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February 5, 2018

Mr. Michael Liberati
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VIA ELECTRONIC MAIL

Re: Revised Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Plant, Area of Concern 4
Waynesboro, Virginia
EPA ID# VAD003114832

Dear Mr. Liberati:

This letter acknowledges the receipt and review of the Revised Long- Term Monitoring Baseline Report (Report), submitted to the Virginia Department of Environmental Quality, Office of Remediation Programs (Department) by AECOM on behalf of the E.I du Pont Nemours and Company (DuPont).

The Department accepts the report as complete.

If you have any additional technical questions, you may contact me at 703-583-3825 or by email at Kurt.Kochan@deq.virginia.gov.

Sincerely,

Kurt W. Kochan
Corrective Action Project Manager
Office of Remediation Programs

cc: DuPont Waynesboro Correspondence File
Brett Fisher, Calvin Jordan, VDEQ-CO
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AECOM

Long-Term Monitoring Baseline Report

Former DuPont Waynesboro Site, Area of Concern 4
Waynesboro, Virginia

Submitted on behalf of:
E.I. du Pont de Nemours and Company

Submitted by:
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Project Number: 60394083
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Acronym List

Acronym	Explanation
%MeHg	Percent of THg present as MeHg
°C	degrees Celsius
ANCOVA	Analysis of Covariance
ANOSIM	Analysis of Similarities
AOC	Area of Concern
BASS	Bioaccumulation and Aquatic System Simulator
BMA	Bank Management Area
COC	Chain-of-Custody
CSM	Conceptual Site Model
DOC	Dissolved Organic Carbon
DuPont	E.I. du Pont de Nemours and Company
DQO	Data Quality Objective
dw	dry weight
EPT	% Ephemeroptera, Plecoptera, and Trichoptera
Ecological Study	Ecological Study of the South River
EPA	U.S. Environmental Protection Agency
FDA	Food and Drug Administration
FGCM	Fine-grained Channel Margin
FMeHg	filtered methylmercury
FTHg	filtered total mercury
GIS	Geographic Information System
GPS	Global Positioning System
HRAD	Hg (mercury)-Release Age Deposit
IHg	inorganic mercury
IM	Interim Measure
LTM	Long-term Monitoring
LTM Plan	Long-Term Monitoring Plan
LiDAR	Light Detection and Ranging
LWD	large, woody debris
MDL	Method Detection Limit
MeHg	Methylmercury
mg/kg	milligram per kilogram
mm	Millimeter
ng/g	nanograms per gram
NMDS	Non-Metric Multidimensional Scaling
NRDC	Natural Resources Defense Council
QA/QC	Quality Assurance/Quality Control
RA	Release Assessment
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RRM	Relative River Mile
SFS	South Fork Shenandoah
SOP	Standard Operating Procedure
SQT	Sediment Quality Triad
SRST	South River Science Team
STM Plan	Short-Term Monitoring Plan

Acronym	Explanation
THg	total mercury
TL	total length
TOC	total organic carbon
TSS	total suspended solids
URS	URS Corporation
VDEQ	Virginia Department of Environmental Quality
VDGIF	Virginia Department of Game and Inland Fisheries
VDH	Virginia Department of Health
WWTP	Wastewater Treatment Plant
YOY	Young-of-Year

Executive Summary

This report summarizes three years of baseline data collection relevant to the Interim Measures (IMs) currently being implemented by E.I. du Pont de Nemours and Company (DuPont) in accordance with the requirements set forth in the site's U.S. Environmental Protection Agency (EPA) Resource Conservation and Recovery Act (RCRA) Corrective Action Permit (Final Hazardous Waste Permit for Corrective Action-Renewal EPA ID No. VAD003114832, issued on September 24, 2009; amended on February 4, 2014). The IMs and monitoring strategy for Area of Concern (AOC) 4 were developed largely from conclusions drawn from the multi-year study (Ecological Study) and the Remedial Proposal (URS, 2012; Anchor QEA and URS, 2013), both of which were conducted under a Consent Decree between DuPont, the Natural Resources Defense Council (NRDC) and the Virginia Chapter of the Sierra Club. The purpose of the IMs is to address historical mercury release to the South River from the former DuPont facility in Waynesboro, Virginia (site). Riverbank soils impacted by these historical releases are currently the primary source of mercury loading to the South River and as such, are the focus of the on-going IMs (URS, 2012; Anchor QEA et al., 2015).

Long-term monitoring (LTM) is being conducted to evaluate the performance of the IMs and proposed remedial approach. The LTM program evaluates potential system-wide changes to mercury transport and exposure in the South River and South Fork Shenandoah (SFS) River over a long timeframe and large spatial scales relative to the short-term monitoring (STM), which is implemented near IMs. LTM monitoring element categories include Aquatic and Terrestrial Ecological Exposure, Human Exposure, and Water and Habitat Quality. Collectively, LTM and STM data are used to further develop the site relative risk model, and to inform risk and remedial decision-making.

The baseline LTM dataset documents pre-remediation conditions from 2014 to 2016 in AOC 4, and will serve as the basis for comparison of post-remediation data; post-remediation data aims to document sustainable reduction in mercury concentrations in biotic and abiotic media in South River and SFS Rivers. As concluded in this report, the majority of the baseline LTM data have limited annual variability and are generally consistent with historical concentrations and spatial trends established in previous investigations. Although statistically significant seasonal differences were not apparent for a majority of the baseline LTM data, some media, including smallmouth bass, did exhibit seasonal differences in mercury concentrations, which is consistent with previous studies (URS, 2012; Murphy, 2004). Within each exposure group (i.e., aquatic ecological exposure, terrestrial ecological exposure, and human exposure), concentrations of THg, IHg, and MeHg are significantly correlated among numerous monitoring media; this indicates data redundancy and potential for reduction or elimination [with the concurrence of the Virginia Department of Environmental Quality (VDEQ)] of specific LTM media that do not materially impact the remedial decision process.

Remediation of the Constitution Park bank management area (BMA) was performed from November 2016 to February 2017; thus, 2016 represents the end of baseline monitoring for the STM and LTM programs. Monitoring data collected in 2017, and thereafter, will be considered "post-remediation" or "transitional," depending on proximity to ongoing completion of IMs at other BMAs. These data will be summarized and evaluated in the context of pre-remediation conditions in subsequent LTM (triennial) and STM (annual) reports.

Consistent with the adaptive management framework established in the Remediation Proposal (Anchor QEA and URS, 2013), some aspects of the LTM and STM may change depending on whether the results obtained have a material impact on current or future remedial decisions. The relationships and trends identified in this report will be re-evaluated as post-remediation data become available. Continuing the collaborative approach established with the South River Science Team (SRST) over the past 15 years, recommendations for alterations to the remedial or monitoring strategy will be presented to SRST for technical consideration. Modifications to either approach will only be made upon concurrence of the VDEQ.

1.0 Introduction

1.1 Background

On behalf of E.I. du Pont de Nemours and Company (DuPont), AECOM has prepared this Long-Term Monitoring Baseline Report (Baseline Report) to describe baseline conditions in physical and biological media of a portion of the South River and South Fork Shenandoah, Virginia. These data will provide a basis against which post-remediation conditions can be compared. The remedial strategy was designed to address legacy mercury in the South River Watershed, as a result of historical mercury release from the former DuPont Waynesboro facility to the South River, Virginia (site). Remedial actions are being conducted by DuPont in accordance with the requirements set forth in the site's U.S. Environmental Protection Agency (EPA) Resource Conservation and Recovery Act (RCRA) Corrective Action Permit (Final Hazardous Waste Permit for Corrective Action-Renewal EPA ID No. VAD003114832, issued on September 24, 2009; amended on February 4, 2014). The South River and a portion of the South Fork of the Shenandoah River (SFS) are collectively referred to in the amended permit as the Area of Concern 4 (AOC 4) (see Figure 1-1). The interim measures (IMs) and monitoring strategy for AOC 4 were developed largely from conclusions drawn from the multi-year study (Ecological Study) conducted in collaboration with the Natural Resources Defense Council (NRDC) and the Virginia Chapter of the Sierra Club, and the Remediation Proposal, which was part of the final settlement agreement between DuPont and NRDC in 2013 (URS, 2012; Anchor QEA and URS, 2013).

Owing to the river's size, linear nature, and spatial variability, the remedial strategy requires that the river system be divided into manageable segments. In addition, remediation will most effectively occur in an upstream-to-downstream fashion, with components of each segment (e.g., banks, in-channel bed sediments, and floodplain soil) addressed in an appropriate sequence. The Phase I Interim Measures Work Plan (IM Work Plan; Anchor QEA, URS and DuPont, 2015) outlined a phased remedial approach, whereby segments of the river would be remediated in one-to-two year construction sequences. The first phase of remediation (Phase 1) targets bank management areas (BMAs) within the first two relative river miles (RRM) downstream of the site that contribute a disproportionately high mercury load to the South River. The Phase 1 IMs are anticipated to address more than 90% of mercury loading to the South River from eroding riverbanks within the first two river miles as detailed in the Phase 1 Basis of Design Report (Anchor QEA, 2016).

The remedial approach outlined in the IM Work Plan which formed the framework for the Long-Term Monitoring Plan (LTM Plan) initially anticipated completion of each phase of IM within one to two years; that schedule has now been extended due to permitting and property access issues. This expansion of the schedule likely creates a transitional period where post-remediation mercury concentrations and aquatic habitat quality may not respond as quickly as anticipated due to the reduced extent of bank remediation over the timeframe. Construction of the first portion of the Phase 1 IM at Constitution Park was performed from November 2016 to February 2017; the 2016 monitoring dataset is therefore the last of three years of baseline data collection activities from 2014-2016. Post-remediation data are also being evaluated in context of the short-term monitoring (STM) data in an adaptive management framework. Some aspects of the LTM and STM may change depending on whether the results obtained have a material

impact on current or future remedial decisions. This condition, in addition to how data are collected and used in determining remedy effectiveness, is consistent with DuPont's plan to perform the program in an enhanced adaptive management framework with the technical collaboration of the Virginia Department of Environmental Quality (VDEQ) and the South River Science Team (SRST). Monitoring data that do not materially impact the remedial decision process may be reduced or eliminated.

1.2 Purpose

The primary purpose of this report is to evaluate the first three years of baseline LTM data in context of historical data to establish baseline conditions for comparison with post-remediation data. Regional climatic conditions play a key role influencing river conditions during historical and current sampling periods.

1.3 Mercury in the South River and South Fork Shenandoah River

This section includes a description of the facility, and the river and floodplain portions of the study area.

1.3.1 Former DuPont Waynesboro Facility

The former DuPont Waynesboro facility is currently owned and operated by INVISTA and is located on approximately 177 acres of flat lying land along the South River in the southeastern corner of Waynesboro, Virginia. From 1929 to 1950, the site used mercury compounds (e.g., mercuric sulfate) in the production of acetate flake and yarn. Mercury from the process wastes was recovered at an on-site retort facility. During that period, mercury releases occurred and were subsequently remediated in accordance with applicable waste management practices of the time. In addition to localized soil and groundwater impacts, the storm sewers draining these areas were found to be impacted by the former mercury operations and are currently the primary transport mechanism for mercury loading from the site to the South River. Beginning in 1998, DuPont began a Release Assessment (RA) and RCRA Facility Investigation (RFI) at the site. IMs were started in 2010 to control off-site mercury migration through the site outfall. On-site IMs including sewer and below ground pipe abandonments, cleaning, slip lining, and installation of filtration sumps, have been completed. Final on-site corrective measures as outlined in the statement of basis are anticipated to be completed in in 2018 (VDEQ, 2017). Currently, the former DuPont Waynesboro facility continues to act as a relatively small point source of IHg to the river system.

1.3.2 River Channel

The South River has unique geophysical, chemical, and biological features that facilitate the mechanisms allowing legacy inorganic mercury (IHg) to continue to enter the river. Once released from the site, IHg was transported by surface water to sediment and floodplain soils. Sediment is stored in the gravel matrix of the stream channel and along the channel margins in deposits. Mercury is transported through the river channel and has been detected in soil throughout the 100-year floodplain (EPA, 2014), but the primary mechanism for mercury transport is bank erosion from riverbanks.

Once IHg enters the South River, a small portion of it is methylated in sediment. Mercury methylation is the biological mechanism whereby IHg is converted to methylmercury (MeHg), which efficiently enters the aquatic food web and is bioaccumulated in river biota and biomagnified through trophic transfer.

1.3.3 Floodplain

As described above, mercury was transported by the river channel and was deposited on riverbanks and throughout the 100-year floodplain (EPA, 2014). Spatial distribution of mercury in floodplain soils within AOC 4 is dynamic and influenced by factors such as distance from the former site, floodplain inundation frequency, land use, and stream geomorphology. Although legacy mercury is present in the floodplain, a tributary loading study conducted during storm events in the Ecological Study show that the floodplain (excluding South River bank soils) is not a significant source of total mercury (THg) and MeHg to the South River (URS, 2012).

1.4 Report Organization

This baseline LTM report is organized into the following sections:

- Section 2 provides the remediation monitoring strategy, objectives, hypotheses, and the basis for decision making. This section also summarizes the STM Plan.
- Section 3 presents the sampling approach and methodology.
- Section 4 presents the results of baseline monitoring activities in context of historical data.
- Section 5 reviews the data quality assessment.
- Section 6 provides the conclusions of the 2014-2016 baseline LTM data.
- Section 7 lists references cited in this report.

2.0 Remedial Strategy

The primary focus of the Phase 1 IMs is the reduction of mercury transport from RRM 0 through RRM 2.0 riverbanks. This section describes the objectives, hypotheses being tested and general approach of the LTM program; a brief description of the STM Plan is also provided.

2.1 Monitoring Program Objectives

Remedial Action Objectives (RAOs) constitute a framework for developing protective, implementable, and effective remedial alternatives. Additionally, RAOs provide a basis for evaluating different remediation alternatives by describing what the remedial measures are intended to accomplish and helping to focus alternative development and evaluation. The remedial alternative evaluation process evaluates the feasibility, implementability, and sustainability of remedial alternatives, while assessing the extent to which remedies are expected to achieve the RAOs. RAOs should reflect objectives that are achievable through remediation (EPA, 2005). Short- and long-term AOC 4 RAOs are media-specific and consist of the following:

- General response objectives that identify the exposure pathway to be addressed to assess potential risks to human health and the environment;
- Performance objectives that identify specific media targets intended to fulfill the general response objective; and
- Measurable metrics that include quantitative criteria, which establish whether performance objectives have been met.

A combination of some or all of these objectives is developed as part of the remedy.

Short-term RAOs are expected to be met relatively quickly, in two to five years following remedial construction. Long-term RAOs may require additional time to respond before they are attained. Preliminary RAOs described in the Remediation Proposal (Anchor QEA and URS, 2013) are subject to refinement during future remediation planning, as well as follow-on adaptive management. It is also likely that some or all of these RAOs will apply to other river segments during subsequent phases of remediation. Initial elements of the short- and long-term RAOs, subject to regulatory agency review and comment, include the following:

- Short-Term RAOs:
  - General response objectives: Reduce IHg transport and exposure and improve bank habitat functions within the upper two miles of the South River.
  - Performance objectives: Conduct and/or maintain bank remediation actions within upper two miles of the South River to achieve sustainable reductions in mercury concentrations and improve bank habitat functions within this reach.
  - Measurable metrics: Bank erosion rates, measured using detailed topographic surveys; establishment of bank vegetation; and mercury concentrations in physical media and biological tissues.
- Long-Term RAOs:
  - General response objectives: Reduce MeHg exposure and improve habitat conditions throughout the South River and SFS River.

- Performance objectives: Conduct and/or maintain remediation actions that sustain reductions in tissue MeHg concentrations and improve water quality and habitat functions throughout the South River and SFS River.
- Measurable metrics: Mercury concentrations in biological tissues and physical media, and bank and in-channel habitat metrics.

2.2 Long-Term Monitoring Program Objectives

The overall goal of the LTM is to provide data to assess the efficacy of the remedy in addressing both migration and potential exposure pathways. Specific objectives of the baseline data collection efforts are to provide data to monitor the following:

- Human and ecological exposure to mercury
- System responses to remediation
- Integrity of the remediation action

Monitoring data will detect changes in the potential MeHg concentrations in human and ecological exposure media. It is expected that once remedial actions have been implemented, the mercury loading to the South River and SFS River should decline over time and be accompanied by a concomitant reduction in potential mercury exposures and risks to humans and ecological receptors. Climatic factors, including temperature and precipitation, may affect MeHg production within the South River (URS, 2012). The regional climate in Virginia is expected to continue to change due to climate change over the course of this century (IPCC, 2014). These changes may include increased air temperatures, changes in the frequency and magnitude of precipitation, species distribution shifts, and the number of extreme weather events (Romero-Lankao et al., 2014). As the LTM program is expected to last at least for the next 5 to 10+ years, many of these changes may influence both and monitoring. The impacts of climate change on regional climatic conditions will continue to be monitored to place post-remediation LTM data into the appropriate climatic context.

Monitoring data will provide input to the adaptive management framework and relative risk model to evaluate whether any aspect of the remedial action, monitoring strategy, corrective action design, or conceptual site model (CSM) needs to be revisited. The scope of the LTM program is outlined in Table 2-1. The LTM Plan (URS, 2015a) evaluates potential changes to mercury transport and exposure in the South River and SFS River over longer timeframes and larger spatial scales compared to the STM that is focused primarily in the South River at or near those areas where BMA remedies are being implemented. Similar to the STM Plan (URS, 2015b), chemical and biological results from the LTM Plan will feed into the relative risk model and the adaptive management approach. In this way, both the short- and long-term information will be used as input to management decisions regarding the efficacy of remediation actions, the need to alter approaches or evaluate new or improved technologies, or to maintain and/or repair areas as necessary. Baseline data collected in accordance with the LTM plan will be used as a comparison to post-remediation datasets and drive enhanced adaptive management decisions as outlined below in Section 2.4.2.

2.3 Hypotheses

The main working hypothesis governing the IM is that reducing or eliminating the transport of mercury to the South River in a stepwise manner, beginning with source

controls at the former DuPont facility, will result in improvements in and downstream of the river reach where remediation has occurred. It is expected that once corrective actions have been implemented, mercury loading to the South River and SFS River should decline over time. This decline will be accompanied by a corresponding reduction in potential mercury exposures and potential risks to humans and ecological receptors. Some terrestrial ecological receptors in the South River and SFS River may be exposed to mercury via consumption of aquatic invertebrates and fish. Therefore, it is expected that reducing mercury loading to the South River and SFS River will reduce exposure of terrestrial organisms to mercury.

With the sequential completion of interim measures, improvements to the system in e.g., mercury reductions will likely first occur proximal to the bank restoration areas; these mercury reductions will be observed in media that are collected as part of the STM Program (e.g., pore water, near-bank sediment, near-bank clams, and near-bank periphyton). There is likely to be a lag in mercury reductions in media down gradient of the completed interim measures that will vary among the media; abiotic and lower trophic level media will likely display reduced mercury concentrations prior to higher trophic level media like snapping turtles and bass.

Site data have been used to develop a multiple linear regression statistical model that predicts THg concentrations in smallmouth bass and largemouth bass based on bank Hg loading, time of year, land coverage adjacent to river bank, fish diet, precipitation, and interaction terms between discharge and bank Hg loading. The statistical model was used to predict bass tissue THg concentrations for ‘remediation scenarios’ including 50% and 100% bank loading reduction within RRM 0-2. Modelled results of these ‘remediation scenarios’ indicate that under the 50% bank loading reduction scenario, bass in the South River would still be unsafe to consume (<0.3 ppm); 5% of the bass in the South River would be safe to consume in the 100% bank loading reduction scenario. It is important to note that the statistical model does not provide an estimate of the period of necessary to realize the simulated reductions. The ‘remediation scenario’ statistical model results are consistent with the expectation that bass will be among the last exposure endpoints, or receptors, in the South River to reflect reduced mercury concentrations related to completion of interim measures.

2.4 Basis for Decisions

Monitoring data are being evaluated in the context of the historical AOC 4 data collected and managed in a master database. The tools used to measure the effectiveness of the potential remedial alternatives include the Enhanced Adaptive Management Framework and the Relative Risk Model. These tools are described below and can be reviewed in more detail in the Ecological Study (URS, 2012) and the Remediation Proposal (Anchor QEA and URS, 2013).

2.4.1 South River Database

Baseline data collected under the LTM and STM Plans are being evaluated in the context of the historical data collected for AOC 4. These data are managed in a master database developed as part of the Ecological Study (URS, 2012). The database integrates analytical and other performance data generated during this project with geographic information systems (GIS) data. Datasets include current and historical aerial photography, geomorphology studies, land-use and habitat delineations, and hydrological data.

Analytical data generated from the baseline characterization and future post-remediation sampling events are incorporated into the Locus EIM™ database via electronic data deliverables. This data warehouse is maintained on a DuPont server that provides for a high level of data backup and security.

The integration of monitoring data with historical data and the decision tools described above is a key step in evaluating remedial effectiveness and potential attainment of RAOs. Figure 2-1 provides a schematic of how the understandings generated from the model are integrated into the adaptive management process and used to update the regional risk in the relative risk model.

2.4.2 Enhanced Adaptive Management Framework

Consistent with the approach to the remediation, the LTM program also incorporates an adaptive management framework. Adaptive management is a structured and iterative decision-making process that improves management decisions and reduces uncertainty over time as the outcomes of earlier decisions are monitored and lessons learned are incorporated (see Figure 2-2).

Adaptive management promotes flexible decision-making in the face of uncertainty. Careful monitoring of the outcome of implemented actions advances understanding and helps adjust future remedy decisions as part of an iterative learning process. If there are changes made to the remedial effort based on the adaptive management strategy, these changes will also be reflected by changes to the LTM Plan. Adaptive management also recognizes the importance of natural variability in ecological systems and variability in measures of effectiveness of remediation.

Adaptive management requires the following:

- A decision framework that can be updated with new information
- Specific objectives of the remediation defined
- An understanding of the processes and drivers that impact those objectives
- A range of monitoring alternatives
- Monitoring of key performance metrics

Adaptive management is particularly well suited to the AOC 4 remediation and monitoring strategy, in part because remedial measures will be implemented sequentially over time, providing an opportunity to effectively integrate lessons learned as data are collected. It will facilitate testing and monitoring remediation actions, particularly where there is a need to assess effectiveness prior to undertaking additional actions. Where actions do not result in measureable improvements, changes in remedial technologies or applications may be required; these changes will be reflected in changes to the LTM Plan.

2.4.3 Relative Risk Model

DuPont has funded the development of a relative risk model for AOC 4, which includes a framework for assessment of all known stressors within the system (Johns, et. al., 2017; Landis, et. al., 2017a; Landis, et al., 2017b). In an ecological system such as the South River ecosystem, there are a variety of potential physical, chemical, and biological environmental stressors that may pose potential risk to ecological receptors, in addition to Hg. The relative risk model is a tool to understand the interaction of multiple stressors,

and their potential impacts on assessment endpoints (i.e., the characteristic of the system that society values and is trying to protect, such as protection of biological community diversity). For example, chemical stressors and habitat degradation, both of which may be improved by the proposed remediation, can affect the assessment endpoint of avian reproduction.

Chemical and biological results from the LTM program will feed into the model and be evaluated using probability distributions for ecosystem responses. The findings of this exercise will be entered into the adaptive management framework to inform management decisions regarding the efficacy of remediation actions, the need to alter approaches or evaluate new or improved technologies, or to maintain and/or repair areas as necessary. For example, if data collected show no change in macroinvertebrate mercury tissue concentrations after several years of monitoring, modification to either the remedy or monitoring strategy may be considered.

2.5 Short-Term Monitoring

The STM program is also an important component of the overall monitoring strategy for the AOC 4 remediation, as it will likely demonstrate a response to remedial actions more quickly than the LTM program. The STM Plan evaluates the relationship between riverbanks with elevated mercury concentrations in soil to instream biotic and abiotic media and their response to remediation.

A summary of physical and biological monitoring metrics included in the STM Plan is provided below:

- Bulk sediment sampling
- Pore-water sampling
- Transplanted Asiatic Clam [*Corbicula fluminea;* (*Corbicula*)]
- Epilithic periphyton sampling

The scope of the STM program is outlined in Table 2-2. Complete details of STM approach and results of the baseline STM efforts are provided in STM Plan and the *2016 Annual Short-Term Monitoring Report; Former DuPont Waynesboro Site, AOC 4* (URS, 2015; AECOM, 2017).

Baseline STM began in 2015 at the three monitoring locations that were anticipated to be the first BMAs to be remediated (Figure 2-3):

- STM-01 – Adjacent to the Constitution Park BMA (~RRM 0.15 to 0.25)
- STM-05 – Adjacent to the North Park A and B BMAs (~RRM 0.75 to 1.05)
- STM-07 – Adjacent to North Park C and the Wastewater Treatment Plant (WWTP) BMAs (~RRM 1.15 to 1.5)

Additionally, STM-08 (~RRM 1.25 to 1.6) was added as a monitoring station in 2016 due to anticipated remediation (Figure 2-3). Remediation of the Constitution Park BMA was completed in February 2017, thus representing the end of the baseline monitoring for the STM program. The 2017 STM data collected at STM-01 will be considered post-remediation, while data collected at other monitoring locations will be considered as “transitional.”

3.0 Sampling Approach and Methods

The following sections describe sampling approach for the baseline LTM data collection effort including sample locations, and field and analytical methodologies. This information is organized by exposure group (i.e., Aquatic Ecological, Terrestrial Ecological, Human Exposure, and Water/Habitat Quality).

3.1 Sampling Design

The LTM Plan was designed through careful evaluation of the large body of scientific studies conducted to date on the South River. In addition, the LTM Plan was developed after consultations with the NRDC, the VDEQ, and the SRST. Monitoring program locations were selected to be consistent with existing datasets, including the Ecological Study and the VDEQ 100-Year Monitoring Program (see Appendix B). Additionally, larger sampling reaches were selected for certain media such as fish, snapping turtles (*Chelydra serpentina*), and mallard ducks (*Anas platyrhynchos*), as opposed to discrete locations, based upon consultation with Virginia Department of Game and Inland Fisheries (VDGIF). These sampling reaches were selected to minimize the impact to local biological communities at a given location from repeated sampling.

The sample sizes selected in the LTM Plan are based on statistical evaluations of data collected in the South River during the Ecological Study or by the SRST. The results of the power analysis and the data analysis techniques that will be employed for comparison of post-remediation data are described in more detail in Section 3.6 and protocol SRDA-1 (see Appendix A).

3.2 Aquatic Ecological Exposure

Aquatic ecological exposure to mercury and MeHg, was evaluated for interstitial sediment, epilithic periphyton, benthic macroinvertebrates (i.e., mayfly nymphs, and *Corbicula*), and young-of-year smallmouth bass at seven locations. Five monitoring stations were sampled on the South River, including an upstream reference station located approximately 2.5 miles upstream of the site (SR -2.7, SR 0.1, SR 3.5, SR 11.8, and SR 23.5); two monitoring stations were sampled on the SFS River (SF 26.6 and SF 48). The following sections describe the sampling approach and methods specific to the collection and data analysis of aquatic media.

3.2.1 Sediment

The substrate of the South River consists primarily of a coarse gravel/cobble river bed with very little fine sediment present. Limited fine-grained sediment occurs as interstitial sediment that is interspersed within the coarser substrates of the stream bed or channel area of the river. The areal extent of fine-grained sediment deposits is much smaller than the coarse-grained stream bed; interstitial sediment is targeted in the LTM program because these areas are important production areas of MeHg.

Interstitial sediment was collected to establish baseline exposure of benthic invertebrates to sediment MeHg and to assess potential recovery of sediment post-remediation. Samples were collected once annually, beginning in June 2014 at the locations identified in Section 3.2 (see Table 2-1 and Figure 3-1) using the “guzzler” technique. Sediment sampling locations were co-located with benthic invertebrate sample collection locations (see Section 3.2.3). Three samples were collected at each

monitoring station from coarse-grained substrate beds following procedures outlined in SRSE-01 (see Appendix A); samples were analyzed at CEBAM Analytical (Bothell, Washington) for THg and MeHg. Table 3-1 provides a complete summary of sampling locations, methodology, and analytical data quality objectives (DQOs).

3.2.2 Periphyton

Periphyton is operationally defined as the algae and suspended solids that are attached to cobbles and boulders of the river substrate. Periphyton is a key component of the trophic transfer of MeHg in the South River (URS, 2012). Aquatic invertebrates feeding on epilithic periphyton (i.e., periphyton living on the surface of the substrate) ingest MeHg adsorbed to sediment particles (Tom et al., 2010). THg and MeHg concentrations in periphyton have been monitored as part of numerous historical investigations at sample locations throughout the South River.

Epilithic periphyton was collected to monitor THg and MeHg concentrations as an important exposure medium for benthic invertebrates and to provide a dataset for comparison with STM elements. Samples were collected bi-annually (i.e., June and October), beginning in June 2014 at the locations identified in Section 3.2 (see Table 2-1 and Figure 3-1). Three periphyton samples were collected by scraping cobbles collected from the interstitial sediment sampling transects, coarsely rinsed, and frozen on dry ice. Descriptions of periphyton type (e.g., filamentous algae), sample weight [grams (g)] and relative abundance were documented in the field notebook. Samples were submitted to CEBAM Analytical under proper chain-of-custody (COC) procedures for THg and MeHg analysis by EPA Method 1631 and Method 1630, respectively. Table 3-2 and SOP SRTI-1 (see Appendix A) provide a complete summary of sampling locations, methodology, and analytical DQOs.

3.2.3 Benthic Invertebrates

Beginning in June 2014, aqueous uptake of THg and MeHg by *Corbicula* was monitored bi-annually, in June and October, at each of the seven locations described in Section 3.2 (see Table 2-1 and Figure 3-1). Similarly-sized *Corbicula* were collected from reference areas in the Middle River and deployed in cages (mid-channel) at each monitoring station for a five-week deployment. Three composite samples, comprised of approximately 10 (n = 10) individuals each, were collected from each location per sample event. The organisms were depurated for a period of 24 hours to allow for clearance of gut contents prior to the collection of shell width [millimeter (mm)] and weight (g) data to account for any potential differences or trends in sizes of available clams at the Middle River reference site. Samples were submitted frozen to CEBAM Analytical under proper COC procedures for THg and MeHg analysis by EPA Method 1631 and Method 1630, respectively. Table 3-3 and SOP SRBI-1 (see Appendix A) provide a complete summary of sampling locations, methodology, and analytical DQOs.

Flathead mayfly nymphs (Order Ephemeroptera, Family Heptageniidae) were collected to monitor THg and MeHg concentrations in invertebrate tissue at each of the seven locations described in Section 3.2 (see Table 2-1 and Figure 3-1). Three composite flathead mayfly nymph samples were collected from stream substrates at each sample location bi-annually in May and October. Cobbles were removed from the river and rinsed in a sorting tray for invertebrate collection. Each composite sample was comprised of approximately 10 individual (n = 10) mayflies of similar size; length (mm) data were recorded on field datasheets during sample processing. Organisms were depurated for a period of 24 hours to allow for clearance of gut contents, and frozen prior

to shipment to CEBAM Analytical under proper COC procedures. Samples were analyzed for THg and MeHg by EPA Method 1631 and Method 1630, respectively. Table 3-3 and SOP SRBI-1 (see Appendix A) provide a complete summary of sampling locations, methodology, and analytical DQOs.

3.2.4 Young-of-Year (YOY) Smallmouth Bass

YOY fish are an ideal monitoring element to track long-term changes in mercury exposure due to the relatively short exposures that they experience and their site fidelity or small home range. YOY smallmouth bass sampling was conducted annually each October, from 2014 through 2016 to document baseline conditions. YOY fish were selected to monitor exposure to MeHg in water and dietary items and exposure of ecological receptors (e.g., piscivorous birds) to MeHg in YOY fish.

Per monitoring event, ten YOY smallmouth bass, ranging from approximately 60 to 110 mm total length, were collected at each of the seven locations described in Section 3.2 (see Table 2-1 and Figure 3-1), with the exception of SR 3.5. YOY smallmouth bass are not collected from SR 3.5 because adult bass are not sampled within this reach, per the LTM Plan (see Section 3.4). Fish were collected by electrofishing all likely habitats at each monitoring station during the collection of adult bass samples. Individual total length (mm) and weight (g) data were collected and fish were frozen prior to submittal to CEBAM Analytical for THg and MeHg analysis (whole-body) EPA Method 1631 and Method 1630, respectively. Table 3-4 and SOP SRBF-1 (see Appendix A) provide a complete summary of sampling locations, methodology, and analytical DQOs.

3.3 Terrestrial Ecological Exposure

Terrestrial ecological exposure to mercury and MeHg was evaluated in floodplain soils, invertebrates (i.e., earthworms and wolf spiders), and passerine birds [i.e., Carolina wren (*Thryothorus ludovicianus*)] at nine monitoring locations to better understand the transfer of MeHg between aquatic and terrestrial habitats in response to remediation. Wolf spiders (family *Lycosidae*) and earthworms (suborder *Lumbricina)* are important food items for songbirds and other terrestrial ecological receptors and may be an important potential link in the transfer of MeHg between the aquatic and terrestrial components of the South River (Cristol et al., 2008).

Five monitoring locations were sampled on the South River including two upstream reference sites (i.e., SR-6.2, SR-2.7) and three downstream sites (SR 2.0, SR 11.8[1], and SR 22); four monitoring locations were sampled on the SFS River (SF 31, SF 50, SF 66, and SF 85). The following sections describe the sampling approach and methods specific to the collection and data analysis of terrestrial media.

3.3.1 Soil

The characterization of mercury concentrations in floodplain soils is important to understanding potential sources and fate and transport of mercury from those sources through the terrestrial food web. Floodplain soils are monitored as part of the 100-year monitoring plan administered by VDEQ, and as such, comprehensive soil monitoring is

[1] Earthworms, soil, and spiders were sampled at the original SR 8.9 monitoring location identified in the LTM Plan in 2014. This station was moved in 2016 to SR 11.8 due to poor habitat suitability and presence of Carolina wren.

not included in the LTM Plan. Soil mercury data collected as part of the LTM program are intended to provide a basis for comparison of THg and MeHg concentrations in other terrestrial media such as earthworms, wolf spiders, and Carolina wren to help determine mercury transport pathways in the terrestrial food web.

Three composite soil samples were collected annually each June/July at the nine terrestrial exposure locations identified in Section 3.3 (see Table 2-1 and Figure 3-1), beginning in July 2014. Sample locations were targeted in areas near Carolina wren sample collection, and specific locations varied year-to-year. A composite sample included equal aliquots of soil from each of five soil borings at a given location as outlined in SOP SRET-1 (see Appendix A). The soil was thoroughly homogenized in stainless-steel bowls, and soil color and texture were visually characterized prior to being placed in jars for shipment to Brooks Applied Labs (formerly Brooks Rand Labs, Bothell Washington) for THg and MeHg analysis. Samples were analyzed for THg and MeHg by EPA Method 1631 and Method 1630, respectively. Table 3-5 and SOP SRET-1 (see Appendix A) provide a complete summary of sampling locations, methodology, and analytical DQOs.

3.3.2 Terrestrial Invertebrates

Wolf spiders were sampled to evaluate potential trophic transfer of mercury from the aquatic to the terrestrial food web. Five wolf spiders were collected and analyzed individually from each of the nine study sites described in Section 3.3 (see Table 2-1 and Figure 3-1). Spiders were collected by active capture (sweep netting) and passive dry pitfall trapping techniques. Once collected, spiders were immediately euthanized on dry ice prior to processing. Length (combined cephalothorax/abdomen length; mm) and weight (g) data were collected prior to being rinsed with deionized water and then frozen for submittal to CEBAM Analytical under proper COC procedures. Samples were analyzed for THg and MeHg by EPA Method 1631 and 1630, respectively. Table 3-6 and SOP SRBS-1 (see Appendix A) provide a complete summary of sampling locations, methodology, and analytical DQOs.

Earthworm tissue samples were co-located with floodplain soil sample locations identified in Sections 3.3 and 3.3.1 (see Table 2-1 and Figure 3-1). As discussed above, co-located earthworm/soil sampling locations were selected where Carolina wren data were collected each year and varied year-to-year. Three composite samples comprised of approximately three to five earthworms each, were collected by hand digging with a soil auger and/or shovel. Earthworms were depurated for 24 hours prior to processing. Total length, individual weight, and composite weight data were collected, and samples were frozen and shipped to CEBAM Analytical for THg and MeHg analysis. Samples were analyzed for THg and MeHg by EPA Method 1631 and 1630, respectively. Table 3-6 and SOP SRET-1 (see Appendix A) provide a complete summary of sampling locations, methodology, and analytical DQOs.

3.3.3 Passerine Birds

Several studies have been conducted that found terrestrial Carolina wren that occupy the floodplain adjacent to South River had mercury in their blood and feathers at concentrations that were elevated above reference (Cristol et al., 2008; Jackson and Evers, 2011). The Carolina wren is a year-round resident bird that is widely distributed in the watershed, which makes it an ideal measurement endpoint to evaluate potential changes in mercury exposure in passerine birds following remediation.

Exposure to mercury in Carolina wren was monitored at nine study locations (two reference and seven study sites) within the AOC 4 study area as described in Section 3.3 (see Table 2-1 and Figure 3-1). Baseline data collection activities were performed annually in June/July in 2015 and 2016; no data were collected in 2014 due to federal scientific collection permit delays. Carolina wrens were collected using nylon mist nets placed in suitable riparian habitats along the South River/SFS River at each monitoring location. Mist nests had three to four panels that overlapped to form bottom pockets; any bird that encountered the net, would drop into a pocket and immediately be removed. Blood samples were collected for THg analysis (EPA Method 1631) from the right jugular vein in three to eight individuals at each monitoring location; analyses were performed at Brooks Applied Labs (Bothell, Washington). Wing chord length (mm), weight (g), sex, and approximate age (e.g., hatch-year, juvenile, adult) data were recorded on field datasheets. Table 3-7 and SOP SRAT-1 (see Appendix A) provide a complete summary of sampling locations, methodology, and analytical DQOs.

3.4 Human Exposure

Human exposure to mercury in AOC 4 occurs primarily through ingestion of aquatic and semi-aquatic food items. This primarily occurs through the consumption of fish tissue, but humans on the South River floodplain may also be potentially exposed through ingestion of snapping turtle and mallard duck tissues. As detailed in the LTM Plan (AECOM, 2015), baseline data collection for evaluation of human exposure to mercury in AOC 4 was conducted at 13 monitoring reaches on the South River, SFS River, and Shenandoah River (see Figure 3-1) as follows:

- South River: Four locations including an upstream reference site: SR -2.7, SR 0.1, SR 11.8, and SR 23.5
- South Fork Shenandoah River – Seven reaches: SF 26.6[2], SF 48, SF 63, SF 72, SF 89.4, SF 106, and SF 115
- Shenandoah River – Two reaches: SH 143 and SH 158.

The following sections describe the sampling approach and methods specific to the collection and data analysis of human exposure media.

3.4.1 Fish

Edible-sized (i.e., > 7 inches) largemouth and smallmouth bass were sampled to monitor trends in human exposure to MeHg in adult fish. Ten fish of each species were collected by electro-fishing all likely habitats at each monitoring location described in Section 3.4. Biopsy tissue plugs (mid-dorsal) and fillet samples were collected bi-annually in May and October to monitor MeHg trends in adult bass and to further document the relationship between the two tissue sample types (Collins et. al., 2011). Total length (mm), weight (g), sex, and reproductive status of each adult bass were documented. Tissue samples were preserved in the field on dry ice and shipped to CEBAM Analytical for THg and MeHg analysis by EPA Method 1631 and 1630, respectively. Table 3-8 and SOP SRBF-1 (see Appendix A) provide a complete summary of sampling locations, methodology, and analytical DQOs.

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[2] Monitoring location SF 26.6 at Lynwood was sampled in the spring of 2014; however, this location was moved to SF 31 at Front Royal to provide safer conditions for repeated long-term access.

An evaluation of paired plug/fillet data (n = 548) was conducted in 2015 to determine if a transition to non-lethal tissue sampling could be made (AECOM, 2015). Mean THg and MeHg concentrations (wet weight basis) were comparable between biopsy plug and fillet samples for all groups; however, mercury concentrations were consistently and slightly higher in biopsy plug than fillet samples in paired comparisons (see Figure 3-2). Additionally, strong correlations were observed between mercury concentrations measured in paired biopsy plug and fillet samples (R^2 values ranging from 0.89 to 0.93; see Figure 3-3) as well as between THg and MeHg (Spearman ρ = 0.99).

As part of the on-going community outreach efforts being conducted on the South River, creel surveys documenting recreational fishing activities have been conducted in conjunction with VDGIF every three to four years. The most recent creel survey was conducted in 2016 (VDGIF, 2017). These surveys provide valuable information on recreational fishing use of the South River and provide data on angler/public awareness of the consumption bans/advisories that are in place. Additionally, they serve as a means to inform users who may not be aware of the current advisories of the river.

3.4.2 Reptiles

The snapping turtle is a semi-aquatic piscivorous ecological receptor common in the South River. They are a long-lived (up to 50 years), apex predator, feeding on relatively large fish and, as such, are capable of accumulating mercury to a greater degree than other animals in the South River (Hopkins et al., 2013a). Bioaccumulation of mercury by snapping turtles within the primary study area was evaluated using toe-nail clips. Historical studies documented a strong predictive relationship (R^2~0.9) between concentrations in blood mercury and nails to concentrations in muscle tissue in snapping turtles (Hopkins et. al., 2013b). This relationship allows for mercury concentrations in turtle nails to be converted into mercury concentrations in turtle tissue, which is representative of potential human exposure to mercury through consumption of snapping turtles.

Samples were collected from three individuals at each of the 13 study sites identified in Section 3.4 (see Table 2-1 and Figure 3-1). Snapping turtles were collected in early summer (June-July) using baited hoop nets set in the most appropriate microhabitats (slow moving water, presence of large woody debris, structured bank) present at each the sampling location. Hoop nets were left in place for 24 hours and checked daily. Carapace and plastron length (mm) and width (mm) data as well as sex data were collected prior to marking a unique three-digit code of the individual's scutes; lastly, two nail clips were obtained for THg and MeHg analysis. Turtle nail samples were frozen and shipped on dry ice to CEBAM Analytical. Table 3-9 and SOP SRBT-1 (see Appendix A) provide a complete summary of sampling locations, methodology, and analytical DQOs.

3.4.3 Waterfowl

Several studies have evaluated mercury concentrations in blood, feathers, edible tissue, and organs of mallard ducks from the South River [Savoy and Evers 2007, 2008, VDEQ, 2009 (unpublished)]. Waterfowl were collected to monitor trends in human exposure to MeHg through consumption of mallard ducks harvested within AOC 4.

Three mallard ducks were targeted for collection in late winter (March) 2016[3] at the 13 monitoring locations identified in Section 3.4 (see Table 2-1 and Figure 3-1). Samples were collected using traditional hunting methods (i.e., firearms) and/or netted with hand-nets/net guns. Wing chord length (mm), weight (g), sex, and reproductive status were documented on field datasheets following collection. Breast muscle tissue was removed from the mallard ducks using traditional "breasting" techniques to closely mimic the approach a hunter would use in cleaning their harvest. Breast muscle tissue placed into Ziploc bags, frozen and shipped to Brooks Applied Labs on dry ice under proper COC procedures. Tissue samples were analyzed by EPA Method 1631 and Method 1630, respectively. Table 3-10 and SOP SRMD-1 (see Appendix A) provide a complete summary of sampling locations, methodology, and analytical DQOs.

3.5 Water and Habitat Quality

The baseline characterization of mercury in surface water and the evaluation of habitat quality are described in the following sections.

3.5.1 Surface Water Quality

Surface water samples were collected in AOC 4 to monitor long-term changes in mercury species, ancillary parameters, and nutrients in response to remediation. The AOC 4 LTM surface water sampling program supplements the existing routine monitoring programs conducted the VDEQ and builds on a long-term (1999-present) database. Surface water sampling is useful in identifying the potential effect of climate and inter-annual variability on mercury methylation in the South River, providing an important context for other data [e.g., mercury concentrations in fish tissue, (URS, 2015)].

Surface water sampling was conducted approximately monthly through coordination between VDEQ and DuPont. Surface water samples were collected from bridges along the South River (see Table 2-1, and Figure 3-1) and at locations on the SFS River. Water samples were collected using either a diaphragm or submersible pump following the methods outlined in sampling protocol SRSW-1 (see Appendix A). Samples were collected from approximately 0.3 meters below the water surface of the thalweg and analyzed for THg, MeHg, filtered total mercury (FTHg), filtered methylmercury (FMeHg), total organic carbon (TOC), dissolved organic carbon (DOC), total suspended solids (TSS), and nutrients (phosphorous). Sample aliquots for dissolved parameters were field-filtered using a 0.45 µm inline capsule filter. Two replicate samples were collected at each location for filtered and unfiltered THg, MeHg[4], and TSS. Table 3-11 provides a complete summary of sampling locations, methodology, and analytical DQOs.

3.5.2 Benthic Invertebrate Sampling

Historical benthic macroinvertebrate investigations conducted as part of the Ecological Study suggested that effects of mercury on macroinvertebrate communities in the South River were minimal and likely confounded by natural variation in physicochemical variables, such as grain size, organic carbon content and other abiotic variables.

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[3] Mallard duck sampling was not collected in 2014 and 2015 due to delays in obtaining federal migratory bird permits and health and safety concerns associated with the use of firearms in sample collection.
[4] MeHg samples were collected quarterly during months sampled by AECOM. VDEQ does not monitor MeHg as part of 100-year monitoring program for the South River.

Baseline characterization, of benthic macroinvertebrate communities within AOC 4 followed procedures outlined in the EPA Rapid Bioassessment Protocol (Barbour et al., 1999). Six replicate samples were collected at each of the six aquatic ecological exposure locations identified in Section 3.2 (see Table 2-1 and Figure 3-1) bi-annually in June and October. Samples were collected along a gradient from toe of pool, transitional, and head of riffle habitats at the left, middle, and right points of the wetted stream channel using a Surber sampler. Collected material was transferred to an appropriately labeled sample container and preserved with 70% ethanol. Preserved samples were submitted to Eco-Analysts (Moscow, Idaho) for taxonomic analysis. In the laboratory, benthic community samples were sampled using a random 300-organism sub-count in accordance with Barbour et al. (1999). Organisms included in the sub-count were identified to the lowest taxonomic level practical, typically genus or species. Quality control on sorting procedures was checked by re-sorting 20% of each sample to ensure a 90% sorting efficiency. The accuracy of taxonomic identification was evaluated by the re-identification of 10% of the samples by an experienced taxonomist to ensure 90% similarity. Complete details of benthic community sampling procedures are provided in protocol SRBI-3 (see Appendix A). DQOs are provided in Table 3-12.

3.5.3 Substrate Characterization

Characterizing stream substrate composition is an important part of understanding watershed land-use practices and physical habitat suitability for fish and benthic invertebrate species. The embeddedness of coarse stream substrates (e.g., cobbles) in finer particles (e.g., silts and sands) can impact the ability of benthic invertebrates to colonize. This was documented on the South River, where substrate condition was found to be a key factor influencing benthic invertebrate community composition and distribution (URS, 2012).

Substrate composition was quantified annually in the fall using the Wolman pebble count methodology (Wolman, 1954) at the same transects established for benthic community sampling in order to establish a baseline for comparison with post-remediation data. No data were collected at the Middle River reference site MR 01 in 2014 and 2015. The median axis of 20 randomly selected substrates was measured at each transect using a gravelometer with standard sized openings. The selected substrate was fit through the smallest opening possible to assign it to a substrate category based upon the Wentworth scale. Substrate data for each monitoring location were compiled to determine the percent of particles less than 2 mm in size. This approach provides a quantitative assessment of substrate size within the reach, which will serve as an indicator of habitat quality for aquatic organisms, including benthic invertebrates and fish pre- and post-remediation.

3.6 Data Evaluation

The three primary objectives of the data evaluation are as follows:

- Evaluate the baseline monitoring data in context of historical data collected within AOC 4.
- Establish pre-remediation baseline conditions against which post-remedial conditions can be compared.
- Establish relationships among sampling matrices within exposure groups (e.g., aquatic ecological, terrestrial ecological, etc.) to determine relatedness and identify potential sampling redundancies.

The baseline LTM data (2014-2016) presented in this report summarizes pre-remediation conditions. The purpose of this report is to qualitatively and quantitatively, where appropriate, assess these data in the context of the historical data collected within AOC 4. The objective of the data assessment is to establish a baseline dataset to use as a benchmark for evaluation of post-remediation conditions.

Data were first visually inspected to evaluate consistency with historical datasets, and established spatial and temporal trends identified in the Ecological Study (e.g., generally higher MeHg concentrations in spring compared to fall mercury, increasing mercury concentrations with distance downstream, etc.). Statistical comparisons were not made to historical data, as a number of factors including differences in the spatial/temporal context of sampling, and field/laboratory methodologies may affect such comparisons. Additionally, the post-remediation statistical data evaluation will focus on comparisons to the baseline LTM dataset presented in this report.

Next, correlations between relevant media within each data group (i.e., aquatic ecological, terrestrial ecological, human, and water and habitat quality) were analyzed to determine how well media was related to one another. These correlations used a linear regression model and a two-tail F test ($\alpha = 0.05$) to determine if statistically significant correlations existed among the media. Lastly, a non-metric multidimensional scaling (NMDS) approach based on a Bray-Curtis dissimilarity matrix was used with ANOSIM (Analysis of Similarities) to test for differences between years, and seasons (Clarke, 1993).

As an additional supporting line of evidence, traditional analysis of covariance (ANCOVA) tests were performed for YOY smallmouth bass and surface water, where sufficient data were available. The fish field sampling strategy targets similarly-sized fish to account for size and age differences in test organisms and it relates to mercury tissue concentrations. Despite focused quality control efforts in the field, it is unlikely that field sampling efforts will collect the same age class of fish each year. The ANCOVA tested for the influence of fish length on adult bass THg concentrations. If a correlation exists between fish length and mercury concentration, accounting for fish length can reduce any confounding effects from sampling different age classes during different sampling events.

Subsequent LTM reports will be prepared every three years to analyze post-remediation data and document progress toward achievement of RAOs. Post-remediation LTM reports will build upon the baseline dataset established in this report and will follow the data analysis framework outlined in the LTM Plan (URS, 2015). The Plan was designed to have adequate statistical power for at least a 75% probability of finding a significant downward trend in mercury concentrations within three to five years. Three different trend tests were considered:

- Williams test
- Jonckheere-Terpstra
- Simple linear regression

These tests will be employed following collection of three years of data. Interim data analysis will focus on relationships between the data and the baseline conditions for each monitoring element.

4.0 Results

The results provided below summarize baseline, pre-remediation conditions in media associated with aquatic ecological exposure, terrestrial ecological exposure, human exposure, and water and habitat quality. As outlined in Section 3.6, the purpose of this report is to establish a baseline dataset for evaluation of post-remediation conditions in AOC 4. Baseline LTM data were first qualitatively assessed in the context of the relevant historical data to validate their appropriateness. Additionally, potential differences or relationships in mercury concentrations between media, seasons, and years were statistically evaluated to confirm consistency among the baseline LTM data (2014-2016). Statistically significant relationships among media indicate potential data redundancy and promote opportunities to reduce or eliminate specific monitoring elements from the LTM program via the adaptive management approach.

4.1 Regional Climate

Climatic factors, including temperature and precipitation, can play a role in MeHg production within the South River (URS, 2012). As such, regional climate data collected at the Staunton Sewage Treatment Plant were evaluated to place the baseline data collected in 2014-2016 into context with long-term climatic trends (1970-2013; SERCC, 2017). Stream discharge is closely related to precipitation and was also reviewed as a supporting line of evidence. Regional air temperatures during the baseline monitoring period were generally similar to long-term trends during the early spring; however, summer and fall temperatures were higher than the long-term average (see Figure 4-1, Figure 4-2, and Table 4-1). Discharge on the South River and SFS River was generally higher in the spring of 2014 and of 2016 and was below long-term averages in 2015 (see Figure 4-1 and Figure 4-3). Although the annual cumulative precipitation was higher than the historical average in 2015, this was skewed by a few large magnitude rainfall events throughout the year. While the influence of regional climatic conditions is generally understood for surface water (e.g., warmer, drier years tend to produce higher MeHg concentrations in the aquatic environment), the impact of timing and magnitude of storm events in relation to data collection events and mercury concentrations in biota is less understood. Regional climatic conditions will continue to be monitored to place post-remediation data into the appropriate context.

4.2 Aquatic Ecological Exposure

Mercury concentrations in baseline LTM aquatic ecological exposure media were correlated with one another in most comparisons (see Figure 4-4); the strongest correlation exists between sediment and periphyton IHg ($p = 0.94$). The linear regression results indicate that for IHg, all media evaluated are significantly correlated with one another ($\alpha=0.05$, one-tailed F-test; see Figure 4-4). Interstitial sediment IHg and MeHg concentrations were noticeably lower in baseline LTM data compared to historical data (Figure 4-5). This decrease likely does not reflect a temporal decline in mercury concentrations, but rather is an artifact of elevated concentrations collected in 2006, likely driven by climatic conditions favorable for methylation. Other baseline aquatic exposure media generally reflect similar spatial and temporal trends with historic data, although some deviations from historical data do exist for certain locations and media types (Figure 4-6 to Figure 4-8). These deviations are likely driven by the relatively small

number of samples collected each year for the baseline LTM and may notbe a reflection of actual differences in mercury concentrations between years.

Inorganic mercury concentrations in baseline LTM aquatic ecological exposure media, particularly in sediment, periphyton, and benthic invertebrates (i.e., *Corbicula* and mayflies), reached maximum concentrations generally at RRM 11.8, before decreasing with distance downstream (see Figure 4-5 to Figure 4-9; URS, 2012). For MeHg, each paired media comparison evaluated was also significantly correlated (α=0.05) with the exception of sediment-periphyton, and periphyton-YOY bass (see Figure 4-4). MeHg concentrations in aquatic media were more variable than IHg concentrations; however, MeHg concentrations tended to increase with distance downstream to SR 23.5 (Murphy, 2004; URS, 2012). Table 4-2 through Table 4-5 provide a complete summary of historical and LTM aquatic ecological exposure data.

Media were grouped to be evaluated for statistical differences among seasons and years based on the results of the correlation evaluation. For the aquatic ecological exposure group, clam, periphyton, and mayfly tissue that were sampled in both the spring and the fall were included in the NMDS and ANOSIM statistical evaluation (see Figure 4-10). Results indicate that there are no statistically significant differences among seasons (p=0.17) or years (p=0.42) for IHg; this is consistent with the findings of the Ecological Study (URS, 2012) that showed minimal seasonal/annual variation in IHg concentrations in aquatic media. Season (p=0.05) and year (p=0.02) each had a significant effect on MeHg concentrations, that was not always consistent between media. For example, MeHg concentrations in periphyton were generally higher at most stations in the fall (see Figure 4-6). Conversely, MeHg concentrations in mayflies were generally higher in the spring at most stations, in most years (see Figure 4-7). Concentrations of mercury in YOY smallmouth bass were not significantly different between years for either IHg (p=0.07) or MeHg (ANCOVA; p=0.22; Table 4-6).

Regional climatic conditions can influence the production of MeHg within the South River, which in turn can affect MeHg concentrations in environmental media (URS, 2012). The rate at which different media integrate these changes is less understood; however, it appears that abiotic media (i.e., sediment and surface water) may respond more quickly to regional climatic changes. For example, sediment MeHg concentrations were notably lower than those measured in the historical dataset at LTM stations on the South River downstream of the former site (see Table 4-2 and Figure 4-5); a similar trend is also evident in the baseline surface water MeHg data (see Section 4.4.1). As documented in the Ecological Study (URS, 2012), lower than average rainfall/stream discharges and higher air temperatures in the spring of 2006 led to increased MeHg concentrations in abiotic media. A large proportion of the historical sediment data (60.5%) was collected during this time period, which may bias the data high.

The disparity between historical and baseline LTM MeHg concentrations is not as apparent in biotic media at the base of the food chain (i.e., periphyton, mayflies, *Corbicula*) as historical data collection events were more evenly distributed across multiple years. However, as discussed above, statistically significant differences were observed between seasons and years in the baseline aquatic ecological exposure data. While annual variation in MeHg concentrations is to be expected in the post-remediation dataset, it will be important to be mindful of regional climatic conditions when evaluating potential success of the remedy.

The concentration of IHg detected in mayfly samples collected in fall 2016 at SR-2.7 and other locations (see Figure 4-7) were higher than detected previously at that/those locations. The reason for the increase is not known, but the increase is not consistent with life history or behavior of these organisms. MeHg concentrations and % solids data for this sampling event were consistent with other data. Other media collected during this same period (e.g. periphyton, sediment, *Corbicula* did not demonstrate similar increases in IHg concentrations. Review of Level-2 laboratory data deliverables did not identify any anomalies, such as in sample handling or carryover from other analyses.

4.3 Terrestrial Ecological Exposure

Mercury concentrations in baseline terrestrial ecological exposure media were correlated in most paired comparisons (see Figure 4-11); however, spatial trends in THg, IHg, and MeHg varied between media (see Figure 4-12 to Figure 4-15). Relationships between soil, earthworms, wolf spiders, and Carolina wren were statistically evaluated for IHg and MeHg[5]. The linear regression results indicated that terrestrial ecological exposure media (i.e., soil, earthworms, wolf spiders, and Carolina wren) were significantly correlated (α=0.05) with one another for each mercury species evaluated, with the exception of the earthworm-Carolina Wren relationship for IHg and MeHg (see Figure 4-11). Certain IHg relationships [e.g., Carolina wren-spider (Pearson r = 0.83), and soil-earthworm (Pearson r = 0.83)] were more linear in nature, with higher predictive capabilities using a linear model than others (i.e., Carolina wren-earthworm; Pearson r = 0.42).

Qualitative comparison of baseline LTM data with available historical data demonstrated similar spatial trends; however, the trends were not consistent between media or mercury species (see Figure 4-12 to Figure 4-15). For example, IHg concentrations in earthworms reached maximum concentrations at SR 2.0, while the soil that the worms were collected from reached maximum concentrations at SR 11.8 before decreasing with distance downstream (see Figure 4-13 and Figure 4-12). However, MeHg concentrations in soil and earthworms had a stronger relationship, with MeHg concentrations generally reaching maximum concentrations at SR 2.0 and remaining consistently elevated to SR 22 before decreasing with distance downstream (see Figure 4-13). Historical MeHg soil data are limited; however, this important relationship between MeHg concentrations in soil and earthworms will be further examined as additional data are produced with continued LTM efforts.

MeHg concentrations in wolf spiders displayed a similar spatial trend to aquatic ecological exposure media described in Section 4.1; concentrations increased with distance from the former site and generally reached maximum concentrations at SR 22, before decreasing (see Figure 4-14). Similar spatial trends between spiders, which are known to feed on aquatic invertebrates (Howie, 2010), and aquatic media (e.g., mayflies) collected from similar reaches of the South River supports the hypothesis that spiders may be an important potential link in the transfer of MeHg between the aquatic and terrestrial components of the South River (Cristol et al., 2008). THg concentrations in mayflies were significantly correlated with THg in wolf spiders ($p<0.05$; Pearson), further supporting this hypothesis. Additionally, THg concentrations in Carolina wren demonstrated a similar spatial pattern to that described above (see Figure 4-15). The

[5] Carolina wren blood was analyzed for THg only as previous work has established that 90-100% of mercury in bird blood is present as MeHg (Rimmer, et. al., 2005). THg data for Carolina wren were included in the evaluation of relationships between media for both IHg and MeHg for comparative purposes.

similar spatial trends observed in the aquatic and terrestrial exposure media support the overall hypothesis that MeHg has the potential to transfer through the South River food web from the aquatic environment to the terrestrial environment (e.g., mayfly → wolf spider → Carolina wren). Tables 4-7 through Table 4-9 provide a complete summary of historical and LTM terrestrial ecological exposure data.

Based on the results of the correlation evaluation, media were grouped to be evaluated for annual variation; seasonal evaluation was not performed as terrestrial ecological exposure media are sampled once annually. The NMDS and ANOSIM statistical evaluation results indicate that there are no statistically significant differences between baseline monitoring data collected in 2014-2016 for either IHg or MeHg (α=0.05; Figure 4-16). Carolina wren data were not included in the NMDS and ANOSIM data evaluation as data were not collected in 2014.

4.4 Human Exposure

Tables 4-10 through Table 4-12 provide a complete summary of historical and LTM human exposure data; a comprehensive discussion of relevant data evaluations is provided below. LTM mallard duck sampling was limited to 2016 only; subsequent LTM will include annual mallard duck sampling per the LTM Work Plan (URS, 2015).

Fish length and THg concentrations in both smallmouth bass and largemouth bass were significantly correlated when considering all AOC 4 data (ANCOVA $p < 0.001$ for both). Additionally, the interaction between fish length and RRM was highly significant ($p < 0.001$) for both species, indicating that the relatively lower variation of fish size within smaller areas of the river still explains variability of mercury concentrations in adult bass. Therefore, mercury concentrations in adult bass were length-normalized to an average fish length of 300 mm, with a linear transformation for all subsequent statistical analyses.

Mercury concentrations in human exposure media displayed temporal and spatial trends that were visually similar to historical data (see Figures 4-17 to 4-19). THg concentrations in bass, turtle, and mallard duck tissue generally reached maximum concentrations at RRM 11.8, and then decreased with distance downstream (see Figure 4-17 to Figure 4-19). MeHg concentrations in mallard duck tissue followed a similar spatial pattern (see Figure 4-19).

Additionally, relationships between THg concentrations in human exposure media (i.e., smallmouth bass, largemouth bass, mallard ducks, and snapping turtles) were statistically evaluated to determine how well theywere correlated. The linear regression results indicated that all human exposure media were well-correlated, with the exception of mallard duck (α=0.05; Figure 4-20). A correlation between the mallards and bass or snapping turtles is not likely due to the difference in dietary preferences and life histories, including migratory habits. Mallards are herbivores, whereas bass and snapping turtles are piscviorous/omnivorous. Additionally, mallard may migrate, introducing a larger degree of variability/uncertainty to Hg exposure.

The vast majority (94%) of THg in mallard duck muscle tissue is present as MeHg (see Figure 4-21); results of the regression analysis indicate a significant linear relationship between THg and MeHg in mallard duck muscle tissue (R^2=0.993).

Based on the results of the correlation evaluation, human exposure media were grouped and evaluated for statistical differences among seasons and years, where applicable. Smallmouth bass, largemouth bass, and turtles were included in the NMDS and ANOSIM statistical evaluations; mallard ducks were not included due to the single 2016

dataset. There were no statistically significant differences between years using ANOSIM for THg in bass and snapping turtles (p = 0.93; Figure 4-22). Differences between seasons were not evaluated using NMDS and ANOSIM because LTM turtles were monitored in the summer only; annual averages were used for smallmouth bass and largemouth bass.

Concentrations of length-normalized THg in smallmouth bass and largemouth bass tissue collected between 2014 and 2016 were also evaluated across years and seasons with multiple one-way ANCOVAs (location as the covariate). Statistically significant differences between largemouth and smallmouth bass tissue ($p<0.001$), prompted further separate evaluation within each species (see Table 4-13). There were significant differences between smallmouth bass THg concentrations between seasons ($p=0.05$) but not years ($p=0.65$; Table 4-13); although an increasing trend in smallmouth bass tissue mercury concentrations was observed (Figure 4-17). The interaction between Season and RRM was significant in smallmouth bass ($p = 0.01$), indicating that seasonal trends in smallmouth bass THg vary spatially. There were no significant differences in largemouth bass THg tissue concentrations between seasons ($p=0.13$) or years ($p=0.46$). Largemouth bass were not present at every location due to limited habitat, and in general had a higher degree of variability within the dataset compared to smallmouth bass (see Figure 4-17). In all tests, the covariate (location) had a significant effect ($p<0.05$) on the outcome of the ANCOVA.

Fish consumption represents the primary potential human exposure pathway in the South River and SFS River. This potential exposure pathway has been effectively managed through fish tissue consumption bans and advisories issued by Virginia Department of Health (VDH) and VDEQ. The 2016 Angler Survey (VDGIF) conducted on the South River identified an increase in angler awareness of the consumption advisory (87% of anglers were aware) over the past 11 years; conversely there was a 10% decrease in awareness of the advisory on the SFS River (75% of anglers were aware). Of those that were aware of the advisories, 96% knew that they pertained specifically to mercury; an increase of 23% from the 2011 survey. Most anglers reported hearing about the advisory through either word of mouth (54%) or signage posted along the river (42%). Overall 2% of respondents strictly harvested their catch (regardless of species), while 19% practiced a combination of harvest/catch and release. The majority (79%) of anglers reported practicing catch and release only. The survey also documented that 100% of the smallmouth bass caught and reported by anglers during the survey were released. The complete 2016 angler survey is provided in Appendix C.

4.5 Water and Habitat Quality

4.5.1 Surface Water

In total, 298 surface water samples were collected throughout the year as part of the baseline LTM. As described in Section 3.5.1, surface water samples were collected at bridges along the South River and SFS River on an approximately monthly basis through coordination between VDEQ and DuPont. Baseline LTM surface water MeHg sampling and analysis was only performed quarterly, resulting in 142 MeHg surface water samples. Historical and LTM surface water data are displayed graphically in Figure 4-23 to Figure 4-25 and are summarized in Table 4-14 (THg) and Table 4-15 (MeHg).

