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FINAL

RRF HEALTH RISK ASSESSMENT UPDATE

MONTGOMERY COUNTY RESOURCE RECOVERY FACILITY (RRF)

Prepared for

Department of Environmental Protection, Division of Solid Wastes Services

Rockville, Maryland

Prepared by

TRC Environmental Corporation

21 Griffin Road North
Windsor, Connecticut

November 2014

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TRC Project No. 200454
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EXECUTIVE SUMMARY

The Montgomery County Resource Recovery Facility (RRF), located in Dickerson, MD began operations in 1995. The County made commitments to the Dickerson community to conduct human health risk assessments relative to RRF emissions and ambient environmental monitoring during both preconstruction (pre-operational) and post-construction (post-operational) phases. The County conducted environmental monitoring programs for ambient air and non-air environmental media, generally on a five (5) year and three (3) year periodic basis, respectively, pending budgetary appropriations. The County's most recent non-air media monitoring was conducted during June of 2007, and its most recent ambient air monitoring was conducted during the winter of 2008 (Montgomery County 2013a).

The RRF has been the subject of two previous human health risk assessments sponsored by the County, one in 1989 (pre-construction) and the other published in 2006 (post-construction). A separate HRA was also conducted by the Maryland Department of Natural Resources in 1989. The 1989 health risk assessments were based on literature-based emissions and engineering data available at that time and followed assessment protocols generally accepted at that time. The post-construction health risk assessment (ENSR 2006) relied on measured emissions data from stack tests and one year of onsite meteorological data available for the RRF and the now obsolete 1998 Draft Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities (USEPA 1998a and 1999a). In addition, the 2006 ENSR health risk assessment update used the USEPA's Industrial Source Complex (ISC) model, which has been since supplanted by USEPA's AMS/EPA Regulatory Model (AERMOD). The 2006 health risk assessment update included the chemicals of potential concern (COPCs) identified from the literature research in the County's 1989 assessment and supplemented that list with additional species identified in the stack testing data. Ultimately, the acute (i.e. short-term) and chronic (i.e. long-term) risks associated with a suite of 19 COPCs including metals, inorganics, dioxins/furans, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and formaldehyde were assessed.

Overall, the prior human health risk assessments showed that potential human health risks due to emissions from the Montgomery County RRF facility are within the range of or below regulatory and other benchmark risk levels for protection of human health. The Final 2006 Report concluded that "*the relative risk of harm to human health presented by the RRF, as it is operating today, is very low. In fact, the results indicate a very low chance (less than 1 chance in 1 million) for occurrence of potential carcinogenic health effects, and that no adverse noncarcinogenic health effects are expected as a result of exposure to facility related emissions*."

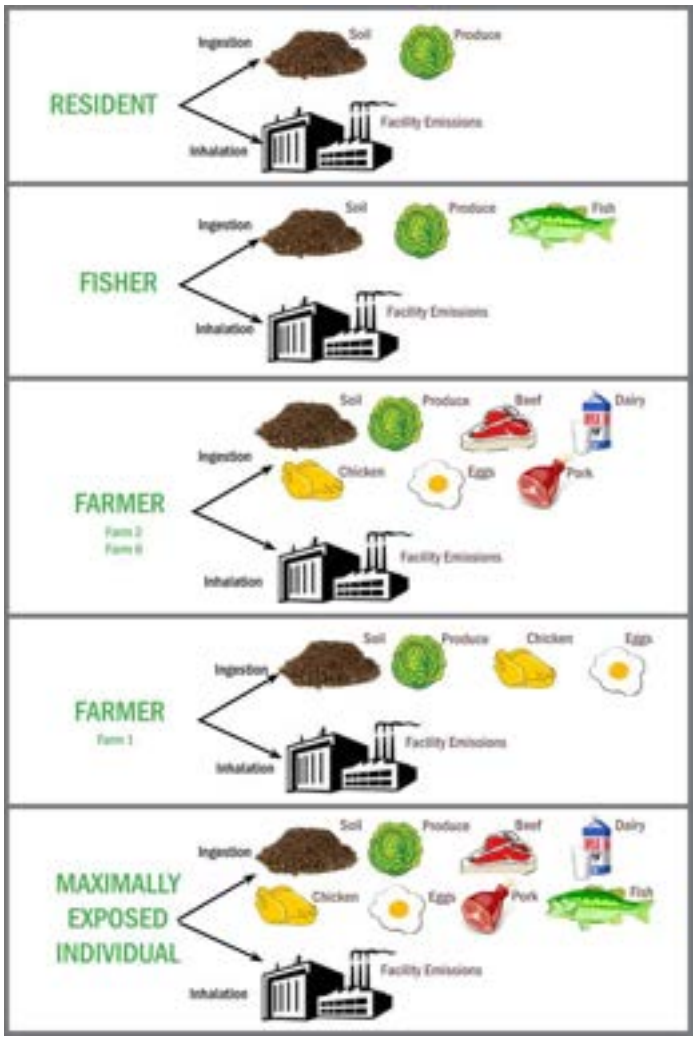
This Human Health Risk Assessment (HHRA) updates the ENSR risk assessment with the following changes:

- Updated the dispersion/deposition modeling from ISCST3 (Industrial Source Complex Short-Term 3) to AERMOD, the current USEPA approved model,
- Updated equations to reflect current USEPA guidance, including updated deposition and media concentration equations for mercury,
- Additional receptors (Reasonable Maximum Exposed (RME) Resident, RME Fisher and RME Farmer) per the 2005 Final HHRAP Guidance for Hazardous Waste Facilities,
- Updated emission rates for metals, dioxins/furans, PCBs, PAHs and formaldehyde to include all stack testing results from start of operations (1995) through August 2013,
- Included acid gas emission rates (hydrogen chloride, hydrogen fluoride and sulfuric acid) for acute inhalation,
- Used 95% Upper Confidence Limit (UCL) of the mean emission rates,
- Included non-detected emissions at full detection limit, and
- Reviewed and updated toxicity criteria to the most current values provided by USEPA.

A draft version of this report has undergone independent 3rd party review by CPF Associates, Inc. and the USEPA. Comments and responses to those comments can be found in Appendix I. All applicable changes have been carried through this final document.

This HHRA evaluated a variety of potential receptors to capture a range of exposure scenarios in the vicinity of the RRF. Three RME exposure scenarios addressing potential long-term exposure and risks, not previously considered in the 2006 ENSR risk assessment, were evaluated. In addition, seven long-term exposure and risk scenarios that were evaluated in the 2006 ENSR report were addressed. An acute inhalation risk scenario and potential impacts associated with breast milk ingestion by an infant were also evaluated. The methods used to evaluate exposures and risks were consistent with current USEPA guidance and are designed to tend to overestimate potential risks (i.e., be health protective).

This HHRA provides theoretical estimates of individual risk for a variety of exposure scenarios as shown in the following schematic:



In order to evaluate potential health risks, USEPA has established targets within which the Agency strives to manage risks. To evaluate potential carcinogenic risks, the Agency generally uses a risk range of 10^{-4} (1 in 10,000) to 10^{-6} (1 in 1,000,000), and to evaluate the potential for non-cancer health effects, the Agency generally uses a hazard index/quotient of 1.0. However, for purposes of RCRA combustion permitting decisions, USEPA Region VI has modified the target levels to reflect the contribution of background levels of contamination. Per USEPA Region VI Guidance (USEPA 1998b), calculated cancer risks and the potential for non-cancer effects are compared against the USEPA target risk level of 1 in 100,000 for cancer risks and target hazard level of 0.25 for non-cancer effects. The risk level of 1 in 100,000 indicates a 1 in 100,000 chance of developing cancer due to lifetime exposure to a substance. Lifetime exposure to a substance with a cancer risk of 1 in 100,000 would increase one's current chance of cancer from all causes (which is currently a 1 in 2 chance for males and a 1 in 3 chance for females (American Cancer Society, 2013)) by 0.00001.

The potential for non-carcinogenic effects is represented by a Hazard Quotient (HQ), obtained by dividing the calculated dose to the receptor dose by the chemical-specific reference dose (RfD). The RfD is a lifetime dose of a chemical, established by USEPA or other health agency, that has been determined not to cause health effects over a lifetime of exposure. In calculating the RfD, exposures to sensitive individuals such as infants and the elderly are considered. Noncancer hazard indices (HIs) for each receptor were obtained by adding all COPC-specific HQs regardless of target organ potentially affected of type of health effect. It should be noted that the use of a noncancer hazard level of 0.25 is very conservative (i.e., health-protective) and provides a four-fold safety factor when compared to USEPA's conventional non-cancer hazard target level of 1.0 (USEPA 1989). This four-fold safety factor is meant to be protective of cumulative risk from other sources in the area.

Infant exposures to dioxin/furans in mother's breast milk that are modeled to occur as a result of the RRF emissions breast milk are evaluated by calculating an average daily dose (ADD) for an exposed infant and comparing the ADD against typical infant intakes of dioxin. The typical infant intake of 60 pg/kg-day TCDD-TEQ is identified by USEPA Region VI (USEPA 1998b) and the 2005 HHRAP as the national average background value to compare an infant's exposure to TCDD-TEQ via breast milk. These background intakes were calculated to be about 60 pg/kg-day in 1994; current estimates are not available. This comparison is not meant to be analogous to the comparison with health-based benchmarks such as the RfD, but in the absence of infant exposure benchmarks, it is expected that this comparison will be meaningful. A ratio of the calculated ADD versus the 60 pg/kg/day value is made such that a ratio of 1.0 would indicate that the ADD equaled the comparison value, therefore a ratio of less than one means that exposures are less than the average background intake level. It should be noted that at the time of the finalization of the HHRAP, USEPA had not developed a RfD for TCDD. USEPA has recently promulgated a RfD for TCDD of 0.7 pg/kg/day which is almost 100 times less than the comparison value of 60 pg/kg/day. An evaluation of breast milk ingestion using the RfD is further discussed in the Uncertainty Analysis section of this report.

Acute (short-term) inhalation hazards are evaluated by comparing against the USEPA target level of 1.0.

Table ES-1 summarizes the receptor exposures, while ES-2 summarizes the total risk and noncancer hazard by receptor. The results of the HHRA are summarized below.

RME Scenarios

RME Residential Scenario

The RME Residential scenario assumed that the adult and child resident were directly exposed to COPCs by inhalation and indirectly exposed to chemicals via the incidental ingestion of soil, and the consumption of homegrown produce. Media concentrations were calculated based on the modeled maximum annual concentration or maximum 5-year average dry and wet deposition, regardless of whether they occurred in different locations (i.e., assumes modeled impacts at different locations are collocated). This assumption would tend to overestimate risk. An exposure pathway for infants via the ingestion of breast milk was also evaluated.

As shown in Table ES-2 neither the total excess lifetime cancer risk nor the total HIs associated with indirect and direct exposures for the adult and child RME Resident scenarios exceed the target cancer risk of 1 in 100,000 or the HI target of 0.25. The excess lifetime cancer risk estimates of 0.01 in 100,000 and 0.003 in 100,000 for the adult and child, respectively, are well below the benchmark risk of 1 in 100,000. The total HIs of 0.0012 and 0.0018 for the adult and child receptor are well below the target HI of 0.25. In addition, the dioxin/furan intake ratio of 0.00003 for the infant receptor is well below the target of 1.0.

RME Fisher Scenario

The RME Fisher scenario assumed the Fisher lived at the RME residential location and also ate fish from the Potomac River. Thus, the Fisher was assumed to be directly exposed to COPCs by inhalation and indirectly exposed to chemical via the incidental ingestion of soil, the consumption of homegrown produce from the residential area and via the consumption of fish caught in the Potomac River. Since the Fisher was assumed to live in the residential area, the direct inhalation pathway was modeled using the RME Residential impacts. Air, soil and produce concentrations were calculated based on the modeled maximum annual concentration or maximum 5-year average dry and wet deposition, regardless of whether they occurred in different locations (i.e., assumes modeled impacts at different locations are collocated). This assumption would tend to overestimate risk. An exposure pathway for infants via the ingestion of breast milk was also evaluated.

As shown in ES-2 neither the total excess lifetime cancer risks nor the total HIs associated with indirect and direct exposures for the adult and child RME Fisher scenarios exceed the target cancer risk of 1 in 100,000 or the HI target of 0.25. The excess lifetime cancer risk estimates of

0.1 in 100,000 and 0.02 in 100,000 for the adult and child, respectively, are well below the target risk of 1 in 100,000. The total HIs of 0.012 and 0.0095 for the adult and child receptor are well below the target HI of 0.25. In addition, the dioxin/furan intake ratio of 0.00023 for the infant receptor is well below the target of 1.0.

RME Farmer Scenario

The RME Farmer was hypothetically assumed to live on Farm 2 which has the highest potential facility impacts of four evaluated farm areas. This receptor is assumed to be directly exposed to COPCs by inhalation and indirectly exposed to the COPCs via the incidental ingestion of soil, and the consumption of homegrown produce, beef, dairy, pork, chicken and eggs. These exposures are assumed to occur even if all the food products are not produced at the assumed farm location. In addition, it is assumed that all animal feed ingested by the food producing animals is grown on-site. An exposure pathway for infants via the ingestion of breast milk was also evaluated.

For the RME Farmer, the total excess lifetime cancer risk estimates of 0.06 in 100,000 and 0.01 in 100,000 for the adult and child, respectively, are well below the target cancer risk of 1 in 100,000 (Table ES-2). The total HIs of 0.0069 and 0.011 for the adult and child receptor are well below the target HI of 0.25. In addition, the dioxin/furan intake ratio of 0.0022 for the infant receptor is well below the target of 1.0.

Additional Chronic Risk Scenarios

Seven additional scenarios from the ENSR report were evaluated in this HHRA. These include two MEI Scenarios, three Fisher Scenarios and two Resident Farm Scenarios.

MEI Scenarios

MEI A Scenario

As discussed in the ENSR Report, MEI A scenario assumed that the adult and child resident were directly exposed to COPCs via maximum inhalation exposure; consumed agricultural products (milk, beef, pork, and poultry products) raised at the closest reference beef and/or dairy farm location (per the Farm Directory, Montgomery County 2008) that was predicted to exhibit maximum facility-related impacts; ingested fish caught from the Potomac River; and consumed above and below ground vegetables, and incidentally ingested soil. Contact with soil and home-grown produce occurred at the location of maximum dry particle deposition. The MEI A scenario assumes that the modeled impacts (maximum concentrations and dry particle deposition are

collocated even though they are not. This assumption would tend to overestimate risk. An exposure pathway for infants via the ingestion of breast milk was also evaluated.

The ENSR Report evaluated the consumption of agricultural products that were hypothetically assumed to come from Farm 5 (Johnson's Dairy Farm) as that was the nearest actual beef and/or dairy farm that was predicted to exhibit maximum facility-impacts. In the current HHRA it was determined that a different farm, designated as Farm 6, was the nearest beef and/or dairy farm that was predicted to exhibit maximum facility-impacts. It was assumed that 100% of consumed produce, agricultural products, fish and incidentally ingested soils were impacted by facility emissions. These exposures are assumed to occur even if all the food products are not produced at the assumed locations. In addition, it is assumed that all animal feed ingested by the food producing animals is grown on-site.

As shown in Table ES-2, neither the total excess lifetime cancer risks nor the total HIs associated with indirect and direct exposures for the adult and child MEI A scenario exceeds the target cancer risk of 1 in 100,000 or the target HI of 0.25. The excess lifetime cancer risk estimates of 0.1 in 100,000 and 0.02 in 100,000 for the adult and child, respectively, are well below the target risk of 1 in 100,000. The total HIs of 0.016 for the adult and 0.015 for the child receptor are well below the target HI of 0.25. In addition, the dioxin/furan intake ratio of 0.0014 for the infant receptor in the 2013 assessment is well below the target of 1.0.

MEI B Scenario

As discussed in the ENSR Report, MEI B scenario assumed that the adult and child resident were directly exposed to COPCs via inhalation exposure at the secondary maximum location; consumed agricultural products (milk, beef, pork, and poultry products) raised at the closest reference beef and/or dairy farm location (per the Farm Directory, Montgomery County 2008) that was predicted to exhibit maximum facility-related impacts; ingested fish caught from the Potomac River; and consumed above and below ground vegetables, and incidentally ingested soil. Contact with soil and home-grown produce occurred at the location of maximum total particle and vapor deposition. The MEI B scenario assumes that the modeled impacts (secondary maximum air concentrations and maximum total particle and vapor deposition are collocated even though they are not. This assumption would tend to overestimate risk. An exposure pathway for infants via the ingestion of breast milk was also evaluated.

The ENSR Report evaluated the consumption of agricultural products that were hypothetically assumed to come from Farm 5 (Johnson's Dairy Farm) as that was the nearest actual

beef and/or dairy farm that was predicted to exhibit maximum facility-impacts. In the current HHRA it was determined that a different farm, designated as Farm 6, was the nearest beef and/or dairy farm that was predicted to exhibit maximum facility-impacts. It was assumed that 100% of consumed produce, agricultural products, fish and incidentally ingested soils were impacted by facility emissions. These exposures are assumed to occur even if all the food products are not produced at the assumed locations. In addition, it is assumed that all animal feed ingested by the food producing animals is grown on-site.

As shown in Table ES-2, neither the total excess lifetime cancer risks nor the total HIs associated with indirect and direct exposures for the adult and child MEI B scenario exceeds the target cancer risk of 1 in 100,000 or the target HI of 0.25. The excess lifetime cancer risk estimates of 0.1 in 100,000 and 0.02 in 100,000 for the adult and child, respectively, are well below the target risk of 1 in 100,000. The total HIs of 0.015 for both the adult and child receptors are well below the target HI of 0.25. In addition, the dioxin/furan intake ratio of 0.0014 for the infant receptor is well below the target of 1.0.

Additional Fisher Scenarios

Three additional Fisher Scenarios from the ENSR report were evaluated and are discussed below.

Monocacy River Fisher

The Monocacy River Fisher scenario assumed the Fisher lived at the RME Residential location and also ate fish from the Monocacy River. Thus, the Fisher was assumed to be directly exposed to COPCs by inhalation and indirectly exposed to chemicals via the incidental ingestion of soil, the consumption of homegrown produce from the RME Residential location and via the consumption of fish caught in the Monocacy River. Air, soil and produce concentrations were calculated based on the modeled maximum annual concentration or maximum 5-year average dry and wet deposition, regardless of whether they occurred in different locations (i.e., assumes modeled impacts at different locations are collocated). This assumption would tend to overestimate risk. Since the Fisher was assumed to live in the RME Residential area, the direct inhalation pathway was modeled using the RME Residential impacts. An exposure pathway for infants via the ingestion of breast milk was also evaluated.

As shown in Table ES-2, neither the total excess lifetime cancer risks nor the total HIs associated with indirect and direct exposures for the adult and child Monocacy Fisher scenarios

exceed the target cancer risk of 1 in 100,000 or the target HI of 0.25. The excess lifetime cancer risk estimates of 0.09 in 100,000 and 0.01 in 100,000 for the adult and child, respectively, are well below the target risk of 1 in 100,000. The total HIs of 0.0099 and 0.0079 for the adult and child receptors are well below the target HI of 0.25. In addition, the dioxin/furan intake ratio of 0.00042 for the infant receptor is well below the target of 1.0.

Resident Fisher near Farm 1

The Resident Fisher near Farm 1 scenario assumed the Resident Fisher lived in the vicinity of Farm 1 and ate fish from Farm Pond 2 (see Figure 4-3). Thus, the Resident Fisher was assumed to be directly exposed to COPCs by inhalation and indirectly exposed to chemicals via the incidental ingestion of soil, the consumption of homegrown produce and via the consumption of fish caught in Farm Pond 2. An exposure pathway for infants via the ingestion of breast milk was also evaluated.

As shown in Table ES-2, respectively, neither the total excess lifetime cancer risks nor the total HIs associated with indirect and direct exposures for the adult and child RME Fisher scenarios exceed the target cancer risk of 1 in 100,000 or the target HI of 0.25. The excess lifetime cancer risk estimates of 0.06 in 100,000 and 0.009 in 100,000 for the adult and child, respectively, are well below the target risk of 1 in 100,000. The total HIs of 0.014 and 0.01 for the adult and child receptors are well below the target HI of 0.25. In addition, the dioxin/furan intake ratio of 0.0004 for the infant receptor is well below the target of 1.0.

Resident Fisher near Farm 2

The Resident Fisher near Farm 2 scenario assumed the Resident Fisher lives in the vicinity of Farm 2 and ate fish from Farm Pond 3 (see Figure 4-3). Thus, the Resident Fisher was assumed to be directly exposed to COPCs by inhalation and indirectly exposed to chemicals via the incidental ingestion of soil, the consumption of homegrown produce and via the consumption of fish caught in Farm Pond 3. An exposure pathway for infants via the ingestion of breast milk was also evaluated.

As shown in ES-2 neither the total excess lifetime cancer risks nor the total HIs associated with indirect and direct exposures for the adult and child RME Fisher scenarios exceed the target cancer risk of 1 in 100,000 or the target HI of 0.25. The excess lifetime cancer risk estimates of 0.1 in 100,000 and 0.02 in 100,000 for the adult and child, respectively, are well below the target risk of 1 in 100,000. The total HIs of 0.025 and 0.018 for the adult and child receptors are well

below the target HI of 0.25. In addition, the dioxin/furan intake ratio of 0.00069 for the infant receptor is well below the target of 1.0.

Additional Resident Farmer Scenarios

Two additional Resident Farmer Scenarios from the ENSR report were evaluated and are discussed below.

Resident Farm 1

As discussed in the ENSR report, the Resident Farmer 1 was hypothetically assumed to live on Farm 1 (see Figure 4-3) and thus, is directly exposed to COPCs by inhalation and indirectly exposed to the COPCs via the incidental ingestion of soil, and the consumption of homegrown produce and chicken and eggs. These exposures are assumed to occur even if all the food products are not produced at the assumed farm location. In addition, it is assumed that all animal feed ingested by the food producing animals is grown on-site. An exposure pathway for infants via the ingestion of breast milk was also evaluated.

As shown in Table ES-2, neither the total excess lifetime cancer risks nor the total HIs associated with indirect and direct exposures for the adult and child Resident Farmer 1 exceed the target cancer risk of 1 in 100,000 or the target HI of 0.25. The total excess lifetime cancer risk estimates of 0.005 in 100,000 and 0.0009 in 100,000 for the adult and child, respectively, are well below the target cancer risk of 1 in 100,000. The total HIs of 0.00055 and 0.00066 for the adult and child receptor are well below the target HI of 0.25. In addition, the dioxin/furan intake ratio of 0.000013 for the infant receptor is well below the target of 1.0.

Resident Farm 6

The ENSR report evaluated a subsistence Farmer scenario in which a subsistence Farmer was located at Johnson Dairy Farm (Farm 5). Farm 5 was described as being the nearest actual beef/dairy farm location predicted to be maximally impacted by facility-related emissions. However, for this update Farm 6 was determined to be the nearest beef/dairy farm location predicted to be maximally impacted by facility-related emissions. Therefore, the Resident Farmer 6 was assumed to live on Farm 6 and thus is directly exposed to COPCs by inhalation and indirectly exposed to the COPCs via the incidental ingestion of soil, and the consumption of homegrown produce, and home-raised beef, dairy, pork, chicken and eggs. These exposures are assumed to occur even if all the food products are not produced at the assumed farm location. In addition, it is

assumed that all animal feed ingested by the food producing animals is grown on-site. An exposure pathway for infants via the ingestion of breast milk was also evaluated.

As shown in Table ES-2, neither the total excess lifetime cancer risks nor the total HIs associated with indirect and direct exposures for the adult and child Resident Farmer 6 exceed the target cancer risk of 1 in 100,000 or the target HI of 0.25. The total excess lifetime cancer risk estimates of 0.02 in 100,000 and 0.006 in 100,000 for the adult and child, respectively, are well below the target cancer risk of 1 in 100,000. The total HIs of 0.0036 and 0.0057 for the adult and child receptor are well below the target HI of 0.25. In addition, the dioxin/furan intake ratio of 0.0011 for the infant receptor is well below the target of 1.0.

Acute Inhalation Scenario

As shown in Table ES-2, the total acute inhalation index (AHI) associated with the acute inhalation of the one-hour maximum air concentrations of the stack emissions is 0.054, which is less than the acute target AHI of 1.0.

Groundwater

Since groundwater wells and not surface water are the source of drinking water in the area, the drinking water pathway was not evaluated in the HHRA. However, due to a local concern that emissions from the RRF are depositing onto soils and leaching into groundwater, a comparison of maximum predicted soil concentrations to groundwater protection soil screening levels (SSLs) (USEPA, 2013c) was conducted.

Deposition of facility emissions onto surrounding soils does not pose a risk to groundwater drinking wells. A comparison of maximum predicted soil concentrations potentially associated with stack emissions to USEPA's groundwater protection soil screening levels (SSLs) showed that the predicted soil concentrations were well below the SSLs by more than 430 times (for cobalt) to more than 370 billion times (for 2-methylnaphthalene) (Table ES-3).

Conclusion

This HHRA was conducted using USEPA's 2005 HHRAP guidance. Assumptions used in the HHRA were meant to be health protective and would tend to overestimate risk. For example, the RME Resident, RME Fisher, MEI A and B receptors and the Monocacy River Fisher scenarios all assume that exposure occurs regardless if modeled impacts occur at different locations (i.e., assumes modeled impacts at different locations are collocated). All Farmer scenarios assume that

all the food products consumed are grown on the property, including the feed (forage, silage and grain) ingested by the food producing animals. This would overestimate exposure if feed is actually bought and not grown on the property.

It can be concluded from the results of the HHRA that potential risks associated with stack emissions from the RRF are below regulatory and other target risk levels for human health. All calculated cancer risks were approximately 10 to 250 times less than the cancer target level of 1 in 100,000, while calculated noncancer hazard indices were approximately 10 to 600 times less than the noncancer target level of 0.25. Calculated infant exposures to TCDD were approximately 500 to 34,000 times less than the 60 pg/kg/day background comparison value. These results indicate a very low likelihood that potential health effects would occur as a result of exposure to RRF emissions under the various exposure conditions evaluated in this HHRA.

Table ES-1
Summary of Receptor Scenarios
Montomery County RRF
Dickerson, MD

	Soil	Produce	Beef	Dairy	Pork	Chicken	Eggs	Fish	Inhalation	Point of Modeling Impacts (a)
RME Scenarios										
Reasonable Maximum Exposed Resident	x	x							x	Maximum wet and dry deposition, maximum air concentrations, assumed to be collocated in same location
Reasonable Maximum Exposed Fisher (Potomac River)	x (a)	x (a)						x	x (a)	Maximum wet and dry deposition, maximum air concentrations, assumed to be collocated in same location. Average over Potomac River and watershed
Reasonable Maximum Exposed Farmer (Farm 2)	x	x	x	x	x	x	x		x	Potential farm location with highest potential concentration and depositional impacts. Concentration and depositional impacts at Farm 2.
MEI Scenarios										
Maximally Exposed Individual A	x	x	x (b)	x (b)	x (b)	x (b)	x (b)	x (c)	x	Maximum dry particle deposition, maximum air concentration, assumed to be collocated in same location
Maximally Exposed Individual B	x	x	x (b)	x (b)	x (b)	x (b)	x (b)	x (c)	x	Maximum total particle and vapor deposition, secondary maximum air concentration, assumed to be collocated in same location
Additional Fisher Scenarios										
Monocacy River Fisher	x (a)	x (a)						x	x (a)	Maximum wet and dry deposition, maximum air concentrations, , assumed to be collocated in same location. Average over Monocacy River and watershed
Resident Fisher near Farm 1 (Fishes Farm Pond 2)	x	x						x	x	Concentration and depositional impacts at Farm 1 and Farm Pond 2
Resident Fisher near Farm 2 (Fishes Farm Pond 3)	x	x						x	x	Concentration and depositional impacts at Farm 2 and Farm Pond 3
Additional Resident Farm Scenarios										
Resident Farm 1	x	x				x	x		x	Concentration and depositional impacts at Farm 1
Resident Farm 6	x	x	x	x	x	x	x		x	Actual farm location with highest potential concentration and depositional impacts. Concentration and depositional impacts at Farm 6.
Acute (1-hr) Hazard Index									x	Maximum 1-hr air concentrations, , assumed to be collocated in same location

(A) It should be noted that each modeling parameter (air concentration, vapor, dry and wet deposition) each have a vapor, particulate and particle-bound component. So even with in a modeling parameter (e.g., air concentration), the vapor, particulate and particulate-bound fractions may not impact the same location. In addition, AERMOD models the vapor phase of the COPCs individually which can potentially result in the maximums for each COPC also impacting in different locations. For the purpose of this risk assessment, they were assumed to all be collocated at the receptor location. This would tend to overestimate risk.

x - exposure pathway at receptor location, unless otherwise footnoted:

(a) Resides at location of RME resident, therefore same inhalation, soil and produce exposure as RME Resident

(b) Obtains beef, dairy, pork, chicken and eggs from Farm 6

(c) Ingests fish from the Potomac River

Table ES-2
Summary of Total Excess Lifetime Cancer Risk and Total Noncancer HIs
Montomery County RRF
Dickerson, MD

	Cancer Risk		Chronic Noncancer HI			Acute
	Adult	Child	Adult	Child	Infant	HI
Reasonable Maximum Exposed Scenarios						
RME Resident	0.01E-05	0.003E-08	0.0012	0.0018	0.00003	
RME Fisher (a)	0.1E-05	0.02E-05	0.012	0.0095	0.00023	
RME Farmer (a)	0.06E-05	0.01E-05	0.0069	0.011	0.0022	
Maximally Exposed Individual Scenarios						
MEI A (a)	0.1E-05	0.02E-05	0.016	0.015	0.0014	
MEI B (a)	0.1E-05	0.02E-05	0.015	0.015	0.0014	
Additional Fisher Scenarios						
Monocacy River Fisher (a)	0.09E-05	0.01E-05	0.0099	0.0079	0.00042	
Resident Fisher near Farm 1 (Fishes Farm Pond 2) (a)	0.06E-05	0.009E-05	0.014	0.01	0.0004	
Resident Fisher near Farm 2 (Fishes Farm Pond 3) (a)	0.1E-05	0.02E-05	0.025	0.018	0.00069	
Additional Resident Farm Scenarios						
Resident Farm 1 (a)	0.005E-05	0.0009E-05	0.00055	0.00066	0.000013	
Resident Farm 6	0.02E-05	0.006E-05	0.0036	0.0057	0.0011	
Acute (1-hr) Hazard Index						0.054
Cancer and Non-Cancer Target Values (b)	1E-05	1E-05	0.25	0.25	1	1

Table ES-3
Comparison of Predicted Soil Concentrations to Groundwater Protection Soil Screening Levels (SSLs)
Montomery County RRF
Dickerson, MD

	Protection of Ground Water SSLs (a)			
	MCL-based SSL (mg/kg)	Risk-Based SSL (mg/kg)	Maximum Soil Concentration (mg/kg)	SSL vs. Soil Conc.
Inorganics				
Antimony	0.27		0.0000000001	1,968,361,786
Arsenic	0.29		0.00000012	2,398,189
Beryllium	3.2		0.000026	121,410
Cadmium	0.38		0.000010	36,779
Chromium +3	180000 (b)		0.00090	199,983,752
Chromium +6	180000 (b)		0.00037	488,513,726
Cobalt		0.21	0.00048	437
Copper	46		0.0069	6,652
Lead	14		0.0017	8,112
Manganese		21	0.0051	4,099
Mercury as HgCl2	0.1		0.00019	539
Mercury as Methyl Hg	0.1		0.0000038	26,552
Nickel		20	0.000017	1,169,168
Selenium	0.26		0.0000024	106,341
Zinc		290	0.00018	1,622,323
Dioxins/Furans				
2,3,7,8-TCDD-TEQ	0.000015		0.0000000017	9,010
PCBs				
Total PCBs	0.078		0.000000056	1,404,124
PAHs				
Acenaphthene		4.1	0.000000073	55,917,219
Acenaphthylene	NA	NA	0.000000000017	NC
Anthracene		42	0.000000083	504,067,054
Benzo(a)anthracene	0.24 (c)		0.0000015	160,315
Benzo(a)pyrene	0.24		0.0000018	134,469
Benzo(b)fluoranthene	0.24 (c)		0.00000041	589,834
Benzo(k)fluoranthene	0.24 (c)		0.0000045	52,757
Benzo(ghi)perylene			0.000000067	NC
Chrysene	0.24 (c)		0.0000089	27,084
Dibenzo(a,h)anthracene	0.24 (c)		0.000063	3,822
Fluoranthene		70	0.00000018	395,146,572
Fluorene		4	0.000000014	291,425,788
Indeno(1,2,3-cd)pyrene	0.24 (c)		0.000040	6,015
2-Methylnaphthalene		0.14	0.00000000000038	371,798,675,437
Naphthalene		0.00047	0.000000013	36,947
Phenanthrene	NA	NA	0.0000010	NC
Pyrene		9.5	0.00000072	13,145,730
Aldehyde Ketones				
Formaldehyde		0.62	0.0000084	73,567

(a) When no MCL-based SSL is available, risk-based SSL is used. From USEPA RSL Tables (USEPA 2013c)
(b) MCL for Total Chromium
(c) MCL for cPAHs based upon benzo(a)pyrene
NA = Not Available
NC = Not Calculated

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LIST OF APPENDICES – Provided in attached CD-ROM

LIST OF ACRONYMS

ADD	Average Daily Dose
ADI	Average Daily Intake
AEGL	Acute Exposure Guidelines
AERMOD	AMS/EPA Regulatory Model
AHQ	Acute Hazard Quotient
AIEC	Acute Inhalation Exposure Criteria
APC	Air Pollution Control
ATSDR	Agency for Toxic Substances and Disease Registry
AT	Averaging Time
BPIPPRM	Building Profile Input Program for PRIME
CalEPA	California Environmental Protection Agency
CEM	Continuous Emissions Monitor
CFR	Code of Federal Regulations
CO	Carbon Monoxide
COPC	Chemical of Potential Concern
DL	Detection Limit
EF	Exposure Frequency
ED	Exposure Duration
EDL	Estimated Detection Limit
ES	Executive Summary
ERAP	Ecological Risk Assessment Protocol
ERPG	Emergency Response Planning Guidelines
FR	Federal Register
FY	Fiscal Year
GEP	Good Engineering Practice
GIS	Geographical Information System
GOF	Goodness of Fit
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HHRAP	Human Health Risk Assessment Protocol
HI	Hazard Index
HSDB	Hazardous Substance Database
HQ	Hazard Quotient
IRIS	Integrated Risk Information System
ISCST3	Industrial Source Complex Short-Term 3
LADD	Lifetime Average Daily Dose
LULC	Land Use and Land Cover

LIST OF ACRONYMS
(Continued)

Mg/kg	Milligram per kilogram
Mg/kg-d	Milligram per kilogram per day
Mg/m^3	Milligram per cubic meter of air
MCL	Maximum Contaminant Level
MD DNR	Maryland Department of Natural Resources
MDE	Maryland Department of the Environment
MDL	Method Detection Limit
MEI	Maximally Exposed Individual
ND	Non-Detect
NED	National Elevation Dataset
NLCD	National Land Cover Dataset
NOx	Nitrogen Oxide
NWS	National Weather Service
O_2	Oxygen
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PCDD/PCDF	Polychlorodibenzo-dioxin/ polychlorodibenzo-furan
PPRTV	Provisional Peer Reviewed Toxicity Values
pg/kg-day	Picograms/kilogram-day
RAGs	Risk Assessment Guidance for Superfund
RAIS	Risk Assessment Information System
REL	Reference Exposure Level
RDL	Reliable Detection Limit
RfD	Reference Dose
RfC	Reference Concentration
RME	Reasonable Maximum Exposure
RL	Reporting Limit
RRF	Resource Recovery Facility
RSL	Regional Screening Level
SCAPA	Subcommittee for Consequence Assessment and Protective Action
SD	Standard Deviation
SF	Surface
SNCR	Selective Non-Catalytic Reduction
SSL	Soil Screening Level
STSC	Superfund Technical Support Center
SVOC	Semivolatile Organic Compound

LIST OF ACRONYMS
(Continued)

TCDD	Tetrachlorodibenzo-p-dioxin
TEEL	Temporary Emergency Exposure Limits
TOC	Total Organic Carbon
TOE	Total Organic Emissions
TEF	Toxic Equivalent Factor
TEQ	Toxicity Equivalence
UA	Upper Air
UCL	Upper Confidence Limit
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
ug/dl	Microgram per deciliter
ug/m^3	Microgram per cubic meter of air

1.0 INTRODUCTION

The Montgomery County Resource Recovery Facility (RRF), located in Dickerson, MD began operations in 1995. The Facility is owned by the Northeast Maryland Waste Disposal Authority on behalf of the County. Covanta Montgomery, Inc. operates the facility. The ten year annual average RRF throughput for fiscal year (FY) 2003 through 2012 (FY03-FY12) was 582,309 tons of waste (Davidson 2013; personal communication).

The County made commitments to the Dickerson community to conduct human health risk assessments relative to RRF emissions and environmental monitoring during both preconstruction (pre-operational) and post-construction (operational) phases. From 1997 through 2011, the County conducted environmental monitoring programs for ambient air and non-air environmental media generally on a five (5) year and three (3) year periodic basis, respectively, pending budgetary appropriations. The County's most recent non-air media monitoring event was conducted during June of 2007 (ENSR 2009), and its most recent ambient air monitoring event was conducted during the winter of 2008 (AECOM 2010).

The RRF has been the subject of two previous human health risk assessments sponsored by the County in one in 1989 (pre-construction) and the other published in 2006 (post-construction). A separate HHRA was also conducted by the Maryland Department of Natural Resources, also in 1989. The 1989 health risk assessments were based on literature-based emissions and engineering data available at that time and followed assessment protocols generally accepted at that time. The 2006 ENSR risk assessment relied on measured emissions data from stack tests, one year of onsite meteorological data available for the RRF, and the now obsolete 1998 Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities (USEPA 1998a and 1999a). The 2006 ENSR risk assessment included the chemicals of potential concern (COPCs) identified from the literature research in the County's 1989 assessment and supplemented that list with additional species identified in the stack testing data. Ultimately, the acute (i.e., short-term) and chronic (i.e., long-term) risks associated with a suite of 19 COPCs including metals, inorganics, dioxins/furans, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and formaldehyde were assessed.

The ENSR health risk assessment update used the USEPA's Industrial Source Complex (ISC) model. The ISC modeling was conducted with one year of onsite meteorological data and predicted ambient air concentrations as well as wet, dry and total deposition to estimate exposures via inhalation and ingestion pathways.

Overall, the human health risk assessments showed that potential risks due to emissions from the Montgomery County RRF facility are within the range of or below regulatory and other target risk levels for human health. The 2006 ENSR report concluded that "*the relative risk of harm to human health presented by the RRF, as it is operating today, is very low. In fact, the results indicate a very low chance (less than 1 chance in 1 million) for occurrence of potential carcinogenic health effects, and that no adverse noncarcinogenic health effects are expected as a result of exposure to facility related emissions*."

This Human Health Risk Assessment (HHRA) updates the ENSR risk assessment with the following changes:

- Updated the dispersion/deposition modeling from ISCST3 (Industrial Source Complex Short-Term 3) to AMS/EPA Regulatory Model (AERMOD), the current USEPA approved model,
- Updated equations to reflect current USEPA guidance and included additional receptors (Reasonable Maximum Exposed (RME) Resident, RME Fisher and RME Farmer) per the 2005 HHRAP Guidance,
- Updated emission rates for metals, dioxins/furans, PCBs, PAHs and formaldehyde to include all stack testing results from start of operations (1995) through August 2013,
- Included acid gas emission rates (hydrogen chloride, hydrogen fluoride and sulfuric acid) for acute inhalation,
- Used 95% Upper Confidence Limit (UCL) of the mean emission rates,
- Included non-detected emissions at full detection limit, and
- Reviewed and updated toxicity criteria to the most current values provided by USEPA.

This HHRA provides theoretical estimates of individual risk for a variety of exposure scenarios and includes an evaluation of potential risks associated with direct and indirect exposures. For the purposes of this document, direct exposures are defined as those associated with the inhalation of chemicals released via stack emissions. Exposures to chemicals in surface soils, and food (produce, beef, dairy, pork, chicken, eggs and fish), following deposition on to soils, plants, and surface water bodies are considered indirect exposures, as are potential exposures associated with breast milk ingestion.

This HHRA evaluated a variety of potential receptors to capture a range of exposure scenarios in the vicinity of the RRF. Three RME exposure scenarios addressing potential long-

term exposure and risks, not previously considered in the 2006 ENSR risk assessment, were evaluated. In addition, seven long-term exposure and risk scenarios that were evaluated in the 2006 ENSR report were addressed. An acute inhalation risk scenario and potential impacts associated with breast milk ingestion by an infant were also evaluated. The methods used to evaluate exposures and risks were consistent with current USEPA guidance and are designed to tend to overestimate potential risks (i.e., be health protective).

Following the Risk Assessment Guidance accepted by the USEPA, the basic components of the HHRA for the RRF are organized and presented as follows:

- Data Collection and Evaluation (Section 2)
- Air Dispersion and Deposition Modeling (Section 3)
- Exposure Assessment (Section 4)
- Toxicity Assessment (Section 5)
- Risk Characterization (Section 6)
- Uncertainty Assessment (Section 7)

2.0 FACILITY CHARACTERIZATION

The facility characterization component of the HHRA is comprised of compiling basic facility information, identifying emission sources, estimating emission rates, and identifying COPCs.

2.1 Facility Information

The Facility is owned by the Northeast Maryland Waste Disposal Authority on behalf of the County and is operated by Covanta Montgomery, Inc. The facility is located approximately two miles southwest of the town of Dickerson, MD, in Montgomery County. Montgomery County is situated just to the north of Washington, D.C., and southwest of the city of Baltimore. The County has a population of approximately 1,004,779 and a land area of 491 square miles (US Census Bureau 2013). Figure 2-1 presents a plot plan of the facility and Figure 2-2 presents an aerial view of the facility and surrounding area.

The Montgomery County RRF has a design capacity to process up to 1,800 tons of solid waste each day, generating up to 63 megawatts of electricity. The facility, designed and built by Ogden Projects, has three (3) Martin GmbH Stokers and Distral waterwall furnaces that each processes up to 600 tons of waste per day. Waste is combusted at furnace temperatures exceeding 1,800 degrees Fahrenheit and reduced to an inert ash residue. Before leaving the facility, combustion air is directed through technologically advanced air pollution control (APC) equipment. The APC equipment consists of a dry scrubber and fabric filter baghouse for controlling acid gases, particulates and organics, direct lime injection into the furnace for additional acid gas control, ammonia injection at the top of the furnace for nitrogen oxide control and activated carbon injection at the scrubber inlet for mercury control. In addition, the combustion residue is treated with dolomitic lime for minimizing leaching of metals from the residue. Data from continuous emissions monitoring (CEM) systems are sent to a data logging recorder located in the control room.

The area surrounding the RRF facility is rural, the majority of which is designated as Agricultural Reserve (Montgomery County 2008). Within a 10-kilometer radius of the RRF, the majority of the area is used for agricultural purposes. The remaining area is woodland with some open land and scattered small towns and residential housing. The NRG coal-fired power plant facility is located 0.5 miles to the northwest of the RRF, and a leaf composting operation is located 0.3 miles to the southeast of the RRF. A few residences are located within two miles of the facility.

Three townships (Beallsville, Barnesville, and Dickerson) are located within five miles of the RRF (ENSR 2006).

Several recreational areas are located within ten kilometers of the facility. These include the Chesapeake and Ohio Canal National Park that runs along the Potomac River, the Dickerson Regional Park, the Monocacy River Natural Resources Management Area which is comprised of 1,800 acres of natural areas and farmlands along the Monocacy River, and Sugarloaf Mountain. Both the Potomac and Monocacy Rivers are located within 10 km (see Figure 3-2) and are used for fishing and other recreational purposes. There are several other smaller water bodies, including the Little Monocacy River and several unnamed tributaries of the Potomac River within a one-mile radius of the site. In addition to the major rivers and tributaries in the area, several small ponds can also be found in the vicinity of the RRF. The nearest drinking water intake on the Potomac River serves the City of Leesburg, VA and is located approximately 7.5 miles downstream from the facility. Drinking water in the local area is supplied by private wells (ENSR 2006).

2.2 Emission Sources

The emission sources for this facility are the three (3) Martin GmbH Stokers and Distral waterwall furnaces, each exhausting out of a separate flue, but wrapped in a single stack.

2.3 Stack Emission Characterization Data

This updated HHRA is based on emissions data collected from the stacks of Units 1, 2 and 3 from 1995 through 2013. These data are collected as part of the annual air emissions testing program which is conducted to quantify specific emissions from Units 1, 2, and 3 for determining compliance status. The RRF must comply with the requirements of Maryland Department of the Environment (MDE) Permit # 24-031-01718, as well as Federal standards. The methods used to collect and analyze stack emissions are conducted in accordance with USEPA methodologies specified in the Title V Air Operating Permit issued to the Facility. Those methodologies are designed by the USEPA to assure representative sampling. The stack testing is conducted by independent testing firms that are accredited by the State of Maryland and by the USEPA. The stack test results are submitted directly to, and reviewed by, the State of Maryland. The laboratories used for the chemical analyses are audited in accordance with USEPA requirements. Each lab performs quality control procedures to ensure that the results are accurate,

and each lab report is certified true, accurate, and complete by a registered professional engineer. These data sets are presented in Appendix A.

