1.0
	cooked in distilled water (boiling)	0.004	0.003	75	
Root					
beetroot	raw	0.168	0.16	95	0.26
	cooked in distilled water (boiling)	0.05	0.042	84	
carrot	raw	0.138	0.128	93	0.29
	cooked in distilled water (peeling and boiling)	0.038	0.037	97	
garlic	raw	0.03	0.03	100	0.90
	cooked in distilled water (boiling)	0.028	0.027	96	
onion	raw	0.067	0.075	112	1.0
	cooked in distilled water (boiling)	0.074	0.072	97	
potatoes	raw	0.021	0.024	114	0.17
	cooked in distilled water (peeling and boiling)	0.004	0.004	100	

Notes:
mg/kg wet wt = milligrams arsenic per kilogram produce in wet weight; iAs = inorganic arsenic
Each of the values shown in the table is the mean of three replicates.
Source of cooked concentration: Diaz et al 2004; source of raw concentration: Muñoz et al 2002.

Table 15: Mean per capita intake of homegrown produce for consumers who garden in the Northeast

Type	Intake Rate (g/kg-day)[a]	Percent of Middleport Dataset [b]
Exposed Vegetables	0.28	86
Exposed Fruits	0.03	0
Protected Vegetables	0.06	0
Root Vegetables	0.06	14
Total	0.43	

Notes:
a. grams of produce consumed per kilogram body weight per day, adapted from Exposure Factors Handbook as described in Section 3.4.3 (Moya and Phillips 2001, USEPA 2011)
b. percent of each type of produce sample collected in Middleport gardens, from Exponent 2004 and associated data table

Table 16: Cancer risks for current users

Property	Ingestion	Inhalation	Dermal	Total CR
Recreational User (combined child and adult)				
R2a	8E-07	8E-10	2E-07	1E-06
R2f	6E-07	6E-10	1E-07	8E-07
Background	6E-07	6E-10	1E-07	7E-07
Agricultural Worker				
R2b	2E-07	2E-09	5E-08	3E-07
R2c	2E-07	2E-09	5E-08	3E-07
R2d	2E-07	1E-09	4E-08	2E-07
Background	2E-07	2E-09	5E-08	3E-07
Trespasser				
R2e	6E-08	2E-11	4E-09	7E-08
Background	4E-08	9E-12	3E-09	4E-08

Table 17: Cancer risks for future residents (combined child and adult)

Property	Ingestion	Homegrown Produce	Inhalation	Dermal	Risk Combined
R2b	3E-06	5E-06	5E-09	2E-07	8E-06
R2c	3E-06	5E-06	5E-09	2E-07	9E-06
R2d	2E-06	5E-06	4E-09	2E-07	8E-06
R2f	3E-06	5E-06	4E-09	2E-07	8E-06
Background	3E-06	5E-06	5E-09	2E-07	9E-06

Table 18: Hazard quotients for current users

Property	Ingestion	Inhalation	Dermal	Hazard Index
Recreational User - Child				
R2a	0.008	1E-08	0.002	0.01
R2f	0.006	1E-08	0.001	0.008
Background	0.006	9E-09	0.001	0.007
Recreational User - Adult				
R2a	0.001	1E-08	0.0003	0.002
R2f	0.001	1E-08	0.0002	0.001
Background	0.0009	9E-09	0.0002	0.001
Agricultural Worker				
R2b	0.001	8E-08	0.0003	0.002
R2c	0.001	7E-08	0.0003	0.002
R2d	0.001	6E-08	0.0003	0.001
Background	0.001	7E-08	0.0003	0.002
Trespasser				
R2e	0.001	2E-09	0.0001	0.001
Background	0.001	1E-09	0.00005	0.001

Table 19: Hazard quotients for future residents

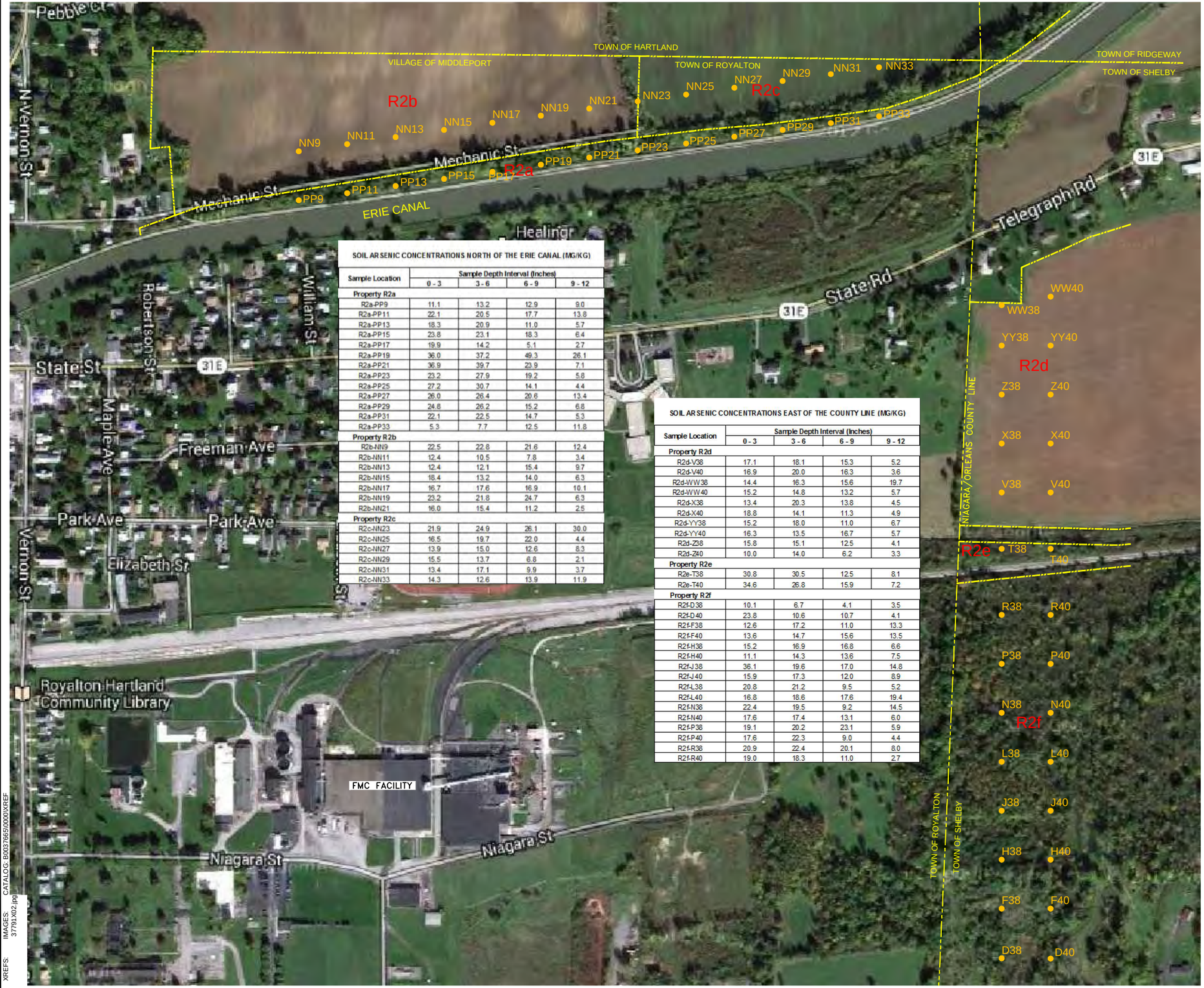
Property	Ingestion	Homegrown Produce	Inhalation	Dermal	Hazard Index
Future Resident - Child					
R2b	0.06	0.03	4E-08	0.003	0.1
R2c	0.07	0.03	5E-08	0.003	0.1
R2d	0.05	0.03	3E-08	0.002	0.08
R2f	0.06	0.03	4E-08	0.003	0.09
Background	0.07	0.03	5E-08	0.003	0.1
Future Resident - Adult					
R2b	0.002	0.03	7E-08	0.0002	0.03
R2c	0.003	0.03	8E-08	0.0002	0.03
R2d	0.002	0.03	6E-08	0.0002	0.03
R2f	0.002	0.03	7E-08	0.0002	0.03
Background	0.003	0.03	8E-08	0.0002	0.03

Table 20: Concentrations of arsenic from EFSA for food category "vegetables, nuts, and pulses"

Food Subgroup	N	<LOD[a]	Type	P5[b]	Median[b]	Mean[b]	P95[b]	Max[b]	SAF
Vegetable soups	22	59%	LB	0.0000	0.0000	0.0050	0.0220	0.0260	1.0%
			UB	0.0007	0.0045	0.0110	0.0500	0.0500	
Leafy vegetables	1232	58%	LB	0.0000	0.0000	0.0162	0.0560	1.0000	21%
			UB	0.0030	0.0100	0.0235	0.0580	1.0000	
Mushrooms	710	57%	LB	0.0000	0.0000	0.0611	0.1200	19.200	2.0%
			UB	0.0030	0.0145	0.0699	0.1200	19.200	
Fresh herbs	367	41%	LB	0.0000	0.0070	0.0254	0.1300	0.5375	1.0%
			UB	0.0039	0.0130	0.0310	0.1300	0.5375	
Brassica vegetables	849	74%	LB	0.0000	0.0000	0.0029	0.0220	0.1530	13%
			UB	0.0009	0.0070	0.0108	0.0300	0.1530	
Pulses (legumes)	523	73%	LB	0.0000	0.0000	0.0062	0.0200	0.3430	13%
			UB	0.0011	0.0100	0.0153	0.0500	0.3430	
Nuts	572	86%	LB	0.0000	0.0000	0.0079	0.0400	0.4440	1.0%
			UB	0.0070	0.0200	0.0363	0.1140	0.4440	
Other vegetables and vegetable products	1643	70%	LB	0.0000	0.0000	0.0106	0.0300	0.5600	22%
			UB	0.0010	0.0100	0.0192	0.0500	0.5600	
Root vegetables	656	74%	LB	0.0000	0.0000	0.0044	0.0210	0.1280	16%
			UB	0.0030	0.0100	0.0145	0.0400	0.1280	
Stem vegetables	272	89%	LB	0.0000	0.0000	0.0103	0.0500	0.4000	4.0%
			UB	0.0030	0.0100	0.0211	0.1000	0.4000	
Oilseeds	528	57%	LB	0.0000	0.0000	0.0450	0.1480	5.7000	4.0%
			UB	0.0076	0.0295	0.0643	0.1500	5.7000	
Dried vegetables	203	5.40%	LB	0.0000	0.2600	0.3347	0.7840	4.9000	2.0%
			UB	0.0300	0.2600	0.3363	0.7840	4.9000	
Vegetables, nuts, pulses except soups	7555	66%	LB	0.0000	0.0000	0.0262	0.1050	19.200	99%
			UB	0.0015	0.0100	0.0367	0.1140	19.200	
Total for vegetables, nuts, pulses	7577	66%	LB	0.0000	0.0000	0.0261	0.1050	19.200	100%
			UB	0.0015	0.0100	0.0366	0.1140	19.200	

Notes:
N: number of samples; LOD: limit of detection; LB: lower bound (values below the detection limit set equal to zero); UB: upper bound (values below the detection limit set equal to the detection limit); P5: 5th percentile; P95: 95th percentile; Max: maximum; SAF: sampling adjustment factor
The number of figures after the decimal point is the same for all food categories and does not reflect significant figures for each reported value. If N<130 then the calculated P95 should be considered only as an indicative value due to limited number of data (EFSA, 2008a).
a. <LOD: indicates the percentage of results below the LOD or the limit of quantification.
b. milligrams arsenic per kilogram vegetable in wet weight
Source: (European Food Safety Authority 2009)

FIGURES



SOIL ARSENIC CONCENTRATIONS NORTH OF THE ERIE CANAL (MG/KG)

Sample Location	Sample Depth Interval (Inches) 0 - 3	3 - 6	6 - 9	9 - 12
Property R2a				
R2a-PP9	11.1	13.2	12.9	9.0
R2a-PP11	22.1	20.5	17.7	13.8
R2a-PP13	18.3	20.9	11.0	5.7
R2a-PP15	23.8	23.1	18.3	6.4
R2a-PP17	19.9	14.2	5.1	2.7
R2a-PP19	36.0	37.2	49.3	26.1
R2a-PP21	36.9	39.7	23.9	7.1
R2a-PP23	23.2	27.9	19.2	5.8
R2a-PP25	27.2	30.7	14.1	4.4
R2a-PP27	26.0	26.4	20.6	13.4
R2a-PP29	24.8	26.2	15.2	6.8
R2a-PP31	22.1	22.5	14.7	5.3
R2a-PP33	5.3	7.7	12.5	11.8
Property R2b				
R2b-NN9	22.5	22.8	21.6	12.4
R2b-NN11	12.4	10.5	7.8	3.4
R2b-NN13	12.4	12.1	15.4	9.7
R2b-NN15	18.4	13.2	14.0	6.3
R2b-NN17	16.7	17.6	16.9	10.1
R2b-NN19	23.2	21.8	24.7	6.3
R2b-NN21	16.0	15.4	11.2	2.5
Property R2c				
R2c-NN23	21.9	24.9	26.1	30.0
R2c-NN25	16.5	19.7	22.0	4.4
R2c-NN27	13.9	15.0	12.6	8.3
R2c-NN29	15.5	13.7	6.8	2.1
R2c-NN31	13.4	17.1	9.9	3.7
R2c-NN33	14.3	12.6	13.9	11.9

SOIL ARSENIC CONCENTRATIONS EAST OF THE COUNTY LINE (MG/KG)

Sample Location	Sample Depth Interval (Inches) 0 - 3	3 - 6	6 - 9	9 - 12
Property R2d				
R2d-V38	17.1	18.1	15.3	5.2
R2d-V40	16.9	20.0	16.3	3.6
R2d-WW38	14.4	16.3	15.6	19.7
R2d-WW40	15.2	14.8	13.2	5.7
R2d-X38	13.4	20.3	13.8	4.5
R2d-X40	18.8	14.1	11.3	4.9
R2d-YY38	15.2	18.0	11.0	6.7
R2d-YY40	16.3	13.5	16.7	5.7
R2d-Z38	15.8	15.1	12.5	4.1
R2d-Z40	10.0	14.0	6.2	3.3
Property R2e				
R2e-T38	30.8	30.5	12.5	8.1
R2e-T40	34.6	26.8	15.9	7.2
Property R2f				
R2f-D38	10.1	6.7	4.1	3.5
R2f-D40	23.8	10.6	10.7	4.1
R2f-F38	12.6	17.2	11.0	13.3
R2f-F40	13.6	14.7	15.6	13.5
R2f-H38	15.2	16.9	16.8	6.6
R2f-H40	11.1	14.3	13.6	7.5
R2f-J38	36.1	19.6	17.0	14.8
R2f-J40	15.9	17.3	12.0	8.9
R2f-L38	20.8	21.2	9.5	5.2
R2f-L40	16.8	18.6	17.6	19.4
R2f-N38	22.4	19.5	9.2	14.5
R2f-N40	17.6	17.4	13.1	6.0
R2f-P38	19.1	20.2	23.1	5.9
R2f-P40	17.6	22.3	9.0	4.4
R2f-R38	20.9	22.4	20.1	8.0
R2f-R40	19.0	18.3	11.0	2.7

LEGEND:

APPROXIMATE PROPERTY BOUNDARY

R2a PROPERTY IDENTIFICATION

2009 SOIL SAMPLE LOCATION

NOTES:

1. ALL LOCATIONS AND PROPERTY BOUNDARIES SHOWN ARE APPROXIMATE AND SUBJECT TO VERIFICATION.
2. PROPERTY IDENTIFICATION NUMBERS SHOWN ARE NOT RELATED TO STREET ADDRESS OR TAX PARCEL ID.
3. ARSENIC CONCENTRATIONS ARE THE ARITHMETIC AVERAGE OF ALL PRIMARY, DUPLICATE AND SPLIT SAMPLE RESULTS FOR EACH SAMPLE AND ARE PRESENTED IN MILLIGRAMS PER KILOGRAM (MG/KG); EQUIVALENT TO PARTS PER MILLION (PPM).