Data on ancillary surface water parameters were also collected, including total suspended solids, organic carbon, phosphorus, magnesium, nitrogen, potassium,

sodium, sulfate, and alkalinity. These ancillary surface water parameters are summarized in Table 4-16; their values fall generally within the location-specific range of historical data.

Concentrations of THg and MeHg on particles (THgP and MeHgP), and the percent of MeHg on particles (%MeHg), were evaluated between historical (2006-2013) and baseline LTM surface water (2014-2016) data, using multiple one-way ANCOVAs with location as the covariate. ANCOVA results indicate that the LTM surface water concentrations observed in 2014 to 2016 are not significantly different than historical data for THgP (p=0.32), MeHgP (p=0.51), and %MeHg (p=0.92). A greater range of concentrations is evident in the historical surface water dataset, likely attributable to the larger sample size collected over a longer time period (1,468 historical THg samples versus 298 baseline LTM THg samples). Consistent with established spatial trends (URS, 2012), mercury concentrations in surface water increase downstream of SR 0 and reach maximum concentrations between SR 9.9 to SR 23.5; concentrations decrease thereafter with distance downstream.

Surface water data demonstrate that the current sampling regime is of adequate temporal resolution to detect seasonal changes and provide important context for interpretation of concentrations in potential human and ecological exposure media. Temporal evaluations focused on the concentration of THgP, MeHgP, and %MeHg because these data are normalized to the suspended solids concentration and account for some of the variation driven by changes in river discharge. The temporal variation observed in 2014-2016 was consistent with the seasonal patterns evident throughout the historical data period (2006-2013), where MeHgP and %MeHg increase in the spring/summer, and decline in colder months. There were no large deviations from the quarterly average MeHgP or %MeHg during the period of 2014-2015, consistent with the relative agreement between climatic conditions (i.e., discharge, air temperature, and precipitation) of the 2014-2016 sampling period and historical record (see Figure 4-1).

4.5.2 Benthic Invertebrate Community

Historical and LTM benthic community metrics are displayed graphically in Figure 4-26 (standard metrics) and Figure 4-27 (diversity/evenness metrics), and are summarized in Table 4-17. Appropriate historic benthic community data were limited to the spring season as a basis for comparison with spring LTM data.

Select benthic community metrics such as abundance, % dominant taxa, taxa richness, % Ephemeroptera, Plecoptera, and Trichoptera (EPT), Shannon-Weaver H', and Pielou's J' were used to test for significant differences between years and seasons using NMDS and ANOSIM statistical evaluations; these benthic community metrics (combined) are significantly different between seasons (p=0.010) but not years (p=0.108; Figure 4-28). Seasonal variability in benthic communities occurs in riverine environments due to the nature of continuous life cycles of diverse aquatic invertebrate communities, and a natural seasonal succession based on environmental conditions. Baseline LTM benthic community data were generally within the location-specific range of historical data (see Figure 4-27; URS, 2012).

4.5.3 Substrate Characterization

With several exceptions, baseline LTM substrate characterization was performed each fall at the locations outlined in Table 2-1. No data were collected at the Middle River reference site MR 01 in 2014 and 2015. Additionally, substrate characterization was

performed at SF 26.6 and SF 48 although these locations were not included in the LTM scope (see Table 2-1). A summary of substrate composition is presented in Figure 4-29.

With the exception of reference location, MR-01, streambed substrate composition was similar among LTM locations and generally consistent with previous investigations (URS, 2012). More specifically, the MR-01 substrate was primarily composed of fine to coarse gravels. Locations SR 0.1 and SF 26.6 had similar substrate composition, with slightly higher amounts of fines/sands/gravels compared to other locations, as well as more boulders/bedrock. Locations SR 23.5 and SF 48 were also similar, with slightly lower amounts of fines/sands/gravels and more cobbles compared to other locations. The remaining locations, SR -2.7, SR 3.5, and SR 11.8 were similar, with more even substrate composition relative to the other locations.

5.0 Data Quality Assessment

Baseline LTM analytical data were reviewed in accordance with the DuPont Data Verification Module (DVM) process to determine data usability. The DVM is an internal review process used by the DuPont Corporate Remediation Group (CRG) Analytical Data Quality Management Group (ADQM) to assist with the determination of data quality. The electronic data deliverables received from the laboratory were loaded into the Locus EIM™ database and processed through a series of data quality checks, which are a combination of software (Locus EIM™ database DVM) and manual reviewer evaluations. The review process included comparing available laboratory data deliverables [hardcopy and electronic data deliverable (EDD)] versus the original project specifications, examining the completed COC, and using the automated DVM during the data evaluation. Applicable DVM narratives are included in Appendix D; DVM narratives were only included for sampling programs with reported data usability qualifiers.

All Baseline LTM data collected between 2014 and 2016 were usable with no major analytical or field sampling challenges. Future Long-term Monitoring sampling efforts will continue to follow SOPs included in the LTM Plan (URS, 2015a) and utilize the DuPont DVM process.

5.1 Findings

Based on the quality assurance/ quality control (QA/QC) data review conducted, baseline LTM data collected in 2014-2016 are considered usable.

6.0 Conclusions

The baseline LTM dataset described in this report documents pre-remediation conditions in AOC 4, in accordance with the Final AOC 4 LTM Plan (URS, 2015) and the Remediation Proposal, which was part of the final settlement agreement between DuPont and NRDC in 2013 (Anchor QEA and URS, 2013). This dataset will serve as the baseline for comparison of post-remediation data, which aims to document sustainable reductions in mercury concentrations in biotic and abiotic media, as well as improvements in water quality and habitat function within the South River and SFS Rivers. Effectiveness of the IMs will be evaluated based on metrics and success criteria that have been established for the LTM program (URS, 2015a).

While the baseline LTM dataset provides a limited snapshot of pre-remediation conditions observed from 2014 to 2016, the data have limited annual variability and were generally consistent with historical concentrations and spatial trends established in the Ecological Study (URS, 2012) and by SRST Researchers over the past 15 years.

A summary of conclusions based on a review of the baseline LTM data are provided below by exposure group:

Aquatic Ecological Exposure

- With the exception of surface water, the aquatic ecological exposure media interstitial sediment, periphyton, mayflies, and YOY smallmouth bass appear more responsive to regional climatic conditions than other exposure groups.
- IHg concentrations in aquatic ecological exposure media are generally similar among years; however, MeHg concentrations were significantly different for all media with the exception of YOY smallmouth bass.
- Consistent seasonal differences in IHg and MeHg concentrations in aquatic ecological exposure media were not apparent.

Terrestrial Ecological Exposure

- IHg and MeHg concentrations in the terrestrial ecological exposure media soil, earthworms, wolf spiders, and Carolina wren (THg), are significantly correlated.
- IHg and MeHg concentrations in terrestrial ecological exposure media are not significantly different among years.

Human Exposure

- THg concentrations in bass and snapping turtles monitored as part of the LTM program are well-correlated.
- Significant annual variation in THg concentrations in smallmouth bass, largemouth bass, and snapping turtles was not apparent.
- Statistically significant seasonal differences were documented in smallmouth bass THg concentrations.
- Awareness of the consumption advisory among South River anglers has increased over the past 11 years (VDGIF, 2017).

Water and Habitat Quality

- Baseline LTM water and habitat quality parameters of mercury concentrations in surface water, aquatic benthic communities, and streambed substrate compositions, are consistent with established spatial trends (URS, 2012).
- Benthic community metrics were significantly different among baseline LTM seasons but were not statistically different among baseline LTM years; however, these differences may be driven by natural variability.

With the completion of IMs at the Constitution Park BMA in February 2017, the 2017 LTM monitoring represents the first post-remediation dataset. As discussed in Section 1.1, the expansion of the remedial schedule will create a transitional period where post-remediation mercury concentrations and aquatic habitat quality may not respond as quickly as anticipated due to the reduced extent of bank remediation over the timeframe. The next LTM report will be produced following completion of the 2019 data collection, and will include an evaluation of the effectiveness of the completed IMs at Constitution Park, as well as other remediation completed by then, in the context of the LTM program RAOs (URS, 2012).

Consistent with adaptive management principles for AOC 4, the LTM approach may be revised based on data redundancy, documented progress towards the achievement of success criteria, contingency actions, and emerging decision analysis options (URS, 2015a). Moreover, specific LTM media that do not materially impact the remedial decision process may be reduced [e.g., sampling frequency (seasons and years), sample size, monitoring locations, etc.] or eliminated from the LTM program with the concurrence of the VDEQ.

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Tables

Table 2-1
Long-Term Monitoring Scope Summary
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

Monitoring Element	Objective	Measurements	Proposed Sampling Frequency	Samples per Location	Locations
Monitor Ecological Exposure					
Aquatic					
Sediment	• Monitor exposure of invertebrates to sediment MeHg • Monitor natural recovery of sediment	• THg and MeHg in sediment collected from coarse grained beds	Once annually (Spring)	3	RRM -2.7* RRM 0.1 RRM 3.5 RRM 11.8 RRM 23.5 SFS near Lynwood, VA (RRM 26) SFS near Shenandoah, VA (RRM 48)
Periphyton	• Monitor THg and MeHg in periphyton, which is an important exposure medium for benthic invertebrates • Provide a data set for comparison with short-term monitoring elements	• THg and MeHg in periphyton	Twice annually (Spring and Fall)	3	
Benthic Invertebrates	• Monitor exposure to invertivorous ecological receptors (e.g., YOY fish) • Monitor responses to decreasing mercury loads	• THg and MeHg in mayfly tissue	Twice annually (Spring and Fall)	3	
Transplanted Asiatic Clam	• Provide a data set for comparison with short-term monitoring elements	• THg and MeHg in transplanted Asiatic clam tissue	Twice annually (Spring and Fall)	3	
YOY Smallmouth Bass	• Monitor exposure of YOY fish to MeHg in water and dietary items • Monitor exposure of ecological receptors (e.g., piscivorous birds) to MeHg in YOY fish • Document potential declines in exposure due to remediation	• THg and MeHg in whole fish	Once annually (Summer/Fall)	10	RRM -2.7* RRM 0.1 to 2.3 RRM 5.2 to 11.8 RRM 16 to 23.5 SFS near Lynwood, VA (RRM 26) SFS near Shenandoah, VA (RRM 48)
Terrestrial					
Earthworms	• Monitor exposure of terrestrial ecological receptors to MeHg in earthworms • Monitor potential terrestrial MeHg bioaccumulation	• THg and MeHg in earthworm tissue and co-located soil	Once annually (Summer)	3 composite samples	**South River (Reference):** Waynesboro Nursery (RRM -6.2)* Ridgeview Park (RRM -1.2)* **South River:** RRM 0.1 to 2.3 RRM 9 (Pond Pilot area) Grottoes City Park (RRM 22) **SFS:** Power Dam (RRM 31) Shuller's Island (RRM 50) Long Bend Farm (RRM 66) Bealer's Ferry (RRM 85)
Wolf Spiders (family Lycosidae)	• Monitor exposure of terrestrial ecological receptors to MeHg in spiders • Monitor MeHg transfer between aqueous and terrestrial compartment of the South River	• THg and MeHg in spider tissue • Size	Once annually (Summer)	5 individuals	
Adult Carolina Wren	• Monitor songbird exposure to MeHg	• THg in blood • Weight	Once annually (Summer)	3-8 individuals	
Monitor Potential Human Exposure					
Largemouth Bass Smallmouth Bass	• Monitor trends in human exposure to MeHg in adult fish[1] • Develop non-lethal mercury monitoring techniques for the South River[2]	• THg and MeHg in biopsy plugs[2] • Total length, weight	Twice annually (Spring and Fall)	10 bass (SMB and LMB)	**South River:** RRM -2.7* RRM 0.1 to 2.3 RRM 5.2 to 11.8 RRM 16 to 23.5 **SFS:** Lynwood, VA near Rt. 708 bridge (RRM 26) Shenandoah, VA boat ramp (RRM 48) Newport Landing (RRM 63) Hamburg, VA near Rt. 211 bridge (RRM 72) Fosters Landing near Rt. 684 bridge (RRM 89) Bentonville Landing near Rt. 613 bridge (RRM 106) Karo Landing (RRM 115) **Shenandoah River:** Rt. 17/50 bridge (RRM 143) Berryville, VA near Rt. 7 bridge (RRM 158)
Snapping Turtle[3]	• Monitor trends in human exposure to MeHg in snapping turtles	• THg and MeHg in nail[4] • Total length, weight	Once annually (Summer)	3	
Mallard Duck[3]	• Monitor trends in human exposure to MeHg in mallard ducks	• THg and MeHg in breast muscle tissue • Sex, reproductive status • Length, weight	Once annually [Winter (waterfowl hunting season)]	3	
Community Outreach	• Monitor trends in human exposure to mercury, including adherence to the fish consumption advisory	• Outreach to non-English-speaking communities (e.g., the Promotores de Salud program and outreach to other non-English language groups) • Physician and clinic newsletters • Angler surveys	• Annual outreach to non-English speaking groups, local physicians, and health clinics • Once every 3 years for the angler survey	NA	Focused on Waynesboro, but also including the downstream locales of Dooms, Crimora and Grottoes. Also dependent on locations of local/state health clinics.
Water Quality and Habitat Quality Monitoring					
Water quality**	• Monitor trends in water quality • Provide information on inter-annual • Continue to describe behavior of mercury species in South River	• Surface water: THg, MeHg**, TSS, TOC, DOC, water quality parameters (T, pH, DO, conductivity), and nutrients (Phosphorous)*	Monthly**	1 to 2**	**South River:** RRM -2.7* RRM 0.2 RRM 2.3 RRM 5.2 RRM 9.9 RRM 16.5 RRM 23.5 **SFS:** Lynnwood, Rt 708 (RRM 26) Shenandoah, below dam (RRM 48) Rt. 663
Benthic Invertebrate Community	• Monitor improvements to benthic community and benthic habitat	• Benthic community (300 count subsampling)	Twice annually (Spring and Fall)	6	RRM -2.7* RRM 0.1 RRM 3.5 RRM 11.8 RRM 23.5 Middle River*
		• Substrate condition	Once annually (Fall)	--	

Notes:
1, Fillet samples were only collected in 2014 and the spring of 2015. Fillet samples were discontinued as part of the monitoring program and replaced with only plug samples (VDEQ, 2015).
2, Sample analysis for methylmercury was only conducted in 2014 and the spring of 2015. Methylmercury analysis was discontinued as part of the monitoring program and replaced with only total mercury analysis (VDEQ, 2015).
3, Final determination of which additional species, if any, that will be monitored will be made in collaboration with VDH and the regulatory agencies
4, Snapping turtle muscle tissue (ww) concentrations are converted from nail (ww) concentrations using Hopkins (2013b) regression and % moisture on muscle tissue samples
DO, dissolved oxygen; DOC, dissolved organic carbon; MeHg, methylmercury; RRM, relative river mile; SFS, South Fork Shenandoah River; T, temperature; THg, total mercury; TOC, total organic carbon; TSS, total suspended solids; YOY, Young-of-Year; LMB, Largemouth bass; SMB, Smallmouth bass
* Reference area
** Sampling conducted in concert with VADEQ routine monitoring; as a result, some parameters are analyzed on a different frequency or for different numbers of replicates
NA, Not applicable

Table 2-2
Short-Term Monitoring Scope Summary
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

Short-Term Remedial Action Objectives				Monitoring Plan Designs			Adaptive Management Outcomes	
General Objective	**Performance Objective**	**Measurable Metric**	**Preliminary Success Criteria**	**General Station Locations**	**Monitoring Frequency**	**Analytical Parameters**	**Contingency Actions**	**Decision Analysis**
Reduce Mercury Transport and Exposure	Increase in Bank Stability	Topography	Reduced Annual Erosion Rate	Shore Based LiDAR Surveys Conducted at Each BMA	Annually for First 3 Years; Post-storm	Average Annual Erosion Rate	Structural and/or Vegetative Stabilization	Refine Effectiveness Estimates
		Vegetation	>80% Cover; <10% Invasives	Vegetation Plots at Each BMA	Annually for First 3 Years; Post-storm	Cover and Species Composition	Additional Vegetation Enhancement	Refine Effectiveness Estimates
		Design and Implementation	Landowner Approvals and Permits	BMA Properties	NA	NA	NA	Refine Implementation Estimates
	Reduce Mercury Loading from Bank	Surface Sediment	>75% Mercury Concentration Reduction	Downstream of Representative BMAs (Nearshore)	Twice Annually for First 3 Years	IHg and MeHg Concentrations	NA	Refine Effectiveness Estimates
		Periphyton	>75% Mercury Concentration Reduction	Downstream of Representative BMAs (Nearshore)	Twice Annually for First 3 Years	IHg and MeHg Concentrations	NA	Refine Effectiveness Estimates
		Asiatic Clam Sampling	>75% Mercury Concentration Reduction	Downstream of Representative BMAs (Nearshore)	Twice Annually for First 3 Years	IHg and MeHg Concentrations	NA	Refine Effectiveness Estimates
	Reduce In-Channel Mercury Exposure	Periphyton	>50% Mercury Concentration Reduction	Downstream of Representative BMAs (Channel)	Annually for First 10 Years	IHg and MeHg Concentrations	NA	Refine CSM
		Asiatic Clam Sampling	>50% Mercury Concentration Reduction	Downstream of Representative BMAs (Channel)	Annually for First 10 Years	IHg and MeHg Concentrations	NA	Refine CSM
Maintain or Improve Riparian and Aquatic Habitat	Improve Bank Vegetation	Vegetation	>80% Cover; <10% Invasives	Vegetation Plots at Each BMA	Annually for First 3 Years	Cover and Species Composition	Additional Vegetation Enhancement	Refine Effectiveness Estimates
	Improve In-Stream Habitat	Rapid Bioassessment Protocols	Visual Stream Classification	Downstream of Representative BMAs	Quaterly for the First Year and Semi Annually (Q1/Q3) for years 2-10	Rapid Bioassessment Protocol Scores	NA	Refine Effectiveness Estimates

Notes:
NA, Not applicable
IHg, Inorganic Mercury
MeHg, MethylMercury
CSM, Conceptual Site Model
BMA, Bank Management Area

Table 3-1
Data Quality Objectives for Sediment Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

<table>
<tr><th>DQO Step</th><th>Description</th></tr>
<tr><td>STEP 1: State the problem</td><td>Sediment within the South River is impacted by mercury. These sediments serve as a potential source of methylmercury exposure to ecological receptors.</td></tr>
<tr><td>STEP 2: Identify the goals of the study</td><td>The sediment monitoring program has the following primary objectives:
Monitor exposure of invertebrates to sediment methylmercury, inorganic mercury, and total mercury.
Monitor natural recovery of sediment.</td></tr>
<tr><td>STEP 3: Identify the information inputs</td><td>Existing Data
A number of studies have evaluated mercury concentrations in sediment within the South River and South Fork Shenandoah Rivers. These studies include: CRG, 2008; Pizzuto 2009, 2011; URS, 2012.
New Data to Be Collected
Three interstitial sediment samples will be collected from coarse grained substrate beds at each study location. Samples will be analyzed for total and methylmercury as described below.</td></tr>
<tr><td>STEP 4: Define the boundaries of the study</td><td>Geographic Area
Sediment samples will be collected at 7 stations on the South River and South Fork Shenandoah River. The stations include:
<table>
<tr><th>Station ID</th><th>Description</th></tr>
<tr><td>SR-2.7</td><td>Existing SR-01 located at Lyndhurst Ave. to Ridgeview Park</td></tr>
<tr><td>SR0.1</td><td>Constitution Park/Waynesboro Reach</td></tr>
<tr><td>SR3.5</td><td>RRM 3.5</td></tr>
<tr><td>SR11.8</td><td>Dooms to Crimora Reach</td></tr>
<tr><td>SR23.5</td><td>Hariston to Port Republic Reach</td></tr>
<tr><td>SF26.6</td><td>South Fork Shenandoah @ Lynwood</td></tr>
<tr><td>SF48</td><td>SFS @ Shenandoah (above dam)</td></tr>
</table>
Note: Numbers associated with station IDs are river miles downstream of the footbridge at the former DuPont plant in Waynesboro, VA. Negative numbers indicate distance upstream of the footbridge.
Timeframe
Sampling and analysis will occur semi-annually in May and October
Sample Type
Interstitial sediment samples will be collected from coarse grained beds.</td></tr>
</table>

Table 3-1
Data Quality Objectives for Sediment Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

<table>
<tr><th>DQO Step</th><th>Description</th></tr>
<tr><td>STEP 5: Develop the analytical approach</td><td>Samples will be analyzed for total mercury (EPA 1631), methylmercury (EPA 1630, modified) and percent solids analysis (SM 20 2540 G-1997).</td></tr>
<tr><td>STEP 6: Specify performance or acceptance criteria</td><td>Field quality control sampling (field duplicates) will not be collected for biological samples. Laboratory duplicate samples will be analyzed from separate aliquots of the same parent sample after homogenization of the sample media.

Acceptance criteria for laboratory quality assurance samples and reporting limits are provided below.
<table>
<tr><th>Analyte</th><th>Laboratory Precision % RPD (LCSD)</th><th>Laboratory Accuracy % Recovery (LCS)</th><th>Laboratory Precision % RPD (MSD or Lab DUP)</th><th>Laboratory Accuracy % Recovery (MS)</th><th>Laboratory Reporting Limit (MDL)</th><th>Laboratory Reporting Limit (RL)</th><th>Project Reporting Limit (RL)</th></tr>
<tr><td>Total Mercury</td><td>30</td><td>75 - 125</td><td>30</td><td>70 - 130</td><td>0.12 ng/g</td><td>0.40 ng/g</td><td>0.40 ng/g</td></tr>
<tr><td>Methylmercury</td><td>35</td><td>65 - 135</td><td>35</td><td>65 - 135</td><td>1 ng/g</td><td>3 ng/g</td><td>3 ng/g</td></tr>
<tr><td>% Total Solids / % Dry Weight</td><td>N/A</td><td>N/A</td><td>15%</td><td>N/A</td><td>0.10%</td><td>0.1 ng/g</td><td>0.1 ng/g</td></tr>
</table>
Notes:
N/A - Not analyzed; LCS and LCSD will not be run for % solids analysis</td></tr>
<tr><td>STEP 7: Develop the detailed plan for obtaining data</td><td>Detailed plans for data collection are provided in the AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia (URS 2014).</td></tr>
</table>

References:

Pizzuto, J., M. O'Neal, D. Hubacz, D. Jurk, and S. Pomraning, 2011. Geomorphology Update. Presented at South River Science Team Meeting, Harrisonburg, Virginia, April 2011.

Pizzuto, J.P., and M. O'Neal, 2009. Increased mid-twentieth century riverbank erosion rates related to the demise of mill dams, South River, Virginia. *Geology* 37: 19-22.

URS, 2012. Final Report: Ecological Study of the South River and a Segment of the South Fork Shenandoah River, Virginia. Fort Washington, Pennsylvania. Final report prepared by URS Corporation. September 2012.

URS, 2014. AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia. Conshohocken, Pennsylvania. Final Work Plan prepared by URS Corporation. August 2014.

Table 3-2
Data Quality Objectives for Periphyton Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

DQO Step	Description
STEP 1: State the problem	Periphyton are a key component of the trophic transfer of methylmercury in the South River (URS 2012). Aquatic invertebrates feeding on epilithic periphyton (i.e., periphyton living on the surface of the substrate) ingest methylmercury adsorbed to sediment particles (Tom et al. 2010).
STEP 2: Identify the goals of the study	The periphyton monitoring program has the following primary objectives: • Identify trends in potential ecological exposure to methylmercury, inorganic mercury, and total mercury through consumption of periphyton. • Provide a data set for comparison with short-term monitoring elements
STEP 3: Identify the information inputs	Existing Data • A number of studies have evaluated mercury concentrations within the South River and South Fork Shenandoah Rivers. These studies include: Brent, 2010; Tom et al., 2010; URS, 2012. New Data to Be Collected • Three periphyton samples will be collected at each study location. Samples will be analyzed for total and methylmercury as described below.

Table 3-2
Data Quality Objectives for Periphyton Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

<table>
<tr><th>DQO Step</th><th>Description</th></tr>
<tr><td>STEP 4: Define the boundaries of the study</td><td>
Geographic Area
Periphyton samples will be collected at 7 stations on the South River and South Fork Shenandoah River. The stations include:
<table>
<tr><th>Station ID</th><th>Description</th></tr>
<tr><td>SR-2.7</td><td>Existing SR-01 located at Lyndhurst Ave. to Ridgeview Park</td></tr>
<tr><td>SR0.1</td><td>Constitution Park/Waynesboro Reach</td></tr>
<tr><td>SR3.5</td><td>RRM 3.5</td></tr>
<tr><td>SR11.8</td><td>Dooms to Crimora Reach</td></tr>
<tr><td>SR23.5</td><td>Hariston to Port Republic Reach</td></tr>
<tr><td>SF26.6</td><td>South Fork Shenandoah @ Lynwood</td></tr>
<tr><td>SF48</td><td>SFS @ Shenandoah (above dam)</td></tr>
</table>
Note: Numbers associated with station IDs are river miles downstream of the footbridge at the former DuPont plant in Waynesboro, VA. Negative numbers indicate distance upstream of the footbridge.

Timeframe
Sampling and analysis will occur semi-annually in May and October
Sample Type
Periphyton tissue will be collected from the surfaces of cobbles collected from the stream
</td></tr>
<tr><td>STEP 5: Develop the analytical approach</td><td>Samples will be analyzed for total mercury (EPA 1631) and methylmercury (EPA 1630, modified).
Percent solids analysis (SM 2540 G-1997) will be performed if there is sufficient sample mass.</td></tr>
</table>

Table 3-2
Data Quality Objectives for Periphyton Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

<table>
<tr><th>DQO Step</th><th>Description</th></tr>
<tr><td>STEP 6: Specify performance or acceptance criteria</td><td>Field quality control sampling (field duplicates) will not be collected for biological samples. Laboratory duplicate samples will be analyzed from separate aliquots of the same parent sample after homogenization of the sample media.

Acceptance criteria for laboratory quality assurance samples and reporting limits are provided below.
<table>
<tr><th>Analyte</th><th>Laboratory Precision % RPD (LCSD)</th><th>Laboratory Accuracy % Recovery (LCS)</th><th>Laboratory Precision % RPD (MSD or Lab DUP)</th><th>Laboratory Accuracy % Recovery (MS)</th><th>Laboratory Reporting Limit (MDL)</th><th>Laboratory Reporting Limit (RL)</th><th>Project Reporting Limit (RL)</th></tr>
<tr><td>Total Mercury</td><td>30</td><td>75 - 125</td><td>30</td><td>70 - 130</td><td>0.12 ng/g</td><td>0.40 ng/g</td><td>0.40 ng/g</td></tr>
<tr><td>Methylmercury</td><td>35</td><td>65 - 135</td><td>35</td><td>65 - 135</td><td>1 ng/g</td><td>3 ng/g</td><td>3 ng/g</td></tr>
<tr><td>% Total Solids / % Dry Weight</td><td>N/A</td><td>N/A</td><td>15%</td><td>N/A</td><td>0.10%</td><td>0.1 ng/g</td><td>0.1 ng/g</td></tr>
</table>
Notes:
N/A - Not analyzed; LCS and LCSD will not be run for % solids analysis</td></tr>
<tr><td>STEP 7: Develop the detailed plan for obtaining data</td><td>Detailed plans for data collection are provided in the AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia (URS 2014).</td></tr>
</table>

References:

Brent, R.N., 2010. Use of experimental stream mesocosms to assess mercury uptake in periphyton. South River Science Team, Harrisonburg, Virginia, October 5, 2010.

Tom, K.R., M.C. Newman, and J. Schmerfeld. 2010. Modeling mercury biomagnification (South River, Virginia, USA) to inform river management decision making. Environmental Toxicology and Chemistry. 29 (4): 1013-1020.

URS, 2012. Final Report: Ecological Study of the South River and a Segment of the South Fork Shenandoah River, Virginia. Fort Washington, Pennsylvania. Final report prepared by URS Corporation. September 2012.

URS, 2014. AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia. Conshohocken, Pennsylvania. Final Work Plan prepared by URS Corporation. August 2014.

Table 3-3
Data Quality Objectives for Benthic Invertebrate Tissue Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

DQO Step	Description
STEP 1: State the problem	Benthic invertebrates including the Asiatic clam (*Corbicula fluminea*) and larval *Heptageniidae* mayflies play an important role in the aquatic and terrestrial food webs of the South River. They are also a key component of the trophic transfer of MeHg to ecological receptors within in the South River ecosystem (URS 2012).
STEP 2: Identify the goals of the study	The benthic invertebrate monitoring program has the following primary objectives: • Identify trends in potential ecological exposure to methylmercury, inorganic mercury, and total mercury through consumption of benthic invertebrates. • Monitor responses to decreasing mercury loads

STEP 3: Identify the information inputs	Existing Data
	• A number of studies have evaluated mercury concentrations within the South River and South Fork Shenandoah Rivers. These studies include:
	  o Phase I Ecological Study (CRG, 2008)
	  o Ecological Study Final Report (URS 2012)
	New Data to Be Collected
	• Three composite samples each of Asiatic clams (caged) and larval Heptageniidae mayflies will be collected for mercury analysis at each site.

Table 3-3
Data Quality Objectives for Benthic Invertebrate Tissue Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

<table>
<tr><th>DQO Step</th><th>Description</th></tr>
<tr><td>STEP 4: Define the boundaries of the study</td><td>
Geographic Area
Benthic invertebrate samples will be collected at seven stations on the South River and South Fork Shenandoah River. The stations include:
<table>
<tr><th>Station ID</th><th>Description</th></tr>
<tr><td>SR-2.7</td><td>Existing SR-01 located at Lyndhurst Ave. to Ridgeview Park</td></tr>
<tr><td>SR0.1</td><td>Constitution Park/Waynesboro Reach</td></tr>
<tr><td>SR3.5</td><td>RRM 3.5</td></tr>
<tr><td>SR11.8</td><td>Dooms to Crimora Reach</td></tr>
<tr><td>SR23.5</td><td>Hariston to Port Republic Reach</td></tr>
<tr><td>SF26.6</td><td>South Fork Shenandoah @ Lynwood</td></tr>
<tr><td>SF48</td><td>SFS @ Shenandoah (above dam)</td></tr>
</table>
Notes:
Numbers associated with station IDs are river miles downstream of the footbridge at the former DuPont plant in Waynesboro, VA. Negative numbers indicate distance upstream of the footbridge.
Timeframe
Sampling and analysis will occur semi-annually in May and October
Sample Type
Asiatic clams will be collected from a suitable reference area (e.g. North River or Middle River) and transported to the South River for deployment. Caged clams will be placed into mesh cages suspended 2 inches above the sediment in the approximate center of the river (i.e. away from the banks) to determine the aqueous exposure regime. Clam samples will be harvested after a five-week deployment and depurated for 24 hours in aerated, distilled water to purge gut contents. Three composite samples of 10 individuals will be collected from each site.
Heptagenid mayfly samples will also be composites of ~ 10 individuals of similar size (i.e., smallest individual > 75% of the size largest individual). Mayflies will be depurated for 24 hours in aerated distilled water to purge gut contents.
</td></tr>
<tr><td>STEP 5: Develop the analytical approach</td><td>Samples will be analyzed for total mercury (EPA 1631) and methylmercury (EPA 1630, modified).
Percent solids analysis (SM 2540 G-1997) will be performed if there is sufficient sample mass.</td></tr>
</table>

Table 3-3
Data Quality Objectives for Benthic Invertebrate Tissue Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

<table>
<tr><th>DQO Step</th><th>Description</th></tr>
<tr><td>STEP 6: Specify performance or acceptance criteria</td><td>Field quality control sampling (field duplicates) will not be collected for biological samples. Laboratory duplicate samples will be analyzed from separate aliquots of the same parent sample after homogenization of the sample media.

Acceptance criteria for laboratory quality assurance samples and reporting limits are provided below.
<table>
<tr><th>Analyte</th><th>Laboratory Precision % RPD (LCSD)</th><th>Laboratory Accuracy % Recovery (LCS)</th><th>Laboratory Precision % RPD (MSD or Lab DUP)</th><th>Laboratory Accuracy % Recovery (MS)</th><th>Laboratory Reporting Limit (MDL)</th><th>Laboratory Reporting Limit (RL)</th><th>Project Reporting Limit (RL)</th></tr>
<tr><td>Total Mercury</td><td>30</td><td>75 - 125</td><td>30</td><td>70 - 130</td><td>0.12 ng/g</td><td>0.40 ng/g</td><td>0.40 ng/g</td></tr>
<tr><td>Methylmercury</td><td>35</td><td>65 - 135</td><td>35</td><td>65 - 135</td><td>1 ng/g</td><td>3 ng/g</td><td>3 ng/g</td></tr>
<tr><td>% Total Solids / % Dry Weight</td><td>N/A</td><td>N/A</td><td>15%</td><td>N/A</td><td>0.10%</td><td>0.1 ng/g</td><td>0.1 ng/g</td></tr>
</table>
Notes:
N/A - Not analyzed; LCS and LCSD will not be run for % solids analysis</td></tr>
<tr><td>STEP 7: Develop the detailed plan for obtaining data</td><td>Detailed plans for data collection are provided in the AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia (URS 2014).</td></tr>
</table>

References:

CRG. 2008. *Phase 1, Year 1 Progress Report: Ecological study of the South River and a segment of the South Fork Shenandoah River, Virginia*. Wilmington, Delaware.

URS, 2012. Final Report: Ecological Study of the South River and a Segment of the South Fork Shenandoah River, Virginia. Fort Washington, Pennsylvania. Final report prepared by URS Corporation. September 2012.

URS, 2014. AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia. Conshohocken, Pennsylvania. Final Work Plan prepared by URS Corporation. August 2014.

Table 3-4
Data Quality Objectives for Young-of-Year Bass Tissue Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

DQO Step	Description
STEP 1: State the problem	The consumption of fish by ecological receptors in the South River and South Fork Shenandoah Rivers is an important methylmercury exposure pathway. Among small sized fish (i.e. <130 millimeters) from the South River, juvenile smallmouth bass (*Micropterus dolomieu*) have been demonstrated to have the highest mercury concentrations due to dietary preferences (Murphy, 2004).
STEP 2: Identify the goals of the study	The fish tissue monitoring program has the following three primary objectives: • Monitor exposure of Young-of-Year (YOY) fish to methylmercury, inorganic mercury, and total mercury in water and dietary items • Monitor exposure of ecological receptors (e.g., piscivorous birds) to methylmercury, inorganic mercury, and total mercury in YOY fish • Document potential declines in methylmercury, inorganic mercury, and total mercury exposure due to remediation
STEP 3: Identify the information inputs	Existing Data • To date there have been limited studies evaluating mercury concentrations in YOY bass from the South River or the South Fork Shenandoah River. Murphy (2004) characterized mercury concentrations in prey items (including juvenile smallmouth bass) within the South River and South Fork Shenandoah Rivers. • Ten YOY smallmouth bass will be collected at each monitoring location. Fish will be analyzed as whole-fish samples for total mercury, methylmercury and percent solids as described below.

Table 3-4
Data Quality Objectives for Young-of-Year Bass Tissue Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

<table>
<tr><th>DQO Step</th><th>Description</th></tr>
<tr><td>STEP 4: Define the boundaries of the study</td><td>
Geographic Area
Smallmouth bass samples will be collected at six stations on the South River, South Fork Shenandoah River and Shenandoah River. The stations include:
<table>
<tr><th>Station ID</th><th>Description</th></tr>
<tr><td>SR-2.7</td><td>Existing SR-01 located at Lyndhurst Ave. to Ridgeview Park</td></tr>
<tr><td>SR0.1</td><td>Constitution Park/Waynesboro Reach</td></tr>
<tr><td>SR11.8</td><td>Dooms to Crimora Reach</td></tr>
<tr><td>SR23.5</td><td>Hariston to Port Republic Reach</td></tr>
<tr><td>SF26.6</td><td>South Fork Shenandoah @ Lynwood</td></tr>
<tr><td>SF48</td><td>SFS @ Shenandoah (above dam)</td></tr>
</table>
Note: Numbers associated with station IDs are river miles downstream of the footbridge at the former DuPont plant in Waynesboro, VA. Negative numbers indicate distance upstream of the footbridge.

Timeframe
Sampling and analysis will occur annually in September/October
Sample Type
Samples for analysis will consist of individual, whole-body, YOY smallmouth bass.
</td></tr>
<tr><td>STEP 5: Develop the analytical approach</td><td>Samples will be analyzed for total mercury (EPA 1631), methylmercury (EPA 1630, modified) and percent solids analysis (SM 2540 G-1997).</td></tr>
</table>

Table 3-4
Data Quality Objectives for Young-of-Year Bass Tissue Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

<table>
<tr><th>DQO Step</th><th>Description</th></tr>
<tr><td>STEP 6: Specify performance or acceptance criteria</td><td>Field quality control sampling (field duplicates) will not be collected for biological samples. Laboratory duplicate samples will be analyzed from separate aliquots of the same parent sample after homogenization of the sample media.

Acceptance criteria for laboratory quality assurance samples and reporting limits are provided below.
<table>
<tr><th>Analyte</th><th>Laboratory Precision % RPD (LCSD)</th><th>Laboratory Accuracy % Recovery (LCS)</th><th>Laboratory Precision % RPD (MSD or Lab DUP)</th><th>Laboratory Accuracy % Recovery (MS)</th><th>Laboratory Reporting Limit (MDL)</th><th>Laboratory Reporting Limit (RL)</th><th>Project Reporting Limit (RL)</th></tr>
<tr><td>Total Mercury</td><td>30</td><td>75 - 125</td><td>30</td><td>70 - 130</td><td>0.12 ng/g</td><td>0.40 ng/g</td><td>0.40 ng/g</td></tr>
<tr><td>Methyl Mercury</td><td>35</td><td>65 - 135</td><td>35</td><td>65 - 135</td><td>1 ng/g</td><td>3 ng/g</td><td>3 ng/g</td></tr>
<tr><td>% Total Solids / % Dry Weight</td><td>N/A</td><td>N/A</td><td>15%</td><td>N/A</td><td>0.10%</td><td>0.1 ng/g</td><td>0.1 ng/g</td></tr>
</table>
Notes:
N/A - Not analyzed; LCS and LCSD will not be run for % solids analysis</td></tr>
<tr><td>STEP 7: Develop the detailed plan for obtaining data</td><td>Detailed plans for data collection are provided in the AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia (URS 2014).</td></tr>
</table>

References:

Murphy, G.W. 2004. Uptake of Mercury and Relationship to Food Habits of Selected Fish Species in the Shenandoah River Basin, Virginia. Masters Thesis. Virginia Tech, Blacksburg, Virginia.

URS, 2014. AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia. Conshohocken, Pennsylvania. Final Work Plan prepared by URS Corporation. August 2014.

Table 3-5
Data Quality Objectives for Soil Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

DQO Step	Description
STEP 1: State the problem	Floodplain soils are a primary reservoir of mercury in the South River watershed and serve as a potential exposure pathway of mercury to terrestrial invertebrates.
STEP 2: Identify the goals of the study	The soil monitoring program has the following primary objectives: • Monitor exposure of terrestrial ecological receptors to methylmercury, inorganic mercury, and total mercury. • Provide co-located soils data associated with earthworm tissue data
STEP 3: Identify the information inputs	Existing Data • Mercury concentrations have been documented in soils from the South River floodplain and river banks. Comprehensive sampling of the South River floodplain soils was performed in 2008 to evaluate THg concentration distributions (URS 2012). Additionally, bank soils were sampled extensively from RRM 0 – RRM 5 in support of remedial design (Anchor QEA and URS 2014). New Data to Be Collected • Three composite soil samples will be collected at each study location and analyzed for total and methylmercury.

Table 3-5
Data Quality Objectives for Soil Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

<table>
<tr><th>DQO Step</th><th>Description</th></tr>
<tr><td>STEP 4: Define the boundaries of the study</td><td>
Geographic Area
Soil samples will be collected at 9 stations on the South River and South Fork Shenandoah River. The stations include:
<table>
<tr><th>Station ID</th><th>Description</th></tr>
<tr><td>SR-6.2</td><td>Waynesboro Nursery</td></tr>
<tr><td>SR-2.7</td><td>Existing SR-01 located at Lyndhurst Ave. to Ridgeview Park</td></tr>
<tr><td>SR2.0</td><td>Basic Park</td></tr>
<tr><td>SR8.9</td><td>Crimora</td></tr>
<tr><td>SR22</td><td>Grottoes Town Park</td></tr>
<tr><td>SF31</td><td>South Fork Shenandoah @ the Power Dam</td></tr>
<tr><td>SF50</td><td>Shuler’s Island</td></tr>
<tr><td>SF66</td><td>Long Bend Farm</td></tr>
<tr><td>SF85</td><td>Bealer’s Ferry</td></tr>
</table>
Notes:
Numbers associated with station IDs are river miles downstream of the footbridge at the former DuPont plant in Waynesboro, VA. Negative numbers indicate distance upstream of the footbridge.
Timeframe
Sampling and analysis will occur annually in June-July
Sample Type
Composite soil samples collected from the 0-12” interval will be collected using a stainless steel shovel or hand auger. Soil samples will be collected adjacent to the river in upland habitats.
</td></tr>
<tr><td>STEP 5: Develop the analytical approach</td><td>Samples will be analyzed for total mercury (EPA 1631), methylmercury (EPA 1630, modified) and percent solids analysis (SM 2540 G-1997).</td></tr>
</table>

Table 3-5
Data Quality Objectives for Soil Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

<table>
<tr><th>DQO Step</th><th>Description</th></tr>
<tr><td>STEP 6: Specify performance or acceptance criteria</td><td>Field quality control sampling (field duplicates) will be collected at a rate of 5%. Laboratory QA/QC (MS/MSD) samples will be analyzed from separate aliquots of the same parent sample after homogenization of the sample media.

Acceptance criteria for laboratory quality assurance samples and reporting limits are provided below.
<table>
<tr><th>Analyte</th><th>Laboratory Precision % RPD (LCSD)</th><th>Laboratory Accuracy % Recovery (LCS)</th><th>Laboratory Precision % RPD (MSD or Lab DUP)</th><th>Laboratory Accuracy % Recovery (MS)</th><th>Laboratory Reporting Limit (MDL)</th><th>Laboratory Reporting Limit (RL)</th><th>Project Reporting Limit (RL)</th></tr>
<tr><td>Total Mercury</td><td>30</td><td>75 - 125</td><td>30</td><td>70 - 130</td><td>0.12 ng/g</td><td>0.40 ng/g</td><td>0.40 ng/g</td></tr>
<tr><td>Methylmercury</td><td>35</td><td>65 - 135</td><td>35</td><td>65 - 135</td><td>1 ng/g</td><td>3 ng/g</td><td>3 ng/g</td></tr>
<tr><td>% Total Solids / % Dry Weight</td><td>N/A</td><td>N/A</td><td>15%</td><td>N/A</td><td>0.10%</td><td>0.1 ng/g</td><td>0.1 ng/g</td></tr>
</table>
Notes:
N/A - Not analyzed; LCS and LCSD will not be run for % solids analysis</td></tr>
<tr><td>STEP 7: Develop the detailed plan for obtaining data</td><td>Detailed plans for data collection are provided in the AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia (URS 2014).</td></tr>
</table>

References:

Anchor QEA and URS, 2013. Remediation Proposal – South River and a Segment of the South Fork Shenandoah River, Virginia. Final report prepared by Anchor QEA, 2013.

URS, 2012. Final Report: Ecological Study of the South River and a Segment of the South Fork Shenandoah River, Virginia. Fort Washington, Pennsylvania. Final report prepared by URS Corporation. September 2012.

URS, 2014. AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia. Conshohocken, Pennsylvania. Final Work Plan prepared by URS Corporation. August 2014.

Table 3-6
Data Quality Objectives for Terrestrial Invertebrate Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

DQO Step	Description
STEP 1: State the problem	Spiders are an important food item for songbirds and may be an important potential link in the transfer of MeHg between the aquatic and terrestrial components of the South River (Cristol et al. 2008). Earthworms (suborder *Lumbricina)* are also important food items for terrestrial ecological receptors. In addition, they are in close contact with soil, which is a primary reservoir of mercury in the South River watershed.
STEP 2: Identify the goals of the study	The terrestrial invertebrate monitoring program has the following primary objectives: • Monitor exposure of terrestrial ecological receptors to methylmercury, inorganic mercury, and total mercury. • Monitor methylmercury, inorganic mercury, and total mercury transfer between aqueous and terrestrial compartments of the South River. • Monitor potential terrestrial bioaccumulation.
STEP 3: Identify the information inputs	Existing Data • A number of studies have evaluated mercury concentrations in spiders and earthworms within the South River watershed. These studies include: Cristol et. Al 2008; Newman et al. 2011; Cianchetti et al. 2009. New Data to Be Collected • Five individual wolf spiders (*Lycosidae*) will be collected at each study location and analyzed for total and methylmercury. • Three composite samples of earthworms will be collected at each study location and analyzed for total and methylmercury.

Table 3-6
Data Quality Objectives for Terrestrial Invertebrate Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

<table>
<tr><th>DQO Step</th><th>Description</th></tr>
<tr><td>STEP 4: Define the boundaries of the study</td><td>
Geographic Area
Terrestrial invertebrate samples will be collected at 9 stations on the South River and South Fork Shenandoah River. The stations include:
<table>
<tr><th>Station ID</th><th>Description</th></tr>
<tr><td>SR-6.2</td><td>Waynesboro Nursery</td></tr>
<tr><td>SR-2.7</td><td>Existing SR-01 located at Lyndhurst Ave. to Ridgeview Park</td></tr>
<tr><td>SR2.0</td><td>Basic Park</td></tr>
<tr><td>SR8.9</td><td>Crimora</td></tr>
<tr><td>SR22</td><td>Grottoes Town Park</td></tr>
<tr><td>SF31</td><td>South Fork Shenandoah @ the Power Dam</td></tr>
<tr><td>SF50</td><td>Shuler’s Island</td></tr>
<tr><td>SF66</td><td>Long Bend Farm</td></tr>
<tr><td>SF85</td><td>Bealer’s Ferry</td></tr>
</table>
Notes:
Numbers associated with station IDs are river miles downstream of the footbridge at the former DuPont plant in Waynesboro, VA. Negative numbers indicate distance upstream of the footbridge.

Timeframe
Sampling and analysis will occur annually in June-July
Sample Type
Wolf spider samples will be analyzed individually. Five individuals will be collected at each study site.
Earthworm samples will be analyzed as composite samples comprised of approximately 3-10 worms per composite.
</td></tr>
<tr><td>STEP 5: Develop the analytical approach</td><td>Samples will be analyzed for total mercury (EPA 1631) and methylmercury (EPA 1630, modified).
Percent solids analysis (SM 2540 G-1997) will be performed if there is sufficient sample mass.</td></tr>
</table>

Table 3-6
Data Quality Objectives for Terrestrial Invertebrate Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

<table>
<tr><th>DQO Step</th><th>Description</th></tr>
<tr><td>STEP 6: Specify performance or acceptance criteria</td><td>Field quality control sampling (field duplicates) will not be collected for biological samples. Laboratory duplicate samples will be analyzed from separate aliquots of the same parent sample after homogenization of the sample media.

Acceptance criteria for laboratory quality assurance samples and reporting limits are provided below.
<table>
<tr><th>Analyte</th><th>Laboratory Precision % RPD (LCSD)</th><th>Laboratory Accuracy % Recovery (LCS)</th><th>Laboratory Precision % RPD (MSD or Lab DUP)</th><th>Laboratory Accuracy % Recovery (MS)</th><th>Laboratory Reporting Limit (MDL)</th><th>Laboratory Reporting Limit (RL)</th><th>Project Reporting Limit (RL)</th></tr>
<tr><td>Total Mercury</td><td>30</td><td>75 - 125</td><td>30</td><td>70 - 130</td><td>0.12 ng/g</td><td>0.40 ng/g</td><td>0.40 ng/g</td></tr>
<tr><td>Methyl Mercury</td><td>35</td><td>65 - 135</td><td>35</td><td>65 - 135</td><td>1 ng/g</td><td>3 ng/g</td><td>3 ng/g</td></tr>
<tr><td>% Total Solids / % Dry Weight</td><td>N/A</td><td>N/A</td><td>15%</td><td>N/A</td><td>0.10%</td><td>0.1 ng/g</td><td>0.1 ng/g</td></tr>
</table>
Notes:
N/A - Not analyzed; LCS and LCSD will not be run for % solids analysis</td></tr>
<tr><td>STEP 7: Develop the detailed plan for obtaining data</td><td>Detailed plans for data collection are provided in the AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia (URS 2014).</td></tr>
</table>

References:

Cianchetti, J, W.R. Berti, and D. Cocking, 2009. Survey of the Mercury Content of Earthworms on the South River (Virginia USA) Floodplain. Briefing paper provided to the South River Science Team, Harrisonburg, VA.

Cristol, D.A., R.L. Brasso, A.M. Condon, R.E. Fovargue, S.L. Friedman, K.K. Hallinger, A.P. Monroe, A.E. White. 2008. The movement of aquatic mercury through terrestrial food webs. Science. 320: 335.

Newman, M. C., L. Liang, and X. Xu. 2011. South River Trophic Studies. Prepared for E.I. duPont de Nemours and Company.

URS, 2014. AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia. Conshohocken, Pennsylvania. Final Work Plan prepared by URS Corporation. August 2014.

Table 3-7
Data Quality Objectives for Carolina Wren Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

DQO Step	Description
STEP 1: State the problem	Previous studies conducted on the South River and South Fork Shenandoah river have found that Carolina wren (*Thryothorus ludovicianus*) had mercury in their blood and feathers at concentrations that were elevated above reference (Cristol et al., 2008; Jackson and Evers, 2011).
STEP 2: Identify the goals of the study	The overall objective of avian blood sampling and analyses is to evaluate recent (e.g., weeks to months) dietary exposure of total mercury to a representative aerial insectivore (e.g., Carolina wren) potentially foraging in the South River watershed.

STEP 3: Identify the information inputs	Existing Data
	• Several studies have been conducted to evaluate the potential accumulation of mercury in songbirds in habitat adjacent to South River and South Fork Shenandoah River. These studies include:
	  o Cristol et al., 2008;
	  o Jackson and Evers, 2011.
	
	New Data to Be Collected
	• Blood samples from three to eight individuals will be collected at each study site during the summer months (June-July) and analyzed for total mercury.

Table 3-7
Data Quality Objectives for Carolina Wren Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

<table>
<tr><th>DQO Step</th><th>Description</th></tr>
<tr><td>STEP 4: Define the boundaries of the study</td><td>
Geographic Area
Carolina wren blood samples will be collected at nine stations on the South River and South Fork Shenandoah River. The stations include:
<table>
<tr><th>Station ID</th><th>Description</th></tr>
<tr><td>SR-6.2</td><td>Waynesboro Nursery</td></tr>
<tr><td>SR-1.2</td><td>Ridgeview Park</td></tr>
<tr><td>SR0.1 to 2.3</td><td>Basic Park</td></tr>
<tr><td>SR9</td><td>Crimora</td></tr>
<tr><td>SR22</td><td>Grottoes Town Park</td></tr>
<tr><td>SF31</td><td>South Fork Shenandoah @ the Power Dam</td></tr>
<tr><td>SF50</td><td>Shuler’s Island</td></tr>
<tr><td>SF66</td><td>Long Bend Farm</td></tr>
<tr><td>SF85</td><td>Bealer’s Ferry</td></tr>
</table>
Notes:
Numbers associated with station IDs are river miles downstream of the footbridge at the former DuPont plant in Waynesboro, VA. Negative numbers indicate distance upstream of the footbridge.
Timeframe
Sampling and analysis will occur annually in June-July.
Sample Type
Carolina wren blood samples will be collected from three to eight individuals at each study site.
</td></tr>
<tr><td>STEP 5: Develop the analytical approach</td><td>Samples will be analyzed for total mercury (EPA 1631).</td></tr>
</table>

Table 3-7
Data Quality Objectives for Carolina Wren Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

<table>
<tr><th>DQO Step</th><th>Description</th></tr>
<tr><td>STEP 6: Specify performance or acceptance criteria</td><td>Field quality control sampling (field duplicates) will not be collected for biological samples. Laboratory duplicate samples will be analyzed from separate aliquots of the same parent sample after homogenization of the sample media.

Acceptance criteria for laboratory quality assurance samples and reporting limits are provided below.
<table>
<tr><th>Analyte</th><th>Laboratory Precision % RPD (LCSD)</th><th>Laboratory Accuracy % Recovery (LCS)</th><th>Laboratory Precision % RPD (MSD or Lab DUP)</th><th>Laboratory Accuracy % Recovery (MS)</th><th>Laboratory Reporting Limit (MDL)</th><th>Laboratory Reporting Limit (RL)</th><th>Project Reporting Limit (RL)</th></tr>
<tr><td>Total Mercury</td><td>30</td><td>75 - 125</td><td>30</td><td>70 - 130</td><td>0.12 ng/g</td><td>0.40 ng/g</td><td>0.40 ng/g</td></tr>
</table></td></tr>
<tr><td>STEP 7: Develop the detailed plan for obtaining data</td><td>Detailed plans for data collection are provided in the AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia (URS 2014).</td></tr>
</table>

References:

Cristol, D.A., R.L. Brasso, A.M. Condon, R.E. Fovargue, S.L. Friedman, K.K. Hallinger, A.P. Monroe, A.E. White. 2008. The movement of aquatic mercury through terrestrial food webs. Science. 320: 335.

Jackson, A.K., D.C. Evers, S.B. Folsom, A.M. Condon, J. Diener, L.F. Goodrick, A.J. McGann, J. Schmerfeld, D.A. Cristol. 2011a. Mercury exposure in terrestrial birds far downstream of an historical point source. Environmental Pollution. 159(12): 3302-3308.

Jackson, A.K., D.C. Evers, M.A. Etterson, A.M. Condon, S.B. Folsom, J. Detweiler, J. Schmerfeld, D.A. Cristol. 2011b. Mercury exposure affects the reproductive success of a free-living terrestrial songbird, the Carolina Wren (Thryothorus ludovicianus). The Auk. 128(4): 759-769.

URS, 2014. AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia. Conshohocken, Pennsylvania. Final Work Plan prepared by URS Corporation. August 2014.

Table 3-8
Data Quality Objectives for Adult Bass Tissue Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

DQO Step	Description
STEP 1: State the problem	The consumption of fish tissue by people is one of the main sources of potential mercury exposure in the South River and South Fork Shenandoah River.
STEP 2: Identify the goals of the study	The fish tissue monitoring program has the following three primary objectives: • Identify trends in potential human exposure to methylmercury, inorganic mercury, and total mercury. • Assess variability in methylmercury, inorganic mercury, and total mercury concentrations in adult bass based on seasonality and sex. • Develop a non-lethal fish tissue biopsy method for future monitoring to avoid negative population impacts associated with repeated sampling.[1]
STEP 3: Identify the information inputs	Existing Data • A number of studies have evaluated mercury concentrations in fish tissue from the South River and South Fork Shenandoah River including data sets collected by VADEQ and other members of the South River Science team. The following studies have provided data/input that was considered when designing the current study: VADEQ (multiple datasets); Murphy 2004; URS 2012. New Data To Be Collected • Fish tissue samples (fillets and plugs) will be collected from 10, edible-sized largemouth bass (*Micropterus salmoides*) and smallmouth bass (*Micropterus dolomieu*) at each study location. Samples will be analyzed for total and methylmercury as described below.[2]

[1] Fillet samples were only collected in 2014 and the spring of 2015. Fillet samples were discontinued as part of the monitoring program and replaced with only plug samples (VDEQ, 2015).

[2] Sample analysis for methylmercury was only conducted in 2014 and the spring of 2015. Methylmercury analysis was discontinued as part of the monitoring program and replaced with only total mercury analysis (VDEQ, 2015).

Table 3-8
Data Quality Objectives for Adult Bass Tissue Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

<table>
<tr><th>DQO Step</th><th>Description</th></tr>
<tr><td>STEP 4: Define the boundaries of the study</td><td>
Geographic Area
Smallmouth and Largemouth bass tissue samples will be collected at 13 stations on the South River, South Fork Shenandoah River and Shenandoah River. The stations include:
<table>
<tr><th>Station ID</th><th>Description</th></tr>
<tr><td>SR-2.7</td><td>Existing SR-01 located at Lyndhurst Ave. to Ridgeview Park</td></tr>
<tr><td>SR0.1</td><td>Constitution Park/Waynesboro Reach</td></tr>
<tr><td>SR11.8</td><td>Dooms to Crimora Reach</td></tr>
<tr><td>SR23.5</td><td>Hariston to Port Republic Reach</td></tr>
<tr><td>SF26.6</td><td>South Fork Shenandoah @ Lynwood</td></tr>
<tr><td>SF48</td><td>SFS @ Shenandoah (above dam)</td></tr>
<tr><td>SF63</td><td>Newport Landing</td></tr>
<tr><td>SF72</td><td>Hamburg, VA near Rt. 211 Bridge</td></tr>
<tr><td>SF89.4</td><td>Foster's Landing, near Rt. 694 Bridge</td></tr>
<tr><td>SF106</td><td>Bentonville Landing, near Rt. 613 Bridge</td></tr>
<tr><td>SF115</td><td>Karo Landing</td></tr>
<tr><td>SH143</td><td>Rt. 17/50 Bridge</td></tr>
<tr><td>SH158</td><td>Berryville, VA near Rt. 7 bridge</td></tr>
</table>
Note: Numbers associated with station IDs are river miles downstream of the footbridge at the former DuPont plant in Waynesboro, VA. Negative numbers indicate distance upstream of the footbridge.

Timeframe
Sampling and analysis will occur semi-annually in May/June and September/October
Sample Type
Tissue biopsy plugs (3-3.5 mm) will be collected in the field from each fish in order to evaluate the representativeness of non-lethal sampling techniques.
Fish tissue samples will be analyzed as fillets (skin on, scales off).
</td></tr>
<tr><td>STEP 5: Develop the analytical approach</td><td>Both fillet and plug samples will be analyzed for total mercury (EPA 1631) and methylmercury (EPA 1630, modified).
Additionally, percent solids analysis (SM 2540 G-1997) will be performed on fillet samples due to the low sample mass in plug samples.</td></tr>
</table>

Table 3-8
Data Quality Objectives for Adult Bass Tissue Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

<table>
<tr><th>DQO Step</th><th>Description</th></tr>
<tr><td>STEP 6: Specify performance or acceptance criteria</td><td>Field quality control sampling (field duplicates) will not be collected for biological samples. Laboratory duplicate samples will be analyzed from separate aliquots of the same parent sample after homogenization of the sample media.

Acceptance criteria for laboratory quality assurance samples and reporting limits are provided below.
<table>
<tr><th>Analyte</th><th>Laboratory Precision % RPD (LCSD)</th><th>Laboratory Accuracy % Recovery (LCS)</th><th>Laboratory Precision % RPD (MSD or Lab DUP)</th><th>Laboratory Accuracy % Recovery (MS)</th><th>Laboratory Reporting Limit (MDL)</th><th>Laboratory Reporting Limit (RL)</th><th>Project Reporting Limit (RL)</th></tr>
<tr><td>Total Mercury</td><td>30</td><td>75 - 125</td><td>30</td><td>70 - 130</td><td>0.12 ng/g</td><td>0.40 ng/g</td><td>0.40 ng/g</td></tr>
<tr><td>Methylmercury</td><td>35</td><td>65 - 135</td><td>35</td><td>65 - 135</td><td>1 ng/g</td><td>3 ng/g</td><td>3 ng/g</td></tr>
<tr><td>% Total Solids / % Dry Weight</td><td>N/A</td><td>N/A</td><td>15%</td><td>N/A</td><td>0.10%</td><td>0.1 ng/g</td><td>0.1 ng/g</td></tr>
</table>
Notes:
N/A - Not analyzed; LCS and LCSD will not be run for % solids analysis</td></tr>
<tr><td>STEP 7: Develop the detailed plan for obtaining data</td><td>Detailed plans for data collection are provided in the AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia (URS 2014).</td></tr>
</table>

References:

Murphy, G.W. 2004. Uptake of Mercury and Relationship to Food Habits of Selected Fish Species in the Shenandoah River Basin, Virginia. Masters Thesis. Virginia Tech, Blacksburg, Virginia.

URS, 2012. Final Report: Ecological Study of the South River and a Segment of the South Fork Shenandoah River, Virginia. Fort Washington, Pennsylvania. Final report prepared by URS Corporation. September 2012.

URS, 2014. AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia. Conshohocken, Pennsylvania. Final Work Plan prepared by URS Corporation. August 2014.

VDEQ, 2015. Re: AOC# 4 - Proposed Revision of LTM Plan, Former DuPont Waynesboro Plant, Waynesboro, Virginia, EPA ID# VAD003114832. September 18, 2015.

Table 3-9
Data Quality Objectives for Snapping Turtle Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

DQO Step	Description
STEP 1: State the problem	The consumption of snapping turtle (*Chelydra serpentina*) tissue by people is a source of potential mercury exposure in the South River and South Fork Shenandoah River.
STEP 2: Identify the goals of the study	The snapping turtle tissue monitoring program has the following primary objective: • Identify trends in potential human exposure to methylmercury, inorganic mercury, and total mercury through consumption of snapping turtle tissues.
STEP 3: Identify the information inputs	Existing Data • There has been a large amount of data collected to date on snapping turtles in the South River. Hopkins (2013) evaluated total mercury concentrations in 376 blood samples from snapping turtles collected in 2006 and 2010. Follow up studies demonstrated that nail and blood mercury concentrations are strongly predictive (R^2 ~ 0.9) of mercury concentrations in meat, providing an ideal non-lethal monitoring technique. New Data To Be Collected • Tissue (toenail) samples will be collected from three snapping turtles at each study location. Samples will be analyzed for total and methylmercury as described below.

Table 3-9
Data Quality Objectives for Snapping Turtle Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

<table>
<tr><th>DQO Step</th><th>Description</th></tr>
<tr><td>STEP 4: Define the boundaries of the study</td><td>
Geographic Area
Snapping turtle tissue samples will be collected at 13 stations on the South River, South Fork Shenandoah River and Shenandoah River. The stations include:
<table>
<tr><th>Station ID</th><th>Description</th></tr>
<tr><td>SR-2.7</td><td>Existing SR-01 located at Lyndhurst Ave. to Ridgeview Park</td></tr>
<tr><td>SR0.1</td><td>Constitution Park/Waynesboro Reach</td></tr>
<tr><td>SR11.8</td><td>Dooms to Crimora Reach</td></tr>
<tr><td>SR23.5</td><td>Hariston to Port Republic Reach</td></tr>
<tr><td>SF26.6</td><td>South Fork Shenandoah @ Lynwood</td></tr>
<tr><td>SF48</td><td>SFS @ Shenandoah (above dam)</td></tr>
<tr><td>SF63</td><td>Newport Landing</td></tr>
<tr><td>SF72</td><td>Hamburg, VA near Rt. 211 Bridge</td></tr>
<tr><td>SF89.4</td><td>Foster's Landing, near Rt. 694 Bridge</td></tr>
<tr><td>SF106</td><td>Bentonville Landing, near Rt. 613 Bridge</td></tr>
<tr><td>SF115</td><td>Karo Landing</td></tr>
<tr><td>SH143</td><td>Rt. 17/50 Bridge</td></tr>
<tr><td>SH158</td><td>Berryville, VA near Rt. 7 bridge</td></tr>
</table>
Note: Numbers associated with station IDs are river miles downstream of the footbridge at the former DuPont plant in Waynesboro, VA. Negative numbers indicate distance upstream of the footbridge.

Timeframe
Sampling and analysis will occur annually in May - July
Sample Type
Toenail clippings will be collected in the field from the hind leg(s) of the turtle
</td></tr>
<tr><td>STEP 5: Develop the analytical approach</td><td>Samples will be analyzed for total mercury (EPA 1631) and methylmercury (EPA 1630, modified).
Percent solids analysis (SM 2540 G-1997) will be performed if there is sufficient sample mass.</td></tr>
</table>

Table 3-9
Data Quality Objectives for Snapping Turtle Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

<table>
<tr><th>DQO Step</th><th>Description</th></tr>
<tr><td>STEP 6: Specify performance or acceptance criteria</td><td>Field quality control sampling (field duplicates) will not be collected for biological samples. Laboratory duplicate samples will be analyzed from separate aliquots of the same parent sample after homogenization of the sample media.

Acceptance criteria for laboratory quality assurance samples and reporting limits are provided below.
<table>
<tr><th>Analyte</th><th>Laboratory Precision % RPD (LCSD)</th><th>Laboratory Accuracy % Recovery (LCS)</th><th>Laboratory Precision % RPD (MSD or Lab DUP)</th><th>Laboratory Accuracy % Recovery (MS)</th><th>Laboratory Reporting Limit (MDL)</th><th>Laboratory Reporting Limit (RL)</th><th>Project Reporting Limit (RL)</th></tr>
<tr><td>Total Mercury</td><td>30</td><td>75 - 125</td><td>30</td><td>70 - 130</td><td>0.12 ng/g</td><td>0.40 ng/g</td><td>0.40 ng/g</td></tr>
<tr><td>Methylmercury</td><td>35</td><td>65 - 135</td><td>35</td><td>65 - 135</td><td>1 ng/g</td><td>3 ng/g</td><td>3 ng/g</td></tr>
<tr><td>% Total Solids / % Dry Weight</td><td>N/A</td><td>N/A</td><td>15%</td><td>N/A</td><td>0.10%</td><td>0.1 ng/g</td><td>0.1 ng/g</td></tr>
</table>
Notes:
N/A - Not analyzed; LCS and LCSD will not be run for % solids analysis</td></tr>
<tr><td>STEP 7: Develop the detailed plan for obtaining data</td><td>Detailed plans for data collection are provided in the AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia (URS 2014).</td></tr>
</table>

References:

Hopkins, B.C., J.D. Willson, and W.A. Hopkins, 2013. Mercury exposure is associated with negative effects on turtle reproduction. Environmental Science and Technology. 47:2416-2422.