Metals, dioxins/furans, PCBs, PAHs and formaldehyde were evaluated in the 2006 ENSR health risk study and were also carried through in this updated HHRA. As described in ENSR 2006, these COPCs were similar to those identified by Weston (1989) for the pre-operational risk assessment for this facility, and thus using the same COPCs provides continuity among the three risk assessments. Mercury was not speciated during the compliance stack testing. Mercury emission rates were calculated based upon measured mercury in the stack. Speciation of mercury into mercuric chloride and methyl mercury was conducted during the calculation of various media (soils, foodstuffs, water) in accordance with the USEPA HHRAP. In addition, hydrogen chloride, hydrogen fluoride and sulfuric acid were included in the evaluation of short-term inhalation risks to these acid gases. It should be noted that for each dioxin and furan congener, its dioxin/furans, toxicity equivalency factor (TEF, USEPA 2011a) was applied to its emission rate and then summed to obtain a total 2,3,7,8-Tetrachlorodibenzo-p-dioxin toxicity equivalence (TCDD-TEQ) which was then evaluated as a COPC. The dioxin/furan TEFs and calculation of the TCDD-TEQ can be found in Table 2-1.

For this updated HHRA, the 95% Upper Confidence Limit (UCL) of the arithmetic mean emission rates of the stack emission tests from 1995 through 2013 were used for metals, dioxins/furans, PCBs, PAHs, and formaldehyde, while the emission rates for the acid gases were from the stack emission tests from 2001 through 2013. The 95% UCL was used as a conservative estimate of the mean concentration of each COPC in emissions. The 95% UCL takes into account that we do not have all the information about all the possible sampling days and makes a conservative (i.e., health protective) estimate of what the true concentration over all possible sampling days would be. The 95% UCLs were calculated using USEPA's rigorous statistical program, ProUCL 5.0 (USEPA 2013a) and the results are presented in Appendix B. ProUCL 5.0 has graphical, estimation, and hypotheses testing methods for uncensored-full data sets and for left-censored data sets consisting of nondetect (ND) observations with multiple detection limits (DLs) or reporting limits (RLs). In addition to computing general statistics, ProUCL 5.0 has goodness-of-fit (GOF) tests for normal, lognormal and gamma distributions, parametric and nonparametric methods including bootstrap methods for skewed data sets to compute various decision-making statistics such as UCLs of the mean (USEPA 2013a). For data sets with and without ND observations, ProUCL computes statistics using parametric and nonparametric

methods covering a wide-range of data skewness, data distributions, and sample sizes and recommends the appropriate UCL value based upon those statistics.

In those cases where the ProUCL recommended 95% UCL is the H-statistic, information provided by the ProUCL Technical Guidance (Table 2-10, USEPA 2013b) was used to determine whether the H-statistic was appropriate or whether an alternate value should be selected. ProUCL generally does not recommend using the H-statistic because it yields an unstable value and can be biased either high or low. However, the number of samples and the standard deviation of the log-transformed data set fell within the specified ranges (log standard deviations greater or equal to 0.5, but less than 1.0 for all number of samples; or log standard deviations greater or equal to 1.0 but less than 1.5 for more than 25 samples), it was determined that the H-statistic was an appropriate value. Finally, in some cases where the data set contained predominantly non-detect values, the calculated 95% UCL was higher than the maximum detected sample. In the case of the metals, where there were only 3 samples, all calculated UCL values exceeded the maximum detected value, therefore the maximum detected value was used as the UCL. In the case of the PAHs, ProUCL selected the 99% Chebyshev (Mean, SD) UCL however these values were greater than the maximum detected value. In this case the 95% Chebyshev (Mean, SD) UCL was chosen as the alternate value. Table 2-2 lists the chemicals and the 95% UCL emission rates that were carried through this HHRA.

Table 2-3 provides a comparison of the average emission rates based on 1995 – 2013 data (current update) to the average emission rates used in the ENSR study based on 1995 to 2000 data. Also shown are the 95% UCLs used in this HHRA. Use of 95% UCLs in this study provides a more conservative estimate of potential COPC concentrations in emissions compared to the 2006 ENSR assessment. Table 2-3 provides a comparison of the 2013 95% UCL and average emission rates to the average emission rates used in ENSR 2006 risk assessment update. As shown in Table 2-3, the 95% UCL emission rates of three metals (total chromium, cobalt and mercury) are less than the emission rates as compared to the emission rates used in the ENSR report, while the emission rates of eleven metals (antimony, arsenic, beryllium, cadmium, chromium +6, copper, lead, manganese, nickel, selenium and zinc), PCBs and PAHs were higher than those used in the ENSR report. When comparing the average emission rates to the ENSR 2006 emission rates, the average emission rates of five metals (chromium +6, cobalt, copper, mercury and nickel) and TCDD-TEQ appear to have decreased as compared to the emission rates used in the ENSR report, while the average emission rates of nine metals (antimony, arsenic, beryllium, cadmium, total chromium, lead, manganese, selenium and zinc), PCBs and PAHs appear to have increased.

2.3.1 Treatment of Non-Detects in Calculating Emission Rates

Each stack test consisted of three runs performed for each unit and several parameters analyzed. Stack flue gas concentrations, gas composition, flow rates, and emission rates are provided in the stack test reports. In many cases, the various compounds tested for were not detected based on the analytical method used in the measurement program. For such compounds, guidance provided in the USEPA's 2005 HHRAP was used for estimating emissions associated with measurements below detection limits. For those compounds that were analyzed for, but not detected in an emission test run, the emission rates were numerically based on the method detection limit (MDL) or estimated detection limit (EDL) as supplied in the laboratory results. A detection limit is the lowest level of an analyte that can be detected using a particular analytical method.

USEPA's commonly used definition for the detection limit for non-isotope dilution methods (used for measuring metals and some organic compounds such as PCBs and formaldehyde) is the MDL. The MDL is reported with 99% confidence that the analyte concentration is greater than zero. To increase consistency and reproducibility with nondetects for emissions data, the 2005 HHRAP guidance (USEPA 2005a) recommends calculating a MDL-derived Reliable Detection Limit (RDL), by multiplying the MDL by a factor of 2.623. Therefore, for metals, PCBs and formaldehyde not detected during a test run, their respective detection limit was multiplied by a factor of 2.623 before being utilized in the calculation of the overall emission rate.

The EDL is used in reporting the detection limit for isotope dilution methods (used for measuring dioxin/furans and PAHs) and is specific to a particular analysis of the sample and affected by sample size, dilution, etc. Consistent with the 2005 HHRAP guidance, for dioxin/furans and PAHs not detected during a test run, the detection limit was quantified by the EDL with no application of an empirical adjustment factor.

In calculating the 95% UCL emission rates, and consistent with the HHRAP Guidance, emission rate estimates for non-detected COPCs were assumed to be present at a concentration equivalent to either the MDL-derived RDL for non-isotope dilution methods or the EDL, for isotope dilution methods. Therefore, the non-detect emission rates were treated as detected concentrations, which will tend to overestimate the UCL resulting in a more health-protective evaluation. This particularly true for the PAHs, in particular dibenz(a,h)anthracene which was detected in only 4 of 59 samples (see summary statistics in Appendix A). In addition, the maximum non-detect concentration was four times higher than the maximum detected concentration (1.47E-05 g/sec vs 4.11E-06 g/sec). Therefore, the use of the full reporting limit for PAHs may overestimate the PAH emission rates

evaluated in this risk assessment. In the case of dibenz(a,h)anthracene, the chosen UCL values for each of the three units (see Table 2-2) exceed the actual maximum detected concentration of 4.11E-06 g/sec, thus the use of the non-detects overestimates the emission rate used in the risk assessment.

2.4 Fugitive Emissions and Upset Emissions

2.4.1 Fugitive Emissions

The USEPA HHRAP guidance indicates that the issue of fugitive emissions should be addressed within the HHRA. The RRF handles primarily dry material using bulk loading, transportation and unloading equipment (covered shipping containers, enclosed conveyers, etc.). The facility does not handle liquid or gaseous waste, and thus does not have the pumps, valves, flanges, etc. needed to handle these waste streams. Commonly, leaks in liquid and gaseous waste stream handling equipment may emit volatile compounds that could become airborne fugitives. However, since the RRF does not handle these waste streams, the analysis of potential fugitive emissions is limited to particulate matter as a result of the handling and disposal of ash.

Incoming waste arrives via railcar in enclosed shipping containers. The containers are transferred to the enclosed tipping floor which is generally maintained under negative pressure, effectively preventing significant emissions from the tipping hall. The wastes are conveyed to the combustion units where the non-combustible heavy ash and metal items fall to the bottom of the furnace as bottom ash. Bottom ash consists of large particles that do not readily become airborne. While the combustion gases continue to move through the boiler, the bottom ash slowly makes its way to the end of the grate, where it falls into the water quench trough of the Martin Ash Discharger. The lighter particles that are carried with the combustion gases out of the furnace are effectively removed by the high-efficiency baghouses. The baghouses remove more than 99.9 percent of the particulate matter from combustion gases. The particles captured by the baghouses are referred to as fly ash. Captured fly ash particles fall into enclosed hoppers and are transported by an enclosed conveyor system to the Martin Ash Dischargers, where they are moistened to prevent dust, and mixed with the bottom ash from the grate. The wetted combined ash is sent through a Grizzly Separator to remove large pieces of metal, which are recycled. After the Grizzly Separator, the wetted combined ash is transferred by an enclosed screw conveyor to the Residue Handling Building where it is loaded into enclosed containers for rail shipment to Old Dominion Landfill in Henrico County, VA. Once at the landfill, it is screened into two grades for use as road base and Alternate Daily Cover (ADC), within the confines of modern permitted landfills owned

by Republic Services. After processing, the ash represents approximately 10% of the original waste volume and roughly one-third of the original waste weight (Montgomery County 2013b).

The, potential for fugitive particulate emissions at the RRF is routinely assessed as part of the annual air emissions compliance testing using USEPA Method 22 - Fugitive Opacity. No fugitive emissions have been reported in the compliance test reports. Nonetheless, to be conservative, USEPA's emission factor for municipal solid waste fly ash drop loading operations (USEPA 2006, Chapter 13.2.4, equation 1) was applied to the fly ash portion of the ash loaded at the Residue Handling Building. The 1997 to 2012 annual average total ash production for the RRF was 155,743 tons per year, 25 percent of which is assumed to be fly ash that could potentially become airborne (SWA 2013). Using USEPA's average moisture content for fly ash (27 percent), the annual average wind speed at the site (2.2 meters per second) and USEPA's aerodynamic particle size multiplier (k=0.74) for particles ≤ 30 microns aerodynamic diameter, the fugitive fly ash emission rate was calculated as 2.4 lb/yr. This fly ash emission rate applies to large particles that are not of inhalable size and thus will overestimate emissions that are relevant for assessing potential inhalation exposures. Note that this rate applies to open air drop operations at a landfill site and does not take into account the effect of any enclosed structure (such as the Residue Handling Building). The State of Colorado has determined that fly ash loading operations within buildings may have a 90 percent emission control factor (CDPHE 2011). However, to be conservative, no credit was taken for particulate emission reductions due to the presence of the Residue Handling Building. Fugitive emissions were only calculated for those COPCs characterized as particulates (See Table 2-4). Particle-bound COPCs are assumed to form after the particles have exited the stack (a percentage of the vapor phase adsorbs onto the particle surface area, especially as the plume cools to ambient air temperature). Therefore-particle-bound COPCs were assumed to solely exit from the main RRF stack, and were not included as part of the fugitive emissions. These particle phase fugitive emissions were added to the stack concentration and deposition modeling parameters used in the calculation of COPC concentrations in air, soil, produce, fish and farm-raised products (beef, dairy, pork, chicken and eggs). Appendix C contains the fugitive emission impacts.

2.4.2 Upset Emissions

The potential for upset emissions was evaluated by reviewing the operational history of the RRF following the guidelines provided in USEPA's 2005 HHRAP. As required by Maryland

Department of Environment Permit No. 24-031-01718 for the RRF, the CEM system automatically and continuously measures and records concentrations of carbon monoxide (CO), sulfur dioxide, oxides of nitrogen, oxygen, hydrogen chloride, and opacity, as well as steam flow, baghouse pressure drop and Scrubber inlet and outlet temperature for each unit. Outputs from the CEM are sent to a data logging recorder. Current running values, system status, and emission alarms are displayed full time on the screen in the control room. A daily report is available each day consisting of calibration, hourly data, opacity, 24-hour rolling average, excessive emissions, and system down time. The data from the recorder is backed-up daily.

The 2005 HHRAP indicates that, if available, site specific data such as continuous monitoring data for stack opacity can be used to estimate upset emissions for metals and CO data can be used to estimate upset emissions for organic compounds. The potential for upset emissions was evaluated by reviewing the 24 months of daily CEM data for opacity and CO. The available data are summarized in Appendix D, Figures D-1 (Opacity) and Figure D-2 (CO).

Metal Compounds

Figure D-1 shows that 305,455 6-minute averages were at 0% opacity, 171,391 6-minute averages were in the range of greater than 0% to less than or equal to 1% opacity, 33,449 6-minute averages were in the range of greater than 1% to less than or equal to 2%, 4,122 6-minute averages were in the range of greater than 2% to less than or equal to 3%. Only 46 6-minute averages were greater than 3% opacity. Upset conditions can be defined as those periods when opacity was significantly above the normal operating range. Based on the distribution of data, the normal operating range can be defined to be in the 0% to 3% opacity. Only 0.0089% of the data are above this range. This is a conservative estimate of the time in upset as the opacity standard is 10%. The calculated upset factor based on the observed data showing 0.00089% of the operating time above 3% opacity is 1.000801 as calculated below:

$$(99.9911/100) \times 1 + (0.0089/100) \times 10 = 1.000801.$$

This value is negligible and was therefore not applied to metals emissions in the HHRA.

Organic Compounds

Figure D-2 shows that 158 hourly averages were at 0 ppm CO, 7,513 hourly averages were in the range of greater than 0 ppm to less than or equal to 5 ppm CO and 12,284 hours were in the range of greater than 5 ppm to less than or equal to 10 ppm CO. Most of the data are in the range

of 5 ppm to 20 ppm CO. Only 282 hours out of a total 44,444 hours were greater than 50 ppm CO. The stack test data were collected under normal operating conditions with CO generally in the 5 ppm to 50 ppm range. It is TRC's opinion that small deviations from this range do not constitute an upset condition that would increase organic emissions by a factor of 10. However, to be conservative, the upset condition was defined as only periods when CO emissions exceed 50 ppm. The calculated upset factor based on the observed data showing 0.63% of the hours above 50 ppm is 1.0571 as shown below:

$$(99.37/100) \times 1 + (0.63/100) \times 10 = 1.0571$$

The organics process upset factor of 1.057 was applied to organic emissions in the HHRA. Both chronic and short term risks were considered under upset conditions. The application of the process upset factor and its impact on the results of the HHRA are discussed in the Section 7.0, Uncertainty Assessment. Table 2-5 summarizes the overall process upset factors for metals and organic compounds.

3.0 AIR DISPERSION AND DEPOSITION MODELING

Data collected from annual compliance tests (1995 through 2013) as discussed in Section 2.2, onsite meteorological observations and other facility data were used as input to a USEPA recommended air quality dispersion model to predict one-hour and long-term (five-year) average concentrations and deposition rates for pollutants emitted by the RRF. The modeling approach follows USEPA's Human Health Risk Assessment Protocol (HHRAP; USEPA 2005a).

3.1 Description of Models Selected

The latest version of USEPA's AERMOD (Version 12345) model was used to predict airborne concentrations and surface deposition rates of emissions from the RRF. The model, together with its documentation, is available on USEPA's Support Center for Regulatory Atmospheric Modeling website.

The application of USEPA's Industrial Source Complex Model (ISCST3) is detailed in the HHRAP for assessing the impacts of emissions from waste combustor facilities, however since the HHRAP was issued in 2005, USEPA has adopted AERMOD as its preferred regulatory model and has stopped supporting ISCST3. In the "Guideline on Air Quality Models" (USEPA 2005c) USEPA describes AERMOD as follows:

> "AERMOD is a steady-state plume dispersion model for assessment of pollutant concentrations from a variety of sources. AERMOD simulates transport and dispersion from multiple point, area, or volume sources based on an up-to-date characterization of the atmospheric boundary layer. Sources may be located in rural or urban areas, and receptors may be located in simple or complex terrain. AERMOD accounts for building wake effects (i.e., plume downwash) based on the PRIME building downwash algorithms. The model employs hourly sequential preprocessed meteorological data to estimate concentrations for averaging times from one hour to one year (also multiple years). AERMOD is designed to operate in concert with two pre-processor codes: AERMET processes meteorological data for input to AERMOD, and AERMAP processes terrain elevation data and generates receptor information for input to AERMOD."

AERMOD is listed in the HHRAP, has gained broad regulatory acceptance and is applicable to the emission source types and the terrain of the RRF.

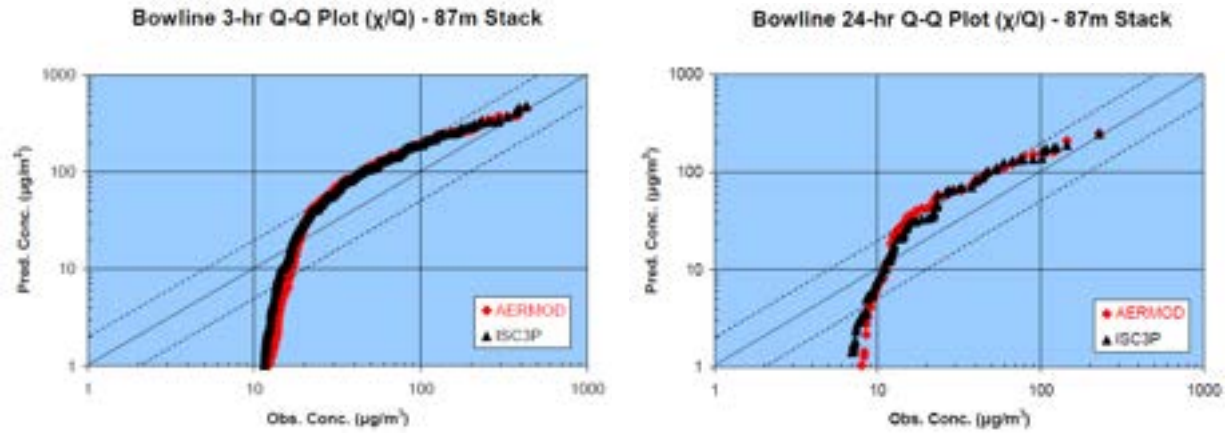
The AERMOD model was jointly developed by a committee of independent scientists representing the American Meteorological Society and the regulatory modeling group within the USEPA and became the recommended model for atmospheric dispersion assessments within 50 km of an emission source in 1995 (Federal Register, "Appendix W to Part 51 – Guideline on Air Quality Models," Vol.70, No. 216, pg. 68229-68261). AERMOD replaced the Industrial Source

Complex Short Term (ISCST3) model developed in the early 1980's and used in the previous health risk assessments of the facility.

AERMOD uses advances in the understanding of dispersion in the lower atmosphere that were developed during the late 1970's through the 1990's. Unlike ISCST3 that used relatively simple Gaussian statistical distributions to simulate plume dispersion (D.B. Turner, Workbook of Atmospheric Dispersion Estimates, USEPA, Research Triangle Park, NC, 1970) AERMOD relies on solving energy balance equations in the lower atmosphere and simulating plume dispersion as a combination of heating and cooling of the earth's surface (thermally induced turbulence), and dispersion caused by the wind blowing over the rough surface (mechanically induced turbulence). By directly simulating the driving forces of dispersion (thermal and mechanical turbulence), AERMOD better simulates the movement and spread of the facility's plume. In order to predict plume dispersion, AERMOD uses not only wind speed, wind direction and cloud cover (which were used by ISCST3 as well), but also considers the intensity of sunlight (solar insolation), the rate of evaporation from different types of surfaces in the modeling domain (open water, forests, urban and rural areas, etc.) and the roughness of the surfaces. Stronger insolation, low evaporation rates and very rough surfaces lead to faster dispersion than night-time conditions, high evaporation rates and smooth surfaces.

AERMOD's prediction capability was evaluated against the observed data from several atmospheric dispersion experiments (EPA 2003, AERMOD: Latest Features and Evaluation Results, USEPA-454/R-03-003, USEPA, Research Triangle Park, NC). Seven of these model evaluation databases were for sources with aerodynamic stack plume downwash, similar to the RRF. The figures below show the model prediction versus observed concentrations for the Bowline Power Plant with a stack height similar to the RRF. The solid line is the perfect agreement line and the dashed lines are for predicted versus observed concentrations within a factor of 2. USEPA presented results for ISC3Prime (an updated version of the ISCST3 model used for the previous health risk assessments) and for AERMOD. Note that both models perform reasonably well and that both produce maximum predicted concentrations in close agreement with the maximum observed concentration. Both models tend to over-predict concentrations through much of the concentration range. For all of these databases the reported overall predicted to observed ratio for AERMOD was 0.97, indicating that AERMOD successfully predicted concentrations for these seven downwashed sources and that AERMOD is a reliable model for application to the

Montgomery County RRF. For ISC3Prime the reported overall predicted to observed ratio was 0.94, a good score but indicating more tendency to under-predict than AERMOD.



3.2 Site Specific Information Required to Support Air Modeling

The RRF is located approximately two miles southwest of the town of Dickerson, MD, in Montgomery County. Figure 2-1 presents a plot plan of the facility indicating the property line and Figure 2-2 presents an aerial photograph showing the location of the main RRF stack. Figures 3-1 and 3-2 are United States Geological Survey (USGS) maps showing the plant location and terrain out to 10 km and 50 km from the plant, respectively. National Elevation Dataset (NED) 1 arc-second (about 30 meters) terrain height data files were obtained from the USGS for the area surrounding the RRF and were used to develop the modeling receptor node array files using the AERMOD pre-processor program AERMAP (version 11103). These files are included on the attached modeling CD ROM at the end of this section.

AERMOD has its own special land use pre-processing program, AERSURFACE (Version 13016) which determines surface characteristics required for the AERMET meteorological pre-processing program. The newest land cover dataset which can be used with AERSURFACE is USGS's National Land Cover Dataset (NLCD) 1992 (USGS 2013c). AERSURFACE was used at both the onsite (primary) meteorological monitoring location, as well as the Dulles airport (secondary) location. Since the RRF was constructed after 1992, the region containing the RRF's property was reclassified to "Commercial/Industrial/Transportation" (category 23) prior to using AERSURFACE. AERSURFACE's input and output files, as well as the original and revised NLCD data files, are included on the attached modeling CD ROM.

Following the Guideline on Air Quality Models, the NLCD data within 3 km of the facility were reviewed to determine if the region should be classified as urban or rural for purposes of

dispersion characterization in AERMOD. Because the land use of the region within 3 km is primarily composed of "Pasture/Hay", "Deciduous Forest", and "Row Crops", the region was determined to be rural. Given this finding, AERMOD's special "urban source" option was not used.

AERMOD accounts for building-induced aerodynamic plume downwash. Direction-specific building downwash parameters were input into AERMOD for the RRF. The Good Engineering Practice (GEP) stack height analyses and the necessary model input downwash parameters were determined using USEPA's Building Profile Input Program for PRIME (BPIPPRM; Version 04274) modeling pre-processor program. Building dimensions were determined using Pictometry Online's height measurement tool (Pictometry 2013), which bases measurements on aerial imagery taken from multiple flyovers of the facility (unique images available looking from the north, south, east, and west). These measurements are then spot checked against available CAD drawings for accuracy. Figure 3-3 shows a three-dimensional rendering of the building tiers as entered into BPIPPRM for analysis.

3.3 Source Locations and Emission Rates

AERMOD was used to model two emission sources: the main RRF stack (Figure 3-4) and fugitive emissions from the Residue Handling Building (Figure 3-5). Their respective source parameters are shown in Table 3-1. Additional details about how these two emission sources were modeled are provided in Section 3.6.

As specified by the HHRAP, unit emission rates (1 g/s) were modeled for each emission source. The main RRF stack and the fugitive emissions were modeled separately, so that source specific COPC emission rates could be combined with the predicted unitized concentration/deposition rates at each receptor node to calculate the impact of each source. Total facility impacts were calculated by adding the source-specific impacts at each modeled receptor.

3.4 Partitioning of Emissions

As specified by the HHRAP guidance, separate AERMOD model runs were made to predict concentrations and deposition rates for vapor phase COPCs, particle phase COPCs (particle mass weighting) and particle-bound COPCs (particle surface area weighting). Facility-specific particle fractionation data were not available and a literature search did not produce any recent particle distributions for similar facilities. Thus, particle fractionation data identified in the

previous RRF risk assessment from a municipal solid waste facility using a fabric filter control device in Wurzburg, Germany were used (ENSR 2006). These values were reasonable in comparison to fabric particle fractionation data provided in USEPA's AP42 Appendix B.2 for the use of a fabric filter by a brick manufacturer (USEPA 1990).

For gaseous deposition, AERMOD requires the user to define seasonal categories, land use categories, COPC specific diffusivity in air (cm^2/s), diffusivity in water (cm^3/s), cuticular resistance (s/cm) and Henry's Law constant (Pa m^3/mol). Seasonal categories (modeling keyword GDSEASON) were assigned based on a review of the monthly onsite meteorological data applicable for over 50 percent of the days in each month: late autumn or winter with no snow on the ground (November to March), spring (April and May), summer (June to August), autumn with unharvested crops (September and October). Per the AERSURFACE analysis, the predominant land use in the region is "Pasture/Hay", based on the NLCD 1992 data. This corresponds to the GDLANDUSE category "Rangeland", which was use uniformly across all wind directions.

COPC-specific diffusivity in air, diffusivity in water, and Henry's Law constant are based on tabulated values as contained in The Hazardous Waste Companion Database to USEPA's HHRAP (USEPA 2005b), or values from other tabulations and calculations for missing or updated values. Cuticular resistance is based on table values contained in Wesely et al. (2002), where available. Otherwise, the cuticular resistance is calculated based on the method presented in Wesely et al. (2002). The Le Bas molar volumes for compounds not listed in the tables are based on the molecular structure of the specific compounds. Physical/chemical input values used in the calculations appear in Appendix H.

Because the dry vapor phase deposition factors are COPC specific, each vapor phase COPC with different deposition parameters was modeled using a separate AERMOD modeling run with unit emission rates, 1 g/s, and then subsequently scaled by the respective COPC emission rate.

3.5 Meteorological Data

The AERMOD model requires observations of representative meteorological variables to calculate ambient concentrations and deposition rates of emissions from the RRF. These data, which include both near surface and upper air meteorological observations, are used as input to the AERMET (Version 12345) meteorological pre-processing program. AERMET stores the observations in a specifically formatted profile file (MP2008-2012.PFL). AERMET also utilizes surface characteristics calculated from AERSURFACE, as described above, to calculate

meteorological parameters (such as mechanical and convective mixing heights), which it stores in a surface meteorological input file (MP2008-2012.SFC).

Onsite met data is available from 2002 to the present, collected at a tower located 0.6 km to the east of the RRF's main stack (see Figure 2-2). These extensive on-site data are representative for this modeling analysis. Per USEPA guidance, the five most recent complete years, 2008 to 2012, were used. This dataset was reformatted into an AERMET onsite input format, and provided the primary surface source of wind speed, wind direction, standard deviation of the horizontal wind direction (sigma-theta), temperature, relative humidity, and precipitation data. Data capture rates are provided in Table 3-3. A wind rose of the hourly surface winds is shown in Figure 3-6. Note the winds predominately occur from the north and south, which is consistent with a flow of winds along the local section of the Potomac River Valley.

The collection of solar radiation insolation values started during the third quarter of 2010. These onsite values were used when available. For those hours without onsite radiometer measured insolation values, USEPA guidance was followed and the percentage of cloud cover at the nearest National Weather Service (NWS) station was used. The cloud cover data were collected at Washington Dulles airport (Weather Bureau Army Navy identification number [WBAN]93738), located 29 km south of the RRF. Without the inclusion of NWS data, AERMOD is unable to calculate impacts for hours when the onsite met tower data is incomplete. Thus, to conservatively cover all hours in the modeling period, the airport was used as a secondary source of wind speed, wind direction, and temperature for missing hours in the onsite dataset. The ENSR risk update used only 1-year of onsite met data with Dulles as a secondary met data source. This analysis benefited from 5-years of onsite met data with Dulles as secondary met data source. Use of 5-years of on-site met data is more representative of the conditions at the RRF than use of one year of data. Data capture rates for Dulles Airport are provided in Table 3-4.

Upper air meteorological observations were provided by radiosonde measurements taken at the NWS Sterling, Virginia station (WBAN 93734). The data were acquired from the National Oceanic and Atmospheric Administration's Forecast Systems Laboratory (FSL) online database of radiosonde observations. Data capture rates for Sterling are provided in Table 3-5.

3.6 AERMOD Model Input Files

Consistent with the USEPA HHRAP guidance, AERMOD was used for three main types of modeling runs for the main RRF stack:

- A “vapor phase” run for each gaseous compound to predict air concentration, dry deposition, wet deposition, and total deposition,

- A “particle phase” run to predict air concentration, dry deposition, wet deposition, and total deposition for particles, and

- A “particle-bound phase” run to predict air concentration, dry deposition, wet deposition, and total deposition for compounds that condense on or coat the surface of particles emitted from the source.

In addition, fugitive emissions from the Residue Handling Building were modeled as a point source with exclusively particle phase emissions. The appended CD ROM contains the AERMOD input files for all final modeling runs. Figures 3-7 through 3-10 present the AERMOD model input runstreams for each phase and each source. Each runstream consists of five main sections: the Control Pathway, the Source Pathway, the Receptor Pathway, the Meteorological Pathway, and the Output Pathway.

The **Control Pathway** in AERMOD was set to run wet and/or dry plume depletion algorithms, as appropriate and both long-term (5 year) average and hourly predictions are made. The model was run considering terrain elevations, however COPC half-life and decay coefficients were not invoked.

In the **Source Pathway**, the source type was set to point sources for the main RRF stack and fugitive emissions from the Residue Handling Building. Source locations were entered in UTM coordinates (NAD83, Zone 18). For the main RRF stack, the stack temperature and exit velocity were based on averages of these variables measured during the 2012 compliance tests for Units 1, 2 and 3. Since each Unit’s exhaust exits from a separate flue contained in a shared stack shell, the plumes were combined (i.e., modeled as a single point source) per guidance using a single equivalent area diameter. The main RRF stack height was based on a detailed CAD drawing, and is consistent with the measurement made using the Pictometry Online height measurement tool. Following USEPA modeling guidance, the fugitive emissions are modeled at ambient temperature, with negligible vertical velocity (horizontal plume), an equivalent area diameter based on the size of the Residue Handling Building garage door (16 ft tall by 28 ft wide), and a source height equal to half the height of the door (16 ft / 2 = 8 ft). Table 3-1 summarizes the source parameter data for the stack and Residue Handling Building. For both sources, particle

densities were all assumed to be 1.0 g/cm^3, as recommended in the HHRAP. Building downwash parameters are also included for the sources, as calculated by BPIPPRM.

The **Receptor Pathway** contains the receptor node grid location coordinates and elevation values. The modeling domain consists of a 40 km by 40 km box centered on the RRF. The domain is covered by a nested Cartesian grid consisting of receptor nodes beyond the facility property line every 100 meters out to 2 km from the property line, 250 meters to 5 km, 500 meters to 15 km and every 1,000 meters out to 20 km. In addition, to the nested grid receptor nodes were placed every 25 meters along the property line of the facility, every 100 meters along the banks of the Potomac and Monocacy Rivers, and at additional points of interest (e.g., ponds and farms) not collocated with existing nested grid receptor nodes. Note that all receptor nodes are contained within the 40 km by 40 km border established by the overall modeling domain, resulting in the truncation of rivers and watersheds at distances beyond the border. Each receptor node has an elevation calculated from AERMAP (Version 11103) using USGS National Elevation Dataset 1 arc-second (about 30 meter) data. Figure 3-11 shows a map of the receptor node grid together with the elevation data. Digital compilations of the receptor nodes are included in the input and output for each AERMOD run, included on the appended CD ROM. The locations of the maximum predicted one-hour and long-term (5-year) concentrations and long-term (5-year) deposition rates for the main RRF stack are shown in Figure 3-12 Similar results for fugitive emissions are shown in Figure 3-13. Note the predicted maxima associated with the RRF stack are within 9 kilometers of the centroid of the sources, and thus contained well within the modeling grid.

The **Meteorological Pathway** specifies the five-year meteorological data as processed by AERMET. The height of the anemometer at the onsite meteorological station was 10 meters above grade. The meteorological input file is presented in the appended CD ROM.

The **Output Pathway** specifies the rank, averaging periods, and output file names for each analysis. The option to list results in scientific notation (OU FILEFORM EXP) has been implemented to maintain the precision of small values.

3.7 Model Output

Maximum hourly and long-term (five-year) average AERMOD model output for each of the four types of runs (vapor, particle, particle-bound, and fugitive emissions) were written to a plot file and subsequently transferred to Excel spreadsheets for use in the risk calculations. The plot files and spreadsheets are contained on the appended CD ROM. It should be noted that the

depositional impacts (dry, wet and total for vapor, particle and particle-bound) for the long-term are the amount of deposition over a five-year period. Since the input into the HHRA is based on an annual deposition, these values were divided by a factor of five when used in the evaluation of long-term (chronic) exposures in the HHRA. The maximum hourly impacts were used in the evaluation of short-term (acute) exposures.

4.0 HUMAN HEALTH RISK ASSESSMENT

Exposures to emissions from the RRF stack can occur in the short-term (acute exposures) and over the long-term (chronic exposures). Chemicals emitted from the RRF stack are dispersed into ambient air and may eventually deposit onto soils, plants, and surface water. Potentially exposed individuals may inhale airborne materials, inadvertently ingest soil, and consume produce, livestock, dairy products or fish from the area. Since groundwater wells and not surface water are the source of drinking water in the area, the drinking water pathway was not evaluated in the HHRA.

4.1 Exposure Assessment

The objective of the exposure assessment is to identify potential receptors and exposure pathways as well as to define, for each exposure scenario, the magnitude, frequency, duration and route of exposure. Once the receptors and exposure pathways have been identified, estimates of exposure concentration and dose potentially received by receptors can be calculated.

The 2005 HHRAP Guidance requires that receptor locations and potential exposure pathways are identified, the concentrations of chemicals detected in emissions are modeled in various environmental media, and potential chemical-specific intakes by identified receptors are estimated. This methodology uses theoretically possible exposures, not actual exposures, and overstates what any individual is likely to experience. Information on potential receptor locations, including beef cattle and dairy farms, residential areas nearby water bodies where fishing may occur was collected, and used to define site-specific characteristics of the study area and ultimately assist in the identification of exposed populations and pathways. The equations and parameters that were used to quantify exposure via each pathway are provided in Appendix E. In addition, specific receptors as defined in the ENSR 2006 health risk assessment were also evaluated for continuity with the prior report. In addition, although drinking water wasn't evaluated, due to a local concern that emissions from the RRF are depositing onto soils and leaching into groundwater, a comparison of maximum predicted soil concentrations to groundwater protection soil screening levels (SSLs) (USEPA, 2013c) was conducted and is discussed in Section 6.

4.1.1 Potential Receptors and Exposure Pathways

The potentially exposed populations and exposure pathways were identified based on an evaluation of the land use characteristics of Montgomery County within the study area surrounding

the RRF. The study area was delineated as extending out to 20 km from the facility, as potential impacts within these areas were determined from the dispersion and deposition modeling effort (See Section 3.0, Figure 3-2).

A variety of receptor scenarios were evaluated in this HHRA and each scenario evaluated an adult and a child. Infants were evaluated separately for potential exposure to dioxin/furans through the ingestion of mother's breast milk. It should be noted that per the 2005 HHRAP Guidance, the Fisher and Farmer Scenarios are no longer referred to as "subsistence" scenarios. The daily consumption amounts are more comparable to reasonable maximum (versus subsistence) amounts. This HHRA provides theoretical estimates of individual risk for a variety of exposure scenarios as shown in the following schematic:

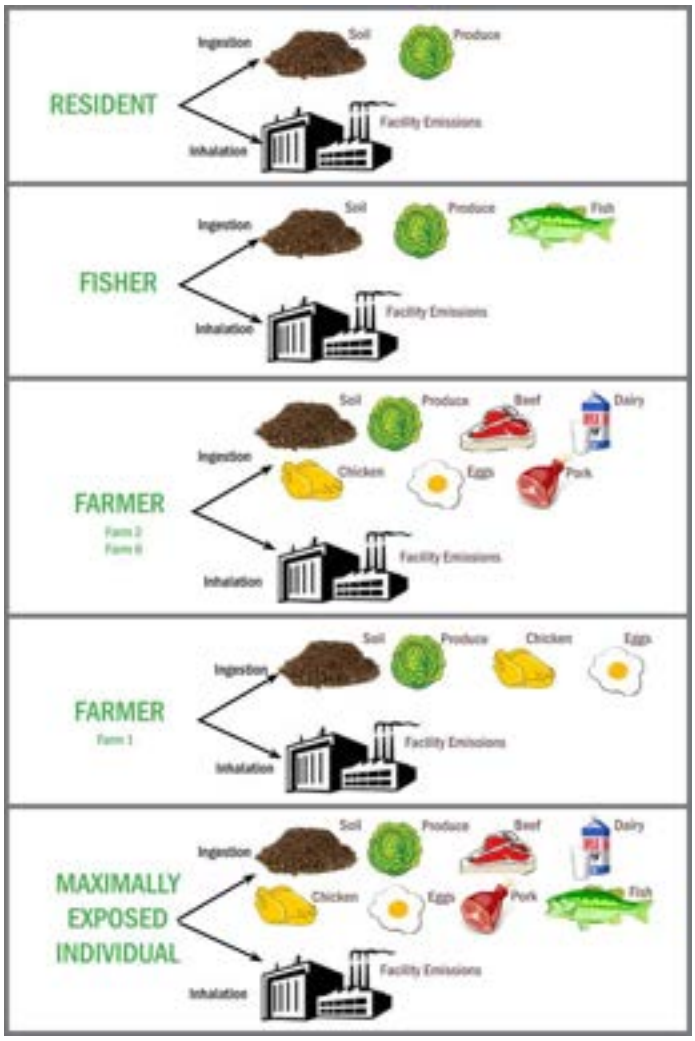


Table 4-1 provides a summary of receptors and pathways and a discussion of the potential exposure pathways and receptors follows:

4.1.2 RME Scenarios

4.1.2.1 RME Residential Scenario (Adult, Child and Infant)

The RME Resident receptor (adult and child) was assumed to be exposed to COPCs in the RRF emissions through direct inhalation exposures, and indirect exposures to soil and homegrown produce. Infants were evaluated for potential exposure to dioxin/furans through the ingestion of mother's breast milk. For direct inhalation exposures, and indirect exposures to soil and homegrown produce, media concentrations were calculated based on the modeled maximum annual concentration or maximum 5-year average dry and wet deposition, regardless of whether they occurred in different locations. Figure 4-1 depicts the modeled maximum annual concentrations and 5-year average dry and wet deposition impact locations for this receptor. Appendix F contains the facility impacts for the resident receptor. The exposure modeling and risk spreadsheets are provided in Appendix G for this scenario.

4.1.2.2 RME Fisher Exposure Scenario (Adult, Child and Infant)

The RME Fisher (adult and child) was assumed to be identical to the Residential adult and child scenario noted above in Section 4.1.2.1 who also fished locally in the Potomac River. As such, direct inhalation exposures and indirect exposures to soil and home-grown produce are assumed to be equivalent to the RME residential exposures. Infants were evaluated for potential exposure to dioxin/furans through the ingestion of mother's breast milk. All of the fish ingested by the RME Fisher is assumed to come from the Potomac River.

To assess potential impacts on the Potomac River, the average combined wet plus dry deposition rates over the waterbody and the average combined wet plus dry deposition rates over the watershed were used to calculate potential water body concentrations. Figure 4-1 depicts the modeled locations for this receptor. To be conservative, the arithmetic average of receptor nodes across the watershed impacts were used, which is expected to overestimate the impact due to a higher density of nodes closer to the facility. For river impacts, as previously discussed, the receptor nodes were placed every 100 meters along the shores, extending upstream and downstream to the border of the overall modeling domain. Due to the river's equal spacing of receptor nodes, their arithmetic average is representative of the entire stream within the modeling domain. Figure 4-2 shows the modeled receptor nodes used to calculate impacts to the Potomac River (Figure 4-2a) and the Potomac River watershed (Figure 4-2b). . It should be noted that this risk assessment used a conservative (i.e., health protective) estimate of flow rate for the Potomac

River. Flow rate impacts the concentration of COPCs in the river. This HHRA used a 117 year average of flow measured at the Point of Rocks station. This flow rate of 4927 ft^3, is slower than the average from the years 2000 – 2012 (~9,500 ft^3). Use of a lower flow rate tends to overestimate potential impacts on the river. Therefore, these assumptions will tend to overestimate risk due to ingestion of fish. Appendix F contains the modeled facility impacts for the RME Fisher scenario receptor (adult and child). The exposure modeling and risk spreadsheets are provided in Appendix G for this scenario.

4.1.2.3 RME Farmer Exposure Scenario (Adult, Child and Infant)

Four potential farm locations were identified in the vicinity of the RRF. Three of these farms were identified in the 2006 ENSR report (Farms 1, 2 and 5). Farms 1 and 2 were considered potential farm locations while Farm 5 was considered the nearest actual beef/dairy farm. Farms 1 and 2 are located closer to the RRF, while Farm 5 is near Dickerson, MD. An additional farm, located in Beallsville, MD, was identified using the 2008 Montgomery County Farm Directory (Montgomery County 2008) which has been designated as Farm 6. Farm 6 is a beef farm and also provides eggs. Each location was modeled and the location with the highest deposition and concentration impacts was selected for the RME Farmer Scenario. Among these four farm locations, the Farm 2 location had the highest impacts and was thus used to evaluate the RME Farmer scenario and was assumed to produce beef, dairy, pork, chicken, eggs and produce, regardless of whether these foodstuffs were actually produced there or not. The RME Farmer (adult and child) was assumed to reside at the Farm 2 location and be exposed to COPCs from the RRF emissions through the incidental ingestion of soil, ingestion of homegrown produce, and ingestion of home-raised beef, dairy, pork, chicken and eggs. Infant exposure to breast milk was also evaluated at this location. Infants were evaluated for potential exposure to dioxin/furans through the ingestion of mother's breast milk.

Figure 4-3 depicts the receptor location for the RME Farmer (Farm 2). Appendix F contains the modeled facility impacts for the RME Farmer exposure scenario. The exposure modeling and risk spreadsheets are provided in Appendix G for this scenario.

4.1.3 Additional Scenarios

The ENSR 2006 risk assessment update evaluated additional scenarios including: two hypothetical Maximally Exposed Individual (MEI) scenarios which were similarly evaluated in

the 1989 Weston risk assessment, three Fisher scenarios in which residents were assumed to ingest fish caught from the Monocacy River and two different farms ponds, and two Farmer scenarios evaluated at the Farm 1 and Farm 5 locations. All of these additional scenarios were evaluated in this HHRA with the exception of one Farm scenario which was evaluated at the Farm 6 location instead of Farm 5 location (since Farm 6 had higher predicted impacts due to facility-related emissions than Farm 5).

4.1.3.1 Maximally Exposed Individual (MEI) Scenarios (Adult, Child and Infant)

The ENSR Report (2006) evaluated two MEI Scenarios. The MEI A scenario represents a hypothetical local resident (adult and child) evaluated at the location most affected by dry deposition associated with RRF emissions and is also exposed to maximum annual air concentrations, while the MEI B scenario represents a hypothetical local resident (adult and child) evaluated at the location of maximum total vapor and particle deposition and is also exposed to insignificant (secondary maximum) air concentrations). Both receptors contact soil and ingests produce grown at their respective locations.

Both MEI Scenarios include consumption of agricultural products (milk, beef, pork, and poultry products) raised at the closest reference beef and/or dairy farm location (per the Farm Report, Montgomery County 2008) that was predicted to exhibit maximum facility-related impacts (Farm 6) and ingestion of fish caught from the Potomac River. Infants were evaluated for potential exposure to dioxin/furans through the ingestion of mother's breast milk for both MEI scenarios.

Figure 4-4 depicts the modeled locations for the MEI A scenario, while Figure 4-5 depicts the modeled locations for the MEI B scenario. Exposure to modeled impacts is expected to occur regardless of whether the impacts occur in different locations.

Appendix F contains the facility impacts for the MEI receptors. The exposure modeling and risk spreadsheets are provided in Appendix G for these scenarios.

4.1.3.2 Additional Fisher Scenarios (Adult, Child and Infant)

Three additional Fisher scenarios were evaluated. A Monocacy River Fisher was assumed to be identical to the RME Residential adult and child scenario noted above in Section 4.1.2.1 who also fished locally in the Monocacy River. As such, direct inhalation exposures and indirect exposures to soil and home-grown produce are assumed to be equivalent to the RME residential

exposures. All of the fish ingested by the Monocacy River Fisher is assumed to come from the Monocacy River.

Figure 4-1 depicts the modeled locations for this receptor. Exposure to modeled impacts is expected to occur regardless of whether the impacts occur in different locations. Figures 4-6a and 4-6b depict the modeled locations for the Monocacy River and the Monocacy River watershed, respectively, within the modeling domain. In addition, two additional residential fisher receptors were evaluated. Resident Fisher 1 (adult and child) was assumed to live near Farm 1 and obtain fish from Farm Pond 2, while Resident Fisher 2 was assumed to live near Farm 2 and obtain fish from Farm Pond 3 and were exposed to COPCs in facility emissions through inhalation exposures; consumption of agricultural products (above and below ground vegetables) grown in a backyard garden; consumption of fish caught from the respective ponds; and incidental ingestion of soil. The locations of the farm ponds and farms in each of the two Fisher scenarios are shown on Figure 4-3. Infants were evaluated for potential exposure to dioxin/furans through the ingestion of mother's breast milk.

Appendix F contains the facility impacts for the Fisher receptors. The exposure modeling and risk spreadsheets are provided in Appendix G for these scenarios.