0 200' 400'
GRAPHIC SCALE

FMC CORPORATION - MIDDLEPORT, NEW YORK
AIR DEPOSITION AREA 2 (OU-3)

SOIL SAMPLING LOCATIONS AND ARSENIC CONCENTRATIONS

ARCADIS

FIGURE 1

CITY: SYRACUSE, NY DIV/GROUP: ENV/IM-DV DB: P. LISTER LD: P. LISTER PM/TM: T. YOUNG TR: D. WRIGHT LYRON=*;OFF=REF, (FR2)
G:\ENVCAD\SYRACUSE\ACTIB\03779\100\000\000001\DWG\ADA237791C01.dwg LAYOUT: 1 SAVED: 10/10/2014 10:03 AM ACADVER: 18.1S (LMS TECH) PAGESETUP: ----
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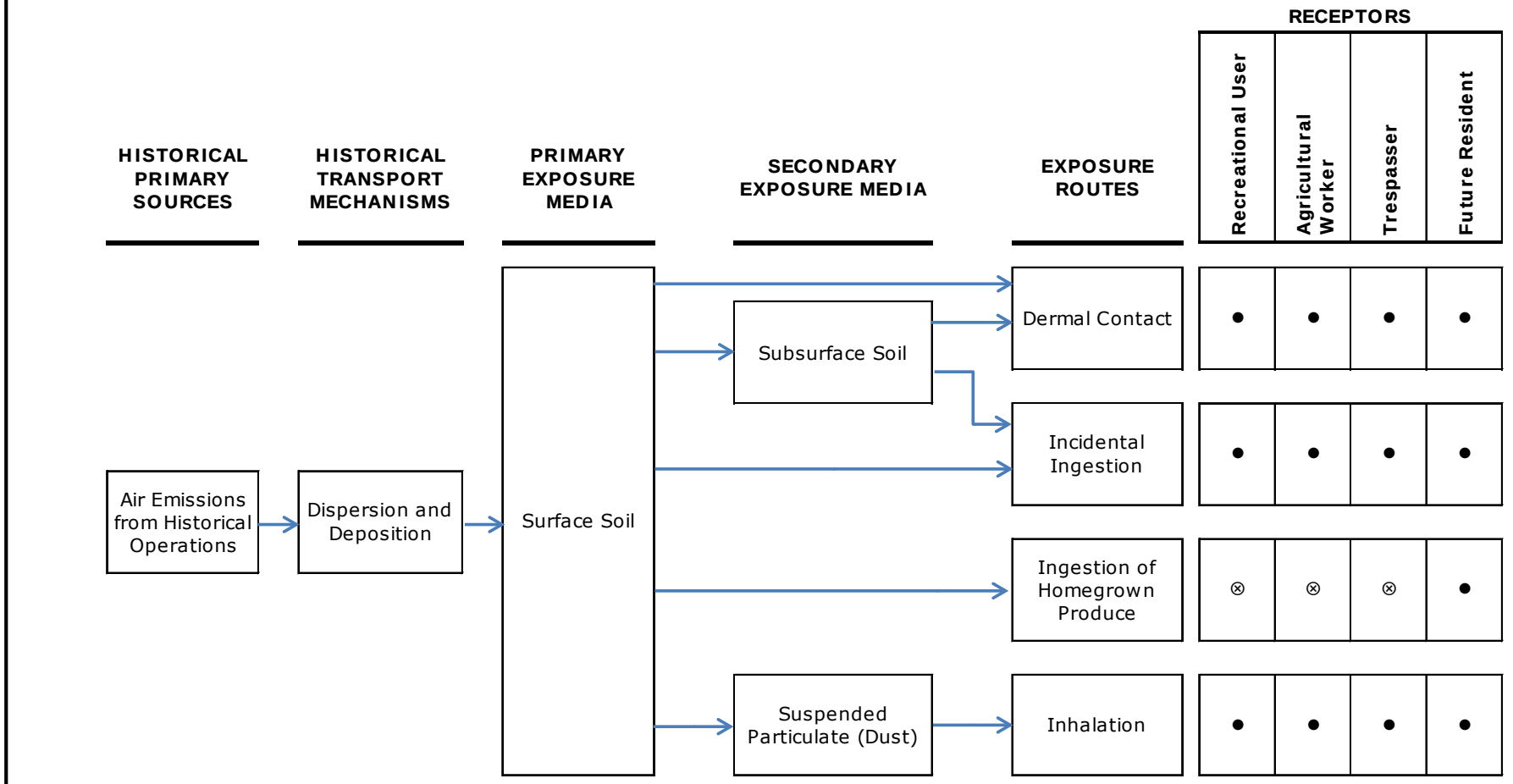

RAMBOLL ENVIRON

Figure 2:
Current conceptual site model for Air Deposition Area 2

ATTACHMENT A: SCREENING HUMAN HEALTH RISK ASSESSMENT, SUSPECTED AIR DEPOSITION STUDY AREA 2

DRAFT

Screening Human Health Risk Assessment

Suspected Air Deposition Study Area 2
Operable Unit 3 (OU-3)
FMC Corporation
Middleport, New York

Prepared for:
FMC Corporation

Prepared by:
ENVIRON International Corporation
Seattle, Washington

Date:
October 2014

Project Number:
30-29872A

ENVIRON

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Acronyms and Abbreviations

95UCL:	95% upper confidence limit
AOC:	administrative order on consent
CAO:	corrective action objective
CMS:	corrective measures study
CSF:	cancer slope factor
CSM:	conceptual site model
CTE:	central tendency exposure
EF:	exposure frequency
ET:	exposure time
EPC:	exposure point concentration
FMC:	FMC Corporation
HHRA:	human health risk assessment
LADD:	lifetime average daily dose
NYSDEC:	New York State Department of Environmental Conservation
NYSDOH:	New York State Department of Health
OU-3:	operable unit 3
PEF:	particulate emission factor
RCRA:	resource conservation and recovery act
RBA:	relative oral bioavailability
RfD:	reference dose
RFI:	RCRA facility investigation
RME:	reasonable maximum exposure
SCO:	soil cleanup objective
USEPA:	United States Environmental Protection Agency

1 Introduction

FMC Corporation (FMC) owns and operates an agricultural products formulating facility located in the Village of Middleport and the Town of Royalton, New York ("Facility" or "Site"). FMC has entered into an Administrative Order on Consent (AOC; Docket No. II RCRA-90-3008(h)-0209, effective July 2, 1991) with the New York State Department of Environmental Conservation (NYSDEC) and the United States Environmental Protection Agency (USEPA) (jointly, "the Agencies") concerning releases of hazardous waste and hazardous constituents at the Facility. The AOC includes requirements to undertake a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) and, if determined to be necessary by the Agencies, a Corrective Measures Study (CMS). In 2005, FMC and the Agencies agreed that FMC should proceed to implement investigative, monitoring and remedial programs under the AOC using an "operable unit" or "study area" approach, consistent with Section VI.3.d. of the AOC.

The Suspected Air Deposition Study Area 2 (Air Deposition Area 2, Figure 1), also identified by the NYSDEC as Operable Unit 3 (OU-3), is one of the Middleport RCRA Facility study areas. An RFI report for Air Deposition Area 2 submitted in 2012 (Arcadis 2012) was accepted by the Agencies. The Agencies subsequently requested that a CMS be conducted to address the presence of FMC-related arsenic in Air Deposition Area 2 soil. A draft CMS work plan was submitted to the Agencies on July 17, 2014 (Arcadis 2014).

This document provides a deterministic screening level human health risk assessment (HHRA) for Air Deposition Area 2. The purpose of this HHRA is to determine if any parcel within Air Deposition Area 2 needs to progress to a CMS. The HHRA was performed in consideration of relevant USEPA risk assessment guidance and recommendations, including the use of site-specific data for some exposure assumptions, as available and appropriate.

1.1 Corrective Action Objectives (CAOs)

This screening HHRA has been conducted according to the March 26, 2009 Corrective Action Objectives (CAOs) for public health issued by NYSDEC. The pertinent CAO is quoted below:

> *To protect human health and the environment relative to FMC-related contamination, in accordance with, and/or in consideration of, applicable, or relevant and appropriate laws, rules and guidance, using site-specific data and information, supported by multiple lines of evidence, including site-specific risk assessment, and based on current and reasonably anticipated future land use(s). Reasonably anticipated future land uses will be identified in consultation with the community.*
>
> *A. Achieve unrestricted use (i.e., without the need for institutional or engineering controls) of current and reasonably anticipated future residential properties within these study areas.*
>
> *B. Reduce and manage potential human health risks associated with FMC-related contaminants in soil and sediment, keeping in mind that risk is a function of contaminant concentration and routes, likelihood of exposure, and other factors, such that:*

- *Excess human health carcinogenic risks are reduced such that the lifetime excess cancer risks fall within the range appropriate for residential communities (i.e., 10^{-4} to 10^{-6});*

- *Human health non-carcinogenic risks are reduced such that non-cancer risks do not exceed the level appropriate for residential communities (i.e., Hazard Index ≤ 1.0); and*

- *The "point of departure", or starting point for corrective action risk-management decisions pertaining to arsenic in soil, is the site-specific residential background considering site-specific histories of use for current and reasonably anticipated future residential properties within these study areas.*

1.2 Description of Air Deposition Area 2 (OU-3) Properties Evaluated

As described in detail in Arcadis (2012 and 2014), Air Deposition Area 2 includes six properties/areas located farther north and east of Air Deposition Area 1 (OU-2), north of the Erie Canal and east of the Niagara/Orleans county line. Current and historical uses of the six properties/areas are summarized below:

Property ID	Current Use	Historical Use
R2a	Towpath and strip of trees/brush	Towpath and strip of trees/brush
R2b	Agricultural field	Agricultural field (orchard in 1930s)
R2c	Agricultural field	Agricultural field
R2d	Agricultural field	Agricultural field
R2e	Wooded land	Wooded land
R2f	Wooded land	Agricultural field

Air Deposition Area 2 soil samples were collected and analyzed for arsenic. Samples were collected from the 0- to 3-inch, 3- to 6-inch, 6- to 9-inch, and 9- to 12-inch depth intervals below surface grade on an approximate 200-foot grid. The Agencies determined that the available data were sufficient to estimate the horizontal and vertical extent of Site-related arsenic in Air Deposition Area 2 soil with respect to a delineation criterion of 20 mg/kg (weighted 95th percentile concentration calculated in the 2001-2003 Gasport background study). The RFI data include arsenic results for 216 soil samples collected from 54 locations within the six properties/areas (see Figure 1). The property/area-specific soil arsenic concentration statistics (from Table 5.1 of RFI Report Volume X, and reproduced in the CMS work plan) are provided in Table 1.

Table 1: Soil Arsenic Data Summary				
Property	Number of Samples	Soil Arsenic Concentration (mg/kg)		
		Maximum	Average (0-3”)	Average (0-12”)
R2a	52	49	23	19
R2b	28	25	17	14
R2c	24	30	16	15
R2d	40	20	15	13
R2e	8	35	33	21
R2f	64	36	18	14

The Agencies determined that no further action was needed at RFI Property R2d (Arcadis 2014). In addition, the CMS work plan states that FMC will not further evaluate Property R2e in the CMS because the observed arsenic concentrations are not consistent with air deposition from the Facility and are more consistent with other historical uses of this parcel. Thus, properties R2a, R2b, R2c and R2f were evaluated in the CMS, and are included in this screening HHRA.

1.3 Document Organization

In addition to this introduction, this document includes the following sections:

- Section 2 – Problem Formulation
- Section 3 – Exposure Assessment
- Section 4 – Toxicity Assessment
- Section 5 – Risk Characterization
- Section 6 – References

2 Problem Formulation

The primary outcome of problem formulation is development of a conceptual model for the Site that characterizes the ways people might be exposed to contaminants of potential concern. As part of this development process, pertinent exposure scenarios are evaluated to identify potentially complete pathways. Data quality and adequacy are also evaluated. This section of the HHRA provides an overview of the exposure pathway screening analysis, followed by a summary of the data used in the HHRA and the data screening process employed to update the conceptual site model (CSM).

2.1 Conceptual Site Model and Pathway Screening

As noted above, arsenic is the only Facility-related constituent to be assessed in the Air Deposition Area 2 CMS. Soil is the only exposure medium being evaluated. Current land uses and activities, as well as possible future uses vary by property. Current and future uses of Property R2a are limited to recreational activities along the canal towpath. Properties R2b and R2c are currently used for agricultural cultivation, and could possibly have future residential use. Property R2f is currently open wooded land that could have current passive recreational use and possible future residential use. Thus, exposure scenarios were developed for recreational use (R2a and R2f), agricultural use (R2b and R2c) and future residential use (R2b, R2c, and R2f). Exposure routes and receptor populations of potential concern for arsenic in Air Deposition Area 2 are shown in the current CSM (Figure 2).

2.1.1 Recreational Use

For property R2a recreational users along the towpath may include both adults and children. Recreational users of property R2f are likely to be limited to older children or adults (either owners or others trespassing on this private property). Incidental ingestion of surface soil is the primary complete exposure pathway and is quantified in this HHRA. Exposures due to inhalation of resuspended soil and dermal contact with surface soil are expected to be negligible (Integral 2011) and are assessed qualitatively. Exposure of recreational users to shallow subsurface soil is not expected to occur.

2.1.2 Agricultural Use

Agricultural workers at properties R2b and R2c are adults exposed to surface soil during routine field activities with periodic potential exposure to shallow subsurface soil due to tilling and digging. Incidental ingestion of soil is the primary exposure pathway during routine field work, with inhalation of resuspended soil (representing a mixture of surface and shallow subsurface soil) being increased during tilling or digging activities. Both of these pathways are assessed quantitatively. Exposure from dermal contact is expected to be negligible and is assessed qualitatively.

2.1.3 Future Residential Use

For future residents of properties R2b, R2c, and R2f, incidental ingestion of surface soil is the primary complete exposure pathway quantified. Exposures due to inhalation of resuspended soil and dermal contact with surface soil are expected to be negligible (Integral 2011) and are

assessed qualitatively. Exposure to shallow subsurface soil may also occur, but is expected to be of low significance relative to exposure to surface soil.

2.2 Data Summary and Exposure Point Concentrations

Exposure potential for surface soil is expected to be greater than for subsurface soil due to more frequent contact with soil at the surface than with subsurface soil. For Air Deposition Area 2 soil, surface soil exposure to arsenic will also be higher due to the presence of higher arsenic concentrations near the surface than in deeper soil as shown in Table 2. Soil samples collected from the 0- to 6-inch depth interval are typically considered to be surface soil. Mean arsenic concentrations for the 0- to 3-inch and 3- to 6-inch sample intervals (Table 2) suggest little difference across the 0- to 6-inch depth horizon. Paired, two-tail t-tests run for each property confirm there is no statistically significant difference between arsenic concentrations in the 0- to 3-inch and 3- to 6-inch interval samples for Air Deposition Area 2.[1] Therefore, results for each interval were averaged to estimate arsenic soil concentrations for a 0- to 6-inch surface soil depth horizon prior to use in the HHRA. Additionally, for conservatism, arsenic concentrations in surface soil (i.e., samples collected from within the 0- to 6-inch depth horizon) are used to assess risks for both surface and shallow subsurface soil exposures. Use of surface soil data will overestimate potential risks from direct exposures to shallow subsurface soil or shallow subsurface soil mixed with surface soil.

Table 2: Soil Arsenic Concentrations by Depth Interval

Property	Depth Interval (inches)	N	Minimum (mg/kg)	Maximum (mg/kg)	Mean (mg/kg)
R2a	0-3	13	5	37	23
	3-6	13	9	40	24
	6-9	13	5	49	18
	9-12	13	3	26	9
R2b	0-3	7	12	23	17
	3-6	7	11	24	17
	6-9	7	8	25	16
	9-12	7	3	12	7
R2c	0-3	6	13	23	16
	3-6	6	13	25	17
	6-9	6	7	26	15
	9-12	6	2	30	10
R2f	0-3	16	10	36	18
	3-6	16	7	22	17
	6-9	16	4	23	13
	9-12	16	3	19	9

[1] At each property, p-values from the t-test were greater than 0.2

Each property within Air Deposition Area 2 is considered a separate exposure area in this HHRA. Exposure point concentrations (EPCs) for each area are intended to provide a representative estimate of the arsenic concentration to which an individual may be exposed within each area. Average exposure by the individual is assumed to occur randomly over the defined exposure area. USEPA recommends that the 95% upper confidence limit (95UCL) of the arithmetic mean be used to represent the EPC (USEPA 1992).