URS, 2014. AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia. Conshohocken, Pennsylvania. Final Work Plan prepared by URS Corporation. August 2014.

Table 3-10
Data Quality Objectives for Waterfowl Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

DQO Step	Description
STEP 1: State the problem	The consumption of waterfowl [e.g. mallard duck (*Anas platyrhynchos*)] tissue by recreational hunters is a source of potential mercury exposure in the South River and South Fork Shenandoah River.
STEP 2: Identify the goals of the study	The mallard tissue monitoring program has the following primary objective: • Monitor trends in potential human exposure to methylmercury, inorganic mercury, and total mercury through consumption of mallard duck tissue.
STEP 3: Identify the information inputs	Existing Data • Several studies have evaluated mercury concentrations in blood, feathers, edible tissue, and organs of mallard ducks from the South River [Savoy and Evers 2007, 2008, VADEQ, 2009 (unpublished)]. New Data To Be Collected • Tissue (breast muscle) samples will be collected from three mallard ducks at each study location. Samples will be analyzed for total and methylmercury as described below.

Table 3-10
Data Quality Objectives for Waterfowl Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

<table>
<tr><th>DQO Step</th><th>Description</th></tr>
<tr><td>STEP 4: Define the boundaries of the study</td><td>
Geographic Area
Mallard duck tissue samples will be collected at 13 stations on the South River, South Fork Shenandoah River and Shenandoah River. The stations include:
<table>
<tr><th>Station ID</th><th>Description</th></tr>
<tr><td>SR-2.7</td><td>Existing SR-01 located at Lyndhurst Ave. to Ridgeview Park</td></tr>
<tr><td>SR0.1</td><td>Constitution Park/Waynesboro Reach</td></tr>
<tr><td>SR11.8</td><td>Dooms to Crimora Reach</td></tr>
<tr><td>SR23.5</td><td>Hariston to Port Republic Reach</td></tr>
<tr><td>SF26.6</td><td>South Fork Shenandoah @ Lynwood</td></tr>
<tr><td>SF48</td><td>SFS @ Shenandoah (above dam)</td></tr>
<tr><td>SF63</td><td>Newport Landing</td></tr>
<tr><td>SF72</td><td>Hamburg, VA near Rt. 211 Bridge</td></tr>
<tr><td>SF89.4</td><td>Foster's Landing, near Rt. 694 Bridge</td></tr>
<tr><td>SF106</td><td>Bentonville Landing, near Rt. 613 Bridge</td></tr>
<tr><td>SF115</td><td>Karo Landing</td></tr>
<tr><td>SH143</td><td>Rt. 17/50 Bridge</td></tr>
<tr><td>SH158</td><td>Berryville, VA near Rt. 7 bridge</td></tr>
</table>
Note: Numbers associated with station IDs are river miles downstream of the footbridge at the former DuPont plant in Waynesboro, VA. Negative numbers indicate distance upstream of the footbridge.

Timeframe
Sampling and analysis will occur annually in October - January
Sample Type
Mallard breast muscle tissue will be collected for analysis using either baited walk-in traps or hunted using traditional waterfowl hunting methods.
</td></tr>
<tr><td>STEP 5: Develop the analytical approach</td><td>Samples will be analyzed for total mercury (EPA 1631), methylmercury (EPA 1630, modified) and percent solids analysis (SM 2540 G-1997).</td></tr>
</table>

Table 3-10
Data Quality Objectives for Waterfowl Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

<table>
<tr><th>DQO Step</th><th>Description</th></tr>
<tr><td>STEP 6: Specify performance or acceptance criteria</td><td>Field quality control sampling (field duplicates) will not be collected for biological samples. Laboratory duplicate samples will be analyzed from separate aliquots of the same parent sample after homogenization of the sample media.

Acceptance criteria for laboratory quality assurance samples and reporting limits are provided below.
<table>
<tr><th>Analyte</th><th>Laboratory Precision % RPD (LCSD)</th><th>Laboratory Accuracy % Recovery (LCS)</th><th>Laboratory Precision % RPD (MSD or Lab DUP)</th><th>Laboratory Accuracy % Recovery (MS)</th><th>Laboratory Reporting Limit (MDL)</th><th>Laboratory Reporting Limit (RL)</th><th>Project Reporting Limit (RL)</th></tr>
<tr><td>Total Mercury</td><td>30</td><td>75 - 125</td><td>30</td><td>70 - 130</td><td>0.12 ng/g</td><td>0.40 ng/g</td><td>0.40 ng/g</td></tr>
<tr><td>Methylmercury</td><td>35</td><td>65 - 135</td><td>35</td><td>65 - 135</td><td>1 ng/g</td><td>3 ng/g</td><td>3 ng/g</td></tr>
<tr><td>% Total Solids / % Dry Weight</td><td>N/A</td><td>N/A</td><td>15%</td><td>N/A</td><td>0.10%</td><td>0.1 ng/g</td><td>0.1 ng/g</td></tr>
</table>
Notes:
N/A - Not analyzed; LCS and LCSD will not be run for % solids analysis</td></tr>
<tr><td>STEP 7: Develop the detailed plan for obtaining data</td><td>Detailed plans for data collection are provided in the AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia (URS 2014).</td></tr>
</table>

References:

Savoy, L., and David C. Evers, 2007. Pilot assessment of methlymercury availability to Mallards on the South River, Virginia - 2007. Report BRI 2007-18 submitted to DuPont Corporate Remediation Group, Newark, Delaware and the U.S. Fish Wildl. Serv., Gloucester, Virginia. BioDiversity Research Institute, Gorham, ME.

Savoy, L., and David C. Evers, 2008. Pilot assessment of methlymercury availability to Mallards on the South River, Virginia - 2008. Report BRI 2009-12 submitted to DuPont Corporate Remediation Group, Newark, Delaware and the U.S. Fish Wildl. Serv., Gloucester, Virginia. BioDiversity Research Institute, Gorham, ME.

URS, 2014. AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia. Conshohocken, Pennsylvania. Final Work Plan prepared by URS Corporation. August 2014.

Table 3-11
Data Quality Objectives for Surface Water Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

DQO Step	Description
STEP 1: State the problem	Routine surface water monitoring conducted by DuPont and VADEQ (1999-present) show that mercury and methylmercury are widely present in the South River watershed.
STEP 2: Identify the goals of the study	Surface water samples will be collected in AOC-4 to monitor potential long-term changes to methylmercury, inorganic mercury, and total mercury concentrations in response to remediation. Ancillary parameters and nutrient concentrations were also collected to monitor potential long-term changes.
STEP 3: Identify the information inputs	Existing Data • Surface water sampling integrates existing routine monitoring programs conducted by DuPont and VADEQ, and builds on a long-term (1999-present) database. New Data to Be Collected • One to two samples will be collected monthly and analyzed for total mercury, methylmercury, total suspended solids, total organic carbon, dissolved organic carbon, water quality parameters (Temperature, pH, dissolved oxygen, conductivity), and nutrients (phosphorus). See Table 4 in the RCRA Quality Assurance Project Plan (QAPP) for ancillary analytes (URS, 2014b).

Table 3-11
Data Quality Objectives for Surface Water Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

<table>
<tr><th>DQO Step</th><th>Description</th></tr>
<tr><td>STEP 4:
Define the boundaries of the study</td><td>
Geographic Area
Surface water samples will be collected at 10 stations on the South River and South Fork Shenandoah River. The stations include:
<table>
<tr><th>Station ID</th><th>Description</th></tr>
<tr><td>RRM -2.7</td><td>Lyndhurst Avenue Bridge</td></tr>
<tr><td>RRM 0.2</td><td>Main Street Bridge</td></tr>
<tr><td>RRM 2.3</td><td>Hopeman Parkway Bridge</td></tr>
<tr><td>RRM 5.2</td><td>Dooms Crossing Bridge</td></tr>
<tr><td>RRM 9.9</td><td>New Hope Crimora Road Bridge</td></tr>
<tr><td>RRM 16.5</td><td>Harriston (Patterson Mill Road Bridge)</td></tr>
<tr><td>RRM 23.5</td><td>Port Republic Road Bridge</td></tr>
<tr><td>SF26.6</td><td>South Fork Shenandoah River at Lynwood</td></tr>
<tr><td>SF48</td><td>South Fork Shenandoah River at Shenandoah (below dam)</td></tr>
<tr><td>SF94</td><td>South Fork Shenandoah River at Rt. Rt. 663 bridge</td></tr>
</table>
Notes:
Numbers associated with station IDs are river miles downstream of the footbridge at the former DuPont plant in Waynesboro, VA. Negative numbers indicate distance upstream of the footbridge.
Timeframe
Sampling and analysis will occur monthly. Sampling is to be conducted in concert with VADEQ routine monitoring; as a result, some parameters are analyzed on a different frequency or for different numbers of replicates.
Sample Type
Water samples will be collected using either a diaphragm or submersible pump following the methods outlined in sampling protocol SRSW-1 (Appendix B).
</td></tr>
<tr><td>STEP 5:
Develop the analytical approach</td><td>Samples will be analyzed for THg, FTHg, MeHg, FMeHg, TSS, TOC, DOC, and phosphorous in accordance with EPA Methods 1631, 1630, 160.2, 415.1, 415.3, and 365.1 or 365.3, respectively. See Table 4 in the RCRA Quality Assurance Project Plan (QAPP) for ancillary analytes (URS, 2014b).</td></tr>
<tr><td>STEP 6:
Specify performance or acceptance criteria</td><td>Field quality and laboratory QA/QC sampling (field duplicates, MS/MSD, etc.) will be collected and analyzed at a rate of 5%. MS/MSD samples may be collected as additional sample volume within the same bottle as the parent sample.
Acceptance criteria for laboratory quality assurance samples and reporting limits are provided in Table 4 of the RCRA Quality Assurance Project Plan (QAPP) (URS 2014b).</td></tr>
</table>

Table 3-11
Data Quality Objectives for Surface Water Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

DQO Step	Description
STEP 7: Develop the detailed plan for obtaining data	Detailed plans for data collection are provided in the AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia (URS 2014a).

References:

URS, 2014a. AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia. Conshohocken, Pennsylvania. Final Work Plan prepared by URS Corporation. August 2014.

URS, 2014b. RCRA Quality Assurance Project Plan (QAPP) Former DuPont Waynesboro Site Area of Concern (AOC) 4: South River and a Segment of the South Fork Shenandoah River, Virginia. Conshohocken, Pennsylvania. Prepared by URS Corporation. May, 2014.

Table 3-12
Data Quality Objectives for Benthic Invertebrate Community Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

DQO Step	Description
STEP 1: State the problem	The benthic invertebrate community of the South River is listed as impaired (VDEQ 2009) for a number of reasons including sedimentation among other environmental stressors.
STEP 2: Identify the goals of the study	The benthic invertebrate monitoring program has the following primary objectives: • Monitor improvements to the benthic community in response to remediation.

STEP 3:
Identify the information inputs
	Existing Data
	• A number of studies have evaluated benthic invertebrate community dynamics within the South River and South Fork Shenandoah Rivers. These studies include:
	  o Phase I Ecological Study (CRG, 2008)
	  o Ecological Study Final Report (URS 2012)
	  o Bacteria and Benthic Total Maximum Daily Load for South River(VDEQ 2009).
	New Data to Be Collected
	• Six benthic community samples will be collected at each study location.

Table 3-12
Data Quality Objectives for Benthic Invertebrate Community Monitoring
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

<table>
<tr><th>DQO Step</th><th>Description</th></tr>
<tr><td>STEP 4:
Define the boundaries of the study</td><td>Geographic Area
• Benthic invertebrate samples will be collected at six stations on the South River and South Fork Shenandoah River. The stations include:
<table>
<tr><th>Station ID</th><th>Description</th></tr>
<tr><td>SR-2.7</td><td>Existing SR-01 located at Lyndhurst Ave. to Ridgeview Park</td></tr>
<tr><td>SR0.1</td><td>Constitution Park/Waynesboro Reach</td></tr>
<tr><td>SR3.5</td><td>RRM 3.5</td></tr>
<tr><td>SR11.8</td><td>Dooms to Crimora Reach</td></tr>
<tr><td>SR23.5</td><td>Hariston to Port Republic Reach</td></tr>
<tr><td>MR-01</td><td>Middle River Reference location</td></tr>
</table>
Notes:
Numbers associated with station IDs are river miles downstream of the footbridge at the former DuPont plant in Waynesboro, VA. Negative numbers indicate distance upstream of the footbridge.
Timeframe
• Sampling and analysis will occur semi-annually in May and October
Sample Type
• Benthic community samples will be collected as a three-surber composite sample collected from the left, center and right hand sides of the wetted channel at each location.</td></tr>
<tr><td>STEP 5:
Develop the analytical approach</td><td>Benthic community samples will have a random 300 organism sub-count performed in accordance with the methods outlined in Barbour et al. (1999). Organisms will be identified to the lowest taxonomical level practical, typically genus or species.</td></tr>
<tr><td>STEP 6:
Specify performance or acceptance criteria</td><td>Field quality control sampling (field duplicates) will not be collected for benthic community samples.
Quality control on sorting procedures will be checked by re-sorting 20 percent of each sample to ensure a 90% sorting efficiency. The accuracy of taxonomic identification will be evaluated by the re-identification of 10% of the samples by an experienced taxonomist to ensure a 90% similarity.</td></tr>
<tr><td>STEP 7:
Develop the detailed plan for obtaining data</td><td>Detailed plans for data collection are provided in the AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia (URS 2014).</td></tr>
</table>

References:

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling, 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. USEPA 841-B-99-002. USEPA Office of Water, Washington, D.C.

CRG. 2008. *Phase 1, Year 1 Progress Report: Ecological study of the South River and a segment of the South Fork Shenandoah River, Virginia*. Wilmington, Delaware.

URS, 2012. Final Report: Ecological Study of the South River and a Segment of the South Fork Shenandoah River, Virginia. Fort Washington, Pennsylvania. Final report prepared by URS Corporation. September 2012.

URS, 2014. AOC 4 Long-Term Monitoring Plan of the South River and a Segment of the South Fork of the Shenandoah River, Virginia. Conshohocken, Pennsylvania. Final Work Plan prepared by URS Corporation. August 2014.

Virginia Department of Environmental Quality, 2009. Bacteria and Benthic Total Maximum Daily Load for South River. Prepared by Engineering Concepts, Inc. July 2009.

Table 4-1
Regional Climatic Data Summary
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

Month	Precipitation (Inches)				Temperature (°C)			
	Historical[1,2] (Mean ± SE)	LTM			Historical[1] (Mean ± SE)	LTM (Mean)		
		2014	2015	2016		2014	2015	2016
Jan	2.7 ± 0.3	1.7	1.6	2.8	0.1 ± 0.4	-3.0	-0.6	-0.8
Feb	2.4 ± 0.3	3.7	2.3	3.9	1.4 ± 0.4	1.4	-3.1	1.8
Mar	3.3 ± 0.2	4.0	2.7	1.9	5.9 ± 0.3	2.8	5.6	9.9
Apr	3.0 ± 0.3	4.2	4.8	1.9	11.3 ± 0.2	11.7	12.1	11.8
May	3.8 ± 0.3	4.9	3.9	6.1	16.1 ± 0.2	17.7	18.8	15.3
Jun	3.5 ± 0.4	4.0	5.5	4.0	20.6 ± 0.2	22.1	22.5	21.4
Jul	3.9 ± 0.3	2.1	5.9	5.7	22.8 ± 0.2	22.0	23.1	24.1
Aug	3.7 ± 0.3	2.4	2.6	2.9	22.1 ± 0.2	20.8	21.8	24.2
Sept	3.9 ± 0.5	0.9	6.2	3.8	18.3 ± 0.2	19.2	19.6	21.6
Oct	3.1 ± 0.4	4.1	4.0	2.1	11.9 ± 0.3	13.6	12.6	14.7
Nov	2.9 ± 0.3	2.6	2.8	1.6	7.0 ± 0.3	4.6	10.2	9.2
Dec	2.7 ± 0.2	2.4	3.2	3.3	2.1 ± 0.4	3.7	8.4	2.6
Annual[3]	**37.1 ± 1.3**	**37.0**	**45.3**	**39.9**	**11.6 ± 0.1**	**11.4**	**12.6**	**13.0**

Notes:

1, Historical includes data from 1970 to 2013

2, Mean (± SE) of monthly cumulatives

3, Precipitation- Annual cumulative; Temperature- Arithmetic mean of months

°C, Degrees Celsius

Mean, Arithmetic mean; SE, standard error

Data were recorded at the Staunton Sewage Plant, Virginia, by the Southeast Regional Climate Center.

Table 4-2
Interstitial Sediment Data Summary
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

Parameter Name	Season	Location	Historical[1]				LTM			
			Sample Size (n)	Min (mg/kg, dw)	Max (mg/kg, dw)	Mean ± SD (mg/kg, dw)	Sample Size (n)	Min (mg/kg, dw)	Max (mg/kg, dw)	Mean ± SD (mg/kg, dw)
Inorganic Mercury	Spring	SR-2.7	16	0.04	0.08	0.06 ± 0.01	9	0.05	0.33	0.10 ± 0.09
		SR0.1	57	0.94	9.19	2.99 ± 2.00	9	0.80	3.34	1.72 ± 0.89
		SR3.5	28	8.94	43.8	18.4 ± 7.14	9	7.26	14.0	11.3 ± 1.79
		SR11.8	22	11.4	18.1	14.4 ± 1.71	9	11.9	41.5	20.1 ± 8.79
		SR23.5	24	7.23	17.0	9.51 ± 2.09	9	9.79	15.5	11.87 ± 2.10
		SF26.6	13	0.35	2.43	1.39 ± 0.68	9	0.96	1.40	1.20 ± 0.15
		SF48	0	--	--	--	9	0.53	0.91	0.76 ± 0.11
Methylmercury	Spring	SR-2.7	16	0.001	0.004	0.002 ± 0.001	9	0.001	0.003	0.001 ± 0.001
		SR0.1	21	0.002	0.06	0.02 ± 0.02	9	0.003	0.04	0.02 ± 0.01
		SR3.5	25	0.01	0.18	0.08 ± 0.04	9	0.005	0.04	0.01 ± 0.01
		SR11.8	22	0.02	0.23	0.13 ± 0.07	9	0.02	0.04	0.02 ± 0.01
		SR23.5	23	0.02	0.19	0.10 ± 0.04	9	0.01	0.04	0.02 ± 0.01
		SF26.6	12	0.01	0.04	0.02 ± 0.01	9	0.003	0.03	0.01 ± 0.01
		SF48	0	--	--	--	9	0.003	0.02	0.01 ± 0.01

Notes:
1, Historical data include interstitial sediment samples collected annually from 2004 to 2013.
LTM, Long-term monitoring (2014- 2016)
mg/kg, Milligrams per kilogram
dw, Dry weight
Min, Minimum detected concentration
Max, Maximum detected concentration
Mean ± SD, Arithmetic mean ± standard deviation of detected concentrations
--, Not available
Interstitial sediment samples (Historical and LTM) were collected using the "guzzler" technique, outlined in SRSE-01 (see Appendix A).

Table 4-3
Epilithic Periphyton Data Summary
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

Parameter Name	Season	Location	Historical[1]				LTM			
			Sample Size (n)	Min (mg/kg, ww)	Max (mg/kg, ww)	Mean ± SD (mg/kg, ww)	Sample Size (n)	Min (mg/kg, ww)	Max (mg/kg, ww)	Mean ± SD (mg/kg, ww)
Inorganic Mercury	Spring	SR-2.7	1	0.002	0.002	0.002	9	0.004	0.02	0.01 ± 0.005
		SR0.1	10	0.04	0.24	0.12 ± 0.07	9	0.04	0.24	0.10 ± 0.08
		SR3.5	8	0.08	3.47	0.75 ± 1.11	9	0.33	1.45	0.74 ± 0.32
		SR11.8	22	0.02	0.78	0.29 ± 0.21	9	0.61	2.58	1.30 ± 0.59
		SR23.5	22	0.02	0.84	0.30 ± 0.22	9	0.31	0.78	0.67 ± 0.15
		SF26.6	1	0.13	0.13	0.13	9	0.09	0.25	0.15 ± 0.05
		SF48	0	--	--	--	9	0.07	0.18	0.11 ± 0.03
	Fall	SR-2.7	0	--	--	--	9	0.004	0.01	0.01 ± 0.003
		SR0.1	0	--	--	--	9	0.09	0.51	0.23 ± 0.15
		SR3.5	6	1.10	3.10	2.02 ± 0.79	9	0.32	2.60	0.86 ± 0.70
		SR11.8	3	0.65	1.33	0.95 ± 0.35	9	0.12	1.88	0.74 ± 0.71
		SR23.5	6	1.53	1.97	1.74 ± 0.19	9	0.58	0.89	0.70 ± 0.11
		SF26.6	0	--	--	--	9	0.09	0.43	0.26 ± 0.11
		SF48	0	--	--	--	9	0.03	0.24	0.12 ± 0.08
Methylmercury	Spring	SR-2.7	1	0.0002	0.0002	0.0002	9	0.0001	0.0004	0.0003 ± 0.0001
		SR0.1	10	0.0001	0.002	0.001 ± 0.0004	9	0.0002	0.001	0.001 ± 0.0004
		SR3.5	8	0.002	0.05	0.02 ± 0.02	9	0.002	0.01	0.01 ± 0.004
		SR11.8	22	0.0005	0.05	0.01 ± 0.01	9	0.001	0.01	0.002 ± 0.002
		SR23.5	22	0.0004	0.08	0.01 ± 0.02	9	0.001	0.01	0.003 ± 0.003
		SF26.6	1	0.01	0.01	0.01	9	0.001	0.003	0.002 ± 0.001
		SF48	0	--	--	--	9	0.0001	0.003	0.001 ± 0.001
	Fall	SR-2.7	0	--	--	--	9	0.0001	0.002	0.001 ± 0.001
		SR0.1	0	--	--	--	9	0.0002	0.02	0.01 ± 0.01
		SR3.5	6	0.03	0.04	0.03 ± 0.01	9	0.0001	0.03	0.01 ± 0.01
		SR11.8	3	0.12	0.16	0.14 ± 0.02	9	0.001	0.06	0.02 ± 0.02
		SR23.5	6	0.02	0.03	0.03 ± 0.01	9	0.001	0.04	0.01 ± 0.02
		SF26.6	0	--	--	--	9	0.0005	0.02	0.01 ± 0.01
		SF48	0	--	--	--	9	0.0004	0.01	0.003 ± 0.004

Notes:
1, Historical data include epilithic periphyton samples collected annually from 2005 to 2011.
LTM, Long-term monitoring (2014- 2016)
mg/kg, Milligrams per kilogram
ww, Wet weight
Min, Minimum detected concentration
Max, Maximum detected concentration
Mean ± SD, Arithmetic mean ± standard deviation of detected concentrations
--, Not available

Table 4-4
Benthic Invertebrate Tissue Data Summary
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

Parameter Name	Season	Location	Historical[1]				LTM			
			Sample Size (n)	Min (mg/kg, ww)	Max (mg/kg, ww)	Mean ± SD (mg/kg, ww)	Sample Size (n)	Min (mg/kg, ww)	Max (mg/kg, ww)	Mean ± SD (mg/kg, ww)
Mayfly										
Inorganic Mercury	Spring	SR-2.7	9	0.01	0.11	0.05 ± 0.04	9	0.02	0.07	0.05 ± 0.02
		SR0.1	1	0.01	0.01	0.01	9	0.04	0.09	0.07 ± 0.01
		SR3.5	3	0.05	0.12	0.08 ± 0.04	9	0.19	0.38	0.27 ± 0.06
		SR11.8	5	0.004	0.27	0.12 ± 0.12	9	0.11	0.43	0.24 ± 0.11
		SR23.5	5	0.07	0.26	0.17 ± 0.13	9	0.18	0.35	0.23 ± 0.06
		SF26.6	0	--	--	--	9	0.03	0.09	0.05 ± 0.02
		SF48	0	--	--	--	9	0.03	0.10	0.06 ± 0.02
	Fall	SR-2.7	0	--	--	--	9	0.03	0.63	0.24 ± 0.26
		SR0.1	0	--	--	--	9	0.10	0.58	0.26 ± 0.17
		SR3.5	0	--	--	--	9	0.01	0.46	0.25 ± 0.13
		SR11.8	0	--	--	--	9	0.03	0.52	0.26 ± 0.18
		SR23.5	0	--	--	--	9	0.01	0.60	0.25 ± 0.23
		SF26.6	0	--	--	--	9	0.04	0.28	0.12 ± 0.08
		SF48	0	--	--	--	9	0.01	0.16	0.08 ± 0.05
Methylmercury	Spring	SR-2.7	9	0.02	0.03	0.02 ± 0.005	9	0.01	0.03	0.01 ± 0.01
		SR0.1	1	0.01	0.01	0.01	9	0.01	0.04	0.02 ± 0.01
		SR3.5	3	0.20	0.29	0.25 ± 0.05	9	0.11	0.20	0.14 ± 0.03
		SR11.8	5	0.15	0.48	0.38 ± 0.13	9	0.19	0.33	0.25 ± 0.04
		SR23.5	5	0.21	0.54	0.40 ± 0.14	9	0.24	0.38	0.30 ± 0.06
		SF26.6	0	--	--	--	9	0.03	0.07	0.05 ± 0.02
		SF48	0	--	--	--	9	0.04	0.08	0.06 ± 0.01
	Fall	SR-2.7	0	--	--	--	9	0.01	0.02	0.01 ± 0.003
		SR0.1	0	--	--	--	9	0.004	0.12	0.03 ± 0.04
		SR3.5	0	--	--	--	9	0.01	0.17	0.07 ± 0.07
		SR11.8	0	--	--	--	9	0.01	0.21	0.08 ± 0.09
		SR23.5	0	--	--	--	9	0.01	0.21	0.08 ± 0.10
		SF26.6	0	--	--	--	9	0.01	0.08	0.04 ± 0.03
		SF48	0	--	--	--	9	0.01	0.06	0.03 ± 0.02
Transplanted Asiatic Clam (Caged)										
Inorganic Mercury	Spring	SR-2.7	0	--	--	--	9	0.002	0.02	0.01 ± 0.005
		SR0.1	9	0.01	0.02	0.02 ± 0.003	9	0.002	0.02	0.01 ± 0.01
		SR3.5	6	0.01	0.07	0.05 ± 0.02	9	0.03	0.12	0.05 ± 0.03
		SR11.8	0	--	--	--	6	0.04	0.08	0.05 ± 0.02
		SR23.5	6	0.02	0.06	0.04 ± 0.01	9	0.02	0.08	0.05 ± 0.03
		SF26.6	0	--	--	--	9	0.01	0.03	0.02 ± 0.01
		SF48	0	--	--	--	9	0.01	0.03	0.02 ± 0.01
	Fall	SR-2.7	0	--	--	--	9	0.004	0.01	0.01 ± 0.002
		SR0.1	0	--	--	--	9	0.01	0.04	0.02 ± 0.01
		SR3.5	0	--	--	--	9	0.01	0.06	0.03 ± 0.02
		SR11.8	0	--	--	--	9	0.02	0.04	0.03 ± 0.01
		SR23.5	0	--	--	--	9	0.01	0.04	0.02 ± 0.01
		SF26.6	0	--	--	--	9	0.01	0.02	0.01 ± 0.004
		SF48	0	--	--	--	9	0.01	0.05	0.01 ± 0.01
Methylmercury	Spring	SR-2.7	0	--	--	--	9	0.003	0.01	0.004 ± 0.001
		SR0.1	9	0.004	0.01	0.01 ± 0.001	9	0.001	0.01	0.005 ± 0.002
		SR3.5	6	0.001	0.02	0.01 ± 0.01	9	0.01	0.03	0.02 ± 0.01
		SR11.8	0	--	--	--	6	0.01	0.02	0.02 ± 0.004
		SR23.5	6	0.01	0.06	0.04 ± 0.02	9	0.01	0.08	0.04 ± 0.02
		SF26.6	0	--	--	--	9	0.01	0.02	0.02 ± 0.003
		SF48	0	--	--	--	9	0.01	0.02	0.01 ± 0.002
	Fall	SR-2.7	0	--	--	--	9	0.002	0.00	0.003 ± 0.001
		SR0.1	0	--	--	--	9	0.003	0.01	0.01 ± 0.002
		SR3.5	0	--	--	--	9	0.01	0.02	0.02 ± 0.01
		SR11.8	0	--	--	--	9	0.02	0.04	0.03 ± 0.01
		SR23.5	0	--	--	--	9	0.004	0.02	0.01 ± 0.01
		SF26.6	0	--	--	--	9	0.01	0.01	0.01 ± 0.001
		SF48	0	--	--	--	9	0.01	0.03	0.01 ± 0.01

Notes:
1, Historical data include mayfly tissue samples collected in 2006, 2007, 2010, and 2013 and transplanted caged clam tissue samples collected in 2009 and 2013.
LTM, Long-term monitoring (2014- 2016)
mg/kg, Milligrams per kilogram
ww, Wet weight
Min, Minimum detected concentration
Max, Maximum detected concentration
Mean ± SD, Arithmetic mean ± standard deviation of detected concentrations
--, Not available

Table 4-5
Young-of-Year Smallmouth Bass (Whole Body) Data Summary
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

Parameter Name	Season	Location	Historical[1]	LTM			
			Sample Size (n)	Sample Size (n)	Min (mg/kg, ww)	Max (mg/kg, ww)	Mean ± SD (mg/kg, ww)
Inorganic Mercury	Fall	SR-2.7	0	16	0.001	0.01	0.01 ± 0.003
		SR0.1	0	30	0.03	0.31	0.09 ± 0.06
		SR11.8	0	30	0.04	0.25	0.09 ± 0.05
		SR23.5	0	30	0.01	0.10	0.06 ± 0.03
		SF26.6	0	30	0.001	0.03	0.02 ± 0.01
		SF48	0	29	0.002	0.04	0.02 ± 0.01
Methylmercury	Fall	SR-2.7	0	16	0.02	0.05	0.03 ± 0.01
		SR0.1	0	30	0.07	1.21	0.50 ± 0.28
		SR11.8	0	30	0.39	2.08	0.75 ± 0.31
		SR23.5	0	30	0.08	1.56	0.62 ± 0.32
		SF26.6	0	30	0.02	0.34	0.21 ± 0.08
		SF48	0	29	0.06	0.29	0.15 ± 0.06

Notes:
1, Applicable historical data not available
LTM, Long-term monitoring (2014- 2016)
mg/kg, Milligrams per kilogram
ww, Wet weight
Min, Minimum detected concentration
Max, Maximum detected concentration
Mean ± SD, Arithmetic mean ± standard deviation of detected concentrations

Table 4-6
Summary of ANCOVA Results for Young-of-Year Smallmouth Bass
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

One-Way ANCOVA			
Dataset	**Factor**	**Location (CV)**	**Year[1]**
Young-of-Year Smallmouth Bass (Whole Body)			
IHg	Sum of Squares	0.056	0.011
	p-value	**<0.001**	0.069
MeHg	Sum of Squares	1.096	0.329
	p-value	**0.002**	0.221

Notes
1, ANCOVA test was limited to LTM samples years only (i.e., 2014, 2015, and 2016)
ANCOVA, Analysis of covariance
CV, Covariate
IHg, Inorganic mercury
MeHg, Methylmercury
Bold values indicate a significant difference (p<0.05)

Table 4-7
Soil Data Summary
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

Parameter Name	Season	Location	Historical[1]	LTM			
			Sample Size (n)	Sample Size (n)	Min (mg/kg, dw)	Max (mg/kg, dw)	Mean ± SD (mg/kg, dw)
Inorganic Mercury	Summer	SR-6.2	0	9	0.02	0.09	0.05 ± 0.02
		SR-2.7	0	9	0.06	0.51	0.14 ± 0.15
		SR2.0	0	9	3.13	28.6	11.9 ± 8.05
		SR11.8[2]	0	9	3.92	53.2	22.5 ± 13.3
		SR22	0	9	6.51	9.54	7.48 ± 0.87
		SF31	0	9	0.46	12.5	4.45 ± 5.06
		SF50	0	9	0.16	1.17	0.55 ± 0.32
		SF66	0	9	0.11	0.97	0.49 ± 0.23
		SF85	0	9	0.23	0.72	0.48 ± 0.16
Methylmercury	Summer	SR-6.2	0	9	0.0001	0.0004	0.0002 ± 0.0001
		SR-2.7	0	9	0.0002	0.001	0.0004 ± 0.0003
		SR2.0	0	9	0.002	0.01	0.004 ± 0.003
		SR11.8[2]	0	9	0.0005	0.01	0.004 ± 0.004
		SR22	0	9	0.001	0.02	0.004 ± 0.005
		SF31	0	9	0.0004	0.003	0.002 ± 0.001
		SF50	0	9	0.0002	0.002	0.001 ± 0.001
		SF66	0	9	0.0004	0.002	0.001 ± 0.001
		SF85	0	9	0.001	0.003	0.002 ± 0.001

Notes:
1, Applicable historical data not available
2, 2014 LTM samples collected at SR8.9
LTM, Long-term monitoring (2014- 2016)
mg/kg, Milligrams per kilogram
dw, Dry weight
Min, Minimum detected concentration
Max, Maximum detected concentration
Mean ± SD, Arithmetic mean ± standard deviation of detected concentrations

*Soil sampling locations are targeted where Carolina wren data were collected each year; specific sampling locations may vary year-to-year, per LTM station. Annual variability observed in soil data may be attributable to the spatial distribution of mercury in floodplain soils.

Table 4-8
Terrestrial Invertebrate Tissue Data Summary
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

Parameter Name	Season	Location	Historical[1]				LTM			
			Sample Size (n)	Min (mg/kg, ww)	Max (mg/kg, ww)	Mean ± SD (mg/kg, ww)	Sample Size (n)	Min (mg/kg, ww)	Max (mg/kg, ww)	Mean ± SD (mg/kg, ww)
Earthworm										
Inorganic Mercury	Summer/ Fall[2]	SR-6.2	0	--	--	--	9	0.04	0.19	0.12 ± 0.06
		SR-2.7	6	0.07	0.18	0.13 ± 0.05	9	0.02	0.13	0.07 ± 0.05
		SR2.0	12	1.72	5.37	3.46 ± 0.98	9	0.18	7.97	3.31 ± 2.73
		SR11.8[3]	12	1.98	4.79	3.18 ± 0.85	9	0.95	5.13	2.25 ± 1.40
		SR22	12	0.37	4.65	1.59 ± 1.19	9	0.28	2.03	1.27 ± 0.61
		SF31	0	--	--	--	9	0.06	0.54	0.36 ± 0.16
		SF50	0	--	--	--	9	0.11	0.50	0.25 ± 0.15
		SF66	0	--	--	--	9	0.07	0.83	0.30 ± 0.24
		SF85	0	--	--	--	9	0.07	0.87	0.37 ± 0.25
Methylmercury	Summer/ Fall[2]	SR-6.2	0	--	--	--	9	0.0002	0.02	0.01 ± 0.01
		SR-2.7	6	0.002	0.004	0.003 ± 0.0005	9	0.002	0.03	0.01 ± 0.01
		SR2.0	12	0.03	0.22	0.10 ± 0.09	9	0.03	0.50	0.13 ± 0.14
		SR11.8[3]	12	0.01	0.09	0.05 ± 0.03	9	0.01	0.11	0.05 ± 0.04
		SR22	12	0.04	0.11	0.07 ± 0.02	9	0.02	0.41	0.15 ± 0.13
		SF31	0	--	--	--	9	0.01	0.05	0.03 ± 0.01
		SF50	0	--	--	--	9	0.01	0.07	0.03 ± 0.03
		SF66	0	--	--	--	9	0.01	0.06	0.03 ± 0.02
		SF85	0	--	--	--	9	0.01	0.05	0.03 ± 0.02
Wolf Spider										
Inorganic Mercury	Spring/ Summer[4]	SR-6.2	0	--	--	--	13	0.002	0.18	0.04 ± 0.06
		SR-2.7	0	--	--	--	16	0.002	0.06	0.03 ± 0.02
		SR2.0	3	0.05	0.20	0.12 ± 0.08	17	0.02	0.74	0.22 ± 0.23
		SR11.8[3]	0	--	--	--	16	0.01	0.68	0.27 ± 0.17
		SR22	6	0.05	0.25	0.12 ± 0.07	15	0.04	0.56	0.22 ± 0.19
		SF31	0	--	--	--	15	0.01	0.17	0.04 ± 0.05
		SF50	0	--	--	--	16	0.02	0.06	0.03 ± 0.01
		SF66	0	--	--	--	17	0.01	0.11	0.05 ± 0.03
		SF85	0	--	--	--	15	0.01	0.66	0.08 ± 0.16
Methylmercury	Spring/ Summer[4]	SR-6.2	0	--	--	--	13	0.01	0.08	0.03 ± 0.02
		SR-2.7	0	--	--	--	16	0.02	0.13	0.04 ± 0.03
		SR2.0	3	0.18	0.66	0.36 ± 0.26	17	0.002	1.43	0.54 ± 0.37
		SR11.8[3]	0	--	--	--	16	0.06	1.47	0.76 ± 0.43
		SR22	6	0.04	1.03	0.27 ± 0.38	15	0.13	2.18	0.89 ± 0.62
		SF31	0	--	--	--	15	0.04	0.16	0.08 ± 0.04
		SF50	0	--	--	--	16	0.06	0.41	0.19 ± 0.09
		SF66	0	--	--	--	17	0.09	0.34	0.20 ± 0.08
		SF85	0	--	--	--	15	0.05	0.50	0.15 ± 0.12

Notes:
1, Historical data include earthworm tissue samples collected in 2006 and wolf spider tissue samples collected in 2009 and 2010.
2, LTM samples collected in the summer; Historical samples collected in the fall
3, 2014 LTM samples collected at SR8.9
4, Historical samples collected in the spring; LTM samples collected in the summer
LTM, Long-term monitoring (2014- 2016)
mg/kg, Milligrams per kilogram
ww, Wet weight
Min, Minimum detected concentration
Max, Maximum detected concentration
Mean ± SD, Arithmetic mean ± standard deviation of detected concentrations
--, Not available

Table 4-9
Carolina Wren Blood Data Summary
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

Parameter Name	Season	Location	Historical[1]				LTM[2]			
			Sample Size (n)	Min (mg/kg, ww)	Max (mg/kg, ww)	Mean ± SD (mg/kg, ww)	Sample Size (n)	Min (mg/kg, ww)	Max (mg/kg, ww)	Mean ± SD (mg/kg, ww)
Total Mercury	Spring/ Summer	SR-6.2	4	0.14	0.29	0.21 ± 0.06	6	0.11	1.12	0.33 ± 0.39
		SR-2.7	6	0.18	0.41	0.27 ± 0.08	7	0.14	0.58	0.34 ± 0.17
		SR2.0	9	1.45	4.83	2.44 ± 1.21	9	0.09	3.89	1.63 ± 1.12
		SR11.8	20	1.03	7.47	4.24 ± 1.75	7	2.09	8.19	4.11 ± 2.20
		SR22	15	1.54	13.30	6.06 ± 3.44	7	1.47	13.9	4.60 ± 4.20
		SF31	0	--	--	--	5	0.47	1.63	1.11 ± 0.54
		SF50	0	--	--	--	7	0.16	2.32	0.79 ± 0.76
		SF66	0	--	--	--	8	0.50	5.54	1.36 ± 1.70
		SF85	0	--	--	--	7	0.19	1.81	0.58 ± 0.56

Notes:
1, Historical data include Carolina wren blood samples collected annually from 2005 to 2008.
2, No LTM samples collected in 2014
LTM, Long-term monitoring (2014- 2016)
mg/kg, Milligrams per kilogram
ww, Wet weight
Min, Minimum detected concentration
Max, Maximum detected concentration
Mean ± SD, Arithmetic mean ± standard deviation of detected concentrations
--, Not available

Table 4-10
Adult Bass Muscle Tissue (Plug) Data Summary
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

Parameter Name	Species	Season	Location	Historical[1,2]				LTM[1]			
				Sample Size (n)	Min (mg/kg, ww)	Max (mg/kg, ww)	Mean ± SD (mg/kg, ww)	Sample Size (n)	Min (mg/kg, ww)	Max (mg/kg, ww)	Mean ± SD (mg/kg, ww)
Total Mercury	LMB	Spring	SR-2.7	0	--	--	--	14	0.19	2.68	0.99 ± 0.93
			SR0.1	46	0.40	2.63	1.10 ± 0.63	30	0.50	8.40	2.16 ± 1.50
			SR11.8	31	0.85	4.49	2.51 ± 0.61	29	0.53	6.31	3.27 ± 1.28
			SR23.5	36	0.68	2.76	1.95 ± 0.45	30	0.13	5.07	2.46 ± 1.16
			SF26.6	0	--	--	--	18	0.34	1.82	1.17 ± 0.41
			SF48	0	--	--	--	30	0.69	1.76	1.13 ± 0.21
			SF63	0	--	--	--	29	0.90	2.01	1.20 ± 0.24
			SF72	0	--	--	--	30	0.24	1.56	1.19 ± 0.25
			SF89.4	0	--	--	--	0	--	--	--
			SF106	0	--	--	--	0	--	--	--
			SF115	0	--	--	--	29	0.78	1.63	1.04 ± 0.21
			SH143	0	--	--	--	5	0.69	0.92	0.83 ± 0.11
			SH158	0	--	--	--	2	0.66	1.05	0.86 ± 0.28
		Fall	SR-2.7	0	--	--	--	5	0.16	0.47	0.31 ± 0.11
			SR0.1	25	0.52	2.20	0.96 ± 0.40	18	0.26	3.89	1.76 ± 1.04
			SR11.8	20	0.92	4.58	2.52 ± 0.82	19	1.11	4.44	3.10 ± 0.76
			SR23.5	26	0.40	2.81	1.94 ± 0.73	18	1.41	3.82	2.58 ± 0.69
			SF26.6	0	--	--	--	22	0.12	2.63	1.19 ± 0.53
			SF48	0	--	--	--	30	0.75	1.87	1.17 ± 0.26
			SF63	0	--	--	--	25	0.34	1.95	1.15 ± 0.34
			SF72	0	--	--	--	30	0.68	1.55	1.05 ± 0.23
			SF89.4	0	--	--	--	1	0.60	0.60	0.60
			SF106	0	--	--	--	0	--	--	--
			SF115	0	--	--	--	6	0.69	1.36	0.98 ± 0.25
			SH143	0	--	--	--	5	0.62	0.92	0.76 ± 0.12
			SH158	0	--	--	--	0	--	--	--
	SMB	Spring	SR-2.7	0	--	--	--	21	0.12	0.44	0.23 ± 0.07
			SR0.1	32	0.41	3.13	1.00 ± 0.76	30	0.22	4.46	1.98 ± 1.09
			SR11.8	26	1.32	4.22	2.78 ± 0.66	23	2.81	5.30	3.75 ± 0.68
			SR23.5	59	0.72	6.91	2.40 ± 0.96	30	0.86	4.11	2.74 ± 1.00
			SF26.6	0	--	--	--	24	0.85	1.83	1.28 ± 0.26
			SF48	0	--	--	--	30	0.62	1.95	1.25 ± 0.25
			SF63	0	--	--	--	30	0.33	1.55	1.09 ± 0.27
			SF72	0	--	--	--	30	0.70	2.50	1.16 ± 0.36
			SF89.4	0	--	--	--	30	0.48	1.46	0.93 ± 0.26
			SF106	0	--	--	--	30	0.62	1.56	0.98 ± 0.25
			SF115	0	--	--	--	25	0.77	1.86	1.16 ± 0.22
			SH143	0	--	--	--	27	0.32	1.17	0.66 ± 0.19
			SH158	0	--	--	--	27	0.32	0.93	0.57 ± 0.19
		Fall	SR-2.7	0	--	--	--	8	0.10	0.28	0.17 ± 0.05
			SR0.1	34	0.32	1.44	0.68 ± 0.28	19	0.67	2.25	1.36 ± 0.46
			SR11.8	32	1.78	4.29	2.96 ± 0.61	31	1.02	5.76	3.58 ± 0.98
			SR23.5	22	0.22	4.43	1.77 ± 1.07	30	0.19	4.23	2.90 ± 0.79
			SF26.6	0	--	--	--	24	0.13	1.80	1.15 ± 0.47
			SF48	0	--	--	--	28	0.53	1.72	1.09 ± 0.34
			SF63	0	--	--	--	30	0.33	1.63	1.09 ± 0.31
			SF72	0	--	--	--	24	0.54	1.60	1.08 ± 0.27
			SF89.4	0	--	--	--	13	0.42	1.52	0.84 ± 0.32
			SF106	0	--	--	--	30	0.47	1.67	0.91 ± 0.34
			SF115	0	--	--	--	15	0.76	1.69	1.19 ± 0.31
			SH143	0	--	--	--	23	0.24	0.99	0.62 ± 0.21
			SH158	0	--	--	--	23	0.14	0.77	0.48 ± 0.19

Notes:
1, Bass tissue plug data were length-normalized based on average fish length (300 mm).
2, Historical data include adult bass tissue plug samples collected annually from 2009 to 2011.
LMB, Largemouth bass
SMB, Smallmouth bass
LTM, Long-term monitoring (2014- 2016)
mg/kg, Milligrams per kilogram
ww, Wet weight
Min, Minimum detected concentration
Max, Maximum detected concentration
Mean ± SD, Arithmetic mean ± standard deviation of detected concentrations
--, Not available

Table 4-11
Snapping Turtle Muscle Tissue Data Summary
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

Parameter Name	Season	Location	Historical[1]				LTM[2]			
			Sample Size (n)	Min (mg/kg, ww)	Max (mg/kg, ww)	Mean ± SD (mg/kg, ww)	Sample Size (n)	Min (mg/kg, ww)	Max (mg/kg, ww)	Mean ± SD (mg/kg, ww)
Total Mercury	Spring/ Summer[3]	SR-2.7	0	--	--	--	5	0.38	0.58	0.46 ± 0.08
		SR0.1	17	0.55	2.11	1.24 ± 0.39	9	0.96	2.25	1.58 ± 0.41
		SR11.8	38	0.03	6.46	2.12 ± 1.32	9	1.09	6.00	2.68 ± 1.65
		SR23.5	25	1.16	6.78	3.76 ± 1.40	9	0.53	2.83	1.86 ± 0.65
		SF26.6	6	0.03	3.23	1.77 ± 1.04	9	0.60	1.83	1.19 ± 0.39
		SF48	6	0.85	2.77	1.53 ± 0.77	6	0.48	1.40	1.18 ± 0.35
		SF63	0	--	--	--	9	0.68	1.84	1.30 ± 0.38
		SF72	0	--	--	--	9	0.47	1.40	1.10 ± 0.27
		SF89.4	0	--	--	--	9	0.66	0.98	0.83 ± 0.13
		SF106	0	--	--	--	9	0.54	1.03	0.79 ± 0.17
		SF115	0	--	--	--	9	0.38	1.71	1.12 ± 0.41
		SH143	0	--	--	--	9	0.34	0.92	0.58 ± 0.16
		SH158	0	--	--	--	8	0.34	0.64	0.50 ± 0.09

Notes:
1, Historical data include snapping turtle muscle tissue samples (as measured) collected in 2010 and 2011.
2, LTM muscle tissue concentrations (wet weight) are converted from field -collected toenail concentrations (dry weight) using Hopkins (2013b) regression and % moisture on muscle tissue samples
3, Historical samples collected in the spring and summer; LTM samples collected in the summer only
LTM, Long-term monitoring (2014- 2016)
mg/kg, Milligrams per kilogram
ww, Wet weight
Min, Minimum detected concentration
Max, Maximum detected concentration
Mean ± SD, Arithmetic mean ± standard deviation of detected concentrations
--, Not available

Table 4-12
Mallard Duck Muscle Tissue Data Summary
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

Parameter Name	Season	Location	Historical[1]				LTM[2]			
			Sample Size (n)	Min (mg/kg, ww)	Max (mg/kg, ww)	Mean ± SD (mg/kg, ww)	Sample Size (n)	Min (mg/kg, ww)	Max (mg/kg, ww)	Mean ± SD (mg/kg, ww)
Inorganic Mercury	Winter	SR-2.7	0	--	--	--	3	0.001	0.002	0.002 ± 0.0004
		SR0.1	3	0.04	0.07	0.06 ± 0.02	3	0.01	0.19	0.10 ± 0.13
		SR11.8	5	0.01	0.17	0.06 ± 0.07	3	0.001	0.11	0.04 ± 0.06
		SR23.5	3	0.001	0.01	0.01 ± 0.01	3	0	0	0
		SF26.6	0	--	--	--	3	0.003	0.003	0.003
		SF48	0	--	--	--	3	0.01	0.02	0.01 ± 0.01
		SF63	0	--	--	--	3	0.001	0.02	0.01 ± 0.01
		SF72	0	--	--	--	3	0.003	0.005	0.004 ± 0.001
		SF89.4	0	--	--	--	2	0.01	0.01	0.01 ± 0.003
Methylmercury	Winter	SR-2.7	0	--	--	--	3	0.02	0.03	0.02 ± 0.003
		SR0.1	3	0.37	1.14	0.77 ± 0.39	3	0.05	1.44	0.64 ± 0.72
		SR11.8	5	0.02	1.25	0.61 ± 0.51	3	0.02	0.33	0.13 ± 0.18
		SR23.5	3	0.04	0.14	0.09 ± 0.05	3	0.32	0.54	0.40 ± 0.12
		SF26.6	0	--	--	--	3	0.05	0.07	0.06 ± 0.01
		SF48	0	--	--	--	3	0.06	0.14	0.10 ± 0.04
		SF63	0	--	--	--	3	0.08	0.11	0.10 ± 0.02
		SF72	0	--	--	--	3	0.02	0.08	0.04 ± 0.03
		SF89.4	0	--	--	--	2	0.14	0.14	0.14 ± 0.002

Notes:
1, Historical data include mallard duck muscle tissue samples collected in 2008 and 2010.
2, No LTM samples collected in 2014 and 2015
LTM, Long-term monitoring (2014- 2016)
mg/kg, Milligrams per kilogram
ww, Wet weight
Min, Minimum detected concentration
Max, Maximum detected concentration
Mean ± SD, Arithmetic mean ± standard deviation of detected concentrations
--, Not available

Table 4-13
Summary of ANCOVA Results for Adult Bass
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

One-Way ANCOVA					
Dataset	**Factor**	**Location (CV)**	**Taxa[1]**	**Season[2]**	**Year[3]**
Adult Bass Muscle Tissue (Plug) - Total Mercury					
All Bass	Sum of Squares	85.8	10.8	0.48	0.86
	p-value	**<0.001**	**<0.001**	0.28	0.35
Smallmouth Bass	Sum of Squares	61.4	--	1.7	0.38
	p-value	**<0.001**	--	**0.05**	0.65
Largemouth Bass	Sum of Squares	16.1	--	0.83	0.55
	p-value	**<0.001**	--	0.13	0.46

Notes
1, Taxa- Smallmouth bass and largemouth bass
2, Seasons- Spring and fall
3, ANCOVA test was limited to LTM samples only (i.e., 2014, 2015, and 2016)
ANCOVA, Analysis of covariance
CV, Covariate
--, Not available
Bold values indicate a significant difference ($p<0.05$)
Bass tissue plug data were length-normalized based on average fish length (300 mm) and log-transformed prior to analysis.

Table 4-14
Surface Water Total Mercury Data Summary
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

Parameter Name	Location	Historical[1]				LTM			
		Sample Size (n)	Min	Max	Mean ± SD	Sample Size (n)	Min	Max	Mean ± SD
UTHg (ng/l)	SR-2.7	143	0.34	51.1	1.45 ± 4.26	46	0.30	2.70	0.72 ± 0.48
	SR0.2	125	0.75	166	14.5 ± 21.2	32	2.00	120	12.7 ± 22.7
	SR2.3	174	2.76	413	51.4 ± 58.9	32	7.85	143	38.2 ± 29.9
	SR5.1	205	3.09	530	84 ± 73.4	32	20.0	304	90.8 ± 60.2
	SR9.9	162	4.20	633	91 ± 81.5	32	20.7	252	83.3 ± 51.5
	SR16.5	215	13.9	334	77 ± 62.2	32	23.7	119	59.7 ± 27.8
	SR23.5	115	4.50	363	65.4 ± 61.1	32	15.6	212	56.3 ± 46.0
	SF26	69	1.50	127	14.6 ± 16.2	27	3.72	39.6	12.8 ± 8.64
	SF48	38	1.50	131	10.3 ± 20.7	27	2.60	16.8	6.48 ± 4.07
	SF94	38	0.60	156	8.27 ± 24.9	27	0.80	9.30	2.99 ± 1.93
FTHg (ng/l)	SR-2.7	146	0.08	32.2	0.83 ± 2.65	46	0.10	1.90	0.29 ± 0.29
	SR0.2	151	0.53	33.1	4.36 ± 6.39	32	0.10	13.8	2.87 ± 3.43
	SR2.3	351	0.25	101	5.85 ± 8.55	32	0.10	8.81	2.63 ± 1.89
	SR5.1	234	0.75	44.7	7.50 ± 6.31	32	0.20	21.4	4.83 ± 4.13
	SR9.9	220	1.50	65.0	11.4 ± 8.39	32	0.10	31.9	9.9 ± 8.40
	SR16.5	222	0.15	67.5	9.93 ± 6.35	32	0.10	21.8	7.45 ± 5.63
	SR23.5	144	3.00	60.3	10.6 ± 8.29	32	0.10	14.5	6.29 ± 3.63
	SF26	69	0.07	5.64	1.99 ± 1.24	27	0.10	4.23	1.51 ± 1.11
	SF48	38	0.50	4.60	1.48 ± 0.85	27	0.10	2.54	1.25 ± 0.80
	SF94	38	0.50	5.70	1.41 ± 0.95	27	0.10	2.15	1.03 ± 0.66
PTHg (ng/l)	SR-2.7	148	0.02	18.9	0.80 ± 1.88	41	0.11	1.50	0.40 ± 0.28
	SR0.2	155	1.10	148	9.51 ± 16.5	28	0.90	119	9.9 ± 23.0
	SR2.3	374	2.55	408	48.8 ± 57.2	28	4.68	137	35.2 ± 29.6
	SR5.1	248	8.90	487	81.2 ± 68.2	28	15.3	298	85.2 ± 59.8
	SR9.9	226	9.20	371	78.0 ± 68.0	28	16.1	245	71.8 ± 50.5
	SR16.5	222	8.87	321	67.3 ± 60.6	28	21.1	105	51.1 ± 25.2
	SR23.5	144	5.55	357	55.9 ± 57.2	28	12.0	203	49.3 ± 45.4
	SF26	70	1.00	125	12.6 ± 16.1	22	1.92	38.6	10.9 ± 8.76
	SF48	38	1.00	130	8.80 ± 20.7	22	1.70	15.4	4.94 ± 3.93
	SF94	38	0.10	154	8.44 ± 27.3	22	0.20	8.40	1.71 ± 1.85
THgP (ug/g)	SR-2.7	110	0.005	1.09	0.18 ± 0.16	35	0.03	0.40	0.16 ± 0.10
	SR0.2	150	0.21	59.0	4.02 ± 7.33	25	0.32	39.5	3.89 ± 7.68
	SR2.3	370	0.65	87.3	12.9 ± 13.0	25	2.29	35.9	13.5 ± 9.51
	SR5.1	243	1.18	58.4	22.2 ± 11.6	26	3.74	62.8	26.4 ± 16.0
	SR9.9	223	1.57	198	22.7 ± 18.7	26	5.37	61.0	29.6 ± 13.8
	SR16.5	221	2.38	45.1	15.9 ± 7.51	26	1.54	38.1	18.3 ± 9.64
	SR23.5	144	2.01	1429	25.6 ± 133	25	2.40	38.2	15.4 ± 9.64
	SF26	69	0.28	19.0	2.57 ± 2.89	20	0.54	5.80	2.31 ± 1.47
	SF48	38	0.18	10.1	1.63 ± 1.73	20	0.19	4.20	1.24 ± 0.86
	SF94	31	0.10	4.40	1.07 ± 0.92	20	0.05	3.90	0.79 ± 0.81

Notes:
1, Historical data include surface water samples collected annually from 2006 to 2013.
LTM, Long-term monitoring (2014- 2016)
UTHg, Unfiltered total mercury
FTHg, Filtered total mercury
PTHg, Non-filter-passing total mercury
THgP, Total mercury on non-filter-passing particles [normalized by total suspended solid (TSS)]
ng/l, Nanograms per liter
µg/l, Micrograms per liter
µg/g, Micrograms per gram
Min, Minimum detected concentration
Max, Maximum detected concentration
Mean ± SD, Arithmetic mean ± standard deviation of detected concentrations

Table 4-15
Surface Water Methylmercury Data Summary
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

Parameter Name	Location	Historical[1]				LTM			
		Sample Size (n)	Min	Max	Mean ± SD	Sample Size (n)	Min	Max	Mean ± SD
UMeHg (ng/l)	SR-2.7	104	0.01	0.13	0.04 ± 0.02	16	0.02	0.23	0.05 ± 0.06
	SR0.2	105	0.01	1.53	0.12 ± 0.17	16	0.03	0.29	0.12 ± 0.07
	SR2.3	151	0.01	3.52	0.46 ± 0.56	16	0.09	0.46	0.32 ± 0.12
	SR5.1	188	0.01	3.99	0.92 ± 0.83	16	0.16	1.44	0.86 ± 0.36
	SR9.9	138	0.15	5.31	1.44 ± 1.23	16	0.44	2.01	1.27 ± 0.44
	SR16.5	200	0.07	6.42	1.54 ± 1.46	16	0.49	1.89	1.15 ± 0.41
	SR23.5	100	0.12	5.68	1.30 ± 1.23	16	0.56	1.69	1.00 ± 0.36
	SF26	30	0.06	1.05	0.42 ± 0.34	10	0.19	0.46	0.28 ± 0.10
	SF48	0	--	--	--	10	0.07	0.47	0.26 ± 0.11
	SF94	0	--	--	--	10	0.14	0.37	0.22 ± 0.09
FMeHg (ng/l)	SR-2.7	108	0.01	0.05	0.03 ± 0.01	16	0.02	0.22	0.04 ± 0.05
	SR0.2	134	0.01	0.60	0.08 ± 0.08	16	0.03	0.25	0.09 ± 0.07
	SR2.3	241	0.02	62.4	0.92 ± 4.20	16	0.07	0.40	0.21 ± 0.09
	SR5.1	217	0.01	5.94	0.59 ± 0.60	16	0.15	0.70	0.52 ± 0.17
	SR9.9	200	0.01	33.7	1.45 ± 3.50	16	0.30	1.35	0.86 ± 0.30
	SR16.5	207	0.04	3.06	0.98 ± 0.82	16	0.34	1.24	0.77 ± 0.23
	SR23.5	129	0.08	5.31	0.88 ± 0.73	16	0.36	1.00	0.68 ± 0.22
	SF26	30	0.04	0.74	0.28 ± 0.23	10	0.11	0.28	0.19 ± 0.05
	SF48	0	--	--	--	10	0.13	0.51	0.22 ± 0.12
	SF94	0	--	--	--	10	0.10	0.28	0.17 ± 0.05
PMeHg (ng/l)	SR-2.7	76	0.001	0.08	0.02 ± 0.01	11	0.001	0.02	0.01 ± 0.01
	SR0.2	96	0.001	1.42	0.07 ± 0.16	16	0.002	0.08	0.03 ± 0.02
	SR2.3	136	0.01	3.29	0.26 ± 0.47	16	0.01	0.21	0.11 ± 0.06
	SR5.1	166	0.02	2.69	0.44 ± 0.48	15	0.10	0.74	0.37 ± 0.19
	SR9.9	133	0.03	3.66	0.58 ± 0.64	16	0.13	0.81	0.41 ± 0.22
	SR16.5	198	0.01	3.85	0.61 ± 0.76	16	0.07	1.25	0.38 ± 0.29
	SR23.5	97	0.01	2.79	0.48 ± 0.53	16	0.08	0.72	0.32 ± 0.18
	SF26	30	0.01	0.39	0.14 ± 0.12	10	0.04	0.21	0.09 ± 0.06
	SF48	0	--	--	--	8	0.03	0.13	0.08 ± 0.03
	SF94	0	--	--	--	8	0.02	0.14	0.07 ± 0.05
MeHgP (ug/g)	SR-2.7	82	0.0002	0.02	0.004 ± 0.003	11	0.001	0.01	0.01 ± 0.004
	SR0.2	127	0.0004	0.33	0.02 ± 0.05	16	0.001	0.08	0.01 ± 0.02
	SR2.3	350	0.003	0.44	0.06 ± 0.07	16	0.01	0.12	0.04 ± 0.03
	SR5.1	221	0.003	0.41	0.11 ± 0.08	15	0.04	0.20	0.11 ± 0.05
	SR9.9	201	0.02	1.14	0.15 ± 0.16	16	0.09	0.74	0.21 ± 0.17
	SR16.5	205	0.01	0.71	0.13 ± 0.10	16	0.04	0.38	0.15 ± 0.09
	SR23.5	128	0.003	0.40	0.11 ± 0.08	16	0.02	0.27	0.13 ± 0.07
	SF26	30	0.01	0.09	0.03 ± 0.03	10	0.01	0.05	0.03 ± 0.01
	SF48	0	--	--	--	8	0.01	0.06	0.04 ± 0.02
	SF94	0	--	--	--	8	0.01	0.07	0.04 ± 0.02

Notes:
1, Historical data include surface water samples collected annually from 2006 to 2013.
LTM, Long-term monitoring (2014- 2016)
UMeHg, Unfiltered Methylmercury
FMeHg, Filtered Methylmercury
PMeHg, Non-filter-passing Methylmercury
MeHgP, Methylmercury on non-filter-passing particles [normalized by total suspended solid (TSS)]
ng/l, Nanograms per liter
µg/l, Micrograms per liter
µg/g, Micrograms per gram
Min, Minimum detected concentration
Max, Maximum detected concentration
Mean ± SD, Arithmetic mean ± standard deviation of detected concentrations
--, Not available

Table 4-16
Surface Water Ancillary Data Summary
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