4.1.3.3 Additional Farm Scenarios (Adult, Child and Infant)

In addition to the RME Farmer location, two additional Farmer scenarios were evaluated: Farmer Resident 1 and Farmer Resident 6. Farmer Resident 6 was evaluated as the nearest *actual* farm location predicted to be maximally impacted by facility-related emissions. The locations of the Farms are shown on Figure 4-3. The Resident Farm 6 receptor replaces the subsistence farmer scenario (Farm 5) discussed in the ENSR report as it had higher predicted facility-related emissions than Farm 5. These individual farm locations were assumed to produce beef, dairy, pork, chicken, eggs and produce. The Farmer was assumed to be exposed to COPCs from the RRF emissions through the incidental ingestion of soil, ingestion of homegrown produce, and ingestion of home raised beef, dairy, pork, chicken and eggs. Infants were evaluated for potential exposure to dioxin/furans through the ingestion of mother's breast milk.

Appendix F contains the facility impacts for these Farmer receptors. The exposure modeling and risk spreadsheets are provided in Appendix G for this scenario.

4.1.4 Acute Inhalation Scenario

The acute inhalation exposure to stack emissions was evaluated in this HHRA. In this scenario, potential short-term maximum hourly air concentrations were assessed. The locations evaluated are depicted on Figure 4-7. Exposure to modeled impacts is expected to occur regardless of whether the impacts occur in different locations. Appendix F contains the maximum hourly concentrations. The exposure modeling and risk spreadsheets are provided in Appendix G for this scenario.

4.1 Exposure Concentration and Dose

The estimation of exposure concentration and dose potentially received by receptors followed procedures outlined in USEPA's 2005 HHRAP Guidance (USEPA 2005a).

The equations and parameters that were used to quantify exposure via each pathway are provided in Appendix E, input parameters for the equations are provided in Table 4-2, and exposure parameters are provided in Table 4-3. Concentration calculations vary depending on the environmental media or food type evaluated. The concentration in air was calculated using the unitized yearly air concentrations from vapor, particle and particle bound phases, while concentrations in soil, water, plant, or animal tissue were derived using the unitized yearly wet and dry deposition rates also for vapor, particle and particle bound phase for each COPC. Particle phase fugitive emissions were added to the stack concentration and deposition modeling parameters used in the calculation of COPC concentrations in air, soil, produce, fish and farm-raised products (beef, dairy, pork, chicken and eggs). The equations used to calculate environmental concentrations are described in Appendix E. A table of physical/chemical properties used in this HHRA is presented in Appendix H.

Maternal exposures from the each scenario are used to determine infant exposure via breast-feeding. The concentrations of dioxins/furans as a 2,3,7,8-TCDD TEQ is compared with an infant target intake level of 60 picograms per kilogram per day (pg/kg-d). The equations are discussed further in Appendix E and shown in Appendix G.

5.0 DOSE-RESPONSE ASSESSMENT

A hierarchical approach was used to select toxicity criteria for the COPCs evaluated in this HHRA. Cancer and noncancer toxicity values, in order of preference, were obtained according to USEPA's revised hierarchy of toxicological sources of information (USEPA 2003). This approach was selected to ensure that the most up-to-date information was used for this HHRA. The recommended toxicity value hierarchy is as follows:

- Tier 1- USEPA's IRIS database (USEPA 2013c)

- Tier 2- USEPA's Provisional Peer Reviewed Toxicity Values (PPRTVs) – The Office of Research and Development/National Center for Environmental Assessment/ Superfund Health Risk Technical Support Center (STSC) develops PPRTVs on a chemical-specific basis when requested by USEPA's Superfund program. Provisional values were obtained from the most recent USEPA Regional Screening Level (RSL) Table (USEPA 2013d).

- Tier 3- Other Toxicity Values – Tier 3 includes additional USEPA and non-USEPA sources of toxicity information. Priority was given to those sources of information that are the most current, the basis for which is transparent and publicly available, and which have been peer reviewed. Tier 3 values include toxicity values obtained from California EPA (CalEPA), Agency for Toxic Substances and Disease Registry's (ATSDR's) Minimum Risk Levels (MRLs) and toxicity values obtained from Health Effects Assessment Summary Tables (HEAST) (USEPA 1997).

The chronic toxicity criteria for each COPC evaluated in this HHRA are summarized in tabular form (Tables 5-1 through 5-4). These toxicity criteria characterize the relationship between the level of exposure and the potential magnitude of health effect (i.e., dose-response), and include cancer slope factors for evaluating the increased lifetime risk of developing cancer and noncancer reference doses for evaluating the potential for non-carcinogenic (e.g., systemic) effects.

The COPCs included in the HHRA exhibit a combination of potential carcinogenic and/or non-carcinogenic effects. In the case of human health effects associated with exposure to potential carcinogens, estimates of cancer risk are expressed as the lifetime probability of additional cancer risk associated with the given exposure. Potential cancer risks were evaluated using oral cancer slope factors and inhalation unit risk factors expressed in terms of risk per unit exposure dose for oral exposures (i.e., risk per mg/kg-d or $(mg/kg\text{-}d)^{-1}$) and risk per concentration for inhalation exposures (i.e. risk per ug/m^3 or (ug/m^3)-1). The oral cancer risks are calculated as the cancer-based exposure dose (mg/kg-d) times the oral cancer slope factor $(mg/kg\text{-}d)^{-1}$, inhalation cancer risks are calculated as the cancer-based air concentration (ug/m^3) times the inhalation unit

risk factor ($(ug/m^3)^{-1}$). In numerical terms, the excess lifetime cancer risks are presented in scientific notation in this report. Thus, an estimated excess lifetime cancer risk of 1E-04 means an incremental lifetime cancer risk of one in ten thousand; an estimated cancer risk of 1E-06 means an incremental lifetime cancer risk of one in one million and so on.

For determining whether noncancer health effects may be a concern, the hazard quotient (HQ) is used. Non-carcinogenic effects from exposures were evaluated using oral reference doses (RfDs) expressed in units of mg/kg-d and inhalation reference concentrations (RfCs) expressed in units of mg/m^3. Reference doses and Reference concentrations have been determined by USEPA and other State or Health Agencies to be a dose or air concentration to which the most sensitive individual can be exposed without a risk for non-cancer health effects. The HQ for oral exposures is calculated as the noncancer exposure (mg/kg-d) divided by the RfD and the HQ for inhalation exposures is calculated as the noncancer based air concentration (mg/m^3) divided by the RfC to obtain a ratio. The HQs are summed across chemicals to calculate a hazard index (HI) per receptor in each scenario. The HQs (and HIs) represent a ratio, where an HQ of 0.25 means, for example, that the estimated exposure dose is one-quarter the RfD.

In addition, Table 5-5 summarizes the acute inhalation exposure criteria (AIEC). Acute values were obtained in the order of preference specified in the HHRAP (2005a):

1. CalEPA Acute Reference Exposure Levels (RELs) (CalEPA 2013)
2. USEPA Acute Exposure Guidelines (AEGL-1) (SCAPA 2012)
3. AIHA Emergency Response Planning Guidelines – 1 (ERPG-1) (SCAPA 2012)
4. Temporary Emergency Exposure Limits (TEEL-1) (SCAPA 2012)

Per the HHRAP recommendation, the CalEPA Acute RELs are used as the first choice when available. For COPCs lacking Acute RELs, acute toxicity values are selected as AEGL-1 values and so on according to the HHRAP hierarchy. These acute inhalation exposure guidelines and criteria are designed to protect a variety of exposure groups including the general public (which includes sensitive subpopulations such as the elderly and children). In addition, they are intended to protect against a variety of toxic endpoints. The Level 1 endpoints used in this hierarchy protect against discomfort or mild health effects.

6.0 RISK CHARACTERIZATION

The risk characterization step combines estimates of exposure and chemical toxicity to produce estimates of potential risks. Several different types of risk results are calculated in this assessment. They include estimates of long-term excess lifetime cancer risk and the potential for non-carcinogenic effects, the potential for acute inhalation risks, a child's potential lead exposure, and an evaluation of infant exposures via breast milk ingestion. In addition, potential impacts to drinking water are evaluated by comparing predicted soil concentrations to USEPA's groundwater protection criteria.

Potential excess lifetime carcinogenic risks and the potential for non-carcinogenic effects are calculated by combining the long-term exposure calculations with chronic toxicity criteria for each COPC. Theoretical individual excess lifetime carcinogenic risk is generally estimated as the product of the estimated dose and the chemical-specific slope factor. The potential for non-carcinogenic effects is represented by a HQ, obtained by dividing the dose by the chemical-specific RfD. The excess lifetime cancer risks for each pathway were obtained by adding calculated risks for carcinogenic COPC. Noncancer HIs for each receptor were obtained by adding all COPC-specific HQs regardless of target organ potentially affected of type of health effect. This is a conservative method for the initial calculation of noncancer HIs. The calculated excess lifetime cancer risks were evaluated in relation to a target value of 1 in 100,000 (i.e., risk of 1 in 100,000) and noncancer HIs were evaluated in relation to a noncancer target of 0.25. These target levels are provided in by USEPA Region VI as a regulatory framework for risk management. It should be noted that the use of a noncancer target of 0.25 is very conservative (i.e., health-protective) and provides a four-fold safety factor when compared to USEPA's conventional non-cancer hazard target level of 1.0 (USEPA 1989). This four-fold safety factor is meant to be protective of cumulative risk from other sources in the area. Regarding non carcinogenic health hazards, (USEPA 1989) states that:

> "When the total hazard index for an exposed individual or group of individuals exceeds unity, there may be concern for potential non-cancer health effects."

Should the total HI exceed the noncancer target level, a critical endpoint (i.e., target organ toxicity) HI would be calculated by summing the HQs of those chemicals with the same critical endpoint.

For acute exposures, the acute hazard quotient (AHQ) is calculated as the acute modeled air concentration (mg/m^3) divided by the AIEC (mg/m^3). The acute modeled air concentration is

the maximum 1-hour ambient air concentration. AHIs were evaluated in relation to a target level of 1.0. Since this is a short-term impact, USEPA's conventional target level is used.

Since there are no toxicity criteria for environmental lead exposure, child lead exposures were evaluated by comparing modeled soil concentrations against USEPA's residential soil lead target level of 400 mg/kg as recommended in the HHRAP.

Infant exposures through the ingestion of mother's breast milk are evaluated by calculating an average daily dose (ADD) for an exposed infant and comparing the ADD against typical infant intakes of dioxin. The typical infant intake of 60 pg/kg-day TCDD-TEQ is identified by USEPA Region VI (USEPA 1998b) and the 2005 HHRAP as the national average background value to compare an infant's exposure to TCDD-TEQ via breast milk. A ratio of the calculated ADD versus the 60 pg/kg/day value is made such that a ratio of 1.0 would indicate that the ADD equaled the comparison value. The target ratio for infant exposures is 1.0, therefore a ratio of less than one means that exposures are less than the national background level for infant exposure to TCDD via breast milk ingestion. It should be noted that at the time of the finalization of the HHRAP, USEPA had not developed a RfD for TCDD. USEPA has recently promulgated a RfD for TCDD of 0.7 pg/kg/day which is almost 100 times less than the comparison value of 60 pg/kg/day. An evaluation of breast milk ingestion using the RfD is further discussed in the Uncertainty Analysis section of this report.

Due to a local concern that emissions from the RRF are depositing onto soils and leaching into groundwater, a comparison of maximum predicted soil concentrations to groundwater protection soil screening levels (SSLs) (USEPA, 2013c) was conducted.

The results of the risk characterization are summarized below.

6.1 RME Scenarios

The risk characterization for the HHRA follows the procedure described above for each potential receptor in each of the exposure scenarios. Tables 6-1.1 and 6-1.2 present the total excess lifetime cancer risk and noncancer total HIs, respectively, for the RME exposure scenarios. The results are presented below.

6.1.1 RME Residential Scenario

The RME Residential scenario assumed that the adult and child resident were directly exposed to COPCs by inhalation and indirectly exposed to chemicals via the incidental ingestion

of soil, and the consumption of homegrown produce. Media concentrations were calculated based on the modeled maximum annual concentration or maximum 5-year average dry and wet deposition, regardless of whether they occurred in different locations. An exposure pathway for infants via the ingestion of breast milk was also evaluated. The exposure and risk tables for these receptors can be found in Appendix G.

As shown in Tables 6-1.1 and 6-1.2, respectively, neither the total excess lifetime cancer risk nor the total HIs associated with indirect and direct exposures for the adult and child RME Resident scenarios exceed the target cancer risk of 1 in 100,000 or the target HI of 0.25. The excess lifetime cancer risk estimates of 0.01 in 100,000 and 0.003 in 100,000 for the adult and child, respectively, are well below the target risk of 1 in 100,000. The total HIs of 0.0012 and 0.0018 for the adult and child receptor are well below the target HI of 0.25.

In addition, the dioxin/furan intake ratio of 0.00003 for the infant receptor is well below the target of 1.0.

6.1.2 RME Fisher Scenario

The RME Fisher scenario assumed the Fisher lived at the RME residential location and also ate fish from the Potomac River. Thus, the Fisher was assumed to be directly exposed to COPCs by inhalation and indirectly exposed to chemicals via the incidental ingestion of soil, the consumption of homegrown produce from the residential area and via the consumption of fish caught in the Potomac River. Since the Fisher was assumed to live in the residential area, the direct inhalation pathway was modeled using the RME Residential impacts. Air, soil and produce concentrations were calculated based on the modeled maximum annual concentration or maximum 5-year average dry and wet deposition, regardless of whether they occurred in different locations. An exposure pathway for infants via the ingestion of breast milk was also evaluated. The exposure and risk tables for these receptors can be found in Appendix G.

As shown in Tables 6-1.1 and 6-1.2, respectively, neither the total excess lifetime cancer risks nor the total HIs associated with indirect and direct exposures for the adult and child RME Fisher scenarios exceed the target cancer risk of 1 in 100,000 or the target HI of 0.25. The excess lifetime cancer risk estimates of 0.1 in 100,000 and 0.02 in 100,000 for the adult and child, respectively, are well below the target risk of 1 in 100,000. The estimated excess lifetime cancer risk in the 2013 scenario is approximately 3 to 4 times higher than the 2006 assessment of the Subsistence Fisher. This is a result of higher risk estimates attributed to carcinogenic PAHs,

particularly dibenz(a,h)anthracene. It should be noted that the 2006 ENSR report evaluated the cPAHs as a total based upon benzo(a)pyrene. This HHRA evaluated the PAHs separately. Dibenz(a,h)anthracene has the highest risk estimates of the cPAHs. Although it is equipotent as benzo(a)pyrene, the factors involved in calculating accumulation in fish tissue are higher than benzo(a)pyrene. Therefore, calculating risk based on total cPAH as benzo(a)pyrene may have underestimated the risk due to these compounds. Additionally, the emission estimates for the PAHs and in particular, dibenz(a,h)anthracene may have been overestimated due to the use of non-detects in the calculation of the emission rates.

The total HIs of 0.012 and 0.0095 for the adult and child receptor are well below the target HI of 0.25. As compared to the 2006 ENSR results for the Subsistence Fisher, the current HIs are decreased as a result of a decrease in risk due to methyl mercury. The decrease in noncancer risk associated with long-term exposure to mercury may be attributable to a number of factors, namely a decrease in mercury emissions from the facility; a decrease in mercury deposition due to the change to the AERMOD model, differences in watershed delineation and changes to the deposition and media concentration equations presented in the USEPA 2005 HHRAP guidance document.

In addition, the dioxin/furan intake ratio of 0.00023 for the infant receptor is well below the target of 1.0 (Table 6.1.2) and is less than the ratio calculated for the Subsistence Fisher in the 2006 assessment (0.0032).

6.1.3 RME Farmer Scenario

The RME Farmer was hypothetically assumed to live on Farm 2 which has the highest potential facility impacts of the evaluated farm areas. This receptor is assumed to be directly exposed to COPCs by inhalation and indirectly exposed to the COPCs via the incidental ingestion of soil, and the consumption of homegrown produce, beef, dairy, pork, chicken and eggs. These exposures are assumed to occur even if all the food products are not produced at the assumed farm location. An exposure pathway for infants via the ingestion of breast milk was also evaluated. The exposure and risk tables for these receptors can be found in Appendix G.

For the RME Farmer, the total excess lifetime cancer risk estimates of 0.06 in 100,000 and 0.01 in 100,000 for the adult and child, respectively, are well below the target cancer risk of 1 in 100,000 (Table 6-1.1). The estimated excess lifetime cancer risk for the adult and child receptors in the 2013 scenario are approximately equal to the 2006 assessment of the adult and child Resident Farm 2 receptor. The total HIs of 0.0069 and 0.011 for the adult and child receptor are well below

the target HI of 0.25 (Table 6-1.2). The HI for the 2013 adult receptor is approximately 5 times higher than the adult in the 2006 assessment, while the HI for the 2013 child receptor is approximately 2.5 times higher than the child in the 2006 assessment which is attributable to the calculation of a noncancer HI for TCDD-TEQ. At the time of the 2006 ENSR report, USEPA had not developed a noncancer RfD for TCDD and it was therefore not evaluated.

In addition, the dioxin/furan intake ratio of 0.0022 for the infant receptor is well below the target of 1.0 (Table 6.1.2) and is approximately equal to the ratio calculated for the infant Resident Farm 2 receptor in the 2006 assessment (0.0026).

6.2 Additional Chronic Risk Scenarios

As discussed in Section 4.1.4, in addition to the RME scenarios, specific additional scenarios from the ENSR report were evaluated. The following sections discuss the updated evaluation of these additional scenarios. Tables 6-2.1 and 6-2.2 presents the total excess lifetime cancer risk and noncancer total HIs for the two MEI exposure scenarios (A and B). These tables also compare the 2013 results of the MEI scenarios vs. the 2006 ENSR Report results for those scenarios. Tables 6-3.1 and 6-3.2 presents the total excess lifetime cancer risks and noncancer total HIs for the additional Fisher exposure scenarios, while Tables 6-4.1 and 6-4.2 presents the total excess lifetime cancer risk and noncancer total HIs for the additional Farmer exposure scenarios.

6.2.1 MEI Scenarios

MEI A Scenario

As discussed in the ENSR Report, the MEI A scenario assumed that the adult and child resident were directly exposed to COPCs via maximum inhalation exposure; consumed agricultural products (milk, beef, pork, and poultry products) raised at the closest reference beef and/or dairy farm location (per the Farm Report, Montgomery County 2008) that was predicted to exhibit maximum facility-related impacts (Farm 6); ingested fish caught from the Potomac River; and consumed above and below ground vegetables, and incidentally ingested soil. Contact with soil and home-grown produce occurred at the location of maximum dry particle deposition. It was assumed that 100% of consumed produce, agricultural products, fish and incidentally ingested soils were impacted by facility emissions. The exposure and risk tables for these receptors can be found in Appendix G.

As shown in Tables 6-2.1 and 6-2.2, respectively, neither the total excess lifetime cancer risks nor the total HIs associated with indirect and direct exposures for the adult and child MEI A scenario exceeds the target cancer risk of 1 in 100,000 or the target HI of 0.25. The excess lifetime cancer risk estimates of 0.1 in 100,000 and 0.02 in 100,000 for the adult and child, respectively, are well below the target risk of 1 in 100,000. The estimated excess lifetime cancer risk in the 2013 scenario is approximately 1.5 (child) to 5 (adult) times higher than the 2006 assessment. This is a result of higher risk estimates attributed to carcinogenic PAHs, particularly dibenz(a,h)anthracene. It should be noted that the 2006 ENSR report evaluated the cPAHs as a total based upon benzo(a)pyrene. This HHRA evaluated the PAHs separately. Dibenz(a,h)anthracene has the highest risk estimates of the cPAHs. Although it is equipotent as benzo(a)pyrene, the factors involved in calculating accumulation in plant and animal tissue are higher than benzo(a)pyrene. Therefore, calculating risk on the total cPAH may have underestimated the risk due to these compounds. Additionally, the emission estimates for the PAHs and in particular, dibenz(a,h)anthracene may have been overestimated due to the use of non-detects in the calculation of the emission rates.

The total HIs of 0.016 for the adult and 0.015 for the child receptors are well below the target HI of 0.25. The estimated noncancer HIs for the child receptor in the 2013 scenario is approximately 2 times lower than in the ENSR Report and is attributable to a decrease in noncancer risk associated with potential long-term exposure to mercury. The decrease in noncancer risk associated with long-term exposure to mercury may be attributable to a number of factors, namely a decrease in mercury emissions from the facility; a decrease in mercury deposition due to the change to the AERMOD model, differences in watershed delineation and changes to the deposition and media concentration equations presented in the USEPA 2005 HHRAP guidance document.

In addition, the dioxin/furan intake ratio of 0.0014 for the infant receptor in the 2013 assessment is well below the target of 1.0 (Table 6-2.2). These intake ratios are approximately equal to the ratio calculated for the infant MEI A receptor in the 2006 assessment (0.0015).

MEI B Scenario

As discussed in the ENSR Report, the MEI B scenario assumed that the adult and child resident were directly exposed to COPCs via inhalation exposure at the secondary maximum location; consumed agricultural products (milk, beef, pork, and poultry products) raised at the closest reference beef and/or dairy farm location (per the Farm Report, Montgomery County 2008)

that was predicted to exhibit maximum facility-related impacts (Farm 6); ingested fish caught from the Potomac River; and consumed above and below ground vegetables and through incidentally ingested soil. Contact with soil and home-grown produce occurred at the location of maximum total particle and vapor deposition. It was assumed that 100% of consumed produce, agricultural products, fish and incidentally ingested soils were impacted by facility emissions. The exposure and risk tables for these receptors can be found in Appendix G.

As shown in Tables 6-2.1 and 6-2.2, respectively, neither the total excess lifetime cancer risks nor the total HIs associated with indirect and direct exposures for the adult and child MEI B scenario exceeds the target cancer risk of 1 in 100,000 or the target HI of 0.25. The excess lifetime cancer risk estimates of 0.1 in 100,000 and 0.02 in 100,000 for the adult and child, respectively, are well below the target risk of 1 in 100,000. The estimated excess lifetime cancer risk for the adult in the 2013 scenario is approximately 2 times higher than the 2006 assessment. This is a result of higher risk estimates attributed to carcinogenic PAHs, particularly dibenz(a,h)anthracene. It should be noted that the 2006 ENSR report evaluated the cPAHs as a total based upon benzo(a)pyrene. This HHRA evaluated the PAHs separately. Dibenz(a,h)anthracene has the highest risk estimates of the cPAHs. Although it is equipotent as benzo(a)pyrene, the factors involved in calculating accumulation in plant and animal tissue are higher than benzo(a)pyrene. Therefore, calculating risk on the total cPAH may have underestimated the risk due to these compounds. Additionally, the emission estimates for the PAHs and in particular, dibenz(a,h)anthracene may have been overestimated due to the use of non-detects in the calculation of the emission rates.

The total HIs of 0.015 for both the adult and child receptors are well below the target HI of 0.25. The estimated noncancer HI for the child in the 2013 scenario is approximately 2 times lower than the 2006 assessment and is attributable to a decrease in noncancer risk associated with potential long-term exposure to mercury. The decrease in noncancer risk associated with long-term exposure to mercury may be attributable to a number of factors, namely a decrease in mercury emissions from the facility; a decrease in mercury deposition due to the change to the AERMOD model, differences in watershed delineation and changes to the deposition and media concentration equations presented in the USEPA 2005 HHRAP guidance document.

In addition, the dioxin/furan intake ratio of 0.0014 for the infant receptor is well below the target of 1.0 (Table 6-2.2). These intake ratios are approximately equal to the ratio calculated for the infant MEI A receptor in the 2006 assessment (0.0015).

6.2.2 Additional Fisher Scenarios

Three additional Fisher Scenarios from the ENSR report were evaluated and are discussed below.

Monocacy River Fisher

The Monocacy River Fisher scenario assumed the Fisher lived at the RME Residential location and also ate fish from the Monocacy River. Thus, the Fisher was assumed to be directly exposed to COPCs by inhalation and indirectly exposed to chemicals via the incidental ingestion of soil, the consumption of homegrown produce from the RME Residential location and via the consumption of fish caught in the Monocacy River. Since the Fisher was assumed to live in the RME Residential area, the direct inhalation pathway was modeled using the RME Residential impacts. An exposure pathway for infants via the ingestion of breast milk was also evaluated. The exposure and risk tables for these receptors can be found in Appendix G.

As shown in Tables 6-3.1 and 6-3.2, respectively, neither the total excess lifetime cancer risks nor the total HIs associated with indirect and direct exposures for the adult and child RME Fisher scenarios exceed the target cancer risk of 1 in 100,000 or the target HI of 0.25. The excess lifetime cancer risk estimates of 0.09 in 100,000 and 0.01 in 100,000 for the adult and child, respectively, are well below the target risk of 1 in 100,000. The estimated excess lifetime cancer risk in the 2013 scenario is approximately 30 times higher for the adult and 5 times higher for the child than the 2006 assessment of the adult and child Monocacy River Fisher. Presumably, this is a result of higher risk estimates attributed to carcinogenic PAHs, particularly dibenz(a,h)anthracene (COPC risk totals were not provided in the 2006 ENSR report for this receptor). It should be noted that the 2006 ENSR report evaluated the cPAHs as a total based upon benzo(a)pyrene. This HHRA evaluated the PAHs separately. Dibenz(a,h)anthracene has the highest risk estimates of the cPAHs. Although it is equipotent as benzo(a)pyrene, the factors involved in calculating accumulation in fish tissue are higher than benzo(a)pyrene. Therefore, calculating risk based on total cPAH as benzo(a)pyrene may have underestimated the risk due to these compounds. Additionally, the emission estimates for the PAHs and in particular, dibenz(a,h)anthracene may have been overestimated due to the use of non-detects in the calculation of the emission rates.

The total HIs of 0.0099 and 0.0079 for the adult and child receptors are well below the target HI of 0.25. The estimated noncancer HIs in the 2013 scenario are lower than the 2006

assessment for both the adult and child receptors and is presumed to be attributable to a decrease in noncancer risk associated with potential long-term exposure to mercury. The decrease in noncancer risk associated with long-term exposure to mercury may be attributable to a number of factors, namely a decrease in mercury emissions from the facility; a decrease in mercury deposition due to the change to the AERMOD model, differences in watershed delineation and changes to the deposition and media concentration equations presented in the USEPA 2005 HHRAP guidance document.

In addition, the dioxin/furan intake ratio of 0.00042 for the infant receptor is well below the target of 1.0 (Table 6-3.2).

Resident Fisher near Farm 1

The Resident Fisher near Farm 1 scenario assumed the Resident Fisher lived in the vicinity of Farm 1 and ate fish from Farm Pond 2 (see Figure 4-3). Thus, the Resident Fisher was assumed to be directly exposed to COPCs by inhalation and indirectly exposed to chemicals via the incidental ingestion of soil, the consumption of homegrown produce and via the consumption of fish caught in Farm Pond 2. An exposure pathway for infants via the ingestion of breast milk was also evaluated. The exposure and risk tables for these receptors can be found in Appendix G.

As shown in Tables 6-3.1 and 6-3.2, respectively, neither the total excess lifetime cancer risks nor the total HIs associated with indirect and direct exposures for the adult and child RME Fisher scenarios exceed the target cancer risk of 1 in 100,000 or the target HI of 0.25. The excess lifetime cancer risk estimates of 0.06 in 100,000 and 0.009 in 100,000 for the adult and child, respectively, are well below the target risk of 1 in 100,000. The estimated excess lifetime cancer risk in the 2013 scenario is approximately 15 times higher for the adult and 9 times higher for the child than the 2006 assessment of the adult and child Resident Fisher near Farm 1. This is a result of higher risk estimates attributed to carcinogenic PAHs, particularly dibenz(a,h)anthracene. It should be noted that the 2006 ENSR report evaluated the cPAHs as a total based upon benzo(a)pyrene. This HHRA evaluated the PAHs separately. Dibenz(a,h)anthracene has the highest risk estimates of the cPAHs. Although it is equipotent as benzo(a)pyrene, the factors involved in calculating accumulation in fish tissue are higher than benzo(a)pyrene. Therefore, calculating risk based on total cPAH as benzo(a)pyrene may have underestimated the risk due to these compounds. Additionally, the emission estimates for the PAHs and in particular,

dibenz(a,h)anthracene may have been overestimated due to the use of non-detects in the calculation of the emission rates.

The total HIs of 0.014 and 0.01 for the adult and child receptors are well below the target HI of 0.25. The total HIs in the ENSR 2006 report are 14 times higher for the 2013 adult receptor and 38 times higher than the child receptor. Although mercury emissions from the facility have decreased it is not enough to account for the difference. It may be due to a difference in depositional impacts in relation to the Farm Pond as modeled using AERMOD versus ISCST3, differences in watershed delineation as well as changes in the depositional and media concentration calculations as presented by the USEPA 2005 HHRAP guidance document.

In addition, the dioxin/furan intake ratio of 0.0004 for the infant receptor is well below the target of 1.0 (Table 6.3-2).

Resident Fisher near Farm 2

The Resident Fisher near Farm 2 scenario assumed the Resident Fisher lives in the vicinity of Farm 2 and ate fish from Farm Pond 3 (see Figure 4-3). Thus, the Resident Fisher was assumed to be directly exposed to COPCs by inhalation and indirectly exposed to chemicals via the incidental ingestion of soil, the consumption of homegrown produce and via the consumption of fish caught in Farm Pond 3. An exposure pathway for infants via the ingestion of breast milk was also evaluated. The exposure and risk tables for these receptors can be found in Appendix G.

As shown in Tables 6-3.1 and 6-3.2, respectively, neither the total excess lifetime cancer risks nor the total HIs associated with indirect and direct exposures for the adult and child RME Fisher scenarios exceed the target cancer risk of 1 in 100,000 or the target HI of 0.25. The excess lifetime cancer risk estimates of 0.1 in 100,000 and 0.02 in 100,000 for the adult and child, respectively, are well below the target risk of 1 in 100,000. The estimated excess lifetime cancer risk in the 2013 scenario is approximately 16 times higher for the adult and 10 times higher for the child than the 2006 assessment of the adult and child Resident Fisher near Farm 2. This is a result of higher risk estimates attributed to carcinogenic PAHs, particularly dibenz(a,h)anthracene. It should be noted that the 2006 ENSR report evaluated the cPAHs as a total based upon benzo(a)pyrene. This HHRA evaluated the PAHs separately. Dibenz(a,h)anthracene has the highest risk estimates of the cPAHs. Although it is equipotent as benzo(a)pyrene, the factors involved in calculating accumulation in fish tissue are higher than benzo(a)pyrene. Therefore, calculating risk based on total cPAH as benzo(a)pyrene may have underestimated the risk due to

these compounds. Additionally, the emission estimates for the PAHs and in particular, dibenz(a,h)anthracene may have been overestimated due to the use of non-detects in the calculation of the emission rates.

The total HIs of 0.025 and 0.018 for the adult and child receptors are well below the target HI of 0.25. The total HIs in the ENSR 2006 report are 25 times higher than the 2013 adult receptor and 55 times higher than the 2013 child receptor. Although mercury emissions from the facility have decreased it is not enough to account for the difference. It may be due to a difference in depositional impacts in relation to the Farm Pond as modeled using AERMOD versus ISCST3, differences in watershed delineation as well as changes in the depositional and media concentration calculations as presented by the USEPA 2005 HHRAP guidance document.

In addition, the dioxin/furan intake ratio of 0.00069 for the infant receptor is well below the target of 1.0 (Table 6-3.2).

6.2.3 Additional Farmer Scenarios

Two additional Resident Farmer Scenarios from the ENSR report were evaluated and are discussed below.

Resident Farm 1

As discussed in the ENSR report, the Farmer was hypothetically assumed to live on Farm 1 (see Figure 4-3) and thus, is directly exposed to COPCs by inhalation and indirectly exposed to the COPCs via the incidental ingestion of soil, and the consumption of homegrown produce and home-raised beef, dairy, pork, chicken and eggs. These exposures are assumed to occur even if all the food products are not produced at the assumed farm location. An exposure pathway for infants via the ingestion of breast milk was also evaluated. The exposure and risk tables for these receptors can be found in Appendix G. For the Farmer, the total excess lifetime cancer risk estimates of 0.005 in 100,000 and 0.0009 in 100,000 for the adult and child, respectively, are well below the target cancer risk of 1 in 100,000 (Table 6-4.1). The total excess lifetime cancer risk for the Resident Farm 1 adult and child receptors in the 2006 evaluation were approximately 8 and 5 times higher, respectively than in this HHRA. The increased risk in the ENSR 2006 report was due to TCDD-TEQ.

The total HIs of 0.00055 and 0.00066 for the adult and child receptor are well below the target HI of 0.25 (Table 6-4.2). The estimated noncancer HIs in the 2013 scenario are slightly higher than the 2006 assessment (less than 2 times) for both the adult and child receptors.

In addition, the dioxin/furan intake ratio of 0.000013 for the infant receptor is well below the target of 1.0 (Table 6-4.2).

Resident Farm 6

The ENSR report evaluated a subsistence Farmer scenario in which a subsistence Farmer was located at Farm 5. Farm 5 was described as being the nearest actual beef/dairy farm location predicted to be maximally impacted by facility-related emissions. However, for this update Farm 6 (see Figure 4-3) was determined to be the nearest actual beef/dairy farm location predicted to be maximally impacted by facility-related emissions. Therefore, the Farmer was assumed to live on Farm 6 and thus is directly exposed to COPCs by inhalation and indirectly exposed to the COPCs via the incidental ingestion of soil, and the consumption of homegrown produce, and home-raised beef, dairy, pork, chicken and eggs. These exposures are assumed to occur even if all the food products are not produced at the assumed farm location. An exposure pathway for infants via the ingestion of breast milk was also evaluated. The exposure and risk tables for these receptors can be found in Appendix G. For the Farmer, the total excess lifetime cancer risk estimates of 0.02 in 100,000 and 0.006 in 100,000 for the adult and child, respectively, are well below the target cancer risk of 1 in 100,000 (Table 6-4.1). The total excess lifetime cancer risk for the Resident Farm 5 (Johnson Dairy Farm) adult and child receptors in the 2006 evaluation were approximately 3 and 2 times higher, respectively than in this HHRA. It should be noted however that these are different locations and therefore are not directly comparable. However, Farm 6 did show higher depositional impacts than the Johnson Farm and therefore the decrease may be due to a decrease in emissions such as TCDD-TEQ.

The total HIs of 0.0036 and 0.0057 for the adult and child receptor are well below the target HI of 0.25 (Table 6-4.2). The estimated noncancer HIs in the 2013 scenario are approximately three times higher than the 2006 assessment for both the adult and child receptors. It should be noted however that these are different locations and therefore are not directly comparable. The increase in the non-cancer HI may be attributable to the calculation of a noncancer HI for TCDD-TEQ. At the time of the 2006 ENSR report, USEPA had not developed a noncancer RfD for TCDD and therefore it was not evaluated.

In addition, the dioxin/furan intake ratio of 0.0011 for the infant receptor is well below the target of 1.0 (Table 6-4.2) and is less than the ratio calculated for the infant Resident Farm 5 receptor in the 2006 assessment (0.0043).

6.3 Acute Inhalation Scenario

As shown in Table 6-5, the total acute inhalation index (AHI) associated with the acute inhalation of the one-hour maximum air concentrations of the stack emissions is 0.054, which is less than the target AHI of 1.

6.4 Children's Lead Exposure

The USEPA's Integrated Exposure Uptake Biokinetic Model (v1.1, Build 11) is used to estimate blood lead concentrations due to exposure to lead in the environment. However, the estimated total lead intake (see Appendix G) for the RME child receptors was negligible (in the range of E-07 mg/kg) such that the model could not compute a blood lead level. The worst case soil lead concentration was calculated for "untilled" RME Residential soils (which also includes the RME Fisher Scenario). The concentration of lead in soil calculated for the RME Resident is 0.0017 mg/kg. This concentration is more than 200,000 times less than the residential soil lead target concentration of 400 mg/kg. Therefore, childhood exposure to lead as a result of the RRF emissions is significantly below a level of concern.

6.5 Comparison of Soil Concentrations to Groundwater Protection Criteria

The worst case soil concentrations were calculated for "untilled" RME Residential soils, due to the hypothetical location at the point of maximum air concentration and depositional impact. The predicted soil concentrations were compared against USEPA's groundwater protection SSLs to determine whether there is a potential for groundwater contamination via deposition of RRF emissions onto soils. The groundwater protection SSLs are soil concentrations that are protective of groundwater and are either based upon USEPA's Maximum Contaminant Limit (MCL) for drinking water or a risk-based target drinking water concentration. Risk-based SSLs are back-calculated from a drinking water concentration to a soil concentration at a risk level of 1 in one million for carcinogens or at a noncancer target level of 1.0. For those compounds for which there is not an available MCL-based SSL, the soil concentrations were compared against the risk-based SSL. Table 6-6 shows the results of this comparison. The groundwater protection SSLs (either

MCL-based or risk-based) are all significantly higher than the calculated worst-case soil concentrations. Soil concentrations range from 437 times less than the SSL (cobalt) to 372 billion times less than the SSL (2-methylnaphthalene).

6.6 Risk Assessment Conclusions

As discussed above total excess lifetime cancer risks and noncancer hazards associated with combined stack and fugitive emissions from the Montgomery County RRF are well below USEPA target levels of 1 in 100,000 and 0.25, respectively for all receptors. Table 6-7 provides a summary of the results for each of the receptors evaluated in this HHRA.

All calculated cancer risks were approximately 10 to 250 times less than the cancer target level of 1 in 100,000, while calculated noncancer hazard indices were approximately 10 to 600 times less than the noncancer target level of 0.25. All calculated dioxin/furan intake ratios for the various infant receptors were approximately 500 to 34,000 times less than the background comparison value of 60 pg/kg/day.

Short-term exposures to the one-hour maximum air concentration were approximately 20 times lower than the target AHI of 1.

Deposition of facility emissions onto surrounding soils does not pose a risk to groundwater drinking wells. A comparison of maximum soil concentrations associated with combined stack and fugitive emissions to USEPA's groundwater protection SSLs showed soil concentrations ranging from 437 times less than the SSL (cobalt) to 372 billion times less than the SSL (2-methylnaphthalene).

This HHRA was conducted using USEPA's 2005 HHRAP guidance. Assumptions used in the HHRA were meant to be health protective and would tend to overestimate risk. For example, the RME Resident, RME Fisher, MEI A and B receptors and the Monocacy River Fisher scenarios all assume that exposure occurs regardless if modeled impacts occur at different locations (i.e., assumes modeled impacts at different locations are collocated). All Farmer scenarios assume that all the food products consumed are grown on the property, including feed ingested by the food producing animals. This would overestimate exposure if feed is actually bought and not grown on the property.

It can be concluded from the results of the HHRA that potential risks associated with stack emissions from the RRF are below regulatory and other target risk levels for human health and that there is a very low likelihood that potential health effects would occur as a result of exposure

to RRF emissions under the various exposure conditions evaluated in this HHRA. Although the highest estimated total excess lifetime cancer risk is below the target cancer risk level by at least a factor of 10, the carcinogenic (cPAHs), primarily dibenz(a,h)anthracene is the primary risk driver. The emission estimates for the PAHs and in particular, dibenz(a,h)anthracene may have been overestimated due to the use of non-detects in the calculation of the emission rates, thus overestimating risk. In addition, USEPA is currently assessing the cancer slope factor for benzo(a)pyrene, on which the slope factor for dibenz(a,h)anthracene is based, and is proposing to revise it downward. Use of the new oral slope factor for benzo(a)pyrene would result in a decrease in the overall excess lifetime cancer risk by approximately 5-fold.

7.0 UNCERTAINTY ASSESSMENT

In accordance with HHRAP guidance, sources of uncertainty are discussed in further detail in the following sections.

7.1 Uncertainty Associated with the Stack Emissions

7.1.1 Source Emission Testing

Annual compliance testing is conducted at the RRF. The RRF must comply with the requirements of Maryland Department of the Environment (MDE) Permit # 24-031-01718, as well as Federal standards. Emission rates were obtained from 32 stack tests conducted over a period of 18 years (1995 – 2013). The presence of such an extended set of measured emission rates is exceptional for an assessment of a waste combustion facility and helps to reduce uncertainty in the emission rates used in this HHRA. Metals, dioxins/furans, PAHs, PCBs and formaldehyde were analyzed during the compliance testing, however, not all three units were tested for each parameter during each stack test. However, since the stack testing is conducted in accordance to with the Permit and under MDE regulatory review, and a large database of measurements are available, this is not expected to increase or decrease the HHRA results.

7.1.2 Selection of COPCs

Metals, dioxins/furans, PCBs, PAHs and formaldehyde were evaluated in the post-operational 2006 ENSR health risk study and were also carried through in this updated HHRA. As described in ENSR 2006, these COPCs were similar to those identified by Weston (1989) for the pre-operational risk assessment for this facility, and thus using the same COPCs provides continuity among the three risk assessments. Similarly to the ENSR 2006 health risk study, this HHRA evaluated dioxin/furans as a TCDD-TEQ at the point of emission rate and did not carry through each dioxin/furan congener through the risk assessment individually. The use of this method did not underestimate risk. In evaluating food chain uptake factors, no dioxin/furan congener had values that were significantly higher (greater than 100x) than the uptake factors for TCDD. In addition, USEPA has only developed a unique oral slope factor for "Hexachlorodibenzo-p-dioxin, Mixture". The slope factor for this compound is 6,200 per mg/kg/day (which means 6,200 excess cancer risk per 1 mg/kg/day exposure), this is in contrast to the oral slope factor for 2,3,7,8-TCDD which is 150,000 per mg/kg/day (150,000 excess cancer risk per 1 mg/kg/day exposure).

7.1.3 Evaluation of Non-Detected Chemicals

As part of the HHRA evaluation, detected and non-detected concentrations were carried through the risk assessment process. The inclusion of the non-detected compounds at their full detection limit and their inclusion as surrogates for detected values in the calculation of the 95% UCL value increases the conservative nature of the HHRA, since a detection limit represents a range from zero up to the detection limit. In addition, for those compounds analyzed by non-isotope dilution methods (used for measuring metals and some organic compounds such as PCBs and formaldehyde), the MDL was multiplied by a factor of 2.623 to achieve an RDL in accordance with the HHRAP. Therefore for metals, PCBs and formaldehyde not detected during a test run, their respective detection limits were increased by a factor of 2.623 before being utilized in the calculation of the overall emission rate. The use of this factor increases the conservative nature of the HHRA.

7.1.4 Derivation of Emission Rates

Detected and non-detected concentrations were used to calculate the 95% UCL of the mean of the emission rates. In calculations involving a series of measurements comprised of detected values and non-detect quantitation limits, the full quantitation limit was included for the non-detects and ProUCL was used in "no non-detect" mode such that it treated all values as detected values, this is a conservative assumption which results in higher UCL values than if calculated in "non-detect" mode. Treating non-detected concentrations as detected concentrations will tend to overestimate the UCL resulting in a more health-protective evaluation. This particularly true for the PAHs, in particular dibenz(a,h)anthracene which was detected in only 4 of 59 samples (see summary statistics in Appendix A). In addition, the maximum non-detect concentration was four times higher than the maximum detected concentration (1.47E-05 g/sec vs 4.11E-06 g/sec). Therefore, the use of the full reporting limit for PAHs may overestimate the PAH emission rates evaluated in this risk assessment. In the case of dibenz(a,h)anthracene, the chosen UCL values for each of the three units (see Table 2-2) exceed the actual maximum detected concentration of 4.11E-06 g/sec. Overestimated emission rates will result in overestimated risks. However, as shown in the results, none of the calculated risks exceeded the USEPA target risk levels.

The definition of the 95% UCL of the arithmetic mean is such that there is 95% confidence that the true mean (average) concentration of the population is below the calculated UCL value.

The 95% UCL of the arithmetic mean of the emission rates is greater than the arithmetic mean of the emission rates (See Table 2-3).

In addition, the emission rates used in the HHRA assumed that all three identical combustion units at the RRF will operate continuously at maximum load for 30 years. Therefore, the use full non-detect values as detected concentrations, the use of the 95% UCL of the arithmetic mean and the assumption that the RRF operates continuously at maximum load overestimates the HHRA results.

7.1.5 Fugitive Emissions

As discussed in Section 2.5.1, fugitive emissions were calculated based on a number of assumptions:

- fly ash was comprised of 25% of the total ash production,
- estimates of fugitive emission rates for fly ash were obtained from AP-42,
- no reduction of fugitive emissions due to ash handling occurring in the Residue Handling Building, and
- use USEPA's aerodynamic particle size multiplier (k=0.74) for particles ≤ 30 microns aerodynamic diameter.

Based on these assumptions, the fugitive fly ash emission rate was calculated as 2.4 lb/yr. This fly ash emission rate applies to large particles that are not of inhalable size and thus will overestimate emissions that are relevant for assessing potential inhalation exposures.

7.1.6 Upset Emissions

Process upsets have the potential to cause short term emission excursions. Twenty-four months of site-specific daily CEM data were used to determine the percentage of time in upset conditions. As described in the 2005 HHRAP guidance, a generic 10-fold increase in emissions during process upsets is used with the site-specific percentage of time in upset to calculate the upset factor. This 10-fold increase in emissions is based upon a default procedure presented by the California Air Resources Board (CARB) (CARB 1990, as cited in USEPA 2005a), however no basis for this factor is provided in the HHRAP guidance. Process upset factors were calculated for metals based upon the percentage of time the percent opacity exceeded 5%. This is a conservative estimate in that the opacity standard is 10%. The calculation of the metals process

upset factor results in a value of 1.0008, which is negligible and was therefore, not applied to metals emissions in the HHRA.

For organic compounds, the process upset factor was based upon the percentage of time the CO concentrations exceeded 50 ppm. Only 282 hours out of a total 44,444 hours were greater than 50 ppm. Therefore, the calculated percentage of time that the facility exhibited a CO excursion was 0.63%, resulting in an organics process upset factor of 1.057, which was applied to organic emissions in the HHRA. The addition of the process upset factor to the organic compounds increases the risk from those compounds by approximately 6%.