USEPA's software application, ProUCL v4.0 (USEPA 2007) was used to calculate 95UCL values for this HHRA. A number of factors, including the number of available data points, the shape of the distribution of the values, and the degree of censoring (e.g., samples below the detection limit) are considered in determining which mathematical approach is most appropriate for 95UCL calculation of a data set (USEPA 2002a). The ProUCL software includes several different strategies to calculate a 95UCL from the data set and recommends a preferred value based on the properties of the input dataset. EPC results are shown in Table 3.

Table 3: Exposure Point Concentrations by Location for 0-6 Depth Interval

Property	N	Percent Detected	Minimum (mg/kg)	Maximum (mg/kg)	Mean (mg/kg)	95% UCL (mg/kg)[a]
R2a	13	100	7.0	38	24	28
R2b	7	100	11	24	17	20
R2c	6	100	13	24	17	20
R2f	16	100	8.4	28	18	20

[a]95% Student's-t UCL

As discussed above, surface soil EPCs are conservatively used for all exposure calculations in this HHRA, including shallow subsurface exposure pathways.

Site-specific house dust arsenic concentration data were collected from 96 homes in Middleport in the summer and fall of 2003 (Tsuji et al. 2005). Tsuji et al. (2005) also collected soil sample arsenic concentration data from a majority of the homes for which residents consented to house dust sampling. The authors found that arsenic in soil appeared to contribute little to arsenic in house dust and that house dust arsenic concentrations were not correlated with average or maximum soil arsenic concentrations. Therefore, in the Air Deposition Area 2 HHRA, hypothetical future house dust arsenic concentrations were assumed to be similar to background house dust arsenic concentrations. Tsuji et al. (2005) reported that the geometric mean soil concentration was higher than the dust (20.6 and 10.8 mg/kg, respectively). For this screening HHRA, dust concentrations are conservatively assumed to be the same as soil arsenic concentrations.

3 Exposure Assessment

Population differences will exist in the level of exposure at a specific location due to differences in intake rates, body weights, exposure frequencies, and exposure durations. Because of this, a wide range of average daily intake values usually exist among members of the exposed population. Daily intake calculations must specify which part of the range of doses is being estimated. This attention is usually focused on 'average' intakes or intakes near the center of the range, called the central tendency exposure (CTE), or intakes that are near the upper end of the range, also known as the reasonable maximum exposure (RME). Both are used in the screening HHRA. CTE parameters utilize intake variables that represent the typical or average exposure, while RME parameters use a combination of intake variables that are averages and reasonable maximum estimates to most accurately calculate the upper bound of exposure. Values for children (0-6 years of age) and adults are utilized to more accurately portray exposure parameter differences between age groups.

Exposure assumptions used in this HHRA are based on a combination of values presented in USEPA guidance and NYSDEC and New York State Department of Health (NYSDOH) guidance, site-specific studies, and professional judgment. The assumptions selected are also discussed in relation to the exposure assumptions used in the soil cleanup objectives (SCOs) developed for the New York State brownfield cleanup program (as presented in NYSDEC and NYSDOH 2006). Arsenic exposures are calculated using factors that incorporate scenario- and receptor-specific exposure assumptions. For the Air Deposition Area 2 the receptors evaluated are child and adult recreational users and future residents, and adult agricultural workers. The exposure pathways quantified are incidental ingestion of arsenic in soil and house dust, and for the agricultural worker only, arsenic in soil resuspended during soil cultivation activities.

A site-specific study (Roberts et al. 2007) was used to identify values for the relative oral bioavailability (RBA) of arsenic ingested in a soil matrix compared with the dosing regimen used in the toxicity study on which the cancer slope factor is based. Exposure by dermal contact was not quantified based on the findings of Lowney et al. (2007) of negligible dermal absorption of arsenic from soil. Results of a biomonitoring study conducted among Middleport residents (Tsuji et al. 2005) documented an absence of influence of soil arsenic on urine arsenic concentrations, or on house dust and home grown produce concentrations. Selection of values for exposure frequency (EF) and duration were based on consideration of data from a regional office of the National Weather Service and USEPA guidance, as well as the data sources relied upon for derivation of the SCOs.

3.1 Incidental Ingestion of Soil and Dust

Soil exposure occurs primarily from incidental ingestion of soil, and in the case of residential exposures, from indoor dust with tracked in soil. The average daily dose from incidental ingestion of soil and dust is calculated with Equation 1, consistent with USEPA guidance (USEPA 1989).

Equation 1: Average Daily Dose from Ingestion of Soil and Dust

$$A_{ing} \quad \frac{C_{soil} \quad IR_s \quad R\,A \quad EF \quad E}{AT}$$

Where:

ADD_{ing}	= average daily dose from ingestion of soil (mg/kg_{BW}-day)
C_{soil}	= chemical concentration in soil (mg/kg_{soil})
IR_s	= soil ingestion rate (kg_{soil}/day)
EF	= exposure frequency (days/year)
ED	= exposure duration (years)
RBA	= relative oral bioavailability of arsenic in soil (unitless)
AT	= averaging time (days)
BW	= body weight (kg_{BW})

For cancer, the average daily dose is combined for children and adults to represent chronic exposure that occurs over a lifetime (Equation 2).

Equation 2: Lifetime Average Daily Dose from Ingestion of Soil and Dust

$$LA_{ing} \quad \frac{C_{soil} \quad R\,A \quad \left(\frac{EF_c \quad E_c \quad IR_c}{c} \quad \frac{EF_a \quad E_a \quad IR_a}{a}\right)}{AT}$$

Where:

$LADD_{ing}$	= lifetime average daily dose from ingestion of soil (mg/kg_{BW}-day)
IR_c	= child soil ingestion rate (kg_{soil}/day)
EF_c	= child exposure frequency (days/year)
ED_c	= child exposure duration (years)
BW_c	= child body weight (kg_{BW})
IR_a	= adult soil ingestion rate (kg_{soil}/day)
EF_a	= adult exposure frequency (days/year)
ED_a	= adult exposure duration (years)
BW_a	= adult body weight (kg_{BW})

Exposure factors are provided in Tables 4 through 6 and the basis for the values is discussed further below.

Table 4: Recreational Receptor Exposure Parameters

Exposure Parameter	Units	Child Recreational User		Adult Recreational User	
		CTE	RME	CTE	RME
Exposure Duration (ED)	years	2	6	9	20
Body Weight (BW)	kg	15		80	
Averaging Time, Non Cancer (AT_{NC})	days	730	2190	3285	7300
Averaging Time, Cancer (AT_C)	days	25550			
Ingestion Exposure Parameters					
Soil Ingestion Rate (IR_S)	mg/day	20	56	10	28
Exposure Frequency (EF)	days/year	62		62	
Oral Relative Bioavailability (RBA)	unitless	0.22			

Table 5: Agricultural Worker Exposure Parameters

Exposure Parameter	Units	Agricultural Worker	
		CTE	RME
Exposure Duration (ED)	years	6.6	25
Body Weight (BW)	kg	80	
Averaging Time, Non Cancer (AT_{NC})	days	2409	9125
Averaging Time, Cancer (AT_C)	days	25550	
Ingestion Exposure Parameters			
Soil Ingestion Rate (IR_S)	mg/day	50	100
Exposure Frequency (EF)	days/year	62	
Oral Relative Bioavailability (RBA)	unitless	0.22	

Table 6: Future Resident Exposure Parameters					
Exposure Parameter	**Units**	**Child Future Resident**		**Adult Future Resident**	
		CTE	**RME**	**CTE**	**RME**
Exposure Duration (ED)	years	2	6	9	20
Body Weight (BW)	kg	15		80	
Averaging Time, Non Cancer (AT_{NC})	days	730	2190	3285	7300
Averaging Time, Cancer (AT_C)	days	25550			
Ingestion Exposure Parameters					
Soil Ingestion Rate (IR_S)	mg/day	45	124	22.5	62
Exposure Frequency (EF)	days/year	291		291	
Oral Relative Bioavailability (RBA)	unitless	0.22			

Exposure Frequency

Exposure frequency (EF) describes how many days per year someone may have contact with soil in a typical one-year period. Values for EF can vary by receptor, scenario, and different exposure pathways within a scenario.

For the Air Deposition Area 1 HHRA, several approaches were considered to determine estimates of days when people might contact residential soil. Both snow cover and frozen ground were considered. One inch of snow cover was selected as a reasonable estimate of snow cover that would limit soil exposures. The National Weather Service (2008) provides data on the number of days per year, from the years 1950 to 2005, that various depths of snow remained on the ground in Buffalo, New York[2]. For the site-specific deterministic analyses, the mean value (291 days/year) was selected for both CTE and RME as a measure of surface soil EF per year. This same EF value was applied in this screening HHRA for Air Deposition Area 2.

In developing NYSDEC SCOs for residents, NYSDEC and NYSDOH (2006) also considered that outdoor soil ingestion occurs only during the warmer months of the year. Based on the latest date of the first fall frost (after November 10) and the earliest date of the last spring frost (before April 10) in southern New York State counties, NYSDEC and NYSDOH assumed that outdoor soil ingestion will occur during a 31-week period between early April and early November. Incorporating additional assumptions that residents do not go outside during inclement weather and for time spent away from home, NYSDEC and NYSDOH derived soil exposure frequencies of 155 days/year for children and 62 days/year for adults. The time spent outside is likely to be more limited in Niagara County than in the southern counties assessed by NYSDEC and NYSDOH. The EF assumption of 291 days/year used in this screening HHRA for the child and adult future resident is higher than the assumptions used in the SCO derivation.

[2] Buffalo, New York is the nearest city to Middleport for which National Weather Service data are available.

In this HHRA the EF for the child and adult recreational user is assumed to be 62 days/year, which is two days per week during the 31-week period between early April and early November when NYSDEC and NYSDOH assumed that outdoor soil ingestion will occur.

For the agricultural worker EF is assumed to be 62 days/year, the same as the SCO assumption for adult soil EF. This equates to two days per week during the 31-week period between early April and early November when agricultural activities might be routinely be conducted.

Exposure Duration

Exposure duration represents the number of years a person could have contact with the exposure medium. The age range for child receptors is defined as 1 to 6 years based on peak soil ingestion rates. Default exposure durations of 2 years for the CTE and 6 years for the RME case (USEPA 1993) are used. For adult exposures, the default values of 9 and 20 years are used for CTE and RME, respectively (USEPA 1993; USEPA 2014). These assumptions are applied to both the recreational user and future resident. For the SCOs, NYSDEC and NYSDOH assumed a 70 year total exposure duration for cancer risks. For non-cancer risks, the exposure duration and averaging time cancel each other out, so there is no difference between the assumptions in this HHRA and the SCOs.

The USEPA (2014) default exposure duration for an outdoor worker is 25 years, which is considered to be an RME case. This assumption is the same as that used for the SCOs. The median occupational tenure of 6.6 years from all workers was chosen to represent the CTE case (USEPA 2011).

Body Weight

The body weight parameter represents the mass (in kg) of the receptor being evaluated. The default child body weight value of 15 kg (USEPA 2002b) is used for both the CTE and RME cases. The EPA default body weight value of 80 kg (USEPA 2014) is used to assess risks in adults (CTE and RME). These values are slightly different than (and more current than) the assumptions used in the SCOs of 13.3 kg for a child and 70 kg for an adult[3].

Averaging Time

The averaging time is the period over which an exposure is averaged. When evaluating noncarcinogenic effects, contaminant intakes are averaged over the exposure duration, so the noncancer averaging time is a function of the exposure duration (exposure duration multiplied by 365 days). When evaluating carcinogenic effects, contaminant intakes are averaged over a full lifetime (70 years or 25,550 days) to be consistent with the way cancer slope factors are derived.

[3] The SCOs use 70 kg for an adult for the non-cancer risks and 69.3 kg for cancer risks.

Soil Ingestion Rate

Incidental soil ingestion rates for direct exposures to soil vary based on several factors, including the following:

- Frequency of an individual's hand-to-mouth behaviors
- Seasonal climate conditions that affect availability of soil (e.g., snow cover)
- Type of groundcover at the exposure location (e.g., grass versus bare ground)
- Amount and type of outdoor activity
- Individual personal hygiene practices (e.g., frequency of hand washing).

Of these factors, the frequency of an individual's hand-to-mouth behaviors is considered a primary determinant of soil intake. Studies have found that the frequent hand-to mouth behaviors typical of young children increase the potential for ingestion of soil that adheres to hands. Although fewer studies of adult soil ingestion have been published, hand-to-mouth activities in adults are considered much less frequent than in children. For this reason, risk assessment guidance typically recommends soil ingestion rates that are higher for children than for adults, and young children are evaluated separately in risk assessments.

The HHRA for Air Deposition Area 1 included a detailed discussion of the basis for deriving soil ingestion rates. Since that HHRA was issued several new studies have been published that support alternate assumptions. For the purposes of this screening HHRA; however, the Air Deposition Area 1 HHRA assumptions are used for residents. For the child RME resident, the 95th percentile value from Stanek et al. (2001b) of 124 mg/day was used. For the CTE child, the 50th percentile value of 45 mg/day is used. For the adult resident, the soil ingestion rate is assumed to be half that of the child soil ingestion rate, with an RME of 62 mg/day and a CTE of 22.5 mg/day.

The SCO soil ingestion assumptions are applied differently than the standard EPA HHRA approach, with the SCOs incorporating the EF into the average soil ingestion rate, and also adjusting indoor dust intake to reflect only the portion of dust that is derived from soil. Specifically, NYSDEC and NYSDOH (2006) assume that a child ingests 80 mg/day of soil from outdoors on days spent outdoors, and 40 mg/day of soil tracked into the home every day. Assuming that the child is outside 155 days/year (5 days per week during the 217 days from early April to early November) yields an average daily soil ingestion rate of 74 mg/day. This value is lower than the 124 mg/day value used in this HHRA, but when the higher EF is considered (i.e., 291 days/year assumed in this HHRA vs. 155 days/year assumed for the SCOs), the effective soil ingestion rates are similar. For the SCOs adult residents are assumed to ingest 100 mg/day of soil 2 days/week during 217 days/year for a daily ingestion rate of 17 mg/day.

Current human health risk assessment guidance (USEPA 2014) recommends default soil ingestion rates of 100 mg/day for outdoor workers, which was applied to the agricultural worker

RME and half that value (i.e., 50 mg/day) was used for the CTE. The RME value is consistent with the SCO assumption prior to adjustments for EF.

Oral Relative Bioavailability

For practical reasons, toxicity tests are usually designed using water soluble forms of metals in dosing media such as diet or water. The bioavailability of metals in soil, on the other hand, can vary depending on such factors as the following:

- Form of the chemical present (e.g., oxidation state or molecular composition)
- Physical form in the soil (e.g., encapsulation of a mineral within a soil particle)
- Length of time the chemical has been present in soil (aging or weathering)
- Soil characteristics (e.g., fraction organic carbon, pore size).

A RBA factor accounts for differences in the bioavailability of a metal in the exposure medium, which is soil in the case of incidental soil and dust ingestion exposures, relative to the dosing medium used in the critical toxicity study that is the basis for the toxicity value. It can be calculated as follows:

$$\text{R A} \quad \frac{\text{absorbed fraction from soil}}{\text{absorbed fraction from dosing medium used in to ic ity study}} \quad 00$$

The RBA is typically less than one because the most bioavailable form of a metal is commonly used in toxicity studies. This analysis used the site-specific mean value of 0.22 for all receptors, based on data obtained from a study of RBA of arsenic in Middleport soil administered to male Cynomolgus monkeys (Exponent 2007 and Roberts et al. 2007). A portion of each of three Middleport soil samples of varying concentrations was administered to five monkeys, and a mean and standard deviation for RBA were reported for each of the Middleport samples.