Parameter Name	Location	Historical[1]				LTM			
		Sample Size (n)	Min	Max	Mean ± SD	Sample Size (n)	Min	Max	Mean ± SD
Total Suspended Solids (mg/L)	SR-2.7	58	0.60	144	6.79 ± 19.5	24	1.00	6.40	2.20 ± 1.47
	SR0.2	58	0.80	7.50	2.99 ± 1.68	24	1.00	26.2	3.55 ± 4.93
	SR2.3	58	0.70	74.0	7.18 ± 13.5	24	1.00	15.3	3.25 ± 3.01
	SR5.2	58	0.50	21.0	4.21 ± 3.97	24	1.00	18.3	4.29 ± 3.94
	SR9.9	58	0.60	13.3	3.44 ± 2.81	24	1.00	6.30	2.90 ± 1.93
	SR16.5	58	0.60	13.1	3.73 ± 2.65	24	1.00	6.70	3.24 ± 1.87
	SR23.5	58	0.30	16.9	3.58 ± 3.54	24	0.30	26.9	3.81 ± 5.39
	SF26	0	--	--	--	18	1.00	20.5	6.43 ± 5.60
	SF48	0	--	--	--	18	1.30	7.30	3.46 ± 2.36
	SF94	0	--	--	--	18	1.00	13.6	3.91 ± 4.53
Total Organic Carbon (mg/L)	SR-2.7	29	0.50	2.30	1.19 ± 0.40	12	0.50	2.20	0.96 ± 0.56
	SR0.2	29	0.50	1.90	1.16 ± 0.39	12	0.50	2.00	0.86 ± 0.48
	SR2.3	29	0.50	2.5	1.54 ± 0.61	12	0.50	2.00	0.99 ± 0.58
	SR5.2	29	0.50	6.60	1.63 ± 1.10	12	0.50	2.20	0.99 ± 0.61
	SR9.9	29	0.50	3.1	1.55 ± 0.60	12	0.50	2.20	1.03 ± 0.63
	SR16.5	29	0.50	3.60	1.56 ± 0.66	12	0.50	2.00	1.06 ± 0.52
	SR23.5	29	0.50	3.30	1.54 ± 0.59	12	0.50	2.10	1.04 ± 0.59
	SF26	0	--	--	--	9	0.50	2.10	1.20 ± 0.50
	SF48	0	--	--	--	9	0.72	3.90	1.50 ± 0.98
	SF94	0	--	--	--	9	1.00	2.30	1.51 ± 0.44
Dissolved Organic Carbon (ug/L)	SR-2.7	28	500	1800	1193 ± 358	12	500	1800	995 ± 452
	SR0.2	28	500	1800	1134 ± 337	13	500	1700	868 ± 410
	SR2.3	28	500	2600	1586 ± 560	12	500	1600	1028 ± 422
	SR5.2	29	500	2400	1370 ± 511	11	500	1700	1039 ± 390
	SR9.9	29	500	3100	1576 ± 555	12	500	2000	1088 ± 464
	SR16.5	29	500	3600	1589 ± 657	12	500	1800	1098 ± 434
	SR23.5	28	500	2900	1530 ± 503	11	500	1900	1141 ± 475
	SF26	0	--	--	--	9	500	2100	1322 ± 471
	SF48	0	--	--	--	8	500	1900	1300 ± 510
	SF94	0	--	--	--	9	570	2400	1586 ± 556
Phosphorous, unfiltered (mg/L)	SR-2.7	16	0.08	0.08	0.08 ± <0.001	12	0.05	0.08	0.06 ± 0.01
	SR0.2	16	0.08	0.08	0.08 ± <0.001	12	0.05	0.08	0.06 ± 0.01
	SR2.3	15	0.08	0.13	0.08 ± 0.01	12	0.05	0.08	0.06 ± 0.01
	SR5.2	16	0.08	0.08	0.08 ± <0.001	12	0.05	0.08	0.06 ± 0.01
	SR9.9	16	0.08	0.09	0.08 ± 0.004	12	0.05	0.08	0.06 ± 0.01
	SR16.5	15	0.08	0.08	0.08 ± <0.001	12	0.05	0.08	0.06 ± 0.01
	SR23.5	16	0.08	0.09	0.08 ± 0.001	12	0.05	0.08	0.06 ± 0.01
	SF26	0	--	--	--	9	0.05	0.06	0.05 ± 0.003
	SF48	0	--	--	--	9	0.05	0.05	0.05 ± <0.001
	SF94	0	--	--	--	9	0.05	0.05	0.05 ± <0.001
Magnesium, unfiltered (mg/L)	SR-2.7	16	5.08	12.9	9.07 ± 2.30	12	5.22	12.2	9.85 ± 2.82
	SR0.2	16	5.97	12.4	9.52 ± 1.93	12	6.01	12.4	10.2 ± 2.49
	SR2.3	16	6.17	12.4	9.72 ± 1.95	12	5.98	12.6	10.2 ± 2.53
	SR5.2	16	6.08	14.0	10.1 ± 2.21	12	6.07	13.2	10.5 ± 2.66
	SR9.9	16	6.45	13.7	10.3 ± 2.05	12	6.16	13.2	10.4 ± 2.60
	SR16.5	16	6.77	13.3	10.2 ± 1.90	12	6.30	13.5	10.6 ± 2.61
	SR23.5	16	6.83	12.8	10.0 ± 1.74	12	6.23	13.1	10.4 ± 2.55
	SF26	0	--	--	--	9	9.78	18.5	15.0 ± 2.97
	SF48	0	--	--	--	9	8.91	16.7	14.0 ± 2.71
	SF94	0	--	--	--	9	7.96	16.0	12.8 ± 2.97
Magnesium, filtered (mg/L)	SR-2.7	16	5.08	12.7	9.07 ± 2.26	12	5.10	12.1	9.80 ± 2.80
	SR0.2	16	5.83	12.4	9.50 ± 1.99	13	5.87	12.4	10.1 ± 2.44
	SR2.3	16	6.16	12.4	9.68 ± 1.91	12	6.08	12.4	10.1 ± 2.37
	SR5.2	16	6.01	13.9	10.1 ± 2.24	11	6.04	13.4	10.6 ± 2.86
	SR9.9	16	6.51	14.0	10.2 ± 2.03	12	6.21	13.4	10.6 ± 2.63
	SR16.5	16	6.57	13.4	10.1 ± 1.87	12	6.23	13.1	10.5 ± 2.52
	SR23.5	16	6.66	12.7	9.92 ± 1.72	12	6.20	13.0	10.4 ± 2.49
	SF26	0	--	--	--	9	9.71	18.0	15.3 ± 2.95
	SF48	0	--	--	--	9	8.70	16.7	13.9 ± 2.82
	SF94	0	--	--	--	9	7.97	16.6	12.9 ± 3.09
Nitrogen, unfiltered (mg/L)	SR-2.7	38	0.410	0.98	0.64 ± 0.14	30	0.38	3.50	0.82 ± 0.52
	SR0.2	38	0.040	0.87	0.61 ± 0.14	30	0.38	3.20	0.82 ± 0.48
	SR2.3	37	0.04	1.60	0.69 ± 0.26	30	0.36	0.99	0.70 ± 0.12
	SR5.2	38	0.44	1.50	0.76 ± 0.23	30	0.39	0.93	0.73 ± 0.12
	SR9.9	38	0.46	1.70	0.75 ± 0.28	30	0.38	0.95	0.73 ± 0.12
	SR16.5	37	0.04	1.40	0.76 ± 0.26	30	0.36	1.80	0.80 ± 0.23
	SR23.5	38	0.43	1.50	0.77 ± 0.23	30	0.39	2.40	0.87 ± 0.33
	SF26	0	--	--	--	21	0.81	2.50	1.59 ± 0.42
	SF48	0	--	--	--	21	0.70	2.20	1.44 ± 0.34
	SF94	0	--	--	--	21	0.51	2.10	1.11 ± 0.42
Potassium, unfiltered (mg/L)	SR-2.7	16	1.32	2.95	2.00 ± 0.462	12	1.22	2.78	2.13 ± 0.53
	SR0.2	16	1.42	2.69	1.97 ± 0.37	12	1.30	2.49	2.06 ± 0.40
	SR2.3	16	1.60	3.12	2.29 ± 0.47	12	1.47	2.95	2.38 ± 0.51
	SR5.2	16	1.55	3.07	2.20 ± 0.49	12	1.42	2.92	2.33 ± 0.53
	SR9.9	16	1.64	2.92	2.30 ± 0.44	12	1.40	3.07	2.36 ± 0.53
	SR16.5	16	1.63	2.97	2.27 ± 0.46	12	1.47	3.10	2.44 ± 0.53
	SR23.5	16	1.57	3.22	2.29 ± 0.46	12	1.54	2.95	2.42 ± 0.51
	SF26	0	--	--	--	9	1.97	3.93	3.14 ± 0.63
	SF48	0	--	--	--	9	1.86	3.75	2.98 ± 0.62
	SF94	0	--	--	--	9	1.87	3.66	2.85 ± 0.63
Potassium, filtered (mg/L)	SR-2.7	16	1.38	2.81	1.97 ± 0.43	12	1.210	2.62	2.12 ± 0.51
	SR0.2	16	1.35	2.80	1.95 ± 0.41	13	1.290	2.47	2.03 ± 0.39
	SR2.3	16	1.59	3.04	2.27 ± 0.48	12	1.42	2.96	2.37 ± 0.52
	SR5.2	16	1.46	2.97	2.17 ± 0.49	11	1.34	2.98	2.35 ± 0.56
	SR9.9	16	1.61	2.93	2.26 ± 0.44	12	1.44	3.03	2.39 ± 0.53
	SR16.5	16	1.59	2.91	2.25 ± 0.45	12	1.38	3.08	2.40 ± 0.54
	SR23.5	16	1.62	2.89	2.25 ± 0.40	12	1.50	3.00	2.40 ± 0.48
	SF26	0	--	--	--	9	1.92	3.92	3.17 ± 0.66
	SF48	0	--	--	--	9	1.76	3.82	2.96 ± 0.66
	SF94	0	--	--	--	9	1.73	3.63	2.86 ± 0.66
Sodium, unfiltered (mg/L)	SR-2.7	16	3.15	6.50	4.45 ± 0.96	12	3.16	6.60	4.70 ± 1.12
	SR0.2	16	4.20	16.5	6.44 ± 3.05	12	4.11	14.1	6.84 ± 2.80
	SR2.3	16	5.12	10.8	7.91 ± 1.84	12	4.81	11.8	7.23 ± 1.94
	SR5.2	16	4.67	14.6	7.72 ± 2.69	12	4.59	9.72	6.93 ± 1.62
	SR9.9	16	4.84	10.3	7.24 ± 1.65	12	4.52	9.30	6.76 ± 1.65
	SR16.5	16	4.65	9.40	6.56 ± 1.33	12	4.49	8.02	6.50 ± 1.34
	SR23.5	16	4.70	7.84	6.51 ± 0.99	12	4.43	8.22	6.42 ± 1.35
	SF26	0	--	--	--	9	7.11	14.5	11.28 ± 2.69
	SF48	0	--	--	--	9	7.28	16.9	11.85 ± 3.25
	SF94	0	--	--	--	9	5.87	14.1	10.42 ± 2.78
Sodium, filtered (mg/L)	SR-2.7	16	3.25	6.56	4.48 ± 0.95	12	3.22	6.36	4.68 ± 1.08
	SR0.2	16	4.12	16.8	6.30 ± 3.12	13	4.10	13.8	6.66 ± 2.67
	SR2.3	16	5.11	11.7	7.96 ± 1.92	12	4.99	11.2	7.18 ± 1.74
	SR5.2	16	4.69	14.6	7.72 ± 2.69	11	4.44	9.94	7.03 ± 1.70
	SR9.9	16	4.99	10.5	7.20 ± 1.63	12	4.53	9.52	6.94 ± 1.77
	SR16.5	16	4.62	9.39	6.55 ± 1.35	12	4.57	7.96	6.45 ± 1.30
	SR23.5	16	4.74	7.71	6.46 ± 0.95	12	4.45	8.08	6.38 ± 1.30
	SF26	0	--	--	--	9	7.23	14.6	11.5 ± 2.73
	SF48	0	--	--	--	9	7.13	16.8	11.8 ± 3.30
	SF94	0	--	--	--	9	5.85	14.7	10.6 ± 2.92
Sulfate, unfiltered (mg/L)	SR-2.7	16	5.50	15.1	9.69 ± 2.70	12	4.50	17.7	10.1 ± 3.57
	SR0.2	16	5.50	12.3	9.24 ± 1.95	12	5.10	11.3	9.08 ± 2.09
	SR2.3	16	6.60	12.8	10.5 ± 1.83	12	6.20	13.0	10.3 ± 2.27
	SR5.2	16	6.20	18.9	10.5 ± 2.74	12	6.00	13.5	10.1 ± 2.36
	SR9.9	16	6.40	14.3	10.3 ± 1.94	12	5.60	14.0	10.1 ± 2.58
	SR16.5	16	6.20	14.3	10.1 ± 2.00	12	6.40	47.9	12.8 ± 11.4
	SR23.5	16	6.80	13.9	10.2 ± 1.82	12	5.80	13.7	9.60 ± 2.34
	SF26	0	--	--	--	9	10.50	14.7	13.1 ± 1.31
	SF48	0	--	--	--	9	8.50	15.0	12.6 ± 2.13
	SF94	0	--	--	--	9	9.00	14.1	11.98 ± 1.78
Alkalinity, unfiltered (mg/l CaCO3)	SR-2.7	3	49.8	92.3	74.8 ± 22.2	12	51.2	123	92.3 ± 28.2
	SR0.2	3	56.3	94.2	78.9 ± 20.0	12	55.9	119	97.2 ± 24.0
	SR2.3	3	59.6	99.4	82.4 ± 20.5	12	0.70	121	88.8 ± 36.1
	SR5.2	3	59.9	105	85.8 ± 23.3	12	57.4	127	101 ± 23.3
	SR9.9	3	62.7	107	88.2 ± 22.9	12	48.6	126	96.5 ± 27.7
	SR16.5	3	63.5	107	88.5 ± 22.5	12	0.70	128	91.5 ± 37.1
	SR23.5	3	64.3	109	89.1 ± 22.7	12	58.5	128	100 ± 23.8
	SF26	0	--	--	--	9	58.3	181	143 ± 40.2
	SF48	0	--	--	--	9	99.9	161	143 ± 24.1
	SF94	0	--	--	--	9	88.0	150	129 ± 22.1

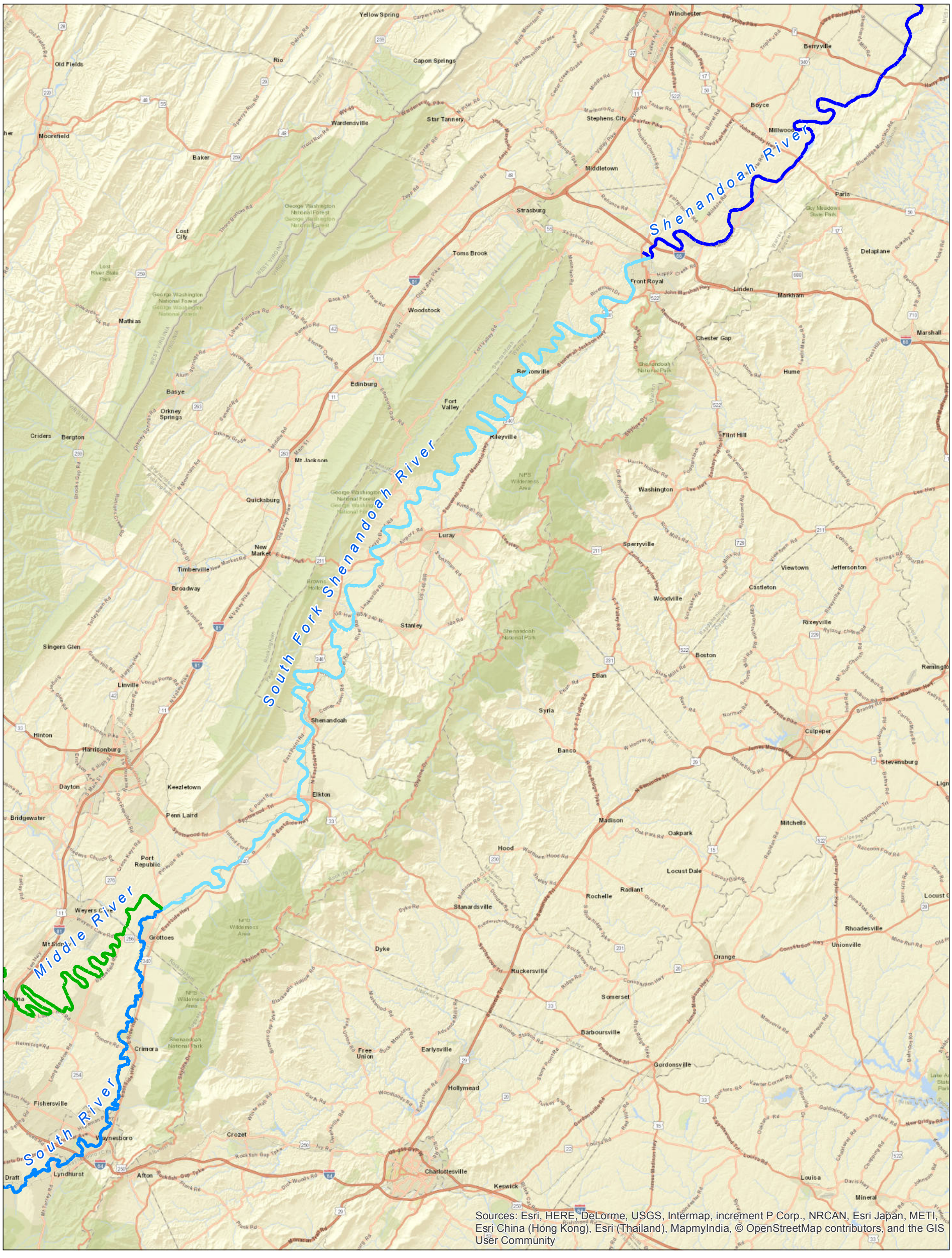
Notes:
1, Historical data include surface water samples collected annually from 2006 to 2013.
LTM, Long-term monitoring (2014- 2016)
mg/L, Milligrams per liter
ug/L, Micrograms per liter
Min, Minimum detected concentration
Max, Maximum detected concentration
Mean ± SD, Arithmetic mean ± standard deviation of detected concentrations

Table 4-17
Benthic Invertebrate Community Data Summary
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

Monitoring Program	Season	Location	Mean ± SD					
			Abundance (n)	Taxa Richness	% EPT	% Dominant Taxon	Shannon-Weaver H' (log 10)	Pielou's J'
Historical[1]	Spring	MR01	382 ± 292	38 ± 9	26 ± 12	23 ± 7	1.3 ± 0.1	0.8 ± 0.05
		SR-2.7	772 ± 541	36 ± 6	16 ± 6	25 ± 8	1.1 ± 0.2	0.7 ± 0.1
		SR0.1	866 ± 328	42 ± 10	25 ± 8	17 ± 7	1.4 ± 0.1	0.8 ± 0.1
		SR3.5	923 ± 589	31 ± 12	30 ± 20	21 ± 3	1.2 ± 0.1	0.8 ± 0.1
		SR11.8	771 ± 764	31 ± 5	31 ± 24	26 ± 10	1.1 ± 0.1	0.8 ± 0.1
		SR23.5	366 ± 320	28 ± 12	24 ± 16	22 ± 13	1.2 ± 0.2	0.9 ± 0.1
LTM	Spring	MR01	1533 ± 1344	34 ± 5	36 ± 10	23 ± 8	1.1 ± 0.1	0.8 ± 0.1
		SR-2.7	1719 ± 1507	30 ± 5	38 ± 9	31 ± 11	1.0 ± 0.1	0.7 ± 0.1
		SR0.1	1767 ± 1181	34 ± 9	31 ± 13	26 ± 12	1.1 ± 0.2	0.7 ± 0.1
		SR3.5	1496 ± 663	33 ± 5	53 ± 11	21 ± 7	1.2 ± 0.1	0.8 ± 0.05
		SR11.8	1779 ± 1637	33 ± 3	31 ± 12	29 ± 12	1.1 ± 0.1	0.8 ± 0.1
		SR23.5	1204 ± 698	35 ± 3	37 ± 16	23 ± 9	1.2 ± 0.1	0.8 ± 0.1
	Fall	MR01	898 ± 573	33 ± 6	30 ± 13	29 ± 11	1.1 ± 0.2	0.7 ± 0.1
		SR-2.7	1744 ± 1646	30 ± 5	44 ± 16	38 ± 16	1.0 ± 0.2	0.7 ± 0.1
		SR0.1	845 ± 531	34 ± 4	28 ± 9	31 ± 7	1.1 ± 0.1	0.7 ± 0.04
		SR3.5	690 ± 396	31 ± 8	42 ± 10	23 ± 7	1.1 ± 0.1	0.8 ± 0.05
		SR11.8	1563 ± 1423	30 ± 4	30 ± 16	35 ± 9	1.0 ± 0.1	0.7 ± 0.1
		SR23.5	1008 ± 420	30 ± 4	33 ± 14	28 ± 9	1.1 ± 0.1	0.7 ± 0.1

Notes:
1, Historical data include benthic community samples collected in 2010 and 2011.
LTM, Long-term monitoring (2014- 2016)
Mean ± SD, Arithmetic mean ± standard deviation
EPT, Ephemeroptera, Plecoptera, Trichoptera

Figures



Legend

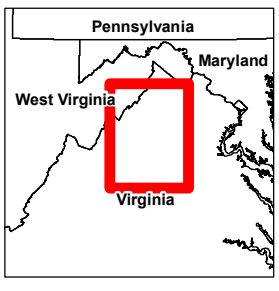
- Middle River
- South River
- South Fork Shenandoah River
- Shenandoah River

N

0 5 10 20 Miles

Reference:
esri Streets

NAD 1983 StatePlane Virginia North
Projection: Transverse Mercator
Linear Unit: Foot US



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Prepared by: VP	
Checked by: BR	
Date: 3/9/2017	

Figure 1-1
Investigation Area Overview Map

Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

S:\Projects\IMS\DUPONT\STHRIVER\Projects\LongtermMonitoringPlan\Figure 1-1 Investigation Area Overview Map_AECOMformat.mxd

Figure 2-1
Integration of Monitoring with Adaptive Management and Relative Risk Model
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

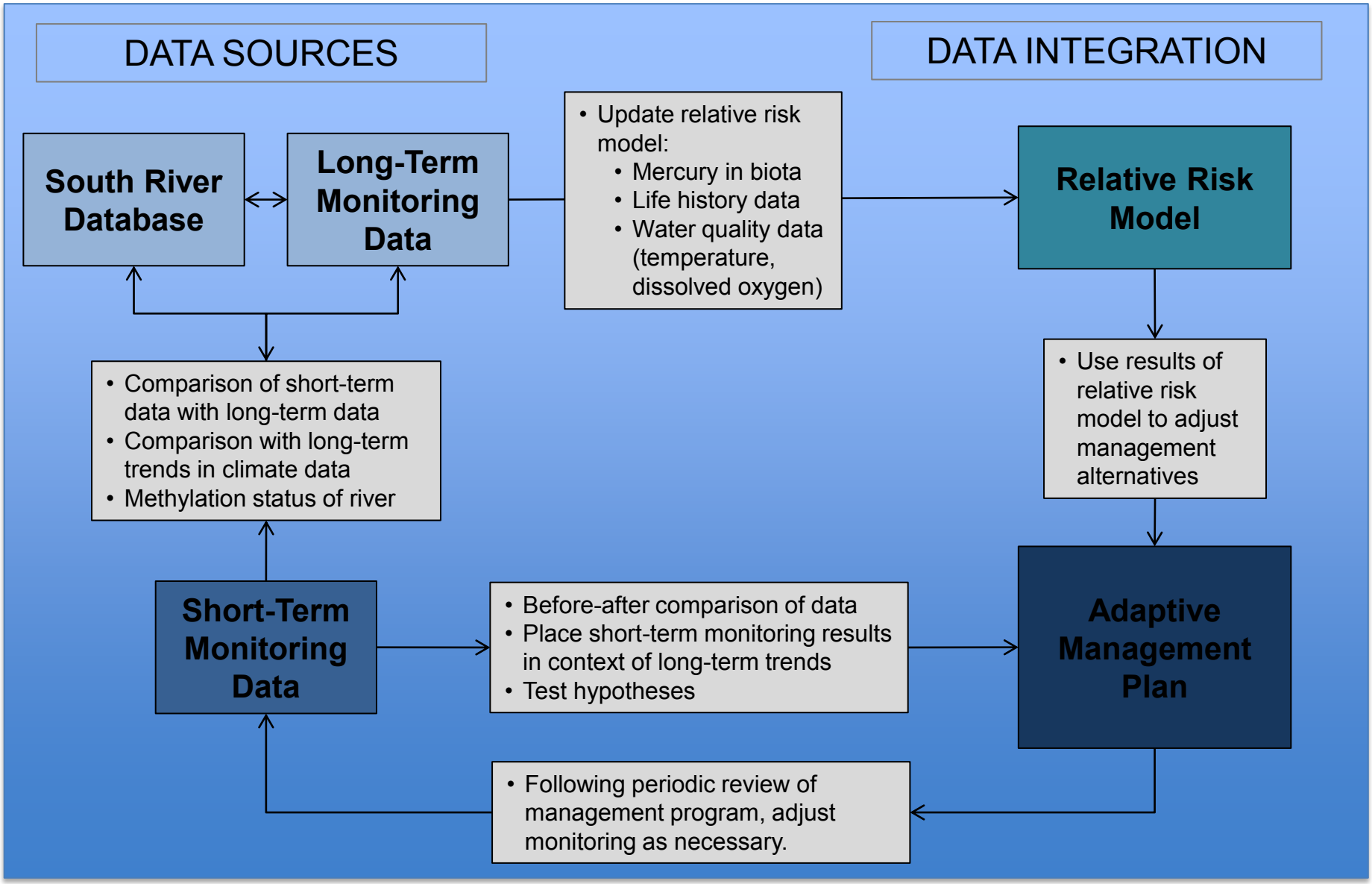
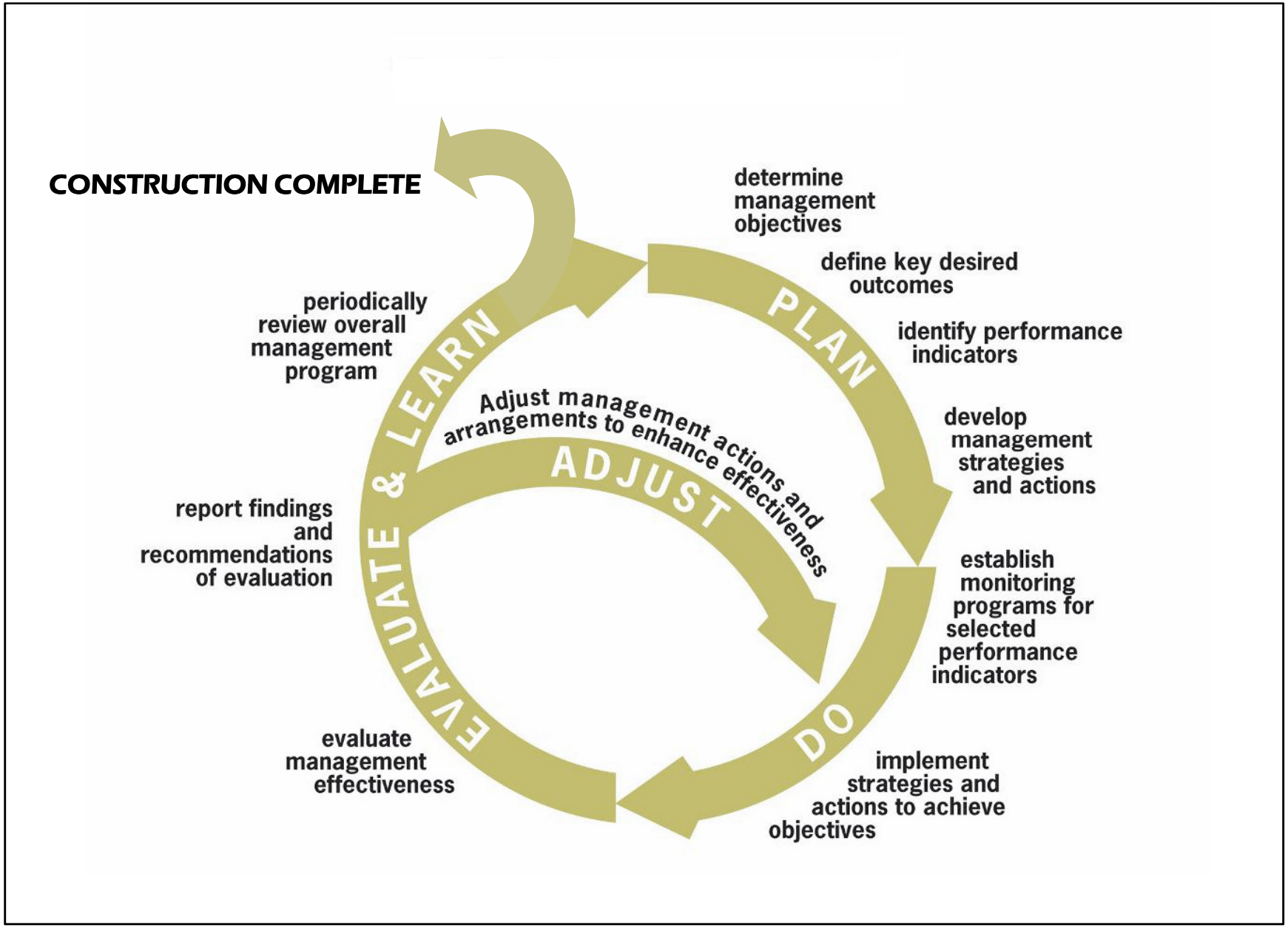
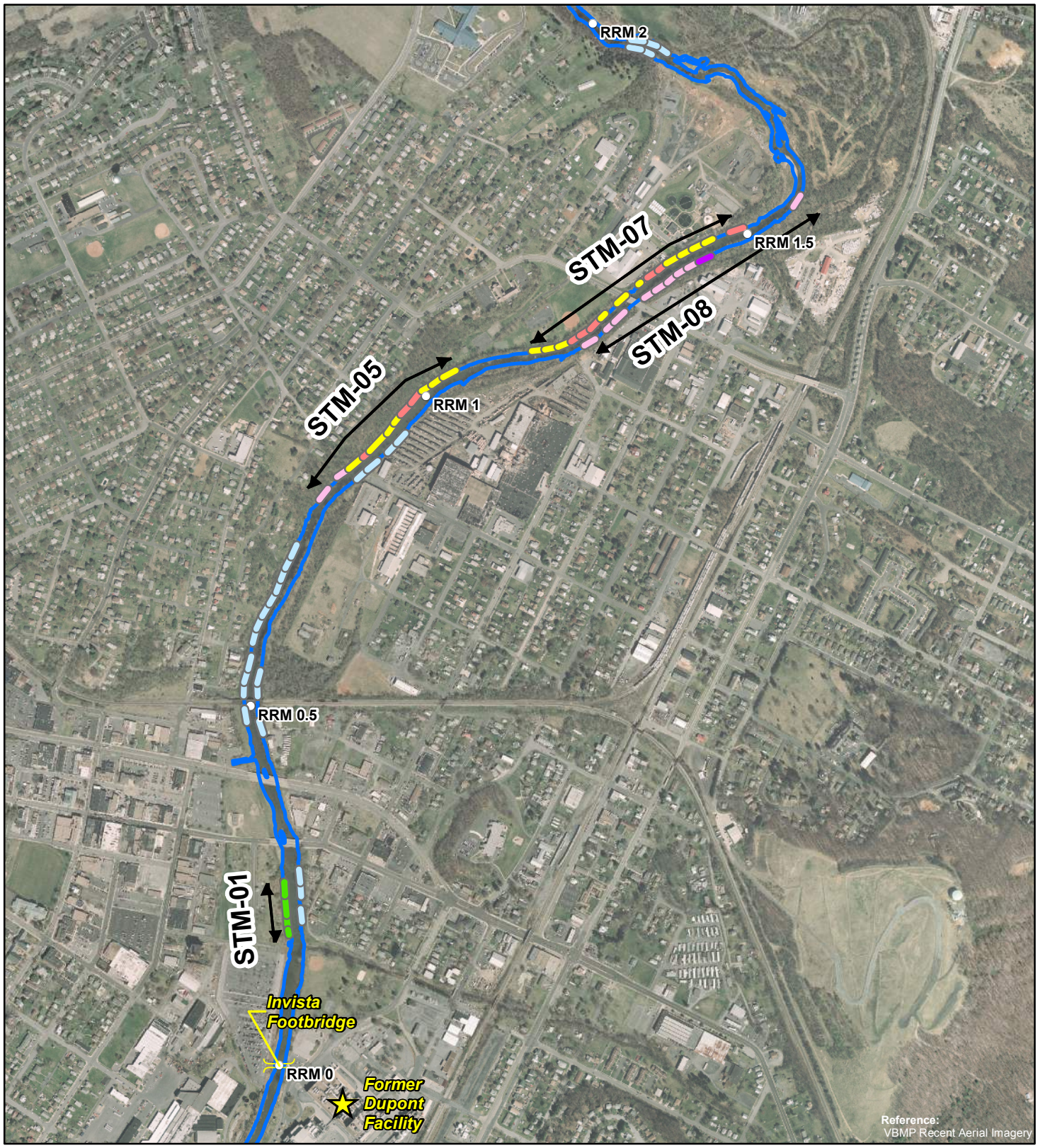


Figure 2-2
Basis for Adaptations to Monitoring Plan*
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



Adapted from Anchor QEA and URS (2013) and Jones (2005).



Legend

- Extent of Short-term Monitoring Location
- Shoreline
- Relative River Mile (RRM)

Bank Management Area

- Interim Measures Complete
- BMAs not included in 2016 STM monitoring program
- Phase 1A Primary BMAs
- Phase 1A Secondary BMAs
- Phase 1B Primary BMAs
- Phase 1B Secondary BMAs

0 375 750 1,500 Feet

N

Rockingham
Staunton
Augusta
Waynesboro
Albemarle
Nelson

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Figure 2-3
Short-term Monitoring Area and BMA Status Overview Map
Former Dupont Waynesboro Site, Area of Concern 4
Waynesboro, Virginia

S:\Projects\IMS\DUPONT\STHRIVER\Projects\ShortTermMonitoringPlan\Memo\2016\Figure 1 STMP Locations Overview_LTM_Baseline_Report.mxd

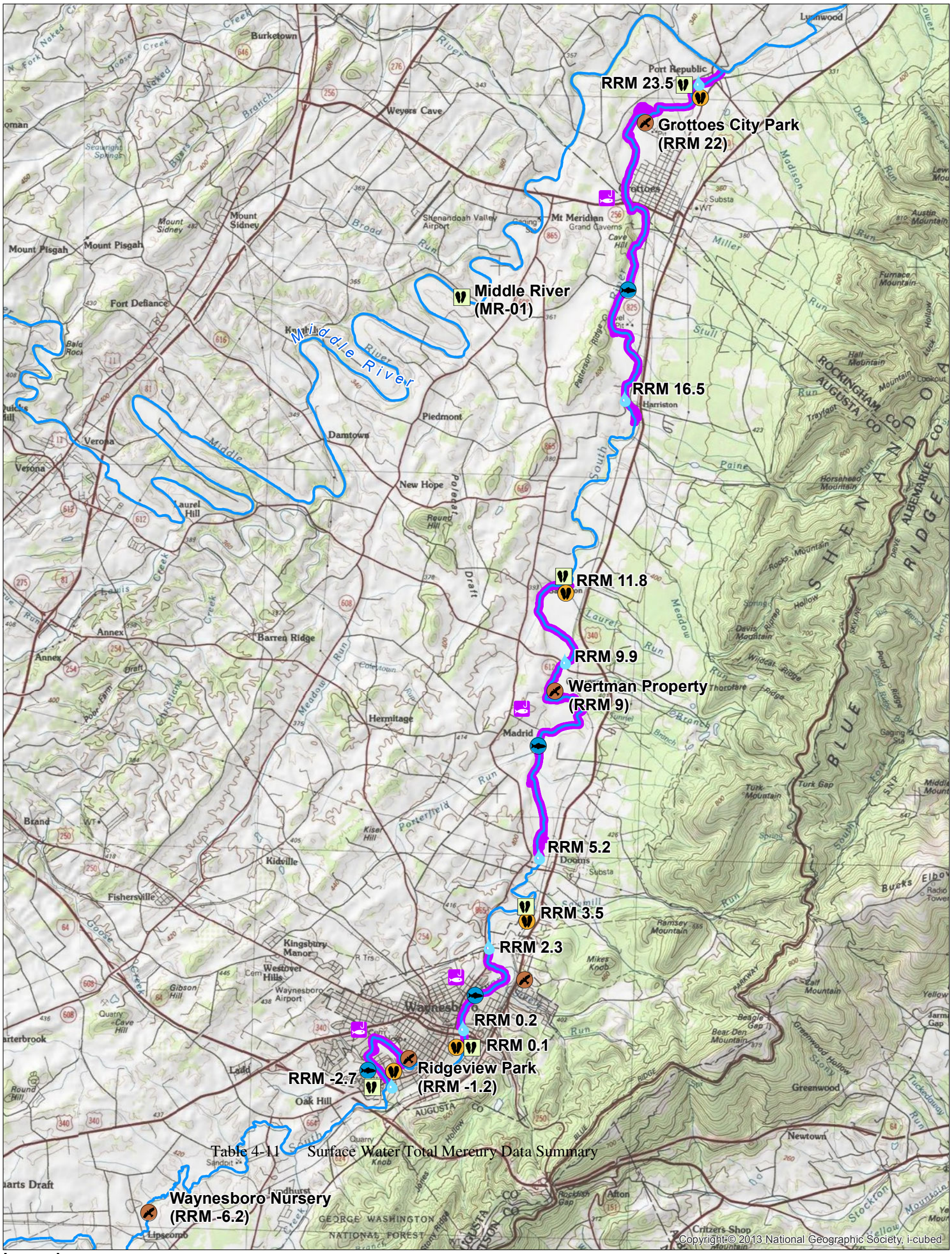

Table 4-11 Surface Water Total Mercury Data Summary

Legend

- Water Quality - Surface Water
- Ecological Exposure (Aquatic) - Sediment; Benthic Invertebrates; Periphyton; Asiatic Clam
- Ecological Exposure (Aquatic) - YOY Fish
- Ecological Exposure (Terrestrial) - Carolina Wren; Wolf Spider; Earthworm
- Benthic Community
- Human Exposure - Largemouth Bass; Smallmouth Bass; Snapping Turtle; Mallard Duck

NAD 1983 StatePlane Virginia North
Projection: Transverse Mercator
Linear Unit: Foot US

N

0 1 2 4 Miles

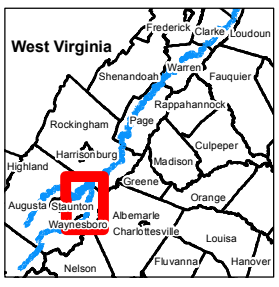

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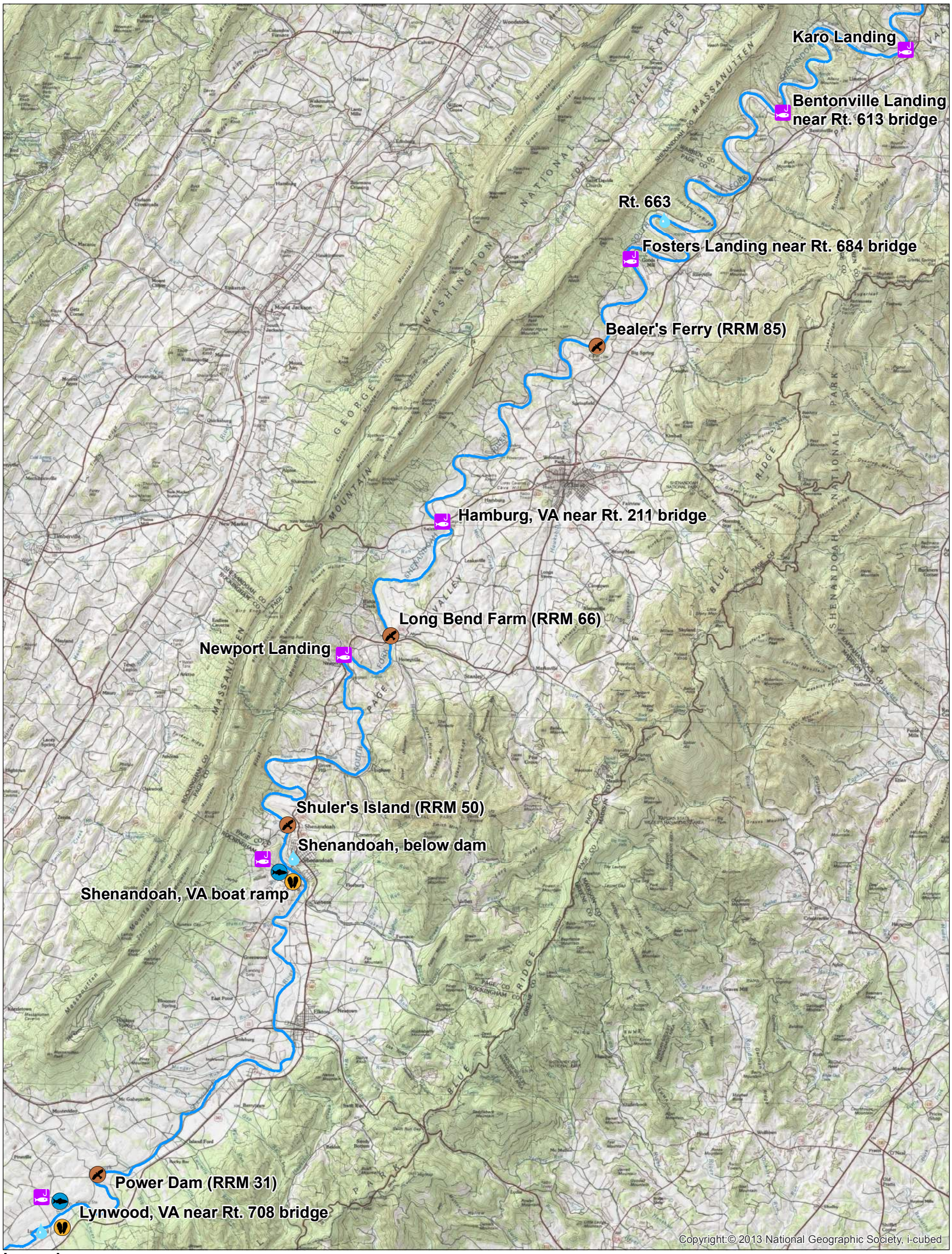
Figure 3-1a
Long-Term Monitoring Stations

Former DuPont Waynesboro Site,
Area of Concern 4

S:\Projects\IMS\DUPONT\STHRIVER\Projects\LongtermMonitoringPlan\Figure 3-1 Sample Location Map.mxd



Legend

- Water Quality - Surface Water
- Ecological Exposure (Aquatic) - Sediment; Benthic Invertebrates; Periphyton; Asiatic Clam
- Ecological Exposure (Aquatic) - YOY Fish
- Ecological Exposure (Terrestrial) - Carolina Wren; Wolf Spider; Earthworm
- Human Exposure - Largemouth Bass; Smallmouth Bass; Snapping Turtle; Mallard Duck

NAD 1983 StatePlane Virginia North
Projection: Transverse Mercator
Linear Unit: Foot US

N

0 1 2 4 Miles

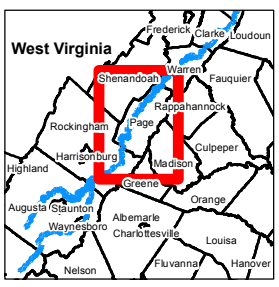


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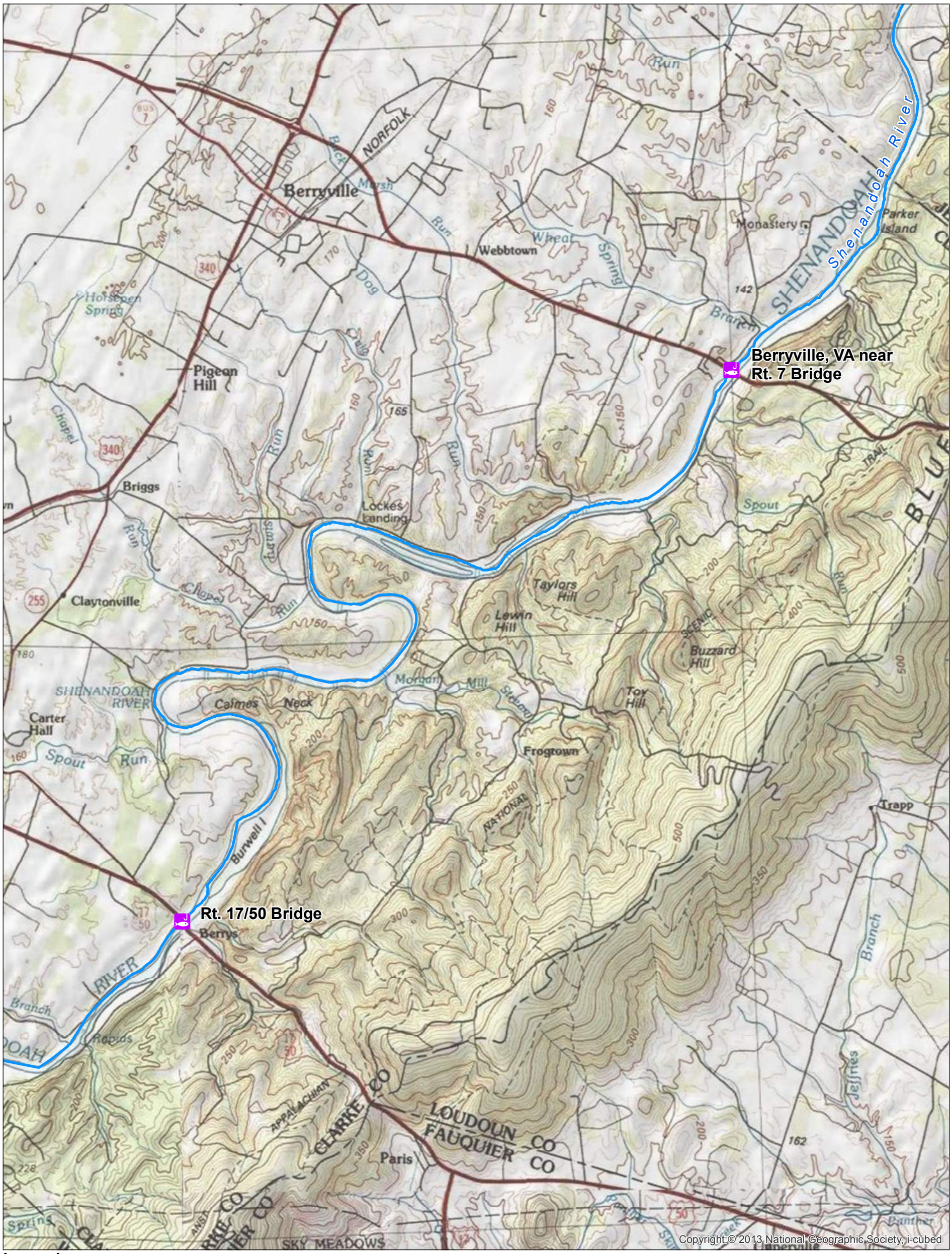
Figure 3-1b
Long-Term Monitoring Stations

Former DuPont Waynesboro Site,
Area of Concern 4

S:\Projects\IMS\DUPONT\STHRIVER\Projects\LongtermMonitoringPlan\Figure 3-1 Sample Location Map.mxd



Legend

Human Exposure - Largemouth Bass; Smallmouth Bass; Snapping Turtle; Mallard Duck

NAD 1983 StatePlane Virginia North
Projection: Transverse Mercator
Linear Unit: Foot US

N

0 1 2 4 Miles

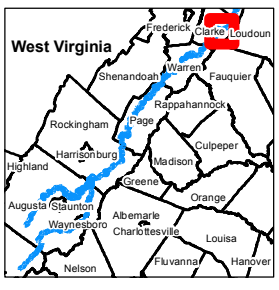


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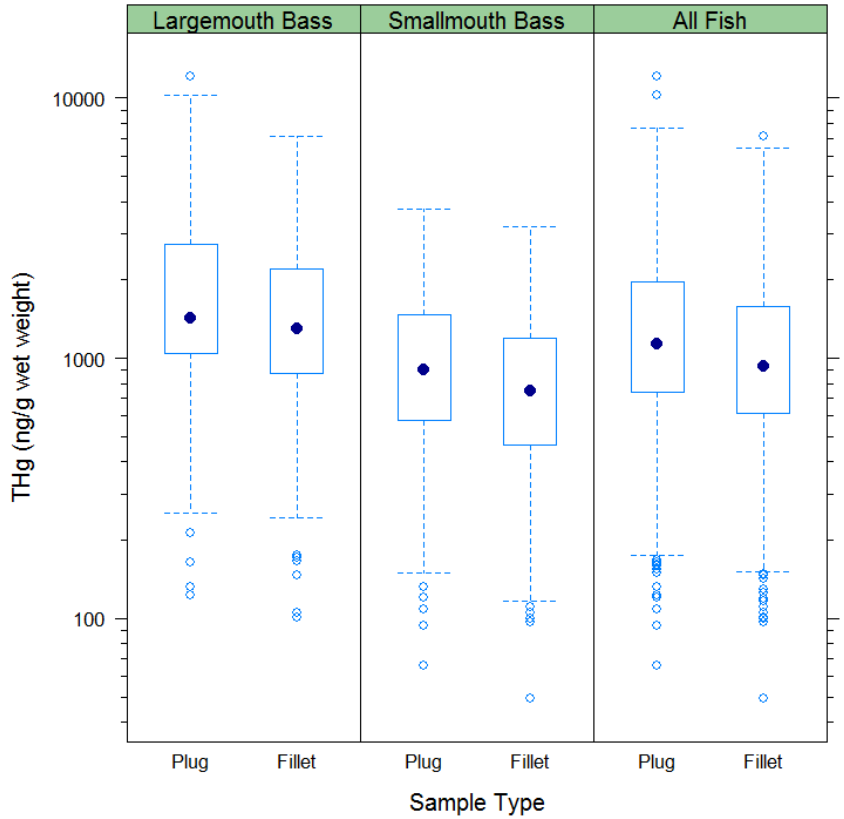
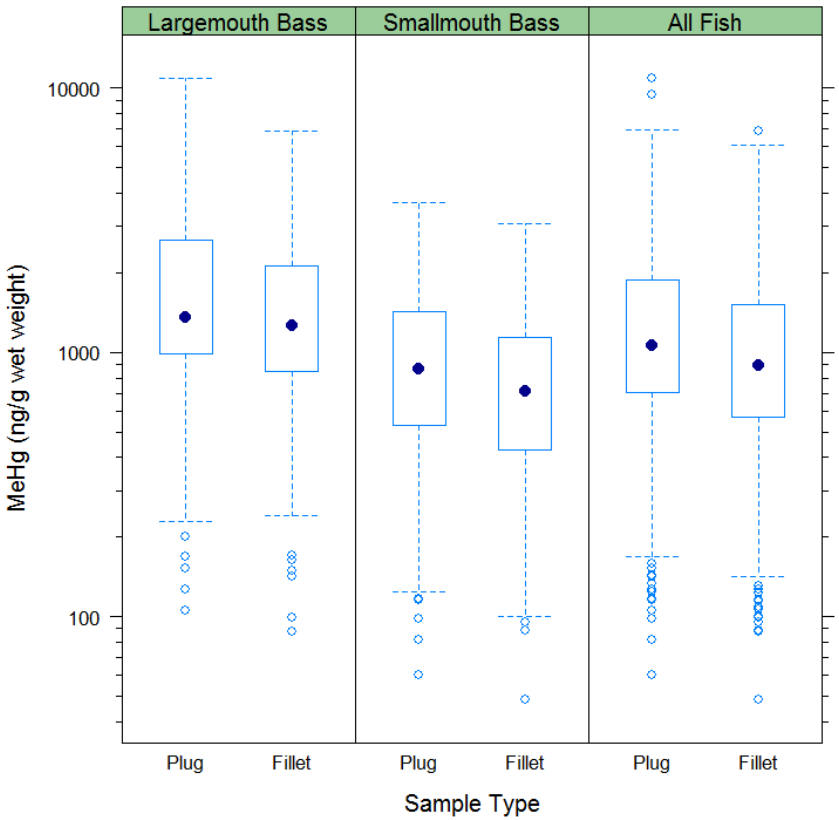
Figure 3-1c
Long-Term Monitoring Stations

Former DuPont Waynesboro Site,
Area of Concern 4

S:\Projects\IMS\DUPONT\STHRIVER\Projects\LongtermMonitoringPlan\Figure 3-1 Sample Location Map.mxd

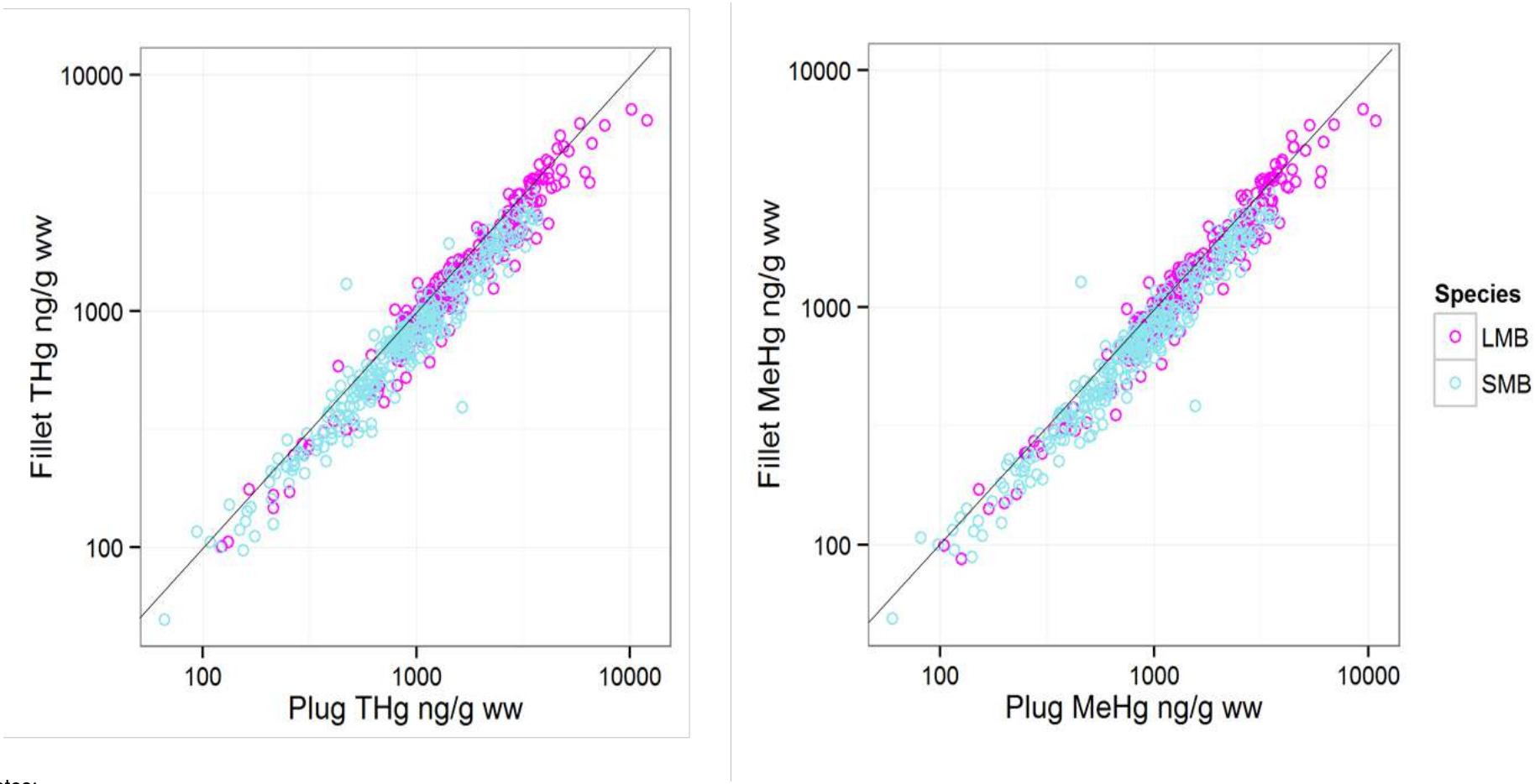
Figure 3-2
Summary of Mean Mercury Concentrations In Bass Biopsy Plugs and Fillets
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4





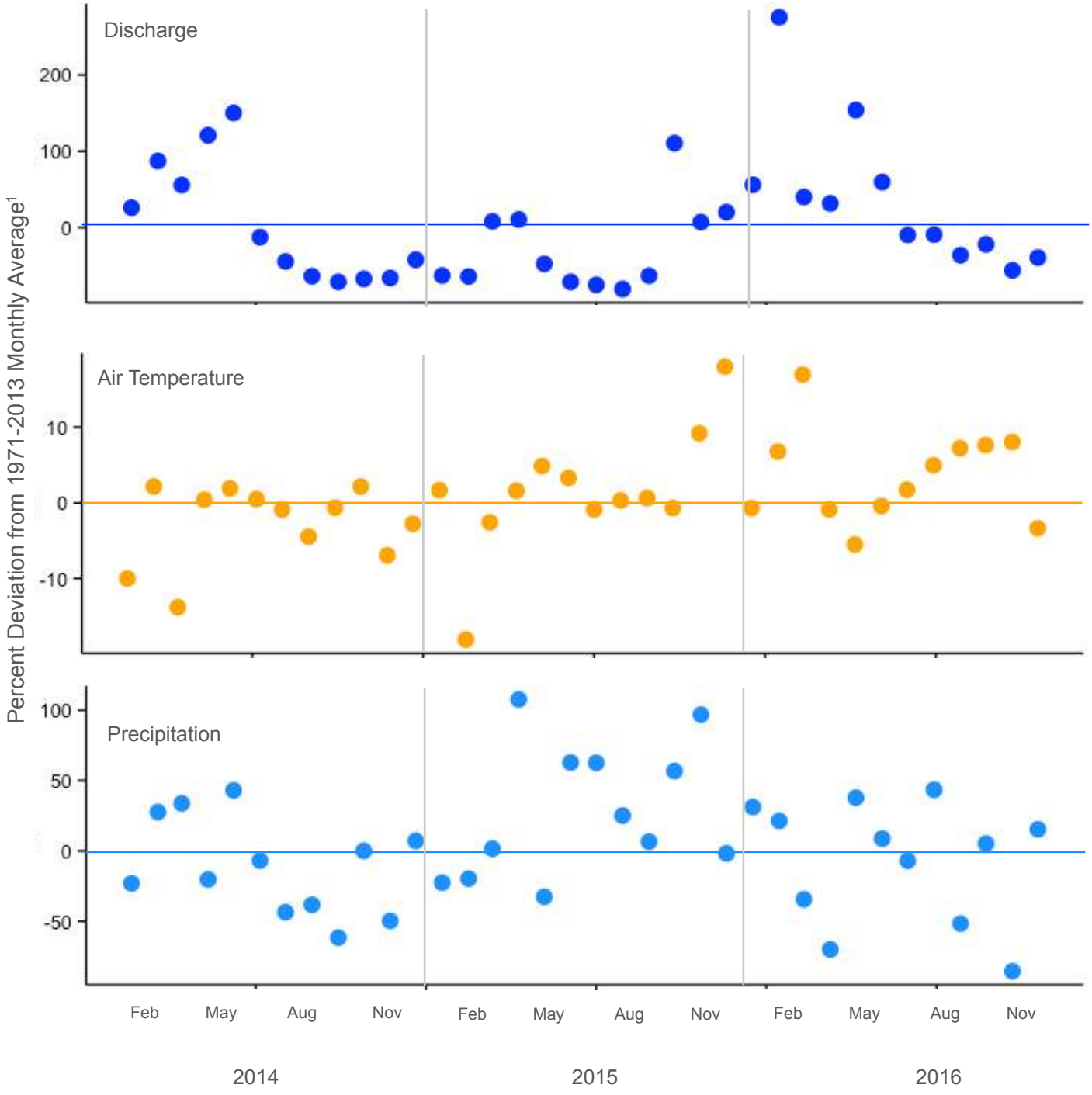
Notes:
THg, Total mercury
MeHg, Methylmercury
ng/g, Nanograms per gram

Figure 3-3
Summary of Mercury Concentrations In Paired Bass Biopsy Plugs and Fillets
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



Notes:
THg, Total mercury
MeHg, Methylmercury
ng/g, Nanograms per gram
ww, Wet weight
SMB, Smallmouth bass
LMB, Largemouth bass
Diagonal black line, 1:1 slope

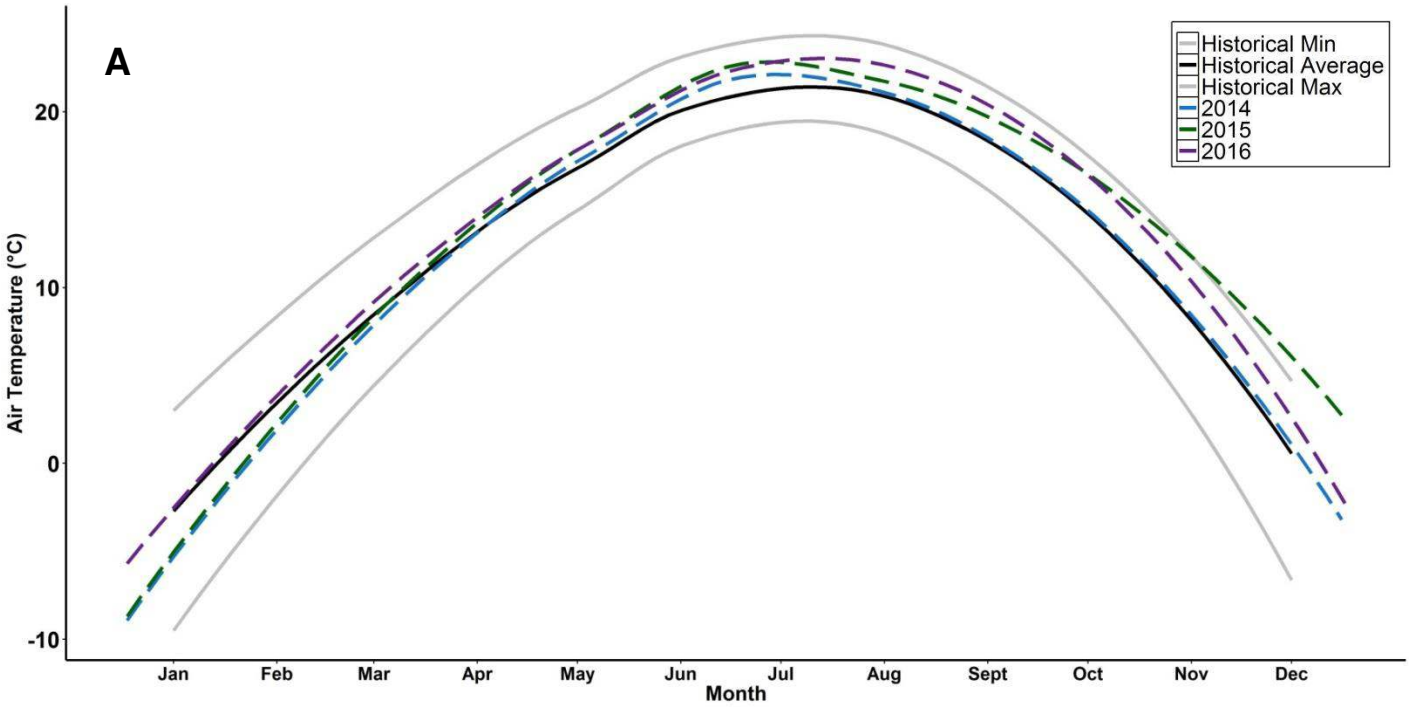
Figure 4-1
Percent Deviation from Monthly Average Discharge, Temperature and Precipitation
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

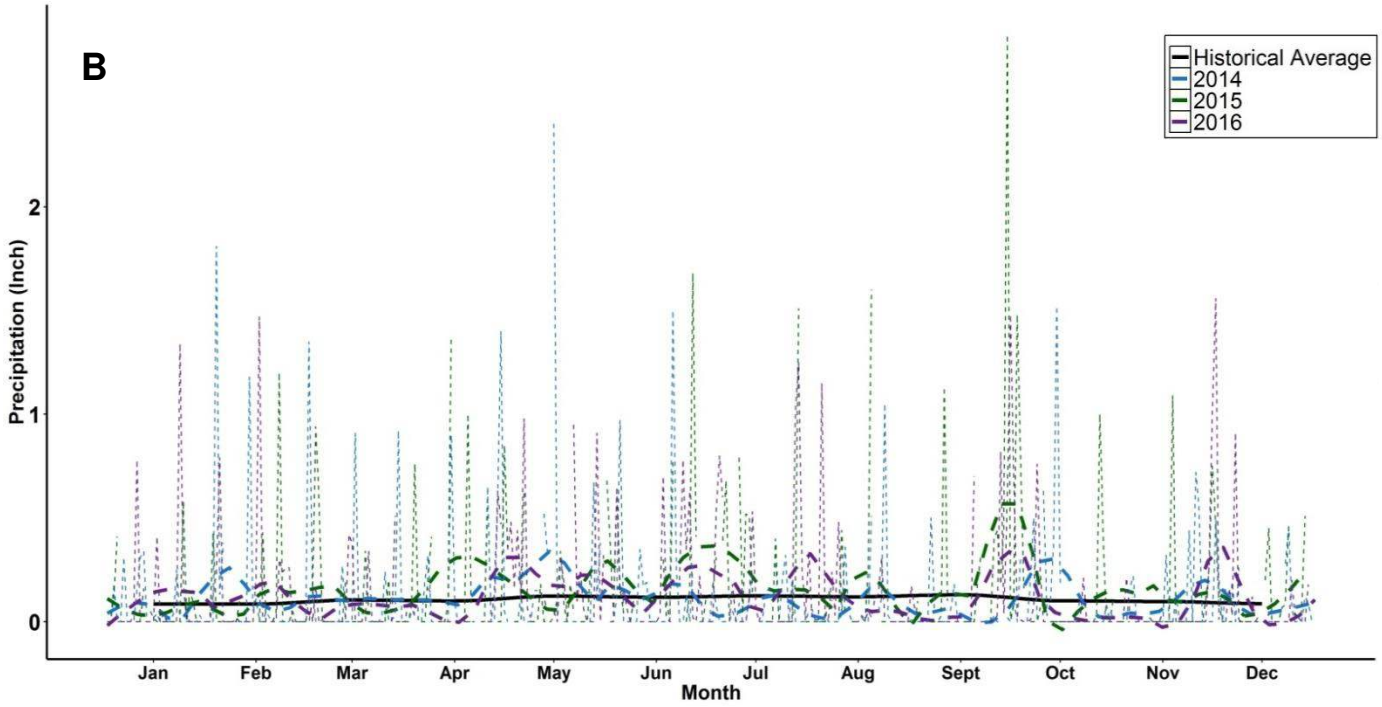


Notes:

1, Discharge data is from 1925-2016 at Harriston, VA (USGS gage #01627500).