For acute (short-term) hazards, applying a 10 fold increase to the emission rates used in the evaluation would result in an AHI of 0.54 at the point of maximum short-term impact. Therefore, under the unlikely event that a process upset would cause a short-term 10 fold increase in emissions, the cumulative acute hazard is still less than a level of concern as the AHI is less than the target level of 1.0. The AHI would be less at all other locations.

7.1.7 Unidentified Emissions

According to the HHRAP Guidance (USEPA 2005a), in order to account for unidentified organic compounds, a Total Organic Emission (TOE) Factor should be calculated and applied to the results of the HHRA. Since these emissions tests were conducted to achieve compliance with permit levels, they were not designed to include risk assessment data requirements. The necessary parameters to calculate a TOE factor were not collected in the stack emissions tests and therefore, the TOE factor was not calculated. However, as a conservative estimate, if the risk from unknown organics was equivalent to the risk from the known organics, it would result in a calculated excess lifetime cancer risk range of 0.016 in 100,000 (RME Resident Adult) to 0.2 in 100,000 (RME Fisher, MEI A and B and Resident Fisher near Farm 1 scenarios) which would still be below the target cancer risk level of 1 in 100,000.

7.2 Uncertainty Associated with the Dispersion and Deposition Modeling

The AERMOD model was jointly developed by a committee of independent scientists representing the American Meteorological Society and the regulatory modeling group within the USEPA. The model has gone through extensive scientific peer-review and through a public comment period. AERMOD's prediction capability was evaluated against observed data from nineteen atmospheric dispersion experiments (USEPA 2003, AERMOD: Latest Features and

Evaluation Results, USEPA-454/R-03-003, USEPA, Research Triangle Park, NC). These studies included short-term tracer studies and long-term SO2 (sulfur dioxide) monitoring studies conducted in a variety of locations across the United States. The purpose of the evaluation studies was to be sure that AERMOD had been tested in a variety of types of environments for which it will be used. Seven of these model evaluation databases were for sources with aerodynamic stack plume downwash, similar to the RRF. For these databases, the reported overall predicted to observed ratio was 0.97 (as compared to 1.0 which would indicate perfect alignment with observed to predicted results), indicating that AERMOD successfully predicted concentrations for these seven downwashed sources and that AERMOD is a reliable model for application to the Montgomery County RRF.

The lack of facility-specific particle fractionation data introduces uncertainty for particle and particle-bound impacts. Larger particles will deposit out quicker than smaller particles. Conversely, smaller particles will remain airborne at further downwind distances from the RRF. Particle fractionation data collected downstream of fabric filters at a German municipal solid waste facility (ENSR 2006) and a U.S. brick manufacturer provided in USEPA's AP42 show similar particle mass distributions. Due to the German municipal solid waste facility's similarity to the RRF, its particle size distribution was selected for use.

A major difference between using ISC and AERMOD is that each vapor phase COPC is modeled separately. Therefore, the locations of the maximum concentration or depositional impact may occur in different places. For those scenarios that relied on using a maximum concentration and maximum depositional impact, the maximum value was used regardless of whether it was occurring in a different location. This method increases the conservative nature of the HHRA.

Following USEPA modeling guidance, the fugitive emissions are modeled at ambient temperature, with negligible vertical velocity (horizontal plume), an equivalent area diameter based on the size of the Residue Handling Building garage door (16 ft tall by 28 ft wide), and a source height equal to half the height of the door (16 ft / 2 = 8 ft). Since there is no available analytical data of the fly ash, it was assumed that it contained particulate COPCs in the same proportion as what was analyzed in the stack emissions. For each COPC considered (e.g. metals and PAHs listed in Table 2-4), the COPC-specific emission rate (g/s) from the RRF stack was multiplied by the ratio of the fugitive fly ash emission rate divided by the RRF reported filterable particulate matter emission rate. This adds uncertainty to the contribution of the fugitive emissions

to the overall risk, by potentially underestimating the COPCs in the fugitive emissions. However, even though conservative assumptions were used to calculate the overall fly ash emission rate, the contribution to the overall risk was negligible. Therefore the uncertainty associated with the COPCs in the fly ash is not expected to underestimate risk.

7.3 Uncertainty Associated with Exposure Assessment

The major areas of uncertainty associated with the exposure assessment include selection of receptor locations, environmental fate and transport modeling, and calculation of exposures.

7.3.1 Selection of Receptor Scenarios

The magnitude of risk to each receptor evaluated in this HHRA is predicated upon the exposure actually occurring under the described exposure scenarios and that it occurs under the exposure duration assumptions (e.g. regular exposure for 30 years for an adult resident/fisher; 40 years for an adult farmer). Each of the assumptions associated with each receptor scenario overestimates the results of the HHRA.

7.3.1.1 RME Scenarios

RME Resident

The HHRAP Guidance (USEPA 2005a) requires the use of the maximum vapor impact and the maximum combined wet and dry particulate deposition to estimate contaminant intakes by potential residential receptors even if they occur at different locations. This was the case for the RRF HHRA. Figure 4-1 shows the maximum vapor and wet and dry deposition impacts for the facility. Although the depositional impacts are located close to the facility, the maximum concentrations are located on Sugar Loaf Mountain. The maximum of each parameter was used to derive the total impact for the RME residential receptor, regardless of where the impacts occurred. As such, calculated risks reflect "worst-case" maximum potential impacts. Actual risks associated with exposures in residential areas would therefore be less.

RME Fisher

The RME Fisher is assumed to live at the RME Residential location and therefore reflects a "worst-case" maximum potential exposure to soils and produce impacted by facility emissions.

In addition, per the HHRAP, the RME Fisher scenario assumes that the receptors only consume fish caught in the Potomac River.

The calculation of COPCs in fish tissue is based upon the concentration of COPCs in the water which is calculated by estimating the COPC loading from the Potomac River watershed into the Potomac River. The deposition of COPCs onto the watershed and the river is determined by taking the average deposition of COPCs across the watershed and the river within the identified impact area. Using an average deposition tends to overestimate the amount of COPCs depositing on the watershed and river because the highest deposition will tend to be closer to the facility and decreases further away from the facility. Therefore the average will be biased high because more of the higher depositional values will be used in the calculation. An additional parameter that impacts the concentration of COPCs in the river is the flow rate. This HHRA used a 117 year average of flow measured at the Point of Rocks station. This flow rate of 4927 ft^3, is slower than the average from the years 2000 – 2012 (~9,500 ft^3). Use of a lower flow rate tends to overestimate potential impacts on the river. Therefore, these assumptions will tend to overestimate risk due to ingestion of fish.

RME Farmer

RME Farmer lives at the point of maximum vapor and depositional impact in a potential farm area. The RME Farmer scenario assumes that this receptor grows their own vegetables, livestock for consumption (beef, pork and chicken) and dairy products (milk and eggs) and that 100% of these food products are affected by facility emissions. In addition, it is assumed that all animal feed for the food animals is grown on location. Each of these assumptions overestimate the results of the HHRA.

7.3.1.2 Additional Scenarios

A number of receptors were evaluated in the 2006 ENSR report and were re-evaluated in this update. These additional receptor scenarios were meant to reflect the range of possible exposure scenarios in the impact area of the RRF. For example, the MEI receptors consumed produce grown at the point of maximum dry deposition (Scenario A) or maximum total particle and vapor deposition (Scenario B), consumed 100% of livestock and dairy products from the *actual* farm with highest impacts and 100% fish caught from the Potomac River.

7.3.1.3 Site Specific versus Default Input Parameters

Environmental media concentrations (i.e., soil, water, produce, meat and dairy products and fish) and intake equations were calculated using site-specific information if available and default parameters when it was not. Tables 4-1 and 4-2 provide the input parameters, exposure assumptions and their sources. Site-specific information was available for some soil calculation parameters and water calculation parameters. The majority of the inputs, however, were based upon default values provided in USEPA's HHRAP Guidance. These values are intended to provide high-end estimates of media concentrations and intake, thus overestimating the results of the HHRA.

7.3.2 Exposure Parameters

Typically, screening-level assessments are undertaken to identify those receptors, pathways, compounds, etc., that do not require further evaluation and to identify those items that would benefit from additional evaluation. As such, screening assessments use "high-end" exposure factors to derive potential chemical intakes at the upper end of the intake distribution. This approach yields intakes that are considered overestimates when compared to potential intakes that might occur in reality. In addition, the HHRAP assumes that only food produced at the exposure location is impacted by emissions from the RRF and therefore, the recommended consumption rates are for food that is both produced and consumed at the exposure location. These assumptions tend to increase the conservative nature of the HHRA.

7.3 Dose-Response Assessment

The toxicity criteria used in the dose-response assessment are peer-reviewed values developed by the USEPA or other health or regulatory agencies. Toxicity criteria are specifically developed to be protective of sensitive individuals and young children. These toxicity criteria are periodically reviewed by the agencies to determine if they are still appropriate.

TCDD in Breast Milk

At the time of the finalization of the HHRAP, USEPA had not developed a RfD for TCDD, therefore the HHRAP guidance recommended comparing PCDD and PCDF oral exposure estimates to national average background exposure levels. The national average background exposure level for nursing infants was 60 pg/kg/day, which was compared to the

ADD, experienced over the course of the exposure duration. USEPA has recently promulgated a RfD for TCDD of 0.7 pg/kg/day which is approximately 86 times less than the comparison value of 60 pg/kg/day.

Comparing the calculated dioxin ADD for breast-fed infants across all exposure scenarios to the 60 pg/kg/day background level resulted in ratios ranging from 1.1E-03 to 2.9E-05, indicating that dioxin exposure through breast milk ingestion was well below the national average background exposure level. The use of the more stringent RfD in the evaluation of the infant breast milk ingestion pathway would result in HQs ranging from 9.5E-02 to 2.2E-03, indicating that dioxin exposure via breast milk ingestion is below the non-cancer target value of 0.25 and below a level of concern for health effects.

Benzo(a)pyrene

The toxicity criteria for benzo(a)pyrene is currently under reassessment by the USEPA. The Public Comment Draft Toxicological Profile was issued in August 2013 (USEPA 2013e). The Toxicological Review, prepared under the auspices of USEPA's Integrated Risk Information System (IRIS) program, critically reviewed the publicly available studies on benzo(a)pyrene in order to identify potential adverse health effects and to characterize exposure-response relationships. The current oral cancer slope factor of 7.3 per mg/kg/day was issued in 1994. USEPA had not issued an inhalation unit risk factor or a noncancer RfD or RfC for benzo(a) pyrene. Each of the cPAH cancer slope factors is based upon their relative potency as compared to benzo(a)pyrene (USEPA 1993). Dibenz(a,h)anthracene is considered equipotent to benzo(a)pyrene, while benzo(a)anthracene, benzo(b)fluoranthene and indeno(1,2,3-cd)pyrene are one-tenth as potent, benzo(k)fluoranthene is one-hundredth as potent and chrysene is one-thousandth as potent. The proposed cancer slope factor for benzo(a)pyrene is 1.0 per mg/kg/day, which indicates a decrease in estimated cancer potency of this compound. In addition there is a proposed unit risk factor of 0.5 per mg/m^3 as well as a proposed RfD and RfC for benzo(a)pyrene.

Although the highest estimated total excess lifetime cancer risk is below the target cancer risk level by a factor of 10, the cPAHs, primarily dibenz(a,h)anthracene is the primary risk driver in the Fisher Receptor Scenarios. Use of the new oral slope factor for benzo(a)pyrene would result in a decrease in the overall excess lifetime cancer risk by approximately 5-fold.

7.4 Risk Characterization

The uncertainties associated with the risk characterization may be categorized into two groups: (1) those related to the other components of the HHRA (i.e., stack emissions characterization, AERMOD modeling, exposure assessment, and dose-response assessment) and (2) those inherent in the risk characterization methodologies. One source of uncertainty associated with the latter category is the assumption that chemical specific risks are additive (i.e., act independently (e.g., 1 + 1 = 2)). This oversimplifies the fact that chemicals may also act synergistically (e.g., 1 + 1 > 2) or antagonistically (e.g., 1 + 1 < 2). For the non-carcinogenic assessment, it also overlooks the fact that different chemicals may be associated with varying health endpoints.

7.5 Uncertainty Assessment Conclusions

This HHRA followed USEPA's 2005 HHRAP guidance. Estimates of risk and noncancer hazards as a result of modeled facility impacts were calculated using equations and input parameters outlined in the HHRAP. In general, the methods and assumptions recommended in the HHRAP are intended to provide a conservative, health protective estimate of risk (i.e., to overestimate risk).

As discussed in each of the sections above, the assumptions and methods used in this risk assessment are conservative and health protective. For example, assumptions used in the calculation of the emission estimates such as inclusion of non-detected concentrations as detects, use of the 95% UCL of the emissions vs the average, assumptions that the RRF operates at full maximum load, 100% of the time all contribute to over-predicting the concentrations of contaminants emitted by the RRF. The methods used to evaluate how those emissions impacted near-by, hypothetical receptors were also developed to be conservative and health protective. For example, the maximum impacted residential receptor was assumed to be impacted by maximum wet and dry deposition and the maximum air concentrations, regardless of the fact that they all occurred in different locations. Farmers were presumed to eat vegetables, beef, dairy, pork, chicken and eggs, all grown at their locations, regardless of whether they produced those foodstuffs or not. In addition, it was assumed that all livestock feed was grown at the farm location. Therefore, this HHRA provides a conservative, health protective estimate of risk from the emissions from the RRF. Although these estimates would over-estimate risk from exposure, the results of the HHRA show that potential risks associated with stack emissions from the RRF are

below regulatory and other target risk levels for human health and that there is a very low likelihood that potential health effects would occur as a result of exposure to RRF emissions under the various exposure conditions evaluated in this HHRA.

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FIGURES

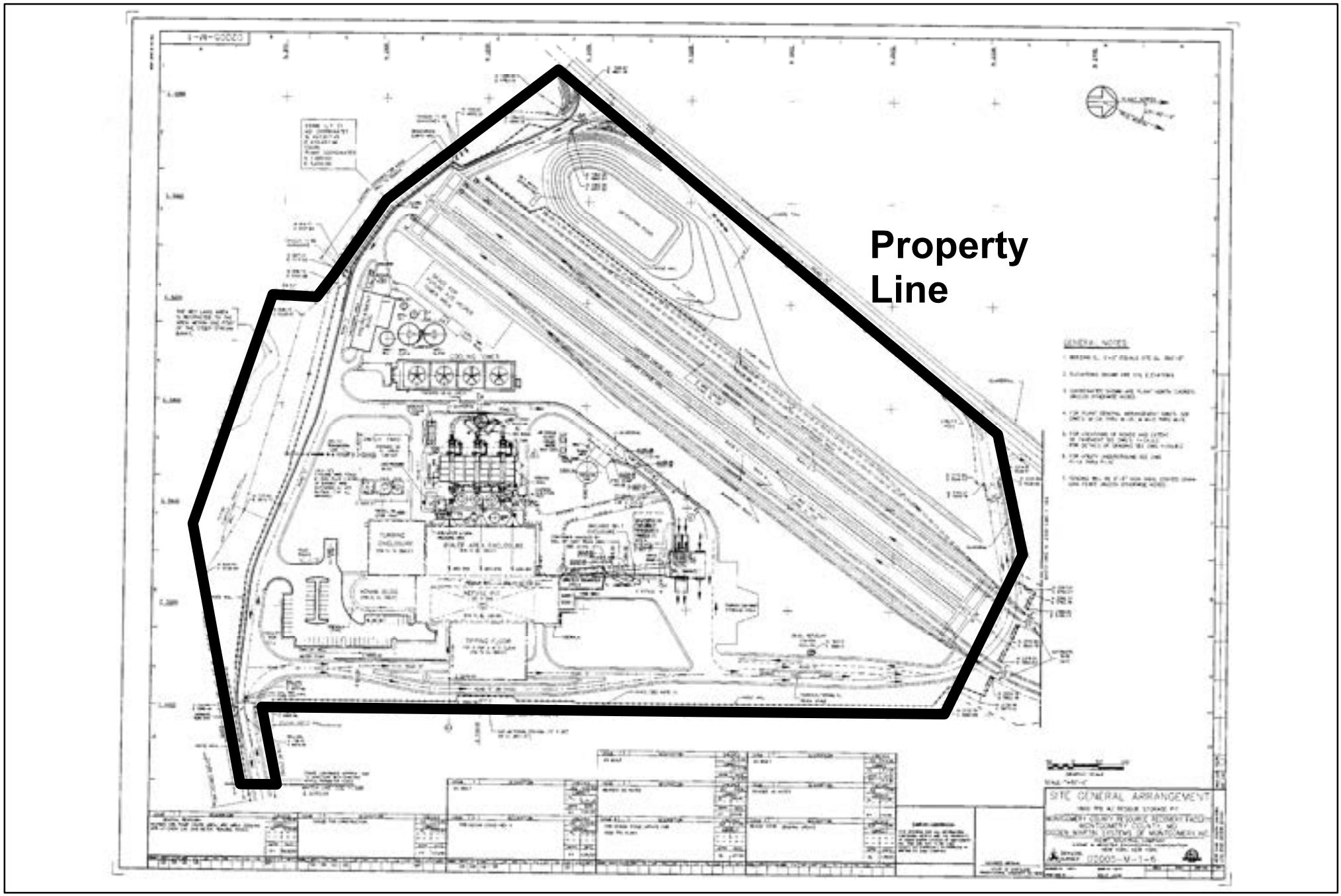

Figure 2-1

RRF Plant Site Map

Montgomery County RRF, Dickerson, MD

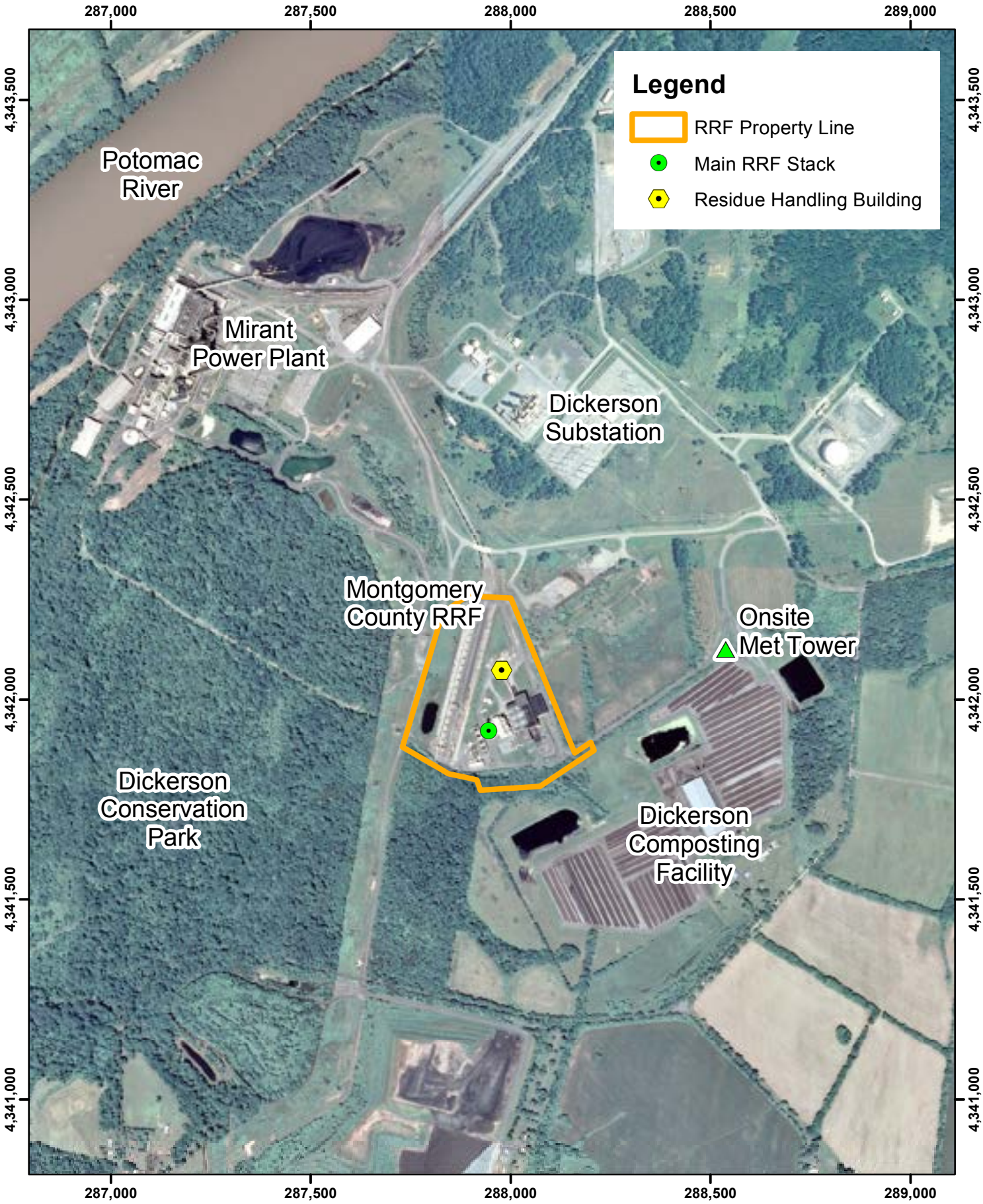

Figure 2-2
Aerial Photograph of the RRF

Montgomery County RRF, Dickerson, MD

330 165 0 330 Meters

NAD 1983 UTM Zone 18N Meters

N

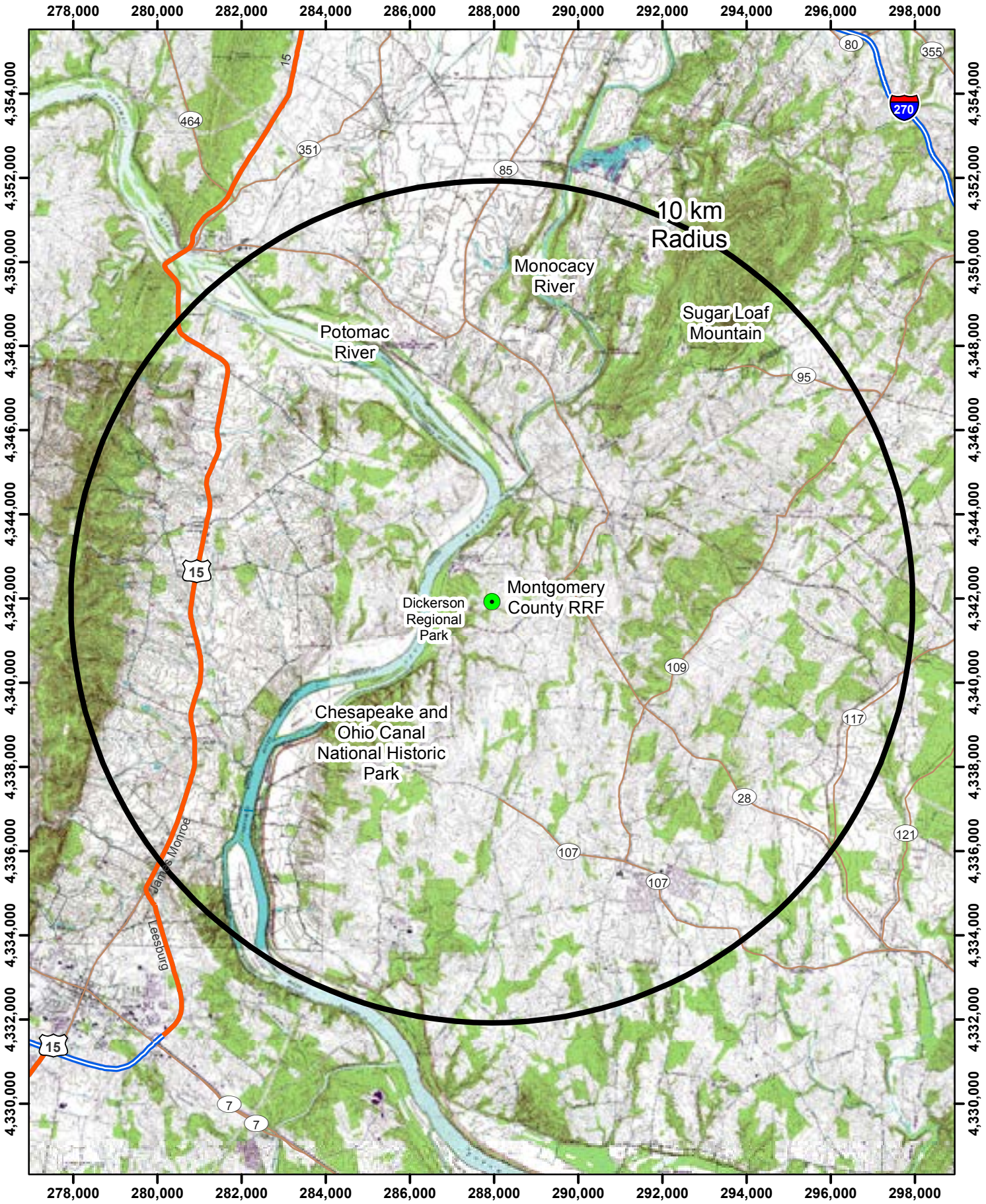

Figure 3-1

Facility Location and Terrain Out to 10 km

Montgomery County RRF, Dickerson, MD

2,400 1,200 0 2,400 Meters

NAD 1983 UTM Zone 18N Meters

N

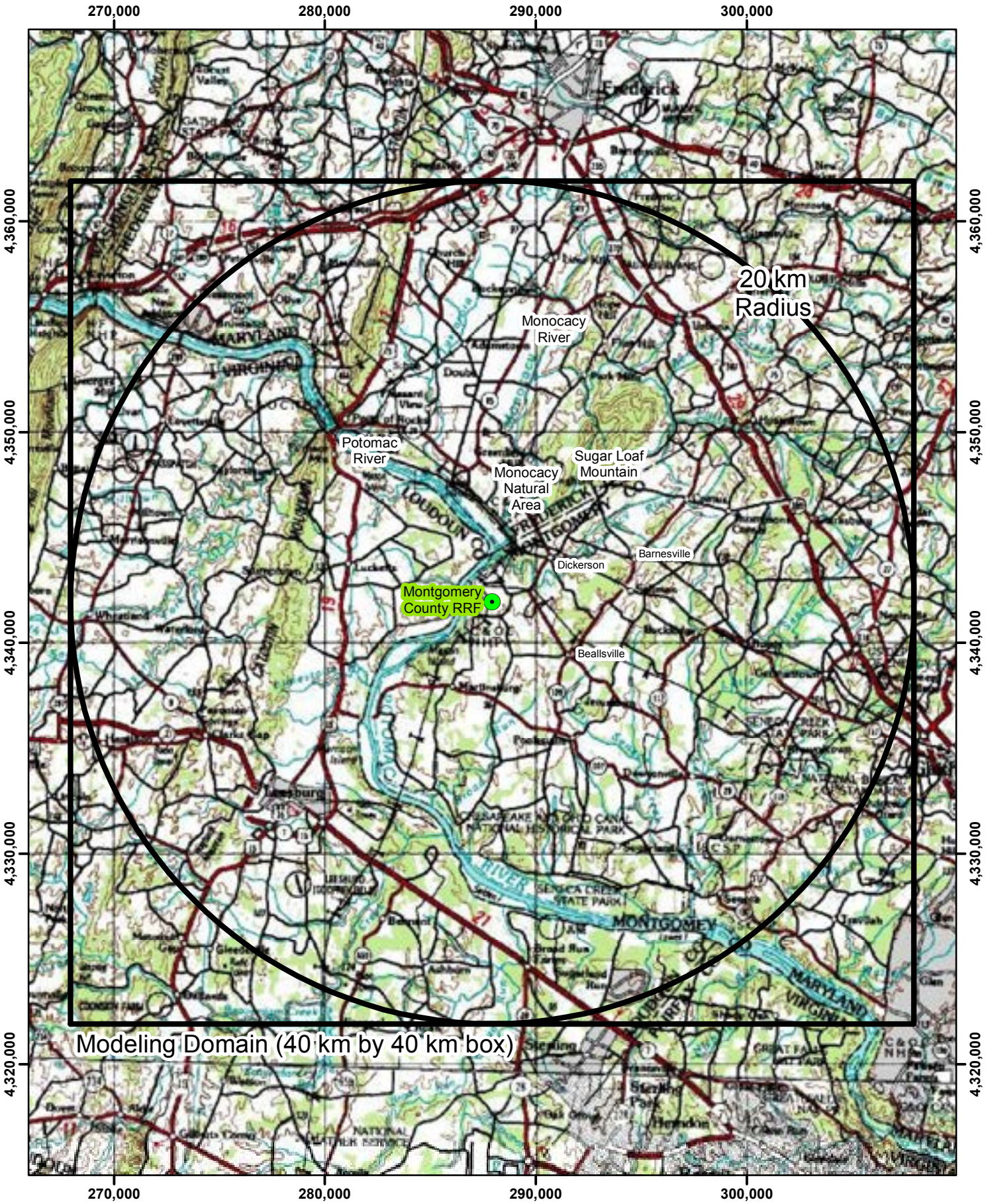

Figure 3-2

Facility Location and Terrain Out to 20 km

Montgomery County RRF, Dickerson, MD

4,900 2,450 0 4,900 Meters

NAD 1983 UTM Zone 18N Meters

N

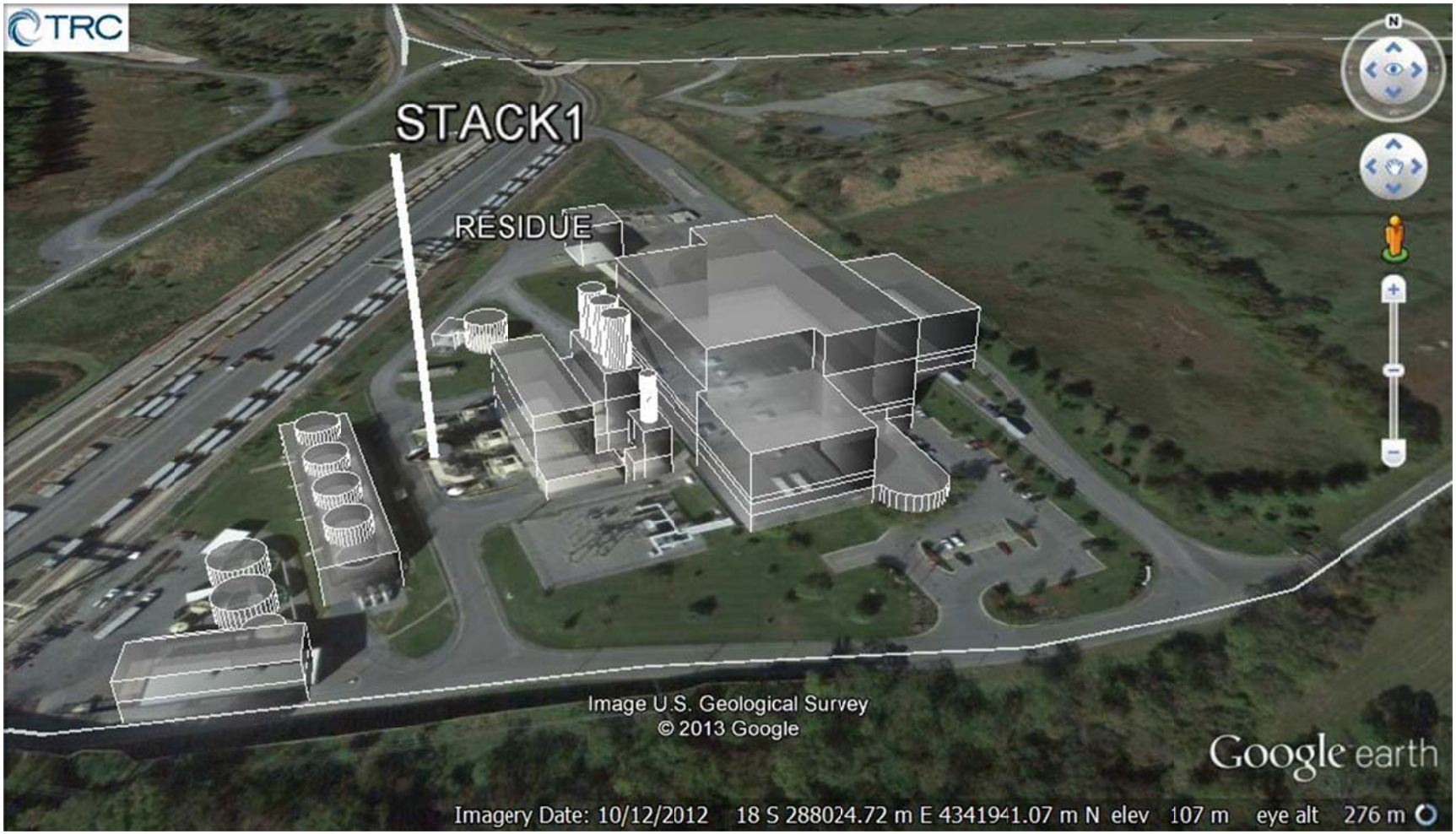

Figure 3-3

Building Structures Loaded in BPIPPRM

Montgomery County RRF, Dickerson, MD

Figure 3-4

Stack Location

Montgomery County RRF,
Dickerson, MD

Figure 3-5
Fugitive Emissions Location
Montgomery County RRF, Dickerson, MD

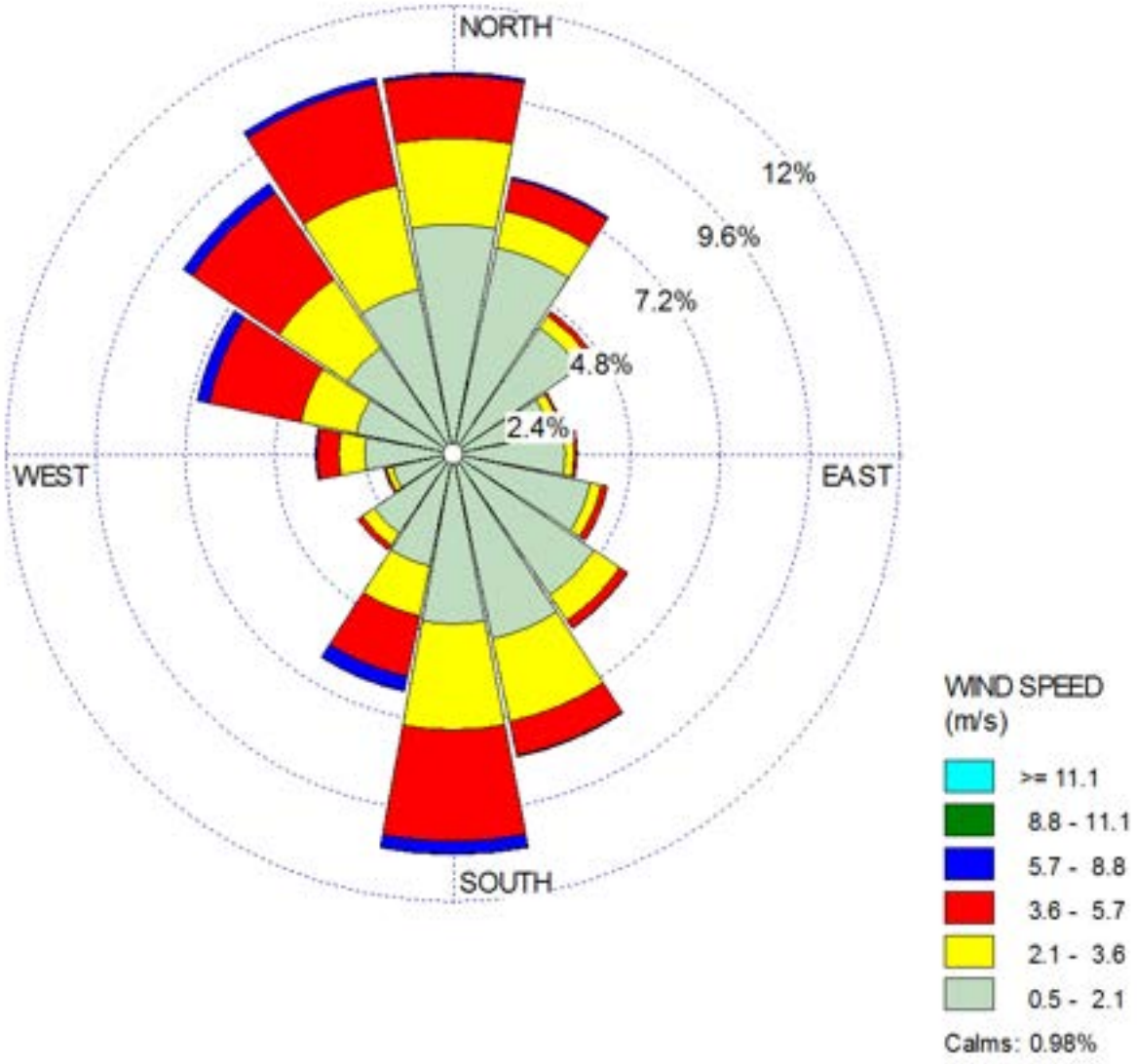

Figure 3-6

Wind Rose (Onsite Met Tower: 2008 to 2012)

Montgomery County RRF
Dickerson, MD

Figure 3-7: Vapor Phase Model Input for RRF Stack

```
CO STARTING
CO TITLEONE Montgomery County RRF: Vapor Phase
CO MODELOPT CONC DDEP WDEP DEPOS
CO AVERTIME PERIOD
CO POLLUTID P001

** GDSEASON  JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
CO GDSEASON  3   3   3   5   5   1   1   1   2   2   3   3

** Category 3 = "Rangeland" (NLCD1992 Cat 81: Pasture/Hay)
** GDLANUSE  SEC01 SEC02 ..... SEC36
CO GDLANUSE  36*3

CO RUNORNOT RUN
CO FINISHED

SO STARTING

** Coordinates in NAD83 UTM Zone 18, Meters
** LOCATION Srcid  Srctyp X        Y         Z
SO LOCATION STACK1 POINT  287945.3 4341922.0 106.1

** SRCPARAM Srcid  Ptemis  Stkhgt Stktmp Stkvel Stkdiam
SO SRCPARAM STACK1 1.000   82.6   416.36 24.48  3.65

** BPIPPRM: mont01.out
SO BUILDHGT STACK1  19.90  19.90  33.53  33.53  33.53  33.53
SO BUILDHGT STACK1  33.53  33.53  33.53  33.53  27.00  22.02
SO BUILDHGT STACK1  19.90   0.00   0.00   0.00   0.00  13.42
SO BUILDHGT STACK1  19.90 19.90   33.53   33.53   33.53   33.53
SO BUILDHGT STACK1 33.53  33.53   33.53   33.53   27.00   22.02
SO BUILDHGT STACK1 19.90  0.00    0.00    0.00    0.00   13.42
SO BUILDWID STACK1 37.69 42.49   94.83   93.04   92.83   91.15
SO BUILDWID STACK1 88.64 92.96   98.50  101.04  107.66  135.70
SO BUILDWID STACK1 35.35 0.00    0.00    0.00    0.00   17.64
SO BUILDWID STACK1 37.69 42.49   94.83   93.04   92.83   91.15
SO BUILDWID STACK1 88.64 92.96   98.50  101.04  107.66  135.70
SO BUILDWID STACK1 35.35 0.00    0.00    0.00    0.00   17.64
SO BUILDLEN STACK1 47.28 44.61   96.93   90.41   81.13   69.39
SO BUILDLEN STACK1 62.47  73.91   83.11   89.78   93.73  100.21
SO BUILDLEN STACK1 48.11  0.00    0.00    0.00    0.00   26.80
SO BUILDLEN STACK1 47.28 44.61   96.93   90.41   81.13   69.39
SO BUILDLEN STACK1 62.47  73.91   83.11   89.78   93.73  100.21
SO BUILDLEN STACK1 48.11   0.00    0.00    0.00    0.00   26.80
SO XBADJ STACK1 -10.14 -4.46   30.92   42.05   51.89   60.17
SO XBADJ STACK1 63.46 56.10   47.04   36.55   24.95   12.59
SO XBADJ STACK1 -7.98  0.00    0.00    0.00    0.00   26.21
SO XBADJ STACK1 -37.14 -40.15 -127.85 -132.45 -133.03 -129.56
SO XBADJ STACK1 -125.92 -130.01 -130.15 -126.33 -118.68 -112.80
SO XBADJ STACK1 -40.12    0.00    0.00    0.00    0.00  -53.01
SO YBADJ STACK1 -26.46  -23.68  -60.01  -46.37  -29.13  -10.33
SO YBADJ STACK1 9.01   27.25   42.64   56.74   65.54   75.16
SO YBADJ STACK1 24.80    0.00    0.00    0.00    0.00  -13.36
SO YBADJ STACK1 26.46   23.68   60.01   46.37   29.13   10.33
SO YBADJ STACK1 -9.01  -27.25  -42.64  -56.74  -65.54  -75.16
SO YBADJ STACK1 -24.80    0.00    0.00    0.00    0.00   13.36

** GASDEPOS Srcid Da       Dw       rcl      Henry
SO GASDEPOS STACK1   7.72E-02 9.57E-06 1.00E+05 2.53E+03

SO SRCGROUP  STACK1  STACK1

SO FINISHED

RE STARTING
RE INCLUDED montgom2.rec
RE FINISHED

ME STARTING
ME SURFFILE  MP2008-2012.SFC
ME PROFFILE  MP2008-2012.PFL
ME SURFDATA  93738     2008  KIAD_DULLES_VA
ME UAIRDATA  93734     2008  STERLING_VA
ME SITEDATA  99999     2008  ONSITE
ME PROFBASE  113.4 METERS
ME FINISHED

OU STARTING
OU FILEFORM  EXP
OU RECTABLE ALLAVE 1ST
OU PLOTFILE PERIOD STACK1       YP001.PLT 31
OU FINISHED
```

Figure 3-8: Particle Phase Model Input for RRF Stack

```
CO STARTING
CO TITLEONE Montgomery County RRF: Particle Phase
CO MODELOPT CONC DDEP WDEP DEPOS
CO AVERTIME 1  PERIOD
CO POLLUTID UNITY
CO RUNORNOT RUN
CO FINISHED

SO STARTING

** Coordinates in NAD83 UTM Zone 18, Meters
** LOCATION Srcid  Srctyp X        Y         Z
SO LOCATION STACK1 POINT  287945.3 4341922.0 106.1

** SRCPARAM Srcid  Ptemis  Stkhgt Stktmp Stkvel Stkdiam
SO SRCPARAM STACK1 1.000   82.6   416.36 24.48  3.65

** BPIPPRM: mont01.out
SO BUILDHGT STACK1  19.90  19.90  33.53  33.53  33.53  33.53
SO BUILDHGT STACK1  33.53  33.53  33.53  33.53  27.00  22.02
SO BUILDHGT STACK1  19.90   0.00   0.00   0.00   0.00  13.42
SO BUILDHGT STACK1  19.90 19.90   33.53   33.53   33.53   33.53
SO BUILDHGT STACK1 33.53  33.53   33.53   33.53   27.00   22.02
SO BUILDHGT STACK1 19.90  0.00    0.00    0.00    0.00   13.42
SO BUILDWID STACK1 37.69 42.49   94.83   93.04   92.83   91.15
SO BUILDWID STACK1 88.64 92.96   98.50  101.04  107.66  135.70
SO BUILDWID STACK1 35.35 0.00    0.00    0.00    0.00   17.64
SO BUILDWID STACK1 37.69 42.49   94.83   93.04   92.83   91.15
SO BUILDWID STACK1 88.64 92.96   98.50  101.04  107.66  135.70
SO BUILDWID STACK1 35.35 0.00    0.00    0.00    0.00   17.64
SO BUILDLEN STACK1 47.28 44.61   96.93   90.41   81.13   69.39
SO BUILDLEN STACK1 62.47  73.91   83.11   89.78   93.73  100.21
SO BUILDLEN STACK1 48.11  0.00    0.00    0.00    0.00   26.80
SO BUILDLEN STACK1 47.28 44.61   96.93   90.41   81.13   69.39
SO BUILDLEN STACK1 62.47  73.91   83.11   89.78   93.73  100.21
SO BUILDLEN STACK1 48.11   0.00    0.00    0.00    0.00   26.80
SO XBADJ STACK1 -10.14 -4.46   30.92   42.05   51.89   60.17
SO XBADJ STACK1 63.46 56.10   47.04   36.55   24.95   12.59
SO XBADJ STACK1 -7.98  0.00    0.00    0.00    0.00   26.21
SO XBADJ STACK1 -37.14 -40.15 -127.85 -132.45 -133.03 -129.56
SO XBADJ STACK1 -125.92 -130.01 -130.15 -126.33 -118.68 -112.80
SO XBADJ STACK1 -40.12    0.00    0.00    0.00    0.00  -53.01
SO YBADJ STACK1 -26.46  -23.68  -60.01  -46.37  -29.13  -10.33
SO YBADJ STACK1 9.01   27.25   42.64   56.74   65.54   75.16
SO YBADJ STACK1 24.80    0.00    0.00    0.00    0.00  -13.36
SO YBADJ STACK1 26.46   23.68   60.01   46.37   29.13   10.33
SO YBADJ STACK1 -9.01  -27.25  -42.64  -56.74  -65.54  -75.16
SO YBADJ STACK1 -24.80    0.00    0.00    0.00    0.00   13.36

SO PARTDIAM  STACK1  0.30  0.59  0.91  1.77
SO PARTDIAM  STACK1  2.94  4.35  6.38  13.56
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SO MASSFRAX  STACK1  3.60E-02 1.50E-02 1.00E-02 3.78E-01
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RE STARTING
RE INCLUDED montgom2.rec
RE FINISHED

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ME PROFFILE  MP2008-2012.PFL
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ME UAIRDATA  93734     2008  STERLING_VA
ME SITEDATA  99999     2008  ONSITE
ME PROFBASE  113.4 METERS
ME FINISHED

OU STARTING
OU FILEFORM  EXP
OU RECTABLE ALLAVE 1ST

** PLOTFILE Aveper Grpid  Hivalu Filenam   Funit
OU PLOTFILE 1      STACK1 FIRST  ZPART.PLT 31

** PLOTFILE PERIOD Grpid         Filenam   Funit
OU PLOTFILE PERIOD STACK1        ZPART.PLT 31

OU FINISHED
```