3.2 Inhalation of Resuspended Soil

Equation 3 and 4 are used to estimate the agricultural worker's inhalation e pos ure to arsenic-containing particulate in air that originates from arsenic in soil.

Equation 3: Average Daily Dose from Inhalation of Soil-Derived Dust in Air

$$EC_{inh} \quad \frac{C_{air} \quad ET \quad EF \quad E}{AT \quad CF}$$

Where:

EC_{inh} = exposure concentration from inhalation of soil ($\mu g/m^3$)

C_{air} = concentration in air ($\mu g/m^3$) (from Equation 4)

ET = exposure time (hours/day)

EF = exposure frequency (days/year)

ED = exposure duration (years)

AT = averaging time (days)

CF = conversion factor (24 hours/days)

Data for the concentration of arsenic in air are not available from OU3. The concentration in air was estimated using Equation 4.

Equation 4: Concentration in Air from Fugitive Dust

$$C_{air} \quad C_{soil} \quad PEF \quad CF$$

Where:

C_{air} = concentration in air ($\mu g/m^3$)

C_{soil} = concentration in soil (mg/kg)

PEF = particulate emission factor (kg/m^3)

CF = conversion factor (1000 µg/mg)

General exposure parameters such as the exposure duration (6.6 years for CTE, 25 years for RME), and averaging time (exposure duration multiplied by 365 days per year for non-cancer and 25,550 days for cancer) were the same as those assumed for the agricultural worker's soil ingestion exposure.

Inhalation Exposure Frequency (EF)

Exposure frequency for inhalation is assumed to be 10 days/year, given the limited duration of tilling and cultivation activities.

Inhalation Exposure Time (ET)

The default ET for the agricultural worker is 8 hours per day, the length of a standard work day (USEPA 2014).

Particulate Emissions Factor (PEF)

USEPA (2002b) publishes default particulate emission factor (PEF) values for different U.S. climatic zones. OU3 is located within zone VII, which includes the cities of Chicago, Illinois, Cleveland, Ohio, Harrisburg, Pennsylvania, and Huntington, West Virginia. The default PEF for Cleveland, Ohio (950,330,944 m^3/kg) was used as a surrogate for a site-specific PEF for Middleport, NY.

4 Toxicity Assessment

The toxicity assessment provides an overview of toxicity values selected for estimating the risk of adverse health effects from chemical exposures and summarizes toxicity information from governmental health authorities and in peer-reviewed publications. Toxicity values for carcinogenic and noncarcinogenic health effects have been developed for many chemicals by government agencies, including USEPA, the U.S. Agency for Toxic Substances and Disease Registry, and some state agencies. These toxicity values are numerical expressions of chemical dose and response, and vary based on factors such as route of exposure (e.g., oral, inhalation, or dermal) and duration of exposure. The toxicity assessment includes a description of procedures used to identify toxicity values and the critical studies that form the basis for them. Some of the key methodological issues, assumptions, and uncertainties that underlie the toxicity information also are provided.

In addition to providing recommended toxicity values, the toxicity assessment provides a description of the forms and behavior of the chemical in the environment and in the human body (called toxicokinetics) and a summary of toxicity information. This includes a discussion of carcinogenic and noncarcinogenic systemic effects such as neurological effects, and reproductive and developmental effects.

Arsenic is the only chemical of concern in this HHRA. A detailed toxicity assessment was provided in the HHRA for Air Deposition Area 1 (Integral 2011). The arsenic toxicity values have not changed since that HHRA was conducted. USEPA is in the process of conducting an updated toxicity assessment for arsenic, but revised toxicity values are not anticipated to be released until early 2016.

4.1 Cancer Effects

Arsenic is classified by the USEPA as a human carcinogen. Sufficient data exist to show that lung cancer mortality increases with arsenic inhalation and skin and internal organ cancers increase in populations exposed to high concentrations of arsenic in drinking water. The oral slope factor is 1.5 $(mg/kg\text{-}day)^{-1}$ based on skin cancer. The inhalation unit risk factor is 0.0043 per $\mu g/m^3$ based on lung cancer.

4.2 Non-Cancer Effects

The non-cancer oral reference dose for arsenic is 0.0003 mg/kg-day. This value was derived from a critical effect based on human chronic oral exposure resulting in hyperpigmentation and keratosis (Tseng 1977; Tseng et al. 1968). An uncertainty factor of three was used due to a lack of reproductive toxicity data and uncertainty in whether the NOAEL is protective of all sensitive individuals. A subchronic oral reference dose (RfD) for arsenic of 0.005 mg/kg-day developed by Tsuji et al. (2005) is applicable for child exposures, but was not used in this screening HHRA.

USEPA does not provide an inhalation reference concentration for arsenic. However, California EPA has derived a reference exposure level of 0.015 $\mu g/m^3$ based on a critical effect of decreased intellectual function in children (Wasserman et al. 2004; Tsai et al. 2003).

5 Risk Characterization

To characterize risks related to arsenic exposure, estimated intakes calculated in the exposure assessment and the toxicity values are combined to yield numerical estimates of potential health risk for both carcinogenic and noncarcinogenic endpoints. This phase of a risk assessment also involves interpreting and qualifying the derived risk estimates and the associated uncertainty. For recreational users and future residents, long-term exposure as both a child and an adult was assumed for the evaluation of cancer and non-cancer risks. For agricultural workers, all exposure was assumed to have occurred as an adult.

5.1 Cancer

A cancer risk estimate derived using standard risk assessment methods is characterized as the excess probability that an individual will develop cancer during his or her lifetime due to exposure to site-related chemicals in the specific exposure scenario evaluated. The term "e ce ss" reflects the fact that the calculated risk associated with site-related exposures is in addition to background cancer risk experienced by all individuals in the course of daily life. In this document, this risk is referred to as the "total" excess lifetime cancer risk.

Excess lifetime cancer risks for ingestion exposure pathways are typically calculated by multiplying the daily contaminant intake, or lifetime average daily dose (LADD), by the contaminant-specific oral cancer slope factor (CSF), as shown in Equation 5. The oral CSF for arsenic is 1.5 $(mg/kg\text{-}day)^{-1}$. The inhalation unit risk factor for arsenic is 0.0043 $(\mu g/m^3)^{-1}$.

Equation 5: Cancer Risk Calculation

CR LA S F

Where:

CR	= excess lifetime cancer risk associated with exposure to contaminant via the specified exposure route (unitless)
LADD	= estimated lifetime average daily dose of contaminant via the specified exposure route (mg/kg_{BW}-day)
SF	= cancer slope factor ($(mg/kg_{BW}\text{-}day)^{-1}$)

The discussion of risk results focuses on key risk levels within EPA's acceptable risk range: i n 1,000,000 (10^{-6}), 1 in 100,000 (10^{-5}), and 1 in 10,000 (10^{-4}).

Because there are risks associated with arsenic in soil due to background conditions in addition to FMC activities, comparison between the contribution from FMC activities and background conditions is a critical issue in understanding the potential risk reduction associated with any remedial actions that might be undertaken at the site. This risk difference is termed the "incremental" risk and reflects the risks currently present in the study areas above background conditions. In the HHRA for Air Deposition Area 1, both total and incremental excess lifetime

cancer risks for the study areas were calculated. This distinction is not made in this screening risk assessment, but risks are also presented for the NYSDEC-specified Middleport background soil arsenic delineation criterion of 20 mg/kg (listed as “ ac kground” in Tables 7, 8 and 0) .

Cancer risks for RME and CTE recreational users are all less than 1E-06, with RME risks for property R2a and R2f of 7E-07 and 5E-07, and CTE risks of 8E-08 and 6E-08, respectively (Table 7). Cancer risks from soil ingestion for RME and CTE agricultural workers on property R2b or R2c are also below 1E-06 (RME risks of 5E-07 for both properties) (Table 8). Cancer risks from inhalation of resuspended soil are orders of magnitude below 1E-06 (Table 9). Cancer risks for a RME future resident of property R2b, R2c, or R2f are 5E-06, which is the same as the risk associated with the background delineation criterion. CTE risks are 6E-07 for R2b and R2c and 7E-07 for R2a (Table 10).

Table 7: Cancer Risks for Recreational User from Soil Ingestion

Property	EPC (mg/kg)	Child + Adult Recreational User	
		CTE	RME
R2a	28	8E-08	7E-07
R2f	20	6E-08	5E-07
Background	20	6E-08	5E-07

Table 8: Cancer Risks for Agricultural Worker from Soil Ingestion

Property	EPC (mg/kg)	CTE	RME
R2b	20	7E-08	5E-07
R2c	20	7E-08	5E-07
Background	20	7E-08	5E-07

Table 9: Cancer Risks for Agricultural Worker from Soil Inhalation

Property	EPC (µg/m^3)	CTE	RME
R2b	2.1E-05	8E-10	8E-10
R2c	2.1E-05	8E-10	8E-10

Table 10: Cancer Risks for Future Resident from Soil Ingestion			
Property	EPC (mg/kg)	Child + Adult Future Resident	
		CTE	RME
R2b	20	7E-07	5E-06
R2c	20	6E-07	5E-06
R2f	20	6E-07	5E-06
Background	20	6E-07	5E-06

5.2 Non-Cancer

A noncarcinogenic health risk is typically calculated as a simple ratio of the intake from site exposures to the level determined to be without any risk of adverse effects, such as the RfD. This ratio is referred to as the hazard quotient. If receptors are exposed to contaminant levels less than or equal to the RfD (hazard quotient less than or equal to 1), no adverse health effects are expected. Exposures above an RfD (hazard quotient greater than 1) do not mean that adverse human health effects are certain to occur, but rather that further evaluation is appropriate. The non-cancer hazard quotient is calculated using the average daily dose of the chemical and the RfD, as shown in Equation 6.

Equation 6: Non-Cancer Hazard Quotient Calculation

$$\frac{A}{Rf}$$

Where:

HQ = hazard quotient associated with exposure to contaminant via the specified exposure route (unitless)

ADD = estimated average daily dose of contaminant via the specified exposure route (mg/kg_{BW}-day)

RfD = reference dose (mg/kg_{BW}-day)

The chronic oral RfD for arsenic of 0.0003 mg/kg-day was used in calculations for the adult plus child recreational user and future resident, and adult agricultural worker. The inhalation reference exposure level of 0.015 $\mu g/m^3$ was used in the agricultural worker inhalation risk calculations.

All RME and CTE hazard quotients were less than one, indicating a lack of non-cancer risks.

Table 11: Hazard Quotients for Recreational User from Soil Ingestion					
Property	EPC (mg/kg)	Child Recreational User - Chronic		Adult Recreational User - Chronic	
		CTE	RME	CTE	RME
R2a	28	0.005	0.01	0.0004	0.001
R2f	20	0.003	0.01	0.0003	0.001
Background	20	0.003	0.01	0.0003	0.001

Table 12: Hazard Quotients for Agricultural Worker from Soil Ingestion			
Property	EPC (mg/kg)	CTE	RME
R2b	20	0.002	0.003
R2c	20	0.002	0.003
Background	20	0.002	0.003

Table 13: Hazard Quotients for Agricultural Worker from Soil Inhalation			
Property	EPC (µg/m^3)	CTE	RME
R2b	2.1E-05	1E-05	1E-05
R2c	2.1E-05	1E-05	1E-05

Table 14: Hazard Quotients for Future Resident from Soil Ingestion					
Property	EPC (mg/kg)	Child Future Resident - Chronic		Adult Future Resident - Chronic	
		CTE	RME	CTE	RME
R2b	20	0.04	0.1	0.003	0.01
R2c	20	0.03	0.1	0.003	0.01
R2f	20	0.03	0.1	0.003	0.01
Background	20	0.04	0.1	0.003	0.01

5.3 Summary and Conclusions

Excess lifetime cancer risks from soil ingestion for current recreational and agricultural users were less than 1 x 10^{-6} using RME assumptions for all properties evaluated. Inhalation risks for agricultural workers inhaling resuspended soil were orders of magnitude less than 1 x 10^{-6}. Risks from dermal contact were not quantified, but are negligible. The SCOs based on dermal exposure are approximately ten times higher than the SCOs based on oral exposure. Using the more recent and site-specific data of Lowney et al. (2007), dermal risks are so low they cannot be estimated accurately.

For the three properties with potential future residential uses (R2b, R2c and R2f), excess lifetime cancer risks from soil ingestion for the RME future resident are 5 x 10^{-6}. This estimate is based on an assumption that soil ingestion occurs far more frequently than assumed in the derivation of the SCOs. Furthermore, risk estimates associated with the NYSDEC-specified background soil concentration are the same as those for these properties.

For all properties and all scenarios, noncancer risks were well below 1.0, indicating an absence on noncancer health risks.

Based on the results of this screening HHRA, property R2a does not have risks greater than 1 x 10^{-6}, a finding that means there is no need to evaluate the property further in the CMS. For properties R2b, R2c and R2f, risks associated with the most contact intensive possible future use (i.e., residential development) fall within the range appropriate for residential communities, as specified by the CAOs, and were not higher than risks associated with the background delineation criterion. Consequently, none of those properties need to be evaluated further in the CMS.

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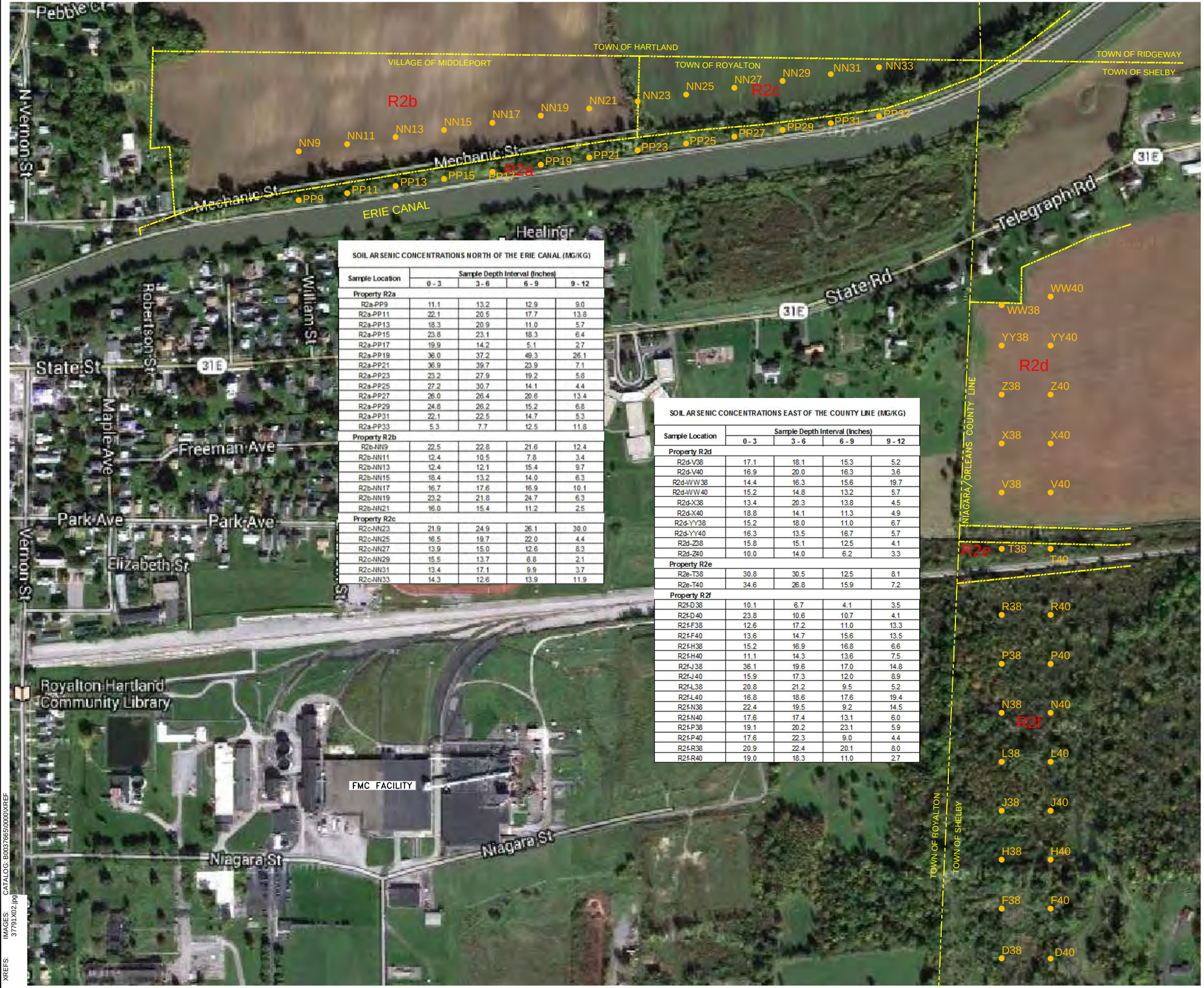
Figures