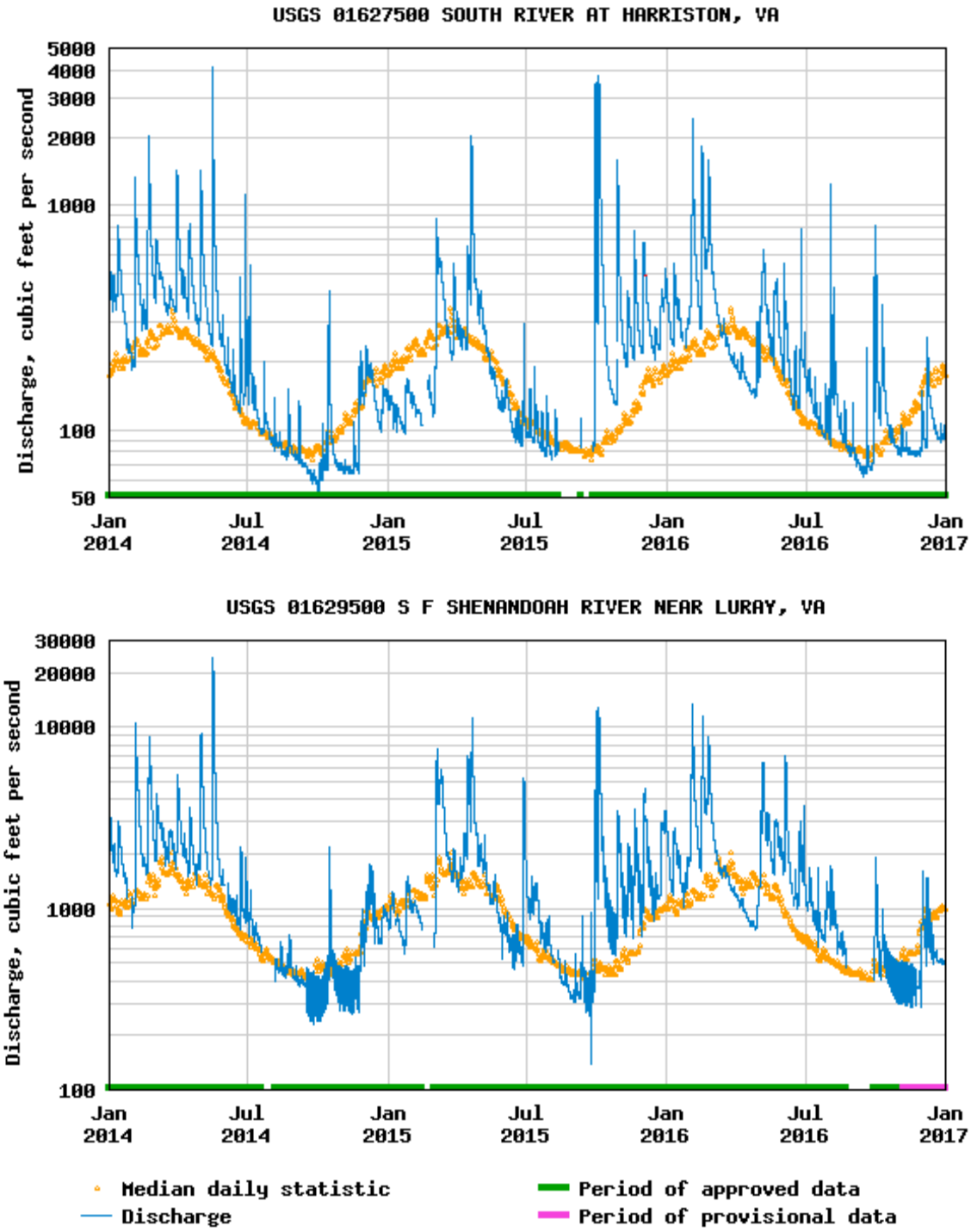
Figure 4-2
Regional Climatic Data Summary
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4





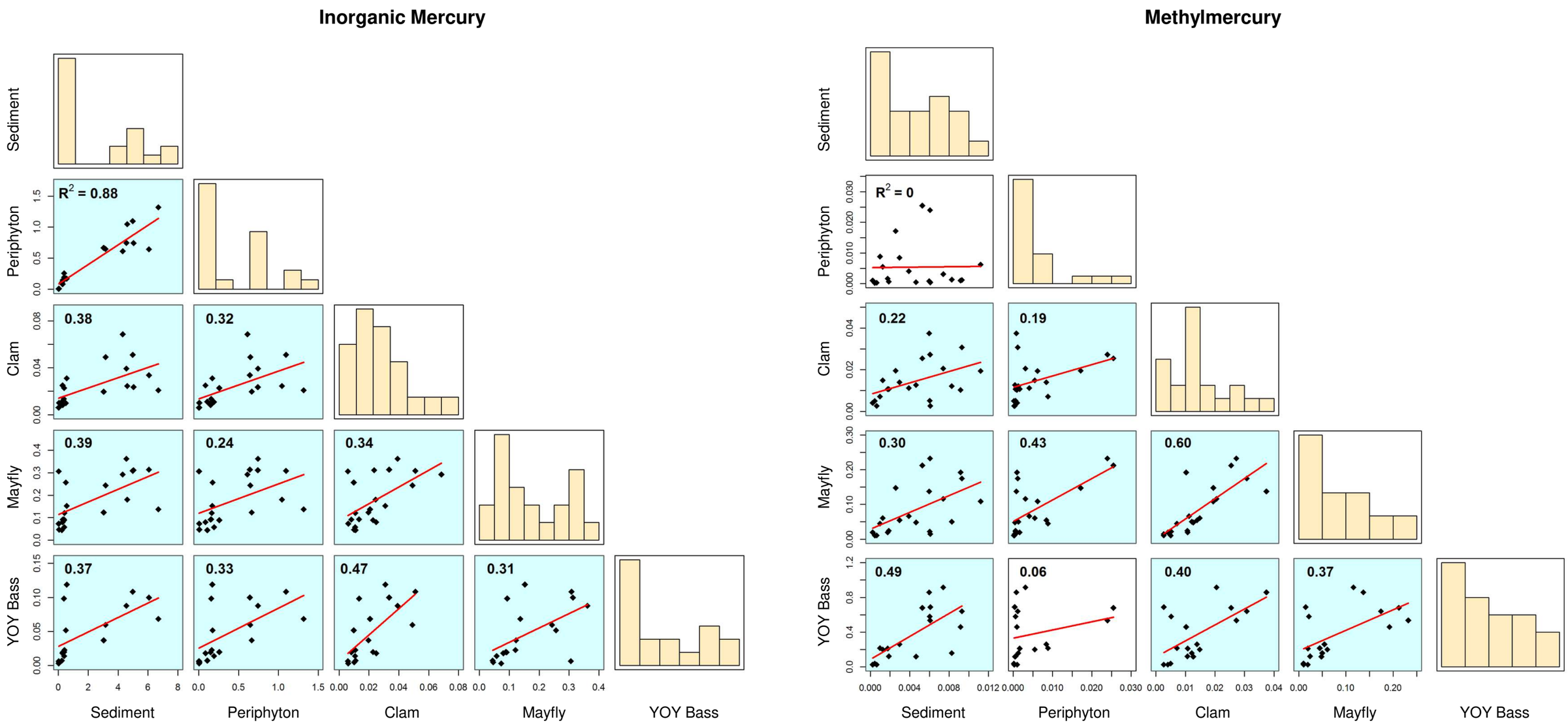
Notes
Average historical (1970-2013) and Long-term monitoring (LTM; 2014-2016) air temperature data (Panel A) were calculated from monthly and daily data sets, respectively. Data are represented by loess curves (span = 1) in order to compare relationships between average air temperatures by year. Average historical (1970-2013) and Long-term Monitoring (2014-2016) precipitation data (Panel B) were calculated from monthly and daily data sets, respectively. Historical data are represented by a loess curve (span= 0.1). LTM data are shown both as average daily values (background dotted lines) and also fit with a loess curve (span= 0.1, dashed lines). Data were recorded at the Staunton Sewage Plant, Virginia, by the Southeast Regional Climate Center.

Figure 4-3
South River and South Fork Shenandoah River Discharge Data
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



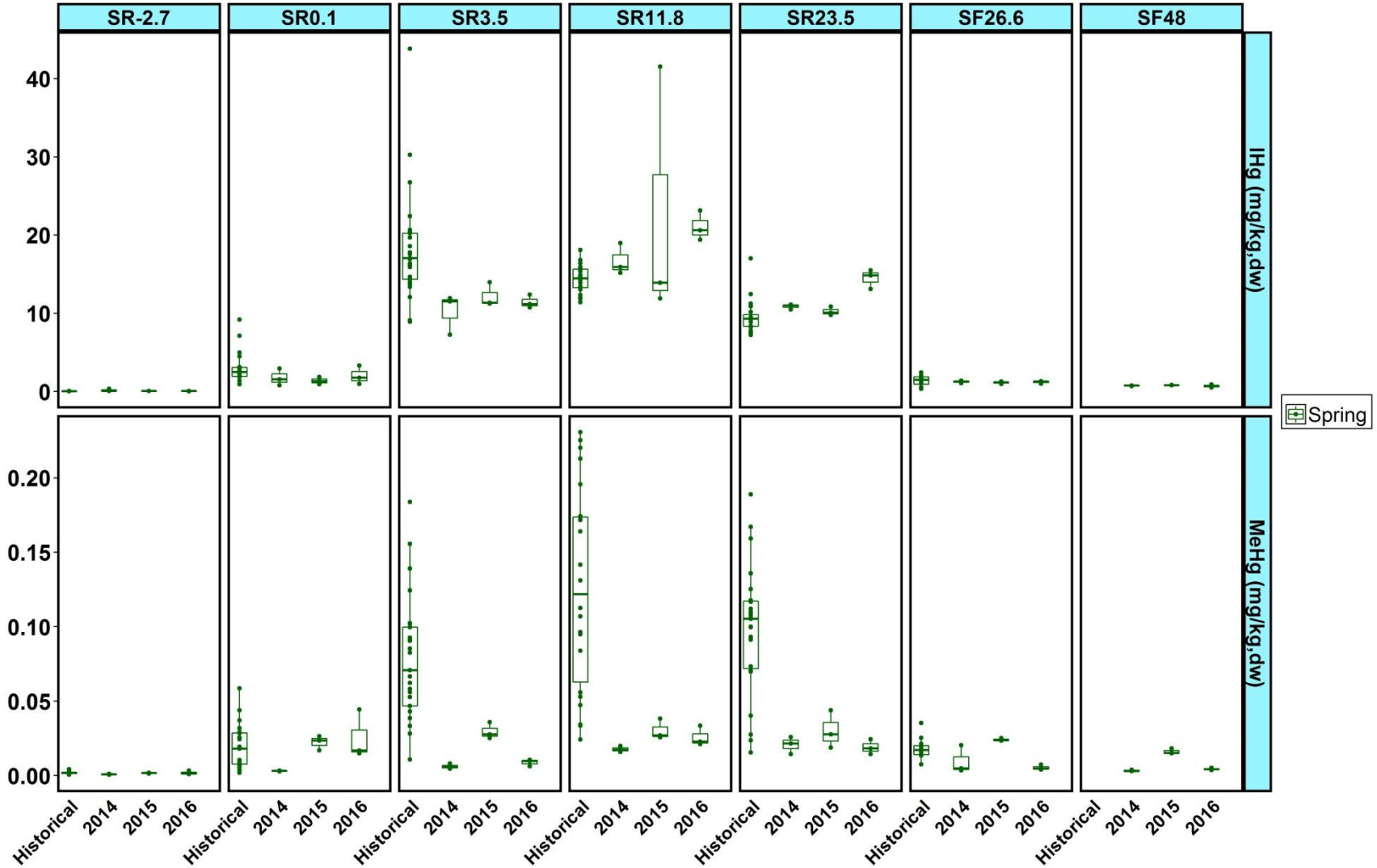
Notes
Source- https://nwis.waterdata.usgs.gov (Accessed on 3/16/2017)

Figure 4-4
Relationships among Aquatic Ecological Exposure Media
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



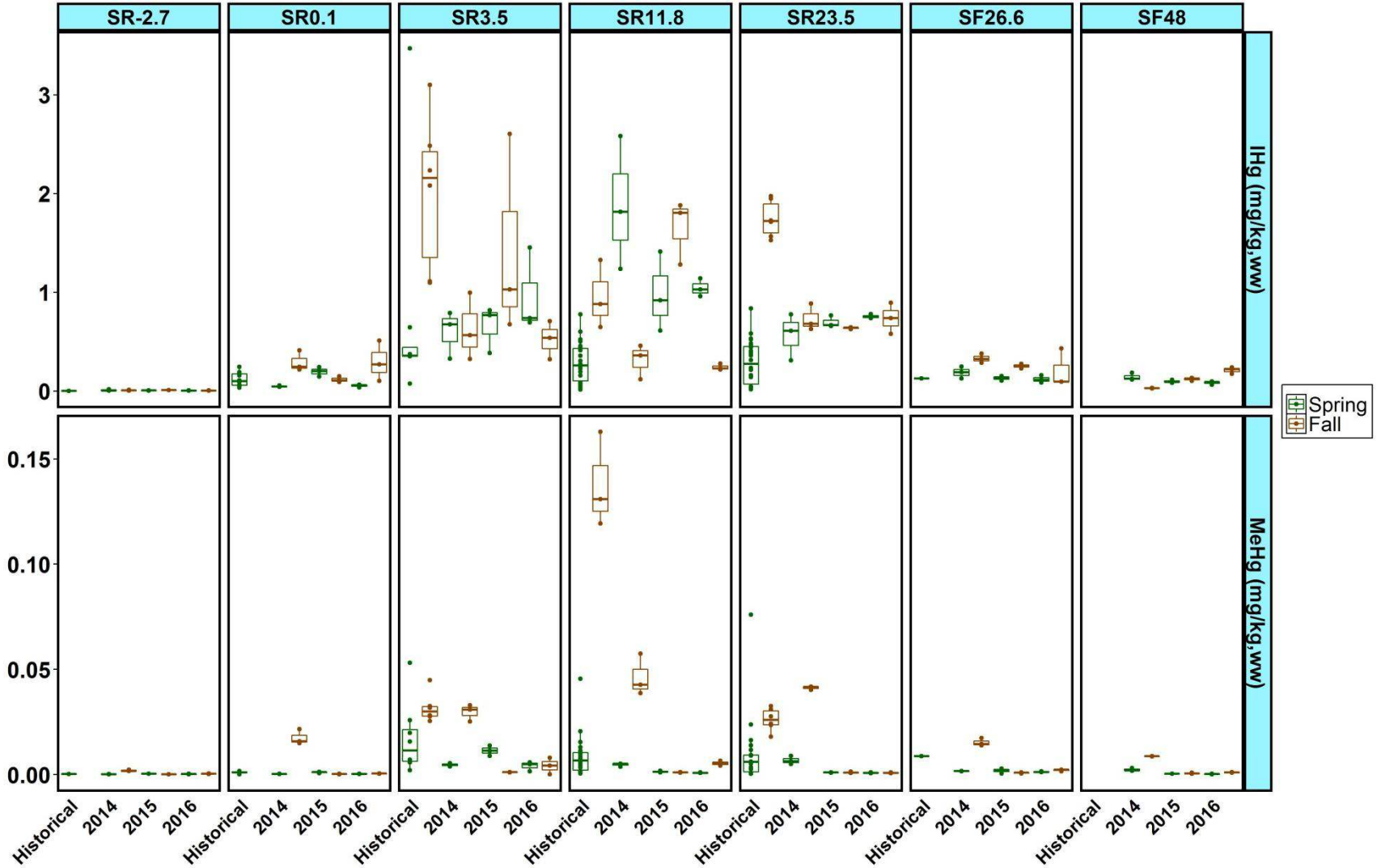
Notes
- Evaluation limited to LTM (2014-2016) data only; all data are in milligrams per kilogram (mg/kg), wet weight (ww).
- Each panel (Inorganic Mercury and Methylmercury) displays linear trend lines among paired media with associated R^2 value (bottom left) and data histograms per media (center diagonal).
- Data points displayed in the trend line panels represent annual averages of data from each Long-term Monitoring station.
- Boxes that are highlighted light blue indicate a significant regression model ($p < 0.05$), according to a one-tailed F-test.

Figure 4-5
Mercury Concentrations in Interstitial Sediment
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



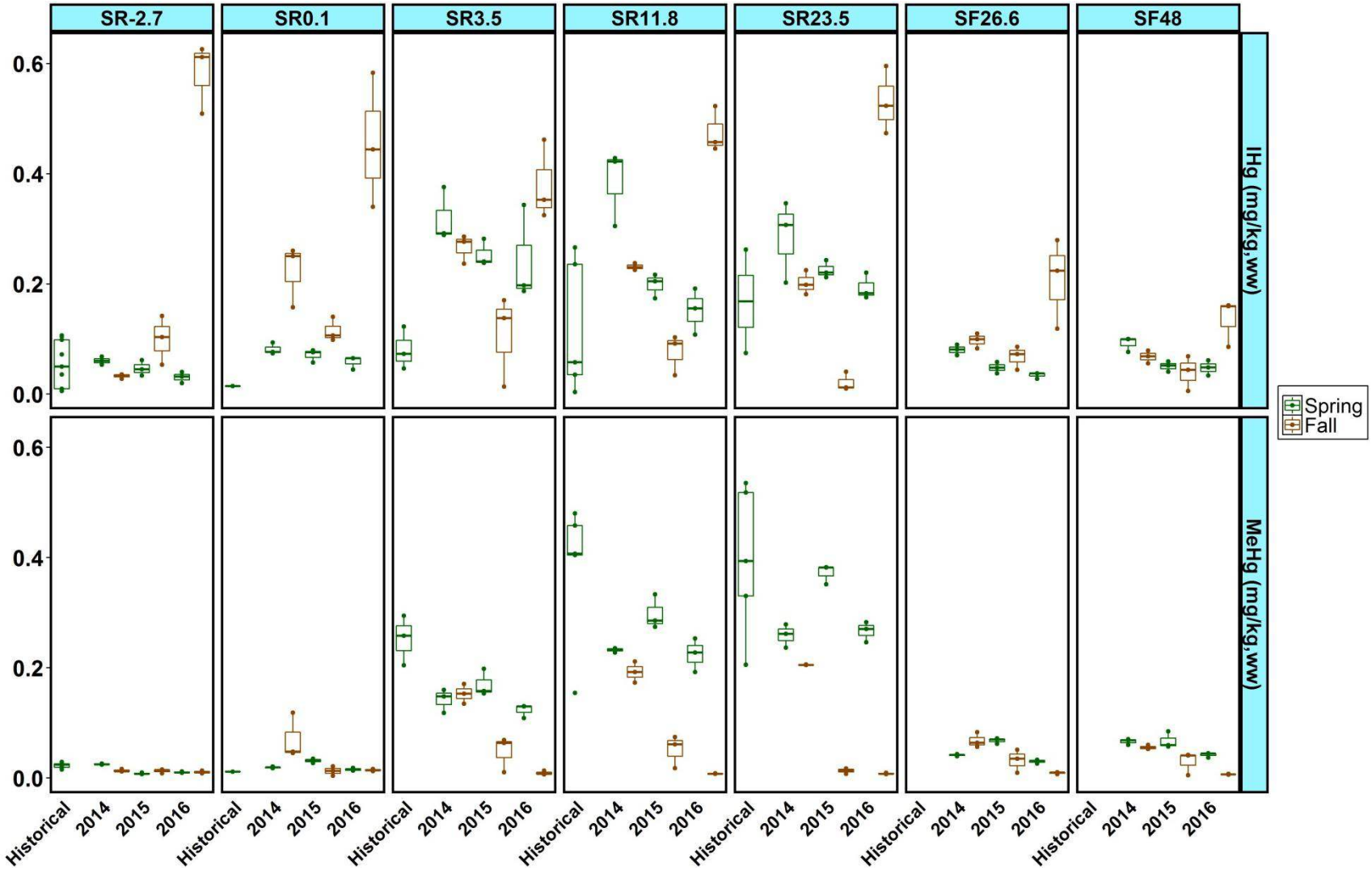
Notes
IHg, Inorganic mercury
MeHg, Methylmercury
mg/kg, Milligrams per kilogram
dw, Dry weight
- Historical data include interstitial sediment samples collected annually from 2004 to 2013.

Figure 4-6
Mercury Concentrations in Epilithic Periphyton
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



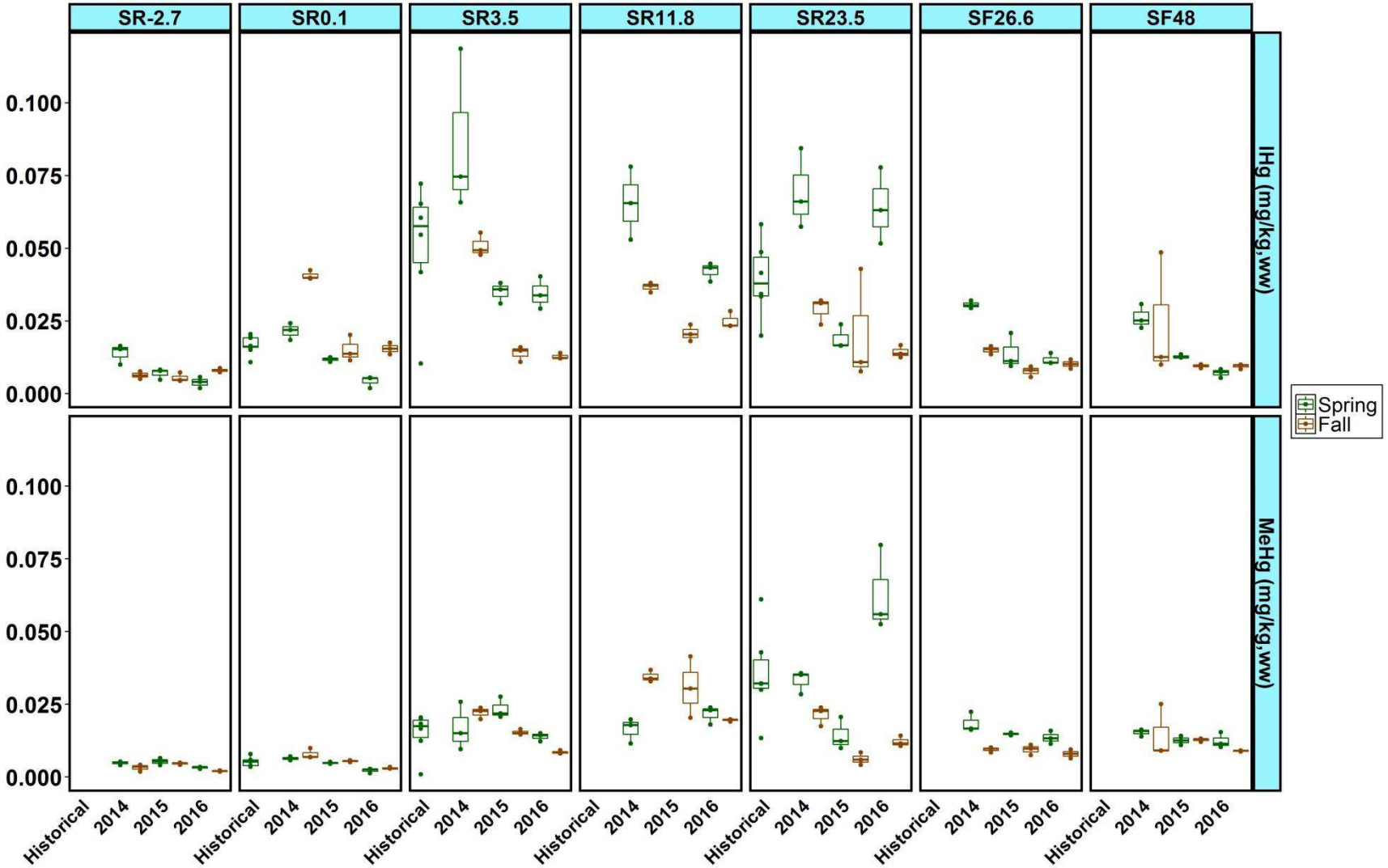
Notes
IHg, Inorganic mercury
MeHg, Methylmercury
mg/kg, Milligrams per kilogram
ww, Wet weight
- Historical data include epilithic periphyton samples collected annually from 2005 to 2011.

Figure 4-7
Mercury Concentrations in Mayfly Tissue
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



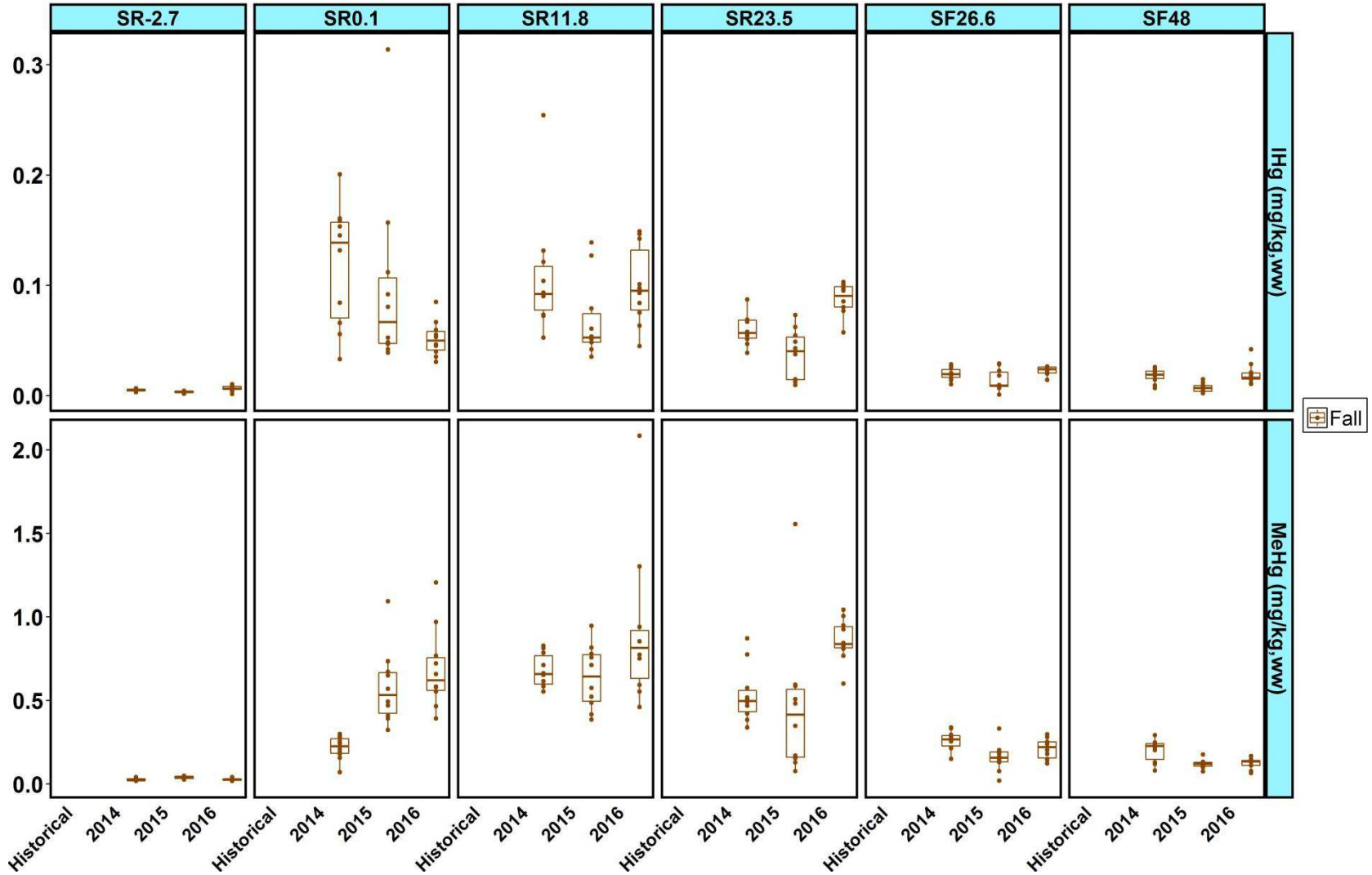
Notes
IHg, Inorganic mercury
MeHg, Methylmercury
mg/kg, Milligrams per kilogram
ww, Wet weight
- Historical data include mayfly tissue samples collected in 2006, 2007, 2010, and 2013.
- See Section 4.2 for discussion of atypically high IHg concentrations in fall 2016 data.

Figure 4-8
Mercury Concentrations in Transplanted Asiatic Clam Tissue
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



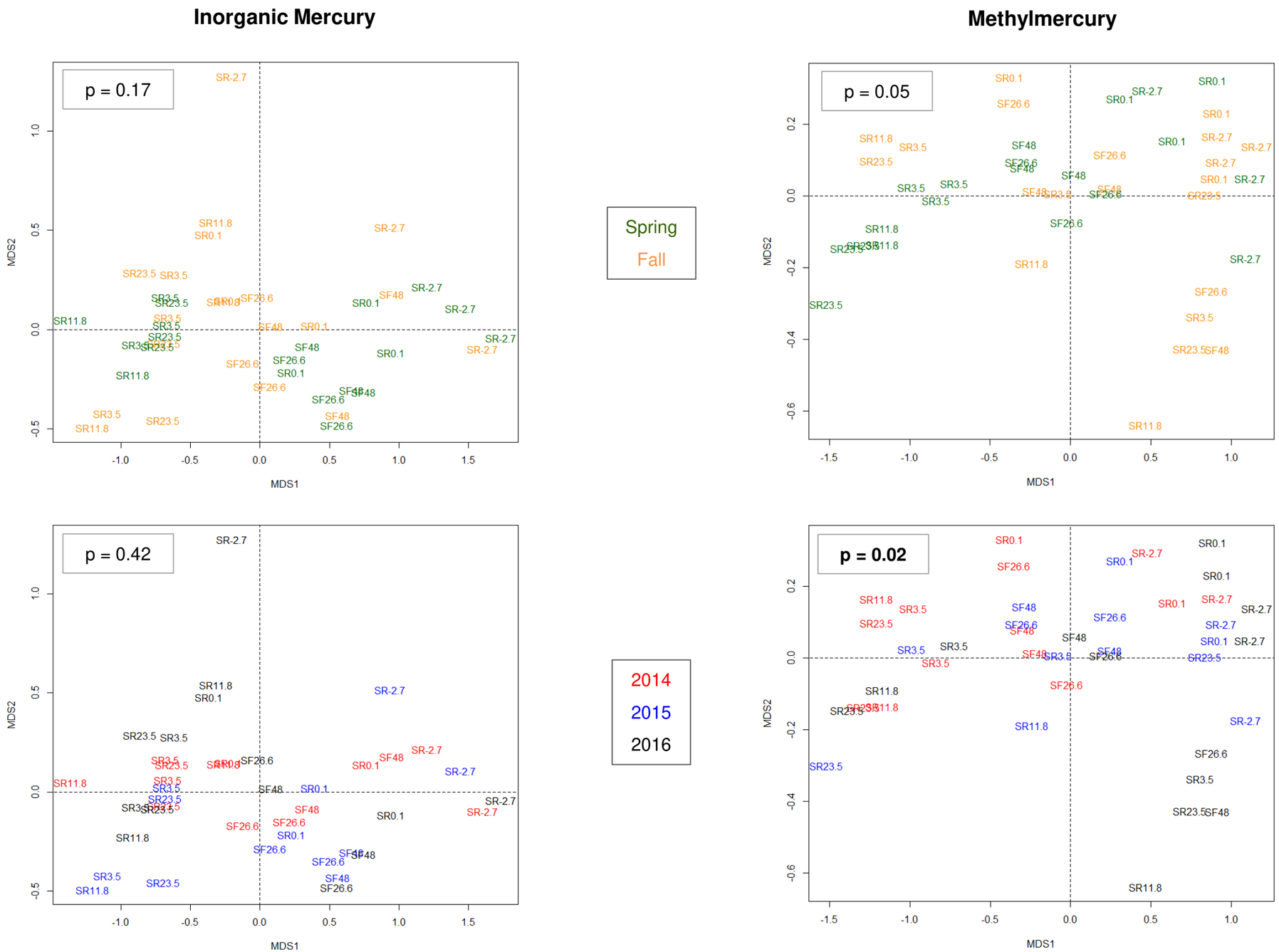
Notes
IHg, Inorganic mercury
MeHg, Methylmercury
mg/kg, Milligrams per kilogram
ww, Wet weight
- Historical data include transplanted caged clam tissue samples collected in 2009 and 2013.

Figure 4-9
Mercury Concentrations in Young-of-Year Smallmouth Bass
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



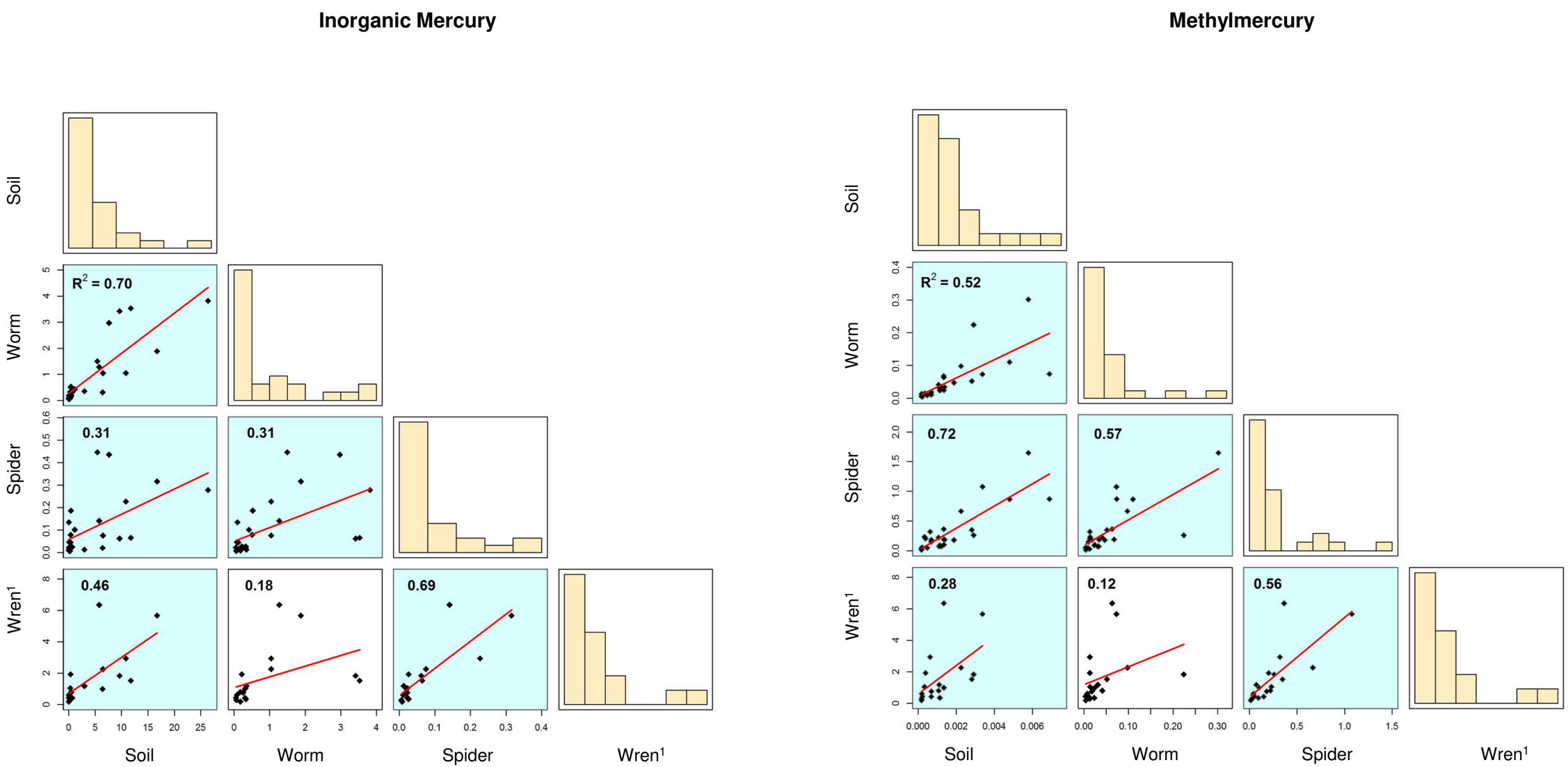
Notes
IHg, Inorganic mercury
MeHg, Methylmercury
mg/kg, Milligrams per kilogram
ww, Wet weight
- Applicable historical data not available

Figure 4-10
Statistical Evaluation of Aquatic Ecological Exposure Media
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



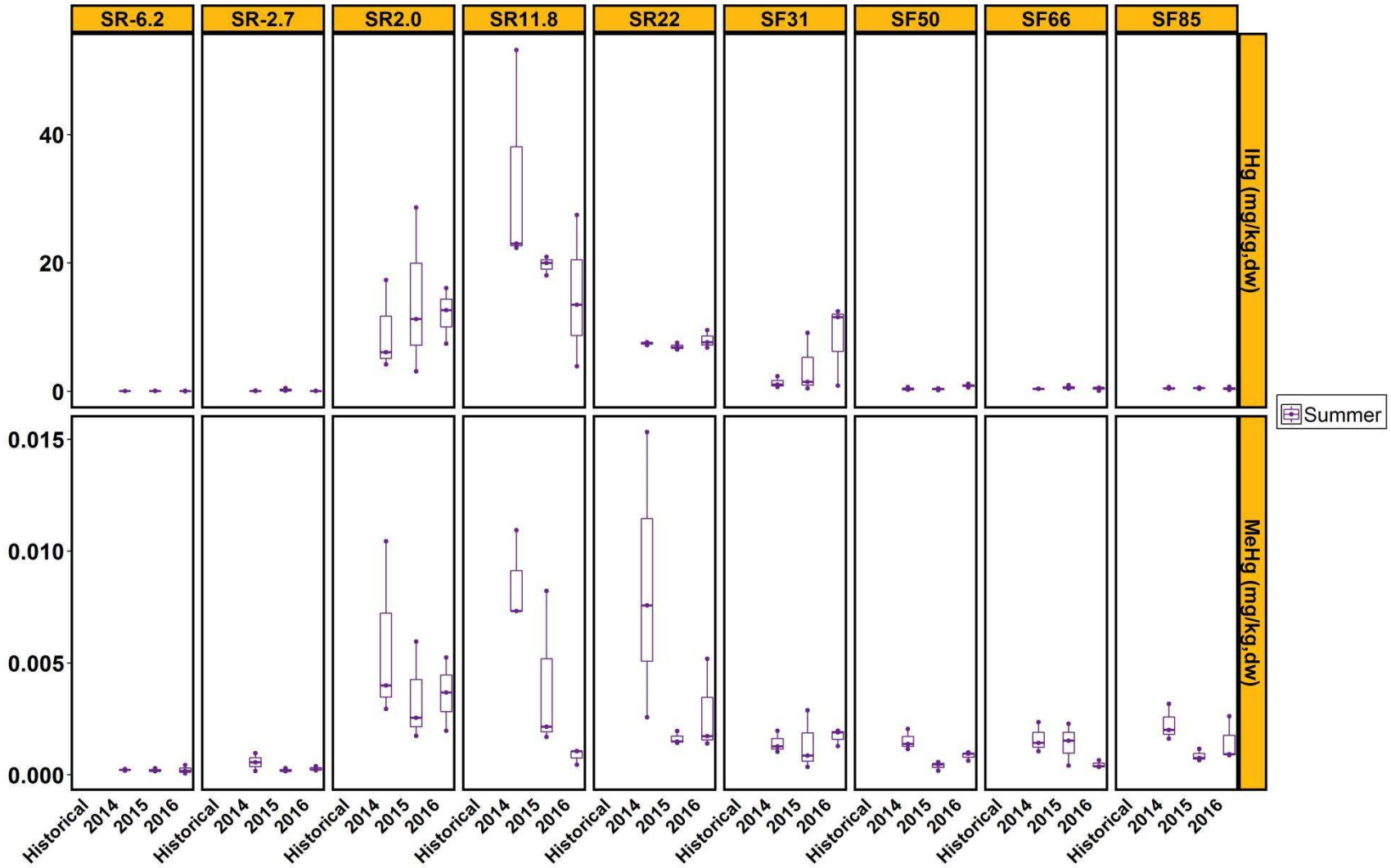
Notes
- Non-metric multidimensional scaling (NMDS), based on Bray-Curtis dissimilarity was used to plot data ordinations and statistically evaluate LTM (2014- 2016) data only. Each point within the ordinations is calculated using periphyton, mayfly, and clam data for each specific station and sampling event; sampling seasons and years are compared for inorganic mercury and methylmercury. P-values were calculated using an analysis of similarities (ANOSIM), which uses ranking within the Bray-Curtis matrix (10000 permutations) to test if significant differences exist between the variation of years, seasons, and stations (Clarke 1993); bold p-values indicate a difference between variables ($p < 0.05$).

Figure 4-11
Relationships among Terrestrial Ecological Exposure Media
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



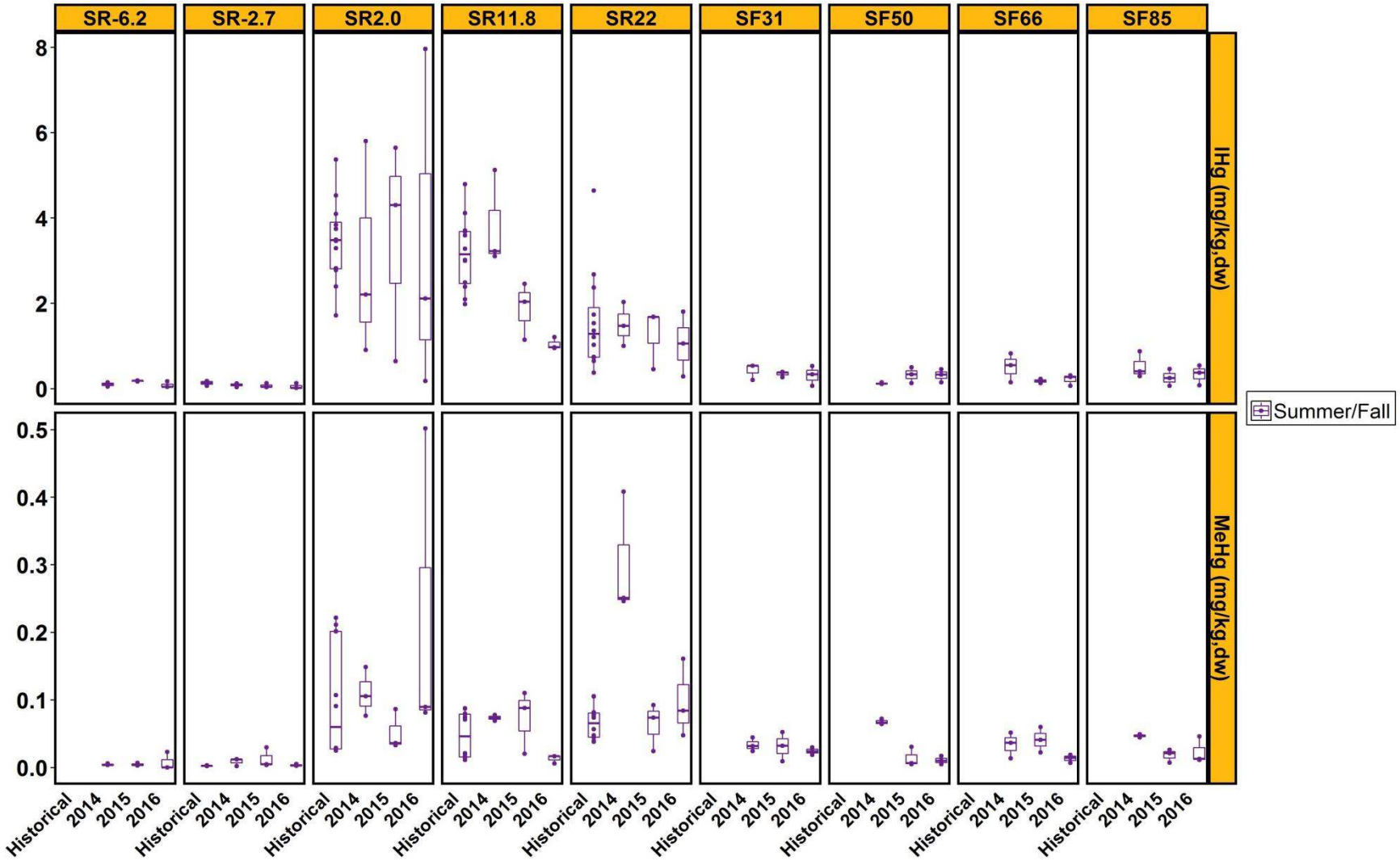
Notes
- 1, Carolina wren blood was analyzed for THg only and was included in the evaluation of relationships between media for both IHg and MeHg for comparative purposes .
- Evaluation limited to LTM (2014-2016) data only; all data are in milligrams per kilogram (mg/kg), wet weight (ww).
- Each panel (Inorganic Mercury and Methylmercury) displays linear trend lines among paired media with associated R^2 value (bottom left), and data histograms per media (center diagonal).
- Data points displayed in the trend line panels represent annual averages of data from each Long-term Monitoring station.
- Boxes that are highlighted light blue indicate a significant regression model ($p < 0.05$), according to a one-tailed F-test.

Figure 4-12
Mercury Concentrations in Soil
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



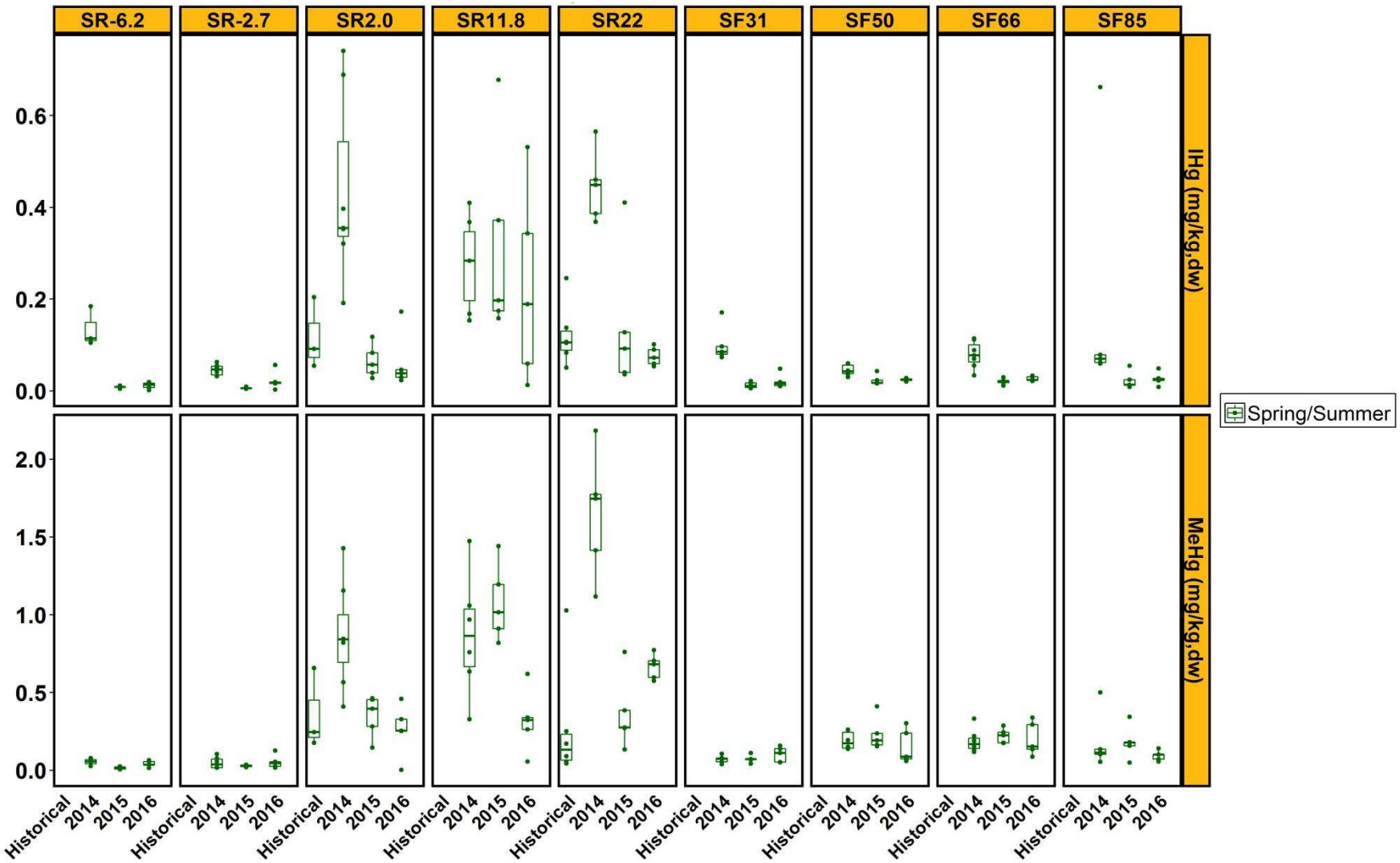
Notes
IHg, Inorganic mercury
MeHg, Methylmercury
mg/kg, Milligrams per kilogram
dw, Dry weight
- Applicable historical data not available
- LTM Soil sampling locations are targeted where Carolina wren data were collected each year; specific sampling locations may vary year-to-year, per LTM station. Annual variability observed in soil data may be attributable to the spatial distribution of mercury in floodplain soils.

Figure 4-13
Mercury Concentrations in Earthworm Tissue
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



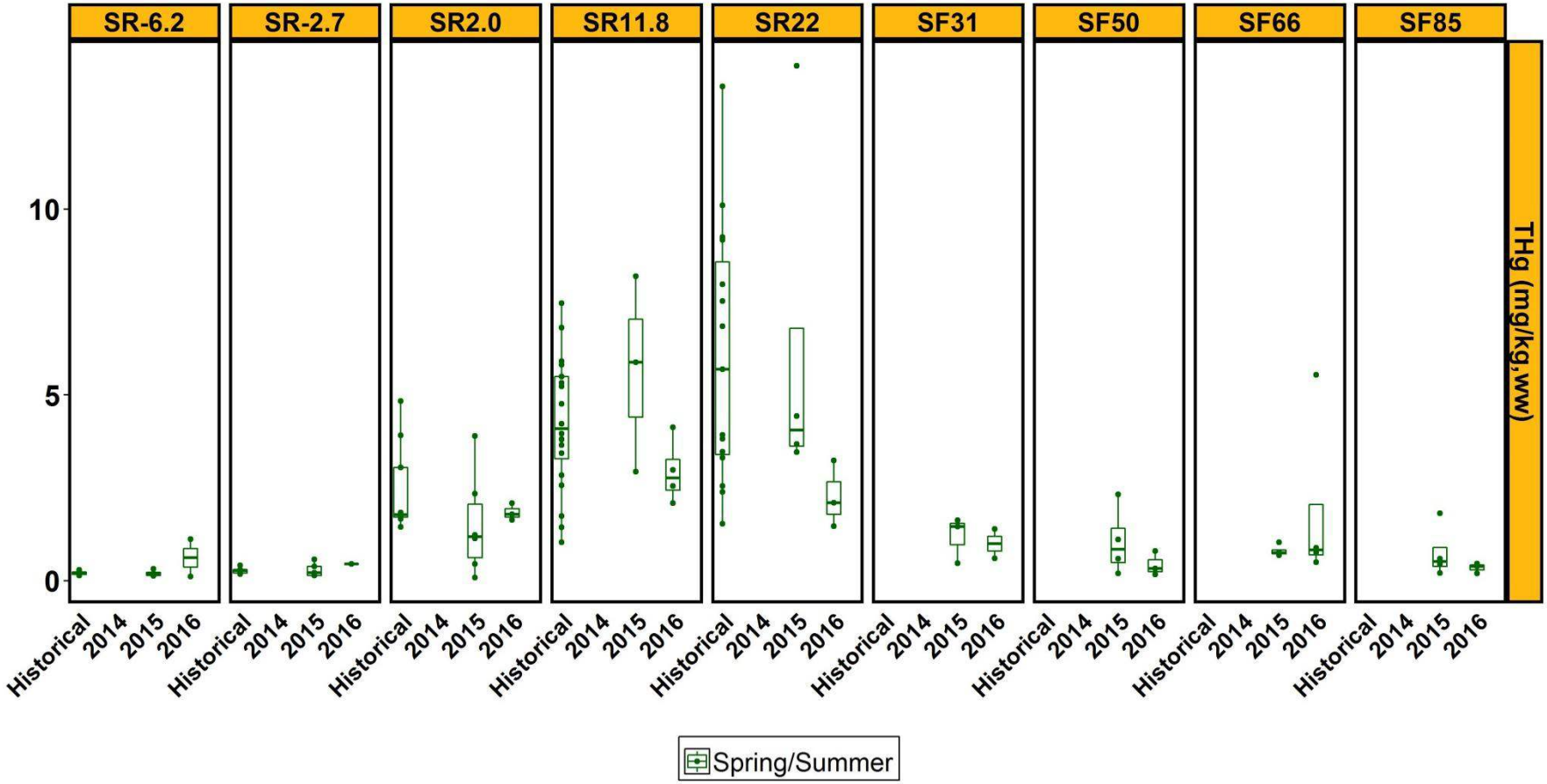
Notes
IHg, Inorganic mercury
MeHg, Methylmercury
mg/kg, Milligrams per kilogram
ww, Wet weight
- Historical data include earthworm tissue samples collected in 2006.
- LTM Earthworm and soil sampling locations are co-located and targeted where Carolina wren data were collected each year; specific sampling locations may vary year-to-year, per LTM station. Annual variability observed in earthworm (and soil) data may be attributable to the spatial distribution of mercury in floodplain soils.

Figure 4-14
Mercury Concentrations in Wolf Spider Tissue
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



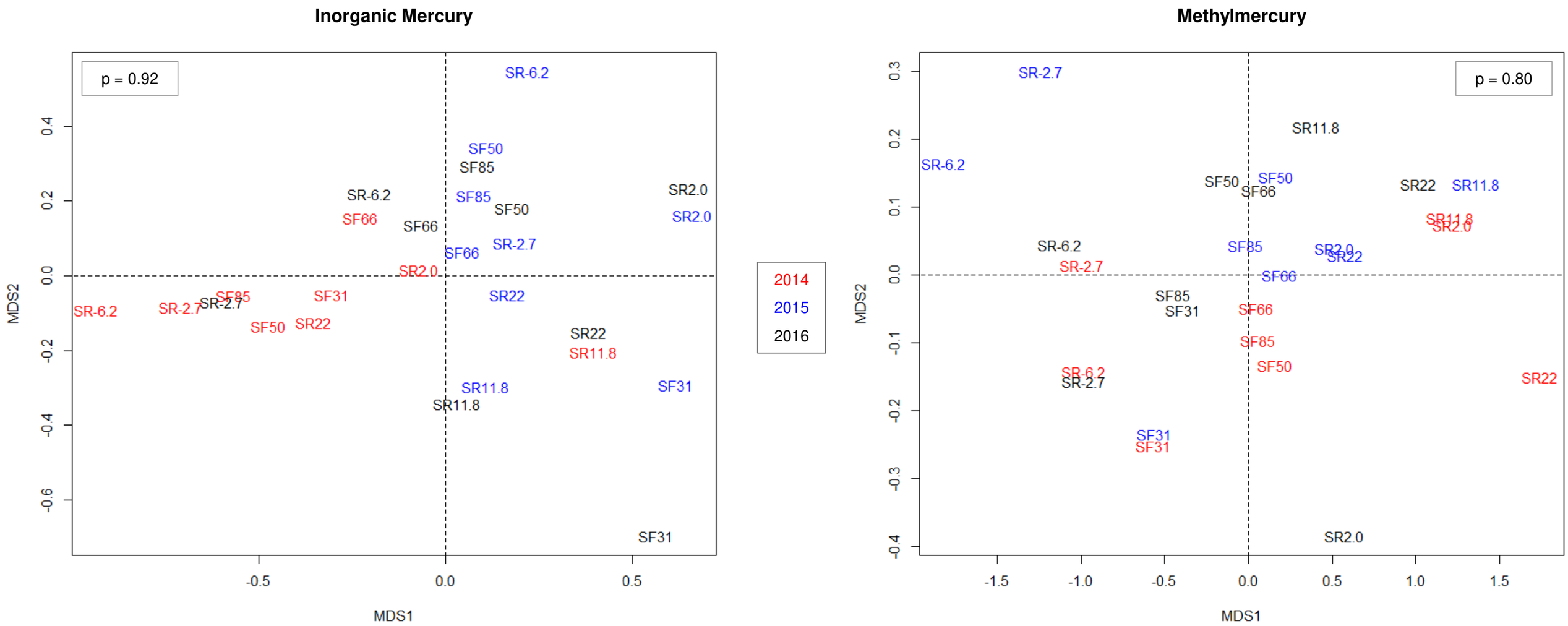
Notes
IHg, Inorganic mercury
MeHg, Methylmercury
mg/kg, Milligrams per kilogram
ww, Wet weight
- Historical data include wolf spider tissue samples collected in 2009 and 2010.

Figure 4-15
Mercury Concentrations in Carolina Wren Blood
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



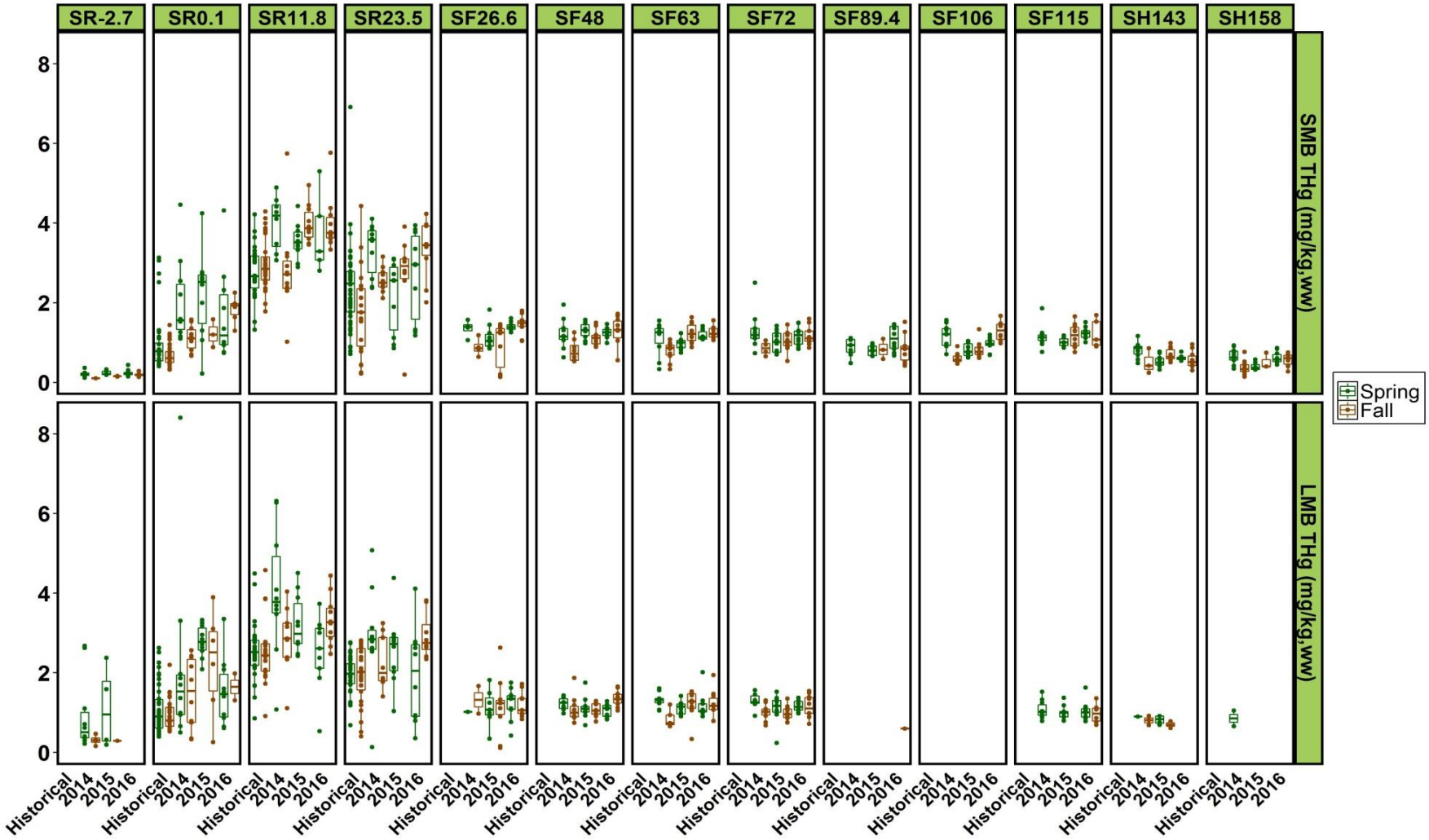
Notes
THg, Total mercury
mg/kg, Milligrams per kilogram
ww, Wet weight
- Historical data include Carolina wren blood samples collected annually from 2005 to 2008.

Figure 4-16
Statistical Evaluation of Terrestrial Ecological Exposure Media
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



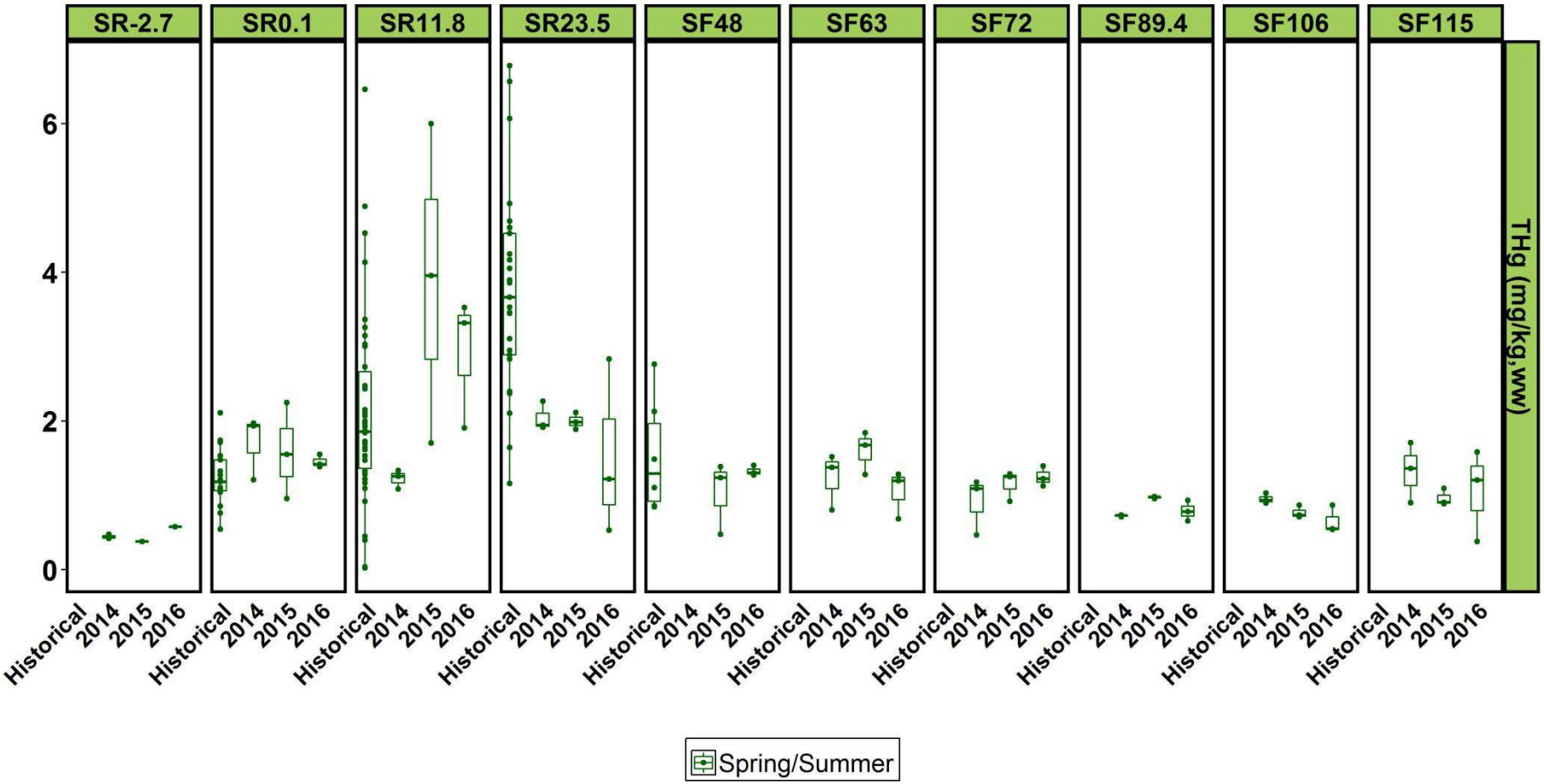
Notes
- Non-metric multidimensional scaling (NMDS), based on Bray-Curtis dissimilarity was used to plot data ordinations and statistically evaluate LTM (2014-2016) data only. Each point within the ordinations is calculated using soil, earthworm, and wolf spider data for each specific station and sampling event; sampling years are compared for inorganic mercury and methylmercury. P-values were calculated using an analysis of similarities (ANOSIM), which uses ranking within the Bray-Curtis matrix (10000 permutations) to test if significant differences exist between the variation of years and stations (Clarke 1993).