Figure 3-9: Particle-Bound Phase Model Input for RRF Stack

```
CO STARTING
CO TITLEONE Montgomery County RRF: Particle-Bound Phase
CO MODELOPT CONC DDEP WDEP DEPOS
CO AVERTIME 1  PERIOD
CO POLLUTID UNITY
CO RUNORNOT RUN
CO FINISHED

SO STARTING

** Coordinates in NAD83 UTM Zone 18, Meters
** LOCATION Srcid  Srctyp X        Y         Z
SO LOCATION STACK1 POINT  287945.3 4341922.0 106.1

** SRCPARAM Srcid  Ptemis  Stkhgt Stktmp Stkvel Stkdiam
SO SRCPARAM STACK1 1.000   82.6   416.36 24.48  3.65

** BPIPPRM: mont01.out
SO BUILDHGT STACK1  19.90  19.90  33.53  33.53  33.53  33.53
SO BUILDHGT STACK1  33.53  33.53  33.53  33.53  27.00  22.02
SO BUILDHGT STACK1  19.90   0.00   0.00   0.00   0.00  13.42
SO BUILDHGT STACK1  19.90 19.90   33.53   33.53   33.53   33.53
SO BUILDHGT STACK1 33.53  33.53   33.53   33.53   27.00   22.02
SO BUILDHGT STACK1 19.90  0.00    0.00    0.00    0.00   13.42
SO BUILDWID STACK1 37.69 42.49   94.83   93.04   92.83   91.15
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SO XBADJ STACK1 -40.12    0.00    0.00    0.00    0.00  -53.01
SO YBADJ STACK1 -26.46  -23.68  -60.01  -46.37  -29.13  -10.33
SO YBADJ STACK1 9.01   27.25   42.64   56.74   65.54   75.16
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SO YBADJ STACK1 -24.80    0.00    0.00    0.00    0.00   13.36

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SO MASSFRAX  STACK1  9.57E-01 9.25E-03 3.00E-03 6.17E-03
SO MASSFRAX  STACK1  6.68E-03 1.88E-03 8.55E-04 1.52E-02
SO PARTDENS  STACK1  1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0

SO SRCGROUP  STACK1  STACK1

SO FINISHED

RE STARTING
RE INCLUDED montgom2.rec
RE FINISHED

ME STARTING
ME SURFFILE  MP2008-2012.SFC
ME PROFFILE  MP2008-2012.PFL
ME SURFDATA  93738     2008  KIAD_DULLES_VA
ME UAIRDATA  93734     2008  STERLING_VA
ME SITEDATA  99999     2008  ONSITE
ME PROFBASE  113.4 METERS
ME FINISHED

OU STARTING
OU FILEFORM  EXP
OU RECTABLE ALLAVE 1ST

** PLOTFILE Aveper Grpid  Hivalu Filenam   Funit
OU PLOTFILE 1      STACK1 FIRST  ZPBND.PLT 31

** PLOTFILE PERIOD Grpid         Filenam   Funit
OU PLOTFILE PERIOD STACK1        ZPBND.PLT 31

OU FINISHED
```
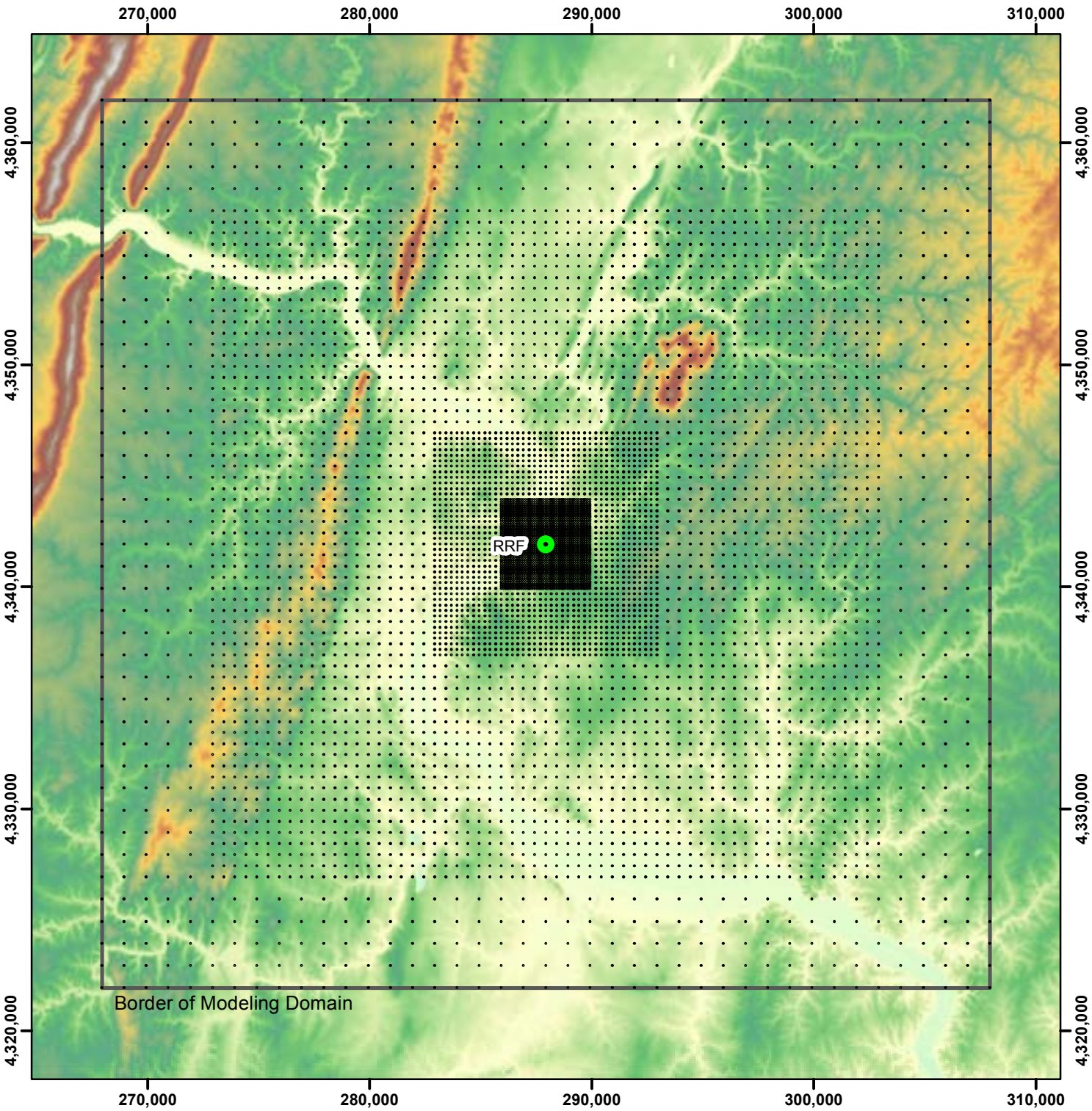

Figure 3-10: Fugitive Emissions Model Input for RRF Stack

```
CO STARTING
CO TITLEONE Montgomery County RRF: Particle Phase
CO MODELOPT CONC DDEP WDEP DEPOS
CO AVERTIME 1  PERIOD
CO POLLUTID UNITY
CO RUNORNOT RUN
CO FINISHED

SO STARTING

** Coordinates in NAD83 UTM Zone 18, Meters
** LOCATION Srcid   Srctyp X        Y         Z
SO LOCATION RESIDUE POINT  287977.5 4342072.9 107.0

** SRCPARAM Srcid   Ptemis  Stkhgt Stktmp Stkvel Stkdiam
SO SRCPARAM RESIDUE 1.000   2.44   0.0    0.001  7.28

** BPIPPRM: mont02.out
SO BUILDHGT RESIDUE 19.90 14.80   14.80   14.80   14.80   14.80
SO BUILDHGT RESIDUE 14.80 14.80   14.80   14.80   14.80   14.80
SO BUILDHGT RESIDUE 14.80 14.80   14.80   14.80   14.80   33.53
SO BUILDHGT RESIDUE 14.80 14.80   14.80   14.80   14.80   14.80
SO BUILDHGT RESIDUE 14.80 14.80   14.80   14.80   14.80   22.02
SO BUILDHGT RESIDUE 33.53 33.53   33.53   33.53   33.53   33.53
SO BUILDWID RESIDUE 136.17 25.73  26.22   25.92   24.84   22.99
SO BUILDWID RESIDUE 22.58 24.87   26.40   27.13   27.03   26.12
SO BUILDWID RESIDUE 24.41 21.96   18.84   16.43   19.73   83.11
SO BUILDWID RESIDUE 24.45 25.73   26.22   25.92   24.84   22.99
SO BUILDWID RESIDUE 22.58 24.87   26.40   27.13   27.03  135.70
SO BUILDWID RESIDUE 90.41 81.13   69.39   62.47   73.91   83.11
SO BUILDLEN RESIDUE 133.80 27.03  26.12   24.41   21.96   18.84
SO BUILDLEN RESIDUE 16.43 19.73   22.43   24.45   25.73   26.22
SO BUILDLEN RESIDUE 25.92 24.84   22.99   22.58   24.87   98.50
SO BUILDLEN RESIDUE 27.13 27.03   26.12   24.41   21.96   18.84
SO BUILDLEN RESIDUE 16.43 19.73   22.43   24.45   25.73  100.21
SO BUILDLEN RESIDUE 93.04 92.83   91.15   88.64   92.96   98.50
SO XBADJ RESIDUE -178.75 -13.55  -13.00  -12.06  -10.76   -9.12
SO XBADJ RESIDUE  -7.96   -9.60  -10.95  -11.96  -12.62  -12.88
SO XBADJ RESIDUE -12.76  -12.25  -11.36  -10.95  -12.16   59.00
SO XBADJ RESIDUE -13.45  -13.48  -13.11  -12.34  -11.20   -9.71
SO XBADJ RESIDUE -8.46  -10.12  -11.48  -12.49  -13.11 -160.34
SO XBADJ RESIDUE-165.20 -170.42 -170.47 -166.08 -162.24 -157.50
SO YBADJ RESIDUE -70.17   -0.25   -0.23   -0.20   -0.17   -0.13
SO YBADJ RESIDUE -0.34   -0.28   -0.20   -0.12   -0.03    0.05
SO YBADJ RESIDUE  0.14    0.22    0.29    0.25    0.26   56.38
SO YBADJ RESIDUE  0.26    0.25    0.23    0.20    0.17    0.13
SO YBADJ RESIDUE  0.34    0.28    0.20    0.12    0.03   71.62
SO YBADJ RESIDUE 49.05   29.21    8.49  -12.81  -35.12  -56.38

SO PARTDIAM  RESIDUE 0.30  0.59  0.91  1.77
SO PARTDIAM  RESIDUE 2.94  4.35  6.38  13.56
SO MASSFRAX  RESIDUE 5.26E-01 1.00E-02 5.00E-03 2.00E-02
SO MASSFRAX  RESIDUE 3.60E-02 1.50E-02 1.00E-02 3.78E-01
SO PARTDENS  RESIDUE 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0

SO SRCGROUP  ALL

SO FINISHED

RE STARTING
RE INCLUDED montgom2.rec
RE FINISHED

ME STARTING
ME SURFFILE  MP2008-2012.SFC
ME PROFFILE  MP2008-2012.PFL
ME SURFDATA  93738     2008  KIAD_DULLES_VA
ME UAIRDATA  93734     2008  STERLING_VA
ME SITEDATA  99999     2008  ONSITE
ME PROFBASE  113.4 METERS
ME FINISHED

OU STARTING
OU FILEFORM  EXP
OU RECTABLE ALLAVE 1ST

** PLOTFILE Aveper Grpid   Hivalu Filenam   Funit
OU PLOTFILE 1      ALL     FIRST  ZPART.PLT 31

** PLOTFILE PERIOD Grpid         Filenam   Funit
OU PLOTFILE PERIOD ALL           ZPART.PLT 31

OU FINISHED
```



Elevation (m)

Value

High : 500

Low : 0

Figure 3-11

AERMOD Receptor Node Grid

Montgomery County RRF, Dickerson, MD

5,100 2,550 0 5,100 Meters

NAD 1983 UTM Zone 18N Meters

N

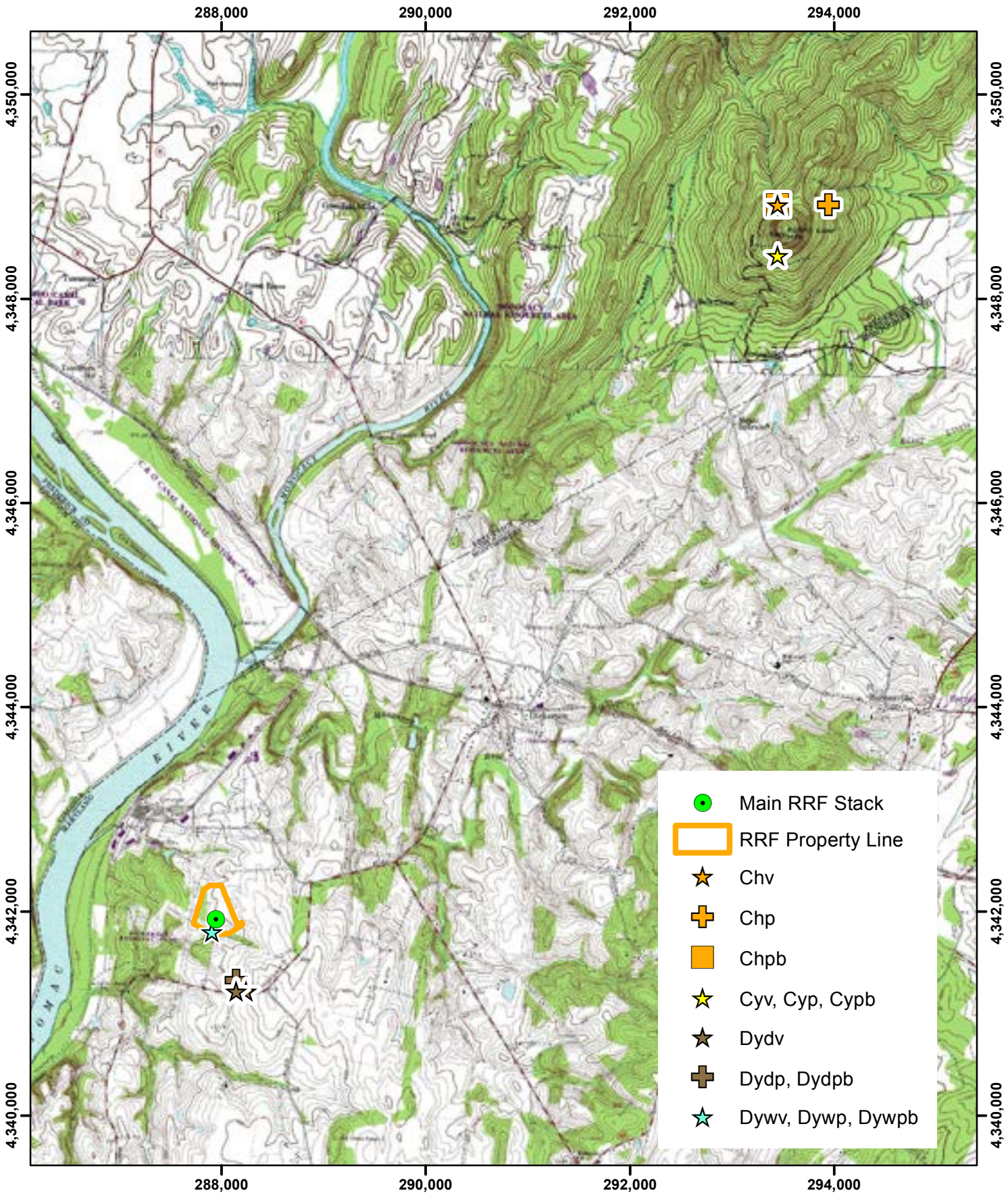


Figure 3-12

Locations of Maximum Unitized Modeling Results

Montgomery County RRF, Dickerson, MD

1,000 500 0 1,000 Meters

NAD 1983 UTM Zone 18N Meters

N

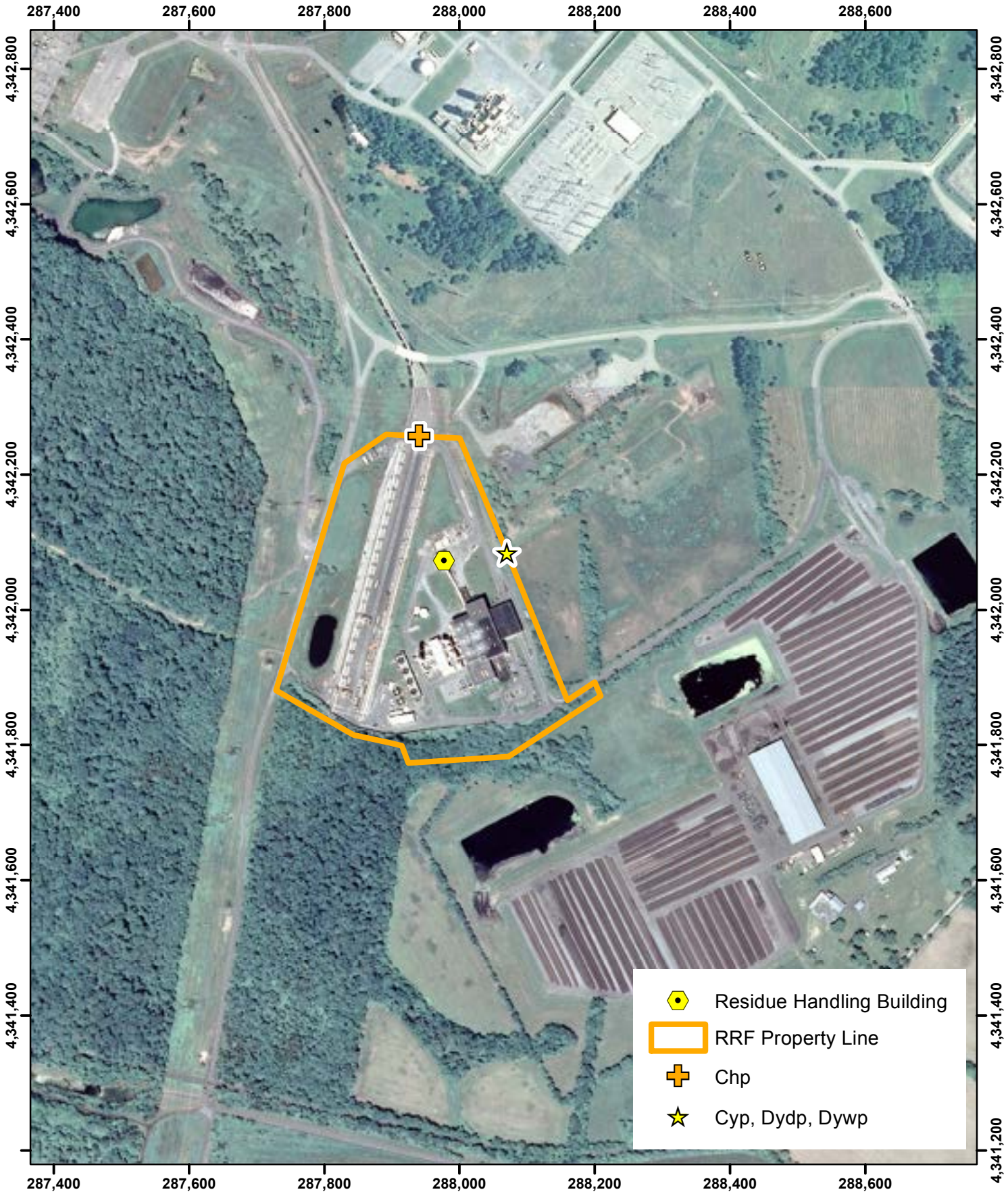


Figure 3-13

Locations of Maximum Unitized Fugitive Emissions Modeling Results

Montgomery County RRF, Dickerson, MD

160 80 0 160 Meters

NAD 1983 UTM Zone 18N Meters

N

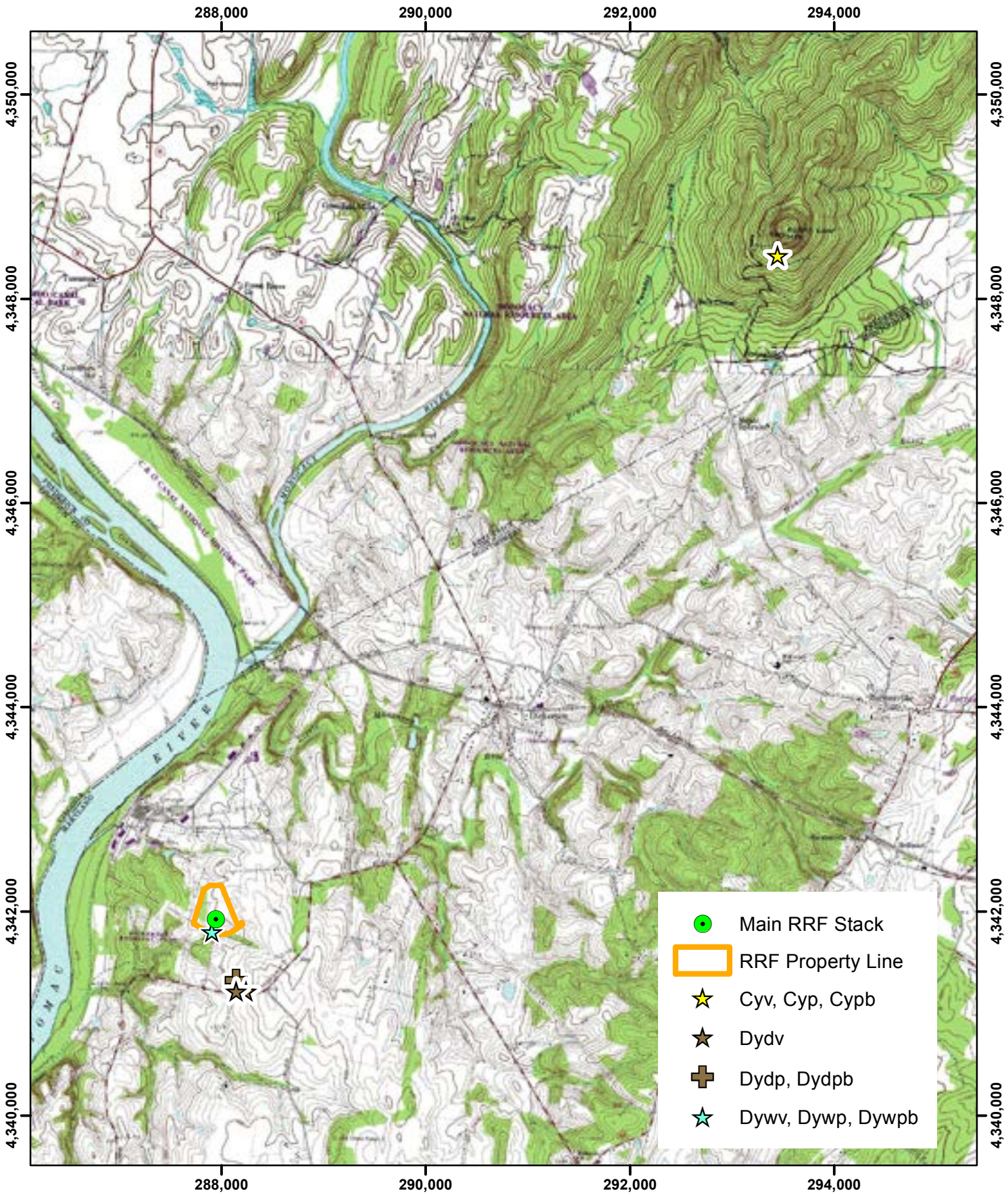


Figure 4-1

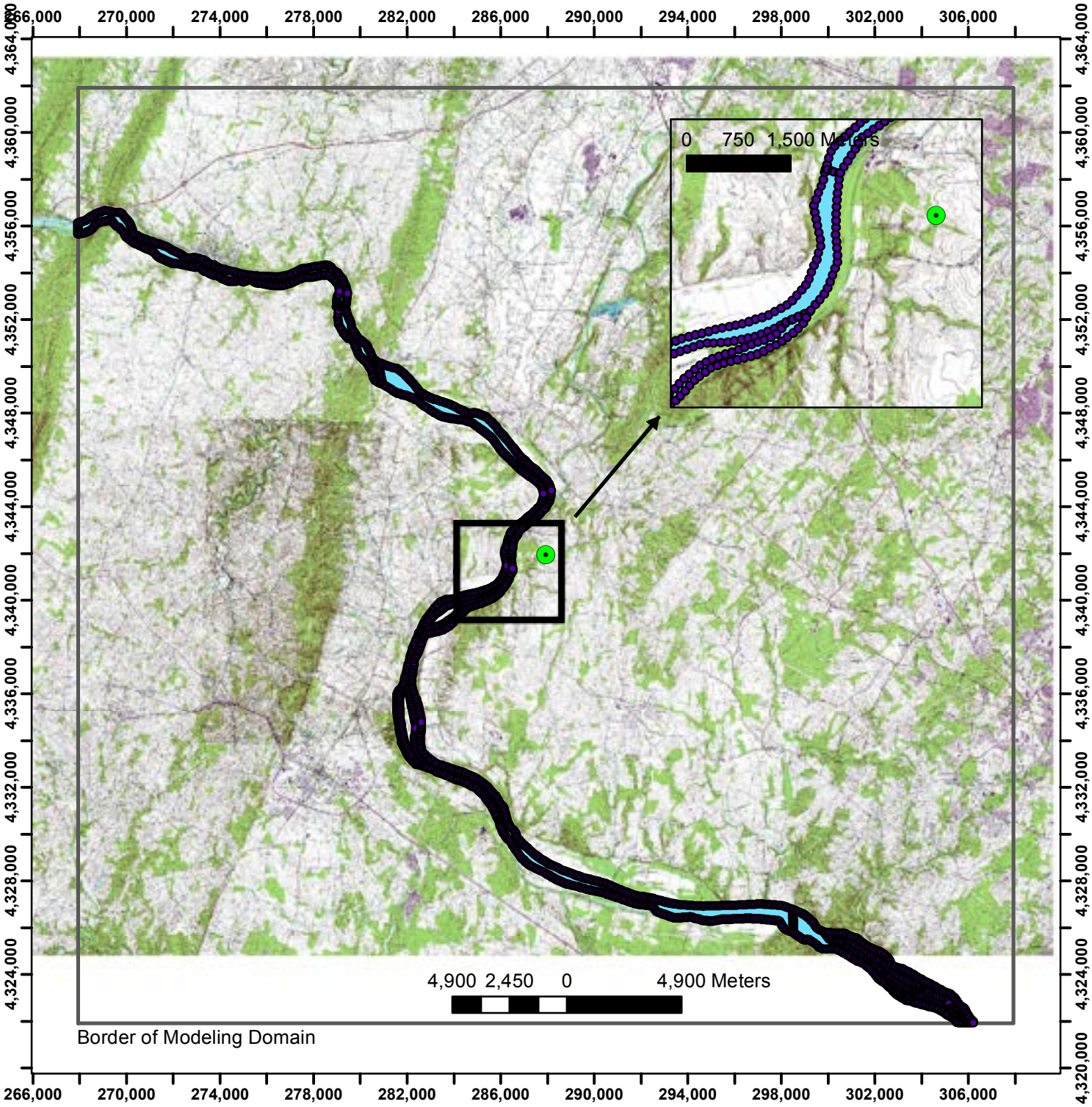
Maximum Long-Term Impact Receptor Nodes for Residents

Montgomery County RRF, Dickerson, MD

1,000 500 0 1,000 Meters

NAD 1983 UTM Zone 18N Meters

N



Main RRF Stack

Receptor Nodes

Potomac River

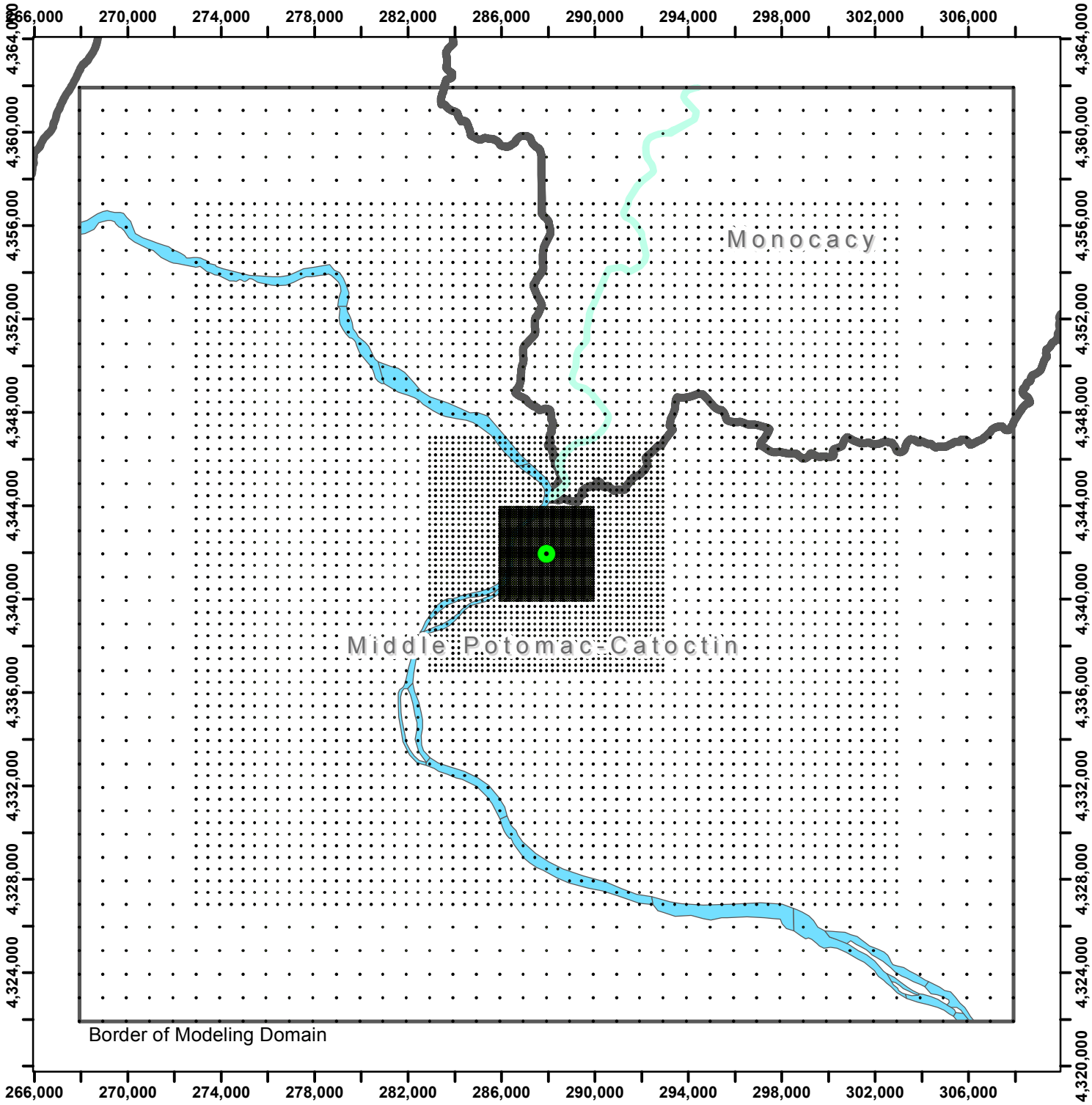
Figure 4-2a

Receptor Nodes Within the Potomac River

Montgomery County RRF, Dickerson, MD

NAD 1983 UTM Zone 18N Meters

N



Main RRF Stack

Receptor Nodes

Monocacy River

Potomac River

8-Digit Basins

4,900 2,450 0 4,900 Meters

NAD 1983 UTM Zone 18N Meters

N

Figure 4-2b

Receptor Nodes Within the Potomac River Watershed

Montgomery County RRF, Dickerson, MD

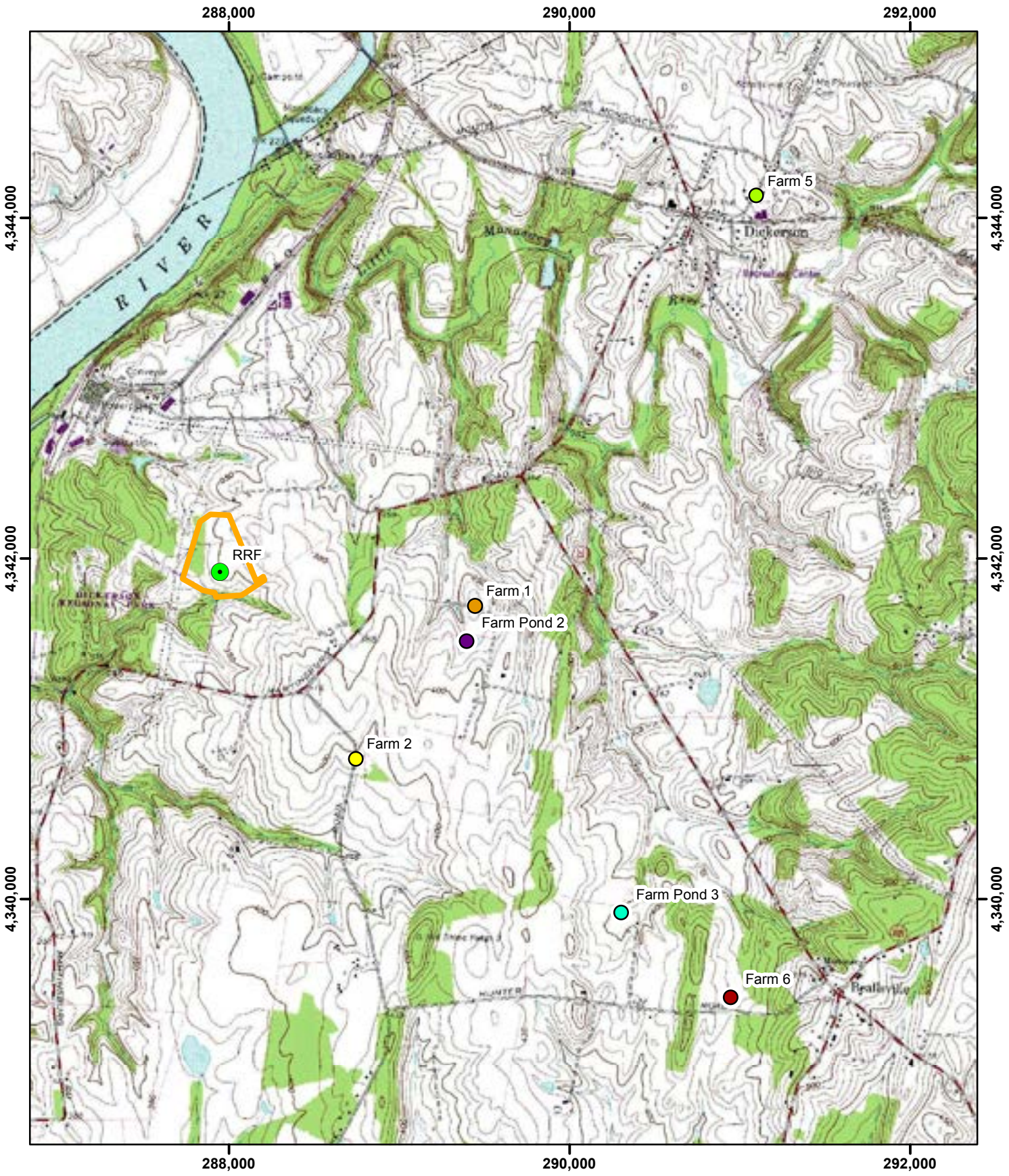


Figure 4-3

Receptor Nodes for Farm Ponds and Farms

Montgomery County RRF, Dickerson, MD

660 330 0 660 Meters

NAD 1983 UTM Zone 18N Meters

N

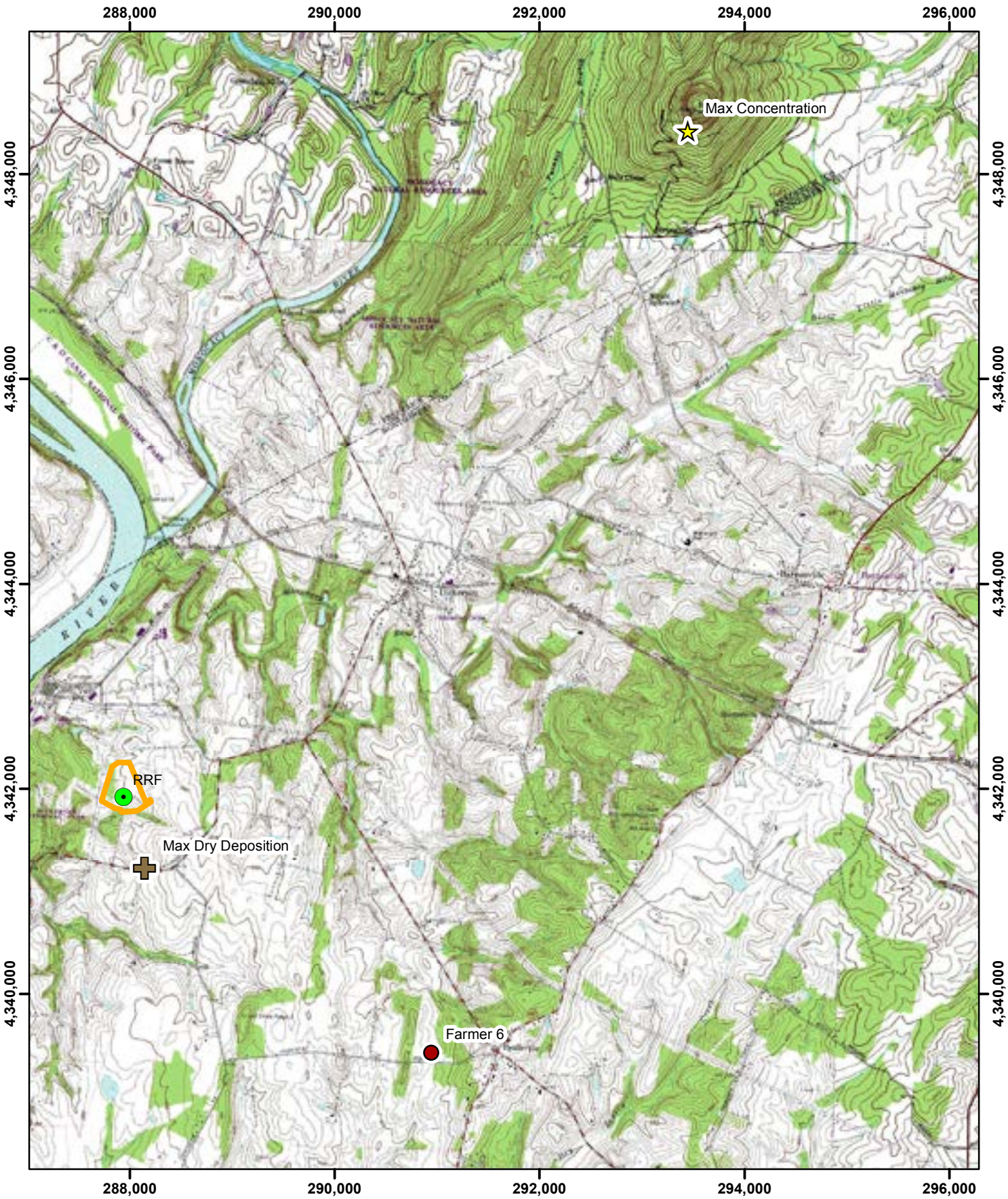


Figure 4-4
Receptor Nodes for MEI Scenario A

Montgomery County RRF, Dickerson, MD

1,000 500 0 1,000 Meters

NAD 1983 UTM Zone 18N Meters

N

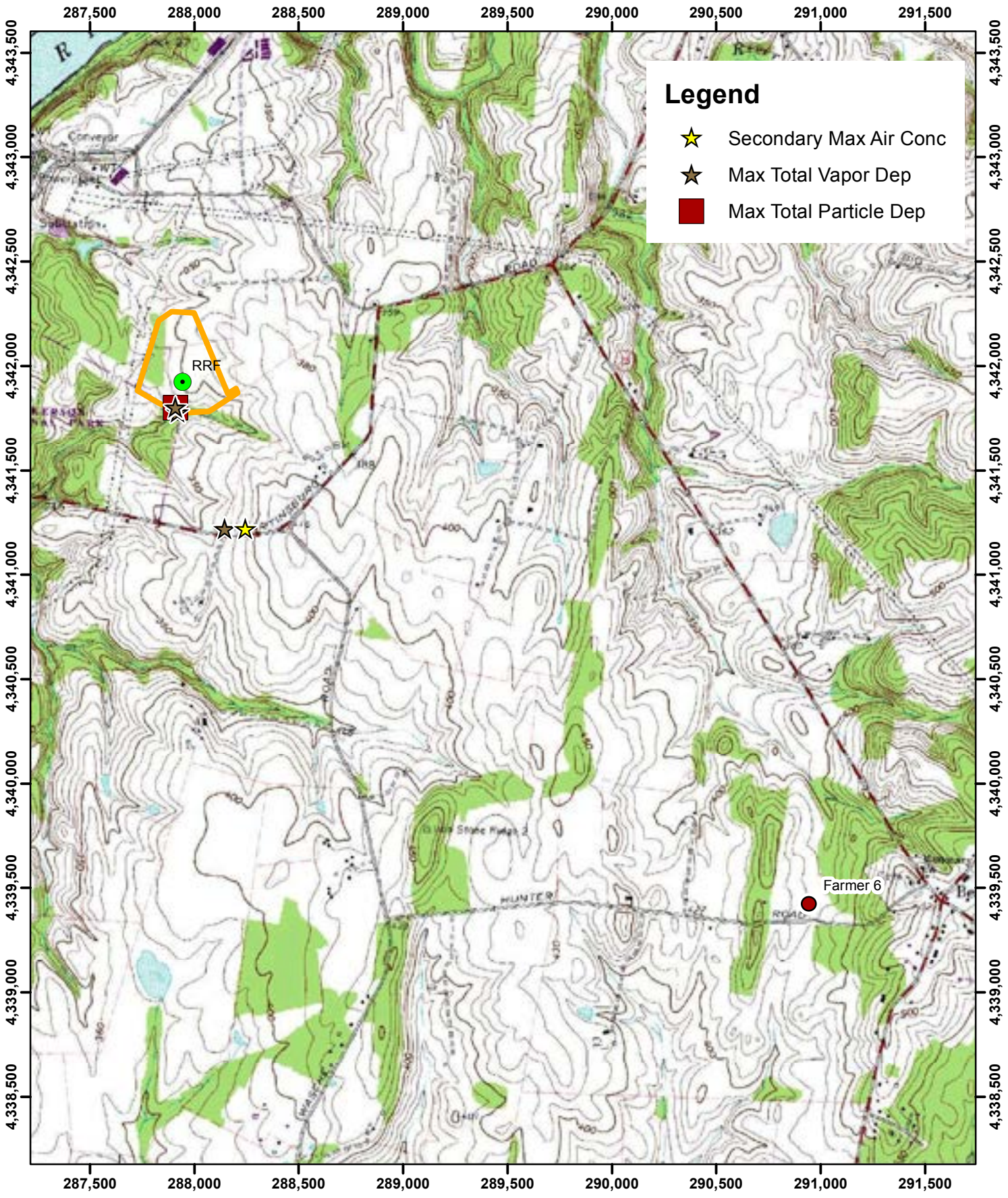


Figure 4-5

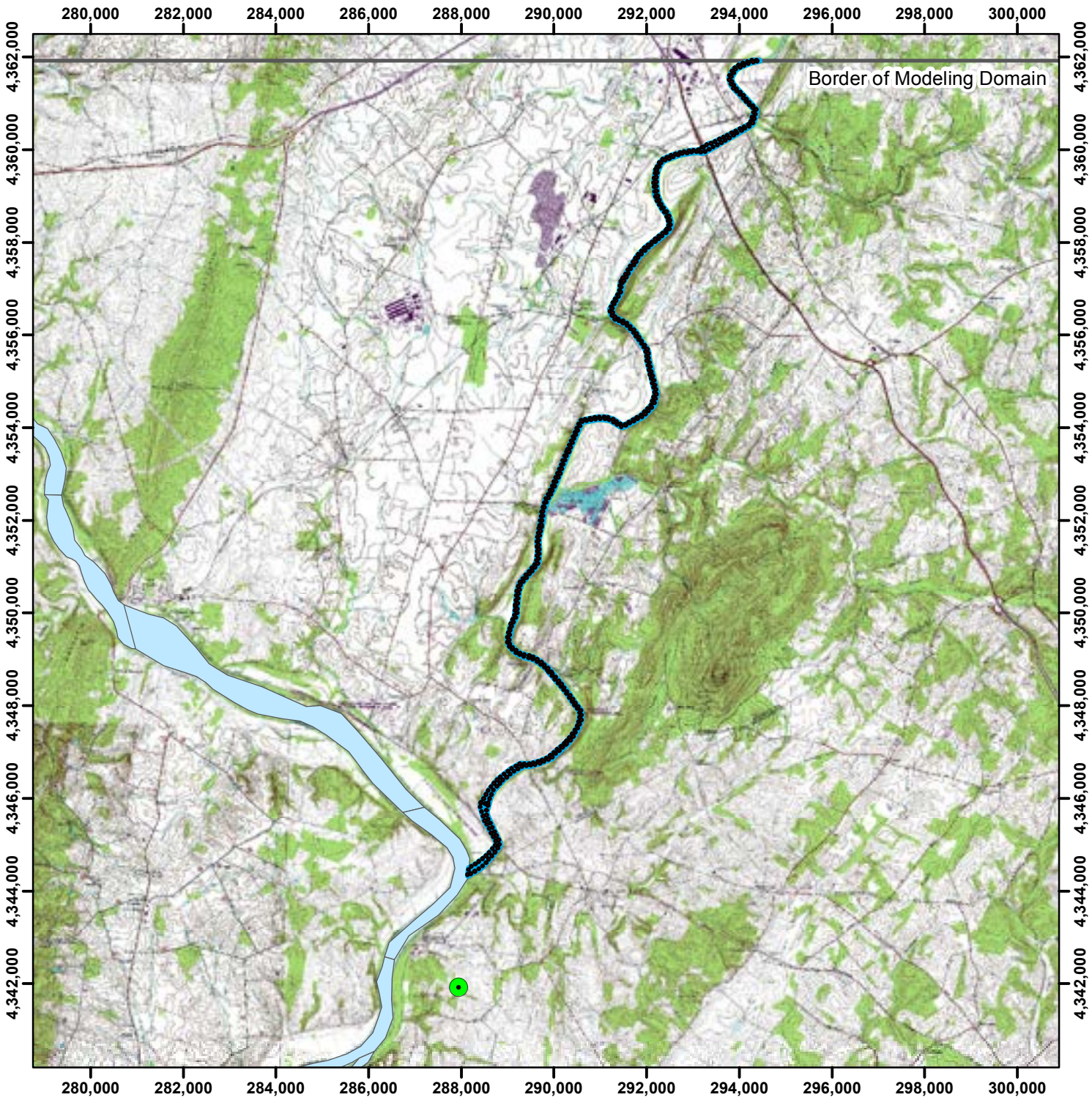
Receptor Nodes for MEI Scenario B

Montgomery County RRF, Dickerson, MD

530 265 0 530 Meters

NAD 1983 UTM Zone 18N Meters

N



Main RRF Stack

Receptor Nodes

Monocacy River

Potomac River

Figure 4-6a

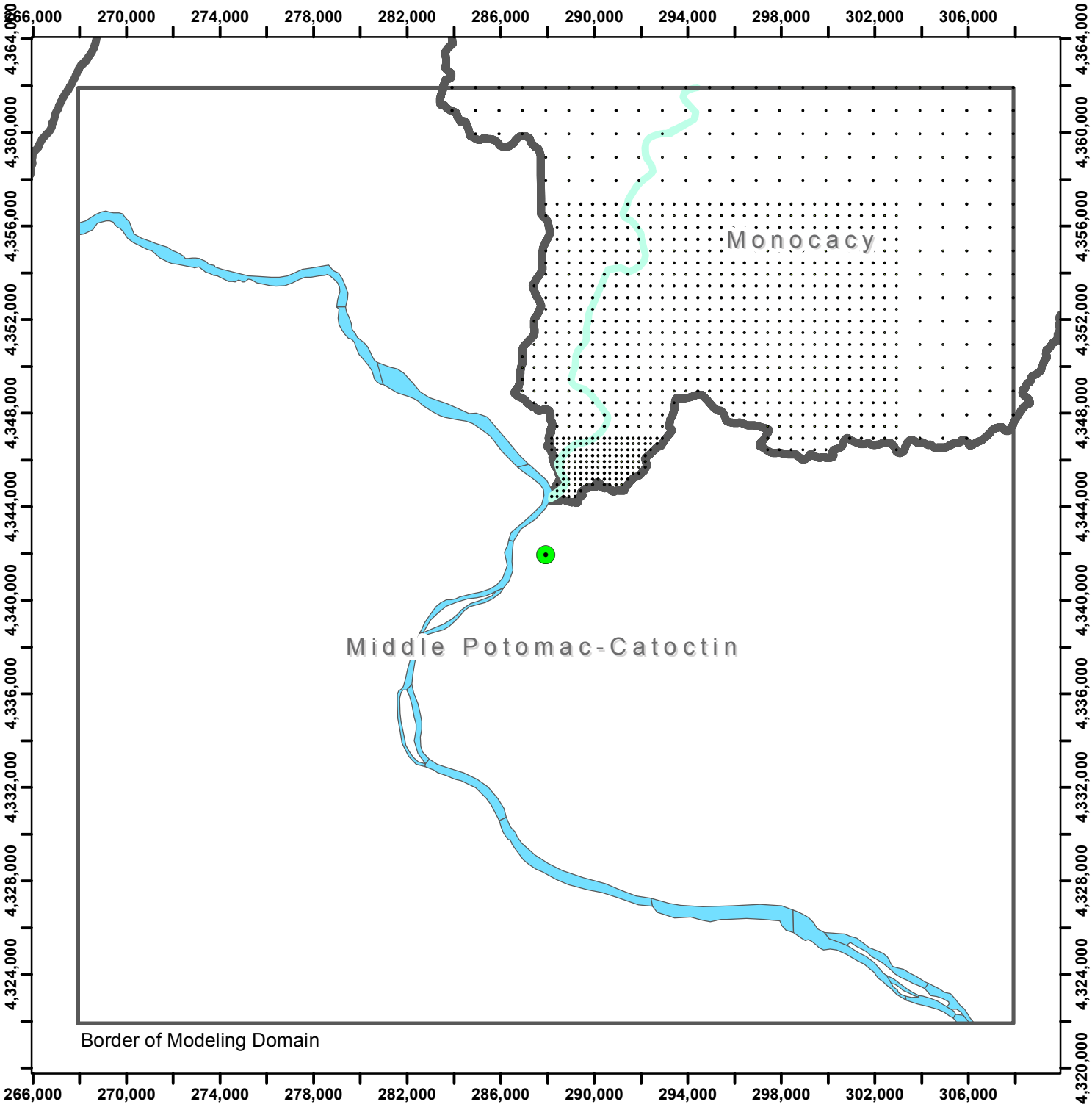
Receptor Nodes Within the Monocacy River