SOIL ARSENIC CONCENTRATIONS NORTH OF THE ERIE CANAL (MG/KG)

Sample Location	Sample Depth Interval (Inches) 0 - 3	3 - 6	6 - 9	9 - 12
Property R2a				
R2a-PP9	11.1	13.2	12.9	9.0
R2a-PP11	22.1	20.5	17.7	13.8
R2a-PP13	18.3	20.9	11.0	5.7
R2a-PP15	23.8	23.1	18.3	6.4
R2a-PP17	19.9	14.2	5.1	2.7
R2a-PP19	36.0	37.2	49.3	26.1
R2a-PP21	36.9	39.7	23.9	7.1
R2a-PP23	23.2	27.9	19.2	5.8
R2a-PP25	27.2	30.7	14.1	4.4
R2a-PP27	26.0	26.4	20.6	13.4
R2a-PP29	24.8	26.2	15.2	6.8
R2a-PP31	22.1	22.5	14.7	5.3
R2a-PP33	5.3	7.7	12.5	11.8
Property R2b				
R2b-NN9	22.5	22.8	21.6	12.4
R2b-NN11	12.4	10.5	7.8	3.4
R2b-NN13	12.4	12.1	15.4	9.7
R2b-NN15	18.4	13.2	14.0	6.3
R2b-NN17	16.7	17.6	16.9	10.1
R2b-NN19	23.2	21.8	24.7	6.3
R2b-NN21	16.0	15.4	11.2	2.5
Property R2c				
R2c-NN23	21.9	24.9	26.1	30.0
R2c-NN25	16.5	19.7	22.0	4.4
R2c-NN27	13.9	15.0	12.6	8.3
R2c-NN29	15.5	13.7	6.8	2.1
R2c-NN31	13.4	17.1	9.9	3.7
R2c-NN33	14.3	12.6	13.9	11.9

SOIL ARSENIC CONCENTRATIONS EAST OF THE COUNTY LINE (MG/KG)

Sample Location	Sample Depth Interval (Inches) 0 - 3	3 - 6	6 - 9	9 - 12
Property R2d				
R2d-V38	17.1	18.1	15.3	5.2
R2d-V40	16.9	20.0	16.3	3.6
R2d-WW38	14.4	16.3	15.6	19.7
R2d-WW40	15.2	14.8	13.2	5.7
R2d-X38	13.4	20.3	13.8	4.5
R2d-X40	18.8	14.1	11.3	4.9
R2d-YY38	15.2	18.0	11.0	6.7
R2d-YY40	16.3	13.5	16.7	5.7
R2d-Z38	15.8	15.1	12.5	4.1
R2d-Z40	10.0	14.0	6.2	3.3
Property R2e				
R2e-T38	30.8	30.5	12.5	8.1
R2e-T40	34.6	26.8	15.9	7.2
Property R2f				
R2f-D38	10.1	6.7	4.1	3.5
R2f-D40	23.8	10.6	10.7	4.1
R2f-F38	12.6	17.2	11.0	13.3
R2f-F40	13.6	14.7	15.6	13.5
R2f-H38	15.2	16.9	16.8	6.6
R2f-H40	11.1	14.3	13.6	7.5
R2f-J38	36.1	19.6	17.0	14.8
R2f-J40	15.9	17.3	12.0	8.9
R2f-L38	20.8	21.2	9.5	5.2
R2f-L40	16.8	18.6	17.6	19.4
R2f-N38	22.4	19.5	9.2	14.5
R2f-N40	17.6	17.4	13.1	6.0
R2f-P38	19.1	20.2	23.1	5.9
R2f-P40	17.6	22.3	9.0	4.4
R2f-R38	20.9	22.4	20.1	8.0
R2f-R40	19.0	18.3	11.0	2.7

LEGEND:

APPROXIMATE PROPERTY BOUNDARY

R2a PROPERTY IDENTIFICATION

2009 SOIL SAMPLE LOCATION

NOTES:

1. ALL LOCATIONS AND PROPERTY BOUNDARIES SHOWN ARE APPROXIMATE AND SUBJECT TO VERIFICATION.
2. PROPERTY IDENTIFICATION NUMBERS SHOWN ARE NOT RELATED TO STREET ADDRESS OR TAX PARCEL ID.
3. ARSENIC CONCENTRATIONS ARE THE ARITHMETIC AVERAGE OF ALL PRIMARY, DUPLICATE AND SPLIT SAMPLE RESULTS FOR EACH SAMPLE AND ARE PRESENTED IN MILLIGRAMS PER KILOGRAM (MG/KG); EQUIVALENT TO PARTS PER MILLION (PPM).

0 200' 400'
GRAPHIC SCALE

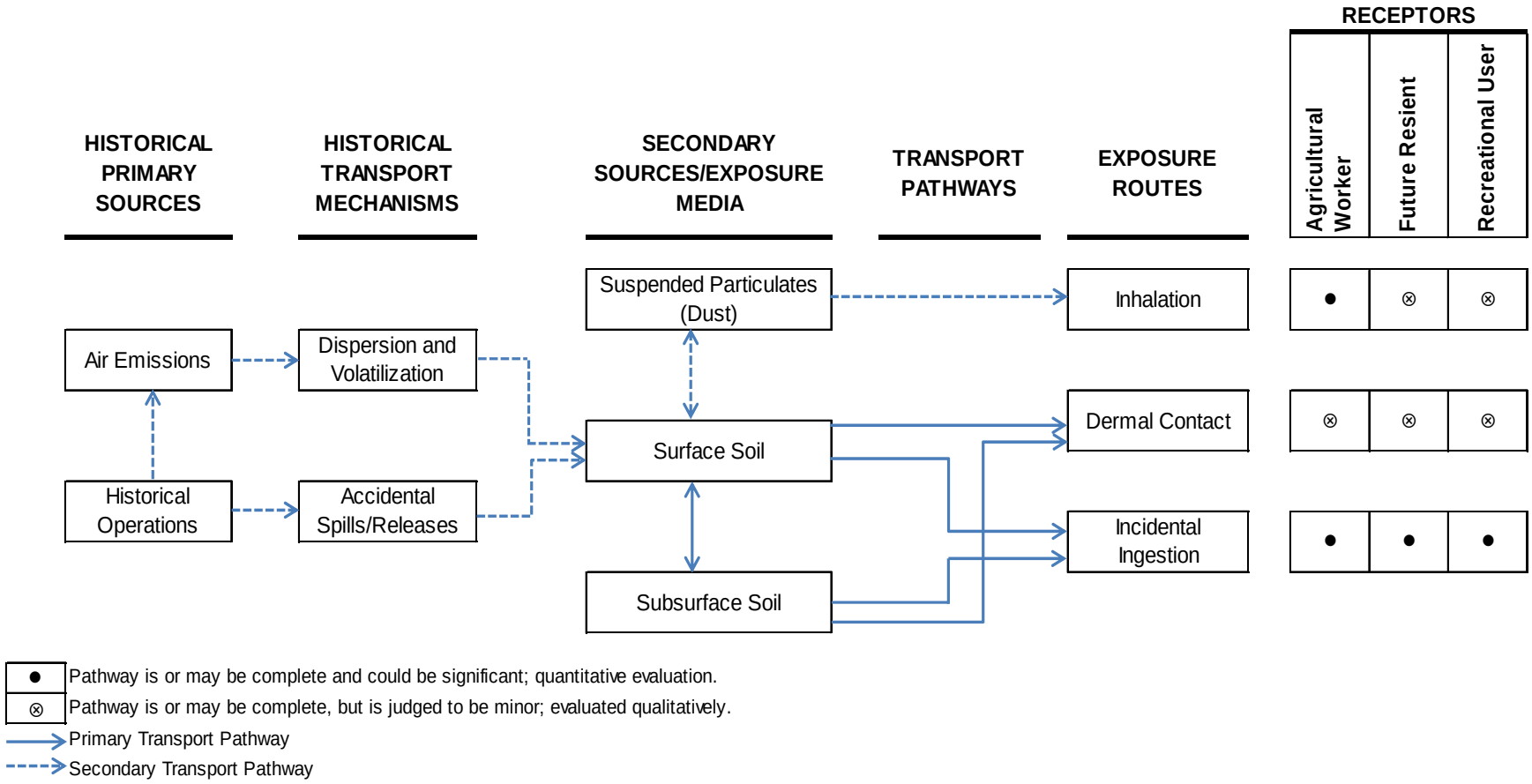
FMC CORPORATION - MIDDLEPORT, NEW YORK
AIR DEPOSITION AREA 2 (OU-3)

SOIL SAMPLING LOCATIONS AND ARSENIC CONCENTRATIONS

ARCADIS

FIGURE 1

CITY: SYRACUSE, NY DIV/GROUP: ENV/IM-DV DB: P. LISTER LD: P. LISTER PM/TM: T. YOUNG TR: D. WRIGHT LYRON=*;OFF=REF, (FR2)
G:\ENVCAD\SYRACUSE\ACTIB\03779\100\000\000001\DWG\ADA237791C01.dwg LAYOUT: 1 SAVED: 10/10/2014 10:03 AM ACADVER: 18.1S (LMS TECH) PAGESETUP: ----
XREFS: IMAGES: CATALOG: B0037665\0000\XREF
37791X02.jpg PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 10/10/2014 10:04 AM BY: POSENAUER, LISA



ENVIRON

Figure 2:
Current Conceptual Site Model for Air Deposition Area 2

ATTACHMENT B: RESPONSES TO AGENCIES' COMMENTS ON THE SCREENING HUMAN HEALTH RISK ASSESSMENT

Responses to Agency Comments on the
Screening Human Health Risk Assessment (HHRA) For Suspected Air Deposition Study Area 2 (Operable Unit 3),
Prepared for the FMC Corporation by ENVIRON International Corporation

FMC Corporation (FMC) submitted a RCRA Facility Investigation (RFI) Report for Operable Unit 3 (OU-3) in 2012 (Arcadis 2012). The New York State Department of Environmental Conservation (NYSDEC) and the United States Environmental Protection Agency (USEPA) (collectively referred to as "Agencies"), in consultation with the New York State Department of Health (NYSDOH), accepted the RFI Report and requested that FMC submit a Corrective Measures Study (CMS) Work Plan for OU-3 to address the presence of FMC-related arsenic in OU-3 soil. A draft CMS work plan was submitted to the Agencies on July 17, 2014 (Arcadis 2014). A screening human health risk assessment (HHRA) for Air Deposition Area 2 was submitted to the Agencies on October 10, 2014. The Agencies and the NYSDOH provided comments on the screening HHRA by letter dated July 16, 2015. The following responds to the July 16th comments.

Exposure Assessment Parameters

Comments: If FMC chooses to revise the HHRA, a more rigorous approach to characterizing the range of potential exposures to children in a residential setting would include an estimate reflecting EPA's generic default exposure parameter values (soil ingestion rate of 200 mg/day and an exposure frequency of 350 days/yr), and would also include exposure parameters used to derive 6 NYCRR Part 375 Soil Cleanup Objectives (SCOs) (DEC/DOH 2006). Further, several parameter values for exposure in the HHRA are inconsistent with methods used to derive the SCOs and/or are not sufficiently justified to support site specific exposure parameters. Below are some examples:

- The exposure duration inputs for adults in the future resident scenario were a central tendency of 9 years and a reasonable maximum exposure (RME) of 20 years. In addition to differing from the lifetime exposure period used to derive the SCOs, it is likely that some current Middleport residents have already exceeded both these values, some by large margins.
- In the agricultural worker scenario, the HHRA assumes this individual only works two days per week over the course of the planting/growing/harvesting season. The document indicates that this input was derived by taking the total number of days of exposure assumed for the adult resident in the SCO technical support document and dividing it by the number of weeks assumed for the season (31). This is an unreasonable approach, given that many farmers are known to work long hours for days on end during the planting/growing/harvesting season. In addition, reference to the SCO technical support document will show that the development of the residential adult exposure scenario that the HHRA links this pathway to, is clearly not intended to represent an agricultural worker.
- The HHRA assumes the inhalation pathway for the worker involves an 8-hour "standard workday" (see page 15), which may not be adequately conservative to represent actual activities during particularly busy times of the season for such workers. Further, the soil ingestion pathway for this worker was evaluated using a value which the HHRA characterizes as the "default" value. However, the HHRA applied this default to the RME component of the scenario, and then arbitrarily used half the default value for the central tendency evaluation.

Responses:

1. Inclusion of risk estimates using EPA's generic default exposure parameter values does not constitute a more rigorous approach. Incorporation of site-specific assumptions into HHRAs is a

more rigorous approach. In fact, as described below, EPA states in its arsenic bioavailability guidance that the default value should not be used when site-specific data are available. For that reason, risk estimates based on EPA's default assumptions have not been derived for the revised OU-3 HHRA.

2. Regarding exposure duration, the intent of EPA's guidance is that the combination of exposure parameters should yield a reasonable maximum exposure estimate. EPA's default assumptions are based on national studies. Nevertheless, the revised OU-3 HHRA includes risk estimates based on the SCO assumptions, including a lifetime exposure.
3. The exposure frequency for the agricultural worker scenario was based on the relatively small size of the fields in each property being evaluated. Further, the study area is small compared to the entire area of land being farmed. For example, the OU-3 portions of R2b and R2c comprise approximately 10 acres of a field, while the entire cultivated field comprises approximately 160 acres, and the same property owner also cultivates an additional approximately 850 acres of contiguous fields. While farmers do work long hours, the fields in the subject properties do not require constant activities. Additional justification for the site-specific exposure frequency has been included in the revised OU-3 HHRA.
4. The revised HHRA applies a 12-hour exposure time to exposure estimates for the agricultural worker. As noted above, these properties are small and represent a small portion of the total acreage cultivated by the property owner, which suggests assuming a 12-hour exposure period is likely to overestimate actual time worked per day. Further, inhalation risk estimates in the screening HHRA were so low that changing the length of time for inhalation will have no effect on the risk estimates.

Bioavailability

Comments: The HHRA uses a relative arsenic bioavailability factor of 22% based on a study that measured bioavailability of arsenic from three Middleport soil samples fed to cynomolgus monkeys (Roberts et al. 2007), but the text does not indicate whether this is intended to represent a central tendency or upper bound estimate. In addition, the gastrointestinal absorption of arsenic from soil is a complex process that is influenced by a variety of factors, including (but not limited to) soil characteristics, the chemical form of arsenic, the concentration of arsenic in soil, the presence of other contaminants, the fasting and nutritional status of the receptor, and the age of the receptor. A more scientifically valid approach would be to use a range of values, including the assumption of 100% bioavailability for arsenic in soil, as well as the US EPA default value of 60% (US EPA 2015).

Responses:

1. The relative bioavailability factor used in the screening HHRA is based on the arithmetic mean of in vivo results (0.19, 0.20, and 0.28) from the three Middleport soil samples. Consistent with EPA guidance, reasonable maximum exposure estimates are derived using a combination of central tendency and upper end estimates for the assumptions. The individual site-specific values used by EPA to derive the default value are mean values. Regarding the influence of other factors on arsenic bioavailability, the factors listed have been considered in the development of the animal models and study design. Fasting status and age of receptor are not critical factors affecting arsenic absorption (in contrast to absorption of lead for which these factors are important). Use of site samples assures that the applicable chemical form of arsenic has been tested, and that the influence of other contaminants is also accounted for (while noting that other contaminants were not found to be present at significant concentrations in site soil). The soil samples were selected to represent a range of soil arsenic concentrations present in site soils (339 – 1000

mg/kg). Although these concentrations are higher than those in OU-3, in vitro bioaccessibility measurements for these samples and those with lower arsenic concentrations were comparable. Details of the study were previously provided as Attachment 8 to the HHRA for Air Deposition Area 1 (Integral and ENVIRON 2011).