Figure 4-17
Mercury Concentrations in Adult Bass Muscle Tissue (Plug)
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



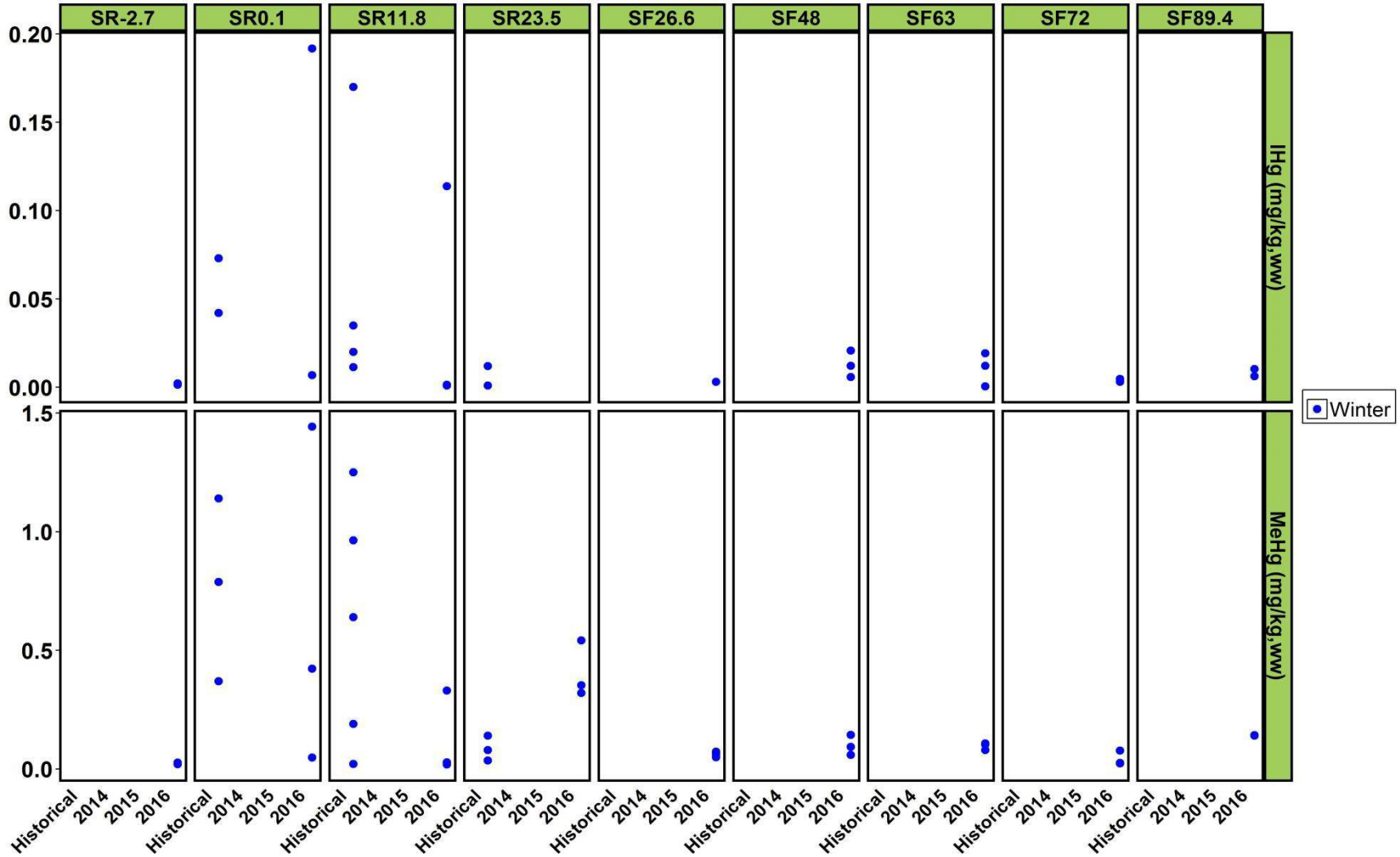
Notes
SMB, Smallmouth bass
LMB, Largemouth bass
THg, Total mercury
mg/kg, Milligrams per kilogram
ww, Wet weight
- Historical data include adult bass tissue plug samples collected annually from 2009 to 2011.
- Bass tissue plug data were length-normalized based on average fish length (300 mm).

Figure 4-18
Mercury Concentrations in Snapping Turtle Muscle Tissue
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



Notes
THg, Total mercury
mg/kg, Milligrams per kilogram
ww, Wet weight
- Historical data include snapping turtle muscle tissue samples (as measured) collected in 2010 and 2011.
- LTM muscle tissue concentrations (wet weight) are converted from field-collected toenail concentrations (dry weight) using Hopkins (2013b) regression and % moisture on muscle tissue samples.

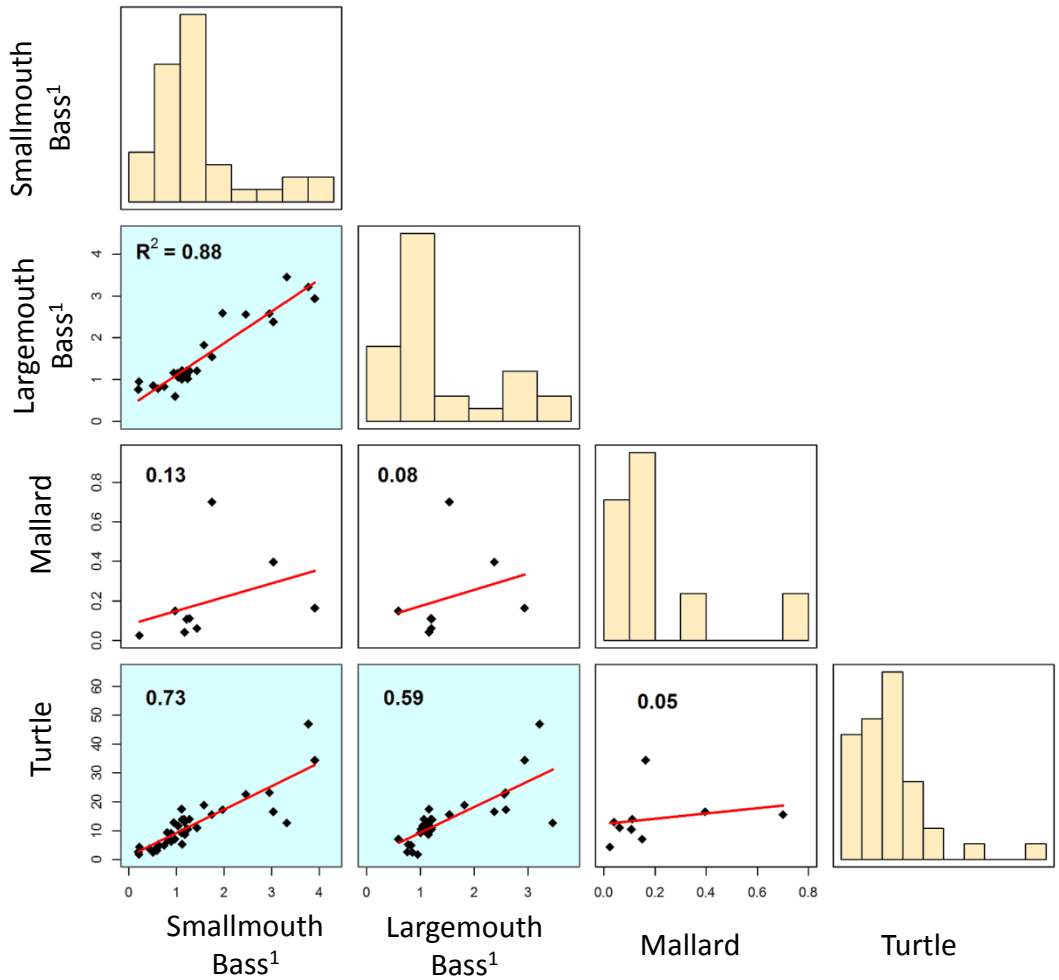
Figure 4-19
Mercury Concentrations in Mallard Duck Muscle Tissue
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



Notes
IHg, Inorganic mercury
MeHg, Methylmercury
mg/kg, Milligrams per kilogram
ww, Wet weight
- Historical data include mallard duck muscle tissue samples collected in 2008 and 2010.

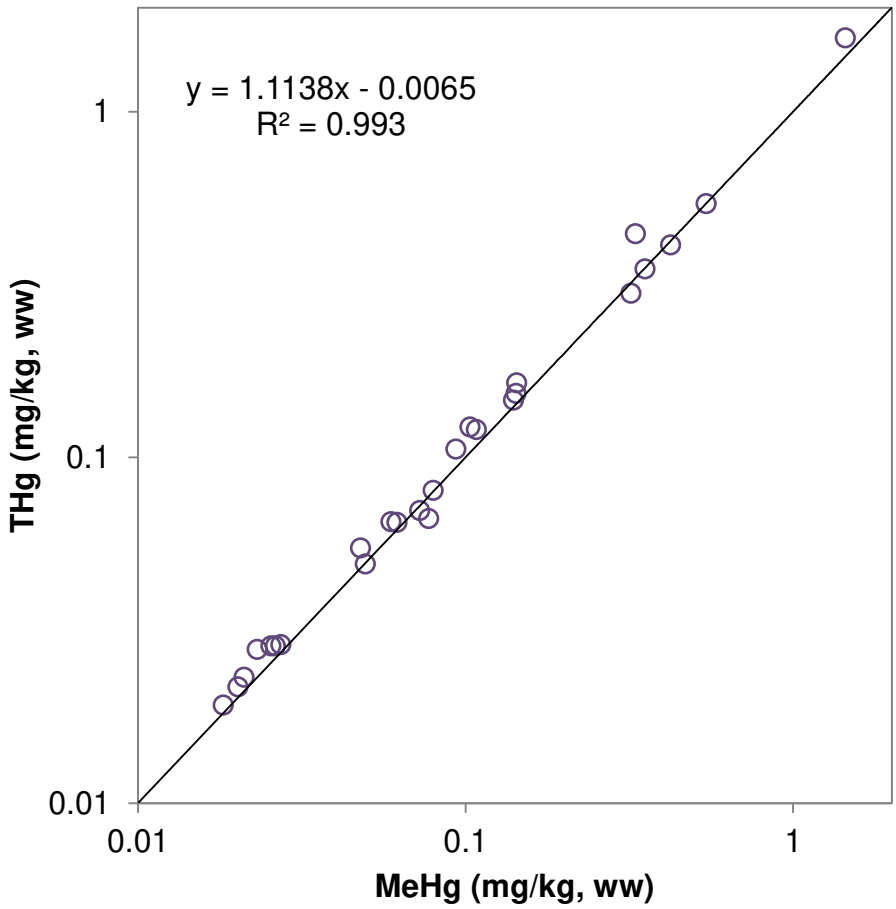
Figure 4-20
Relationships among Human Exposure Media
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

Total Mercury



Notes
-[1]Bass tissue plug data were length-normalized based on average fish length (300 mm).
-Evaluation limited to LTM (2014-2016) data only; all data are in milligrams per kilogram (mg/kg), wet weight (ww).
-Linear trend lines among paired media with associated R^2 values (bottom left) and data histograms per media (center diagonal).
-Data points displayed in the trend line panels represent annual averages of data from each Long-term Monitoring station.
-Boxes that are highlighted light blue indicate a significant regression model ($p < 0.05$), according to a one-tailed F-test.

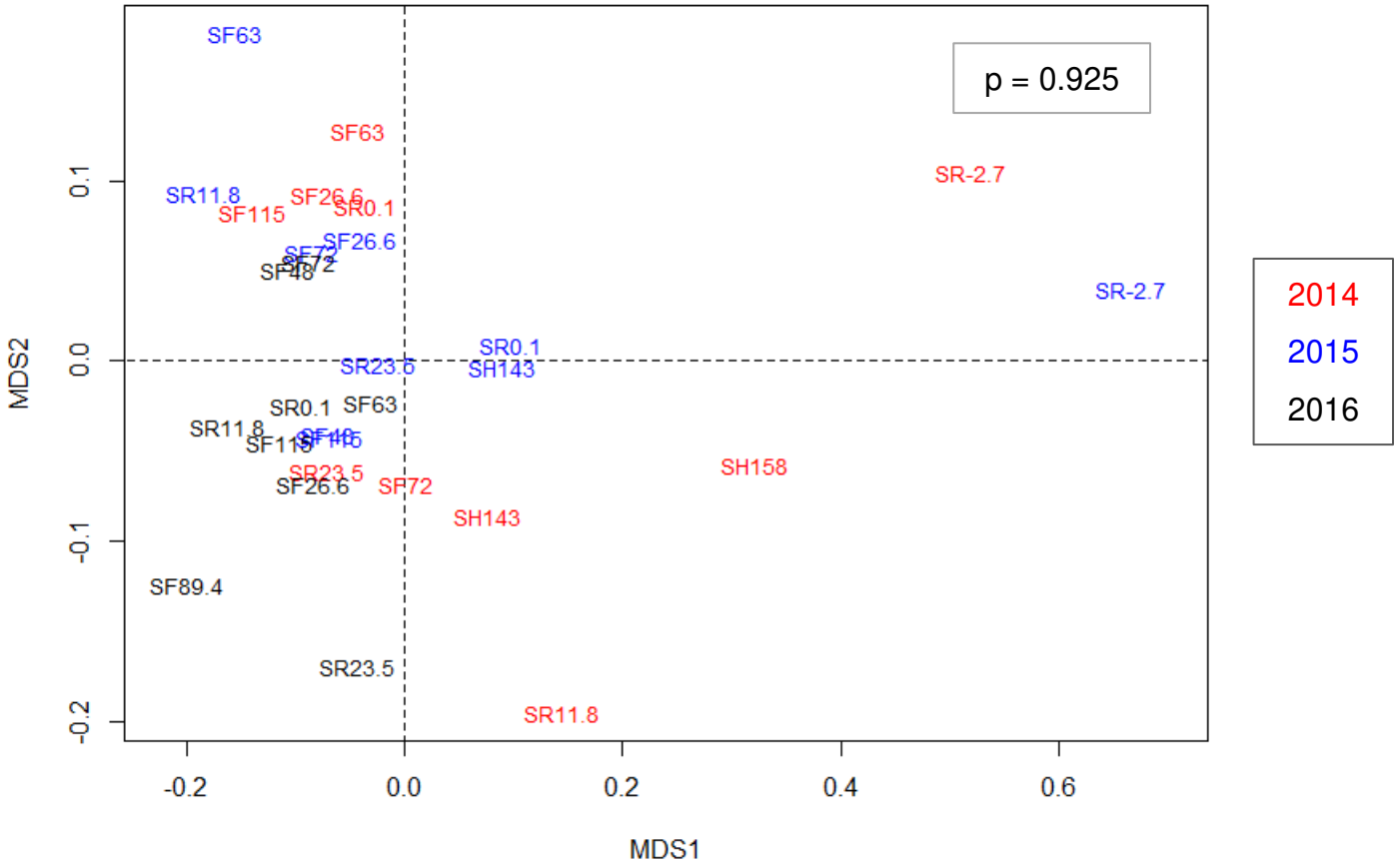
Figure 4-21
Relationship between THg and MeHg in Mallard Duck Muscle Tissue
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



Notes:
THg, Total mercury
MeHg, Methylmercury
mg/kg, Milligrams per kilogram
ww, Wet weight
Diagonal black line, 1:1 slope

Figure 4-22
Statistical Evaluation of Human Exposure Media
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

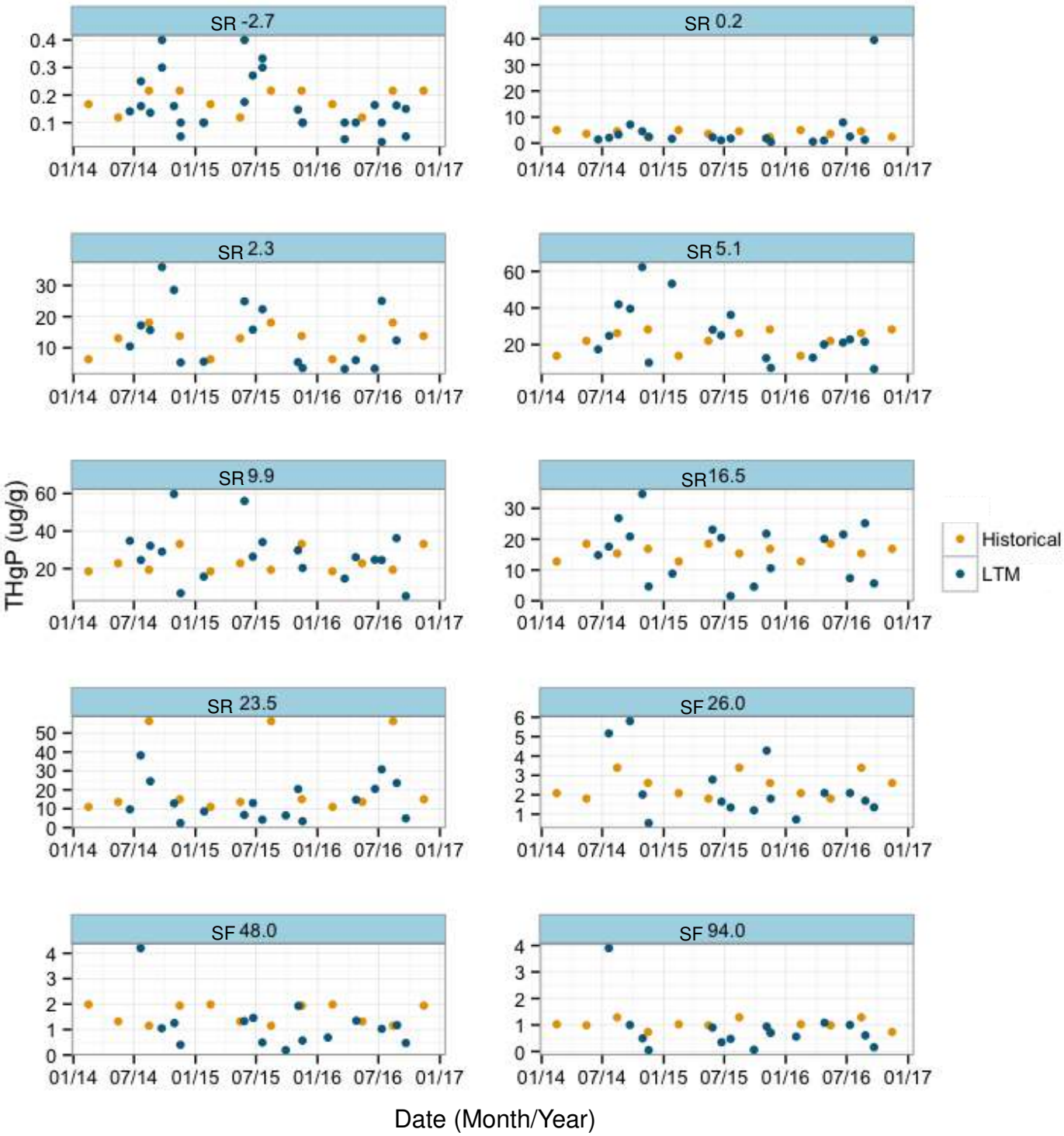
Total Mercury



Notes

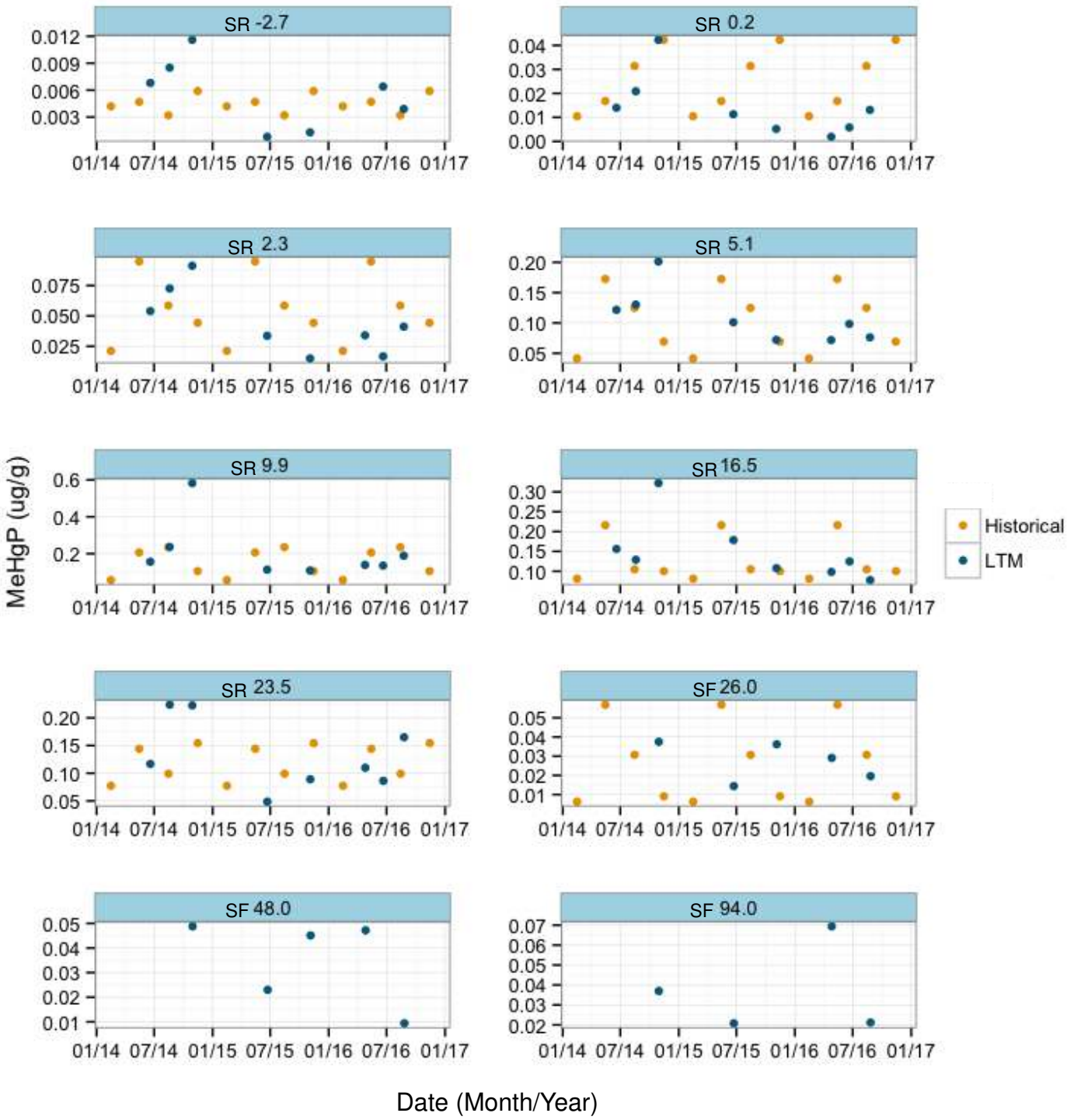
Non-metric multidimensional scaling (NMDS), based on Bray-Curtis dissimilarity was used to plot data ordinations and statistically evaluate LTM (2014-2016) data only. Each point within the ordinations is calculated using smallmouth bass, largemouth bass, and turtle data for each specific station and sampling year. Specific sampling events were omitted from the NMDS evaluation if there was missing data including, SR-2.7 (2006), SH158 (2015, 2016), SH143 (2016), SF89.4 (2014, 2015), SF 48 (2014), and SF106 (all years). P-values were calculated using an analysis of similarities (ANOSIM), which uses ranking within the Bray-Curtis matrix (10000 permutations) to test if significant differences exist between the variation of years and stations (Clarke 1993).

Figure 4-23
Total Mercury Concentrations on Particulates in Surface Water
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



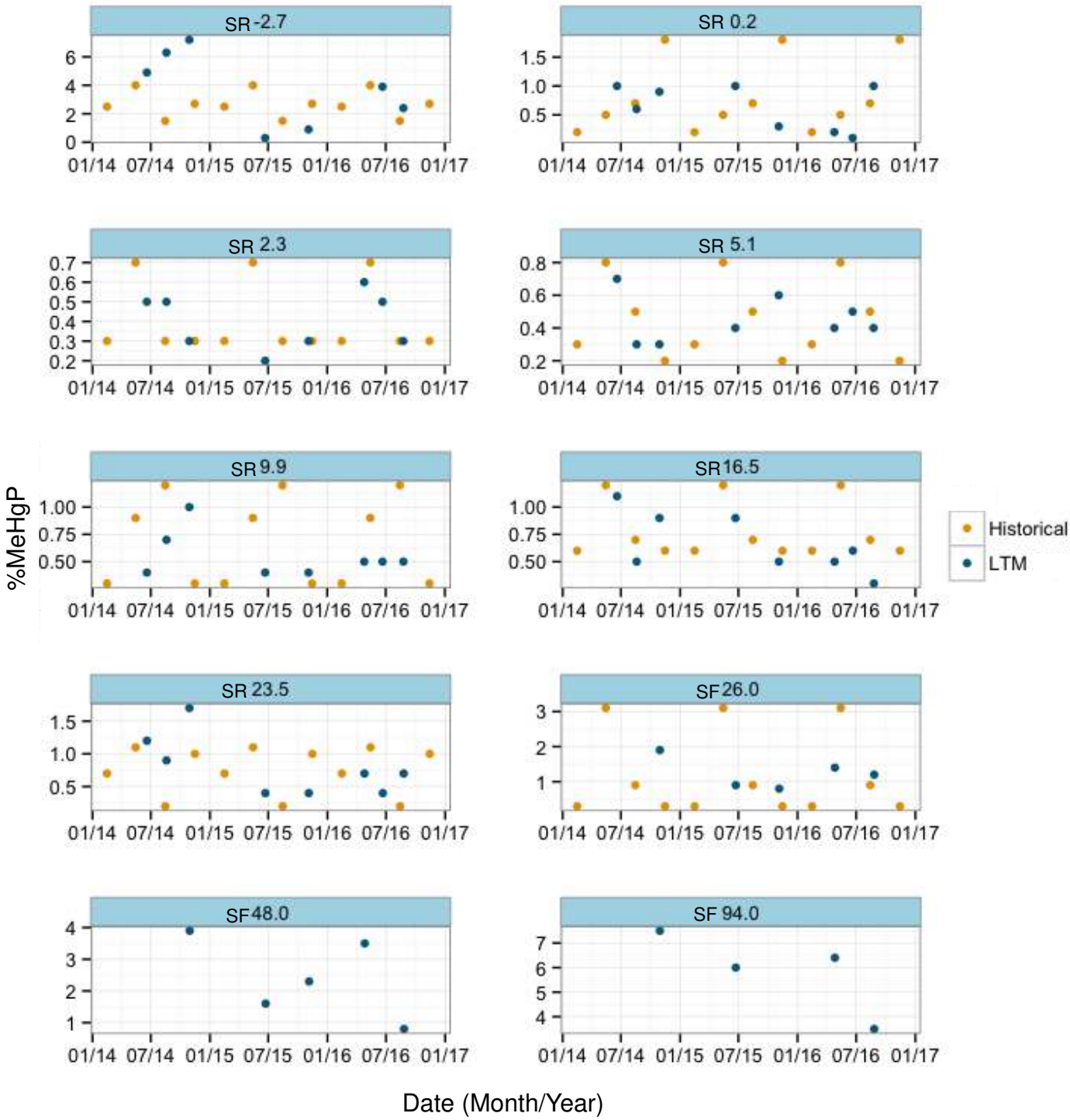
Notes:
THgP, Total mercury on non-filter-passing particles [normalized by total suspended solid (TSS)]
µg/g, Micrograms per gram
LTM, Long-term Monitoring (2014-2016)
- Historical data include surface water samples collected annually from 2006 to 2013 and are plotted as quarterly averages.

Figure 4-24
Methylmercury Concentrations on Particulates in Surface Water
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



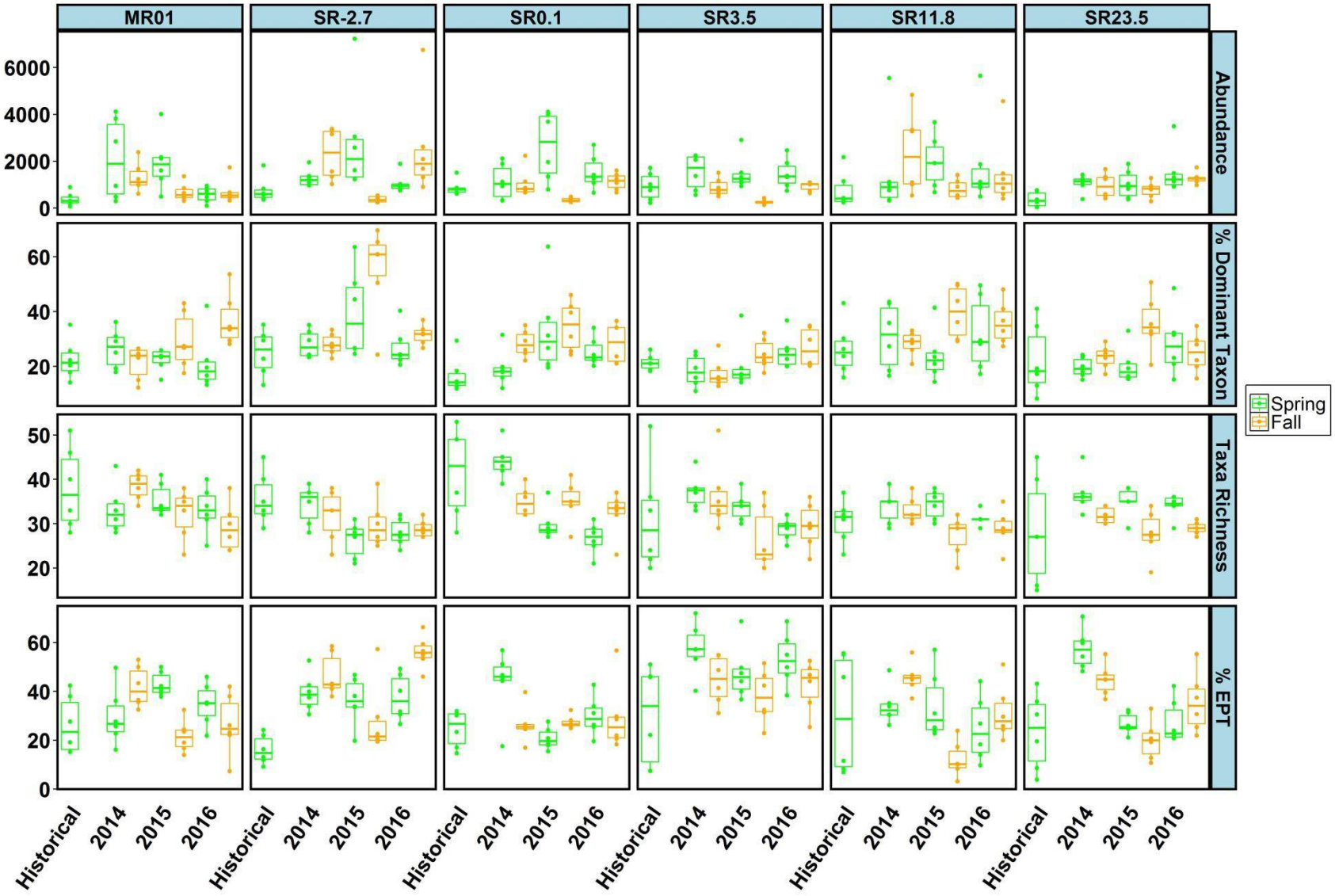
Notes:
MeHgP, Methylmercury on non-filter-passing particles [normalized by total suspended solid (TSS)]
µg/g, Micrograms per gram
LTM, Long-term Monitoring (2014-2016)
- Historical data include surface water samples collected annually from 2006 to 2013 and are plotted as quarterly averages.

Figure 4-25
Percent Methylmercury on Particulates in Surface Water
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



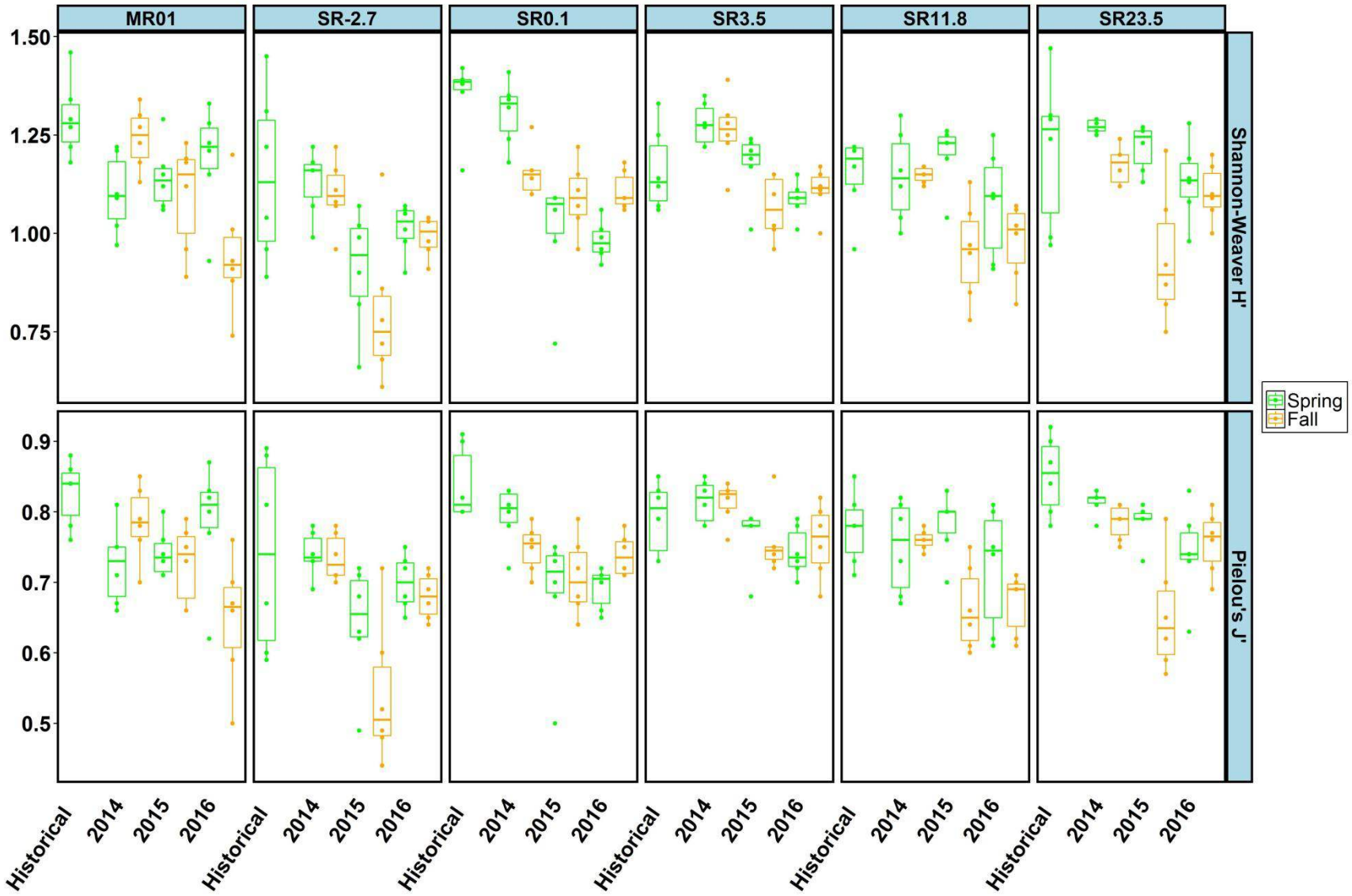
Notes:
%MeHgP, Percent methylmercury on non-filter-passing particles [normalized by total suspended solid (TSS)]
LTM, Long-term Monitoring (2014-2016)
- Historical data include surface water samples collected annually from 2006 to 2013 and are plotted as quarterly averages.

Figure 4-26
Benthic Invertebrate Community - Standard Metrics
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



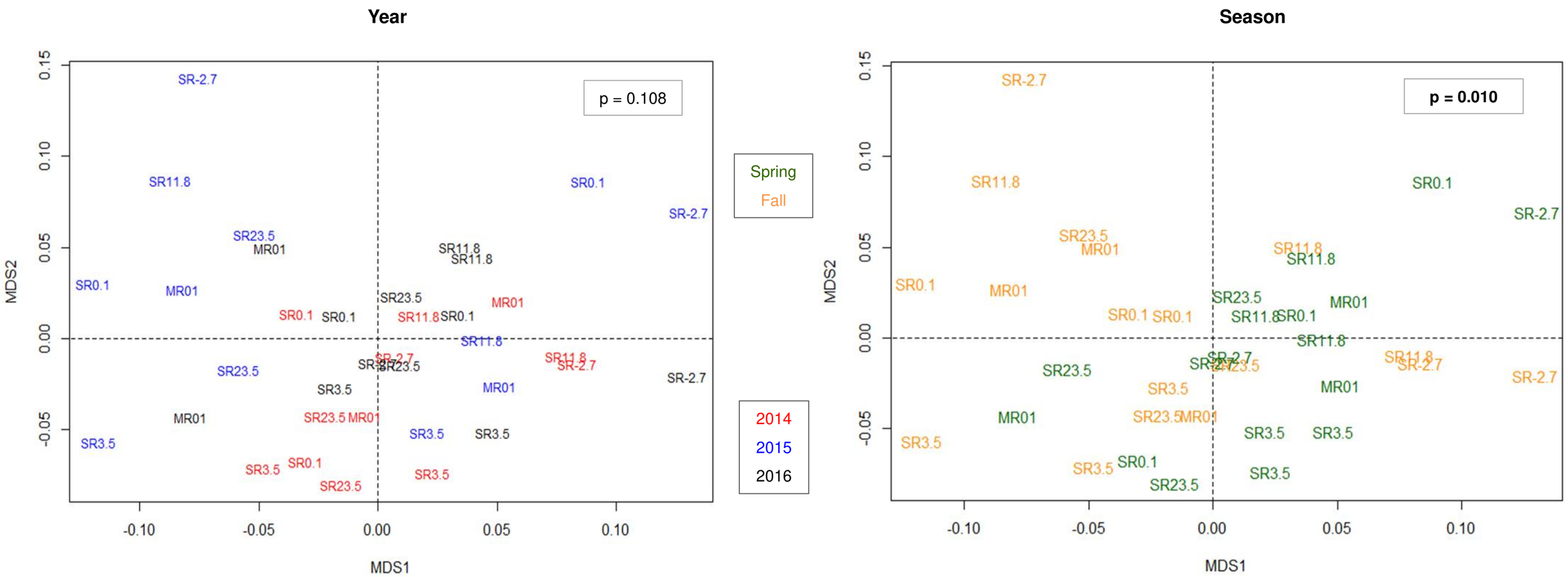
Notes
EPT, Ephemeroptera, Plecoptera, Trichoptera
- Historical data include benthic community samples collected in 2010 and 2011.

Figure 4-27
Benthic Invertebrate Community - Diversity/Evenness Metrics
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



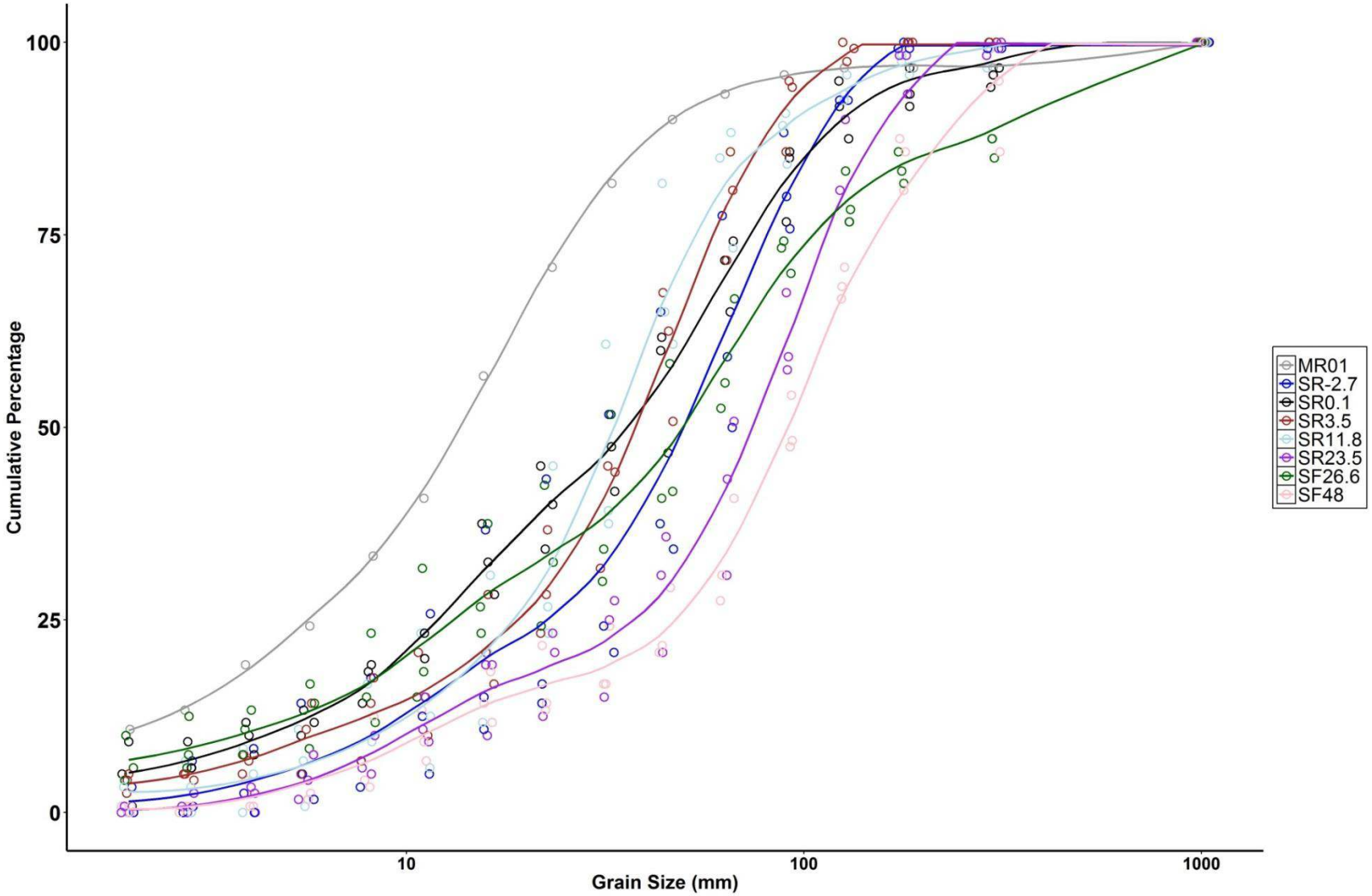
Notes
- Historical data include benthic community samples collected in 2010 and 2011.

Figure 4-28
Statistical Evaluation of Benthic Community Metrics
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



Notes
- Non-metric multidimensional scaling (NMDS), based on Bray-Curtis dissimilarity was used to plot data ordinations and statistically evaluate LTM (2014-2016) data only. Each point within the ordinations is calculated and compared using select benthic community metrics (i.e., abundance, % dominant taxa, taxa richness, % EPT, Shannon-Weaver H' and Pielou's J' for each specific location and sampling event. P-values were calculated using an analysis of similarities (ANOSIM), which uses ranking within the Bray-Curtis matrix (10000 permutations) to test if significant differences exist between the variation of years, seasons, and stations (Clarke 1993); bold p-values indicate a difference between variables ($p < 0.05$).

Figure 4-29
Summary of Substrate Grain Size
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4



Notes
Long-term monitoring (LTM; 2014-2016) substrate grain size data were calculated using cumulative percentages from yearly data sets. Data are represented by loess curves (span = 0.4) in order to compare relationships between grain size and monitoring station.

Appendices

Appendix A

Monitoring SOPs

Protocol SRAT-1
Biological Sampling Guidelines for Avian Tissue Analysis

The overall objective of avian blood sampling and analyses is to evaluate recent (e.g., weeks to months) dietary exposure of mercury to a representative aerial insectivore (e.g., Carolina wren) potentially foraging in the South River watershed.

Equipment

The following equipment/supplies may be used to collect avian tissue samples:

- Mist nets, or other avian nets or traps
- Avian holding bags
- Small crotchet hooks
- Small clippers
- Sterilized 29-30 gauge needles and 1-3 ml syringes
- Swabs
- Heparinized micro-containers
- 'Sharps' container
- Boat and motor
- Chest waders/rubber boots
- Gloves
- Field book/field data sheets
- Global positioning system (GPS)
- Tweezers/forceps
- Magnifying glass
- Sample containers from laboratory
- Sample container labels
- Cooler
- Dry ice
- Chain-of-Custody (COC) forms
- Custody seals
- Camera
- Pencils and waterproof/permanent marking pens
- Scientific collector's permit and field identification guides, as necessary

- Appropriate health and safety equipment

Standard Operating Procedure for Collection of Birds

Sampling will be performed in accordance with the conditions stated in applicable U.S. Fish and Wildlife Service (USFWS) and VDGIF scientific collection permits. The following sections describe each sampling approach, methodologies for avian blood collection, and analytical data quality objectives.

Mist Net Sampling

One to two nylon mist nets will be used to collect target species. Mist nests have three to four panels that overlap to form bottom pockets. When the bird strikes the net, it drops into a pocket where it is retrieved by an experienced handler. Nets will be positioned in the shade or in areas without direct sun exposure and will be checked every 15 to 20 minutes while active. Nets will be closed during unfavorable conditions such as weather, predation, or if proper monitoring is not possible.

The area where the net is deployed will be monitored from a distance. If a bird is detected, it will be removed immediately and processed similarly to the nest box sampling protocol described above. If there are multiple target species collected in the net, individual birds will be removed immediately and placed into small holding bags or buckets in a cool shady location. Captured birds will be processed as quickly as possible and will not be left in the bags for longer than 15 minutes. Special care will be taken to avoid harming captured birds. Several tools will be on hand to remove entangled birds from the net, including a small crotchet hook and small clippers. Following retrieval from the net, the bird will be evaluated and blood will be sampled under the protocol detailed in the following section.

Collection of Avian Blood Samples

Avian blood sampling methods and techniques will follow standard songbird sampling methodology (Evers, 2009; Kramer and Harris, 2010; Owen, 2011). Whole blood will be directly collected from the right jugular vein of the bird using a sterilized 29 – 30 gauge needle and 1 – 3 mL syringe. The area around the jugular vein will be sterilized with an alcohol swab prior to insertion of the needle. A blood sample with a target volume of at least 0.1 mL will be targeted for collection; however, sample volume will not exceed one percent of the total body weight of the bird (i.e., less than 0.2 mL based on a 20 gram (g) tree swallow; Evers, 2009). The blood sample will be collected and placed into a dedicated 1 mL heparinized microtainer; heparin is used to prevent coagulation in the blood sample. Microtainers will be labeled with the sample identification number and collection date and time. Needles will be used once and discarded into a sharps container immediately after use. Each bird will be released at the site of collection after data have been recorded. Birds will not be banded or retained; however, a temporary marking (e.g., feather clip or non-permanent color mark) will be made on the bird to prevent later re-sampling during the current study.

Immediately after collection, blood samples will be frozen and carefully packaged to prevent breakage and placed on dry ice for shipment to the laboratory. Blood samples will be shipped under proper chain-of-custody via overnight courier and analyzed for THg by a certified laboratory.

Field Quality Assurance/Quality Control Samples

Field quality assurance/quality control (QA/QC) samples are designed to help identify and minimize potential sources of sample contamination due to field procedures and to evaluate potential error introduced by sample collection and handling.

Duplicate Samples

Collecting duplicate samples allows for evaluation of sample homogeneity by comparing the analytical results of two samples from the same individual. Duplicate samples also check for the consistency of laboratory analysis. Duplicate samples will be collected by the analytical laboratory from primary samples with sufficient mass. Duplicates will be analyzed at a rate of five (5) percent of the total samples collected for in the study.

Matrix Spikes and Matrix Spike Duplicates

Matrix spikes (MS) and matrix spike duplicate (MSD) samples will be obtained by the analytical laboratory from primary samples with sufficient mass. MS and MSD samples are prepared at the laboratory by dividing a control sample into two aliquots, then spiking each with identical concentrations of specific analytes. The spike samples are then analyzed separately, and the results are compared to evaluate the effects of the sample matrix on the analytical accuracy and precision. MS/MSD samples will be collected from baseline samples to ensure sufficient volume for laboratory QA/QC. MS/MSD samples will be analyzed at a rate of five (5) percent of the total samples collected for in the study.

Sample Identification, Handling, and Chain-of-Custody

Samples will be identified, handled, and recorded as described in this sampling guideline. The sample parameters for analysis, preservation, and handling are specified in scope of work. Each sample container has a sample label affixed to the outside. The sampler marks each label using waterproof ink with the following information:

- Project name
- Sample identification number
- Date and time of collection
- Initials of sampling technician
- Requested analysis
- Method of preservation

Dry ice will be placed around sample containers and additional cushioning material will be added to the cooler, if necessary. Paperwork (i.e., signed Chain-of-Custody forms) will be put in a Ziploc bag and placed on top of the sample containers or taped to the inside lid of the cooler. The cooler will be taped closed and a signed custody seal will be affixed to the side of the cooler. Laboratory address labels will be placed on top of the cooler.

All samples are expected to contain low levels of contamination and will be packaged and shipped as environmental samples in accordance with applicable federal and state regulations. All shipments containing dry ice will conform to federal, state, and carrier regulations. Standard

procedures to be followed for shipping environmental samples to the analytical laboratory are outlined below.

- All environmental samples collected will be transported to the laboratory by AECOM personnel, shipped through Federal Express or equivalent overnight service, or picked up by a lab courier.
- Shipments will be scheduled to meet holding time requirements.

The laboratory will be notified to be prepared to receive a shipment of samples. If the number, type, or date of shipment changes due to site constraints or program changes, the laboratory will be informed.

AECOM has established a program of sample COC that will be followed during sample handling activities in both field and laboratory operations. The primary purpose of COC procedures is to document the possession of the samples from collection through shipping, storage, and analysis to data reporting and disposal. The Task Manager or his/her designee will be responsible for monitoring compliance with COC procedures.

Tracing sample possession will be accomplished using the COC record. A COC entry will be recorded for every sample, and a COC record will accompany every sample shipment to the laboratory. At a minimum, the COC record will contain the following information for each sample:

- Sample number and identification of sampling point
- Date and time of collection
- Sample type
- Number, type, and volume of sample container(s)
- Sample preservative
- Analysis requested
- Name, address, and phone number of laboratory or laboratory contact
- Signature, dates and times of persons in possession
- Any necessary remarks or special instructions

Once the COC is complete and the samples are ready for shipment, the COC will be placed inside the shipping container, and the container will be sealed. Samples are considered to be in custody if they are within sight of the individual responsible for their security or locked in a secure location. Each person who takes possession of the samples, except the shipping courier, is responsible for sample integrity and safekeeping.

Field Logbook and Field Data Sheet

The most important aspect of documentation is thorough, organized, and accurate record keeping. All information pertinent to the investigation will be recorded in the field logbook and/or field data sheets. Entries will include the following, as applicable:

- Project name and number
- Name of sampler and field personnel

- Date and time of sample collection
- Sample number, location, and depth
- Sampling method
- Sampling media
- Sample type
- Observations at the sampling site (e.g., weather conditions)
- Summary of daily tasks and information concerning sampling changes, scheduling modifications, and change orders dictated by field conditions

Field investigation situations vary widely. No general rules can include each type of information that must be entered in a logbook or data sheet for a particular site. Site-specific recording will include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel.

Health and Safety Procedures

To avoid incidents or injuries during sampling, the following task-specific health and safety procedures should be followed in addition to those indicated in the HASP:

- Toxic or otherwise harmful concentrations of metals or other constituents are unlikely to be encountered while sampling avian tissue.
- However, sampling crews should be trained in the general hazards of field sampling (e.g., waterborne pathogens) and how to minimize risks of exposure.
- Operating in or around water bodies carries the inherent risk of drowning. U.S. Coast Guard approved personal flotation devices must be worn when sampling from a boat.
- Collecting samples in extremely hot and humid weather carries the risk of dehydration and heat stroke. Sampling team members should wear adequate clothing and should carry an adequate supply of water or other liquids for protection against dehydration in hot weather.
- Sampling team members must cover exposed skin and/or use sunscreen for protection from sun exposure.
- When working on all water bodies, sampling teams must develop and employ an emergency response plan, including the use of an onshore monitor that is accountable for the whereabouts of the team. The monitor can request aid if the team fails to report in at end of workday and can provide assistance to rescuers or the team under any emergency situation.

References

Evers, D.C. 2009. BioDiversity Research Institute. *Protocol for Sampling Bird and Mammal Tissue for Contaminant Analysis.* Report BRI 2009-01, BioDiversity Research Institute, Gorham, Maine.

Friedman, S.L., Brasso, RL., and A.M. Condon. 2008. *An improved, simple nest box trap*. J. Field Ornithol. 79(1):99–101.

Kramer, M.H. and D.J. Harris. 2010. *Avian Blood Collection*. Journal of Exotic Pet Medicine 19(1): 82-86.

Owen, Jennifer. 2011. *Collecting, Processing and Storing Avian Blood: A Review*. Journal of Field Ornithology 82(4): 339-354.

Protocol SRBF-1:
Biological Sampling Guidelines for
Fish Tissue Analysis

Fish tissue sampling procedures generally follow *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories* (USEPA 2000).

Equipment

The following equipment/supplies may be used to collect fish tissue samples:

- Boat and motor
- Collection equipment, including a tote-barge electrofisher, boat electrofisher, and/or backpack electrofisher
- Insulated dip nets
- Insulated rubber gloves
- Insulated chest waders/rubber boots
- Field book/field data sheets
- Global positioning system (GPS)
- Live wells/pens for holding fish
- Measuring board
- Electronic scale
- Tray for the electronic scale
- Distilled or deionized (DI) water
- Nitrile gloves
- Lint-free wipes (Kimwipe or equivalent)
- Uni-Punch dermal biopsy punches or equivalent
- Scalpel
- Forceps
- Betadine/vaseline mixture
- Fish scale envelopes
- Sample containers from laboratory
- Sample container labels
- Cooler
- Wet ice
- Chain-of-Custody (COC) forms
- Custody seals

- Field data sheets
- Paper towels
- Aluminum foil
- Tables and chairs
- Camera
- Pencils and waterproof/permanent marking pens
- Decontamination supplies
    - Brushes
    - Wash tubs
    - Buckets
    - Sponges and paper towels
    - Formula 409 (low mercury-content cleaner)
    - DI or distilled water
    - Hand-held sprayers or spray bottles
    - Trash bags
    - Plastic sheeting
    - Appropriate personal protective equipment (PPE)
- Scientific collector's permit and field identification guides, as necessary
- Appropriate health and safety equipment

Decontamination Procedures

Between sampling locations, the measuring board and tray for weighing will be thoroughly cleaned and rinsed with DI or distilled water to prevent potential sample contamination. Following decontamination, the equipment will be wrapped in clean plastic sheeting or trash bags to prevent contact with dust and unclean surfaces. Fish tissue sampling equipment (e.g. scalpel, forceps) will be decontaminated with alcohol and rinsed using DI or distilled water after every fish biopsy/lethal fish tissue sample is collected. Dedicated biopsy plugs will be used for each biopsy sample to avoid potential contamination.

Fish Tissue Collection Procedures

Wading will be considered if the water depth is shallow and the substrate is cohesive enough to make wading feasible. If not, a boat may be used to reach some of the sampling locations. Caution will be used when conducting sampling from the boat or by wading. Health and safety procedures are detailed in AOC-4 Project HASP.

All collection permits will be obtained well in advance of the target sampling period to allow for flexibility in the timing of sampling.

The following procedures will be used for electrofishing:

- Electrofish areas of potential fish habitat using a tote-barge mounted, boat-mounted, or backpack electrofisher.
- Wearing insulated rubber gloves and boots and using nets with insulated handles, collect fish stunned by the electrical field.
- Place all target fish in buckets or a livewell for the duration of the sampling effort.
- If sufficient numbers of target species are present, continue to shock until the required number of individuals of target species is obtained.
- If sufficient individuals of target species cannot be collected in a reasonable period of time, document sampling efforts and sample available fish.

Fish Tissue Biopsy Sampling Procedure

Sample Preparation

The following procedures will be used for sample preparation:

- Record fish total length, weight, and morphological or histopathological anomalies on the field data sheet. Sampling conditions (e.g., water depth, time of sampling, general observations of the weather) should also be noted on the field data sheet.
- Rinse fish tissue with DI water or distilled water to remove detritus.
- Using tip of dermal punch, or scalpel, remove several scales from the mid-dorsal (1-2 centimeters below the dorsal fin) region of the fish.
- With a firm grip on the fish, take a new dermal punch and press firmly with a slight twisting motion into the muscle tissue where scales were removed, until the dermal punch is completely inserted.
- Use a short quick sideways motion to separate the tissue from the fish and remove the dermal punch with the muscle tissue inside.
- Remove the tissue plug from the dermal punch using clean forceps.
- Use a clean scalpel to remove the skin from the tissue plug and place the plug in a pre-labeled laboratory supplied sample container which will be stored on wet ice.
- Decontaminate forceps and scalpel after every sample.
- Complete appropriate COC forms and ship overnight to the laboratory for processing and analysis.

The same fish sampled for biopsy plug analyses will be used for lethal fish tissue sampling. To the extent practical, consistent sampling techniques are to be used at all sampling stations for consistency and comparability.

Lethal Fish Tissue Sampling Procedure[1]

The following procedures will be used for sample preparation:

- Record fish total length, weight, and morphological or histopathological anomalies on the field data sheet. Sampling conditions (e.g., water depth, time of sampling, general observations of the weather) should also be noted on the field data sheet
- Rinse fish with deionized water or distilled water to remove surface mucus.
- Dry fish with Kimwipe or other lint-free wipe.
- Place selected fish in a plastic bag and place on dry ice.
- Decontaminate measuring board and tray for weighting after every sample.
- Complete appropriate COC forms and ship overnight to the laboratory for processing and analysis.
- The analytical laboratory will prepare the filet for analysis of total mercury (USEPA Method 1631) and methylmercury (USEPA Method 1630)[2].

To the extent practical, consistent sampling techniques are to be used among all sampling stations for consistency and comparability.

Field Quality Assurance/Quality Control Samples

Field quality assurance/quality control (QA/QC) samples are designed to help identify and minimize potential sources of sample contamination due to field procedures and to evaluate potential error introduced by sample collection and handling.

Equipment Blank Samples

An equipment rinsate sample of sampling equipment is not needed.

Duplicate Samples

Collecting duplicate samples allows for evaluation of natural variability by comparing the analytical results of two samples from the same location. Duplicate samples also check for the consistency of field techniques and laboratory analysis. The duplicate samples will be handled in the same manner as the primary sample, assigned a distinct identification number, and shipped to the laboratory along with the primary sample it duplicates. The number of duplicate samples will be determined based on the sampling program.

Matrix Spikes and Matrix Spike Duplicates

Matrix spikes (MS) and matrix spike duplicate (MSD) samples will be obtained by collecting additional material at a selected station. MS and MSD samples are prepared at the laboratory by dividing a control sample into two aliquots, then spiking each with identical concentrations of

[1] Fillet samples were only collected in 2014 and the spring of 2015. Fillet samples were discontinued as part of the monitoring program and replaced with only plug samples (VDEQ, 2015).

[2] Sample analysis for methylmercury was only conducted in 2014 and the spring of 2015. Methylmercury analysis was discontinued as part of the monitoring program and replaced with only total mercury analysis (VDEQ, 2015).

specific analytes. The spike samples are then analyzed separately, and the results are compared to evaluate the effects of the sample matrix on the analytical accuracy and precision. MS/MSD samples will be collected from baseline samples to ensure sufficient volume for laboratory QA/QC. MS/MSD samples will be labeled and shipped to the laboratory along with the primary sample from which they were collected.

Sample Identification, Handling, and Chain-of-Custody

Samples will be identified, handled, and recorded as described in this sampling guideline. The sample parameters for analysis, preservation, and handling are specified in the Programmatic AOC-4 QAPP. Each sample container has a sample label affixed to the outside. The sampler marks each label using waterproof ink with the following information:

- Project name
- Sample identification number
- Date and time of collection
- Initials of sampling technician
- Requested analysis
- Method of preservation

Sample containers will be packed in bubble wrap to minimize breakage or damage to samples and placed in metal or plastic coolers. Dry will be placed around sample containers and additional cushioning material will be added to the cooler, if necessary. Paperwork (i.e., signed Chain-of-Custody forms) will be put in a Ziploc bag and placed on top of the sample containers or taped to the inside lid of the cooler. The cooler will be taped closed and a signed custody seal will be affixed to the side of the cooler. Laboratory address labels will be placed on top of the cooler.

All samples are expected to contain low levels of contamination and will be packaged and shipped as environmental samples in accordance with applicable federal and state regulations. All shipments containing dry ice will conform to federal, state, and carrier regulations. Standard procedures to be followed for shipping environmental samples to the analytical laboratory are outlined below.

- All environmental samples collected will be transported to the laboratory by AECOM personnel, shipped through Federal Express or equivalent overnight service, or picked up by a lab courier.
- Shipments will be scheduled to meet holding time requirements.

The laboratory will be notified to be prepared to receive a shipment of samples. If the number, type, or date of shipment changes due to site constraints or program changes, the laboratory will be informed.

AECOM has established a program of sample COC that will be followed during sample handling activities in both field and laboratory operations. The primary purpose of COC procedures is to document the possession of the samples from collection through shipping, storage, and analysis to data reporting and disposal. The Task Manager or his/her designee will be responsible for monitoring compliance with COC procedures.

Tracing sample possession will be accomplished using the COC record. A COC entry will be recorded for every sample, and a COC record will accompany every sample shipment to the laboratory. At a minimum, the COC record will contain the following information for each sample:

- Sample number and identification of sampling point
- Date and time of collection
- Sample type
- Number, type, and volume of sample container(s)
- Sample preservative
- Analysis requested
- Name, address, and phone number of laboratory or laboratory contact
- Signature, dates and times of persons in possession
- Any necessary remarks or special instructions

Once the COC is complete and the samples are ready for shipment, the COC will be placed inside the shipping container, and the container will be sealed. Samples are considered to be in custody if they are within sight of the individual responsible for their security or locked in a secure location. Each person who takes possession of the samples, except the shipping courier, is responsible for sample integrity and safekeeping.

Field Logbook and Field Data Sheet

The most important aspect of documentation is thorough, organized, and accurate record keeping. All information pertinent to the investigation will be recorded in the field logbook and/or field data sheets. Entries will include the following, as applicable:

- Project name and number
- Name of sampler and field personnel
- Date and time of sample collection
- Sample number, location, and depth
- Sampling method
- Sampling media
- Sample type
- Observations at the sampling site (e.g., weather conditions)
- Summary of daily tasks and information concerning sampling changes, scheduling modifications, and change orders dictated by field conditions

Field investigation situations vary widely. No general rules can include each type of information that must be entered in a logbook or data sheet for a particular site. Site-specific recording will include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel.

Health and Safety Procedures

To avoid incidents or injuries during sampling, the following task-specific health and safety procedures should be followed in addition to those indicated in the AOC-4 Project HASP:

- Toxic or otherwise harmful concentrations of metals or other constituents are unlikely to be encountered while sampling fish tissue in rivers and streams. However, sampling crews should be trained in the general hazards of field sampling (e.g., waterborne pathogens) and how to minimize risks of exposure.
- Operating in or around waterbodies carries the inherent risk of drowning. U.S. Coast Guard approved personal flotation devices must be worn when operating or sampling from a boat, when sampling in more than a few feet of water, or when sampling in swift currents.
- Collecting samples in cold weather, especially around cold waterbodies, carries the risk of hypothermia, and collecting samples in extremely hot and humid weather carries the risk of dehydration and heat stroke. Sampling team members should wear adequate clothing for protection in cold weather and should carry an adequate supply of water or other liquids for protection against dehydration in hot weather.
- Sampling team members must cover exposed skin and/or use sunscreen for protection from sun exposure.
- When working on all waterbodies, sampling teams must develop and employ an emergency response plan, including the use of an onshore monitor that is accountable for the whereabouts of the team. The monitor can request aid if the team fails to report in at end of workday and can provide assistance to rescuers or the team under any emergency situation.

References

SRST. February 2006. South River Science Team Safety Program.

USEPA. 2000. *Guidance for assessing chemical contaminant data for use in fish advisories: Volume 1 Fish sampling and analysis. Third Edition*. U.S. Environmental Protection Agency. EPA 823-B-00-007.

Protocol SRBI-1:
Biological Sampling Guidelines for Clam (*Corbicula*) Tissue Collection

Equipment

The following equipment/supplies may be used to collect clam tissue samples:

- Dip net
- Clam cages
- Cement pavers
- Sorting tray/sieves
- Calipers
- Decontamination supplies
    - Brushes
    - Wash tubs
    - Buckets
    - Sponges and paper towels
    - Formula 409 (low mercury content cleaner)
    - Organic-free water DI or distilled water
    - Hand-held sprayers or spray bottles
    - Trash bags
    - Plastic sheeting
- Sample bottles/vials and labels provided by the laboratory
- Lint-free wipes (Kimwipes or equivalent)
- Cooler
- Dry ice
- Field notebook/field data sheets
- Pencils and waterproof/permanent marking pens
- Nitrile gloves
- Sampling location map
- Global positioning system (GPS)
- Camera
- Chain-of-custody (COC) forms
- Custody seals

- Depuration chambers
- Shellfish tags
- Plastic label tape (Dymo brand)
- Scientific collector's permit and field identification guides, as necessary
- Appropriate health and safety equipment

Decontamination Procedures

Before collecting each sample, the sampling and sorting equipment will be thoroughly cleaned and rinsed with deionized (DI) or distilled water to prevent potential sample contamination. Following decontamination, the equipment will be wrapped in clean plastic sheeting or trash bags to prevent contact with dust and unclean surfaces.

Initial *Corbicula* Collection Procedures

The following procedures will be used for initial *Corbicula* collection at the reference site:

- Using a GPS unit, document location prior to sampling. Collect *Corbicula* by dipnet or shovel in designated stream reach.
- Place collected *Corbicula* into containers with river water, and limit the size of clams collected to between 15 and 25 millimeter (mm).

The following procedures will be used for caged clam studies:

- Place clams of similar size into mesh sleeves and label sleeves with waterproof labels
- Place sleeves into containers filled with water for transport to site.
- Upon arrival at the sampling location, attach mesh sleeves to cage frames and deploy cages at chosen locations
- Document cage locations with GPS.