Montgomery County RRF, Dickerson, MD

2,400 1,200 0 2,400 Meters

NAD 1983 UTM Zone 18N Meters

N



Main RRF Stack

Receptor Nodes

Monocacy River

Potomac River

8-Digit Basins

4,900 2,450 0 4,900 Meters

NAD 1983 UTM Zone 18N Meters

N

Figure 4-6b

Receptor Nodes Within the Monocacy River Watershed

Montgomery County RRF, Dickerson, MD

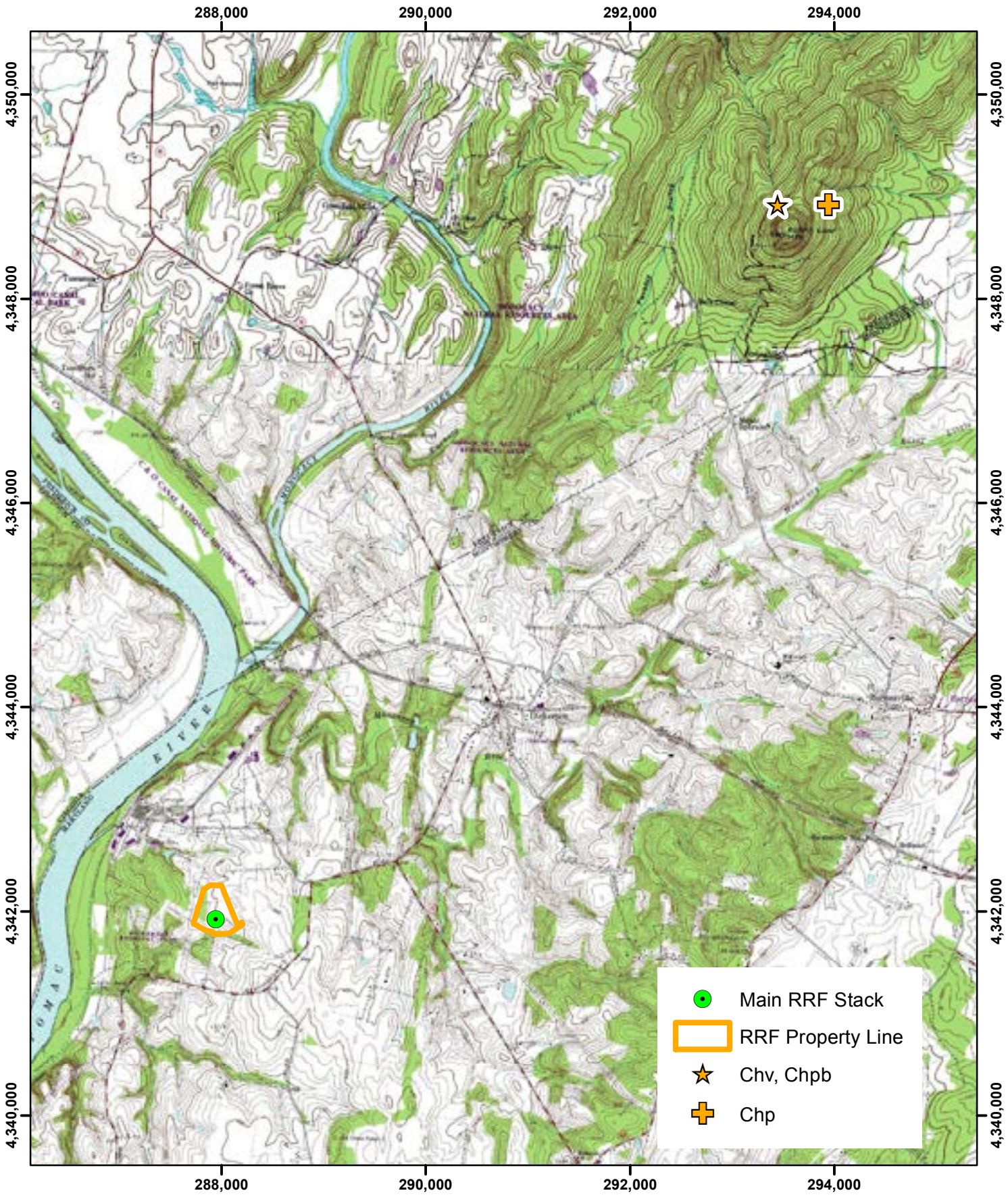


Figure 4-7

Maximum Hourly Concentration Receptor Nodes

Montgomery County RRF, Dickerson, MD

1,000 500 0 1,000 Meters

NAD 1983 UTM Zone 18N Meters

N

TABLES

Table 2-1
Dioxin/Furan Toxicity Equivalency Factors (TEFs) and Toxic Equivalence (TEQ) Calculation
Montgomery County RRF
Dickerson, MD

Dioxins/Furans	TEF (a)	Unit 1 g/sec (c)	Unit 1 * TEF g/sec	Unit 2 g/sec (c)	Unit 2 * TEF g/sec	Unit 3 g/sec (c)	Unit 3 * TEF g/sec
2,3,7,8-TCDD	1	1.23E-10	1.23E-10	3.26E-10	3.26E-10	1.35E-10	1.35E-10
1,2,3,7,8-PeCDD	1	3.08E-10	3.08E-10	6.14E-10	6.14E-10	3.90E-10	3.90E-10
1,2,3,4,7,8-HxCDD	0.1	2.98E-10	2.98E-11	4.64E-10	4.64E-11	5.66E-10	5.66E-11
1,2,3,6,7,8-HxCDD	0.1	5.35E-10	5.35E-11	8.56E-10	8.56E-11	5.60E-10	5.60E-11
1,2,3,7,8,9-HxCDD	0.1	4.57E-10	4.57E-11	9.63E-10	9.63E-11	3.80E-10	3.80E-11
1,2,3,4,6,7,8-HpCDD	0.01	4.62E-09	4.62E-11	7.26E-09	7.26E-11	3.74E-09	3.74E-11
OCDD	0.0003	1.02E-08	3.05E-12	1.95E-08	5.86E-12	1.93E-08	5.80E-12
2,3,7,8-TCDF	0.1	5.51E-10	5.51E-11	1.13E-09	1.13E-10	3.48E-10	3.48E-11
1,2,3,7,8-PeCDF	0.03	7.24E-10	2.17E-11	2.07E-09	6.22E-11	1.24E-09	3.73E-11
2,3,4,7,8-PeCDF	0.3	8.17E-10	2.45E-10	1.80E-09	5.40E-10	7.30E-10	2.19E-10
1,2,3,4,7,8-HxCDF	0.1	1.14E-09	1.14E-10	2.75E-09	2.75E-10	2.54E-09	2.54E-10
1,2,3,6,7,8-HxCDF	0.1	1.64E-09	1.64E-10	4.61E-09	4.61E-10	1.55E-09	1.55E-10
2,3,4,6,7,8-HxCDF	0.1	1.67E-09	1.67E-10	2.46E-09	2.46E-10	1.37E-09	1.37E-10
1,2,3,7,8,9-HxCDF	0.1	5.31E-10	5.31E-11	5.74E-10	5.74E-11	6.16E-10	6.16E-11
1,2,3,4,6,7,8-HpCDF	0.01	4.15E-09	4.15E-11	8.23E-09	8.23E-11	5.77E-09	5.77E-11
1,2,3,4,7,8,9-HpCDF	0.01	1.20E-09	1.20E-11	1.55E-09	1.55E-11	2.46E-09	2.46E-11
OCDF	0.0003	6.26E-09	1.88E-12	6.92E-09	2.08E-12	2.21E-08	6.63E-12
TCDD-TEQ (b)			1.48E-09		3.10E-09		1.71E-09

a) USEPA 2011a
b) TCDD - TEQ = sum of Emission Unit * TEF across all dioxin/furan congeners
c) 95% UCL emission rates

Table 2-2
95% UCL Emission Rates Used in the Risk Assessment
Montgomery County RRF
Dickerson, MD

Chemical	Unit 1 Q g/sec	Unit 2 Q g/sec		Unit 3 Q g/sec		Sum (a) Q g/sec
Metals (b)						
Antimony	6.00E-05	4.39E-05		6.64E-05		1.70E-04
Arsenic	7.21E-05	3.36E-05		3.59E-05		1.42E-04
Beryllium	7.68E-06	7.53E-06		7.03E-06		2.22E-05
Cadmium	7.85E-05	7.78E-05		3.30E-05		1.89E-04
Chromium +3 (c)	3.62E-06	5.04E-05		8.01E-05		1.34E-04
Chromium +6	6.81E-05	5.54E-06	A1	5.29E-06	A1	7.89E-05
Total Chromium (d)	7.17E-05	5.59E-05		8.54E-05		2.13E-04
Cobalt	1.55E-05	1.19E-05	A1	1.16E-05	A1	3.90E-05
Copper	4.75E-05	1.91E-05		1.74E-04		2.40E-04
Lead	1.24E-03	3.29E-04		5.53E-04		2.12E-03
Manganese	1.13E-04	1.27E-04	A1	9.29E-05	A1	3.33E-04
Mercury (e)	6.08E-04	6.70E-04		5.50E-04		1.83E-03
Nickel	1.08E-04	8.72E-05		9.64E-05		2.92E-04
Selenium	5.77E-05	8.13E-05		7.04E-05		2.09E-04
Zinc	2.36E-03	5.28E-04	A1	5.80E-04	A1	3.47E-03
Acid Gasses						
Hydrogen Chloride	6.46E-01	1.38E+00		6.46E-01		2.67E+00
Hydrogen Fluoride	1.90E-02	1.27E-02		1.90E-02		5.07E-02
Sulfuric Acid	6.75E-02	3.88E-02		6.75E-02		1.74E-01
2,3,7,8-TCDD-TEQ (f)	1.48E-09	3.10E-09		1.71E-09		6.29E-09
Total PCBs (b)	6.86E-05	1.19E-04		2.45E-04		4.32E-04
PAHs						
Acenaphthene	7.75E-06	7.46E-05		9.08E-05		1.73E-04
Acenaphthylene	4.01E-06	1.30E-05		6.73E-06	A2	2.38E-05
Anthracene	3.46E-06	6.53E-06		7.65E-06	A2	1.76E-05
Benzo(a)anthracene	3.23E-06	5.56E-06	A2	4.20E-06	A2	1.30E-05
Benzo(a)pyrene	3.76E-06	6.53E-06	A2	4.24E-06	A2	1.45E-05
Benzo(b)fluoranthene	2.53E-05	6.01E-06	A2	3.96E-06	A2	3.52E-05
Benzo(k)fluoranthene	3.64E-06	6.09E-06	A2	1.21E-05		2.19E-05
Benzo(ghi)perylene	3.50E-06	7.86E-06		4.72E-06		1.61E-05
Chrysene	2.83E-06	5.96E-06	A2	1.81E-04		1.90E-04
Dibenzo(a,h)anthracene	4.22E-06	8.81E-06	A2	4.89E-06	A2	1.79E-05
Fluoranthene	2.40E-06	7.72E-06		5.33E-06		1.55E-05
Fluorene	5.20E-06	9.03E-06		1.05E-05	A2	2.47E-05
Indeno(1,2,3-cd)pyrene	3.32E-06	7.30E-06	A2	3.86E-06		1.45E-05
2-Methylnaphthalene	5.14E-06	1.06E-05		1.80E-05		3.37E-05
Naphthalene	3.20E-05	3.19E-05		3.96E-05		1.04E-04
Phenanthrene	3.64E-06	1.49E-05		7.83E-06		2.64E-05
Pyrene	2.67E-06	7.33E-06		4.26E-06		1.43E-05
Aldehyde Ketones						
Formaldehyde (b, g)	4.32E-04	3.89E-04		1.15E-03		1.97E-03

Notes:
a) HHRA emission rates are the 95% UCL of all Emission Rates (1995 - 2013) per unit, which are then summed and carried through the HHRA, with the exception of Formaldehyde which is the average emission rate, due to insufficient samples to calculate a 95% UCL
b) Non-detected metals, PCBs and formaldehyde detection limits adjusted upwards by 2.623 prior to calculation of 95% UCL
c) 95% UCL Cr III = 95% UCL Cr (Total) - 95% UCL Cr VI
d) Total Chromium not evaluated in HHRA
e) Mercury was not speciated during emissions testing
f) See Table 2-1 for calculation of TCDD-TEQ
g) Formaldeyde emission rates are based on the average concentration due to limited samples.
A = Alternate value, ProUCL recommended UCL value > maximum detect
1 = Maximum, all calculated UCL values > Maximum
2 = 95% Chebyshev (Mean, Sd) UCL used as alternate UCL

Table 2-3
Comparison of 95% UCL and Average Emission Rates to Average Emission Rates Used in ENSR 2006 Risk Assessment Update
Montgomery County RRF
Dickerson, MD

Chemical	95% UCL (a) Q g/sec	Average (b) Q g/sec	ENSR 2006 Q g/sec
Metals (c)			
Antimony	1.70E-04	1.19E-04	9.12E-05
Arsenic	1.42E-04	9.54E-05	9.06E-05
Beryllium	2.22E-05	1.69E-05	1.53E-05
Cadmium	1.89E-04	9.47E-05	5.97E-05
Chromium +3 (d)	1.34E-04	1.52E-04	
Chromium +6	7.89E-05	5.71E-05	6.51E-05
Total Chromium (e)	2.13E-04	1.73E-04	1.35E-04
Cobalt	3.90E-05	3.39E-05	6.45E-05
Copper	2.40E-04	1.36E-04	1.58E-04
Lead	2.12E-03	1.26E-03	3.48E-04
Manganese	3.33E-04	2.38E-04	2.33E-04
Mercury (f)	1.83E-03	1.53E-03	2.09E-03
Nickel	2.92E-04	2.38E-04	2.51E-04
Selenium	2.09E-04	1.61E-04	1.10E-04
Zinc	3.47E-03	2.21E-03	1.66E-03
Acid Gasses			
Hydrogen Chloride	2.67E+00	2.05E+00	Not Evaluated
Hydrogen Fluoride	5.07E-02	2.90E-02	Not Evaluated
Sulfuric Acid	1.74E-01	8.35E-02	Not Evaluated
2,3,7,8-TCDD-TEQ (g)	6.29E-09	3.41E-09	4.29E-09
Total PCBs (c)	4.32E-04	1.61E-04	1.59E-04
PAHs			
Acenaphthene	1.73E-04	2.60E-05	
Acenaphthylene	2.38E-05	8.18E-06	
Anthracene	1.76E-05	7.98E-06	
Benzo(a)anthracene	1.30E-05	5.73E-06	
Benzo(a)pyrene	1.45E-05	6.27E-06	
Benzo(b)fluoranthene	3.52E-05	1.12E-05	
Benzo(k)fluoranthene	2.19E-05	7.46E-06	
Benzo(ghi)perylene	1.61E-05	9.63E-06	
Chrysene	1.90E-04	3.29E-05	
Dibenzo(a,h)anthracene	1.79E-05	7.59E-06	
Fluoranthene	1.55E-05	9.91E-06	
Fluorene	2.47E-05	1.21E-05	
Indeno(1,2,3-cd)pyrene	1.45E-05	7.06E-06	
2-Methylnaphthalene	3.37E-05	1.93E-05	
Naphthalene	1.04E-04	6.92E-05	
Phenanthrene	2.64E-05	1.67E-05	
Pyrene	1.43E-05	1.03E-05	
cPAH (h)	3.07E-04	7.82E-05	6.81E-07
Aldehyde Ketones			
Formaldehyde (c)	1.97E-03	1.97E-03	1.97E-03

Notes:
a) See Table 2-2
b) Average HHRA emission rates are the average emission rates (1995 - 2013) per unit, which are then summed. Provided for comparison purposes only, not carried through the risk assessment.
c) Non-detected metals, PCBs and formaldehyde detection limits adjusted upwards by 2.623 prior to calculation of 95% UCL
d) 95% UCL Cr III = 95% UCL Cr (Total) - 95% UCL Cr VI, or average Cr III = average Cr (Total) - average Cr VI
e) Total Chromium not evaluated in HHRA
f) Mercury was not speciated during emissions testing
g) See Table 2-1 for calculation of TCDD-TEQ
h) cPAH - presented for comparison purposes only. Individual PAHs carried through the risk assessment.

Table 2-4
Particulate COPCs evaluated as Fugitive Emissions
Montgomery County RRF
Dickerson, MD

Chemical
Metals
Arsenic
Beryllium
Cadmium
Chromium +3
Chromium +6
Cobalt
Copper
Lead
Manganese
Nickel
Selenium
Zinc
PAHs [1]
Dibenzo(a,h)anthracene
Indeno(1,2,3-cd)pyrene

[1] Per USEPA 2005a. Fraction of vapor phase

Table 2-5
Summary of Process Upset Factors
Montgomery County RRF
Dickerson, MD

Category	Process Upset Factors
Metals	1.0001
Organics	1.0571

Calculation of Metals Process Upset Factor (a)

Total # of 6 minute averages (10/2011 - 09/2013)	514463
# of 6 minute averages >3% opacity	46

0.0089% % time > 3% opacity

Metals Process upset factor = (1-0.63%) * 1 + (0.63% * 10) = 1.000805

Calculation of Organics Process Upset Factor (a)

Total hours (12/1/2011 - 11/30/2013)	44444
# hours < 50 ppm	44162
# hours > 50 ppm	282
% time > 50 ppm	0.63%

Organic Process upset factor = (1-0.63%) * 1 + (0.63% * 10) = 1.057106

(a) See Appendix D for data distributions used in calculations

Table 3-1
Source Parameter Data
Montgomery County RRF
Dickerson, MD

		Source Parameter Data										Source Location			
		Height		Temperature		Exit Velocity		Area	Diameter		Exhaust Flow	UTM Easting (m)	UTM Northing (m)	Base Elevation	
Source ID	Source Description	(m)	(ft)	(K)	(F)	(m/s)	(ft/s)	(ft^2)	(m)	(ft)	(acfm)	NAD83-18	NAD83-18	(m)	(ft)
STACK1	RRF Stack (Combined Flues for Units 1,2,3)	82.6	271	416.36	289.8	24.48	80.3	112.63	3.65	12.0	542,741	287,945.3	4,341,922.0	106.10	348.1
RESIDUE	Residue Handling Building (Fugitive Emissions)	2.44	8	(Ambient)		0.001	0.003	448.05	7.28	23.9	88	287,977.5	4,342,072.9	107.00	351.0

Refer to Section 2.4.1 for a discussion of the fugitive emission source characterization

Table 3-2
Particle Fractionation Data
Montgomery County RRF
Dickerson, MD

"PARTDIAM" Mean Particle Diameter* (µm)	Volume of Mean Particle (m^3)	Density (g/cm^3)	Mass Per Particle (g)	Surface Area / Volume	Particle Phase "MASSFRAX": Fraction of Total Mass*	Proportion Available Surface Area	Particle-Bound Phase "MASSFRAX": Fraction of Total Surface Area
0.30	1.41E-29	1.0	1.41E-23	20.00	5.26E-01	10.520	9.57E-01
0.59	1.08E-28	1.0	1.08E-22	10.17	1.00E-02	0.102	9.25E-03
0.91	3.95E-28	1.0	3.95E-22	6.59	5.00E-03	0.033	3.00E-03
1.77	2.90E-27	1.0	2.90E-21	3.39	2.00E-02	0.068	6.17E-03
2.94	1.33E-26	1.0	1.33E-20	2.04	3.60E-02	0.073	6.68E-03
4.35	4.31E-26	1.0	4.31E-20	1.38	1.50E-02	0.021	1.88E-03
6.38	1.36E-25	1.0	1.36E-19	0.94	1.00E-02	0.009	8.55E-04
13.56	1.31E-24	1.0	1.31E-18	0.44	3.78E-01	0.167	1.52E-02
SUM:					1.000	---	1.000

* Mean particle diameters (PARTDIAM) and particle phase fractions of total mass (MASSFRAX) as used in 2006 Health Risk Study (ENSR 2006). Other values recalculated per HHRAP Guidance (USEPA 2005a).

Table 3-3
Onsite Meteorological Data Capture Rates
Montgomery County RRF
Dickerson, MD

Percent (%) of Capture											
		Height→	Ground Level		2 meters		10 meters				
Year	Quarter	Total Hours Per Quarter	Solar Radiation*	Precipitation	Dew Point*	Temperature*	Relative Humidity	Standard Deviation of the Horizontal Wind Direction	Temperature	Wind Direction	Wind Speed
2008	1	2184	NC	100.00	NC	NC	100.00	99.95	100.00	99.95	100.00
2008	2	2184	NC	100.00	NC	NC	100.00	98.35	100.00	98.35	100.00
2008	3	2208	NC	100.00	NC	NC	100.00	92.62	100.00	92.62	100.00
2008	4	2207	NC	100.00	NC	NC	99.86	99.37	99.95	99.37	99.95
2009	1	2160	NC	100.00	NC	NC	100.00	100.00	100.00	100.00	100.00
2009	2	2184	NC	99.50	NC	NC	99.36	99.45	99.50	99.45	99.50
2009	3	2208	NC	100.00	NC	NC	100.00	99.46	100.00	99.46	100.00
2009	4	2207	NC	100.00	NC	NC	99.86	99.86	99.91	99.86	99.91
2010	1	2160	NC	100.00	NC	NC	99.95	100.00	100.00	100.00	100.00
2010	2	2184	NC	99.95	NC	NC	99.91	99.95	100.00	99.95	99.95
2010	3	2208	78.67	99.59	78.67	78.67	99.59	99.09	99.59	99.18	99.59
2010	4	2207	100.00	100.00	100.00	100.00	100.00	99.55	100.00	99.55	99.86
2011	1	2160	100.00	100.00	100.00	100.00	100.00	99.72	100.00	99.72	100.00
2011	2	2184	100.00	100.00	100.00	100.00	100.00	99.13	100.00	99.27	100.00
2011	3	2208	100.00	100.00	100.00	100.00	100.00	95.92	100.00	95.92	100.00
2011	4	2207	100.00	100.00	100.00	100.00	100.00	99.64	100.00	99.68	100.00
2012	1	2184	100.00	100.00	100.00	100.00	100.00	99.77	100.00	99.82	100.00
2012	2	2184	100.00	100.00	100.00	100.00	100.00	99.18	100.00	99.18	99.91
2012	3	2208	100.00	100.00	100.00	100.00	100.00	98.01	100.00	98.05	100.00
2012	4	2207	100.00	100.00	100.00	100.00	100.00	99.50	100.00	99.59	100.00

* Solar radiation, dew point, and temperature at 2 meter level data collection did not begin until the third quarter of 2010. Prior months have been marked NC (Not Collected). The Dulles NWS station served as a secondary source of meteorological data during any hours when onsite data was not available.

Table 3-4

NWS Dulles Surface Meteorological Data Capture Rates

Montgomery County RRF
Dickerson, MD

Percent (%) of Capture						
Year	Quarter	Total Hours Per Quarter	Temperature	Wind Direction	Wind Speed	Cloud Cover
2008	1	2184	100.0%	100.0%	100.0%	100.0%
2008	2	2184	100.0%	99.8%	100.0%	100.0%
2008	3	2208	100.0%	99.7%	100.0%	99.9%
2008	4	2207	100.0%	99.8%	100.0%	100.0%
2009	1	2160	100.0%	100.0%	100.0%	99.9%
2009	2	2184	100.0%	99.8%	100.0%	100.0%
2009	3	2208	99.9%	99.7%	100.0%	100.0%
2009	4	2207	100.0%	100.0%	100.0%	99.9%
2010	1	2160	100.0%	100.0%	100.0%	99.9%
2010	2	2184	100.0%	99.8%	100.0%	100.0%
2010	3	2208	100.0%	99.5%	100.0%	100.0%
2010	4	2207	100.0%	100.0%	100.0%	100.0%
2011	1	2160	100.0%	99.9%	100.0%	100.0%
2011	2	2184	100.0%	99.5%	100.0%	100.0%
2011	3	2208	99.8%	99.9%	99.9%	99.8%
2011	4	2207	100.0%	100.0%	100.0%	100.0%
2012	1	2184	100.0%	100.0%	100.0%	100.0%
2012	2	2184	100.0%	99.7%	100.0%	100.0%
2012	3	2208	100.0%	100.0%	100.0%	100.0%
2012	4	2207	99.8%	99.7%	99.8%	99.8%

Table 3-5

NWS Sterling Upper Air Meteorological Data Capture Rates

Montgomery County RRF
Dickerson, MD

Year	Quarter	Days Per Quarter	12Z Soundings Recorded	Data Capture (%)
2008	1	91	91	100.0%
2008	2	91	87	95.6%
2008	3	92	89	96.7%
2008	4	92	92	100.0%
2009	1	90	89	98.9%
2009	2	91	91	100.0%
2009	3	92	92	100.0%
2009	4	92	92	100.0%
2010	1	90	90	100.0%
2010	2	91	91	100.0%
2010	3	92	92	100.0%
2010	4	92	92	100.0%
2011	1	90	90	100.0%
2011	2	91	90	98.9%
2011	3	92	87	94.6%
2011	4	92	91	98.9%
2012	1	91	91	100.0%
2012	2	91	90	98.9%
2012	3	92	89	96.7%
2012	4	92	90	97.8%

Table 4-1
Summary of Receptor Scenarios
Montomery County RRF
Dickerson, MD

	Soil	Produce	Beef	Dairy	Pork	Chicken	Eggs	Fish	Inhalation	Point of Modeling Impacts (a)
RME Scenarios										
Reasonable Maximum Exposed Resident	x	x							x	Maximum wet and dry deposition, maximum air concentrations, assumed to be collocated in same location
Reasonable Maximum Exposed Fisher (Potomac River)	x (a)	x (a)						x	x (a)	Maximum wet and dry deposition, maximum air concentrations, assumed to be collocated in same location. Average over Potomac River and watershed
Reasonable Maximum Exposed Farmer (Farm 2)	x	x	x	x	x	x	x		x	Potential farm location with highest potential concentration and depositional impacts. Concentration and depositional impacts at Farm 2.
MEI Scenarios										
Maximally Exposed Individual A	x	x	x (b)	x (b)	x (b)	x (b)	x (b)	x (c)	x	Maximum dry particle deposition, maximum air concentration, assumed to be collocated in same location
Maximally Exposed Individual B	x	x	x (b)	x (b)	x (b)	x (b)	x (b)	x (c)	x	Maximum total particle and vapor deposition, secondary maximum air concentration, assumed to be collocated in same location
Additional Fisher Scenarios										
Monocacy River Fisher	x (a)	x (a)						x	x (a)	Maximum wet and dry deposition, maximum air concentrations, , assumed to be collocated in same location. Average over Monocacy River and watershed
Resident Fisher near Farm 1 (Fishes Farm Pond 2)	x	x						x	x	Concentration and depositional impacts at Farm 1 and Farm Pond 2
Resident Fisher near Farm 2 (Fishes Farm Pond 3)	x	x						x	x	Concentration and depositional impacts at Farm 2 and Farm Pond 3
Additional Resident Farm Scenarios										
Resident Farm 1	x	x				x	x		x	Concentration and depositional impacts at Farm 1
Resident Farm 6	x	x	x	x	x	x	x		x	Actual farm location with highest potential concentration and depositional impacts. Concentration and depositional impacts at Farm 6.
Acute (1-hr) Hazard Index									x	Maximum 1-hr air concentrations, , assumed to be collocated in same location

(A) It should be noted that each modeling parameter (air concentration, vapor, dry and wet deposition) each have a vapor, particulate and particle-bound component. So even with in a modeling parameter (e.g., air concentration), the vapor, particulate and particulate-bound fractions may not impact the same location. In addition, AERMOD models the vapor phase of the COPCs individually which can potentially result in the maximums for each COPC also impacting in different locations. For the purpose of this risk assessment, they were assumed to all be collocated at the receptor location. This would tend to overestimate risk.

x - exposure pathway at receptor location, unless otherwise footnoted:

(a) Resides at location of RME resident, therefore same inhalation, soil and produce exposure as RME Resident

(b) Obtains beef, dairy, pork, chicken and eggs from Farm 6

(c) Ingests fish from the Potomac River

Table 4-2
Input Parameters
Montgomery County RRF
Dickerson, MD

CATEGORY/PARAMETER	VALUE	REFERENCES
SOIL CONCENTRATION		
Time period over which average concentration occurs, tD (yr):	30	site-specific
Time period at beginning of emissions, T1 (yr):	0	default, USEPA 2005a
Length of Exposure Duration, T2 (yr):	6, 30 or 40	default, USEPA 2005a
Soil bulk density (g/cm3):	1.5	default, USEPA 2005a
Soil mixing depth, untilled (cm):	2	default, USEPA 2005a
Soil mixing depth, tilled (cm):	20	default, USEPA 2005a
Fraction of COPC air concentration in vapor phase (--):	0 or 1	default, USEPA 2005a
COPC loss constant due to erosion (yr-1):	0	default, USEPA 2005a
Average annual surface runoff from pervious areas, RO (cm/yr):	17.8	Geraghty et al. 1973
Soil moisture content, theta sw, (cm3/cm3):	0.2	default, USEPA 2005a
Average annual precipitation (cm/yr):	139.8	5-yr average on-site met station
Average annual irrigation (cm/yr):	22	USGS 2000
Average annual evapotranspiration (cm/yr):	70	Sanford and Selnick 2013
Universal gas constant (atm-m3/mol-K):	8.2E-05	default, USEPA 2005a
Ambient air temperature, Kelvin (K):	286	5-yr average on-site met station
Solids particle density (g/cm3):	2.70	default, USEPA 2005a
PLANT UPTAKE		
Interception factor for above ground vegetation, Rp (--):	0.39	default, USEPA 2005a
Fraction of COPC wet deposition that adheres to plant surfaces, Fw (--):	See below:	
anions:	0.2	default, USEPA 2005a
cations and most organics:	0.6	default, USEPA 2005a
Plant surface loss coefficient, kp (yr-1):	18	default, USEPA 2005a
Length of growing season for above ground vegetation, Tp (yr):	0.16	default, USEPA 2005a
Vegetation yield for above ground vegetation, Yp (kg DW/m2):	2.24	default, USEPA 2005a
Air density (g/m3):	1200	default, USEPA 2005a
Empirical correction factor for above ground produce Vg_{ag}(--):	See below:	
log Kow >4:	0.01	default, USEPA 2005a
log Kow <4:	1	default, USEPA 2005a
Empirical correction factor for below ground produce Vg_{bg}(--):	See below:	
log Kow >4:	0.01	default, USEPA 2005a
log Kow <4:	1	default, USEPA 2005a

Table 4-2
Input Parameters
Montgomery County RRF
Dickerson, MD

CATEGORY/PARAMETER	VALUE	REFERENCES
WATERBODY CONCENTRATION - POTOMAC RIVER		
Watershed Soil Constituent Concentration		
Time period over which average concentration occurs, tD (yr):	30	default, USEPA 2005a
Time period at beginning of combustion, T1 (yr):	0	default, USEPA 2005a
Length of Exposure Duration, T2 (yr):	30	default, USEPA 2005a
Soil bulk density (g/cm3):	1.5	default, USEPA 2005a
Soil mixing depth, untilled (cm):	2	default, USEPA 2005a
Fraction of COPC air concentration in vapor phase (--):	0 or 1	default, USEPA 2005a
COPC loss constant due to erosion (yr-1):	0	default, USEPA 2005a
Average annual surface runoff from pervious areas, RO (cm/yr):	34.42	Potomac River Water Quality Report, USGS 2012a
Soil moisture content, theta sw, (cm3/cm3):	0.2	default, USEPA 2005a
Average annual precipitation (cm/yr):	139.8	5-yr average on-site met station
Average annual irrigation (cm/yr):	0	Assumed no irrigation
Average annual evapotranspiration (cm/yr):	70	Sanford and Selnick, 2013
Universal gas constant (atm-m3/mol-K):	8.2E-05	default, USEPA 2005a
Ambient air temperature, Kelvin (K):	286.0	5-yr average on-site met station
Solids particle density (g/cm3):	2.7	default, USEPA 2005a
Total Waterbody Load		
Waterbody area (m2):	1.3E+08	site specific, river waterbody area determined in ESRI ArcGIS based on the USGS topographic maps of the region.
Impervious watershed area receiving fallout (m2):	7.84E+07	site specific, based upon 4.9% impervious area. Impervious areas were identified using: U.S. Geological Survey (USGS). "National Land Cover Dataset 2006 - Impervious Surface".
Average annual surface runoff (cm/yr):	34.42	Potomac River Water Quality Report, USGS 2012a
Total watershed area receiving fallout (m2):	1.60E+09	site specific, acquired from U.S. Geological Department of Agriculture (USDA). 8-digit hydrologic units.
Soil bulk density (g/cm3)	1.5	default, USEPA 2005a
Soil moisture content, theta sw, (cm3/cm3):	0.2	default, USEPA 2005a
Constituent enrichment ratio (--):	See below	
Inorganics:	1	default, USEPA 2005a
Organics:	3	default, USEPA 2005a
Water body temperature (K):	288.8	avg daily mean over 9 years, Point of Rocks Station, Moore 2010
Universal gas constant (atm-m3/mol-K):	8.2E-05	default, USEPA 2005a
USLE rainfall (or erosivity) factor, RF (yr-1):	175	USDA 1997
USLE erodability factor, K (ton/acre)	0.19	Watershed Profile Potomac River Montgomery County (MD DNR 2013a)
USLE length-slope factor, LE (unitless):	1.5	default, USEPA 1994a
USLE cover management factor, C (unitless):	0.041	representitive value, determined using NCLD 1992 and EPA's AERSURFACE program (version 13016) for modeling impact area
USLE supporting practice factor, PF (unitless):	1	default, USEPA 1994a
Empirical intercept coefficient (a):	0.6	default, USEPA 2005a, based on site specific information
Empirical slope coefficient (b):	0.125	default, USEPA 2005a
μ = Current velocity (m/s):	0.34	Point of Rocks to Mouth of Monocacy, Vann et al., 2002
dz = Total water body depth (m):	1.04	Calculated (depth of water column + Depth of benthic layer)
Water Concentration		
Average volumetric flow rate (m3/yr):	4.4E+09	site specific (117 yr avg Point of Rocks Station), USGS 2013a
Depth of water column (m):	1.01	Moore 2010, average daily mean over 8 years Point of Rocks Station
Depth of benthic layer (m):	0.03	default, USEPA 2005a
Total suspended solids (mg/L):	38	site specific (23 yr avg Point of Rocks Station), USGS 2013a
Bed sediment porosity (Lwater/L):	0.6	default, USEPA 2005a
Bed sediment concentration (g/cm3):	1	default, USEPA 2005a
Fish Concentration		
Fish lipid content:	0.07	default, USEPA 2005a
Fraction organic carbon in bottom sediment:	0.04	default, USEPA 2005a

Table 4-2
Input Parameters
Montgomery County RRF
Dickerson, MD

CATEGORY/PARAMETER	VALUE	REFERENCES
WATERBODY CONCENTRATION - Monocacy River		
Watershed Soil Constituent Concentration		
Time period over which average concentration occurs, tD (yr):	30	default, USEPA 2005a
Time period at beginning of combustion, T1 (yr):	0	default, USEPA 2005a
Length of Exposure Duration, T2 (yr):	30	default, USEPA 2005a
Soil bulk density (g/cm3):	1.5	default, USEPA 2005a
Soil mixing depth, untilled (cm):	2	default, USEPA 2005a
Fraction of COPC air concentration in vapor phase (--):	0 or 1	default, USEPA 2005a
COPC loss constant due to erosion (yr-1):	0	default, USEPA 2005a
Average annual surface runoff from pervious areas, RO (cm/yr):	40.4	Monocacy River Water Quality Report, USGS 2012b
Soil moisture content, theta sw, (cm3/cm3):	0.2	default, USEPA 2005a
Average annual precipitation (cm/yr):	139.8	5-yr average on-site met station
Average annual irrigation (cm/yr):	0	Assumed no irrigation
Average annual evapotranspiration (cm/yr):	70	Sanford and Selnick, 2013
Universal gas constant (atm-m3/mol-K):	8.2E-05	default, USEPA 2005a
Ambient air temperature, Kelvin (K):	286.0	5-yr average on-site met station
Solids particle density (g/cm3):	2.7	default, USEPA 2005a
Total Waterbody Load		
Waterbody area (m2):	1.1E+06	site specific, river waterbody area determined in ESRI ArcGIS based on the USGS topographic maps of the region.
Impervious watershed area receiving fallout (m2):	1.22E+07	site specific, based upon 3.8% impervious area. Impervious areas were identified using: U.S. Geological Survey (USGS). "National Land Cover Dataset 2006 - Impervious Surface".
Average annual surface runoff (cm/yr):	40.4	Monocacy River Water Quality Report, USGS 2012b
Total watershed area receiving fallout (m2):	3.21E+08	site specific, acquired from U.S. Geological Department of Agriculture (USDA). 8-digit hydrologic units.
Soil bulk density (g/cm3)	1.5	default, USEPA 2005a
Soil moisture content, theta sw, (cm3/cm3):	0.2	default, USEPA 2005a
Constituent enrichment ratio (--):	See below	
Inorganics:	1	default, USEPA 2005a
Organics:	3	default, USEPA 2005a
Water body temperature (K):	287	Site specific
Universal gas constant (atm-m3/mol-K):	8.2E-05	default, USEPA 2005a
USLE rainfall (or erosivity) factor, RF (yr-1):	175	USDA 1997
USLE erodability factor, K (ton/acre)	0.28	Watershed Profile Lower Monocacy River (MD DNR 2013b)
USLE length-slope factor, LE (unitless):	1.5	default, USEPA 1994a
USLE cover management factor, C (unitless):	0.041	representitive value, determined using NCLD 1992 and EPA's AERSURFACE program (version 13016) for modeling impact area
USLE supporting practice factor, PF (unitless):	1	default, USEPA 1994a
Empirical intercept coefficient (a):	0.6	default, USEPA 2005a, based on site specific information
Empirical slope coefficient (b):	0.125	default, USEPA 2005a
μ = Current velocity (m/s):	0.82	CPF Associates, 2012
dz = Total water body depth (m):	0.96	Calculated (depth of water column + Depth of benthic layer)
Water Concentration		
Average volumetric flow rate (m3/yr):	3.5E+08	site specific, 87 yr avg flow rate at Jug Bridge Station (USGS 2013b)
Depth of water column (m):	0.93	5-yr avg at Jug Bridge (USGS 2013b)
Depth of benthic layer (m):	0.03	default, USEPA 2005a
Total suspended solids (mg/L):	8.7	Median TSS concentration at 3 MD DNR monitoring stations (CPF Associates 2012)
Bed sediment porosity (Lwater/L):	0.6	default, USEPA 2005a
Bed sediment concentration (g/cm3):	1	default, USEPA 2005a