2. In contrast to DEC's comment, the most scientifically valid approach is to use applicable site-specific data. The EPA default value of 60% (US EPA 2014) is based on a comprehensive analysis of the results of many studies. EPA concluded that the default of 60% is more scientifically valid than an assumption of 100%. Specifically, EPA states:

> "Based on the above considerations, the TRW Bioavailability Committee recommends a default value for RBA of arsenic in soil based on an upper percentile from the data set of arsenic RBAs reported in U.S. EPA (2011). An RBA value of 60% was selected as the default value and is supported by the analysis of soil arsenic RBA estimates which showed that less than 5% of the RBA estimates exceeded 60%. Selection of a default RBA value that is expected to be in the upper percentile range reduces the likelihood that sites are screened out from further evaluation when, in fact, they may present a significant health risk."

Furthermore, EPA specifies that site-specific data should be used in preference to the default value whenever available. Specifically, EPA says:

> "Agency guidance (U.S. EPA, 2007b) recommends that even in cases where sufficient data exist to support default medium-specific absorption factors for a chemical, site-specific data collection may also be important. Important factors that can affect the bioavailability of arsenic in soil can be expected to vary from site to site, or within a given site. These include the chemical forms of the arsenic, as well as the physical and chemical characteristics arsenic-bearing soil particles. Default values for arsenic RBA may not reflect all of these factors (e.g., chemistry, particle size, matrix effects) at any given site. Therefore, site-specific assessments of bioavailability should still be performed where such assessments are deemed feasible and valuable for improving the characterization of risk at the site. **Default RBA values generally should not be used when site-specific assessments are performed**.[*emphasis added*] In general, the Agency (U.S. EPA, 2007b) recommends that efforts be made to collect data that support site-specific estimates, rather than relying on the default value recommended in this memorandum which may not accurately represent arsenic RBA at any specific site. Use of the national default in place of site-specific estimates may underestimate or overestimate risk."

Additional Exposure Pathways

Comments: The HHRA does not evaluate some important exposure pathways. The dermal exposure pathway is dismissed in Sections 2.1.1, 2.2.1 and 2.1.3 (recreational, agricultural and future residential scenarios) without an adequate justification. The potential dermal contribution to total exposure and dose in these scenarios should be properly developed and presented, in the absence of a fully documented technical justification to do otherwise. In addition, residential exposures to arsenic in soil through homegrown fruits and vegetables are not evaluated. Fruits and vegetables grown in arsenic-contaminated soil can take up arsenic (Meharg and Hartley-Whitaker 2002; Zhao et al. 2008). Consumption of homegrown fruits and vegetables can contribute to arsenic exposure, and this pathway should be evaluated.

Responses: The dermal pathway and homegrown produce are included in the revised OU-3 HHRA.

Methods Used to Obtain Exposure Point Concentrations

Comments: We do not agree with the methods used in the HHRA to derive exposure point concentrations. The hypothetical exposure point concentrations were generally limited to 20 parts per million (ppm), a value developed by averaging sampling results from different sampling points and from different sampling intervals (depths). Other than listing them in tables, the document does not address the data above 20 ppm from these parcels. This averaging approach does not adequately consider the potential for exposure to the higher concentrations identified by sampling. Such approaches to evaluating the concentration term fail to recognize the influence of human activity patterns and behaviors on human exposure scenarios that incidental soil ingestion is episodic in nature, and that different individuals may use a property in different ways at different life stages. Exposures and risks are more appropriately evaluated using individual sampling results as inputs. In addition, in Section 2.2 (Data Summary and Exposure Point Concentration), surface soil is defined as the 0-6 inch interval after an analysis was performed noting that there was not a statistical difference between the 0-3 interval and 0- 6 inch interval. However, a common risk assessment practice is to define surface soil as the 0-2 inch interval. Moreover, given that contamination is attributable to air deposition, surficial soil may very well have a higher arsenic concentration than samples from deeper cores. In light of these facts, and the high efficiency and computing power of modern personal computers and software packages that make it a simple matter to evaluate data from separate sampling depths as relevant to various hypothetical exposure scenarios, such merging of results from multiple intervals is both arbitrary and unnecessary.

Responses:

1. The revised OU-3 HHRA follows EPA guidance for calculation of exposure point concentrations (USEPA 1992). In contrast to the Agencies' comment, exposures and risks are **not** more appropriately evaluated using individual sampling results as inputs. The exposure point concentration (EPC) term used in intake estimates is intended to represent the arithmetic average of the concentration that is contacted within a given exposure area over a specified exposure period. Thus, for a hypothetical future resident, we can safely assume that no resident will spend all of their time outdoors at a specific location in their property. Furthermore, soil that is tracked or blown into a home will not be from one location within the property. The suggestion that risks be evaluated for individual sampling results is at odds with good science, as well as accepted risk assessment practices.
2. Consistent with USEPA guidance, the screening HHRA used the 95 percent upper confidence limit on the arithmetic average (95UCLM) for the EPC. The revised OU-3 HHRA also uses the 95UCLM. Because the dataset used in the revised OU-3 HHRA evaluation includes primary field samples, duplicate field samples as well as Agency splits and duplicates, including these individual sample results as individual inputs to the EPC calculation would skew the EPC and resulting intake estimates.
3. Regarding definition of surface soil, common risk assessment practice varies in the interval that is defined as surface soil, with depth intervals of 0- to1-, 0- to 2-, 0- to 3- and 0- to 6-inches being used in various risk assessments. As noted in the comment, the exact interval selected may affect exposure estimates if air deposition has caused the most surficial soils to have higher concentrations. In the case of OU-3 our analysis showed no statistical difference in concentrations between the 0- to 3- and 3- to 6-inch intervals. Based on this finding, use of either 0- to 3- or 0- to 6-inch depths will yield similar exposure estimates, and we have used the 0- to 3-inch interval in the revised HHRA.

4. For hypothetical exposure scenarios assumed to involve contact with soil at multiple depth intervals, averaging depth interval data is neither arbitrary nor unnecessary. For instance, if soils from 0- to 12-inches were relevant to a given exposure scenario, it would be unreasonable to assume that the exposed individual was exposed to each of the four intermediate depth intervals in isolation of the other. This is why risk assessors routinely depth-weight average concentrations at a given sampling location when the sample location relevant to exposure is represented by multiple sample results. The revised OU-3 HHRA has focused on evaluation of exposures to surface soil (defined as 0- to 3-inches as noted above). As discussed above, our analysis found no statistical difference between arsenic soil concentrations in the 0- to 3-inch and 3- to 6-inch depth intervals. Further, arsenic concentrations in soil from deeper than 6 inches were lower than above 6 inches. Therefore, use of soil data from the upper three inches is conservative and will overestimate potential risks from direct exposures to shallow subsurface soils or shallow subsurface soil mixed with surface soil.

Evaluation of Property R2e

Comments: In Section 1.2 (Description of Air Deposition Area), FMC proposes eliminating property R2e from evaluation because the arsenic concentrations "are not consistent with air deposition." The average arsenic concentration in this area is no more than modestly higher than the other areas. No statistical analysis has been performed to support FMC's stance and it should be noted that the average concentration is based on only 8 soil samples compared to sample sizes ranging from 24-64 for the other 5 properties. Property R2e should be carried through the evaluation process.

Response: Property R2e is included in the revised OU-3 HHRA.

References

DEC/DOH (New York State Department of Health/New York State Department of Environmental Conservation). 2006. New York State Brownfield Cleanup Program. Development of Soil Cleanup Objectives. Technical Support Document. September 2006. Accessed (June 23, 2015) on-line at http://www.dec.ny.gov/chemical/34189.html.

Meharg, AA, Hartley-Whitaker, J. 2002. Arsenic uptake and metabolism in arsenic resistant and nonresistant plant species. New Phytologist 154: 29-43.

Roberts, SM, JW Munson, YW Lownery et al. 2007. Relative Oral Bioavailability of Arsenic from Contaminated Soils Measured in the Cynomolgus Monkey. Toxicol. Sci. 95: 281-288.

US EPA (United States Environmental Protection Agency). 2014. Arsenic. Relative Bioavailability Of Arsenic In Soils At 11 Hazardous Waste Sites Using An In Vivo Juvenile Swine Method. Accessed (May 20, 2015) on-line at http://www.epa.gov/superfund/bioavailability/guidance.htm.

Zhao, FJ, JF Ma, A A Meharg, et al. 2008. Arsenic uptake and metabolism in plants. New Phytologist 181: 777-794.

Appendix D

Ecological Risk Assessment

Intended for
FMC Corporation

Date
Draft September 2015

ECOLOGICAL RISK ASSESSMENT SUSPECTED AIR DEPOSITION STUDY AREA 2, OPERABLE UNIT 3

RAMBOLL ENVIRON

ECOLOGICAL RISK ASSESSMENT
OPERABLE UNIT 3

Revision **DRAFT**
Date **September 9, 2015**

Ramboll Environ
901 Fifth Avenue
Suite 2820
Seattle, WA 98164
USA
T +1 206 336 1650
F +1 206 336 1651
www.ramboll-environ.com

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ACRYONYMS AND ABBREVIATIONS

AOC:	Administrative Order on Consent
COC:	constituent of concern
CMA:	corrective measure alternative
CMS:	corrective measure study
Eco-SSL:	ecological soil screening level
EPA:	U.S. Environmental Protection Agency
EcoRA:	ecological risk assessment
FMC:	FMC Corporation
HHRA:	human health risk assessment
NYCRR:	New York Codes, Rules and Regulations
NYNHP:	New York Natural Heritage Program
NYSDEC:	New York State Department of Environmental Conservation
NYSDOH:	New York State Department of Health
OU-3:	Operable Unit 3
RCRA:	Resource Conservation and Recovery Act
RFI:	RCRA facility investigation
UCLM:	95 percent upper confidence limit of the arithmetic mean
USEPA:	United States Environmental Protection Agency
US FWS	United States Fish and Wildlife Service

1. INTRODUCTION

FMC Corporation (FMC) owns and operates an agricultural products formulating facility located in the Village of Middleport and the Town of Royalton, New York ("Facility" or "Site"). FMC has entered into an Administrative Order on Consent (AOC; Docket No. II RCRA-90-3008(h)-0209, effective July 2, 1991) with the New York State Department of Environmental Conservation (NYSDEC) and the United States Environmental Protection Agency (USEPA) (jointly, "the Agencies") concerning releases of hazardous waste and hazardous constituents at the Facility. The AOC includes requirements to undertake a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) and, if determined to be necessary by the Agencies, a Corrective Measures Study (CMS).

The Suspected Air Deposition Study Area 2 (Air Deposition Area 2, Figure 1), also identified by the NYSDEC as Operable Unit 3 (OU-3), is one of the Middleport RCRA Facility study areas. An RFI report for Air Deposition Area 2 submitted in 2012 (ARCADIS 2012) was accepted by the Agencies. The Agencies subsequently requested that a CMS be conducted to address the presence of FMC-related arsenic in Air Deposition Area 2 soil. A draft CMS work plan was submitted to the Agencies on July 17, 2014 (ARCADIS 2014).

The purpose of this ecological risk assessment (EcoRA) report is to present a screening ecological risk assessment regarding FMC-related arsenic in Air Deposition Area 2 soil. This assessment was based on relevant components from the first two steps of the EcoRA process under the Ecological Risk Assessment Guidance for Superfund (USEPA 1997), including comparison to ecological screening benchmarks (ESBs) where applicable. This report relies on the results of the sampling and analyses conducted as part of the RCRA Facility Investigation (RFI) field investigations, summarized in RFI Report Volume X (ARCADIS 2012).

1.1 Site Background

As described in detail in RFI Report Volume X (ARCADIS 2012), Air Deposition Area 2 comprises portion of six properties located beyond Air Deposition Area 1 (OU-2), north of the Erie Canal and east of the Niagara/Orleans county line. Current and historical uses of the six properties/areas are summarized below:

Property ID	Current Use	Historical Use
R2a	Erie Canal towpath trail and strip of trees/brush	Erie Canal towpath trail and strip of trees/brush
R2b	Agricultural field	Agricultural field (orchard in 1930s)
R2c	Agricultural field	Agricultural field
R2d	Agricultural field	Agricultural field
R2e	Wooded land, railroad tracks	Wooded land, railroad tracks
R2f	Wooded land	Agricultural field

Air Deposition Area 2 soil samples were collected and analyzed for arsenic, the only constituent for which site characterization was required (ARCADIS 2012, 2014). Samples were collected from the 0- to 3-inch, 3- to 6-inch, 6- to 9-inch, and 9- to 12-inch depth intervals below surface grade on an approximate 200-foot grid. The RFI data include arsenic results for 216 soil samples collected from 54 locations within the six properties/areas (see Figure 1). FMC also collected 11 duplicate samples and the Agencies collected 21 split samples. Table 1 provides a sample inventory of the soil analytical

dataset (from Table 3.1 of RFI Report Volume X) and Table 2 presents a statistical summary of the analytical results. The arsenic results reflect the average of all FMC and Agencies results. The Agencies determined that the available data were sufficient to estimate the horizontal and vertical extent of Site-related arsenic in Air Deposition Area 2 soil with respect to a delineation criterion of 20 mg/kg (weighted 95th percentile concentration calculated in the 2001-2003 Gasport background study).

The Agencies determined that no further action was needed at RFI Property R2d (ARCADIS 2014). FMC has also provided multiple lines of evidence supporting the conclusion that elevated arsenic concentrations on Property R2e are not a result of FMC's operations (ARCADIS 2014, FMC Corporation 2014). The observed arsenic concentrations are not consistent with air deposition from the Facility and are more consistent with other historical uses of this parcel. Nevertheless, for the purposes of this EcoRA, all six properties are evaluated.

1.2 Report Organization

The organization of the remainder of this EcoRA report is as follows:

- Section 2, Preliminary Problem Formulation and Ecological Effects Evaluation, presents a summary of the ecological setting, potential fate and transport mechanisms, potentially complete exposure pathways, and the conceptual site model.

- Section 3, Exposure Assessment and Screening Risk Evaluation, presents the results of the ecological assessment, which includes a summary of the data collected to date, the comparison of the results to ecological screening values, and the uncertainty discussion.

- Section 4, Summary and Conclusions, summarizes and interprets the results of this EcoRA.

- Section 5, References, includes the literature and guidance cited in the development of this EcoRA.

2. PRELIMINARY PROBLEM FORMULATION AND ECOLOGICAL EFFECTS EVALUATION

This section provides information concerning the regional and site-specific ecological conditions that are relevant to this EcoRA.

2.1 Regional and Site-Specific Ecological Summary

The FMC facility is located in the Great Lakes Ecoregion of New York, which is characterized by gently rolling, low-level landscapes and flat lake plains. The region's climate is influenced by the Great Lakes.

2.1.1 Regional Climate

The climate of the Middleport area is classified as humid continental, consisting of cool-wet winters and hot-wet summers. Climate maps from the Cornell University Cooperative Extension (2010) for Niagara County show a latest date for first fall frost of October 20 and an earliest date of the last spring frost of April 30. Table 5.1 in Volume I of the RFI report (ARCADIS 2009a) summarized the regional climate (based on information generated at the Lockport meteorological station approximately 10 miles west of the FMC facility) as follows:

- The mean annual temperature is 47.8°F, with the coldest average temperature occurring in January (23.6°F) and the warmest in July (70.9°F). Mean daily temperatures below 32°F occur from mid-November through mid-April.
- The mean monthly precipitation ranges from 2.2 to 3.9 in. The annual total mean precipitation is approximately 37 in. Days with precipitation greater than 0.01 in. (rainfall equivalent) occur on average 10 to 16 days/month (153 days/year).
- The prevailing wind direction in the Middleport area is southwest to northeast.