The following procedures will be used for recovering caged clams:

- Locate clam cages visually or with the aid of GPS if marker cannot be seen.
- Collect the specified number of clams by hand picking or using a small hand trowel, ensuring they have the appropriate tag for the location.
- Place tagged clams into labeled containers filled with site water.
- Return all clams to lab and prepare for depuration.

The following procedures will be used for depurating clams:

- Each sampling location will have separate depuration chambers to prevent cross contamination.
- Place clams into mesh bags by location (near bank or center channel).
- Suspend clams off of the bottom of the chamber to prevent uptake of fecal matter.
- Depuration chambers will be filled with DI or distilled water.

- Clams will be allowed to depurate for approximately 24 hours.
- After 24 hours the mesh bags of clams for each location will be placed into laboratory supplied containers and immediately frozen. The laboratory is responsible for shucking the clams to remove the tissue.
- Samples will be shipped overnight on dry ice to the contract laboratory.

Field Quality Assurance/Quality Control Samples

Field quality assurance/quality control (QA/QC) samples are designed to help identify and minimize potential sources of sample contamination due to field procedures and to evaluate potential error introduced by sample collection and handling.

Equipment Blank Samples

An equipment rinsate sample of sampling equipment is not needed.

Duplicate Samples

Collecting duplicate samples allows for evaluation of natural variability by comparing the analytical results of two samples from the same location. Duplicate samples also check for the consistency of field techniques and laboratory analysis. The duplicate samples will be handled in the same manner as the primary sample, assigned a distinct identification number, and shipped to the laboratory along with the primary sample it duplicates. Duplicate samples will be determined by the sample collection program. Stations where duplicates will be collected will be determined in the field based on professional judgment.

Matrix Spikes and Matrix Spike Duplicates

Matrix spikes (MS) and matrix spike duplicate (MSD) samples will be obtained by collecting additional material at a selected station. MS and MSD samples are prepared at the laboratory by dividing a control sample into two aliquots, then spiking each with identical concentrations of specific analytes. The spike samples are then analyzed separately, and the results are compared to evaluate the effects of the sample matrix on the analytical accuracy and precision. MS/MSD samples will be collected from baseline samples to ensure sufficient volume for laboratory QA/QC. MS/MSD samples will be labeled and shipped to the laboratory along with the primary sample from which they were collected.

Sample Identification, Handling, and Chain-of-Custody

Samples will be identified, handled, and recorded as described in this sampling guideline. The sample parameters for analysis, preservation, and handling are specified in the Programatic AOC-4 QAPP. Each sample container has a sample label affixed to the outside. The sampler marks each label using waterproof ink with the following information:

- Project name
- Sample identification number
- Date and time of collection
- Initials of sampling technician
- Requested analysis

- Method of preservation
- Selected taxa

Sample containers will be packed in bubble wrap to minimize breakage or damage to samples and placed in metal or plastic coolers. Dry ice will be placed around sample containers and additional cushioning material will be added to the cooler, if necessary. Signed COC forms will be put in a Ziploc bag and placed on top of the sample containers or taped to the inside lid of the cooler. The cooler will be taped closed and a signed custody seal will be affixed to the side of the cooler. Laboratory address labels will be placed on top of the cooler.

All samples are expected to contain low levels of contamination and will be packaged and shipped as environmental samples in accordance with applicable federal and state regulations. All shipments containing dry ice will conform to federal, state, and carrier regulations. Standard procedures to be followed for shipping environmental samples to the analytical laboratory are outlined below.

- All environmental samples collected will be transported to the laboratory by AECOM personnel, shipped through Federal Express or equivalent overnight service, or picked up by a lab courier.
- Shipments will be scheduled to meet holding time requirements.

The laboratory will be notified to be prepared to receive a shipment of samples. If the number, type, or date of shipment changes due to site constraints or program changes, the laboratory will be informed.

AECOM has established a program of sample COC that will be followed during sample handling activities in both field and laboratory operations. The primary purpose of COC procedures is to document the possession of the samples from collection through shipping, storage, and analysis to data reporting and disposal. The Task Manager or his/her designee will be responsible for monitoring compliance with COC procedures.

Tracing sample possession will be accomplished using the COC record. A COC entry will be recorded for every sample, and a COC record will accompany every sample shipment to the laboratory. At a minimum, the COC record will contain the following information for each sample:

- Sample number and identification of sampling point
- Date and time of collection
- Sample type
- Number, type, and volume of sample container(s)
- Sample preservative
- Analysis requested
- Name, address, and phone number of laboratory or laboratory contact
- Signature, dates and times of persons in possession
- Any necessary remarks or special instructions

Once the COC is complete and the samples are ready for shipment, the COC will be placed inside the shipping container, and the container will be sealed. Samples are considered to be in

custody if they are within sight of the individual responsible for their security or locked in a secure location. Each person who takes possession of the samples, except the shipping courier, is responsible for sample integrity and safekeeping.

Field Logbook and Field Data Sheet

The most important aspect of documentation is thorough, organized, and accurate record keeping. All information pertinent to the investigation will be recorded in the field logbook and/or field data sheets. Entries will include the following, as applicable:

- Project name and number
- Name of sampler and field personnel
- Date and time of sample collection
- Sample number, location, and depth
- Sampling method
- Sampling media
- Sample type
- Sample physical characteristics
- Observations at the sampling site (e.g., weather conditions)
- Summary of daily tasks and information concerning sampling changes, scheduling modifications, and change orders dictated by field conditions

Field investigation situations vary widely. No general rules can include each type of information that must be entered in a logbook or data sheet for a particular site. Site-specific recording will include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel.

Health and Safety Procedures

To avoid incidents or injuries during sampling, the following health and safety procedures should be followed:

- Toxic or otherwise harmful concentrations of metals or other constituents are unlikely to be encountered while invertebrate sampling in rivers and streams. However, sampling crews should be trained in the general hazards of field sampling (e.g., waterborne pathogens) and how to minimize risks of exposure.
- Operating in or around waterbodies carries the inherent risk of drowning. U.S. Coast Guard approved personal flotation devices must be worn when operating or sampling from a boat, when sampling in more than a few feet of water, or when sampling in swift currents.
- Collecting samples in cold weather, especially around cold waterbodies, carries the risk of hypothermia, and collecting samples in extremely hot and humid weather carries the risk of dehydration and heat stroke. Sampling team members should wear adequate clothing for protection in cold weather and should carry an adequate supply of water or other liquids for protection against dehydration in hot weather.

- Sampling team members must cover exposed skin and/or use sunscreen for protection from sun exposure.
- When working on all waterbodies, sampling teams must develop and employ an emergency response plan, including the use of an onshore monitor that is accountable for the whereabouts of the team. The monitor can request aid if the team fails to report in at end of workday and can provide assistance to rescuers or the team under any emergency situation.

References

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition*. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

Protocol SRBI-2:
Biological Sampling Guidelines for
Aquatic Macroinvertebrate Tissue Collection

Aquatic Macroinvertebrate tissue sampling guidelines were developed based on collection procedures for rivers outlined in the *Rapid Bioassessment Protocols: For Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition* (Barbour, et al., 1999).

Equipment

The following equipment/supplies may be used to collect aquatic macroinvertebrate tissue samples:

- Invertebrate sampling equipment
    - D-frame net
- Stainless-steel forceps
- Stainless-steel sorting tray/glass Petri dish
- Calipers
- Decontamination supplies
    - Brushes
    - Wash tubs
    - Buckets
    - Sponges and paper towels
    - Formula 409 (low mercury content cleaner)
    - Organic-free water deoionized (DI) or distilled water
    - Hand-held sprayers or spray bottles
    - Trash bags
    - Plastic sheeting
- Sample bottles/vials and labels provided by the laboratory
- Lint-free wipes (Kimwipes or equivalent)
- Ziploc bags or similar dry storage materials
- Depuration chambers
- Cooler
- Dry ice
- Field notebook/field data sheets
- Pencils and waterproof/permanent marking pens
- Magnifying glass/hand lens

- Paper towels
- Nitrile gloves
- Sampling location map
- Global positioning system (GPS)
- Camera
- Scientific collector's permit and field identification guides, as necessary
- Chain-of-custody (COC) forms
- Custody seals
- Appropriate health and safety equipment

Decontamination Procedures

Before collecting each sample, the sampling and sorting equipment will be thoroughly cleaned and rinsed with DI or distilled water to prevent potential sample contamination. Following decontamination, the equipment will be wrapped in clean plastic sheeting or trash bags to prevent contact with dust and unclean surfaces.

Invertebrate Sample Collection Procedures

The following procedures will be used when collecting aquatic insect larvae tissue by D-frame dip net:

- Place the dip net on the substrate and disturb the upstream substrate with a kicking and shuffling of the feet. For shallow and smaller sized gravel, a hand may be used to disturb the substrate and also rub larger cobbles to dislodge organisms into the net.
- The net may also be forcefully jabbed into submerged aquatic vegetation, root mats, and snag piles to acquire target species.
- After a collection has been obtained, the net is rinsed two to three times with clean stream water to wash all organisms to the back of the net.
- The contents of the net are placed into a sorting pan, and selected individuals are prepared for analysis.
- After the sample has been collected, turn the net inside out and rinse the net with clean stream water. Visually inspect the net to ensure that all debris and benthic organisms have been removed from the net and repeat as necessary prior to moving to different sampling locations.
- This process is repeated to obtain sufficient numbers of target species which will be composited into replicate samples.

The following procedures will be used for aquatic insect larvae depuration:

- Each sampling location and organism type will have separate depuration chambers to prevent cross contamination.
- Depuration chambers will be filled with distilled water
- Organisms will be allowed to depurate for 24 hours

- After 24 hours organisms will be grouped into composite samples and placed into laboratory supplied containers and immediately frozen. Larvae that have hatched will not be included in the sample.
- Samples will be shipped overnight on dry ice to the contract laboratory.

The following procedures will be used for aquatic insect sample preparation:

- Place target species into a sorting pan.
- Separate a pre-specified number of the target species for each sample using pre-cleaned stainless-steel forceps, and place into a decontaminated Petri dish.
- Group target species together according to size class as best as possible with available numbers.
- Total length [millimeter (mm)] of ten organisms per sample will be measured and recorded on data sheets. A total of three samples will be collected at each location.
- Rinse specimens with DI or distilled water.
- Wipe or blot with lint-free wipes to remove excess water.
- Place specimens into sampling containers provided by the laboratory.
- Place samples in a cooler and pack securely with dry ice.

Field Quality Assurance/Quality Control Samples

Field quality assurance/quality control (QA/QC) samples are designed to help identify and minimize potential sources of sample contamination due to field procedures and to evaluate potential error introduced by sample collection and handling.

Equipment Blank Samples

An equipment rinsate sample of sampling equipment is not needed.

Duplicate Samples

Collecting duplicate samples allows for evaluation of natural variability by comparing the analytical results of two samples from the same location. Duplicate samples also check for the consistency of field techniques and laboratory analysis. The duplicate samples will be handled in the same manner as the primary sample, assigned a distinct identification number, and shipped to the laboratory along with the primary sample it duplicates. Duplicate samples will be determined by the sample collection program. Stations will be determined in the field based on professional judgment.

Matrix Spikes and Matrix Spike Duplicates

Matrix spikes (MS) and matrix spike duplicate (MSD) samples will be obtained by collecting additional material at a selected station. MS and MSD samples are prepared at the laboratory by dividing a control sample into two aliquots, then spiking each with identical concentrations of specific analytes. The spike samples are then analyzed separately, and the results are compared to evaluate the effects of the sample matrix on the analytical accuracy and precision. MS/MSD samples will be collected from baseline samples to ensure sufficient volume for laboratory QA/QC. MS/MSD samples will be

labeled and shipped to the laboratory along with the primary sample from which they were collected.

Sample Identification, Handling, and Chain-of-Custody

Samples will be identified, handled, and recorded as described in this sampling guideline. Each sample container has a sample label affixed to the outside. The sampler marks each label with the following information using waterproof ink:

- Project name
- Sample identification number
- Date and time of collection
- Initials of sampling technician
- Requested analysis
- Method of preservation
- Selected taxa

Sample containers will be packed in bubble wrap to minimize breakage or damage to samples and placed in metal or plastic coolers. Dry ice will be placed around sample containers and additional cushioning material will be added to the cooler, if necessary. Paperwork (i.e., signed COC forms) will be put in a Ziploc bag and placed on top of the sample containers or taped to the inside lid of the cooler. The cooler will be taped closed and a signed custody seal will be affixed to the side of the cooler. Laboratory address labels will be placed on top of the cooler.

All samples are expected to contain low levels of contamination and will be packaged and shipped as environmental samples in accordance with applicable federal and state regulations. All shipments containing dry ice will conform to federal, state, and carrier regulations. Standard procedures to be followed for shipping environmental samples to the analytical laboratory are outlined below.

- All environmental samples collected will be transported to the laboratory by AECOM personnel, shipped through Federal Express or equivalent overnight service, or picked up by a lab courier.
- Shipments will be scheduled to meet holding time requirements.

The laboratory will be notified to be prepared to receive a shipment of samples. If the number, type, or date of shipment changes due to site constraints or program changes, the laboratory will be informed.

AECOM has established a program of sample COC that will be followed during sample handling activities in both field and laboratory operations. The primary purpose of COC procedures is to document the possession of the samples from collection through shipping, storage, and analysis to data reporting and disposal. The Task Manager or his/her designee will be responsible for monitoring compliance with COC procedures.

Tracing sample possession will be accomplished using the COC record. A COC entry will be recorded for every sample, and a COC record will accompany every sample

shipment to the laboratory. At a minimum, the COC record will contain the following information for each sample:

- Sample number and identification of sampling point
- Date and time of collection
- Sample type
- Number, type, and volume of sample container(s)
- Sample preservative
- Analysis requested
- Name, address, and phone number of laboratory or laboratory contact
- Signature, dates and times of persons in possession
- Any necessary remarks or special instructions

Once the COC is complete and the samples are ready for shipment, the COC will be placed inside the shipping container, and the container will be sealed. Samples are considered to be in custody if they are within sight of the individual responsible for their security or locked in a secure location. Each person who takes possession of the samples, except the shipping courier, is responsible for sample integrity and safekeeping.

Field Logbook and Field Data Sheet

The most important aspect of documentation is thorough, organized, and accurate record keeping. All information pertinent to the investigation will be recorded in the field logbook and/or field data sheets. Entries will include the following, as applicable:

- Project name and number
- Name of sampler and field personnel
- Date and time of sample collection
- Sample number, location, and depth
- Sampling method
- Sampling media
- Sample type
- Sample physical characteristics
- Observations at the sampling site (e.g., weather conditions)
- Summary of daily tasks and information concerning sampling changes, scheduling modifications, and change orders dictated by field conditions

Field investigation situations vary widely. No general rules can include each type of information that must be entered in a logbook or data sheet for a particular site. Site-specific recording will include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel.

Health and Safety Procedures

To avoid incidents or injuries during sampling, the following health and safety procedures should be followed. Specific details regarding Health and Safety are included in the AOC-4 Project HASP:

- Toxic or otherwise harmful concentrations of metals or other constituents are unlikely to be encountered while invertebrate sampling in rivers and streams. However, sampling crews should be trained in the general hazards of field sampling (e.g., waterborne pathogens) and how to minimize risks of exposure.
- Operating in or around waterbodies carries the inherent risk of drowning. U.S. Coast Guard approved personal flotation devices must be worn when operating or sampling from a boat, when sampling in more than a few feet of water, or when sampling in swift currents.
- Collecting samples in cold weather, especially around cold waterbodies, carries the risk of hypothermia, and collecting samples in extremely hot and humid weather carries the risk of dehydration and heat stroke. Sampling team members should wear adequate clothing for protection in cold weather and should carry an adequate supply of water or other liquids for protection against dehydration in hot weather.
- Sampling team members must cover exposed skin and/or use sunscreen for protection from sun exposure.
- When working on all waterbodies, sampling teams must develop and employ an emergency response plan, including the use of an onshore monitor that is accountable for the whereabouts of the team. The monitor can request aid if the team fails to report in at end of workday and can provide assistance to rescuers or the team under any emergency situation.

References

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition*. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

Protocol SRBI-3:
Guidelines for Macroinvertebrate Community Sampling and Laboratory Analyses

Macroinvertebrate community sampling guidelines were developed based on collection procedures for rivers outlined in the *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition* (Barbour et al. 1999).

Equipment

The following equipment/supplies may be used to collect macroinvertebrate community samples:

- Boat and motor
- Surber sampler
- Stainless-steel spoon
- 500-µm sieve
- Forceps
- Water quality meter
- Measuring calipers
- Macroinvertebrate sample containers and labels
- 70% reagent alcohol
- Field notebook/field data sheets
- Pencils and waterproof and permanent marking pens
- Sampling location map
- GPS unit
- YSI 556 multiprobe water quality meter
- Camera
- Scientific collector's permit and field identification guides, as necessary
- Appropriate health and safety equipment

Instrument Calibration

In addition to a GPS, electronic equipment used during sampling will likely include a multi-functional water sample meter (YSI 556). The meter will be operated, calibrated, and maintained according to manufacturer's guidelines and recommendations. Calibration of the field instruments will be performed on a daily basis, and the stability of the calibration will be verified during sampling activities as warranted. Operation and calibration of the field instruments will be performed by AECOM personnel properly

trained in these procedures and calibration data will be documented in the field logbook or data sheet.

Sample Collection Procedures

Health and safety procedures for conducting the work over water are detailed in the AOC-4 Project HASP. These procedures will be followed as a required component of the sampling.

The following procedures will be used during the macroinvertebrate community sampling:

- Use the GPS system or aerial photos to locate the appropriate section within reach habitat to be sampled.
- Obtain water quality measurements and document the water quality conditions. Parameters to be measured include temperature (degrees Celsius), dissolved oxygen (mg/L), conductivity (mS/cm), pH, dissolved oxygen (% saturated), ORP (mV).

At each sampling location, six replicate samples along a gradient from toe of pool, transitional, and head of riffle habitats will be collected within the sampling area. The following procedure describes the collection of one replicate:

- Prior to collecting the first sample, and between sample replicates, rinse the surber with stream water to remove any organisms/debris. Visually check that all organisms/debris are out of the Surber sampler prior to collecting each sample.
- Place a Surber sampler (500-µm mesh; sample area 1.0 ft^2) firmly on the substrate with the bag facing downstream.
- Be sure that the bottom of the Surber is flush with the bed of the surface, preventing organisms from washing through.
- Using a gloved hand, disturb the substrate within the Surber sampler to dislodge any organisms associated with the substrate. All large substrate (e.g., cobble and larger) should be gently removed from the frame, wiped with a brush or gloved hand and inspected to insure all attached organisms are washed into the net.
- Rinse the sampler with clean stream water, washing all organisms and debris into the back of the net.
- Sample additional locations within the designated sampling area.

The following procedures will be used for sample collection:

- Transfer all organisms and debris from the net into a sample container and preserve with 70% ethanol. Forceps may be needed to remove organisms from the dip net. Place a label indicating the project name, sample identification code, date, stream name, and collector name into the sample container. A label with the same information is to be placed on the outside of the container.
- In the field notebook/data sheet, note the type of sampler, depth, time of sampling, and relevant observations, including but not limited to weather, turbidity, velocity, depth, and type of substrate.

To the extent practical, consistent sampling techniques are to be used among all sampling stations for consistency and comparability.

Sample Handling and Chain of Custody

AECOM has established a program of sample chain-of-custody (COC) that will be followed during sample handling activities in both field and laboratory operations. The primary purpose of COC procedures is to document the possession of the samples from collection through shipping, storage, and analysis to data reporting and disposal. The Task Manager or his/her designee will be responsible for monitoring compliance with COC procedures.

Tracing sample possession will be accomplished using the COC record. A COC entry will be recorded for every sample, and a COC record will accompany every sample shipment to the laboratory. At a minimum, the COC record will contain the following information for each sample:

- Sample number and identification of sampling point
- Date and time of collection
- Sample type
- Number, type, and volume of sample container(s)
- Sample preservative
- Analysis requested
- Name, address, and phone number of laboratory or laboratory contact
- Signature, dates and times of persons in possession
- Any necessary remarks or special instructions

Once the COC is complete and the samples are ready for shipment, the COC will be placed in sealed Ziploc bags and taped to the inside of the shipping container, and the container will be sealed. Samples are considered to be in custody if they are within sight of the individual responsible for their security or locked in a secure location. Each person who takes possession of the samples, except the shipping courier, is responsible for sample integrity and safekeeping.

Field Logbook and Field Data Sheet

The most important aspect of documentation is thorough, organized, and accurate record keeping. All information pertinent to the investigation will be recorded in the field logbook and/or field data sheets. Entries will include the following, as applicable:

- Project name and number
- Name of sampler and field personnel
- Date and time of sample collection
- Sample number, location, and depth
- Sampling method

- Sampling media
- Sample type
- Sample physical characteristics
- Observations at the sampling site (e.g., weather conditions)
- Summary of daily tasks and information concerning sampling changes, scheduling modifications, and change orders dictated by field conditions

Field investigation situations vary widely. No general rules can include each type of information that must be entered in a logbook or data sheet for a particular site. Site-specific recording will include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel.

Laboratory Sample Sorting and Specimen Identification Procedures

In the laboratory, the following procedures are to be followed for sorting and taxonomic identification of samples:

- Rinse sample through a 500-micron mesh sieve to remove excess alcohol and detritus.
- Spread rinsed sample evenly over a numbered grid at the bottom of a sorting tray.
- Select one grid using a random number table and remove all organisms from within the grid.
- Randomly select subsequent grids until 300 organisms are obtained.
- Place organisms into vials of 70% ethanol, sorted by major taxonomic grouping.
- When the entire sample has been sorted, preserve the remaining sediment in 70% ethanol for QA/QC analysis.
- Identify all organisms removed from each sample to the lowest practical taxonomic unit, generally to genus (family for chironomids, class for oligochaetes). Identifications of organisms are to be performed using a dissecting microscope. The most current manuals and publications are to be used for identifications.
- Place identified organisms into vials of 70% ethanol for taxonomic verification.
- Approximately 10% of the total number of replicate samples or sampling trays will be reexamined following the sorting procedures to ensure complete and accurate sorting. If more than 20% of the total number of organisms has been missed, all replicate samples sorted by that person shall be reexamined. Any samples where more than 20% of the total number of organisms was missed must be resorted.
- Information regarding identification and abundance will be recorded on data sheets.

References

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition*. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

Protocol SRBS-1:
Biological Sampling Guidelines for
Spider Tissue Analysis

These data will be used to evaluate potential exposure of invertivorous songbirds that forage on predatory terrestrial invertebrates (spiders) present within the riparian zone surrounding the South River, to mercury.

Equipment

The following equipment/supplies may be used to collect spider tissue samples:

- Boat and motor
- Chest waders/rubber boots
- Collection equipment, including dry pitfall traps and dip nets
- Shovel
- Gloves
- Field book/field data sheets
- Global positioning system (GPS)
- Tweezers/forceps
- Magnifying glass
- Sample containers from laboratory
- Sample container labels
- Cooler
- Dry ice
- Chain-of-Custody (COC) forms
- Custody seals
- Camera
- Pencils and waterproof/permanent marking pens
- Scientific collector's permit and field identification guides, as necessary
- Appropriate health and safety equipment

Standard Operating Procedure for Collection of Spiders

Dry pitfall trapping arrays consisting of 5-10 pitfall traps per sample location will be deployed at each sampling area. Trap arrays will be positioned on the shoreline or on gravel bars within the river 10 meters of the edge of the water. Traps will be set up monitored at least every day. Spiders will also be collected through a variety of active capture techniques including sweep nets, and hand capture.

Procedures for Collecting Spiders Using Dry Pitfall Sampling:

- Locate site where dry pitfall traps are to be deployed; approximately 5-10 pitfall traps will be deployed per sampling location. Spacing of the pitfall traps will be at the discretion of the Field Team leader and will be dependent on available habitat. Collect GPS coordinates once sample location is chosen and record in field book/field data sheets.

- Using a trowel, dig a hole to the desired depth and width so the top of the trap sits flush with the soil and place the plastic container in the hole. Backfill dirt as necessary to ensure there are no gaps around the edges of the pitfall trap.
- When checking traps, remove spiders; place target organisms into sample containers on dry ice to euthanize.
- Record the number of spiders collected and realeased on field data sheets
- Upon return to the lab, record combined cephalo thorax/abdomen length and weight.
- Place target spiders into labeled laboratory supplied containers and place on dry ice.
- Complete appropriate Chain-of-Custody forms and ship overnight to the laboratory for processing and analysis.

To the extent practical, consistent sampling techniques are to be used among all sampling stations for consistency and comparability.

Procedures for Collecting Spiders Using Sweep Net Sampling:

- Locate sites where habitat for wolf spiders is present; the discretion of the Field Team leader will determine the exact sampling location. Collect GPS coordinates once sample location is chosen and record in field book/field data sheets.
- Using dip nets, gently drag the tip of the net through areas with tall grass or brush with a sweeping motion.
- Check net after each sweep. If spiders are present, remove spiders; place target organisms into sample containers on dry ice to euthanize.
- Record the number of spiders collected and realeased on field data sheets
- Upon return to the lab, record combined cephalo thorax/abdomen length and weight.
- Place target spiders into labeled laboratory supplied containers and place on dry ice.
- Complete appropriate Chain-of-Custody forms and ship overnight to the laboratory for processing and analysis.

To the extent practical, consistent sampling techniques are to be used among all sampling stations for consistency and comparability.

Procedures for Collecting Spiders Using Hand Capture Sampling:

- Locate sites where habitat for wolf spiders is present; the discretion of the Field Team leader will determine the exact sampling location. Collect GPS coordinates once sample location is chosen and record in field book/field data sheets.
- While donning gloves and holding a plastic sampling container, over turn rocks or brush where wolf spider habitat is likely. Gently place the sampling container over the spider and scoop the spider into it using the edge of the container.

- Place target organisms into sample containers on dry ice to euthanize.
- Record the number of spiders collected and realeased on field data sheets
- Upon return to the lab, record combined cephalo thorax/abdomen length and weight.
- Place target spiders into labeled laboratory supplied containers and place on dry ice.
- Complete appropriate Chain-of-Custody forms and ship overnight to the laboratory for processing and analysis.

To the extent practical, consistent sampling techniques are to be used among all sampling stations for consistency and comparability.

Field Quality Assurance/Quality Control Samples

Field quality assurance/quality control (QA/QC) samples are designed to help identify and minimize potential sources of sample contamination due to field procedures and to evaluate potential error introduced by sample collection and handling.

Duplicate Samples

Collecting duplicate samples allows for evaluation of sample homogeneity by comparing the analytical results of two samples from the same individual. Duplicate samples also check for the consistency of laboratory analysis. Duplicate samples will be collected by the analytical laboratory from primary samples with sufficient mass. Duplicates will be analyzed at a rate of five (5) percent of the total samples collected for in the study.

Matrix Spikes and Matrix Spike Duplicates

Matrix spikes (MS) and matrix spike duplicate (MSD) samples will be obtained by the analytical laboratory from primary samples with sufficient mass. MS and MSD samples are prepared at the laboratory by dividing a control sample into two aliquots, then spiking each with identical concentrations of specific analytes. The spike samples are then analyzed separately, and the results are compared to evaluate the effects of the sample matrix on the analytical accuracy and precision. MS/MSD samples will be collected from baseline samples to ensure sufficient volume for laboratory QA/QC. MS/MSD samples will be analyzed at a rate of five (5) percent of the total samples collected for in the study.

Sample Identification, Handling, and Chain-of-Custody

Samples will be identified, handled, and recorded as described in this sampling guideline. The sample parameters for analysis, preservation, and handling are specified in scope of work. Each sample container has a sample label affixed to the outside. The sampler marks each label using waterproof ink with the following information:

- Project name
- Sample identification number
- Date and time of collection
- Initials of sampling technician

- Requested analysis
- Method of preservation

Dry ice will be placed around sample containers and additional cushioning material will be added to the cooler, if necessary. Paperwork (i.e., signed Chain-of-Custody forms) will be put in a Ziploc bag and placed on top of the sample containers or taped to the inside lid of the cooler. The cooler will be taped closed and a signed custody seal will be affixed to the side of the cooler. Laboratory address labels will be placed on top of the cooler.

All samples are expected to contain low levels of contamination and will be packaged and shipped as environmental samples in accordance with applicable federal and state regulations. All shipments containing dry ice will conform to federal, state, and carrier regulations. Standard procedures to be followed for shipping environmental samples to the analytical laboratory are outlined below.

- All environmental samples collected will be transported to the laboratory by AECOM personnel, shipped through Federal Express or equivalent overnight service, or picked up by a lab courier.
- Shipments will be scheduled to meet holding time requirements.

The laboratory will be notified to be prepared to receive a shipment of samples. If the number, type, or date of shipment changes due to site constraints or program changes, the laboratory will be informed.

AECOM has established a program of sample COC that will be followed during sample handling activities in both field and laboratory operations. The primary purpose of COC procedures is to document the possession of the samples from collection through shipping, storage, and analysis to data reporting and disposal. The Task Manager or his/her designee will be responsible for monitoring compliance with COC procedures.

Tracing sample possession will be accomplished using the COC record. A COC entry will be recorded for every sample, and a COC record will accompany every sample shipment to the laboratory. At a minimum, the COC record will contain the following information for each sample:

- Sample number and identification of sampling point
- Date and time of collection
- Sample type
- Number, type, and volume of sample container(s)
- Sample preservative
- Analysis requested
- Name, address, and phone number of laboratory or laboratory contact
- Signature, dates and times of persons in possession
- Any necessary remarks or special instructions

Once the COC is complete and the samples are ready for shipment, the COC will be placed inside the shipping container, and the container will be sealed. Samples are

considered to be in custody if they are within sight of the individual responsible for their security or locked in a secure location. Each person who takes possession of the samples, except the shipping courier, is responsible for sample integrity and safekeeping.

Field Logbook and Field Data Sheet

The most important aspect of documentation is thorough, organized, and accurate record keeping. All information pertinent to the investigation will be recorded in the field logbook and/or field data sheets. Entries will include the following, as applicable:

- Project name and number
- Name of sampler and field personnel
- Date and time of sample collection
- Sample number, location, and depth
- Sampling method
- Sampling media
- Sample type
- Observations at the sampling site (e.g., weather conditions)
- Summary of daily tasks and information concerning sampling changes, scheduling modifications, and change orders dictated by field conditions

Field investigation situations vary widely. No general rules can include each type of information that must be entered in a logbook or data sheet for a particular site. Site-specific recording will include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel.

Health and Safety Procedures

To avoid incidents or injuries during sampling, the following task-specific health and safety procedures should be followed in addition to those indicated in the Health and Safety Plan (HASP):

- Toxic or otherwise harmful concentrations of metals or other constituents are unlikely to be encountered while sampling spider tissue in South River. However, sampling crews should be trained in the general hazards of field sampling (e.g., waterborne pathogens) and how to minimize risks of exposure.
- Operating in or around waterbodies carries the inherent risk of drowning. U.S. Coast Guard approved personal flotation devices must be worn when sampling from a boat.
- Collecting samples in extremely hot and humid weather carries the risk of dehydration and heat stroke. Sampling team members should wear adequate clothing and should carry an adequate supply of water or other liquids for protection against dehydration in hot weather.
- Sampling team members must cover exposed skin and/or use sunscreen for protection from sun exposure.
- When working on all waterbodies, sampling teams must develop and employ an emergency response plan, including the use of an onshore monitor that is accountable for

the whereabouts of the team. The monitor can request aid if the team fails to report in at end of workday and can provide assistance to rescuers or the team under any emergency situation.

Protocol SRDA-1
Data Analysis for the Long-Term Monitoring Plan

Timely and accurate data analysis is a critical component of the monitoring plan. The goal of the monitoring plan is to differentiate trends in mercury concentrations due to remediation vs. trends in mercury concentrations due to non-remediation related variability in climate and other factors that affect mercury fate and transport. This protocol describes the data analysis approach for the long-term monitoring plan.

A qualified statistician will be employed by DuPont to help design field and laboratory experiments and will be the primary resource for analyzing the ensuing data. Statistical methods will be fully described in all written reports and will be consistent with currently accepted scientific practices.

Objective

The objective of the long-term monitoring is to be able to determine if there is at least a 75% probability of finding a statistically significant ($p = 0.05$) downward trend in mercury concentrations in key monitoring elements (e.g., fish tissue) within 5 to 10 years.

Statistical Approach

To be able to determine a significant downward trend in mercury concentrations, statistical tests were selected that can provide robust analysis of changes in concentration over time with a wide variety of data types. Three different statistical tests for trend were considered:

- Simple linear regression
- Jonckheere-Terpstra test
- Williams' test

Simple linear regression is a powerful technique when the data are well behaved (i.e., normally distributed with homogeneous variances) and the trend is linear in time. There is no sound reason to expect linearity and the other approaches require only a monotone relationship between time and mercury levels. Williams' test is parametric but assumes well behaved data. The Jonckhere-Terpstra test is non-parametric. Very extensive computer modeling has shown the latter has very similar power properties to the former for well-behaved data and is far superior for highly variable data such as likely to be collected in ecosystems.

Power simulations were conducted to select adequate sample sizes using the data from existing samples for determining the mean total mercury (THg) levels and the variance in selected stretches of the river. The monitoring plans were developed to produce at least 75% power by one or more of the three statistical tests to detect 10% decrease in THg levels (at $p = 0.05$). These are conservative sampling plans in that no additional information was used to obtain the powers of detection, such as season, topography, and river conditions that might be used in the final analyses. These are described in the subsequent section on "Explanatory Variables."

Explanatory Variables

Where possible, statistical analysis of monitoring data will utilize the extensive data collected on mercury in a wide array of biological and inorganic matrices, and variation in climate and physical parameters. Previous statistical modeling approaches were designed to understand relationships between the following responses in the South River:

- Surface water THg and methylmercury (MeHg)
- Sediment THg and MeHg
- Floodplain THg
- Fish tissue THg and MeHg

In addition, all organisms sampled in or near the river were modeled and some relevant species (i.e., those that could be considered food items for fish) were included as components of fish models. For explanatory variables, the statistical model for the South River accounts for the interaction between different media (e.g., surface water, sediment, floodplain soil, rainfall, pore water, and alluvial bank soil) and other factors (e.g., land use). Three main types of explanatory variables can be used in the South River statistical models:

- Variables that are collected recurrently (e.g., surface water mercury), continuously (temperature, discharge) or that are time-dependent (e.g., season)
- Environmental variables that were measured once (e.g., floodplain area, land use, gradient, floodplain THg, erosion, fish diet) and are expected to be relatively constant stable over time
- Explanatory variables that interact with each other (e.g., rainfall, floodplain soil THg concentration, and land use)

This underlying data set will be used to differentiate trends in mercury concentration from changes that are due to natural annual variability in parameters that affect mercury fate and transport.

Monitoring Element	Reach (RRM)	Percent Decrease	Sample Size	Timeframe	Statistical Power		
					Linear Regression	Jonckheere-Terpstra	Williams'
Adult Bass	<0	10	7	5	71	80	91
				10	100	100	100
	0.1 to 2.3	10	5	5	91	95	98
				10	100	100	100
	5.2 to 11.8	10	5	5	100	100	100
				10	100	100	100
	16 to 23.5	10	5	10	100	100	100
Benthic Invertebrate Tissue	<0	10	3	10	100	100	18
		10	10	5	100	100	84
	0.1 to 2.3	10	3	10	100	100	20
	5.2 to 11.8	10	3	10	100	100	16
		10	10	5	73	81	35
	16 to 23.5	10	3	10	94	93	9
Asiatic Clam Tissue	<0	10	3	10	100	100	22
		10	10	5	90	94	44
	0.1 to 2.3	10	3	10	100	100	19
		10	10	5	77	85	34
	5.2 to 11.8	10	3	10	100	100	19
		10	10	5	68	77	35
	16 to 23.5	10	3	10	100	100	14
Periphyton	0.1 to 2.3	10	3	10	99	97	10
	5.2 to 11.8	10	3	10	100	99	12
	16 to 23.5	10	3	10	100	99	12
Interstitial Sediment	<0	10	2	10	98	85	100
	0.1 to 2.3	10	2	10	91	71	100
	5.2 to 11.8	10	2	10	100	88	100
	16 to 23.5	10	2	10	93	72	100
Surface Water	<0	10	2	10	100	97	100
	0.1 to 2.3	10	2	10	100	94	100
	5.2 to 11.8	10	2	10	97	84	100
	16 to 23.5	10	2	10	96	81	100
Earthworms	<0	10	3	5	65	76	89
	0.1 to 2.3	10	3	5	42	57	75
		10	3	10	100	100	100
	5.2 to 11.8	10	3	5	100	100	100
	16 to 23.5	10	3	5	63	75	88
Carolina wren	<0	10	3	10	100	100	100
	0.1 to 2.3	10	3	10	100	100	100
		10	5	5	55	65	83
	5.2 to 11.8	10	3	10	100	100	100
	16 to 23.5	10	3	10	100	99	100

Table 1. Sample size necessary to detect a 10% decrease (at p = 0.05) in THg concentrations in key long-term monitoring elements. Three statistical tests are considered: linear regression, Jonckheere-Terpstra, and Williams' test. Sample sizes were calculated for either a 5- or 10-year window over which declines may be observed. If no result is listed for a 5-year sampling window, then there was no test with at least 75% power to detect a 10% decrease (at p = 0.05).

Protocol SRET-1:
Biological Sampling Guidelines for Earthworm Tissue Collection

Earthworm Tissue Sampling Procedures

Earthworm tissue sampling procedures for South River investigations are summarized in the following steps:

1. Collect soil at a depth interval 0 – 12 inches from subsample locations associated with composite soil sample locations.
2. Sort through the soil and remove approximately equal sample mass of earthworms from each subsample location.
3. Composite soil from which worm samples were obtained and thoroughly homogenize. Collect a subsample of this soil for analysis of THg and MeHg.
4. Place specimens into sampling containers, freeze, and ship to the laboratory for analysis.

The detailed procedures for earthworm tissue collection are provided below.

Equipment

The following equipment/supplies may be used to collect earthworm tissue samples:

- Shovels, spade or hand trowel
- Tape measure
- Stainless steel sampling tools
- Stainless steel or disposable plastic bowls
- Spade or shovel/Stainless steel trowel(s)
- Scale
- Sample bottles/vials and labels provided by the laboratory
- Sample container labels
- Distilled/deionized water
- Pencils and waterproof /permanent marking pens
- Ice chest, wet and dry ice
- Field notebook/field data sheets
- Chain-of-custody (COC) forms
- Custody seals
- Magnifying glass/hand lens
- Paper towels
- Lint-free wipes (Kimwipes or equivalent)
- Nitrile gloves
- Sampling location map
- Global positioning system (GPS)
- Camera
- Appropriate health and safety equipment

Decontamination Procedures

Before collecting each sample, the sampling and sorting equipment will be thoroughly cleaned and rinsed with deionized (DI) or distilled water to prevent potential sample contamination. Following decontamination, the equipment will be wrapped in clean plastic sheeting or trash bags to prevent contact with dust and unclean surfaces. The following is a list of equipment/supplies that may be needed to perform decontamination:

- Decontamination supplies
- Brushes
- Wash tubs
- Buckets
- Sponges and paper towels
- Alconox
- Bleach
- Organic-free water DI or distilled water
- Hand-held sprayers or spray bottles
- Trash bags
- Plastic sheeting

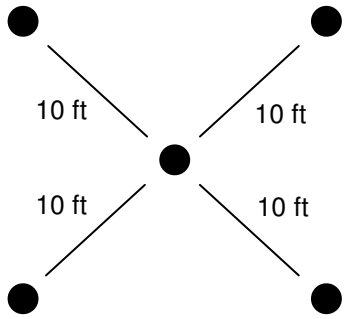
The following steps will be used to decontaminate the shovels, spades, and trowels:

1. Don appropriate personal protective equipment (PPE) and review health and safety procedures and plan.
2. Remove excess soil by scraping.
3. Wash using a brush in the plastic container holding Alconox and tap water. Equipment should be brushed until all soil is removed from the item being decontaminated.
4. Remove the item from the plastic container and rinse thoroughly with DI or distilled water.
5. Dry the item with a clean paper towel.

Following decontamination, the sampling equipment will be placed in a clean area and covered to prevent contact with the ground surface or other unclean surfaces. If the equipment is not to be used immediately, the equipment will be covered or wrapped in plastic sheeting or heavy-duty trash bags to minimize potential contamination.

Earthworm Tissue Sample Collection Procedures

Composite samples for earthworm tissue will consist of subsamples from five (5) sample points distributed around randomly as follows:



Composite earthworm samples will be collected from the five (5) sample points by digging, as necessary, with a decontaminated shovel. The goal will be to collect approximately equal masses of earthworms from each sample point until at least 2.5 - 20 total grams of tissue are obtained for analysis. Gut contents of earthworms will be purged prior to shipment to the laboratory. The following sections describe the sampling procedures for the collection of earthworm samples using shovels, trowels, and scoops and depuration procedures.

This method involves the collection of earthworms from soil at or near the ground surface using tools such as spades, shovels, trowels, and scoops. The surface material is removed to the required depth and a stainless steel trowel or plastic scoop is used to collect the soil. The soil will be hand sorted and earthworms will be removed. To the extent practical, consistent sampling techniques are to be used among all sampling stations for consistency and comparability.

The following procedure describes the methodology for collecting earthworms:

1. Don appropriate PPE and review safety procedures with team.
2. Remove and discard sticks, rocks, vegetation and other debris from the sampling area using a pre-cleaned sampling tool.
3. At the prescribed soil subsample points, excavate soil to 12 inches below ground surface (bgs).
4. Place excavated soil onto aluminum foil.
5. Combine all excavated soil and homogenize.
6. Collect a soil sample for mercury analysis from the homogenized soil.
7. Using gloved hands, sort through the soils and set aside any earthworms in a decontaminated stainless steel bowl or other appropriate clean sampling container.
8. Repeat the process to obtain sufficient numbers of earthworms totaling 2.5 - 20 grams of approximately equal mass from each subsample point for the composite sample for the sampling station.
9. Rinse each earthworm with distilled/deionized water.
10. Wipe or blot with lint-free wipes to remove excess water.
11. Place all worms into a container with moist filter paper for 24 hours to purge gut contents.

12. After 24 hours of depuration, rinse worms again with deionized water and recorded length (mm) and weight of each organism as well as the total composite weight.
13. Place composite sample in clean laboratory-supplied sample containers (one per composite sample).
14. Freeze samples until ready for shipment to the designated analytical laboratory for tissue analyses.
15. Place samples in a cooler and pack securely with dry ice for shipment.

In the field notebook/field data sheets, note the depth of soil sorted, time of sampling, and relevant observations, including but not limited to weather or substrate type.

Sample Identification, Handling, and Chain-of-Custody

Samples will be identified, handled, and recorded as described below. Each sample container will have a sample label affixed to the outside, and documentation will be completed in waterproof ink. Each label will be marked using waterproof ink with the following information:

- Project name;
- Sample identification number;
- Date and time of collection;
- Initials of sampling technician;
- Requested analysis; and
- Method of preservation.

Sample containers will be packed in bubble wrap to minimize breakage and placed in plastic coolers. Ice will be placed around sample containers, and additional cushioning material will be added to the cooler, if necessary. A temperature blank will be included in each cooler. Paperwork will be placed in a sealable plastic bag and placed on top of the sample containers or taped to the inside lid of the cooler. The cooler will be sealed, and signed custody seals will be affixed to two sides of the cooler. Laboratory address labels will be placed on top of the cooler.

Sample coolers will be packaged and shipped as environmental samples in accordance with applicable federal and state regulations. Standard procedures applicable to the shipment of environmental samples to the analytical laboratory are outlined below:

- Environmental samples collected will be transported to the laboratory by field personnel, shipped through Federal Express or equivalent overnight service, or picked up by a laboratory courier. Shipments will be scheduled to meet holding time requirements.
- The laboratory will be notified prior to receipt of samples. If the number, type, or date of shipment changes due to site constraints or program changes, the laboratory will be informed in advance to allow adequate time to prepare.

- The transfer of custody of field collected samples will follow an established sample chain-of-custody (COC) program. The primary purpose of COC procedures is to ensure that sample traceability is maintained from collection through shipping, storage, and analysis to data reporting and disposal.
- Tracing sample possession will be accomplished by using the COC record. A COC entry will be recorded for every sample, and a COC record will accompany every sample shipment to the laboratory. At a minimum, the COC record will contain the following information for each sample:
    - Project name and number
    - Sample number and identification of sampling point
    - Sample media
    - Sample number and identification of sampling point
    - Date and time of collection
    - Sample type
    - Number, type, and volume of sample container(s)
    - Sample preservative
    - Analysis requested
    - Name, address, and phone number of laboratory or laboratory contact
    - Signature, dates, and times of persons in possession
    - Any necessary remarks or special instructions

Once the COC is complete and the samples are prepared for shipment, the COC will be placed inside the shipping container, and the container will be sealed. Samples are considered to be in custody if they are within sight of the individual responsible for their security or locked in a secure location. Each person who takes possession of the samples, except the shipping courier, is responsible for sample integrity and safekeeping. A copy of each COC form will be retained by the sampling team for the project file. Bills of lading will also be retained as part of the chain-of-custody record.

Field Sampling and Project Documentation

All information pertinent to the investigation will be recorded in a bound Field Logbook and/or Field Data Sheets. Entries will include the following, as applicable:

- Project name and number;
- Sampler's and field personnel names;
- Date and time of sample collection;
- Observations at the sampling site such as weather conditions;
- Sample number, location, and depth;
- Sampling method;
- Analyses requested;
- Sampling media;
- Sample type (grab or composite); and
- Sample physical characteristics.

- Summary of daily tasks and information concerning sampling changes and scheduling modifications dictated by field conditions

Field investigation situations vary widely. No general rules can include every type of information that must be entered in a logbook or data sheet for a particular site. Site-specific recording will include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel. At the completion of the field activities, the logbooks will be maintained in the central project file.

Protocol SRSE-1:
Guidelines for Sampling Size-Classified Sediments Using a Beckson Pump

Note: Specific sampling procedures described below may be modified once the detailed scope of work has been developed

This method describes the guidelines for collection of riverbed sediment samples. The method is applicable to small rivers and streams that can be waded or that have maximum water depths less than about eight feet. The method is generally used in high gradient streams where sediment grain size is rarely more than a few millimeters in thickness and where scoops would be ineffective for collection. The method is based on general guidance and principles outlined in EPA's *Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual* (USEPA, 2001).

Equipment

The following equipment/supplies may be used to collect sediment samples:

- Piston type bilge pump (similar to Grainger Item: Portable Hand Pump, item # 4P018)
- HDPE 5-gallon buckets (three per location)
- Wrist watch or other timing device with second hand/display
- Portable analytical balance, 2 kilogram (kg) capacity, 1.0 gram (g) resolution
- Analysis-appropriate sample containers
- Waders
- Dry ice (if methylmercury analysis is requested)
- Decontamination equipment
  - Reagent Water - Reagent water is water in which metals and nutrients and potentially inferring substances are not detected at the minimum detectable level (MDL) of the analytical method used for analysis of samples or are detected at concentration no greater than three times the MDL. Reagent water is used to prepare field blanks and equipment blanks and to rinse apparatus.
  - Formula 409 - This is a commercial liquid cleaner suitable for decontaminating bilge pump and buckets. It is an effective degreaser as well as providing good removal of surface metal contamination.
- Powder-free Nitrile gloves
- Pencils and waterproof/permanent marking pens
- Sampling location maps
- Global positioning system (GPS)
- Camera

- Appropriate health and safety equipment
- Cooler
- Chain-of-custody (COC) forms
- Custody seals

Decontamination Procedures

The buckets and bilge pump will be decontaminated before sampling begins and between sampling locations.

The following steps will be used to decontaminate sampling equipment:

- Don appropriate personal protective equipment (PPE) and review safety procedures and plan.
- The buckets should be scrubbed with Formula 409 and then flushed with river water initially and prior to reuse.
- River water should be flushed through the bilge pump at the end of each sampling use followed by flushing with diluted (10:1) Formula 409 cleaner and more river water. Flush the pump at the end of each day with reagent water and drain off any water that is not expelled by operating the pump. No other cleaning is needed unless oily sediments are encountered. Store the pump in a clean polyethylene bag.

Contamination and Interference

Avoidance of sample and apparatus contamination is of paramount importance for this method. The most important factors in avoiding/reducing sample contamination are as follows: (1) an awareness of potential sources of contamination and (2) strict attention to work being performed. The following procedures should be followed to prevent contamination and interferences:

- Sampling personnel must wear clean, nonpowdered gloves during all operations involving handling of the apparatus and sample bottles. Gloves should be changed if there is any suspicion that the gloves have contacted surfaces that could be contaminated.
- The specific items comprising the apparatus have been demonstrated to effectively avoid contamination when deployed and operated as described in this method. Do not substitute items or change procedures without first demonstrating that the substitution or procedural change maintains sample integrity.
- In general, there are no or few analytical interferences that may be encountered in ambient sediment sampling. However, samplers should record any odors, sheens, colors, or other unusual sample characteristics on the analytical request form to alert laboratory staff of potential analytical issues.

Sample Collection and Handling Procedures

The following procedures will be used to collect sediment samples:

- Identify sample location using GPS unit.

- Evaluate the conditions of the river and assess that both banks and the middle of the channel can be sampled safely. If not, modify location or move to a different station.
- Use a decontaminated pump to pump sediment and water from overlying substrate within an approximate 2 ft^2 area into one of the precleaned 5-gallon buckets. Start on near either the left or right bank. Three areas of the channel will be sampled (left, center, right) and composited to constitute each sample. Short pump strokes reduce the amount of water and maximize the sediment recovered. Move the intake end of pump around as sediment is collected to maximize the volume of sediment obtained. In so far as possible, limit the depth of penetration of the pump tip to the upper 1 to 2 inches of sand, gravel, and cobble. Continue pumping until approximately 1/3 of the 5 gallon bucket is filled. Move to the next location and repeat the above procedure until approximately 2/3 of the bucket is full. Move to the final location and fill the bucket with sediment/water .
- After 5 gallons have been pumped, use a clean paddle or spoon to completely suspend the sediment. Stir for about 15 seconds.
- Allow sediment to settle for 30 seconds. All sand in the sample will settle to the bottom of the bucket in this interval.
- Pour the remaining suspension into a separate precleaned 5-gallon bucket. Stow the bucket someplace where it will be moved as little as possible for 30 minutes.
- At the end of the 30 minute settling period, carefully pour off and discard the as much of the overlying water as possible. Avoid resuspending or losing any of the sediment that has settled at the bottom of the bucket.
- Determine from the analytical lab(s) the minimum acceptable sample volume or mass. If, in the judgment of the field team, the amount of sediment procured from the first sample is insufficient, repeat the above procedure in an adjacent section of the stream. Then, composite each additional grab sample until sufficient volume is achieved.
- As a point of reference, typical dry mass obtained per 5-gallon volume initially pumped is between 30 to 80 g dry weight. This volume will be almost entirely composed of silt and clay because sand is excluded during the 30-second settling.
- In general, field preserve sediment samples for metals and nutrient analysis by chilling and maintaining them in the dark. Sediment samples for methylmercury analysis must be frozen and shipped on dry ice. Also refer to any specific instructions provided by the analytical laboratory.

Field Quality Assurance/Quality Control

Field quality assurance/quality control (QA/QC) samples are designed to help identify and minimize potential sources of sample contamination due to field procedures and to evaluate potential error introduced by sample collection and handling. Strict adherence to the procedures described above in the section titled “Contamination and Interference” will assure collection of uncompromised sediment samples.

Field/Equipment Blank Samples

Field and equipment blank samples will be collected each day that sampling occurs to demonstrate that contamination has been controlled. Field blanks will consist of reagent water that will be used to rinse equipment while equipment blanks will consist of reagent water after it has contacted the pump and buckets.

Duplicate Samples

Collecting duplicate samples allows for evaluation of natural variability by comparing the analytical results of two samples from the same location. Duplicate samples also check for the consistency of field techniques and laboratory analysis. The duplicate samples will be handled in the same manner as the primary sample, assigned a distinct identification number, and shipped to the laboratory along with the primary sample it duplicates. Duplicate samples will be determined by the sample collection program. Stations will be determined in the field based on professional judgment.

Matrix Spikes and Matrix Spike Duplicates

Matrix spikes (MS) and matrix spike duplicate (MSD) samples will be obtained by collecting additional material at a selected station. MS and MSD samples are prepared at the laboratory by dividing a control sample into two aliquots, then spiking each with identical concentrations of specific analytes. The spike samples are then analyzed separately, and the results are compared to evaluate the effects of the sample matrix on the analytical accuracy and precision. Separate samples for matrix spikes (MS) and matrix spike duplicates (MSD) must be collected unless the laboratory specifies that these analyses can be run using an actual sample. MS/MSD samples will be labeled and shipped to the laboratory along with the primary sample from which they were collected.

Sample Identification, Handling, and Chain-of-Custody

Samples will be identified, handled, and recorded as described in this sampling guideline. The sample parameters for analysis, preservation, and handling are specified in the Programatic AOC-4 QAPP. Each sample container has a sample label affixed to the outside. The sampler marks each label using waterproof ink with the following information:

- Project name
- Sample identification number
- Date and time of collection
- Initials of sampling technician
- Requested analysis
- Method of preservation

Sample containers will be packed in bubble wrap to minimize breakage or damage to samples and placed in metal or plastic coolers. Dry ice will be placed around sample containers and additional cushioning material will be added to the cooler, if necessary. Paperwork will be put in a Ziploc bag and placed on top of the sample containers or taped

to the inside lid of the cooler. The cooler will be taped closed and a signed custody seal will be affixed to the side of the cooler. Laboratory address labels will be placed on top of the cooler.

All samples are expected to contain low levels of contamination and will be packaged and shipped as environmental samples in accordance with applicable federal and state regulations. All shipments containing dry ice will conform to federal, state, and carrier regulations. Standard procedures to be followed for shipping environmental samples to the analytical laboratory are outlined below.

- All environmental samples collected will be transported to the laboratory by AECOM personnel, shipped through Federal Express or equivalent overnight service, or picked up by a lab courier.
- Shipments will be scheduled to meet holding time requirements.

The laboratory will be notified to be prepared to receive a shipment of samples. If the number, type, or date of shipment changes due to site constraints or program changes, the laboratory will be informed.

AECOM has established a program of sample COC that will be followed during sample handling activities in both field and laboratory operations. The primary purpose of COC procedures is to document the possession of the samples from collection through shipping, storage, and analysis to data reporting and disposal. The Task Manager or his/her designee will be responsible for monitoring compliance with COC procedures.

Tracing sample possession will be accomplished using the COC record. A COC entry will be recorded for every sample, and a COC record will accompany every sample shipment to the laboratory. At a minimum, the COC record will contain the following information for each sample:

- Sample number and identification of sampling point
- Date and time of collection
- Sample type
- Number, type, and volume of sample container(s)
- Sample preservative
- Analysis requested
- Name, address, and phone number of laboratory or laboratory contact
- Signature, dates and times of persons in possession
- Any necessary remarks or special instructions

Once the COC is complete and the samples are ready for shipment, the COC will be placed inside the shipping container, and the container will be sealed. Samples are considered to be in custody if they are within sight of the individual responsible for their security or locked in a secure location. Each person who takes possession of the samples, except the shipping courier, is responsible for sample integrity and safekeeping.

Field Logbook and Field Data Sheet

The most important aspect of documentation is thorough, organized, and accurate record keeping. All information pertinent to the investigation will be recorded in the field logbook and/or field data sheets. Entries will include the following, as applicable:

- Project name and number
- Name of sampler and field personnel
- Date and time of sample collection
- Sample number, location, and depth
- Sampling method
- Sampling media
- Sample type
- Sample physical characteristics
- Observations at the sampling site (e.g., weather conditions)
- Summary of daily tasks and information concerning sampling changes, scheduling modifications, and change orders dictated by field conditions

Field investigation situations vary widely. No general rules can include each type of information that must be entered in a logbook or data sheet for a particular site. Site-specific recording will include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel.

Health and Safety Procedures

To avoid incidents or injuries during sampling, the following health and safety procedures should be followed. Complete health and safety information is provided in the AOC-4 Project HASP:

- Toxic or otherwise harmful concentrations of metals or other constituents are unlikely to be encountered while sampling ambient sediments in rivers and streams. However, sampling crews should be trained in the general hazards of field sampling (e.g., waterborne pathogens) and how to minimize risks of exposure.
- Operating in or around water bodies carries the inherent risk of drowning. U.S. Coast Guard approved personal flotation devices must be worn when operating or sampling from a boat, when sampling in more than a few feet of water, or when sampling in swift currents.
- Collecting samples in cold weather, especially around cold waterbodies, carries the risk of hypothermia, and collecting samples in extremely hot and humid weather carries the risk of dehydration and heat stroke. Sampling team members should wear adequate clothing for protection in cold weather and should carry an adequate supply of water or other liquids for protection against dehydration in hot weather.
- Sampling team members must cover exposed skin and/or use sunscreen for protection from sun exposure.

- When working on all water bodies, sampling teams must develop and employ an emergency response plan, including the use of an onshore monitor that is accountable for the whereabouts of the team. The monitor can request aid if the team fails to report in at end of workday and can provide assistance to rescuers or the team under any emergency situation.

References

USEPA. 2001. *Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual*. EPA-823-B-01-002, US Environmental Protection Agency, Office of Water, Washington, DC, 208 p

Protocol SRSW-1:
Guidelines for Sampling Water
Using a Diaphragm Pump

This method is for the collection and field filtration of ambient surface and subsurface water samples for subsequent determination of total mercury (THg), filtered total mercury (FTHg), methylmercury (MeHg) and filtered methylmercury (FMeHg) at ultra-trace concentrations (THg and FTHg @ > 0.2 nanograms per liter (ng/L), MeHg and FMeHg @ > 0.02 ng/L) using EPA Methods 1631 (THg and FTHg) and EPA Method 1630 (MeHg and FMeHg). The method is also suitable for the collection and field filtration of ambient surface and subsurface water samples for the subsequent determination of general water quality, metals and polycyclic aromatic hydrocarbons (PAHs).

This method will be used whether sampling by wading, from a boat or from bridges. The method is based on general guidance and principles outlined in EPA Method 1669 *Sampling Ambient Water for Determination of Metals at EPA Water Quality Criteria Levels* (July 1996). It is a "performance validated" alternative to Method 1669, as allowed and encouraged by EPA Method 1669, that has been demonstrated to preclude contamination of samples and blanks as required by the original method.

Equipment

The following equipment/supplies may be used to collect surface water samples:

- Diaphragm pump – Shurflo Model 2088-433-344, 12 volt (V) DC, 3.3 gallons per minute (gpm) flow
- Submersible pump - Forestry Suppliers 12V DC Battery-Operated Purge Pumps
- Tubing – Cole Parmer, C-flex, 3/8" ID x 5/8"OD, Cat# 06424-79
- Hydro weight – Coated iron (not lead) downrigger weight [5, 10, or 15 pound (lbs)]
- Syringe – 25 mL BD plastic, rubber-free plunger
- Filter:
  - Capsule type, high capacity, with barb fitting (e.g., Pall AquaPrep 600)
  - Syringe-tip filter with Luer-Lok or friction fitting (0.45 µm pore size)
- Battery or power pack: 12 V deep cycle battery or portable power pack (e.g., Xantrex Xpower 300)
  - Sample bottles – 250 milliliter (mL) borosilicate glass, IChem Series 300 or equivalent
  - Mercury - 250 mL borosilicate glass, IChem Series 300
  - TSS – 1000 mL HDPE
  - Metals – 1000 mL HDPE (with nitric acid preservative)

- TOC – 125 mL glass (with sulfuric acid preservative)
- Anions – 50 mL HDPE
- Hardness – 100 mL HDPE (with sulfuric acid preservative)
- PAHs – 2 x 1000 mL amber glass (with $Na_2S_2O_3$ preservative)
- Organochlorine pesticides – 2 x 1000 mL amber glass (to be filled by dipping)

- Reagent water – water in which mercury and potentially inferring substances are not detected at the minimum detectable level (MDL) of the analytical method used for analysis of samples *or* are detected at concentration no greater than three times the MDL (e.g., typical MDL for total mercury by EPA Method 1631 is 0.20 ng/L, thus the allowable total mercury in reagent water should be < 0.6 ng/L).
- Powder-free Nitrile gloves
- Pencils and waterproof/permanent marking pens
- Sampling location maps
- Global Positioning System (GPS) unit
- Camera
- Appropriate health and safety equipment
- Ziploc bags or similar dry storage materials
- Cooler
- Ice
- Paper towels
- Field notebook/field data sheets
- Chain-of-custody (COC) forms
- Custody seals

Decontamination Procedures

The following is a list of equipment/supplies and procedures needed to perform decontamination:

- C-Flex Tubing
  When employed as described in this method, this product has demonstrated repeatedly to be acceptably clean from the manufacturer's packaging without laboratory precleaning and may be used within the same waterbody to collect samples from multiple locations without risk of cross-contamination. As a precaution, sampling should always proceed from the cleanest locations to the most contaminated.
- Diaphragm and Submersible Pump
  Reagent water should be flushed through the pump at the end of each sampling day and the pump drained of any water that is not expelled by operation. No other cleaning is needed. The pump should be stored in a clean polyethylene bag.

- The use of any chemicals, especially acids, to clean pump, tubing, or filters in the field is generally discouraged because such treatment may change the properties of the materials of which these items are constructed. In addition, inefficient flushing of such chemicals may cause sample contamination. If suspicion exists that any of these items may have been contaminated with mercury or with substances that might interfere with unbiased sampling and analysis for mercury, the item(s) should be discarded or transferred to a qualified laboratory for cleaning and testing. For example, if hydrocarbon-contaminated water is encountered and contacts the apparatus at any time, the sampling components (with the possible exception of the pump) should be discarded. Similarly, if an industrial outfall to be sampled using this method is known or suspected to contain elevated mercury levels, do not attempt to clean the apparatus after use. Discard all but the pump and do not use the pump again until it is confirmed to be clean with an equipment blank.

Contamination and Interference

Avoidance of sample and apparatus contamination is of paramount importance for this method. The most important factors in avoiding/reducing sample contamination are 1) an awareness of potential sources of contamination and 2) strict attention to work being performed. The following procedures should be followed to prevent contamination and interference:

- The continuous pumping apparatus (pump, tubing, hydro weight) should only be removed from its clean container (cooler or plastic bag) just prior to sampling. When not being used, the system should be stored in a clean plastic bag or a dedicated cooler.
- Sampling personnel must wear clean, nonpowdered gloves during all operations involving handling of the apparatus and sample bottles. Gloves should be changed if there is any suspicion that the gloves have contacted surfaces that could be contaminated.
- The specific items comprising the apparatus have been demonstrated to effectively avoid contamination when deployed and operated as described in this method. Do not substitute items or change procedures without first demonstrating that the substitution or procedural change maintains sample integrity.
- Adhere strictly to the rules provided in subsequent sections with regard to flushing rates and times to avoid contamination carryover. Whenever possible, conduct sampling sequentially from sites of lower to higher known or expected contamination.
- Do not use the apparatus to sample effluents known or suspected to contain elevated mercury concentrations. This method is intended only for ambient samples of lakes, rivers, estuaries, and the ocean.
- In general, there are few analytical interferences that may be encountered in ambient water sampling.

Surface Water Sample Collection, Filtration, and Handling

The setup of equipment for surface water sample collection is shown in Photographs 1 and 2. The following procedures will be used to collect surface water samples from wading or by boat:

- Select surface water sampling locations in accordance with study objectives.

- Sampling sites should exhibit a high degree of cross-sectional homogeneity. Because mixing is principally governed by turbulence and water velocity, the selection of a site immediately downstream of a riffle area will ensure good vertical mixing. Horizontal mixing occurs in constrictions in the channel.
- Look for and avoid flow eddies that often occur near banks and in-stream obstructions.
- Avoid sample locations very near heavily traveled roads, bridges, and overhead utilities. If these features cannot be avoided, then sample upstream and sample during periods when these features are least likely to introduce contamination into the river.
- Plan sampling activity to collect samples known or suspected to contain the lowest concentrations of mercury first, finishing with samples known or suspected to contain the highest concentrations.
- Follow "Clean hands – Dirty hands" sampling techniques below using a diaphragm pump with the intake tube resting on the bottom of the water body.

The following procedures will be used to collect ambient surface water samples from bridges as part of the quarterly monitoring for the South River Program:

- Park vehicle a safe distance off of the road to ensure safe working conditions and turn on vehicle hazard lights.
- Locate thalweg and lower a weighted submersible purge pump into the water on the upstream side of the bridge. The pump is to be lowered to 1/3 of the depth of the water column.
- Follow "Clean hands – Dirty hands" sampling techniques below.

"Clean hands – Dirty hands" Sampling Technique

Upon arrival at the sampling site, one member of the two-person sampling team is designated as "dirty hands;" the second member is designated as "clean hands." All operations involving contact with the sample bottle and the transfer of the sample from the sample pumping system to the sample bottle are handled by the individual designated as "clean hands." "Dirty hands" is responsible for preparation of the sample pumping system, operation of the pump, and all other activities that do not involve direct contact with the sample or sample container.

- "Dirty hands" deploys the weighted sample line into a water mass not affected by the presence of the boat or samplers.
- "Dirty hands" activates the pump and times pump running time prior to indicating to "clean hands" that sampling for unfiltered analytes can begin Pump should be run for at least one minute prior to sampling.
- "Clean hands" opens sample bottle and rinses it twice with sample water prior to filling and recapping. If additional unfiltered samples (e.g., for TSS) are to be collected, the same procedure is followed for additional bottles.
- "Dirty hands" pinches the sample line on the suction side and installs a capsule filter on the discharge line. Then "dirty hands" flushes several liters of sample water through the

filter at a flow rate held low enough (by pinching the suction line) to avoid excessive back pressure in the filter.