Table 4-2
Input Parameters
Montgomery County RRF
Dickerson, MD

CATEGORY/PARAMETER	VALUE	REFERENCES
WATERBODY CONCENTRATION - FARM POND 2		
Watershed Soil Constituent Concentration		
Time period over which average concentration occurs, tD (yr):	30	default, USEPA 2005a
Time period at beginning of combustion, T1 (yr):	0	default, USEPA 2005a
Length of Exposure Duration, T2 (yr):	40	default, USEPA 2005a
Soil bulk density (g/cm3):	1.5	default, USEPA 2005a
Soil mixing depth, untilled (cm):	2	default, USEPA 2005a
Fraction of COPC air concentration in vapor phase (--):	0 or 1	default, USEPA 2005a
COPC loss constant due to erosion (yr-1):	0	default, USEPA 2005a
Average annual surface runoff from pervious areas, RO (cm/yr):	17.8	ENSR 2006
Soil moisture content, theta sw, (cm3/cm3):	0.2	default, USEPA 2005a
Average annual precipitation (cm/yr):	139.8	5-yr average on-site met station
Average annual irrigation (cm/yr):	0	Assumed no irrigation
Average annual evapotranspiration (cm/yr):	70	Sanford and Selnick 2013
Ideal Gas Constant (atm-m3/mole-K):	8.2E-05	default, USEPA 2005a
Ambient air temperature, Kelvin (K):	286.0	5-yr average on-site met station
Solids particle density (g/cm3):	2.7	default, USEPA 2005a
Total Waterbody Load		
Waterbody area (m2):	5.0E+03	site specific, ESRI ArcGIS based on aerial imagery from Microsoft
Impervious watershed area receiving fallout (m2):	0.00E+00	assumed for Farm Pond
Total watershed area receiving fallout (m2):	1.89E+05	site specific, calculated in Quantum GIS/GRASS using the USGS National Elevation Dataset (NED) as the source of terrain data (1 arc second / 30 meter resolution)
Soil bulk density (g/cm3)	1.5	default, USEPA 2005a
Soil moisture content, theta sw, (cm3/cm3):	0.2	default, USEPA 2005a
Constituent enrichment ratio (--):	See below	
Inorganics:	1	default, USEPA 2005a
Organics:	3	default, USEPA 2005a
Water body temperature (K):	286.0	assumed to be same as air temperature
Universal gas constant (atm-m3/mol-K):	8.2E-05	default, USEPA 2005a
USLE rainfall (or erosivity) factor, RF (yr-1):	175	USDA 1997
USLE erodability factor, K (ton/acre)	0.39	default, USEPA 1994a
USLE length-slope factor, LE (unitless):	1.5	default, USEPA 1994a
USLE cover management factor, C (unitless):	0.041	representitive value, determined using NCLD 1992 and EPA's AERSURFACE program (version 13016) for modeling impact area
USLE supporting practice factor, PF (unitless):	1	default, USEPA 1994a
Empirical intercept coefficient (a):	2.1	default, USEPA 2005a, based on site specific information
Empirical slope coefficient (b):	0.125	default, USEPA 2005a
Temperature correction factor (unitless):	1.026	default, USEPA 2005a
Drag Coefficient (unitless):	1.1E-03	default, USEPA 2005a
Average annual wind speed (m/s):	2.2	5-yr average on-site met station
Density of air (g/cm3):	1.2E-03	default, USEPA 2005a
Density of water (g/cm3):	1	default, USEPA 2005a
von Karman's Constant (unitless):	0.4	default, USEPA 2005a
Dimensionless viscous sublayer thickness (unitless):	4	default, USEPA 2005a
Viscosity of water corresponding to water temperature (g/cm-s):	0.017	default, USEPA 2005a
Viscosity of air (g/cm-s)	1.8E-04	default, USEPA 2005a
Average volumetric flow rate (m3/yr):	6.7E+04	calculated, ENSR 2006
Depth of water column (m):	1.50	ENSR 2006
Depth of benthic layer (m):	0.03	default, USEPA 2005a
Total suspended solids (mg/L):	21.1	Calculated, USEPA 2005a
Bed sediment porosity (Lwater/L):	0.6	default, USEPA 2005a
Bed sediment concentration (g/cm3):	1	default, USEPA 2005a

Table 4-2
Input Parameters
Montgomery County RRF
Dickerson, MD

CATEGORY/PARAMETER	VALUE	REFERENCES
WATERBODY CONCENTRATION - POND 3		
Watershed Soil Constituent Concentration		
Time period over which average concentration occurs, tD (yr):	30	default, USEPA 2005a
Time period at beginning of combustion, T1 (yr):	0	default, USEPA 2005a
Length of Exposure Duration, T2 (yr):	40	default, USEPA 2005a
Soil bulk density (g/cm3):	1.5	default, USEPA 2005a
Soil mixing depth, untilled (cm):	2	default, USEPA 2005a
Fraction of COPC air concentration in vapor phase (--):	0 or 1	default, USEPA 2005a
COPC loss constant due to erosion (yr-1):	0	default, USEPA 2005a
Average annual surface runoff from pervious areas, RO (cm/yr):	17.8	ENSR 2006
Soil moisture content, theta sw, (cm3/cm3):	0.2	default, USEPA 2005a
Average annual precipitation (cm/yr):	139.8	5-yr average on-site met station
Average annual irrigation (cm/yr):	0	Assumed no irrigation
Average annual evapotranspiration (cm/yr):	70	Sanford and Selnick, 2013
Ideal Gas Constant (atm-m3/mole-K):	8.2E-05	default, USEPA 2005a
Ambient air temperature, Kelvin (K):	286	5-yr average on-site met station
Solids particle density (g/cm3):	2.7	default, USEPA 2005a
Total Waterbody Load		
Waterbody area (m2):	3.3E+03	site specific, ESRI ArcGIS based on aerial imagery from Microsoft
Impervious watershed area receiving fallout (m2):	0.00E+00	assumed for Farm Pond
Total watershed area receiving fallout (m2):	3.31E+05	site specific, calculated in Quantum GIS/GRASS using the USGS National Elevation Dataset (NED) as the source of terrain data (1 arc second / 30 meter resolution)
Soil bulk density (g/cm3)	1.5	default, USEPA 2005a
Soil moisture content, theta sw, (cm3/cm3):	0.2	default, USEPA 2005a
Constituent enrichment ratio (--):	See below	
Inorganics:	1	default, USEPA 2005a
Organics:	3	default, USEPA 2005a
Water body temperature (K):	286.0	assumed to be same as air temperature
Universal gas constant (atm-m3/mol-K):	8.2E-05	default, USEPA 2005a
USLE rainfall (or erosivity) factor, RF (yr-1):	175	USDA 1997
USLE erodability factor, K (ton/acre)	0.39	default, USEPA 1994a
USLE length-slope factor, LE (unitless):	1.5	default, USEPA 1994a
USLE cover management factor, C (unitless):	0.041	representitive value, determined using NCLD 1992 and EPA's AERSURFACE program (version 13016) for modeling impact area
USLE supporting practice factor, PF (unitless):	1	default, USEPA 1994a
Empirical intercept coefficient (a):	1.4	default, USEPA 2005a, based on site specific information
Empirical slope coefficient (b):	0.125	default, USEPA 2005a
Temperature correction factor (unitless):	1.026	default, USEPA 2005a
Drag Coefficient (unitless):	1.1E-03	default, USEPA 2005a
Average annual wind speed (m/s):	2.2	5-yr average on-site met station
Density of air (g/cm3):	1.2E-03	default, USEPA 2005a
Density of water (g/cm3):	1	default, USEPA 2005a
von Karman's Constant (unitless):	0.4	default, USEPA 2005a
Dimensionless viscous sublayer thickness (unitless):	4	default, USEPA 2005a
Viscosity of water corresponding to water temperature (g/cm-s):	0.017	default, USEPA 2005a
Viscosity of air (g/cm-s)	1.8E-04	default, USEPA 2005a
Average volumetric flow rate (m3/yr):	1.2E+05	calculated, ENSR 2006
Depth of water column (m):	2.30	ENSR 2006
Depth of benthic layer (m):	0.03	default, USEPA 2005a
Total suspended solids (mg/L):	34.7	Calculated, USEPA 2005a
Bed sediment porosity (Lwater/L):	0.6	default, USEPA 2005a
Bed sediment concentration (g/cm3):	1	default, USEPA 2005a

Table 4-2
Input Parameters
Montgomery County RRF
Dickerson, MD

CATEGORY/PARAMETER	VALUE	REFERENCES
LIVESTOCK CONCENTRATIONS		
FORAGE UPTAKE		
Interception factor for above ground vegetation (--):	0.5	default, USEPA 2005a
Plant surface loss coefficient (yr-1):	18	default, USEPA 2005a
Length of growing season for above ground vegetation (yr):	0.12	default, USEPA 2005a
Vegetation yield for above ground vegetation (kg DW/m2):	0.24	default, USEPA 2005a
Air density (g/m3):	1200	default, USEPA 2005a
Above ground vegetable correction factor (--):	1	default, USEPA 2005a
SILAGE UPTAKE		
Interception factor for above ground vegetation (--):	0.46	default, USEPA 2005a
Plant surface loss coefficient (yr-1):	18	default, USEPA 2005a
Length of growing season for above ground vegetation (yr):	0.16	default, USEPA 2005a
Vegetation yield for above ground vegetation (kg DW/m2):	0.8	default, USEPA 2005a
Air density (g/m3):	1200	default, USEPA 2005a
Above ground vegetable correction factor (--):	0.5	default, USEPA 2005a
BEEF AND MILK UPTAKE		
Quantity of soil eaten each day (kg soil/d):	See below	
Beef cattle:	0.5	default, USEPA 2005a
Dairy cattle:	0.4	default, USEPA 2005a
Quantity of forage eaten each day (kg plant DW/d):	See below	
Beef cattle:	8.8	default, USEPA 2005a
Dairy cattle:	13.2	default, USEPA 2005a
Quantity of silage eaten each day (kg plant DW/d):	See below	
Beef cattle:	2.5	default, USEPA 2005a
Dairy cattle:	4.1	default, USEPA 2005a
Quantity of grain eaten each day (kg plant DW/d):	See below	
Beef cattle:	0.47	default, USEPA 2005a
Dairy cattle:	3	default, USEPA 2005a
Fraction of vegetation grown on contaminated soil:	1	default, USEPA 2005a
Soil bioavailability factor (--):	1	default, USEPA 2005a
Metabolism factor (--):	1	default, USEPA 2005a
MF Bis(2-ethylhexyl)phthalate:	0.01	default, USEPA 2005a
PORK UPTAKE		
Quantity of soil eaten each day (kg soil/d):	0.37	default, USEPA 2005a
Quantity of silage eaten each day (kg plant DW/d):	1.4	default, USEPA 2005a
Quantity of grain eaten each day (kg plant DW/d):	3.3	default, USEPA 2005a
Fraction of vegetation grown on contaminated soil:	1	default, USEPA 2005a
Soil bioavailability factor (--):	1	default, USEPA 2005a
Metabolism factor (--):	1	default, USEPA 2005a
CHICKEN UPTAKE		
Quantity of soil eaten each day (kg soil/d):	0.022	default, USEPA 2005a
Quantity of grain eaten each day (kg plant DW/d):	0.2	default, USEPA 2005a
Fraction of grain grown on contaminated soil:	1	default, USEPA 2005a
Soil bioavailability factor (--):	1	default, USEPA 2005a
Metabolism factor (--):	1	default, USEPA 2005a

Table 4-3
Exposure Parameters
Montgomery County RRF, Maryland
Dickerson, MD

EXPOSURE PARAMETERS	Basis/Reference	RME Scenarios									Additional Scenarios		
		Resident			Potomac River Fisher			Farmer (Farm 2)			MEI Resident A		
		Adult	Child	Infant	Adult	Child	Infant	Adult	Child	Infant	Adult	Child	Infant
Soil Consumption:													
Soil consumption rate (kg/d):	default, USEPA 2005a	0.0001	0.0002		0.0001	0.0002		0.0001	0.0002		0.0001	0.0002	
Fraction of consumed soil that is contaminated:	default, USEPA 2005a	1	1		1	1		1	1		1	1	
Home-grown Produce Consumption:													
Consumption rate of above ground vegetables (kg/kgBW-d):	default, USEPA 2005a	0.0003	0.00042		0.0003	0.00042		0.0003	0.00042		0.0003	0.00042	
Consumption rate of protected above ground vegetables (kg/kgBW-d):	default, USEPA 2005a	0.00057	0.00077		0.00057	0.00077		0.00057	0.00077		0.00057	0.00077	
Fraction of above ground vegetables that are contaminated:	default, USEPA 2005a	0.25	0.25		0.25	0.25		1	1		1	1	
Consumption rate of below ground vegetables (kg/kgBW-d):	default, USEPA 2005a	0.00014	0.00022		0.00014	0.00022		0.00014	0.00022		0.00014	0.00022	
Fraction of below ground vegetables that are contaminated:	default, USEPA 2005a	0.25	0.25		0.25	0.25		1	1		1	1	
Fish Consumption:													
Consumption rate of fish (kg/kgBW-d):	default, USEPA 2005a				1.17E-03	7.59E-04					1.17E-03	7.59E-04	
Fraction of ingested fish that is contaminated:	default, USEPA 2005a, Res Fishers - BPJ				1	1					1	1	
Farm Raised Meat and Dairy Products:													
Consumption rate of beef (kg/kgBW-d):	default, USEPA 2005a							0.00114	0.00051		0.00114	0.00051	
Fraction of beef that is contaminated:	default, USEPA 2005a							1	1		1	1	
Consumption rate of milk (kg/kgBW-d):	default, USEPA 2005a							0.00842	0.01857		0.00842	0.01857	
Fraction of milk that is contaminated:	default, USEPA 2005a							1	1		1	1	
Consumption rate of pork (kg/kgBW-d):	default, USEPA 2005a							0.00053	0.000398		0.00053	0.000398	
Fraction of pork that is contaminated:	default, USEPA 2005a							1	1		1	1	
Consumption rate of chicken (kg/kgBW-d):	default, USEPA 2005a							0.00061	0.000425		0.00061	0.000425	
Fraction of chicken that is contaminated:	default, USEPA 2005a							1	1		1	1	
Consumption rate of eggs (kg/kgBW-d):	default, USEPA 2005a							0.00062	0.000438		0.00062	0.000438	
Fraction of eggs that is contaminated:	default, USEPA 2005a							1	1		1	1	
Infant Breast Milk Ingestion													
Fraction of ingested dioxin that is stored in fat (--):	default, USEPA 2005a			0.9			0.9			0.9			0.9
Half-life of dioxin in adults (days):	default, USEPA 2005a			2555			2555			2555			2555
Fraction of mother's breast milk that is fat (--):	default, USEPA 2005a			0.04			0.04			0.04			0.04
Fraction of ingested dioxin that is absorbed (--):	default, USEPA 2005a			0.9			0.9			0.9			0.9
Proportion of Maternal weight that is fat:	default, USEPA 2005a			0.3			0.3			0.3			0.3
Infant consumption rate of breastmilk (kg/d):	default, USEPA 2005a			0.8			0.8			0.8			0.8
Averaging time (yr):													
Carcinogens:	default, USEPA 2005a	70	70		70	70		70	70		70	70	
Non-carcinogens:	default, USEPA 2005a	ED	ED		ED	ED		ED	ED		ED	ED	
Exposure Duration (yr):	default, USEPA 2005a	30	6	1	30	6	1	40	6	1	30	6	1
Exposure Frequency (d/yr):	default, USEPA 2005a	350	350	365	350	350	365	350	350	365	350	350	365
Body weight (kg):	default, USEPA 2005a	70	15	10	70	15	10	70	15	10	70	15	10
Exposure Time (hr/d):	default, USEPA 2005a	24	24		24	24		24	24		24	24	
Inhalation Rate (m3/hr):	default, USEPA 2005a	0.63	0.3		0.63	0.3		0.63	0.3		0.63	0.3	

BPJ = Best Professional Judgement

Table 4-3
Exposure Parameters
Montgomery County RRF, Maryland
Dickerson, MD

EXPOSURE PARAMETERS	Basis/Reference	Additional Scenarios (cont'd)											
		MEI Resident B			Monocacy River Fisher			Resident Fishers (Ponds 2 and 3)			Resident Farmer (Farms 1 and 6)		
		Adult	Child	Infant	Adult	Child	Infant	Adult	Child	Infant	Adult	Child	Infant
Soil Consumption:													
Soil consumption rate (kg/d):	default, USEPA 2005a	0.0001	0.0002		0.0001	0.0002		0.0001	0.0002		0.0001	0.0002	
Fraction of consumed soil that is contaminated:	default, USEPA 2005a	1	1		1	1		1	1		1	1	
Home-grown Produce Consumption:													
Consumption rate of above ground vegetables (kg/kgBW-d):	default, USEPA 2005a	0.0003	0.00042		0.0003	0.00042		0.0003	0.00042		0.0003	0.00042	
Consumption rate of protected above ground vegetables (kg/kgBW-d):	default, USEPA 2005a	0.00057	0.00077		0.00057	0.00077		0.00057	0.00077		0.00057	0.00077	
Fraction of above ground vegetables that are contaminated:	default, USEPA 2005a	1	1		0.25	0.25		0.25	0.25		1	1	
Consumption rate of below ground vegetables (kg/kgBW-d):	default, USEPA 2005a	0.00014	0.00022		0.00014	0.00022		0.00014	0.00022		0.00014	0.00022	
Fraction of below ground vegetables that are contaminated:	default, USEPA 2005a	1	1		0.25	0.25		0.25	0.25		1	1	
Fish Consumption:													
Consumption rate of fish (kg/kgBW-d):	default, USEPA 2005a	1.17E-03	7.59E-04		1.17E-03	7.59E-04		1.17E-03	7.59E-04				
Fraction of ingested fish that is contaminated:	default, USEPA 2005a, Res Fishers - BPJ	1	1		1	1		0.5	0.5				
Farm Raised Meat and Dairy Products:													
Consumption rate of beef (kg/kgBW-d):	default, USEPA 2005a	0.00114	0.00051								0.00114	0.00051	
Fraction of beef that is contaminated:	default, USEPA 2005a	1	1								1	1	
Consumption rate of milk (kg/kgBW-d):	default, USEPA 2005a	0.00842	0.01857								0.00842	0.01857	
Fraction of milk that is contaminated:	default, USEPA 2005a	1	1								1	1	
Consumption rate of pork (kg/kgBW-d):	default, USEPA 2005a	0.00053	0.000398								0.00053	0.000398	
Fraction of pork that is contaminated:	default, USEPA 2005a	1	1								1	1	
Consumption rate of chicken (kg/kgBW-d):	default, USEPA 2005a	0.00061	0.000425								0.00061	0.000425	
Fraction of chicken that is contaminated:	default, USEPA 2005a	1	1								1	1	
Consumption rate of eggs (kg/kgBW-d):	default, USEPA 2005a	0.00062	0.000438								0.00062	0.000438	
Fraction of eggs that is contaminated:	default, USEPA 2005a	1	1								1	1	
Infant Breast Milk Ingestion													
Fraction of ingested dioxin that is stored in fat (--):	default, USEPA 2005a			0.9			0.9			0.9			0.9
Half-life of dioxin in adults (days):	default, USEPA 2005a			2555			2555			2555			2555
Fraction of mother's breast milk that is fat (--):	default, USEPA 2005a			0.04			0.04			0.04			0.04
Fraction of ingested dioxin that is absorbed (--):	default, USEPA 2005a			0.9			0.9			0.9			0.9
Proportion of Maternal weight that is fat:	default, USEPA 2005a			0.3			0.3			0.3			0.3
Infant consumption rate of breastmilk (kg/d):	default, USEPA 2005a			0.8			0.8			0.8			0.8
Averaging time (yr):													
Carcinogens:	default, USEPA 2005a	70	70		70	70		70	70		70	70	
Non-carcinogens:	default, USEPA 2005a	ED	ED		ED	ED		ED	ED		ED	ED	
Exposure Duration (yr):	default, USEPA 2005a	30	6	1	30	6	1	30	6	1	40	6	1
Exposure Frequency (d/yr):	default, USEPA 2005a	350	350	365	350	350	365	350	350	365	350	350	365
Body weight (kg):	default, USEPA 2005a	70	15	10	70	15	10	70	15	10	70	15	10
Exposure Time (hr/d):	default, USEPA 2005a	24	24		24	24		24	24		24	24	
Inhalation Rate (m3/hr):	default, USEPA 2005a	0.63	0.3		0.63	0.3		0.63	0.3		0.63	0.3	

BPJ = Best Professional Judgement

Table 5-1
Summary of Toxicity Values Associated with Carcinogenic Effects: Oral
Montgomery County RRF
Dickerson, MD

Constituent	Slope Factor (SF) Oral (mg/kg-day)-1	Weight-Of Evidence Class (a)	Type of Cancer	SF Basis/ Source
Inorganics				
Antimony	NA			NA/IRIS 2013, USEPA 2013
Arsenic	1.5E+00	A	Skin	Water/IRIS 2013
Beryllium	NA	B1		NA/IRIS 2013, USEPA 2013
Cadmium	NA			NA/IRIS 2013, USEPA 2013
Chromium +3	NA	D		NA/IRIS 2013, USEPA 2013
Chromium +6	5.0E-01	A		USEPA 2013 RSL Table
Cobalt	NA			NA/IRIS 2013, USEPA 2013
Copper	NA	D		NA/IRIS 2013, USEPA 2013
Lead	NA	B2		Cal EPA 2013a
Manganese	NA	D		NA/IRIS 2013, USEPA 2013
Mercury as HgCl2	NA	C	Renal	NA/IRIS 2013, USEPA 2013
Mercury as Methyl Hg	NA	C	Renal	NA/IRIS 2013, USEPA 2013
Nickel	NA			NA/IRIS 2013, USEPA 2013
Selenium	NA	D		NA/IRIS 2013, USEPA 2013
Zinc	NA	D		NA/IRIS 2013, USEPA 2013
2,3,7,8-TCDD (b)	1.3E+05	B2	Multiple Sites	USEPA 2013 RSL Table (a)
Total PCBs (c)	2.0E+00	B2	Multiple Sites	USEPA 2013 RSL Table
PAHs				
Acenaphthene	NA			NA/IRIS 2013, USEPA 2013
Acenaphthylene	NA	D		IRIS 2013
Anthracene	NA	D		IRIS 2013
Benzo(a)anthracene	7.3E-01	B2	Forestomach	USEPA 2013 RSL Table (d)
Benzo(a)pyrene	7.3E+00	B2	Forestomach	Diet/IRIS 2013
Benzo(b)fluoranthene	7.3E-01	B2	Forestomach	USEPA 2013 RSL Table (d)
Benzo(k)fluoranthene	7.3E-02	B2	Forestomach	USEPA 2013 RSL Table (d)
Benzo(ghi)perylene	NA	D		IRIS 2013
Chrysene	7.3E-03	B2	Forestomach	USEPA 2013 RSL Table (d)
Dibenzo(a,h)anthracene	7.3E+00	B2	Forestomach	USEPA 2013 RSL Table (d)
Fluoranthene	NA	D		IRIS 2013
Fluorene	NA	D		IRIS 2013
Indeno(1,2,3-cd)pyrene	7.3E-01	B2	Forestomach	USEPA 2013 RSL Table (d)
2-Methylnaphthalene	NA			NA/IRIS 2013, USEPA 2013
Naphthalene	NA	C		IRIS 2013
Phenanthrene	NA	D		IRIS 2013
Pyrene	NA	D		IRIS 2013
Aldehyde Ketones				
Formaldehyde	NA	B1		NA/IRIS 2013, USEPA 2013

IRIS = U.S. EPA, 2013, Integrated Risk Information System (IRIS) Database
HEAST = U.S. EPA, 1997, Health Effects Assessment Summary Tables (HEAST): Annual Update
Cal EPA = California Environmental Protection Agency, 2013a, Toxicity Criteria Database.
Region Screening Level (RSL) Table, USEPA May 2013
NA = Toxicity value not available
(a) Weight of Evidence Class definitions:
A - Known human carcinogen
B1 - Limited evidence of carcinogenicity in humans, probable human carcinogen
B2 - Inadequate evidence of carcinogencity in humans, probable human carcinogen
C - No evidence of carcinogenicity in humans, limited evidence in animals, possible human carcinogen
D - No evidence at present causes cancer in humans, not classifiable as to human carcinogenicity
(b) TEQ applied to emission rate, not toxicity criteria
(c) Cancer slope factor for PCBs based upon USEPA's "high risk and persistence" classification for food chain and soil exposures
(d) Cancer slope factor for benzo(a)pyrene by the Relative Potency Factor for each of the other carcinogenic PAHs

Table 5-2
Summary of Toxicity Values Associated with Carcinogenic Effects: Inhalation
Montgomery County RRF
Dickerson, MD

Constituent	Inhalation Unit Risk Factor $(ug/m^3)^{-1}$	Weight-Of Evidence Class (a)	Type Of Cancer	UR Basis/ Source
Inorganics				
Antimony	NA			NA/IRIS 2013, USEPA 2013
Arsenic	4.3E-03	A	Lung	Inhalation/IRIS 2013
Beryllium	2.4E-03	B1	Lung	Occup./IRIS 2013
Cadmium	1.8E-03	B1	Lung	Occup./IRIS 2013
Chromium +3	NA	D		NA/IRIS 2013, USEPA 2013
Chromium +6	8.4E-02	A	Lung	USEPA 2013 RSL Table
Cobalt	9.0E-03			USEPA 2013 RSL Table
Copper	NA	D		NA/IRIS 2013, USEPA 2013
Lead	NA	B2		Cal EPA, 2013a
Manganese	NA			NA/IRIS 2013, USEPA 2013
Mercury as HgCl2	NA			NA/IRIS 2013, USEPA 2013
Mercury as Methyl Hg	NA			NA/IRIS 2013, USEPA 2013
Mercury as Elemental Hg	NA			NA/IRIS 2013, USEPA 2013
Nickel (b)	2.4E-04	A	Lung	USEPA 2013 RSL Table
Selenium	NA			NA/IRIS 2013, USEPA 2013
Zinc	NA	D		NA/IRIS 2013, USEPA 2013
2,3,7,8-TCDD (c)	3.8E+01	B2	Lung, Liver	USEPA 2013 RSL Table
Total PCBs	5.7E-04			USEPA 2013 RSL Table
PAHs				
Acenaphthene	NA			NA/IRIS 2013, USEPA 2013
Acenaphthylene	NA	D		NA/IRIS 2013
Anthracene	NA	D		NA/IRIS 2013
Benzo(a)anthracene	1.1E-04	B2		USEPA 2013 RSL Table (d)
Benzo(a)pyrene	1.1E-03	B2		USEPA 2013 RSL Table
Benzo(b)fluoranthene	1.1E-04	B2		USEPA 2013 RSL Table (d)
Benzo(k)fluoranthene	1.1E-04	B2		USEPA 2013 RSL Table (d)
Benzo(ghi)perylene	NA	D		NA/IRIS 2013
Chrysene	1.1E-05	B2		USEPA 2013 RSL Table (d)
Dibenzo(a,h)anthracene	1.2E-03	B2		USEPA 2013 RSL Table (d)
Fluoranthene	NA	D		NA/IRIS 2013
Fluorene	NA	D		NA/IRIS 2013
Indeno(1,2,3-cd)pyrene	1.1E-04	B2		USEPA 2013 RSL Table (d)
2-Methylnaphthalene	NA			NA/IRIS 2013, USEPA 2013
Naphthalene	3.4E-05	C		USEPA 2013 RSL Table
Phenanthrene	NA	D		NA/IRIS 2013
Pyrene	NA	D		NA/IRIS 2013
Aldehyde Ketones				
Formaldehyde	1.3E-05	B1	Nasal Cavity	Inhalation/IRIS 2013

IRIS = U.S. EPA, 2013, Integrated Risk Information System (IRIS) Database
HEAST = U.S. EPA, 1997, Health Effects Assessment Summary Tables (HEAST): Annual Update
Cal EPA = California Environmental Protection Agency, 2013, Toxicity Criteria Database.
Region Screening Level (RSL) Table, USEPA May 2013
NA = Toxicity value not available
(a) Weight of Evidence Class definitions:
A - Known human carcinogen
B1 - Limited evidence of carcinogenicity in humans, probable human carcinogen
B2 - Inadequate evidence of carcingencity in humans, probable human carcinogen
C - No evidence of carcinogenicity in humans, limited evidence in animals, possible human carcinogen
D - No evidence at present causes cancer in humans, not classifiable as to human carcinogenicity
(b) UR for Nickel reflects Nickel refinery dust.
(c) TEQ applied to emission rate, not toxicity criteria
(d) Cancer slope factor for benzo(a)pyrene by the Relative Potency Factor for each of the other carcinogenic PAHs

Table 5-3
Summary of Toxicity Values Associated with Noncarcinogenic Chronic Effects: Oral
Montgomery County RRF
Dickerson, MD

Constituent	Chronic RfD (Oral) (mg/kg-day)	Critical Effect	Oral RfD Basis/Source
Inorganics			
Antimony	4.0E-04	Longevity, blood glucose, cholesterol	Oral/IRIS 2013
Arsenic	3.0E-04	Hyperpigmentation, keratosis, possible vascular effects	Oral/IRIS 2013
Beryllium	2.0E-03	Intestinal lesions	Oral/IRIS 2013
Cadmium	1.0E-03	Proteinuria	Oral/IRIS 2013
Chromium +3	1.5E+00	None observed	Oral/IRIS 2013
Chromium +6	3.0E-03	None observed	Oral/IRIS 2013
Cobalt	3.0E-04	Endocrine Effects	USEPA 2013 RSL Table
Copper	4.0E-02	Gastrointestinal Effects	USEPA 2013 RSL Table
Lead	NA		NA/USEPA 2013 RSL Table
Manganese	1.4E-01	CNS	Oral/IRIS 2013
Mercury as HgCl2	3.0E-04	Autoimmune Effects	Oral/IRIS 2013
Mercury as Methyl Hg	1.0E-04	Developmental Effects	Epidemiology/IRIS 2013
Nickel (a)	2.0E-02	Reduced body and organ weight	Oral/IRIS 2013
Selenium	5.0E-03	Selenosis	Epidemiology/IRIS 2013
Zinc	3.0E-01	Anemia	Oral/IRIS 2013
2,3,7,8-TCDD (a)	7.0E-10	Developmental	Oral/IRIS 2013
Total PCBs (b)	2.0E-05	Developmental	USEPA 2013 RSL Table
PAHs			
Acenaphthene	6.0E-02	Liver	Oral/IRIS 2013
Acenaphthylene	NA		NA/IRIS 2013, USEPA 2013
Anthracene	3.0E-01	No Observed Effects	Oral/IRIS 2013
Benzo(a)anthracene	NA		NA/IRIS 2013, USEPA 2013
Benzo(a)pyrene	NA		NA/IRIS 2013, USEPA 2013
Benzo(b)fluoranthene	NA		NA/IRIS 2013, USEPA 2013
Benzo(k)fluoranthene	NA		NA/IRIS 2013, USEPA 2013
Benzo(ghi)perylene	NA		NA/IRIS 2013, USEPA 2013
Chrysene	NA		NA/IRIS 2013, USEPA 2013
Dibenzo(a,h)anthracene	NA		NA/IRIS 2013, USEPA 2013
Fluoranthene	4.0E-02	CNS, liver, blood	Oral/IRIS 2013
Fluorene	4.0E-02	Blood	Oral/IRIS 2013
Indeno(1,2,3-cd)pyrene	NA		NA/IRIS 2013, USEPA 2013
2-Methylnaphthalene	4.0E-03	Lung	Oral/IRIS 2013
Naphthalene	2.0E-02	Decreased body weight gain	Oral/IRIS 2013
Phenanthrene	NA		NA/IRIS 2013, USEPA 2013
Pyrene	3.0E-02	Kidney	Oral/IRIS 2013
Aldehyde Ketones			
Formaldehyde	2.0E-01	Decreased Body Weight	Oral/IRIS 2013

IRIS = U.S. EPA, 2013, Integrated Risk Information System (IRIS) Database
HEAST = U.S. EPA, 1997, Health Effects Assessment Summary Tables (HEAST): Annual Update
ATSDR = Agency for Toxic Substances and Disease Registry, 2013, MRL Table
Region Screening Level (RSL) Table, USEPA May 2013
NA = Toxicity value not available
(a) TEQ applied to emission rate, not toxicity criteria
(b) Based on Aroclor 1254

Table 5-4
Summary of Toxicity Values Associated with Noncarcinogenic Chronic Effects: Inhalation
Montgomery County RR
Dickerson, MD

Constituent	Chronic RfC (Inhalation) (mg/m3)	Critical Effect/Target Organ(s)	Inhalation RfC Basis/Source
Inorganics			
Antimony	NA		NA/IRIS 2013, USEPA 2013
Arsenic	1.5E-05	Cardiovascular, CNS, Developmental	USEPA 2013 RSL Table
Beryllium	2.0E-05	Sensitization	Occupational/IRIS 2013
Cadmium	1.0E-05		USEPA 2013 RSL Table
Chromium +3	NA		NA/IRIS 2013, USEPA 2013
Chromium +6	1.0E-04	Increased LDH in bronchoalveolar lavage fluid	Inhalation/IRIS 2013
Cobalt	6.0E-06		USEPA 2013 RSL Table
Copper	NA		NA/IRIS 2013, USEPA 2013
Lead	NA		NA/IRIS 2013, USEPA 2013
Manganese	5.0E-05	CNS	Occupational/IRIS 2013
Mercury as HgCl2	3.0E-04	Autoimmune effects	USEPA 2013 RSL Table
Mercury as Methyl Hg	NA		NA/IRIS 2013, USEPA 2013
Mercury as Elemental Hg	3.0E-04	PNS, Autonomic Dysfunction	Inhalation/IRIS 2013
Nickel	9.0E-05		USEPA 2013 RSL Table
Selenium	2.0E-02		USEPA 2013 RSL Table
Zinc	NA		NA/IRIS 2013, USEPA 2013
2,3,7,8-TCDD (a)	4.0E-08		USEPA 2013 RSL Table
Total PCBs	NA		USEPA 2013 RSL Table
PAHs			
Acenaphthene	NA		NA/IRIS 2013, USEPA 2013
Acenaphthylene	NA		NA/IRIS 2013, USEPA 2013
Anthracene	NA		NA/IRIS 2013, USEPA 2013
Benzo(a)anthracene	NA		NA/IRIS 2013, USEPA 2013
Benzo(a)pyrene	NA		NA/IRIS 2013, USEPA 2013
Benzo(b)fluoranthene	NA		NA/IRIS 2013, USEPA 2013
Benzo(k)fluoranthene	NA		NA/IRIS 2013, USEPA 2013
Benzo(ghi)perylene	NA		NA/IRIS 2013, USEPA 2013
Chrysene	NA		NA/IRIS 2013, USEPA 2013
Dibenzo(a,h)anthracene	NA		NA/IRIS 2013, USEPA 2013
Fluoranthene	NA		NA/IRIS 2013, USEPA 2013
Fluorene	NA		NA/IRIS 2013, USEPA 2013
Indeno(1,2,3-cd)pyrene	NA		NA/IRIS 2013, USEPA 2013
2-Methylnaphthalene	NA		NA/IRIS 2013, USEPA 2013
Naphthalene	3.0E-03	Nasal effects	Inhalation/IRIS 2012
Phenanthrene	NA		NA/IRIS 2013, USEPA 2013
Pyrene	NA		NA/IRIS 2013, USEPA 2013
Aldehyde Ketones			
Formaldehyde	9.8E-03	Respiratory tract	USEPA 2013 RSL Table

IRIS = U.S. EPA, 2013, Integrated Risk Information System (IRIS) Database
HEAST = U.S. EPA, 1997, Health Effects Assessment Summary Tables (HEAST): Annual Update
Cal EPA = California Environmental Protection Agency, 2013, Toxicity Criteria Database.
ATSDR = Agency for Toxic Substances and Disease Registry, 2013, MRL Table
Regional Screening Level (RSL) Table, USEPA May 2013
NA = Toxicity value not available
(a) TEQ applied to emission rate, not toxicity criteria

Table 5-5
Summary of Toxicity Values Associated with
Noncarcinogenic Acute Effects: Inhalation
Montgomery County RRF
Dickerson, MD

Constituent	AIEC (Inhalation) (mg/m3)	AIEC Basis/Source
Inorganics		
Antimony	5.0E-01	SCAPA TEEL-1 2012
Arsenic	2.0E-04	CAL EPA REL 2013b
Beryllium	2.3E-03	SCAPA TEEL-1 2012
Cadmium	1.0E-01	USEPA AEGL-1 2012
Chromium +6	1.0E+00	USEPA 2011b
Chromium +6 (a)	1.5E+00	USEPA 2011b
Cobalt	1.8E-01	SCAPA TEEL-1 2012
Copper	1.0E-01	CAL EPA REL 2013b
Lead	1.5E-01	SCAPA TEEL-1 2012
Manganese	3.0E+00	SCAPA TEEL-1 2012
Mercury (as HgCl2)	6.0E-04	CAL EPA REL 2013b
Mercury (as Elemental Hg)	6.0E-04	CAL EPA REL 2013b
Nickel	2.0E-04	CAL EPA REL 2013b
Selenium	2.0E-01	SCAPA TEEL-1 2012
Zinc	1.9E+00	SCAPA TEEL-1 2012
Acid Gases		
Hydrogen Chloride	2.7E+00	AEGL-1
Hydrogen Fluoride	8.2E-01	AEGL-1
Sulfuric Acid	2.0E-01	AEGL-1
2,3,7,8-TCDD	3.0E-08	SCAPA TEEL-1 2012
Total PCBs	1.1E+00	SCAPA TEEL-1 2012
PAHs		
Acenaphthene	3.6E+00	SCAPA TEEL-1 2012
Acenaphthylene	1.0E+01	SCAPA TEEL-1 2012
Anthracene	2.7E-01	SCAPA TEEL-1 2012
Benzo(a)anthracene	1.2E+00	SCAPA TEEL-1 2012
Benzo(a)pyrene	6.0E-01	SCAPA TEEL-1 2012
Benzo(b)fluoranthene	3.1E-02	SCAPA TEEL-1 2012
Benzo(k)fluoranthene	1.9E-02	SCAPA TEEL-1 2012
Benzo(ghi)perylene	3.0E+01	SCAPA TEEL-1 2012
Chrysene	6.0E-01	SCAPA TEEL-1 2012
Dibenzo(a,h)anthracene	3.4E-02	SCAPA TEEL-1 2012
Fluoranthene	1.5E+00	SCAPA TEEL-1 2012
Fluorene	6.6E+00	SCAPA TEEL-1 2012
Indeno(1,2,3-cd)pyrene	1.5E-02	SCAPA TEEL-1 2012
2-Methylnaphthalene	3.0E+00	SCAPA TEEL-1 2012
Naphthalene	7.9E+01	SCAPA TEEL-1 2012
Phenanthrene	7.6E-01	SCAPA TEEL-1 2012
Pyrene	1.5E-01	SCAPA TEEL-1 2010
Aldehyde Ketones		
Formaldehyde	5.5E-02	CAL EPA REL 2013b

Table 6-1.1
Comparison of Total Excess Lifetime Cancer Risk (a) Predicted for RME Receptors
Montomery County RRF
Dickerson, MD

Contaminant	2013 HHRA (b) RME Resident		RME Fisher Potomac River		RME Farmer Farm 2		2006 ENSR HHRA (c) Subsistence Fisher Potomac River		Resident Farm 2 Farm 2	
	Adult	Child	Adult	Child	Adult	Child	Adult	Child	Adult	Child
Inorganics										
Antimony	NC	NC	NC	NC	NC	NC				
Arsenic	9E-09	2E-09	1E-08	2E-09	1E-08	2E-09				
Beryllium	5E-10	1E-10	5E-10	1E-10	4E-10	7E-11	7E-10	5E-10	3E-09	1E-09
Cadmium	3E-09	6E-10	3E-09	6E-10	3E-09	4E-10	8E-09	2E-09	2E-08	7E-09
Chromium +3	NC	NC	NC	NC	NC	NC				
Chromium +6	6E-08	1E-08	6E-08	1E-08	6E-08	1E-08	8E-09	3E-09	3E-08	7E-09
Cobalt	3E-09	6E-10	3E-09	6E-10	3E-09	4E-10				
Copper	NC	NC	NC	NC	NC	NC				
Lead	NC	NC	NC	NC	NC	NC				
Manganese	NC	NC	NC	NC	NC	NC				
Mercury as HgCl2	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Mercury as Methyl Hg	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Mercury as Elemental Hg (d)	NC	NC	NC	NC	NC	NC				
Nickel	6E-10	1E-10	6E-10	1E-10	6E-10	9E-11				
Selenium	NC	NC	NC	NC	NC	NC				
Zinc	NC	NC	NC	NC	NC	NC				
Dioxins/Furans										
2,3,7,8-TCDD-TEQ	5E-09	3E-09	2E-08	5E-09	3E-07	7E-08	3E-07	4E-08	7E-07	7E-08
PCBs										
Total PCBs	3E-09	5E-10	4E-09	7E-10	7E-09	2E-09	2E-08	3E-09	2E-09	5E-10
PAHs										
Acenaphthene	NC	NC	NC	NC	NC	NC				
Acenaphthylene	NC	NC	NC	NC	NC	NC				
Anthracene	NC	NC	NC	NC	NC	NC				
Benzo(a)anthracene	3E-11	2E-11	3E-09	4E-10	1E-09	3E-10				
Benzo(a)pyrene	4E-10	2E-10	4E-08	6E-09	5E-08	1E-08				
Benzo(b)fluoranthene	4E-11	1E-11	3E-09	5E-10	5E-10	1E-10				
Benzo(k)fluoranthene	3E-11	9E-12	5E-10	8E-11	1E-09	3E-10				
Benzo(ghi)perylene	NC	NC	NC	NC	NC	NC				
Chrysene	2E-11	5E-12	9E-11	1E-11	5E-11	1E-11				
Dibenzo(a,h)anthracene	9E-09	6E-09	8E-07	1E-07	1E-07	3E-08				
Fluoranthene	NC	NC	NC	NC	NC	NC				
Fluorene	NC	NC	NC	NC	NC	NC				
Indeno(1,2,3-cd)pyrene	7E-10	4E-10	6E-08	8E-09	9E-09	2E-09				
2-Methylnaphthalene	NC	NC	NC	NC	NC	NC				
Naphthalene	4E-11	7E-12	4E-11	7E-12	3E-11	4E-12				
Phenanthrene	NC	NC	NC	NC	NC	NC				
Pyrene	NC	NC	NC	NC	NC	NC				
cPAH (Total B(a)P-TE) (e)	1E-08	7E-09	1E-06	1E-07	2E-07	4E-08	6E-10	8E-11	3E-10	5E-11
Aldehyde Ketones										
Formaldehyde	2E-10	9E-11	2E-10	9E-11	2E-10	5E-11				
All Other Compounds (f)	1E-08	3E-09	1E-08	3E-09	1E-08	2E-09	3E-09	1E-09	3E-09	8E-10
Total Cancer Risk	0.01E-05	0.003E-08	0.1E-05	0.02E-05	0.06E-05	0.01E-05	0.03E-05	0.005E-5	0.07E-05	0.009E-05
Target Cancer Risk	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05

NC = Not Calculated

(a) Includes indirect (ingestion) exposures and direct (inhalation) exposures

(b) 2013 HHRA Scenarios:

RME Resident - Assumed to live at the point of maximum deposition and air concentrations, exposed through inhalation, incidental ingestion of soil, consumption of home-grown produce

RME Fisher - Assumed to live at the RME Resident location - same inhalation, soil ingestion and produce consumption as RME Resident, consumption of fish from Potomac River

RME Farmer - Assumed to live at Farm Location 2 - exposed through inhalation, incidental ingestion of soil, consumption of homegrown produce, beef, dairy, pork, chicken and eggs

(c) 2006 ENSR HHRA Scenarios:

Subsistence Fisher - Assumed to live at the maximum air concentration - exposed through inhalation and consumption of fish from Potomac River

Resident Farm 2 - Assumed to live at Farm Location 2 - exposed through inhalation, incidental ingestion of soil, consumption of homegrown produce, chicken and eggs

(d) Inhalation only

(e) Calculated cPAH risk listed for 2013 Scenarios provided for comparison purposes only. Not included in Total Cancer Risk.

(f) Calculated "All Oher Compounds" listed for 2013 Scenarios provided for comparison purposes only. Includes individual compounds with no corresponding 2006 risk values. Not included in Total Cancer Risk.