2.1.2 Land Use

For each of the six properties evaluated in this assessment, current land uses, as well as possible future uses, vary by property. Current and future uses of Property R2a are limited to recreational activities along the Erie Canal towpath trail, which follows the canal across the state. Property R2a includes the stone dust trail and areas of maintained grass, brush, and scattered trees (see Attachment A for photos). To the north of R2a are Properties R2b and R2c, which are small sections along one edge of agricultural fields. The OU-3 portions of R2b and R2c comprise approximately 10 acres of a field, while the entire cultivated field comprises approximately 160 acres. Due to their current use, both properties lack trees or brush that could support wildlife. The adjacent land to the north of these areas is also maintained for agriculture and also unlikely to be suitable habitat for significant wildlife. A potential future use of Properties R2b and R2c could be residential development. Consistent with Properties R2b and R2c, Property R2d is a cleared active agricultural field, is much larger than the OU-3 portion of the property, does not contain suitable habitat, and may be used for residential purposes in the future. Property R2e is a section of the mainline railroad tracks corridor that passes through western New York. The OU-3 portion of Property R2e comprises railroad tracks/ballast and a small triangular piece of brush and trees. Future use of Property R2e is not expected to change. Property R2f is currently open land with brush and trees that could have current passive recreational use and possible future residential use.

2.1.3 Wetlands and Waterways

The NYSDEC on-line Environmental Resource Mapper does not identify any regulated wetlands or significant natural communities within Air Deposition Area 2. Waterways in Air Deposition Area 2 (the Erie Canal is not within Air Deposition Area 2) consist of stormwater culverts and ditches. Storm water Culvert

104 transitions from a buried culvert pipe beneath the Erie Canal to an open ditch at the northern (downstream) boundary of Air Deposition Area 2, and therefore is not expected to support aquatic communities in Air Deposition Area 2. Similarly, a storm water drainage ditch that runs along the railroad tracks on Property R2e is not expected to support aquatic communities.

2.1.4 Terrestrial Vegetation

Properties R2b, R2c, and R2d are cultivated agricultural fields (with hay and corn previously grown) and, as such, lack natural terrestrial vegetation that would support robust or diverse ecological communities. Properties R2a and R2e both include small wooded areas as well as grassy portions, which are similarly limited in terms of potential ecological communities. The terrestrial vegetation at these properties is also isolated from larger wooded areas in the vicinity. Grassy areas along the towpath are maintained (i.e., mowed). Populations of plants and soil invertebrates adapted to agricultural or maintained environments in this portion of New York State are likely to be present in this area; however, the size, location, and long-term use of these properties suggest diverse ecological communities are unlikely to be supported now or in the future.

Of the six properties evaluated, the most extensive terrestrial vegetation is currently present at Property R2f. This property was previously used for agricultural activities, but has been undisturbed for long enough that shrubs and small trees have grown in the former fields.

2.1.5 Wildlife

Avian species (e.g., swallows, robins, hawks), small mammals (e.g., gray squirrels), and large mammals (e.g., deer) that would typically be expected in this portion of New York State are also expected to occur in this area.

2.1.6 Rare, Threatened, or Endangered Species

The NYSDEC provides the Environmental Resource Mapper to identify areas with rare plants and animals.[1] As shown in Figure 2, none of these resources are within a mile of the Air Deposition Area 2 properties.

The U.S. Fish and Wildlife Service (US FWS) Information for Planning and Conservation website shows the northern long-eared bat (*Myotis septentrionalis*) as the only federally listed threatened species in Niagara County.[2] This small species of bat requires old-growth forests with intact interior forest habitat with low edge-to-interior ratios (NatureServe 2015). Small, young, or fragmented forests may not provide suitable foraging habitat. The threatened listing status came after population declines due to a fungal disease known as "white-nose syndrome," to which this species is particularly susceptible. There are also 15 species of migratory birds that the US FWS lists as potentially relevant to the properties in Air Deposition Area 2. A majority of these bird species would only be found in the area during breeding, though the bald eagle (*Haliaeetus leucocephalus*) is found year-round.

2.1.7 Summary

Properties R2a, R2b, R2c, R2d, and R2e are not expected to support wildlife habitat because these properties: 1) do not contain wetlands; 2) have only isolated strips of trees/woods; and 3) are subject to routine human activities (i.e., public trail on Property R2a, cultivated fields on Properties R2b, R2c, and R2d; and active railroad track right-of-way on Property R2e). Consequently, these properties are not assessed further in the EcoRA. Property R2f is currently overgrown with brush and trees, and may be frequented by various birds and mammals. This property is evaluated in the following sections.

[1] Accessible at: http://www.dec.ny.gov/animals/38801.html

[22] This information was obtained from http://ecos.fws.gov/tess_public/reports/species-by-current-range-county?fips=36063

2.2 Potential Fate and Transport Mechanisms

Arsenic is the only constituent of concern (COC) for in Air Deposition Area 2. The soil arsenic analytical results were discussed in Section 1.1. As described in RFI Report Volume X (ARCADIS 2012), arsenic in soil samples collected in Air Deposition Area 2 consists or could consist of a combination of several sources, including: natural geologic conditions, potential non-Site-related anthropogenic sources, and potential historical air deposition from past operations at the FMC Facility. The distribution of arsenic in the soils may have been affected by the disruption or regrading of soils, particularly on cultivated lands where tilling and replanting has occurred as part of agricultural activities.

Only complete pathways provide a route of exposure, and therefore a potential risk. Complete pathways are defined by the following four components:

1. A source and mechanism of chemical release (e.g., spills);
2. A receptor;
3. A point of potential contact with the impacted medium, referred to as the exposure point (e.g., exposed soils); and
4. An exposure route (e.g., potential for direct contact with soils).

If any one of the components is missing, the pathway is not considered complete and, therefore, no risk will be associated with that pathway.

As shown in the conceptual site model (Figure 3), arsenic from historical air emissions may be found in surface and subsurface soil and may be taken up into plants and soil invertebrates. Plants may be exposed to arsenic through direct contact with surface soil or direct contact with other plants. Soil invertebrates may ingest surface soil or plants, or come in direct contact with other soil invertebrates. Birds and mammals may ingest surface soil, plants, or soil invertebrates that were exposed to arsenic.

3. EXPOSURE ASSESSMENT AND SCREENING RISK EVALUATION

The 0- to 6-inch depth interval was selected as ecologically relevant for herbaceous plants (with shallow roots) that may be consumed by herbivores, soil invertebrates that may be consumed by higher tropic level receptors, and depths where incidental contact may occur by these receptors. For Property R2f, half of the surface soil samples correspond to the 0- to 3-inch depth interval; the remainder correspond to the 3- to 6-inch depth interval. An evaluation relying instead on the 0- to 12-inch depth interval is presented in the Uncertainty Assessment (Section 3.3).

The analytical results were compiled into a Microsoft Access® database to facilitate data evaluation. Sample-specific analytical results are tabulated in the RFI report, Volume X, Appendix A (ARCADIS 2012) and are not repeated herein. The individual sample results were depth-averaged for each sample location. The 0- to 6-inch depth average concentration (17.8 mg/kg) and the 95 percent upper confidence limit of the arithmetic mean (UCLM) (21.0 mg/kg) for Property R2f were compared to the screening benchmarks. Property average values are more representative of potential population-level exposures by ecological receptors than are values at individual locations. The UCLM provides an upper bound of the expected average exposures for each property.

USEPA's software application, ProUCL v5.0 (USEPA 2013) was used to calculate UCLM values for this EcoRA. A number of factors, including the number of available data points, the shape of the distribution of the values, and the degree of censoring (e.g., samples below the detection limit) are considered in determining which mathematical approach is most appropriate for UCLM calculation of a data set (USEPA 2002). The ProUCL software includes several different strategies to calculate a UCLM from the data set and recommends a preferred value based on the properties of the input dataset.

3.1 Ecological Screening Benchmarks

This section summarizes the screening used to determine whether soil arsenic concentrations exceed ecological screening benchmarks. An ecological soil cleanup objective (SCO) of 13 mg/kg was derived by NYSDEC (from 6 NYCRR Part 375, NYSDEC 2006). That value is lower than the background soil concentrations in Middleport. For that reason the toxicity-based arsenic ecological soil screening levels (Eco-SSLs) developed by the USEPA are used in this assessment (USEPA 2005):

- Plants: 18 mg/kg
- Avian wildlife: 43 mg/kg
- Mammalian wildlife: 46 mg/kg

The Eco-SSLs are based on consideration of both no observed adverse effects levels and lowest observed adverse effect levels, and are intended to be more conservative than clean up levels. Plants are the most sensitive receptor. As described in greater detail below, the conservatism of the plant Eco-SSL is compounded because arsenic tolerance in plants is species-specific and several plants included in the analysis do not grow in Middleport. Additionally, the arsenic plant Eco-SSL is based on greenhouse studies of arsenic compounds mixed with soil, whereas, arsenic in Middleport soil has weathered over decades to less bioavailable forms.

3.2 Evaluation of Soil Arsenic Results

The avian and mammalian wildlife Eco-SSLs are not exceeded by the mean or UCLM arsenic concentration at Property R2f. The mean arsenic concentration also does not exceed the plant Eco-SSL

(18 mg/kg), but the UCLM slightly exceeds it. As noted above, Property R2f is currently undeveloped and lack of recent agricultural use has allowed vegetation to develop. The presence of dense brush and wooded vegetation and lack of any visibly stressed areas (evident in site photographs, Attachment A) indicates the absence of marked phytotoxicity.

The arsenic plant Eco-SSL is a very conservative number based on toxicity values that are the geometric mean of the no observed adverse effect level and the lowest observed adverse effect level for each underlying study. The Eco-SSL for plants is the geometric mean of these toxicity values for ryegrass (22 mg/kg), cotton (69 mg/kg), and rice (4 mg/kg). Arsenic uptake into rice is facilitated differently than for other plants, and toxicity results for rice are not applicable to other plant species (Zhao et al. 2008). Without the rice results, the Eco-SSL would be much higher.

The specific results selected for this Eco-SSL are from studies of highly soluble arsenic compounds not found in Middleport and are biased toward studies anticipated to have high arsenic bioavailability to plants. Mineralogical analysis of site soils to support the HHRA showed that the arsenic is present primarily in iron oxide, manganese oxide, and iron sulfate phases, all of which will have limited bioavailability, and therefore lower toxicity to plants.

3.3 Uncertainty Evaluation

Uncertainty is inherent in all aspects of the risk assessment process, and such uncertainties can result in overestimations or underestimations of the true ecological risk present at the site. For this assessment, the key areas of uncertainty include: 1) the representativeness of the screening benchmarks, and 2) the selection of evaluated sampling depths.

3.3.1 Representativeness of the Ecological Screening Benchmarks

The Eco-SSLs used for this assessment are highly conservative and do not reflect factors that may reduce the bioavailability of arsenic on a site-specific basis. They may also be based on sensitive species not relevant to all areas. As discussed above, the plant Eco-SSL for arsenic is not likely representative of site-specific toxicity thresholds.

3.3.2 Selection of Evaluated Sampling Depths

Surface soil from the depth interval of 0– to 6-inch was used for the comparison to ecological benchmarks. This interval was selected because it represents the most ecologically relevant depth interval. As part of this uncertainty evaluation, the average arsenic concentration was calculated for the 0–to 12-inch depth interval and found to be 14.4 mg/kg, with a UCLM of 15.9 mg/kg. These values are lower than the results for the 0- to 6-inch depth interval, suggesting the use of that depth interval is conservative. Of particular note, the UCLM for the 0- to 12- inch depth interval does not exceed the plant Eco-SSL.

4. SUMMARY AND CONCLUSIONS

The evaluation of the ecological risks for Air Deposition Area 2 began with an assessment of the potential ecological resources associated with each property. This analysis concluded that Properties R2a, R2b, R2c, R2d, and R2e are not expected to support wildlife habitat because these properties: 1) do not contain wetlands; 2) have only isolated strips of trees/woods; and 3) are subject to routine human activities (i.e., public trail on Property R2a, cultivated fields on Properties R2b, R2c, and R2d; and active railroad track right-of-way on Property R2e). Consequently, these properties were not assessed further in the ecological risk assessment. Property R2f is currently overgrown with brush and trees, and may be frequented by various birds and mammals, and was therefore, evaluated further.

Mean and UCLM arsenic concentrations for Property R2f were compared with conservative ecological screening benchmarks (i.e., Eco-SSLs). The avian and mammalian wildlife Eco-SSLs are not exceeded by the mean or UCLM soil arsenic concentration at Property R2f. The mean soil arsenic concentration does not exceed the plant Eco-SSL (18 mg/kg), while the UCLM slightly exceeds the plant Eco-SSL.

The arsenic plant Eco-SSL is very conservative. The Eco-SSL for plants is the geometric mean of toxicity values for ryegrass (22 mg/kg), cotton (69 mg/kg), and rice (4 mg/kg). Arsenic uptake into rice is facilitated differently than for other plants, and toxicity results for rice are not applicable to other plant species. Without the rice results, the Eco-SSL would be much higher.

The specific results selected for this Eco-SSL are from studies of highly soluble arsenic compounds not found in Middleport and are biased toward studies anticipated to have high arsenic bioavailability to plants. Mineralogical analysis of site soils to support the HHRA showed that the arsenic is present primarily in iron oxide, manganese oxide, and iron sulfate phases, all of which will have limited bioavailability, and therefore lower toxicity to plants.

In sum, there is no meaningful risk to wildlife, mature trees/vegetation, or other ecological resources in Air Deposition Area 2. Consequently, corrective action in Air Deposition Area 2 is not warranted or appropriate on the basis of ecological risk.