Table 6-1.2
Comparison of Chronic Non-Cancer Hazard Indices (a) Predicted for RME Receptors
Montomery County RRF
Dickerson, MD

Contaminant	2013 HHRA (b)									2006 ENSR HHRA (c)				
	RME Resident			RME Fisher			RME Farmer			Subsistence Fisher			Resident Farm 2	
	Adult	Child	Infant (d)	Adult	Child	Infant (d)	Adult	Child	Infant (d)	Adult	Child	Infant (d)	Adult	Child
Inorganics														
Antimony	2.7E-12	4.1E-12		1.1E-10	7.9E-11		6.8E-12	9.6E-12						
Arsenic	2.2E-04	2.3E-04		2.2E-04	2.3E-04		1.6E-04	1.6E-04						
Beryllium	2.5E-05	2.5E-05		2.5E-05	2.5E-05		1.7E-05	1.7E-05		1.1E-07	4.0E-07		4.3E-07	1.4E-06
Cadmium	4.2E-04	4.3E-04		4.2E-04	4.3E-04		2.8E-04	2.8E-04		2.4E-07	5.3E-07		7.6E-08	1.7E-07
Chromium +3	1.2E-08	2.2E-08		1.4E-08	2.4E-08		3.0E-08	5.2E-08						
Chromium +6	2.0E-05	2.3E-05		2.0E-05	2.3E-05		2.0E-05	2.7E-05		1.1E-07	2.1E-07		4.2E-07	7.4E-09
Cobalt	1.6E-04	1.8E-04		1.6E-04	1.8E-04		1.8E-04	2.1E-04						
Copper	3.0E-06	2.2E-05		3.0E-06	2.2E-05		5.2E-06	8.5E-06						
Lead	NC	NC		NC	NC		NC	NC						
Manganese	1.4E-04	1.4E-04		1.4E-04	1.4E-04		9.8E-05	9.8E-05						
Mercury as HgCl2	8.3E-05	1.5E-04		8.3E-05	1.5E-04		9.8E-05	1.3E-04		6.3E-04	2.1E-03		1.1E-03	2.2E-03
Mercury as Methyl Hg	1.9E-06	6.1E-06		1.0E-02	7.3E-03		4.7E-06	6.9E-06		3.8E-01	2.4E-01		1.3E-04	2.2E-04
Mercury as Elemental Hg (e)	3.0E-07	3.0E-07		3.0E-07	3.0E-07		1.7E-07	1.7E-07						
Nickel	7.0E-05	7.1E-05		7.0E-05	7.1E-05		5.1E-05	5.3E-05						
Selenium	2.1E-06	2.8E-06		2.1E-06	2.8E-06		2.9E-05	5.9E-05						
Zinc	1.4E-06	1.9E-06		1.6E-06	2.1E-06		4.6E-07	6.7E-07						
Dioxins/Furans														
2,3,7,8-TCDD-TEQ	7.9E-05	5.0E-04	3.2E-05	6.1E-04	8.8E-04	2.3E-04	5.4E-03	9.0E-03	2.2E-03	NC	NC	3.2E-03	NC	NC
PCBs														
Total PCBs	9.5E-07	1.6E-06		5.9E-05	4.2E-05		2.0E-04	3.6E-04		1.4E-03	1.0E-03		1.4E-04	1.4E-04
PAHs														
Acenaphthene	9.7E-11	2.6E-10		5.2E-10	5.5E-10		5.4E-10	8.6E-10						
Acenaphthylene	NA	NA		NA	NA		NA	NA						
Anthracene	9.1E-12	3.9E-11		1.3E-10	1.2E-10		1.2E-10	2.0E-10						
Benzo(a)anthracene	NC	NC		NC	NC		NC	NC						
Benzo(a)pyrene	NC	NC		NC	NC		NC	NC						
Benzo(b)fluoranthene	NC	NC		NC	NC		NC	NC						
Benzo(k)fluoranthene	NC	NC		NC	NC		NC	NC						
Benzo(ghi)perylene	NC	NC		NC	NC		NC	NC						
Chrysene	NC	NC		NC	NC		NC	NC						
Dibenzo(a,h)anthracene	NC	NC		NC	NC		NC	NC						
Fluoranthene	9.8E-11	4.8E-10		9.7E-09	7.2E-09		6.4E-09	1.1E-08						
Fluorene	1.4E-11	5.3E-11		5.3E-10	4.2E-10		2.9E-10	4.8E-10						
Indeno(1,2,3-cd)pyrene	NC	NC		NC	NC		NC	NC						
2-Methylnaphthalene	6.5E-11	1.0E-10		2.5E-10	2.3E-10		4.4E-10	7.1E-10						
Naphthalene	8.5E-07	8.5E-07		8.5E-07	8.5E-07		5.0E-07	5.0E-07						
Phenanthrene	NC	NC		NC	NC		NC	NC						
Pyrene	4.8E-10	2.6E-09		1.2E-08	1.0E-08		1.2E-08	1.9E-08						
Noncarcinogenic PAH (Total PAH) (f)	8.5E-07	8.5E-07		8.7E-07	8.7E-07		5.2E-07	5.3E-07		2.6E-05	1.8E-05		2.0E-06	2.8E-06
Aldehyde Ketones														
Formaldehyde	4.1E-06	8.9E-06		4.8E-06	9.3E-06		2.3E-06	5.0E-06						
All Other Compounds (g)	6.0E-04	6.6E-04		6.0E-04	6.6E-04		5.2E-04	6.0E-04		7.0E-05	1.6E-04		3.4E-05	7.2E-05
Total Chronic Non-Cancer HI	0.00124	0.0018	0.00003	0.012	0.01	0.00023	0.0069	0.011	0.0022	0.38	0.24	0.0032	0.0014	0.0026
Non-Cancer Target HI	0.25	0.25	1	0.25	0.25	1	0.25	0.25	1	0.25	0.25	1	0.25	1

NC = Not Calculated

(a) Includes indirect (ingestion) exposures and direct (inhalation) exposures

(b) 2013 HHRA Scenarios:
RME Resident - Assumed to live at the point of maximum deposition and air concentrations, exposed through inhalation, incidental ingestion of soil, consumption of home-grown produce
RME Fisher - Assumed to live at the RME Resident location - same inhalation, soil ingestion and produce consumption as RME Resident, consumption of fish from Potomac River
RME Farmer - Assumed to live at Farm Location 2 - exposed through inhalation, incidental ingestion of soil, consumption of homegrown produce, beef, dairy, pork, chicken and eggs

(c) 2006 ENSR HHRA Scenarios:
Subsistence Fisher - Assumed to live at the maximum air concentration - exposed through inhalation and consumption of fish from Potomac River
Resident Farm 2 - Assumed to live at Farm Location 2 - exposed through inhalation, incidental ingestion of soil, consumption of homegrown produce, chicken and eggs

(d) Dioxin/furan exposure via the ingestion of Mother's milk.

(e) Inhalation only

(f) Calculated Noncarcinogenic PAH risk listed for 2013 Scenarios provided for comparison purposes only. Not included in Total Non-Cancer HI.

(g) Calculated "All Other Compounds" listed for 2013 Scenarios provided for comparison purposes only. Includes individual compounds with no corresponding 2006 risk values. Not included in Total HI.

Table 6-2.1
Comparison of Total Excess Lifetime Cancer Risk (a) Predicted for MEI Scenarios A and B
Montomery County RRF
Dickerson, MD

Contaminant	2013 HHRA (b)				ENSR 2006 HHRA (c)			
	Scenario A		Scenario B		Scenario A		Scenario B	
	Adult	Child	Adult	Child	Adult	Child	Adult	Child
Inorganics								
Antimony	NC	NC	NC	NC				
Arsenic	1E-08	3E-09	7E-09	1E-09				
Beryllium	5E-10	1E-10	4E-10	9E-11	1E-09	1E-09	2E-08	2E-08
Cadmium	3E-09	6E-10	3E-09	6E-10	7E-09	2E-09	1E-07	4E-08
Chromium +3	NC	NC	NC	NC				
Chromium +6	7E-08	1E-08	6E-08	1E-08	4E-08	2E-08	9E-08	4E-08
Cobalt	3E-09	6E-10	3E-09	6E-10				
Copper	NC	NC	NC	NC				
Lead	NC	NC	NC	NC				
Manganese	NC	NC	NC	NC				
Mercury as HgCl2	NC	NC	NC	NC	NC	NC	NC	NC
Mercury as Methyl Hg	NC	NC	NC	NC	NC	NC	NC	NC
Mercury as Elemental Hg (d)	NC	NC	NC	NC				
Nickel	6E-10	1E-10	6E-10	1E-10				
Selenium	NC	NC	NC	NC				
Zinc	NC	NC	NC	NC				
Dioxins/Furans								
2,3,7,8-TCDD-TEQ	1E-07	4E-08	1E-07	4E-08	1E-07	3E-08	2E-07	8E-08
PCBs								
Total PCBs	6E-09	1E-09	5E-09	1E-09	3E-09	8E-10	3E-09	1E-09
PAHs								
Acenaphthene	NC	NC	NC	NC				
Acenaphthylene	NC	NC	NC	NC				
Anthracene	NC	NC	NC	NC				
Benzo(a)anthracene	4E-09	7E-10	4E-09	7E-10				
Benzo(a)pyrene	7E-08	1E-08	7E-08	1E-08				
Benzo(b)fluoranthene	4E-09	5E-10	3E-09	5E-10				
Benzo(k)fluoranthene	1E-09	2E-10	1E-09	2E-10				
Benzo(ghi)perylene	NC	NC	NC	NC				
Chrysene	1E-10	3E-11	1E-10	3E-11				
Dibenzo(a,h)anthracene	9E-07	1E-07	9E-07	1E-07				
Fluoranthene	NC	NC	NC	NC				
Fluorene	NC	NC	NC	NC				
Indeno(1,2,3-cd)pyrene	6E-08	8E-09	6E-08	8E-09				
2-Methylnaphthalene	NC	NC	NC	NC				
Naphthalene	4E-11	7E-12	3E-11	6E-12				
Phenanthrene	NC	NC	NC	NC				
Pyrene	NC	NC	NC	NC				
cPAH (Total B(a)P-TE) (e)	1E-06	1E-07	1E-06	2E-07	5E-10	2E-10	7E-10	3E-10
Aldehyde Ketones								
Formaldehyde	2E-10	9E-11	2E-10	7E-11				
All Other Compounds (f)	2E-08	4E-09	1E-08	2E-09	3E-09	2E-09	5E-09	3E-09
Total Cancer Risk	0.1E-05	0.02E-05	0.1E-05	0.02E-05	0.02E-05	0.005E-05	0.04E-05	0.02E-05
Target Cancer Risk	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05

NC = Not Calculated

(a) Includes indirect (ingestion) exposures and direct (inhalation) exposures

(b) 2013 HHRA Scenarios:
MEI A - located at the location of maximum predicted air concentration and maximum dry deposition. Exposed through inhalation, ingestion of soil, consumption of home-grown produce, consumption of beef, dairy, pork, chicken and eggs from closest actual farm with maximum impacts (Farm 6)
MEI B - located at the location of maximum total particle and vapor deposition and secondary maximum air concentration. Exposed through inhalation, ingestion of soil, consumption of home-grown produce, consumption of beef, dairy, pork, chicken and eggs from closest actual farm with maximum impacts (Farm 6)

(c) 2006 ENSR HHRA Scenarios:
MEI A - located at the location of maximum predicted air concentration and maximum dry deposition. Exposed through inhalation, ingestion of soil, consumption of home-grown produce, consumption of beef, dairy, pork, chicken and eggs from closest actual farm with maximum impacts (Farm 6 - Johnson Dairy Farm)
MEI B - located at the location of maximum total particle and vapor deposition and secondary maximum air concentration. Exposed through inhalation, ingestion of soil consumption of home-grown produce, consumption of beef, dairy, pork, chicken and eggs from closest actual farm with maximum impacts (Farm 5 - Johnson Dairy Farm)

(d) Inhalation only

(e) Calculated cPAH risk listed for 2013 Scenarios provided for comparison purposes only. Not included in Total Cancer Risk.

(f) Calculated "All Oher Compounds" listed for 2013 Scenarios provided for comparison purposes only. Includes individual compounds with no corresponding 2006 risk values. Not included in Total Cancer Risk.

Table 6-2.2
Comparison of Chronic Non-Cancer Hazard Indices (a) Predicted for MEI Scenarios A and B
Montomery County RRF
Dickerson, MD

Contaminant	2013 HHRA (b)						ENSR 2006 HHRA (c)					
	Scenario A			Scenario B			Scenario A			Scenario B		
	Adult	Child	Infant(d)	Adult	Child	Infant(d)	Adult	Child	Infant(d)	Adult	Child	Infant(d)
Inorganics												
Antimony	1.1E-10	8.7E-11		1.1E-10	8.7E-11							
Arsenic	2.3E-04	2.4E-04		1.9E-04	1.9E-04							
Beryllium	2.4E-05	2.5E-05		2.1E-05	2.1E-05		2.2E-07	1.1E-06		3.5E-06	2.2E-05	
Cadmium	4.2E-04	4.2E-04		3.7E-04	3.7E-04		2.4E-07	5.3E-07		1.1E-07	2.4E-07	
Chromium +3	2.9E-08	4.8E-08		2.5E-08	4.6E-08							
Chromium +6	2.4E-05	2.9E-05		2.1E-05	2.7E-05		8.2E-07	1.5E-06		1.7E-06	4.0E-06	
Cobalt	2.0E-04	2.2E-04		1.8E-04	2.2E-04							
Copper	3.6E-06	8.1E-06		5.0E-06	2.5E-05							
Lead	NC	NC		NC	NC							
Manganese	1.4E-04	1.4E-04		1.3E-04	1.3E-04							
Mercury as HgCl2	9.3E-05	1.2E-04		7.9E-05	9.6E-05		4.1E-04	1.2E-03		6.1E-04	1.9E-03	
Mercury as Methyl Hg	1.0E-02	7.3E-03		1.0E-02	7.3E-03		1.8E-02	2.7E-02		1.8E-02	2.7E-02	
Mercury as Elemental Hg (e)	3.0E-07	3.0E-07		2.3E-07	2.3E-07							
Nickel	7.2E-05	7.3E-05		6.4E-05	6.5E-05							
Selenium	2.7E-05	5.4E-05		2.5E-05	5.1E-05							
Zinc	1.3E-06	1.6E-06		4.9E-07	5.2E-07							
Dioxins/Furans												
2,3,7,8-TCDD-TEQ	3.6E-03	5.6E-03	1.4E-03	3.6E-03	5.8E-03	1.4E-03	NC	NC	1.5E-03	NC	NC	1.5E-03
PCBs												
Total PCBs	1.8E-04	2.7E-04		1.8E-04	2.7E-04		4.3E-06	2.4E-04		1.8E-04	3.5E-04	
PAHs												
Acenaphthene	7.0E-10	7.7E-10		6.7E-10	7.5E-10							
Acenaphthylene	NC	NC		NC	NC							
Anthracene	1.8E-10	2.0E-10		1.8E-10	2.1E-10							
Benzo(a)anthracene	NC	NC		NC	NC							
Benzo(a)pyrene	NC	NC		NC	NC							
Benzo(b)fluoranthene	NC	NC		NC	NC							
Benzo(k)fluoranthene	NC	NC		NC	NC							
Benzo(ghi)perylene	NC	NC		NC	NC							
Chrysene	NC	NC		NC	NC							
Dibenzo(a,h)anthracene	NC	NC		NC	NC							
Fluoranthene	1.4E-08	1.4E-08		1.4E-08	1.4E-08							
Fluorene	6.6E-10	6.0E-10		6.6E-10	6.2E-10							
Indeno(1,2,3-cd)pyrene	NC	NC		NC	NC							
2-Methylnaphthalene	4.3E-10	5.2E-10		4.3E-10	5.2E-10							
Naphthalene	8.5E-07	8.5E-07		6.4E-07	6.4E-07							
Phenanthrene	NC	NC		NC	NC							
Pyrene	1.7E-08	1.9E-08		1.7E-08	1.9E-08							
Noncarcinogenic PAH (Total PAH) (f)	8.8E-07	8.8E-07		6.7E-07	6.8E-07		1.9E-06	3.0E-06		6.3E-06	1.3E-05	
Aldehyde Ketones												
Formaldehyde	4.3E-06	8.6E-06		3.9E-06	7.5E-06							
All Other Compounds (g)	6.8E-04	7.5E-04		6.0E-04	6.9E-04		2.0E-04	1.0E-04		1.0E-04	2.0E-04	
Total Chronic Non-Cancer HI	0.016	0.015	0.0014	0.015	0.015	0.0014	0.019	0.028	0.0015	0.019	0.029	0.0015
Non-Cancer Target HI	0.25	0.25	1	0.25	0.25	1	0.25	0.25	1	0.25	0.25	1

NC = Not Calculated

(a) Includes indirect (ingestion) exposures and direct (inhalation) exposures

(b) 2013 HHRA Scenarios:
MEI A - located at the location of maximum predicted air concentration and maximum dry deposition. Exposed through inhalation, ingestion of soil, consumption of home-grown produce, consumption of beef, dairy, pork, chicken and eggs from closest actual farm with maximum impacts (Farm 6)
MEI B - located at the location of maximum total particle and vapor deposition and secondary maximum air concentration. Exposed through inhalation, ingestion of soil, consumption of home-grown produce, consumption of beef, dairy, pork, chicken and eggs from closest actual farm with maximum impacts (Farm 6)

(c) 2006 ENSR HHRA Scenarios:
MEI A - located at the location of maximum predicted air concentration and maximum dry deposition. Exposed through inhalation, ingestion of soil, consumption of home-grown produce, consumption of beef, dairy, pork, chicken and eggs from closest actual farm with maximum impacts (Farm 6 - Johnson Dairy Farm)
MEI B - located at the location of maximum total particle and vapor deposition and secondary maximum air concentration. Exposed through inhalation, ingestion of soil consumption of home-grown produce, consumption of beef, dairy, pork, chicken and eggs from closest actual farm with maximum impacts (Farm 5 - Johnson Dairy Farm)

(d) Dioxin/furan exposure via the ingestion of Mother's milk.

(e) Inhalation only

(f) Calculated Noncarcinogenic PAH risk listed for 2013 Scenarios provided for comparison purposes only. Not included in Total Non-Cancer HI.

(g) Calculated "All Oher Compounds" listed for 2013 Scenarios provided for comparison purposes only. Includes individual compounds with no corresponding 2006 risk values. Not included in Total HI.

Table 6-3.1

Comparison of Total Excess Lifetime Cancer Risk (a) Predicted for Additional Fisher Receptors

Montomery County RRF

Dickerson, MD

Contaminant	2013 HHRA (b)						2006 ENSR HHRA (c)					
	Monocacy River Fisher		Resident Fisher Near Farm 1 Pond 2		Resident Fisher Near Farm 2 Pond 3		Monocacy River Fisher		Resident Fisher Near Farm 1 Pond 2		Resident Fisher Near Farm 2 Pond 3	
	Adult	Child	Adult	Child	Adult	Child	Adult	Child	Adult	Child	Adult	Child
Inorganics												
Antimony	NC	NC	NC	NC	NC	NC						
Arsenic	1E-08	2E-09	4E-09	9E-10	5E-09	9E-10						
Beryllium	5E-10	1E-10	2E-10	4E-11	3E-10	7E-11			6E-10	5E-10	1E-09	1E-09
Cadmium	3E-09	6E-10	1E-09	3E-10	2E-09	4E-10			4E-09	1E-09	7E-09	2E-09
Chromium +3	NC	NC	NC	NC	NC	NC						
Chromium +6	6E-08	1E-08	3E-08	5E-09	4E-08	8E-09			5E-09	2E-09	9E-09	3E-09
Cobalt	3E-09	6E-10	1E-09	3E-10	2E-09	4E-10						
Copper	NC	NC	NC	NC	NC	NC						
Lead	NC	NC	NC	NC	NC	NC						
Manganese	NC	NC	NC	NC	NC	NC						
Mercury as HgCl2	NC	NC	NC	NC	NC	NC			NC	NC	NC	NC
Mercury as Methyl Hg	NC	NC	NC	NC	NC	NC			NC	NC	NC	NC
Mercury as Elemental Hg (d)	NC	NC	NC	NC	NC	NC						
Nickel	6E-10	1E-10	3E-10	5E-11	4E-10	9E-11						
Selenium	NC	NC	NC	NC	NC	NC						
Zinc	NC	NC	NC	NC	NC	NC						
Dioxins/Furans												
2,3,7,8-TCDD-TEQ	4E-08	8E-09	4E-08	6E-09	7E-08	1E-08			2E-08	8E-09	4E-08	1E-08
PCBs												
Total PCBs	5E-09	8E-10	2E-09	3E-10	3E-09	5E-10			3E-09	9E-10	6E-09	2E-09
PAHs												
Acenaphthene	NC	NC	NC	NC	NC	NC						
Acenaphthylene	NC	NC	NC	NC	NC	NC						
Anthracene	NC	NC	NC	NC	NC	NC						
Benzo(a)anthracene	3E-09	4E-10	1E-09	2E-10	3E-09	5E-10						
Benzo(a)pyrene	4E-08	5E-09	1E-08	2E-09	3E-08	4E-09						
Benzo(b)fluoranthene	6E-09	8E-10	6E-10	8E-11	4E-09	6E-10						
Benzo(k)fluoranthene	5E-10	7E-11	4E-10	6E-11	1E-09	1E-10						
Benzo(ghi)perylene	NC	NC	NC	NC	NC	NC						
Chrysene	1E-10	2E-11	7E-11	1E-11	2E-10	3E-11						
Dibenzo(a,h)anthracene	6E-07	9E-08	5E-07	7E-08	1E-06	1E-07						
Fluoranthene	NC	NC	NC	NC	NC	NC						
Fluorene	NC	NC	NC	NC	NC	NC						
Indeno(1,2,3-cd)pyrene	4E-08	6E-09	2E-08	3E-09	5E-08	7E-09						
2-Methylnaphthalene	NC	NC	NC	NC	NC	NC						
Naphthalene	4E-11	7E-12	1E-11	3E-12	2E-11	4E-12						
Phenanthrene	NC	NC	NC	NC	NC	NC						
Pyrene	NC	NC	NC	NC	NC	NC						
cPAH (Total B(a)P-TE) (e)	7E-07	1E-07	5E-07	7E-08	1E-06	2E-07			5E-11	2E-11	1E-10	3E-11
Aldehyde Ketones												
Formaldehyde	2E-10	9E-11	7E-11	3E-11	1E-10	5E-11						
All Other Compounds (f)	1E-08	3E-09	6E-09	1E-09	7E-09	2E-09			9E-10	4E-10	2E-09	7E-10
Total Cancer Risk	0.09E-05	0.01E-05	0.06E-05	0.009E-05	0.1E-05	0.02E-05	0.003E-05	0.002E-05	0.004E-05	0.001E-05	0.006E-05	0.002E-05
Target Cancer Risk	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05

Not Calculated

(a) Includes indirect (ingestion) exposures and direct (inhalation) exposures

(b) 2013 HHRA Scenarios:

Monocacy River Fisher - Assumed to live at the RME Residential location (point of maximum deposition and air concentrations), consumed fish caught from the Monocacy River

Resident Fisher Near Farm 1/Pond 2 - Assumed to reside near Farm 1, consume home-grown produce and ingest fish caught from Pond 2.

Resident Fisher Near Farm 2/Pond 3 - Assumed to reside near Farm 2, consume home-grown produce and ingest fish caught from Pond 3.

(c) 2006 ENSR HHRA Scenarios:

Monocacy River Fisher - Scenario H. Assumed to live at the maximum air concentration, consumed fish caught from the Monocacy River. Only total risk estimates provided in ENSR 2006.

Resident Fisher Near Farm 1/Pond 2 - Assumed to reside near Farm 1, consume home-grown produce and ingest fish caught from Pond 2.

Resident Fisher Near Farm 2/Pond 3 - Assumed to reside near Farm 2, consume home-grown produce and ingest fish caught from Pond 3.

(d) Inhalation only

(e) Calculated cPAH risk listed for 2013 Scenarios A and B provided for comparison purposes only. Not included in Total Cancer Risk.

(f) Calculated "All Oher Compounds" listed for 2013 Scenarios provided for comparison purposes only. Includes individual compounds with no corresponding 2006 risk values.
Not included in Total Cancer Risk.

Table 6-3.2
Comparison of Chronic Non-Cancer Hazard Indices (a) Predicted for Additional Fisher Receptors
Montomery County RRF
Dickerson, MD

Contaminant	2013 HHRA (b)									2006 ENSR HHRA (c)					
	Monocacy River Fisher			Resident Fisher Near Farm 1 Pond 2			Resident Fisher Near Farm 2 Pond 3			Monocacy River Fisher		Resident Fisher Near Farm 1 Pond 2		Resident Fisher Near Farm 2 Pond 3	
	Adult	Child	Infant (d)	Adult	Child	Infant (d)	Adult	Child	Infant (d)	Adult	Child	Adult	Child	Adult	Child
Inorganics															
Antimony	2.5E-10	1.8E-10		2.8E-10	2.0E-10		2.2E-10	1.5E-10							
Arsenic	2.2E-04	2.3E-04		9.3E-05	9.5E-05		1.4E-04	1.4E-04							
Beryllium	2.5E-05	2.5E-05		1.0E-05	1.0E-05		1.6E-05	1.6E-05				1.1E-07	5.2E-07	2.1E-07	1.1E-06
Cadmium	4.2E-04	4.3E-04		1.8E-04	1.8E-04		2.8E-04	2.8E-04				6.1E-08	1.4E-07	9.7E-08	2.2E-07
Chromium +3	1.3E-08	2.3E-08		3.0E-08	2.3E-08		2.2E-08	1.6E-08							
Chromium +6	2.0E-05	2.3E-05		8.9E-06	8.9E-06		1.3E-05	1.3E-05				7.9E-08	1.5E-07	1.5E-07	2.9E-07
Cobalt	1.6E-04	1.8E-04		6.0E-05	6.4E-05		9.7E-05	9.8E-05							
Copper	3.0E-06	2.2E-05		4.0E-07	2.8E-06		1.8E-07	1.3E-06							
Lead	NC	NC		NC	NC		NC	NC							
Manganese	1.4E-04	1.4E-04		5.9E-05	5.9E-05		9.8E-05	9.8E-05							
Mercury as HgCl2	8.3E-05	1.5E-04		2.5E-05	2.8E-05		4.3E-05	4.8E-05				1.9E-05	1.7E-04	6.8E-05	2.3E-04
Mercury as Methyl Hg	7.2E-03	5.1E-03		1.2E-02	8.6E-03		2.1E-02	1.5E-02				2.0E-01	3.8E-01	7.1E-01	1.0E+00
Mercury as Elemental Hg (e)	3.0E-07	3.0E-07		1.0E-07	1.0E-07		1.7E-07	1.7E-07							
Nickel	7.0E-05	7.1E-05		2.9E-05	2.9E-05		4.7E-05	4.7E-05							
Selenium	2.2E-06	2.9E-06		1.0E-06	1.2E-06		5.5E-07	6.0E-07							
Zinc	1.8E-06	2.3E-06		1.4E-06	1.2E-06		7.7E-07	6.1E-07							
Dioxins/Furans															
2,3,7,8-TCDD-TEQ	1.4E-03	1.4E-03	4.2E-04	1.5E-03	1.1E-03	4.0E-04	2.5E-03	1.9E-03	6.9E-04			NC	NC	NC	NC
PCBs															
Total PCBs	1.1E-04	8.1E-05		5.8E-05	4.1E-05		7.0E-05	5.0E-05				1.8E-04	2.7E-04	3.6E-04	5.5E-04
PAHs															
Acenaphthene	7.6E-10	7.3E-10		1.1E-09	8.2E-10		1.2E-09	9.4E-10							
Acenaphthylene	NC	NC		NC	NC		NC	NC							
Anthracene	1.8E-10	1.6E-10		1.6E-10	1.2E-10		7.0E-10	5.0E-10							
Benzo(a)anthracene	NC	NC		NC	NC		NC	NC							
Benzo(a)pyrene	NC	NC		NC	NC		NC	NC							
Benzo(b)fluoranthene	NC	NC		NC	NC		NC	NC							
Benzo(k)fluoranthene	NC	NC		NC	NC		NC	NC							
Benzo(ghi)perylene	NC	NC		NC	NC		NC	NC							
Chrysene	NC	NC		NC	NC		NC	NC							
Dibenzo(a,h)anthracene	NC	NC		NC	NC		NC	NC							
Fluoranthene	9.2E-09	6.9E-09		6.2E-09	4.4E-09		3.3E-08	2.4E-08							
Fluorene	6.4E-10	4.9E-10		8.2E-10	5.8E-10		1.0E-09	7.3E-10							
Indeno(1,2,3-cd)pyrene	NC	NC		NC	NC		NC	NC							
2-Methylnaphthalene	5.8E-10	4.6E-10		8.5E-10	6.0E-10		6.2E-10	4.8E-10							
Naphthalene	8.5E-07	8.5E-07		2.9E-07	2.9E-07		5.0E-07	5.0E-07							
Phenanthrene	NC	NC		NC	NC		NC	NC							
Pyrene	1.4E-08	1.2E-08		8.6E-09	6.1E-09		1.0E-07	7.4E-08							
Noncarcinogenic PAH (Total PAH) (f)	8.7E-07	8.7E-07		3.1E-07	3.1E-07		6.4E-07	6.0E-07				1.1E-05	1.6E-05	1.6E-05	2.4E-05
Aldehyde Ketones															
Formaldehyde	4.5E-06	9.1E-06		2.6E-06	3.8E-06		6.1E-06	7.4E-06							
All Other Compounds (g)	6.0E-04	6.6E-04		2.5E-04	2.6E-04		3.9E-04	4.0E-04				2.3E-04	6.1E-04	3.0E-05	5.7E-05
Total Chronic Non-Cancer HI	0.0099	0.0079	0.00042	0.014	0.01	0.00040	0.025	0.018	0.00069	0.025	0.037	0.20	0.38	0.71	1.0
Non-Cancer Target HI	0.25	0.25	1.00	0.25	0.25	1.00	0.25	0.25	1.00	0.25	0.25	0.25	0.25	0.25	0.25

NC = Not Calculated
(a) Includes indirect (ingestion) exposures and direct (inhalation) exposures
(b) 2013 HHRA Scenarios:
Monocacy River Fisher - Assumed to live at the RME Residential location (point of maximum deposition and air concentrations), consumed fish caught from the Monocacy River
Resident Fisher Near Farm 1/Pond 2 - Assumed to reside near Farm 1, consume home-grown produce and ingest fish caught from Pond 2.
Resident Fisher Near Farm 2/Pond 3 - Assumed to reside near Farm 2, consume home-grown produce and ingest fish caught from Pond 3.
(c) 2006 ENSR HHRA Scenarios:
Monocacy River Fisher - Scenario H. Assumed to live at the maximum air concentration, consumed fish caught from the Monocacy River. Only total risk estimates provided in ENSR 2006.
Resident Fisher Near Farm 1/Pond 2 - Assumed to reside near Farm 1, consume home-grown produce and ingest fish caught from Pond 2.
Resident Fisher Near Farm 2/Pond 3 - Assumed to reside near Farm 2, consume home-grown produce and ingest fish caught from Pond 3.
(d) Dioxin/furan exposure via the ingestion of Mother's milk.
(e) Inhalation only
(f) Calculated Noncarcinogenic PAH risk listed for 2013 Scenarios provided for comparison purposes only. Not included in Total Non-Cancer HI.
(g) Calculated "All Oher Compounds" listed for 2013 Scenarios provided for comparison purposes only. Includes individual compounds with no corresponding 2006 risk values. Not included in Total HI.

Table 6-4.1

Comparison of Total Excess Lifetime Cancer Risk (a) Predicted for Additional Farmer Receptors

Montomery County RRF

Dickerson, MD

Contaminant	2013 HHRA (b)				ENSR 2006 HHRA (c)			
	Resident Farm 1		Resident Farm 6		Resident Farm 1		Johnson Dairy Farm (Farm 5)	
	Adult	Child	Adult	Child	Adult	Child	Adult	Child
Inorganics								
Antimony	NC	NC	NC	NC				
Arsenic	1E-08	2E-09	7E-09	1E-09				
Beryllium	3E-10	4E-11	2E-10	3E-11	2E-09	7E-10	2E-09	7E-10
Cadmium	2E-09	3E-10	1E-09	2E-10	1E-08	3E-09	1E-08	3E-09
Chromium +3	NC	NC	NC	NC				
Chromium +6	4E-08	5E-09	3E-08	5E-09	2E-08	4E-09	2E-07	5E-08
Cobalt	2E-09	3E-10	1E-09	2E-10				
Copper	NC	NC	NC	NC				
Lead	NC	NC	NC	NC				
Manganese	NC	NC	NC	NC				
Mercury as HgCl2	NC	NC	NC	NC	NC	NC	NC	NC
Mercury as Methyl Hg	NC	NC	NC	NC	NC	NC	NC	NC
Mercury as Elemental Hg (d)	NC	NC	NC	NC				
Nickel	4E-10	5E-11	3E-10	4E-11				
Selenium	NC	NC	NC	NC				
Zinc	NC	NC	NC	NC				
Dioxins/Furans								
2,3,7,8-TCDD-TEQ	2E-09	6E-10	1E-07	4E-08	3E-07	4E-08	5E-07	8E-08
PCBs								
Total PCBs	1E-09	2E-10	4E-09	9E-10	1E-09	3E-10	3E-09	7E-10
PAHs								
Acenaphthene	NC	NC	NC	NC				
Acenaphthylene	NC	NC	NC	NC				
Anthracene	NC	NC	NC	NC				
Benzo(a)anthracene	1E-11	2E-12	1E-09	3E-10				
Benzo(a)pyrene	2E-10	4E-11	3E-08	7E-09				
Benzo(b)fluoranthene	2E-11	3E-12	3E-10	8E-11				
Benzo(k)fluoranthene	1E-11	2E-12	6E-10	1E-10				
Benzo(ghi)perylene	NC	NC	NC	NC				
Chrysene	1E-11	2E-12	6E-11	1E-11				
Dibenzo(a,h)anthracene	1E-09	4E-10	2E-08	4E-09				
Fluoranthene	NC	NC	NC	NC				
Fluorene	NC	NC	NC	NC				
Indeno(1,2,3-cd)pyrene	1E-10	3E-11	1E-09	3E-10				
2-Methylnaphthalene	NC	NC	NC	NC				
Naphthalene	2E-11	3E-12	1E-11	2E-12				
Phenanthrene	NC	NC	NC	NC				
Pyrene	NC	NC	NC	NC				
cPAH (Total B(a)P-TE) (e)	2E-09	4E-10	5E-08	1E-08	2E-10	2E-11	2E-09	5E-10
Aldehyde Ketones								
Formaldehyde	9E-11	3E-11	7E-11	2E-11	9E-11	3E-11	7E-11	2E-11
All Other Compounds (f)	1E-08	2E-09	9E-09	1E-09	2E-09	6E-10	3E-09	7E-10
Total Cancer Risk	0.005E-05	0.0009E-05	0.02E-05	0.006E-05	0.04E-05	0.005E-05	0.07E-05	0.01E-05
Target Cancer Risk	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05

NC = Not Calculated

(a) Includes indirect (ingestion) exposures and direct (inhalation) exposures

(b) 2013 HHRA Scenarios

Resident Farm 1 - Assumed to consume homegrown produce, chicken and eggs

Resident Farm 6 - Location of maximum impacted actual beef farm, replaces Johnson Dairy Farm (Farm 5). Assumed to consume homegrown produce, beef, dairy, pork, chicken and eggs

(c) 2006 ENSR HHRA

Resident Farm 1 - Assumed to consume homegrown produce, chicken and eggs

Johnson Dairy Farm - Location of maximum impacted actual beef/dairy farm (Farm 5) discussed in ENSR 2006. Assumed to consume homegrown produce, beef, dairy, pork, chicken and eggs

(d) Inhalation only

(e) Calculated cPAH risk listed for 2013 Scenarios provided for comparison purposes only. Not included in Total Cancer Risk.

(f) Calculated "All Oher Compounds" listed for 2013 Scenarios provided for comparison purposes only. Includes individual compounds with no corresponding 2006 risk values. Not included in Total Cancer Risk.

Table 6-4.2
Comparison of Chronic Non-Cancer Hazard Indices (a) Predicted for Additional Farmer Receptors
Montomery County RRF
Dickerson, MD

Contaminant	2013 HHRA (b)						2006 ENSR HHRA (c)				
	Resident Farm 1			Resident Farm 6			Resident Farm 1		Johnson Dairy Farm (Farm 5)		
	Adult	Child	Infant (d)	Adult	Child	Infant (d)	Adult	Child	Adult	Child	Infant (d)
Inorganics											
Antimony	3.2E-12	4.6E-12		5.1E-14	7.3E-14						
Arsenic	1.1E-04	1.2E-04		8.2E-05	8.5E-05						
Beryllium	1.1E-05	1.1E-05		7.7E-06	7.7E-06		2.1E-07	6.8E-07	2.6E-07	6.3E-07	
Cadmium	1.8E-04	1.9E-04		1.3E-04	1.3E-04		5.8E-08	1.3E-07	6.8E-08	1.5E-07	
Chromium +3	7.2E-09	1.1E-08		1.9E-08	3.3E-08						
Chromium +6	9.1E-06	1.0E-05		1.1E-05	1.5E-05		2.4E-07	3.8E-07	2.5E-06	4.4E-06	
Cobalt	6.8E-05	7.4E-05		9.6E-05	1.2E-04						
Copper	7.7E-07	3.3E-06		3.0E-06	4.8E-06						
Lead	NC	NC		NC	NC						
Manganese	5.9E-05	5.9E-05		4.4E-05	4.5E-05						
Mercury as HgCl2	4.6E-05	5.7E-05		5.2E-05	7.8E-05		1.9E-04	3.7E-04	9.1E-04	1.7E-03	
Mercury as Methyl Hg	2.4E-06	3.5E-06		8.0E-06	1.2E-05		2.2E-05	3.8E-05	7.5E-05	1.3E-04	
Mercury as Elemental Hg (e)	NC	NC		NC	NC						
Nickel	3.0E-05	3.0E-05		2.4E-05	2.5E-05						
Selenium	2.6E-06	3.5E-06		2.5E-05	5.2E-05						
Zinc	8.9E-07	1.3E-06		2.9E-07	4.3E-07						
Dioxins/Furans											
2,3,7,8-TCDD-TEQ	2.5E-05	8.8E-05	1.3E-05	2.8E-03	4.6E-03	1.1E-03	NC	NC	NC	NC	4.3E-03
PCBs											
Total PCBs	9.3E-07	9.3E-07		1.3E-04	2.3E-04		8.3E-05	8.2E-05	1.5E-04	2.0E-04	
PAHs											
Acenaphthene	6.7E-11	1.1E-10		1.1E-10	1.8E-10						
Acenaphthylene	NC	NC		NC	NC						
Anthracene	7.0E-13	1.5E-12		4.9E-11	8.1E-11						
Benzo(a)anthracene	NC	NC		NC	NC						
Benzo(a)pyrene	NC	NC		NC	NC						
Benzo(b)fluoranthene	NC	NC		NC	NC						
Benzo(k)fluoranthene	NC	NC		NC	NC						
Benzo(ghi)perylene	NC	NC		NC	NC						
Chrysene	NC	NC		NC	NC						
Dibenzo(a,h)anthracene	NC	NC		NC	NC						
Fluoranthene	1.3E-11	2.4E-11		3.1E-09	5.2E-09						
Fluorene	1.3E-12	2.6E-12		1.1E-10	1.8E-10						
Indeno(1,2,3-cd)pyrene	NC	NC		NC	NC						
2-Methylnaphthalene	2.4E-11	3.7E-11		8.8E-12	1.4E-11						
Naphthalene	2.9E-07	2.9E-07		2.3E-07	2.3E-07						
Phenanthrene	NC	NC		NC	NC						
Pyrene	3.1E-11	7.2E-11		4.2E-09	6.9E-09						
Noncarcinogenic PAH (Total PAH) (f)	2.9E-07	2.9E-07					1.1E-06	1.6E-06	1.4E-06	2.0E-06	
Aldehyde Ketones											
Formaldehyde	1.3E-06	2.9E-06		1.0E-06	2.3E-06						
All Other Compounds (g)	2.7E-04	3.0E-04		2.8E-04	3.3E-04		2.6E-05	5.1E-05	4.2E-05	7.9E-05	
Total Chronic Non-Cancer HI	0.00055	0.00066	0.000013	0.0036	0.0057	0.0011	0.00032	0.00054	0.0012	0.0021	0.0043
Non-Cancer Target HI	0.25	0.25	1	0.25	0.25	1	0.25	0.25	0.25	0.25	1

NC = Not Calculated

(a) Includes indirect (ingestion) exposures and direct (inhalation) exposures

(b) 2013 HHRA Scenarios

Resident Farm 1 - Assumed to consume homegrown produce, chicken and eggs

Resident Farm 6 - Location of maximum impacted actual beef farm, replaces Johnson Dairy Farm (Farm 5). Assumed to consume homegrown produce, beef, dairy, pork, chicken and eggs

(c) 2006 ENSR HHRA

Resident Farm 1 - Assumed to consume homegrown produce, chicken and eggs

Johnson Dairy Farm - Location of maximum impacted actual beef/dairy farm (Farm 5) discussed in ENSR 2006. Assumed to consume homegrown produce, beef, dairy, pork, chicken and eggs

(d) Dioxin/furan exposure via the ingestion of Mother's milk.

(e) Inhalation only

(f) Calculated Noncarcinogenic PAH risk listed for 2013 Scenarios provided for comparison purposes only. Not included in Total Non-Cancer HI.

(g) Calculated "All Oher Compounds" listed for 2013 Scenarios provided for comparison purposes only. Includes individual compounds with no corresponding 2006 risk values. Not included in Total Cancer Risk.

Table 6-5
Summary of Acute Maximum Impact Non-Cancer Hazard Indices (a ,b)
Montomery County RRF
Dickerson, MD

Contaminant	Maximum Acute HI
Inorganics	
Antimony	1.9E-06
Arsenic	2.7E-03
Beryllium	3.7E-05
Cadmium	7.2E-06
Chromium +3	5.1E-07
Chromium +6	2.0E-07
Cobalt	8.3E-07
Copper	9.2E-06
Lead	5.4E-05
Manganese	4.2E-07
Mercury as HgCl2	8.2E-03
Mercury as Elemental Hg	3.4E-05
Nickel	5.5E-03
Selenium	4.0E-06
Zinc	6.9E-06
Acid Gasses	
Hydrogen Chloride	2.1E-03
Hydrogen Flouride	6.9E-03
Sulfuric Acid	2.7E-02
Dioxins/Furans	
2,3,7,8-TCDD-TEQ	1.1E-03
PCBs	
Total PCBs	2.2E-06
PAHs	
Acenaphthene	2.7E-07
Acenaphthylene	1.3E-08
Anthracene	3.7E-07
Benzo(a)anthracene	5.9E-08
Benzo(a)pyrene	1.3E-07
Benzo(b)fluoranthene	6.3E-06
Benzo(k)fluoranthene	6.4E-06
Benzo(ghi)perylene	2.9E-09
Chrysene	1.8E-06
Dibenzo(a,h)anthracene	1.9E-06
Fluoranthene	5.8E-08
Fluorene	2.1E-08
Indeno(1,2,3-cd)pyrene	3.7E-06
2-Methylnaphthalene	6.3E-08
Naphthalene	7.4E-09
Phenanthrene	1.9E-07
Pyrene	5.3E-07
Aldehyde Ketones	
Formaldehyde	2.0E-04
Total Acute Non-Cancer HI	0.054
Target Acute HI	1

(a) Since AHIs calculated for maximum 1-hr modeled air concentrations, potential risks at other locations in the RRF vicinity would be lower
(b)Modeled air concentrations include particulate fugitive emissions and application of the process upset factor of 1.05 to organic COPCs

Table 6-6
Comparison of Predicted Soil Concentrations to Groundwater Protection Soil Screening Levels (SSLs)
Montomery County RRF
Dickerson, MD

	Protection of Ground Water SSLs (a)			
	MCL-based SSL (mg/kg)	Risk-Based SSL (mg/kg)	Maximum Soil Concentration (mg/kg)	SSL vs. Soil Conc.
Inorganics				
Antimony	0.27		0.0000000001	1,968,361,786
Arsenic	0.29		0.0000001	2,398,189
Beryllium	3.2		0.00003	121,410
Cadmium	0.38		0.00001	36,779
Chromium +3	180000 (b)		0.0009	199,983,752
Chromium +6	180000 (b)		0.0004	488,513,726
Cobalt		0.21	0.0005	437
Copper	46		0.007	6,652
Lead	14		0.002	8,112
Manganese		21	0.005	4,099
Mercury as HgCl2	0.1		0.0002	539
Mercury as Methyl Hg	0.1		0.000004	26,552
Nickel		20	0.00002	1,169,168
Selenium	0.26		0.000002	106,341
Zinc		290	0.0002	1,622,323
Dioxins/Furans				
2,3,7,8-TCDD-TEQ	0.000015		0.000000002	9,010
PCBs				
Total PCBs	0.078		0.00000006	1,404,124
PAHs				
Acenaphthene		4.1	0.00000007	55,917,219
Acenaphthylene	NA	NA	0.00	NC
Anthracene		42	0.00000008	504,067,054
Benzo(a)anthracene	0.24 (c)		0.0000015	160,315
Benzo(a)pyrene	0.24		0.0000018	134,469
Benzo(b)fluoranthene	0.24 (c)		0.0000004	589,834
Benzo(k)fluoranthene	0.24 (c)		0.000005	52,757
Benzo(ghi)perylene			0.00	NC
Chrysene	0.24 (c)		0.000009	27,084
Dibenzo(a,h)anthracene	0.24 (c)		0.00006	3,822
Fluoranthene		70	0.0000002	395,146,572
Fluorene		4	0.00000001	291,425,788
Indeno(1,2,3-cd)pyrene	0.24 (c)		0.00004	6,015
2-Methylnaphthalene		0.14	0.0000000000004	371,798,675,437
Naphthalene		0.00047	0.00000001	36,947
Phenanthrene	NA	NA	0.00	NC
Pyrene		9.5	0.0000007	13,145,730
Aldehyde Ketones				
Formaldehyde		0.62	0.000008	73,567

(a) When no MCL-based SSL is available, risk-based SSL is used. From USEPA RSL Tables (USEPA 2013c)
(b) MCL for Total Chromium
(c) MCL for cPAHs based upon benzo(a)pyrene

Table 6-7
Summary of Total Excess Lifetime Cancer Risk and Total Noncancer HIs
Montomery County RRF
Dickerson, MD

	Cancer Risk		Chronic Noncancer HI			Acute
	Adult	Child	Adult	Child	Infant	HI
RME Scenarios						
RME Resident	0.01E-05	0.003E-08	0.0012	0.0018	0.00003	
RME Fisher (a)	0.1E-05	0.02E-05	0.012	0.0095	0.00023	
RME Farmer (a)	0.06E-05	0.01E-05	0.0069	0.011	0.0022	
Maximally Exposed Individual Scenarios						
MEI A (a)	0.1E-05	0.02E-05	0.016	0.015	0.0014	
MEI B (a)	0.1E-05	0.02E-05	0.015	0.015	0.0014	
Additional Fisher Scenarios						
Monocacy River Fisher (a)	0.09E-05	0.01E-05	0.0099	0.0079	0.00042	
Resident Fisher near Farm 1 (Fishes Farm Pond 2) (a)	0.06E-05	0.009E-05	0.014	0.01	0.0004	
Resident Fisher near Farm 2 (Fishes Farm Pond 3) (a)	0.1E-05	0.02E-05	0.025	0.018	0.00069	
Additional Resident Farm Scenarios						
Resident Farm 1 (a)	0.005E-05	0.0009E-05	0.00055	0.00066	0.000013	
Resident Farm 6	0.02E-05	0.006E-05	0.0036	0.0057	0.0011	
Acute (1-hr) Hazard Index						0.054
Cancer and Non-Cancer Target Values (b)	1E-05	1E-05	0.25	0.25	1	1

(a) Receptors evaluated in 2006 ENSR Report

(b) Target Values per USEPA Region VI Guidance (1998b). See Section 6.0 for discussion.