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TABLES

Table 1: Soil arsenic data summary

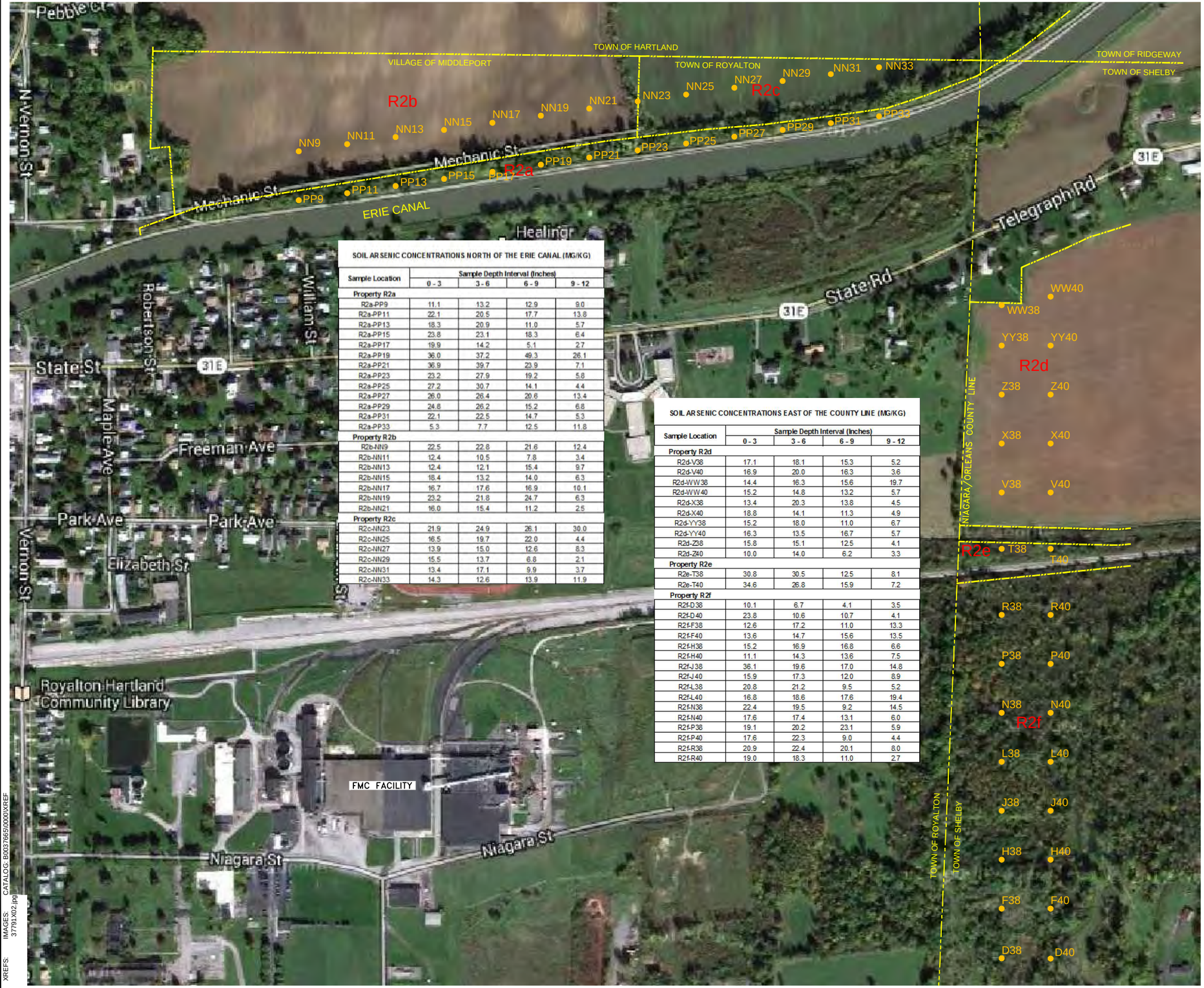
Property	Number of Sampling Locations	Number of FMC Samples		Number of Agencies' Split Samples	
		Primary	Duplicate	Primary	Duplicate
R2a	13	52	2	6	0
R2b	7	28	1	3	1
R2c	6	24	2	2	0
R2d	10	40	2	4	0
R2e	2	8	1	1	0
R2f	16	64	3	5	0
Total	54	216	11	21	1

Table 2: Soil arsenic concentrations by depth interval

Property	Depth Interval (inches)	N[a]	Minimum (mg/kg)	Maximum (mg/kg)	Mean (mg/kg)
R2a	0-3	13	5	37	23
	3-6	13	8	40	24
	6-9	13	5	49	18
	9-12	13	3	26	9
R2b	0-3	7	12	23	17
	3-6	7	11	23	16
	6-9	7	8	25	16
	9-12	7	3	12	7
R2c	0-3	6	13	22	16
	3-6	6	13	25	17
	6-9	6	7	26	15
	9-12	6	2	30	10
R2d	0-3	10	10	19	15
	3-6	10	14	20	16
	6-9	10	6	17	13
	9-12	10	3	20	6
R2e	0-3	2	31	35	33
	3-6	2	27	31	29
	6-9	2	13	16	14
	9-12	2	7	8	8
R2f	0-3	16	10	36	18
	3-6	16	7	22	17
	6-9	16	4	23	13
	9-12	16	3	19	9

Notes:
mg/kg = milligrams arsenic per kilogram soil
Available field duplicate and split sample results were averaged with primary sample results prior to calculation of property- and depth-specific summary statistics.
a. Represents the number of individual soil sampling locations.

FIGURES



SOIL ARSENIC CONCENTRATIONS NORTH OF THE ERIE CANAL (MG/KG)

Sample Location	Sample Depth Interval (Inches) 0 - 3	3 - 6	6 - 9	9 - 12
Property R2a				
R2a-PP9	11.1	13.2	12.9	9.0
R2a-PP11	22.1	20.5	17.7	13.8
R2a-PP13	18.3	20.9	11.0	5.7
R2a-PP15	23.8	23.1	18.3	6.4
R2a-PP17	19.9	14.2	5.1	2.7
R2a-PP19	36.0	37.2	49.3	26.1
R2a-PP21	36.9	39.7	23.9	7.1
R2a-PP23	23.2	27.9	19.2	5.8
R2a-PP25	27.2	30.7	14.1	4.4
R2a-PP27	26.0	26.4	20.6	13.4
R2a-PP29	24.8	26.2	15.2	6.8
R2a-PP31	22.1	22.5	14.7	5.3
R2a-PP33	5.3	7.7	12.5	11.8
Property R2b				
R2b-NN9	22.5	22.8	21.6	12.4
R2b-NN11	12.4	10.5	7.8	3.4
R2b-NN13	12.4	12.1	15.4	9.7
R2b-NN15	18.4	13.2	14.0	6.3
R2b-NN17	16.7	17.6	16.9	10.1
R2b-NN19	23.2	21.8	24.7	6.3
R2b-NN21	16.0	15.4	11.2	2.5
Property R2c				
R2c-NN23	21.9	24.9	26.1	30.0
R2c-NN25	16.5	19.7	22.0	4.4
R2c-NN27	13.9	15.0	12.6	8.3
R2c-NN29	15.5	13.7	6.8	2.1
R2c-NN31	13.4	17.1	9.9	3.7
R2c-NN33	14.3	12.6	13.9	11.9

SOIL ARSENIC CONCENTRATIONS EAST OF THE COUNTY LINE (MG/KG)

Sample Location	Sample Depth Interval (Inches) 0 - 3	3 - 6	6 - 9	9 - 12
Property R2d				
R2d-V38	17.1	18.1	15.3	5.2
R2d-V40	16.9	20.0	16.3	3.6
R2d-WW38	14.4	16.3	15.6	19.7
R2d-WW40	15.2	14.8	13.2	5.7
R2d-X38	13.4	20.3	13.8	4.5
R2d-X40	18.8	14.1	11.3	4.9
R2d-YY38	15.2	18.0	11.0	6.7
R2d-YY40	16.3	13.5	16.7	5.7
R2d-Z38	15.8	15.1	12.5	4.1
R2d-Z40	10.0	14.0	6.2	3.3
Property R2e				
R2e-T38	30.8	30.5	12.5	8.1
R2e-T40	34.6	26.8	15.9	7.2
Property R2f				
R2f-D38	10.1	6.7	4.1	3.5
R2f-D40	23.8	10.6	10.7	4.1
R2f-F38	12.6	17.2	11.0	13.3
R2f-F40	13.6	14.7	15.6	13.5
R2f-H38	15.2	16.9	16.8	6.6
R2f-H40	11.1	14.3	13.6	7.5
R2f-J38	36.1	19.6	17.0	14.8
R2f-J40	15.9	17.3	12.0	8.9
R2f-L38	20.8	21.2	9.5	5.2
R2f-L40	16.8	18.6	17.6	19.4
R2f-N38	22.4	19.5	9.2	14.5
R2f-N40	17.6	17.4	13.1	6.0
R2f-P38	19.1	20.2	23.1	5.9
R2f-P40	17.6	22.3	9.0	4.4
R2f-R38	20.9	22.4	20.1	8.0
R2f-R40	19.0	18.3	11.0	2.7

LEGEND:

APPROXIMATE PROPERTY BOUNDARY

R2a PROPERTY IDENTIFICATION

2009 SOIL SAMPLE LOCATION

NOTES:

1. ALL LOCATIONS AND PROPERTY BOUNDARIES SHOWN ARE APPROXIMATE AND SUBJECT TO VERIFICATION.
2. PROPERTY IDENTIFICATION NUMBERS SHOWN ARE NOT RELATED TO STREET ADDRESS OR TAX PARCEL ID.
3. ARSENIC CONCENTRATIONS ARE THE ARITHMETIC AVERAGE OF ALL PRIMARY, DUPLICATE AND SPLIT SAMPLE RESULTS FOR EACH SAMPLE AND ARE PRESENTED IN MILLIGRAMS PER KILOGRAM (MG/KG); EQUIVALENT TO PARTS PER MILLION (PPM).

0 200' 400'
GRAPHIC SCALE

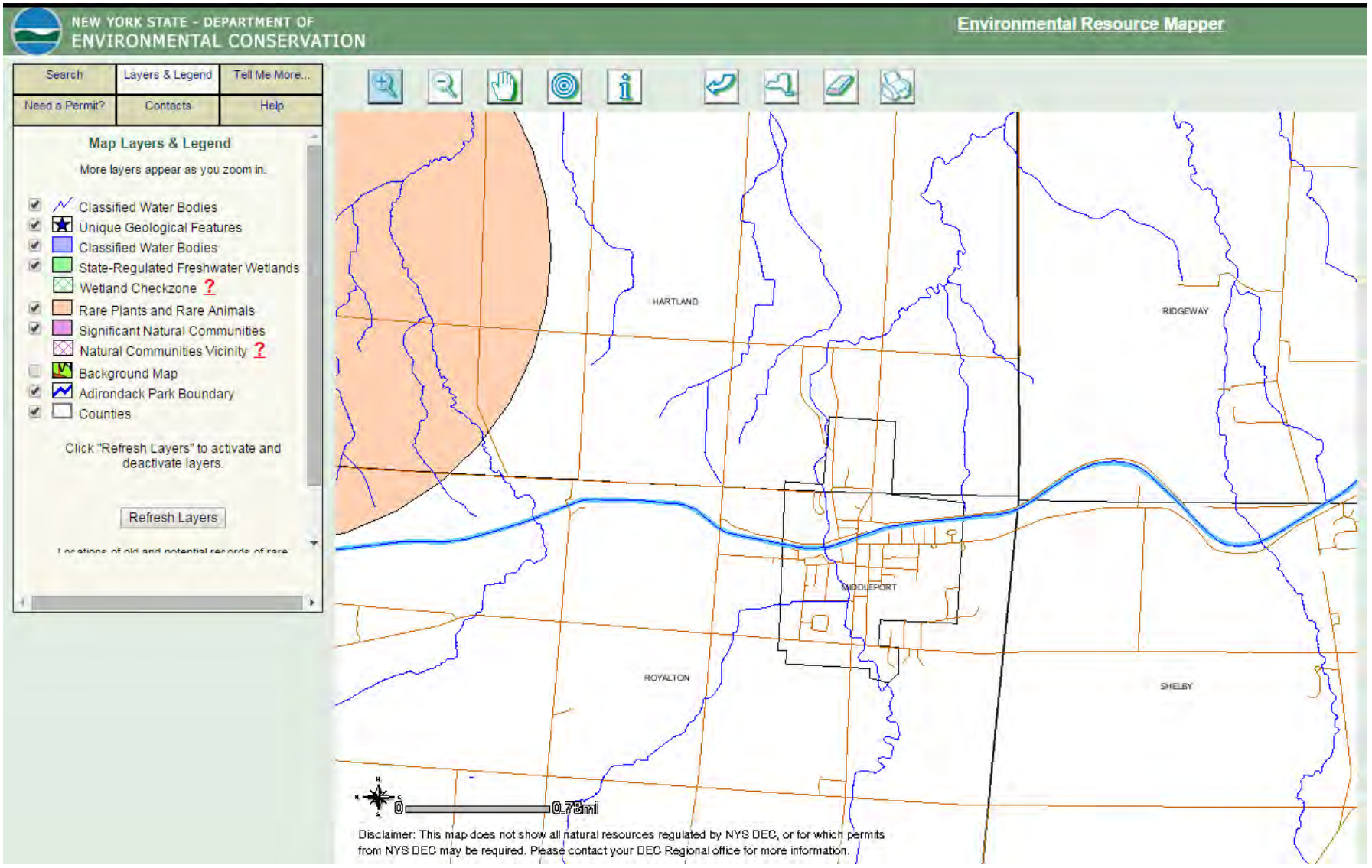
FMC CORPORATION - MIDDLEPORT, NEW YORK
AIR DEPOSITION AREA 2 (OU-3)

SOIL SAMPLING LOCATIONS AND ARSENIC CONCENTRATIONS

ARCADIS

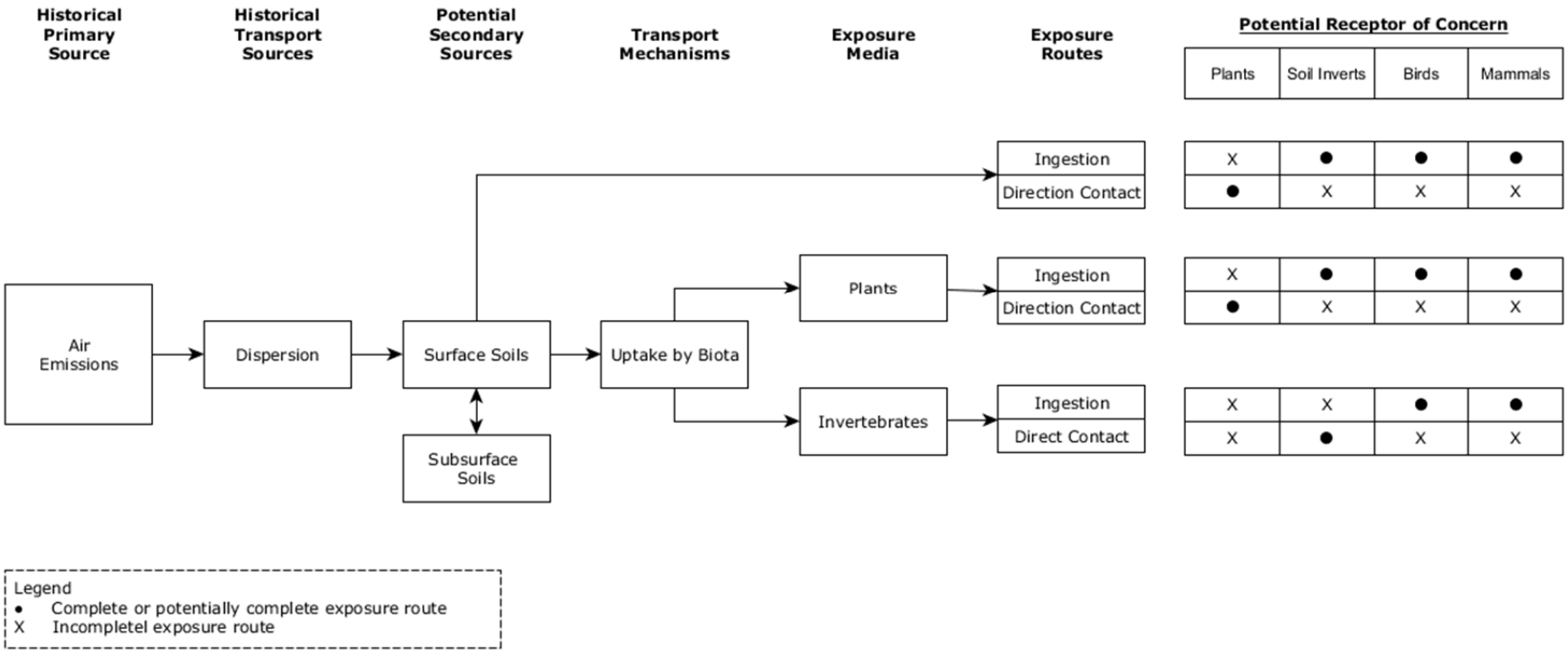
FIGURE 1

CITY: SYRACUSE, NY DIV/GROUP: ENV/IM-DV DB: P. LISTER LD: P. LISTER PM/TM: T. YOUNG TR: D. WRIGHT LYRON=*;OFF=REF, (FR2)
G:\ENVCAD\SYRACUSE\ACTIB\03779\100\000\000001\DWG\ADA237791C01.dwg LAYOUT: 1 SAVED: 10/10/2014 10:03 AM ACADVER: 18.1S (LMS TECH) PAGESETUP: ----
XREFS: IMAGES: CATALOG: B0037665\0000\XREF
37791X02.jpg PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 10/10/2014 10:04 AM BY: POSENAUER, LISA



RAMBOLL ENVIRON

Figure 2:
Environmental Resource Mapper for Air Deposition Area 2



RAMBOLL ENVIRON

Figure 3:
Current conceptual site model for Air Deposition Area 2

ATTACHMENT A: SITE PHOTOS

Photo 1: R2a, view east

Photo 2: R2a, view north

Photo 3: R2b, view east

Photo 4: R2b, view south

Photo 5: R2c, view south

Photo 6: R2c, view west

Photo 7: R2e

Photo 8: R2e, view east

Photo 9: R2f

Photo 10: R2f

Photo 11: R2f

Photo 12: R2d, view south