- "Clean hands" opens sample bottle and rinses it twice with sample water prior to filling and recapping. If additional filtered samples (e.g., for other metals, anions) are to be collected, the same procedure is followed for additional bottles.
- "Dirty hands" secures the pumping system by returning the weighted sample line and pump to a dedicated plastic bag or clean cooler.
- "Clean hands" re-bags the water samples and places them on ice in a cooler.

In general, water samples are not field-preserved other than by chilling and maintaining in the dark due to the increased risk of contamination. However, when there is uncertainty about the elapsed time for arrival at an analytical laboratory and methylmercury is to be requested, samples should be field-preserved with hydrochloric acid as specified in EPA Method 1630.

Field Quality Assurance/Quality Control

Field quality assurance/quality control (QA/QC) samples are designed to help identify and minimize potential sources of sample contamination due to field procedures and to evaluate potential error introduced by sample collection and handling. Strict adherence to the procedures described above in the section titled "Contamination and Interference" will assure collection of uncompromised sediment samples.

Field/Equipment Blanks

It is necessary to collect field blank and equipment blank samples each day that sampling occurs or whenever the pump or tubing is changed to demonstrate that contamination has been controlled.

Duplicate Sample

Frequency of duplicates is identified in the work plan. Additional field duplicates may be collected if conditions suggest the need for more or more are specified in the sampling and analysis plan.

Matrix Spikes and Matrix Spike Duplicates

Separate samples for matrix spikes (MS) and matrix spike duplicates (MSD) do not have to be collected unless the laboratory requests because these analyses can be run by most laboratories using an actual sample.

Method Performance (QA/QC)

Recent results for field blanks and equipment blanks for mercury and methylmercury are summarized in Table 1. Because most laboratories that are qualified to run EPA Method 1631 can detect total mercury above the typical MDL (0.2 ng/L) even in the highest quality water that can be prepared, it is always necessary to request analysis of the water used to prepare equipment blanks. Methylmercury should not be detected in either field

blanks or equipment blanks, and total mercury and methylmercury in blanks should not exceed two times the MDL.

Table 1
Results for Field and Equipment Blanks Prepared Following Method SRSW-1

Date	Location	Field Blank (Source Water)		Pump+Tubing Blank		Pump+Tubing+Filter Blank	
		Total Hg	Methyl Hg	Total Hg	Methyl Hg	Total Hg	Methyl Hg
Sep 04	Penobscot	<0.03		<0.06		<0.04	
Oct 04	Penobscot	<0.03		<0.07		<0.03	
Jan 05	South River	0.30	<0.012			0.59	<0.012
Mar 05	South River	0.19				0.15	
	South River	0.22				0.21	
	South River	0.22				0.32	
	South River	0.21				0.23	
	South River	0.21				0.38	
Jan 05	Pompton	0.09	0.003			<0.08	<0.004
Jan 05	Pompton	0.06				0.06	
Aug 04	Pompton	0.07				0.25	
Aug 04	Pompton	0.30	<0.023			0.67	<0.003
May 04	Pompton	0.42	<0.007			0.20	<0.013

Note: Units are ng/L

Sample Identification, Handling, and Chain-of-Custody

Samples will be identified, handled, and recorded as described in this sampling guideline. The sample parameters for analysis, preservation, and handling are specified in the Programatic AOC-4 QAPP. Each sample container has a sample label affixed to the outside. The sampler marks each label using waterproof ink with the following information:

- Project name
- Sample identification number
- Date and time of collection

- Initials of sampling technician
- Requested analysis
- Method of preservation

Sample containers will be packed in bubble wrap to minimize breakage or damage to samples and placed in metal or plastic coolers. Wet ice will be placed around sample containers and additional cushioning material will be added to the cooler, if necessary. Paperwork will be put in a Ziploc bag and placed on top of the sample containers or taped to the inside lid of the cooler. The cooler will be taped closed and a signed custody seal will be affixed to the side of the cooler. Laboratory address labels will be placed on top of the cooler.

All samples are expected to contain low levels of contamination and will be packaged and shipped as environmental samples in accordance with applicable federal and state regulations. All shipments containing dry ice will conform to federal, state, and carrier regulations. Standard procedures to be followed for shipping environmental samples to the analytical laboratory are outlined below.

- All environmental samples collected will be transported to the laboratory by AECOM personnel, shipped through Federal Express or equivalent overnight service, or picked up by a lab courier.
- Shipments will be scheduled to meet holding time requirements.

The laboratory will be notified to be prepared to receive a shipment of samples. If the number, type, or date of shipment changes due to site constraints or program changes, the laboratory will be informed.

AECOM has established a program of sample COC that will be followed during sample handling activities in both field and laboratory operations. The primary purpose of COC procedures is to document the possession of the samples from collection through shipping, storage, and analysis to data reporting and disposal. The Task Manager or his/her designee will be responsible for monitoring compliance with COC procedures.

Tracing sample possession will be accomplished using the COC record. A COC entry will be recorded for every sample, and a COC record will accompany every sample shipment to the laboratory. At a minimum, the COC record will contain the following information for each sample:

- Sample number and identification of sampling point
- Date and time of collection
- Sample type
- Number, type, and volume of sample container(s)
- Sample preservative
- Analysis requested
- Name, address, and phone number of laboratory or laboratory contact
- Signature, dates and times of persons in possession

- Any necessary remarks or special instructions

Once the COC is complete and the samples are ready for shipment, the COC will be placed inside the shipping container, and the container will be sealed. Samples are considered to be in custody if they are within sight of the individual responsible for their security or locked in a secure location. Each person who takes possession of the samples, except the shipping courier, is responsible for sample integrity and safekeeping.

Field Logbook and Field Data Sheet

The most important aspect of documentation is thorough, organized, and accurate record keeping. All information pertinent to the investigation will be recorded in the field logbook and/or field data sheets. Entries will include the following, as applicable:

- Project name and number
- Name of sampler and field personnel
- Date and time of sample collection
- Sample number, location, and depth
- Sampling method
- Sampling media
- Sample type
- Sample physical characteristics
- Observations at the sampling site (e.g., weather conditions)
- Summary of daily tasks and information concerning sampling changes, scheduling modifications, and change orders dictated by field conditions

Field investigation situations vary widely. No general rules can include each type of information that must be entered in a logbook or data sheet for a particular site. Site-specific recording will include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel.

Health and Safety Procedures

To avoid incidents or injuries during sampling, the following health and safety procedures should be followed:

- Toxic or otherwise harmful concentrations of mercury and methylmercury are unlikely to be encountered while sampling ambient surface water. However, sampling crews should be trained in the hazards of mercury and how to minimize risks of exposure.
- Operating in or around waterbodies carries the inherent risk of drowning. U.S. Coast Guard approved personal flotation devices must be worn when operating or sampling from a boat, when sampling in more than a few feet of water, or when sampling in swift currents.

- Collecting samples in cold weather, especially around cold waterbodies, carries the risk of hypothermia, and collecting samples in extremely hot and humid weather carries the risk of dehydration and heat stroke. Sampling team members should wear adequate clothing for protection in cold weather and should carry an adequate supply of water or other liquids for protection against dehydration in hot weather.
- Sampling team members must cover exposed skin and/or use sunscreen for protection against sunburn and melanoma.
- When working on all waterbodies, sampling teams must develop and employ an emergency response plan, including the use of an onshore monitor that is accountable for the whereabouts of the team. The monitor can request aid if team fails to report in at end of workday and can provide assistance to rescuers or team under any scenario where an emergency situation exists.

References

Parker, J.L. and N.S. Bloom. 2005. "Preservation and Storage Techniques for Low-Level Aqueous Mercury Speciation." *Science of the Total Environment*, 337:253-263.

USEPA. 1996. *Method 1669-Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels*. July 1996. U.S. Environmental Protection Agency, Office of Water, Engineering and Analysis Division (4303), 401 M Street SW, Washington, DC 204460

USGS. 2006. Collection of water samples (ver. 2.0): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A4, September, accessed February 20, 2009 at http://pubs.water.usgs.gov/twri9A4/

Photographs

Photograph 1. Use of clean cooler to protect sample inlet line and hydro weight from contamination when sampling from a boat in deeper water. Round yellow object on end of C-flex tubing is plastic screen to prevent end of inlet line from touching sediment or sucking in algae or other debris. Hydro weight (yellow sphere with fin) is typically only required where current is very swift (>0.5 m/s) and is tethered a foot or more below the sample inlet.

Photograph 2. Use of the continuous pumping system to collect water samples from a shallow stream. The inlet end of the tubing (out of picture) is screened and weighted. Capsule filter is shown installed on the discharge line from the pump.

Protocol SRTI-1
Biological Sampling Guidelines:
Aquatic Vegetation Tissue Collection

1.0 AQUATIC VEGETATION TISSUE SAMPLING GUIDELINES

Vegetation tissue sampling guidelines were developed based on collection procedures for rivers outlined in the *Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition* (Barbour et al., 1999).

2.0 Equipment

The following equipment/supplies may be used to collect aquatic vegetation tissue samples:

- Boat and motor
- Field book/field datasheets
- GPS unit
- Electronic scale
- Tray for weighing
- Plastic or stainless steel scraper
- Stainless-steel scissors
- Distilled or deionized water
- Nitrile gloves
- Lint-free wipes (Kimwipes or equivalent)
- Sample containers from laboratory
- Sample container labels
- Cooler
- Dry ice
- Wet ice
- Chain-of-custody (COC) forms
- Paper towels
- Digital camera
- Waterproof marking pens/ink pens
- Plastic bags/Ziplock bags
- Decontamination supplies
- Appropriate health and safety equipment

3.0 Decontamination Procedures

Before each sample, the measuring board and tray for weighing will be thoroughly cleaned and rinsed with deionized or distilled water to prevent potential sample contamination. The following equipment/supplies may be needed to perform decontamination:

- Brushes
- Wash tubs
- Buckets
- Sponges and paper towels
- Formula 409 (low mercury content detergent)
- Organic-free water (deionized or distilled water)
- Hand-held sprayers or spray bottles
- Trash bags
- Plastic sheeting

Following decontamination, the equipment will be wrapped in clean plastic sheeting or trash bags to prevent contact with dust and unclean surfaces.

4.0 Aquatic Vegetation Collection Procedures

A boat may be required to reach the designated sample locations. Caution will be used when conducting sampling from the boat. Health and safety procedures for conducting the work are detailed in the HASP or the program.

The following procedures will be used for periphyton tissue collection by hand:

- Locate moderate to large sized cobbles with a periphyton covering
- Using a plastic or stainless steel scraper, scrape the surface of the rock to remove periphyton.
- Continue scraping rocks until suitable sample mass is achieved.
- Rinse collected tissue with stream water to remove debris.

The following procedures will be used for macro-algal sample preparation:

- Inspect macro-algae for detritus and invertebrates and remove any if found.
- Rinse sample with deionized water or distilled water.
- Dry macro-algae with lint-free wipe.
- Record the weight of sample on the field data sheet.
- Place sample in laboratory supplied bottleware and place on dry ice.
- Decontaminate tray for weighting after every sample.
- Complete appropriate COC forms, and ship overnight to the laboratory for processing and analysis.

To the extent practical, consistent sampling techniques are to be used among all sampling stations for data consistency and comparability.

5.0 Field Quality Assurance/Quality Control Samples

Field quality assurance/quality control (QA/QC) samples are designed to help identify and minimize potential sources of sample contamination due to field procedures and to evaluate potential error introduced by sample collection and handling.

6.0 Equipment Blank Samples

An equipment rinsate sample of sampling equipment is not needed.

7.0 Duplicate Samples

Collecting duplicate samples allows for evaluation of natural variability by comparing the analytical results of two samples from the same location. Duplicate samples also check for the consistency of field techniques and laboratory analysis. The duplicate samples will be handled in the same manner as the primary sample, assigned a distinct identification number, and shipped to the laboratory along with the primary sample it duplicates. Duplicate samples will be determined based on the sampling program.

8.0 Matrix Spikes and Matrix Spike Duplicates

Matrix spikes (MS) and matrix spike duplicate (MSD) samples will be obtained by collecting additional material at a selected station. MS and MSD samples are prepared at the laboratory by dividing a control sample into two aliquots, then spiking each with identical concentrations of specific analytes. The spike samples are then analyzed separately, and the results are compared to evaluate the effects of the sample matrix on the analytical accuracy and precision. MS/MSD samples will be collected from baseline samples to ensure sufficient volume for laboratory QA/QC. MS/MSD samples will be labeled and shipped to the laboratory along with the primary sample from which they were collected.

9.0 Sample Identification, Handling, and Chain-of-Custody

Samples will be identified, handled, and recorded as described in this sampling guideline. The sample parameters for analysis, preservation, and handling are specified in the Programatic AOC-4 QAPP. Each sample container has a sample label affixed to the outside. The sampler marks each label with the following information using waterproof ink:

- Project name
- Sample identification number
- Date and time of collection
- Initials of sampling technician
- Requested analysis

- Method of preservation
- Selected taxa

Sample containers will be packed in bubble wrap to minimize breakage or damage to samples and placed in metal or plastic coolers. Dry ice will be placed around sample containers and additional cushioning material will be added to the cooler, if necessary. Paperwork will be put in a Ziploc bag and placed on top of the sample containers or taped to the inside lid of the cooler. The cooler will be taped closed and a signed custody seal will be affixed to the side of the cooler. Laboratory address labels will be placed on top of the cooler.

All samples are expected to contain low levels of contamination and will be packaged and shipped as environmental samples in accordance with applicable federal and state regulations. All shipments containing dry ice will conform to federal, state, and carrier regulations. Standard procedures to be followed for shipping environmental samples to the analytical laboratory are outlined below.

- All environmental samples collected will be transported to the laboratory by AECOM personnel, shipped through Federal Express or equivalent overnight service, or picked up by a lab courier.
- Shipments will be scheduled to meet holding time requirements.

The laboratory will be notified to be prepared to receive a shipment of samples. If the number, type, or date of shipment changes due to site constraints or program changes, the laboratory will be informed.

AECOM has established a program of sample COC that will be followed during sample handling activities in both field and laboratory operations. The primary purpose of COC procedures is to document the possession of the samples from collection through shipping, storage, and analysis to data reporting and disposal. The Task Manager or his/her designee will be responsible for monitoring compliance with COC procedures.

Tracing sample possession will be accomplished using the COC record. A COC entry will be recorded for every sample, and a COC record will accompany every sample shipment to the laboratory. At a minimum, the COC record will contain the following information for each sample:

- Sample number and identification of sampling point
- Date and time of collection
- Sample type
- Number, type, and volume of sample container(s)
- Sample preservative
- Analysis requested
- Name, address, and phone number of laboratory or laboratory contact
- Signature, dates and times of persons in possession
- Any necessary remarks or special instructions

Once the COC is complete and the samples are ready for shipment, the COC will be placed inside the shipping container, and the container will be sealed. Samples are considered to be in custody if they are within sight of the individual responsible for their security or locked in a secure location. Each person who takes possession of the samples, except the shipping courier, is responsible for sample integrity and safekeeping.

10.0 Field Logbook and Field Data Sheet

The most important aspect of documentation is thorough, organized, and accurate record keeping. All information pertinent to the investigation will be recorded in the field logbook and/or field data sheets. Entries will include the following, as applicable:

- Project name and number
- Name of sampler and field personnel
- Date and time of sample collection
- Sample number, location, and depth
- Sampling method
- Sampling media
- Sample type
- Sample physical characteristics
- Observations at the sampling site (e.g., weather conditions)
- Summary of daily tasks and information concerning sampling changes, scheduling modifications, and change orders dictated by field conditions

Field investigation situations vary widely. No general rules can include each type of information that must be entered in a logbook or data sheet for a particular site. Site-specific recording will include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel.

11.0 References

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition*. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

Protocol SRMD-1:
Biological Sampling Guidelines for Waterfowl Tissue Analysis

Equipment

The following equipment/supplies may be used to collect waterfowl tissue samples:

- Boat and motor
- Collection equipment, including a legal firearm, such as a shotgun
- Insulated chest waders/rubber boots
- Field book/field data sheets
- Global positioning system (GPS)
- Measuring board
- Electronic scale
- Tray for the electronic scale
- Distilled or deionized (DI) water
- Nitrile gloves
- Lint-free wipes (Kimwipe or equivalent)
- Scalpel
- Filet knife
- Forceps
- Sample containers from laboratory
- Sample container labels
- Cooler
- Wet ice
- Chain-of-Custody (COC) forms
- Custody seals
- Field data sheets
- Paper towels
- Aluminum foil
- Camera
- Pencils and waterproof/permanent marking pens

- Decontamination supplies
    - Brushes
    - Wash tubs
    - Buckets
    - Sponges and paper towels
    - Formula 409 (low mercury-content cleaner)
    - DI or distilled water
    - Hand-held sprayers or spray bottles
    - Trash bags
    - Plastic sheeting
    - Appropriate personal protective equipment (PPE)
- Scientific collector's permit and field identification guides, as necessary
- Appropriate health and safety equipment, including hearing and eye protection, survival jacket, pfd's, etc.

Sample Collection Methods

Samples will be collected by way of legal harvesting via a firearm (e.g., shotgun). Sampling personnel will obtain all appropriate licenses/permits required for waterfowl hunting in the state of Virginia. Sampling personnel will also follow all appropriate hunting regulations applicable to waterfowl hunting in the designated sampling area. Deviations from these regulations may be required (i.e., exceedance of daily bag limits); these deviations will be addressed in the applicable scientific collector's permit.

Decontamination Procedures

Between sampling locations, the measuring board and tray for weighing will be thoroughly cleaned and rinsed with DI or distilled water to prevent potential sample contamination. Following decontamination, the equipment will be wrapped in clean plastic sheeting or trash bags to prevent contact with dust and unclean surfaces. Waterfowl tissue sampling equipment (e.g. filet knife, forceps, scalpel) will be decontaminated with alcohol and rinsed using DI or distilled water after every fish tissue sample is collected.

Waterfowl tissue Collection Procedures

Wading will be considered if the water depth is shallow and the substrate is cohesive enough to make wading feasible. If not, a boat may be used to reach some of the sampling locations. Caution will be used when conducting sampling from the boat or by wading. Health and safety procedures are detailed in the AOC-4 HASP.

All collection permits will be obtained well in advance of the target sampling period to allow for flexibility in the timing of sampling.

Waterfowl tissue Analysis

Sample Preparation

The following procedures will be used for sample preparation:

- Record total length, weight, and morphological or histopathological anomalies on the field data sheet. Sampling conditions (e.g., water depth, time of sampling, general observations of the weather) should also be noted on the field data sheet.
- Carefully remove the breast muscle tissue using a filet knife and/or scalpel.
- Rinse waterfowl muscle tissue with DI water or distilled water to remove surface debris (e.g., feathers, debris, etc.).
- Dry waterfowl muscle tissue with Kimwipe or other lint-free wipe.
- Place the waterfowl muscle tissue sample in a pre-labeled laboratory supplied sample container which will be stored on wet ice.
- Decontaminate filet knife, forceps, and scalpel after every sample.
- Complete appropriate COC forms and ship overnight to the laboratory for processing and analysis.
- The analytical laboratory will prepare the filet for analysis of total mercury (USEPA Method 1631) and methylmercury (USEPA Method 1630).

To the extent practical, consistent sampling techniques are to be used at all sampling stations for consistency and comparability.

Field Quality Assurance/Quality Control Samples

Field quality assurance/quality control (QA/QC) samples are designed to help identify and minimize potential sources of sample contamination due to field procedures and to evaluate potential error introduced by sample collection and handling.

Equipment Blank Samples

An equipment rinsate sample of sampling equipment is not needed.

Duplicate Samples

Field duplicate samples will not be collected. Laboratory duplicates will be evaluated on homogenized sample media from a single organism.Collecting duplicate samples allows for evaluation of variability by comparing the analytical results of two samples from the same organism. The number of duplicate samples will be determined based on the sampling program.

Matrix Spikes and Matrix Spike Duplicates

Matrix spikes (MS) and matrix spike duplicate (MSD) samples will be obtained by collecting additional material at a selected station. MS and MSD samples are prepared at the laboratory by dividing a control sample into two aliquots, then spiking each with identical concentrations of specific analytes. The spike samples are then analyzed separately, and the results are compared to evaluate the effects of the sample matrix on the analytical accuracy and precision. MS/MSD samples will be collected from baseline

samples to ensure sufficient volume for laboratory QA/QC. MS/MSD samples will be labeled and shipped to the laboratory along with the primary sample from which they were collected.

Sample Identification, Handling, and Chain-of-Custody

Samples will be identified, handled, and recorded as described in this sampling guideline. The sample parameters for analysis, preservation, and handling are specified in the Programatic AOC-4 QAPP. Each sample container has a sample label affixed to the outside. The sampler marks each label using waterproof ink with the following information:

- Project name
- Sample identification number
- Date and time of collection
- Initials of sampling technician
- Requested analysis
- Method of preservation

Sample containers will be packed in bubble wrap to minimize breakage or damage to samples and placed in metal or plastic coolers. Wet ice will be placed around sample containers and additional cushioning material will be added to the cooler, if necessary. Paperwork (i.e., signed Chain-of-Custody forms) will be put in a Ziploc bag and placed on top of the sample containers or taped to the inside lid of the cooler. The cooler will be taped closed and a signed custody seal will be affixed to the side of the cooler. Laboratory address labels will be placed on top of the cooler.

All samples are expected to contain low levels of contamination and will be packaged and shipped as environmental samples in accordance with applicable federal and state regulations. All shipments containing dry ice will conform to federal, state, and carrier regulations. Standard procedures to be followed for shipping environmental samples to the analytical laboratory are outlined below.

- All environmental samples collected will be transported to the laboratory by AECOM personnel, shipped through Federal Express or equivalent overnight service, or picked up by a lab courier.
- Shipments will be scheduled to meet holding time requirements.

The laboratory will be notified to be prepared to receive a shipment of samples. If the number, type, or date of shipment changes due to site constraints or program changes, the laboratory will be informed.

AECOM has established a program of sample COC that will be followed during sample handling activities in both field and laboratory operations. The primary purpose of COC procedures is to document the possession of the samples from collection through shipping, storage, and analysis to data reporting and disposal. The Task Manager or his/her designee will be responsible for monitoring compliance with COC procedures.

Tracing sample possession will be accomplished using the COC record. A COC entry will be recorded for every sample, and a COC record will accompany every sample shipment to the laboratory. At a minimum, the COC record will contain the following information for each sample:

- Sample number and identification of sampling point
- Date and time of collection
- Sample type
- Number, type, and volume of sample container(s)
- Sample preservative
- Analysis requested
- Name, address, and phone number of laboratory or laboratory contact
- Signature, dates and times of persons in possession
- Any necessary remarks or special instructions

Once the COC is complete and the samples are ready for shipment, the COC will be placed inside the shipping container, and the container will be sealed. Samples are considered to be in custody if they are within sight of the individual responsible for their security or locked in a secure location. Each person who takes possession of the samples, except the shipping courier, is responsible for sample integrity and safekeeping.

Field Logbook and Field Data Sheet

The most important aspect of documentation is thorough, organized, and accurate record keeping. All information pertinent to the investigation will be recorded in the field logbook and/or field data sheets. Entries will include the following, as applicable:

- Project name and number
- Name of sampler and field personnel
- Date and time of sample collection
- Sample number, location, and depth
- Sampling method
- Sampling media
- Sample type
- Observations at the sampling site (e.g., weather conditions)
- Summary of daily tasks and information concerning sampling changes, scheduling modifications, and change orders dictated by field conditions

Field investigation situations vary widely. No general rules can include each type of information that must be entered in a logbook or data sheet for a particular site. Site-specific recording will include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel.

Health and Safety Procedures

To avoid incidents or injuries during sampling, the following task-specific health and safety procedures should be followed in addition to those indicated in the SRST Safety Program (SRST 2006):

- Toxic or otherwise harmful concentrations of metals or other constituents are unlikely to be encountered while sampling waterfowl tissue in rivers and streams. However, sampling crews should be trained in the general hazards of field sampling (e.g., waterborne pathogens) and how to minimize risks of exposure.
- Operating in or around waterbodies carries the inherent risk of drowning. U.S. Coast Guard approved personal flotation devices must be worn when operating or sampling from a boat, when sampling in more than a few feet of water, or when sampling in swift currents.
- Collecting samples in cold weather, especially around cold waterbodies, carries the risk of hypothermia, and collecting samples in extremely hot and humid weather carries the risk of dehydration and heat stroke. Sampling team members should wear adequate clothing for protection in cold weather and should carry an adequate supply of water or other liquids for protection against dehydration in hot weather.
- Sampling team members must cover exposed skin and/or use sunscreen for protection from sun exposure.
- When working on all waterbodies, sampling teams must develop and employ an emergency response plan, including the use of an onshore monitor that is accountable for the whereabouts of the team. The monitor can request aid if the team fails to report in at end of workday and can provide assistance to rescuers or the team under any emergency situation.

References

SRST. February 2006. South River Science Team Safety Program.

Protocol SRBT-1
Biological Sampling Guidelines for Snapping Turtle Tissue Analysis

The overall objective of herptile tissue sampling and analyses is to evaluate recent (e.g., weeks to months) dietary exposure of Hg to a representative reptile piscivore (e.g., snapping turtle) potentially foraging within the South River.

Equipment

The following equipment/supplies may be used to collect snapping turtle samples:

- Boat and motor
- Hoop nets (Memphis Net and Twine, Memphis, TN, USA)
- Bait (sardines, other fish material)
- Wooden stakes
- Hammer
- Rope/twine
- Protective gloves
- Plastic bin
- Nail clippers
- Metal file
- Electronic scale
- Measuring tape
- Chest waders/rubber boots
- Field book/field data sheets
- Global positioning system (GPS)
- Sample containers from laboratory
- Sample container labels
- Cooler
- Dry ice
- Chain-of-Custody (COC) forms
- Custody seals
- Camera
- Pencils and waterproof/permanent marking pens

- Decontamination supplies
- Scientific collector's permit and field identification guides, as necessary
- Appropriate health and safety equipment, including eye protection, pfd's, etc.

Standard Operating Procedure for Collection of Snapping Turtles

Sampling will be performed in accordance with the conditions stated in applicable VDGIF scientific collection permits. The following sections describe each sampling approach, methodologies for snapping turtle tissue collection, and analytical data quality objectives.

Sampling Collection Methods

Snapping turtles (*Chelydra serpentina*) will be collected with the use of baited hoop nets. Traps will be placed in the most appropriate microhabitats (e.g., slow moving water, presence of large woody debris, structured bank) present at each sampling location. Traps will be baited with sardines or other fish material, and staked and/or tethered to the shoreline so as not to float away and to ensure the traps are not completely submerged.

Once set, traps will be left in place for 1-2 nights and checked daily. Traps will be moved after two nights if not successful. Captured turtles will be removed and placed into a plastic bin using protective gloves. Handlers will then weigh the turtles, collect carapace length and width, and obtain two toe nail clippings for mercury analysis. Turtles will then be permanently marked using a nail file along their marginal scutes according to a three scute code, previously used by Bergeron et al. (2007), for future identification. Captured turtles will be processed quickly and returned to the water as soon as possible. Special care will be taken by the handler to avoid contact with the mouth of the turtle at all times and to avoid harming captured turtles.

Decontamination Procedures

Between sampling locations, the measuring board, nail file, and tray for weighing will be thoroughly cleaned and rinsed with DI or distilled water to prevent potential sample contamination. Following decontamination, the equipment will be wrapped in clean plastic sheeting or trash bags to prevent contact with dust and unclean surfaces. Turtle tissue sampling equipment (e.g. nail clippers) will be decontaminated with alcohol and rinsed using DI or distilled water after every toe nail sample is collected.

Field Quality Assurance/Quality Control Samples

Field quality assurance/quality control (QA/QC) samples are designed to help identify and minimize potential sources of sample contamination due to field procedures and to evaluate potential error introduced by sample collection and handling.

Duplicate Samples

Collecting duplicate samples allows for evaluation of sample homogeneity by comparing the analytical results of two samples from the same individual. Duplicate samples also check for the consistency of laboratory analysis. Duplicate samples will be collected by the analytical laboratory from primary samples with sufficient mass. Duplicates will be analyzed at a rate of five (5) percent of the total samples collected for in the study.

Matrix Spikes and Matrix Spike Duplicates

Matrix spikes (MS) and matrix spike duplicate (MSD) samples will be obtained by the analytical laboratory from primary samples with sufficient mass. MS and MSD samples are prepared at the laboratory by dividing a control sample into two aliquots, then spiking each with identical concentrations of specific analytes. The spike samples are then analyzed separately, and the results are compared to evaluate the effects of the sample matrix on the analytical accuracy and precision. MS/MSD samples will be collected from baseline samples to ensure sufficient volume for laboratory QA/QC. MS/MSD samples will be analyzed at a rate of five (5) percent of the total samples collected for in the study.

Sample Identification, Handling, and Chain-of-Custody

Samples will be identified, handled, and recorded as described in this sampling guideline. The sample parameters for analysis, preservation, and handling are specified in scope of work. Each sample container has a sample label affixed to the outside. The sampler marks each label using waterproof ink with the following information:

- Project name
- Sample identification number
- Date and time of collection
- Initials of sampling technician
- Requested analysis
- Method of preservation

Dry ice will be placed around sample containers and additional cushioning material will be added to the cooler, if necessary. Paperwork (i.e., signed Chain-of-Custody forms) will be put in a Ziploc bag and placed on top of the sample containers or taped to the inside lid of the cooler. The cooler will be taped closed and a signed custody seal will be affixed to the side of the cooler. Laboratory address labels will be placed on top of the cooler.

All samples are expected to contain low levels of contamination and will be packaged and shipped as environmental samples in accordance with applicable federal and state regulations. All shipments containing dry ice will conform to federal, state, and carrier regulations. Standard procedures to be followed for shipping environmental samples to the analytical laboratory are outlined below.

- All environmental samples collected will be transported to the laboratory by AECOM personnel, shipped through Federal Express or equivalent overnight service, or picked up by a lab courier.
- Shipments will be scheduled to meet holding time requirements.

The laboratory will be notified to be prepared to receive a shipment of samples. If the number, type, or date of shipment changes due to site constraints or program changes, the laboratory will be informed.

AECOM has established a program of sample COC that will be followed during sample handling activities in both field and laboratory operations. The primary purpose of COC procedures is to document the possession of the samples from collection through shipping, storage, and analysis to data reporting and disposal. The Task Manager or his/her designee will be responsible for monitoring compliance with COC procedures.

Tracing sample possession will be accomplished using the COC record. A COC entry will be recorded for every sample, and a COC record will accompany every sample shipment to the laboratory. At a minimum, the COC record will contain the following information for each sample:

- Sample number and identification of sampling point
- Date and time of collection
- Sample type
- Number, type, and volume of sample container(s)
- Sample preservative
- Analysis requested
- Name, address, and phone number of laboratory or laboratory contact
- Signature, dates and times of persons in possession
- Any necessary remarks or special instructions

Once the COC is complete and the samples are ready for shipment, the COC will be placed inside the shipping container, and the container will be sealed. Samples are considered to be in custody if they are within sight of the individual responsible for their security or locked in a secure location. Each person who takes possession of the samples, except the shipping courier, is responsible for sample integrity and safekeeping.

Field Logbook and Field Data Sheet

The most important aspect of documentation is thorough, organized, and accurate record keeping. All information pertinent to the investigation will be recorded in the field logbook and/or field data sheets. Entries will include the following, as applicable:

- Project name and number
- Name of sampler and field personnel
- Date and time of sample collection
- Sample number, location, and depth
- Sampling method
- Sampling media
- Sample type

- Observations at the sampling site (e.g., weather conditions)
- Summary of daily tasks and information concerning sampling changes, scheduling modifications, and change orders dictated by field conditions

Field investigation situations vary widely. No general rules can include each type of information that must be entered in a logbook or data sheet for a particular site. Site-specific recording will include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel.

Health and Safety Procedures

To avoid incidents or injuries during sampling, the following task-specific health and safety procedures should be followed in addition to those indicated in the SRST Safety Program (SRST 2006):

- Toxic or otherwise harmful concentrations of metals or other constituents are unlikely to be encountered while sampling snapping turtle tissue in rivers and streams. However, sampling crews should be trained in the general hazards of field sampling (e.g., waterborne pathogens) and how to minimize risks of exposure.
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12.0 References

Bergeron, C.M., J.F. Husak, J.M. Unrine, C.S. Romanek, and W.A. Hopkins. 2007. Influence of feeding ecology on blood mercury concentrations in four species of turtles, Environmental Toxicology and Chemistry. 26: 1733-1741.

Appendix B

Ecological Study Data Matrix

Appendix B
Ecological Study Data Matrix
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

RIVER REACH	DATA TYPE	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	RELATIVE RIVER MILE	MAIN PARAMETERS	PROJECT NAME / DESCRIPTION	SOURCE(S)
Habitat and Geophysical Characterizations																		
RRM 0 - 1	Discharge Characterization	2009						x	x	x			x		0.1	Q (cfs)	Phase II Ecostudy: Physical Loading Study	URS
										x					0.1	Velocity (f/s)	Pilot Bank Stabilization: Pre-Construction Study	URS
		2010						x							0.1	Velocity (f/s)	Pilot Bank Stabilization: Post-Construction Study	URS
	Habitat Characterization	2005									x				0.6		Phase I Ecostudy: Phase I Site Characterization	URS
		2006									x				0.6		Phase I Ecostudy: Phase I Site Characterization	URS
		2009			x			x							0.1		Phase II Ecostudy: Phase II Site Characterization	URS
										x					0.1		Pilot Bank Stabilization: Pre-Construction Study	URS
		2010			x		x		x			x			0.1		Pilot Bank Stabilization: Post-Construction Study	URS
		2011				x									0.1		Pilot Bank Stabilization: Post-Construction Study	URS
	Morphology Assessment	2005													NS		Comprehensive Geomorphological Study: Geomorphic Characterization and Annual Sediment Budget for Silt and Clay	UD
		2006													NS		Comprehensive Geomorphological Study: Geomorphic Characterization and Annual Sediment Budget for Silt and Clay	UD
		2007											x		0.1		Comprehensive Geomorphological Study: LiDAR Study for Bank Erosion and Mercury Content	UD
									x						NS		Comprehensive Geomorphological Study: Reconnaissance Investigation of Floodplain Deposits Formed Through Channel Migration	UD
		2009								x					0.1		Pilot Bank Stabilization: Pre-Construction Study	URS
		2010			x		x		x			x			0.1		Pilot Bank Stabilization: Post-Construction Study	URS
		2011					x								0.1		Pilot Bank Stabilization: Post-Construction Study	URS
									x						NS		Substrate and Aquatic Macrophyte Mapping	URS
Physical and Chemical Monitoring / Assessments																		
RRM 0 - 1	Soil	2003										x			0.1 - 0.4	THg	Greenway Sampling	UE
		2006												x	0.5	THg, MeHg	Survey of the Mercury Content of Earthworms	JMU
		2007		x											0.0 - 0.4	THg, MeHg, LOI, Other Analytes	Turner Plant Reach Sediments	UE
													x		0.1 - 0.2	THg, MeHg	University of Delaware Bank Survey Soils	UD
		2008								x					0 - 0.2, 0.9 - 1.0	THg, MeHg, VOCs	Bank Stabilization Sediment	UD
				x	x	x									0.0 - 1.0	THg	Phase II Ecostudy: Floodplain Soil Investigation	URS
		2009			x										0.1	THg	Phase II Ecostudy: River Bank Soil for Phase II Site Characterization	URS
		2010			x										0.1	THg	Pilot Bank Stabilization: River Bank Soil for Post-Construction Study	URS
	Sediment	2003									x				0.3 - 0.4	THg, Metals	VADEQ Historical Floodplain Monitoring	VADEQ
		2004					x								0.2 - 0.3	THg, Other Analytes	Sediment Sampling	UE
		2005									x				0.2 - 0.3	THg, MeHg, LOI, Other Analytes	Transect Program	UE
					x										0.3 - 0.6	THg, MeHg, LOI, Other Analytes	Water Sampling	UE
		2006			x	x	x	x	x	x	x	x	x	x	0.6	THg, MeHg	Phase I Ecostudy: Interstitial Sediment	URS
												x			0.0, 0.3	THg, MeHg	Mercury Source Tracing and Mechanistic Source Studies	RTG, UE
		2007	x	x											0.6	THg, MeHg	Phase I Ecostudy: Interstitial Sediment	URS
										x					0.1 - 0.4	THg, Other Metals	VADEQ Sediment Sampling	VADEQ
		2009			x										0.1	THg	Phase II Ecostudy: Near-Bank Sediment for Phase II Site Characterization	URS
		2010				x									0.1	THg, MeHg, PCBs, PAHs, Herbicides, Pesticides, Other Analytes	Phase II Ecostudy: Interstitial Sediment for Sediment Quality Triad	URS
					x										0.1	THg	Pilot Bank Stabilization: Near-Bank Sediment for Post-Construction Study	URS
		2011				x									0.1	THg	Pilot Bank Stabilization: Near-Bank Sediment for Post-Construction Study	URS
	Ground Water	2006	x						x			x	x	x	0.1	THg and Water Elev.	Mercury Source Tracing and Mechanistic Source Studies: Basic Park GW	RTG, UE
		2007		x		x	x	x	x	x	x	x			0.1	THg and Water Elev.	Mercury Source Tracing and Mechanistic Source Studies: Basic Park GW	RTG, UE
		2009						x	x	x			x		0.1	THg, MeHg	Phase II Ecostudy: Physical Loading Study	URS
								x							0.1	THg	Pilot Bank Stabilization: Physical Loading Pre-Construction Study	URS
					x										0.0 - 1.0	Spatial Analysis	River Corridor Infrared Thermal Imaging	SITS
		2010						x							0.1	THg, MeHg	Pilot Bank Stabilization: Physical Loading Post-Construction Study	URS
	Pore Water	2006										x			0.0, 0.3	THg, MeHg	Mercury Source Tracing and Mechanistic Source Studies	RTG, UE
		2007	x	x	x	x	x	x	x						0.1	THg	Mercury Source Tracing and Mechanistic Source Studies: Long-Profile Pore Water	RTG, UE
				x											0.0 - 0.4	THg	Turner Plant Reach Pore Water and Surface Water	UE
									x						0.2 - 0.3	MeHg	Turner Spin Pore Waters	UE
		2009						x	x	x			x		0.1	THg, MeHg	Phase II Ecostudy: Physical Loading Study	URS
		2010						x							0.1	THg, MeHg	Pilot Bank Stabilization: Physical Loading Post-Construction Study	URS
		2011						x							0.1	THg, MeHg	Pilot Bank Stabilization: Physical Loading Post-Construction Study	URS
	Surface Water	2001											x		0.2 - 0.3	THg, Metals, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
		2002	x		x			x		x		x		x	0.2 - 0.3	THg, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
									x						0.9 - 1	THg, TSS, Other Analytes	VADEQ Historical Intensive 1	VADEQ
		2003								x					0.0 - 0.3	THg, TSS, Other Analytes	VADEQ Historical Intensive 2	VADEQ
				x		x		x		x		x			0.2 - 0.3	THg, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
		2004										x			0.1 - 0.2	THg	Cutback Survey Sampling	UE
											x				0.1 - 0.3	THg, MeHg, TSS	Flood Sampling	UE
										x					0.2 - 0.3	THg, MeHg, TSS	Hg Speciation Study	UE
			x	x		x		x		x		x			0.2 - 0.3	THg, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
		2005	x	x											0.1 - 0.4, 0.5 - 0.6, 0.7 - 0.8, 0.9 - 1.0	THg, MeHg, TSS	Surface Water/Sediments	UE
											x				0.2 - 0.3	THg, MeHg, TSS	Transect Program	UE
					x		x		x		x		x		0.2 - 0.3	Nutrients, Hg, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
			x												0.2 - 0.3	TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
							x								0.2 - 0.3, 0.4 - 0.5, 0.9 - 1	THg, MeHg, TSS	Water Sampling	UE
					x										0.4 - 0.5	THg, MeHg, Metals, TSS, Other Analytes	Water Sampling	UE
		2006										x			0.0	THg, MeHg	Mercury Source Tracing and Mechanistic Source Studies	RTG, UE
								x		x			x		0.4	THg, MeHg	Phase I Ecostudy: Storm Event Loading	URS
					x	x	x	x	x	x	x	x	x	x	0.6	THg, MeHg	Phase I Ecostudy	URS
											x	x			0.0 - 0.4	THg	Turner Plant Reach Pore Water and Surface Water	UE
			x		x		x		x		x		x		0.2 - 0.3	Nutrients, Bacteria, Hg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
		2007										x			0.1	THg, MeHg	Phase II Ecostudy: Targeted Tributary Loading Study	URS
					x										0.4	THg, MeHg	Phase I Ecostudy: Storm Event Loading	URS
				x											0.1 - 0.2	THg	Turner Plant Reach Pore Water and Surface Water	UE
			x		x		x		x		x		x		0.2 - 0.3	Nutrients, Bacteria, Hg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
			x	x		x	x			x		x		x	0.4, 0.6	THg, MeHg	Phase I Ecostudy	URS
		2008					x								0.1	THg, MeHg	Phase II Ecostudy: Targeted Tributary Loading Study	URS
				x				x		x		x			0.4	THg, MeHg	Phase II Ecostudy	URS
			x		x		x		x		x		x		0.2 - 0.3	Nutrients, Bacteria, Hg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
		2009								x					0.1	THg, MeHg	Phase II Ecostudy: Benthic Flux Study (Loading)	URS
								x	x	x			x		0.1	THg, MeHg	Phase II Ecostudy: Physical Loading Study	URS
				x			x			x					0.4	THg, MeHg	Phase II Ecostudy	URS
			x												0.2 - 0.3	Nutrients, Bacteria, Hg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
		2010						x							0.1	THg, MeHg	Pilot Bank Stabilization: Physical Loading Post-Construction Study	URS
			x	x	x		x	x	x	x	x	x	x	x	0.4	THg, MeHg, Nutrients, Other Analytes	Phase II Ecostudy	URS
					x		x		x		x		x		0.3 - 0.4	Nitrate, Nitrite, Nitrogen	VADEQ Surface Water	VADEQ
		2011		x				x		x		x			0.1	THg, MeHg, Other Analytes	Phase II Ecostudy	URS
			x		x		x		x		x		x		0.1	THg, MeHg, Other Analytes	VADEQ Surface Water	VADEQ
Biological Monitoring / Assessments																		
Aquatic Vegetation / Algae																		
RRM 0 - 1	Tissue	2005							x						0.3, 1	THg, MeHg	Periphyton Assessment	VIMS
		2006								x					0.6	THg, MeHg	Phase I Ecostudy: Macrophytes	URS
							x			x				x	0.6	THg, MeHg	Phase I Ecostudy: Periphyton	URS
		2007					x		x						0.6	THg, MeHg, δN15, δC13	Trophic Transfer Study	VIMS
				x											0.6	THg, MeHg	Phase I Ecostudy: Periphyton	URS
		2008						x		x					0.3	THg, MeHg, δN15, δC13	VIMS Sed and Periphyton Study 2008	VIMS
Aquatic Invertebrates																		
RRM 0 - 1	Population / Community	2006					x			x				x	0.6		Phase I Ecostudy	URS
		2007		x											0.6		Phase I Ecostudy	URS
		2010				x									0.1		Phase II Ecostudy: Sediment Quality Triad	URS
		2011					x	x							0.1		Phase II Ecostudy: Benthic Colonization Study	URS
	Feeding	2010						x		x		x			0.1	δN15, δC13	Phase II Ecostudy: Basal Resource Utilization Study	URS
	Tissue	2002											x		0.1, 0.4, 0.6, 0.8, 1.0	THg	Clam Tissue Study	JMU, EMU
		2003											x		0.1	THg, MeHg	Clam Tissue Study	JMU, EMU
		2006					x			x				x	0.6	THg, MeHg	Phase I Ecostudy: Asian Clams and Aquatic Insects	URS
					x	x	x	x	x	x	x	x	x	x	0.6	THg, MeHg, PAHs, Other Analytes	Phase I Ecostudy: Crayfish	URS
		2007					x								0.6	THg, MeHg, δN15, δC13	Trophic Transfer Study	VIMS
				x											0.6	THg, MeHg	Phase I Ecostudy: Asian Clams and Aquatic Insects	URS
			x	x											0.6	THg, MeHg, PAHs, Other Analytes	Phase I Ecostudy: Crayfish	URS
		2009					x	x							0.1	THg, MeHg	Phase II Ecostudy: Asian Clam Uptake Study	URS
		2010						x							0.1	THg, MeHg	Pilot Bank Stabilization: Asian Clam Uptake Study for Post-Construction Study	URS
		2011					x	x							0.1	THg, MeHg	Pilot Bank Study: Clam Tissue	URS
	Toxicity	2010								x					0.1		Phase II Ecostudy: Field Microcosm Study	URS
							x								0.1		Phase II Ecostudy: Laboratory Sediment Bioassays for Sediment Quality Triad	URS
Fish																		
RRM 0 - 1	Population / Community	2006					x			x					0.6		Phase I Ecostudy	URS
		2010					x				x				0.1		Phase II Ecostudy	URS
	Stomach Contents	2010					x				x	x			0.1		Phase II Ecostudy: Bass, Sunfish, and Forage Fish	URS
	Tissue	2001				x									0.0	THg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
		2002				x									0.0	THg, MeHg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
		2005				x									0.0	THg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
		2006					x			x					0.6	THg, MeHg	Phase I Ecostudy: Forage Fish	URS
		2007				x									0.0	THg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
							x								0.6	THg, MeHg, δN15, δC13	Trophic Transfer Study	VIMS
		2009					x				x				0.1	THg, MeHg	Phase II Ecostudy: Bass	URS
		2010					x				x				0.1	THg, MeHg	Phase II Ecostudy: Bass	URS
							x				x	x			0.1	THg, MeHg	Phase II Ecostudy: Forage Fish	URS
							x				x				0.1	THg, MeHg	Phase II Ecostudy: Sunfish	URS
		2011					x								0.1	THg, MeHg	Phase II Ecostudy: Bass	URS
Herpetofauna																		
RRM 0 - 1	Tissue	2007					x								1.0	THg, MeHg	Mercury Bioaccumulation in Amphibians: Nondestructive Indices of Exposure, Maternal Transfer, and Reproductive Effects	VT
Terrestrial Invertebrates																		
RRM 0 - 1	Tissue	2006												x	0.5	THg, MeHg	Survey of the Mercury Content of Earthworms	JMU

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Ecological Study Data Matrix
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Former DuPont Waynesboro Site, Area of Concern 4

RIVER REACH	DATA TYPE	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	RELATIVE RIVER MILE	MAIN PARAMETERS	PROJECT NAME / DESCRIPTION	SOURCE(S)
Habitat and Geophysical Characterizations																		
RRM 1 - 6	Discharge Characterization	2000	x	x	x	x	x	x	x	x	x	x	x	x	2.3	Q (cfs)	Daily River Discharge (Near Dooms)	USGS
		2001	x	x	x	x	x	x	x	x	x	x	x	x	2.3	Q (cfs)	Daily River Discharge (Near Dooms)	USGS
		2002	x	x	x	x	x	x	x	x	x	x	x	x	2.3	Q (cfs)	Daily River Discharge (Near Dooms)	USGS
		2003	x	x	x	x	x	x	x	x	x	x	x	x	2.3	Q (cfs)	Daily River Discharge (Near Dooms)	USGS
		2004	x	x	x	x	x	x	x	x	x	x	x	x	2.3	Q (cfs)	Daily River Discharge (Near Dooms)	USGS
		2005	x	x	x	x	x	x	x	x	x	x	x	x	2.3	Q (cfs)	Daily River Discharge (Near Dooms)	USGS
		2006	x	x	x	x	x	x	x	x	x	x	x	x	2.3	Q (cfs)	Daily River Discharge (Near Dooms)	USGS
		2007	x	x	x	x	x	x	x	x	x	x	x	x	2.3	Q (cfs)	Daily River Discharge (Near Dooms)	USGS
		2008	x	x	x	x	x	x	x	x	x	x	x	x	2.3	Q (cfs)	Daily River Discharge (Near Dooms)	USGS
		2009	x	x	x	x	x	x	x	x	x	x	x	x	2.3	Q (cfs)	Daily River Discharge (Near Dooms)	USGS
								x	x	x			x		3.5	Q (cfs)	Phase II Ecostudy: Physical Loading Study	URS
		2010	x	x	x	x	x	x	x	x	x	x	x	x	2.3	Q (cfs)	Daily River Discharge (Near Dooms)	USGS
	Precipitation Monitoring	2000										x	x	x	1.4		Daily Precipitation Volume (Waynesboro Sewage Treatment Plant)	NOAA
		2001	x		x	x	x	x	x	x	x	x	x	x	1.4		Daily Precipitation Volume (Waynesboro Sewage Treatment Plant)	NOAA
		2002	x	x	x	x	x		x	x	x	x	x		1.4		Daily Precipitation Volume (Waynesboro Sewage Treatment Plant)	NOAA
		2003	x			x		x	x	x	x	x	x	x	1.4		Daily Precipitation Volume (Waynesboro Sewage Treatment Plant)	NOAA
		2004	x		x	x		x	x	x			x		1.4		Daily Precipitation Volume (Waynesboro Sewage Treatment Plant)	NOAA
		2005	x		x			x	x	x	x	x	x		1.4		Daily Precipitation Volume (Waynesboro Sewage Treatment Plant)	NOAA
		2006	x	x	x	x	x	x			x	x	x	x	1.4		Daily Precipitation Volume (Waynesboro Sewage Treatment Plant)	NOAA
		2007	x	x	x	x	x	x	x	x					1.4		Daily Precipitation Volume (Waynesboro Sewage Treatment Plant)	NOAA
	Habitat Characterization	2005									x				2.0, 3.0, 4.2, 5.2		Phase I Ecostudy: Phase I Site Characterization	URS
		2006									x				5.2		Phase I Ecostudy: Phase I Site Characterization	URS
		2009			x			x							3.0, 3.5, 3.7		Phase II Ecostudy: Phase II Site Characterization	URS
	Morphology Assessment	2005													NS		Comprehensive Geomorphological Study: Geomorphic Characterization and Annual Sediment Budget for Silt and Clay	UD
		2006	x				x								1.8, 3.0		Comprehensive Geomorphological Study: LiDAR Study for Bank Erosion and Mercury Content	UD
															NS		Comprehensive Geomorphological Study: Geomorphic Characterization and Annual Sediment Budget for Silt and Clay	UD
		2007							x						NS		Comprehensive Geomorphological Study: Reconnaissance Investigation of Floodplain Deposits Formed Through Channel Migration	UD
					x										3.0, 5.4		Comprehensive Geomorphological Study: LiDAR Study for Bank Erosion and Mercury Content	UD
		2011							x						NS		Substrate and Aquatic Macrophyte Mapping	URS
Physical and Chemical Monitoring / Assessments																		
RRM 1 - 6	Soil	2004						x							1.1 - 1.2, 1.6 - 1.9	THg	Floodplain Hg Sampling	UE
												x			2.5 - 2.6	THg	Cutback Survey Sampling	UE
		2005									x				2.1 - 2.2, 2.5 - 2.6	THg, MeHg	Core Sampling	UE
			x												2.5 - 2.6	THg	Floodplain Soil Sampling	UE
			x												2.5 - 2.6	THg	Surface Water/Sediments	UE
		2006										x	x	x	1.0, 2.1, 2.4, 5.0	THg, MeHg	Survey of the Mercury Content of Earthworms	JMU
													x		1.7 - 1.8, 5.3 - 5.4	THg, MeHg, LOI, Other Analytes	Turner Crimora Sediments	UE
								x			x				2.1 - 2.2, 3.1 - 3.2, 5.3 - 5.4	THg, MeHg, Mn, Fe, LOI	Flux Chamber Study (Loading)	DuPont
							x								2.1 - 2.3	THg, MeHg, LOI, Other Analytes	Bank Flux Sediment / Soils	UE
											x				2.1 - 2.3	THg, MeHg, LOI, Other Analytes	Turner Basic Park Sediment	UE
												x			2.9 - 3, 3.4 - 4.9, 5.4 - 5.5	THg	USEPA Shifflet Farm Sampling	USEPA
		2007													1.6, 2.2, 3.5, 4.8, 5.4	THg, MeHg	Comprehensive Geomorphological Study: LiDAR Study for Bank Erosion and Mercury Content	UD
			x	x											2.1 - 2.3	THg, MeHg, LOI, Other Analytes	Turner Basic Park Sediment	UE
			x	x											2.1 - 2.3	THg, MeHg, LOI, Other Analytes	Turner Basic Park Sediment Pore Water	UE
												x			2.9 - 3.0,	THg, MeHg, VOCs	Fine Grained Sediment Study	UD
		2008		x	x	x									1.1 - 6.0	THg	Phase II Ecostudy: Floodplain Soil Investigation	URS
				x	x	x		x							1.6 - 1.8, 2.1 - 2.2, 2.9 - 3.1, 3.3 - 3.4, 3.5 - 3.7, 3.9 – 4.0, 4.1 - 4.2, 4.7 - 4.9, 5.1 - 5.2, 5.3 - 5.4, 5.8 - 5.9	THg, MeHg	Comprehensive Geomorphological Study: Bank Erosion and Mercury Content	UD
															1.6, 2.2, 3.5, 4.8, 5.4	THg, MeHg	Comprehensive Geomorphological Study: LiDAR Study for Bank Erosion and Mercury Content	UD
												x			2.8 - 2.9, 3.1 - 3.2, 4.3 - 4.4, 4.6 - 4.7, 4.8 - 4.9	THg, MeHg, LOI	Flux Chamber Study (Loading)	DuPont
		2009						x							2.8 - 3.1	THg, MeHg	River Mile 3.0 Sediment Study	UD
					x										3.0, 3.5, 3.7	THg	Phase II Ecostudy: River Bank Soil for Phase II Site Characterization	URS
		2011					x								0.0 - 0.3, 0.5 - 0.6	THg	Floodplain Soils Investigation	URS
	Sediment	2002										x			4.8 - 4.9, 5.6 - 5.7	THg, MeHg, LOI, Other Analytes	Sediment Core Study - LLI	URS
		2004						x							1.7 - 1.8	THg, % Moisture	Floodplain Hg Sampling	UE
		2005			x		x								1.5 - 1.6, 1.7 - 1.8, 2.5 - 2.6	THg, MeHg, LOI, Other Analytes	Water Sampling	UE
			x												1.7 - 1.8	THg, % Moisture	Oxbow Core Sampling	UE
									x	x					1.7 - 1.8, 2.1 - 2.2, 2.4 - 2.5, 3.8 - 3.9, 4.2 - 4.3, 4.6 - 4.7	THg, LOI, Other Analytes	University of Delaware Program	UD
											x				1.7 - 1.8, 2.4 - 2.6	THg, MeHg, LOI, Other Analytes	Core Sampling	UE
											x				1.7 - 1.9, 5.0 - 5.1	THg, MeHg, LOI, Other Analytes	Transect Program	UE
		2006			x	x	x	x	x	x	x	x	x	x	2.0, 3.0, 4.2, 5.2	THg, MeHg	Phase I Ecostudy: Interstitial Sediment	URS
		2007							x	x	x				1.0 - 1.2, 1.7 - 1.8, 2.3 - 2.4, 2.6 - 2.7, 3.5 - 3.6, 4.7 - 4.9, 5.0 - 5.1, 5.2 - 5.3, 5.5 - 5.6	THg, Other Metals	VADEQ Sediment Sampling	VADEQ
			x	x						x		x		x	2.0, 3.0, 4.2, 5.2	THg, MeHg	Phase I Ecostudy: Interstitial Sediment	URS
												x			3.0, 3.8, 3.9, 4.2, 4.6, 4.8, 5.4	THg, MeHg	Phase I Ecostudy: Channel Margin Deposit Cores for Phase I Site Characterization	URS
		2008		x		x		x		x		x			1.6, 3.0, 4.6, 5.2	THg, MeHg	Phase II Ecostudy: Interstitial Sediment	URS
		2009			x										3.0, 3.5, 3.7	THg	Phase II Ecostudy: Near-Bank Sediment for Phase II Site Characterization	URS
		2010				x									3.5	THg, MeHg, PCBs, PAHs, Herbicides, Pesticides, Other Analytes	Phase II Ecostudy: Interstitial Sediment for Sediment Quality Triad	URS
	Ground Water	2006										x			2.1 - 2.3	THg	Turner Pore / Well Water I & II	UE
												x			2.1 - 2.3	THg, MeHg, Other Analytes	Turner Wells / Turner Wells and Extract	UE
												x			3.7 - 4.3	THg, MeHg, TSS, TOC, VOCs, Other Analytes	Shifflet Farm GW and Pond Sampling: Direct Push Sampling	USEPA
		2007				x									2.1 - 2.3	THg, MeHg, Other Analytes	Turner Wells / Turner Wells and Extract	UE
				x											2.1 - 2.3	THg	Turner Wells and Ultra	UE
		2009			x										1.1 - 6.0	Spatial Analysis	River Corridor Infrared Thermal Imaging	SITS
	Pore Water	2006										x			2.1 - 2.2	THg, MeHg, Other Analytes	Turner Wells / Turner Wells and Extract	UE
							x		x						2.1 - 2.3	THg	Bank Flux Pore Water and Surface Water	UE
												x			2.1 - 2.3	THg	Turner Pore / Well Water I	UE
		2007						x							2.1 - 2.2	THg, MeHg, Other Analytes	Basic Park Surface Water Flux	UE
			x	x											2.1 - 2.2	THg, MeHg	Turner Basic Park Longitudinal Profile Pore Water and Surface Water	UE
			x	x											2.1 - 2.2	THg, MeHg	Turner Basic Park Sediment Pore Water	UE
						x									2.1 - 2.2	Fe	Turner Centrifuge Project	UE
									x						2.1 - 2.2, 5.3 - 5.4	MeHg	Turner Spin Pore Waters	UE
		2008						x							2.1 - 2.2	Fe, Mn	Turner Hyporheic Samples	UE
		2009						x	x	x			x		3.5	THg, MeHg	Phase II Ecostudy: Physical Loading Study	URS
	Surface Water	2001											x		1.3 - 1.4, 2.3 - 2.4, 5 - 5.1	THg, Metals, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
		2002							x						1.0 - 2.6	THg, TSS, Other Analytes	VADEQ Historical Intensive 1	VADEQ
										x					1.2 - 1.3, 1.4 - 1.5, 2.4 - 2.5	THg, TSS	VADEQ Historical Intensive 2	VADEQ
										x					1.3 - 1.4	Nutrients, TSS, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
			x		x			x		x		x		x	1.3 - 1.4, 2.3 - 2.4, 5 - 5.1	THg, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
		2003		x		x		x		x		x			1.3 - 1.4, 2.3 - 2.4, 5 - 5.1	THg, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
										x					2.3 - 2.6	THg, TSS, Other Analytes	VADEQ Historical Intensive 2	VADEQ
									x		x			x	5 - 5.1	Nutrients, TSS, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
		2004									x				1.2 - 1.3, 1.7 - 1.8, 1.8 - 1.9, 5 - 5.1	THg, MeHg, TSS	Flood Sampling	UE
										x					1.2 - 1.3, 1.7 - 1.8, 1.8 - 1.9, 5 - 5.1	THg, MeHg, TSS	Hg Speciation Study	UE
			x	x		x		x		x		x			1.3 - 1.4, 2.3 - 2.4, 5 - 5.1	THg, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
							x								1.7 - 1.8	THg, MeHg	Oxbow Water Sampling	UE
				x		x		x	x		x		x		5 - 5.1	Nutrients, TSS, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
		2005	x	x											1.1 - 1.2, 1.3 - 2.0, 2.1 - 2.2, 2.4 - 2.5, 2.6 - 3.2, 3.4 - 3.5, 3.6 - 3.7, 3.8 - 3.9, 4.1 - 4.2, 4.4 - 4.6, 4.8 - 4.9, 5.0 - 5.1	THg, MeHg, TSS	Surface Water/Sediments	UE
			x												1.3 - 1.4, 5.0 - 5.1	TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
											x				1.3 - 1.5, 1.7 - 1.9, 2.4 - 2.6, 3.2 - 3.3, 5.0 - 5.1	THg, MeHg, TSS	Transect Program	UE
					x										1.3 - 1.6, 1.7 - 1.8, 5.0 - 5.1, 5.2 - 5.5, 5.6 - 5.7, 5.8 - 5.9	THg, MeHg, Metals, TSS, Other Analytes	Water Sampling	UE
							x								1.5 - 1.6, 1.8 - 2.0, 2.2 - 2.7, 3.4 - 3.5, 4.4 - 4.5, 4.7 - 4.9, 5.0 - 5.1, 5.2 - 5.3	THg, MeHg, TSS	Water Sampling	UE
					x		x		x		x		x		2.3 - 2.4, 5.0 - 5.1	Nutrients, Hg, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
					x		x								5 - 5.1	Nutrients, E. Coli, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring	VADEQ
			x												5 - 5.1	Nutrients	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
			x												5 - 5.1	TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
											x				5 - 5.1	THg, TSS	VADEQ Storm Sampling	VADEQ
											x				5.2 - 5.3	THg, MeHg, TSS	Concurrent Sampling	RTG
		2006										x			3.8	THg, MeHg, TSS, TOC, VOCs, Other Analytes	Shifflet Farm GW and Pond Sampling: Direct Push Sampling	USEPA
					x	x	x	x	x	x	x	x	x	x	2.0, 3.0, 4.2, 5.2	THg, MeHg	Phase I Ecostudy	URS
												x			2.1 - 2.2	THg, MeHg, Other Analytes	Turner Wells / Turner Wells and Extract	UE
								x			x				2.1 - 2.2, 3.1 - 3.2, 5.3 - 5.4	THg, MeHg, Mn, Fe, LOI	Flux Chamber Study (Loading)	DuPont
							x		x						2.1 - 2.3	THg	Bank Flux Pore Water and Surface Water	UE
											x				2.1 - 2.3	THg, MeHg, Other Analytes	Basic Park Surface Water Flux	UE
												x			2.1 - 2.3	THg	Turner Pore / Well Water I & II	UE
			x		x		x		x		x		x		2.3 - 2.4, 5.0 - 5.1	Nutrients, Bacteria, Hg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
							x		x				x		2.3, 5.1	THg, MeHg	Phase I Ecostudy: Storm Event Loading	URS
		2007										x			1.5, 2.5, 4.7, 5.6	THg, MeHg	Phase II Ecostudy: Targeted Tributary Loading Study	URS
			x	x		x	x								2.0, 3.0, 4.2, 5.2	THg, MeHg	Phase I Ecostudy	URS
			x					x							2.1 - 2.2	THg, MeHg, Other Analytes	Basic Park Surface Water Flux	UE
			x	x		x									2.1 - 2.2	THg, MeHg	Turner Basic Park Longitudinal Profile Pore Water and Surface Water	UE
						x									2.1 - 2.2	THg	Turner Uptake Study	UE
						x									2.1 - 2.2	THg, MeHg, Other Analytes	Turner Wells / Turner Wells and Extract	UE
			x	x				x	x						2.1 - 2.3	THg, MeHg	Basic Park Surface Water	UE
					x										2.3 - 2.4	Nutrients, Bacteria, Hg, Other Analytes	VADEQHIST Fishkill	VADEQ
			x		x		x		x		x		x		2.3 - 2.4, 5.0 - 5.1	Nutrients, Bacteria, Hg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
										x		x		x	2.3, 5.1	THg, MeHg	Phase I Ecostudy	URS
					x										2.3, 5.1	THg, MeHg	Phase I Ecostudy: Storm Event Loading	URS
			x	x	x	x	x	x	x	x	x		x	x	5.0 - 5.1	Nutrients, Bacteria	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
		2008					x								1.2, 5.2	THg, MeHg	Phase II Ecostudy: Benthic Flux Study (Loading)	URS
							x								1.5, 3.1, 4.7, 5.6	THg, MeHg	Phase II Ecostudy: Targeted Tributary Loading Study	URS
								x							2.3 - 2.4, 5.0 - 5.1	THg, MeHg, Mn, Fe	Flux Chamber Study (Loading)	DuPont
			x		x		x		x		x		x		2.3 - 2.4, 5.0 - 5.1	Nutrients, Bacteria, Hg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
				x				x		x		x			2.3, 5.1	THg, MeHg	Phase II Ecostudy	URS
											x				2.7, 3.0, 4.0, 4.6, 4.9	THg, MeHg	Phase II Ecostudy: Benthic Flux Study (Loading)	URS
							x								2.8, 4.0, 4.5, 4.6	THg, MeHg	Phase II Ecostudy: Benthic Flux Study (Loading)	URS
										x					3.0, 4.6	THg, MeHg	Phase II Ecostudy: Benthic Flux Study (Loading)	URS
											x				4.5 - 4.6	Fe, Mn	Turner Surface Waters	UE
		2009								x					3.5	THg, MeHg	Phase II Ecostudy: Benthic Flux Study (Loading)	URS
							x	x	x			x			3.5	THg, MeHg	Phase II Ecostudy: Physical Loading Study	URS
			x												1.3 - 1.4, 5.0 - 5.1	Nutrients, Bacteria	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
			x												2.3 - 2.4, 5.0 - 5.1	Nutrients, Bacteria, Hg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
				x			x			x					2.3, 5.1	THg, MeHg	Phase II Ecostudy	URS
		2010							x						1.3, 1.7, 2.0, 2.4	THg, MeHg, Nutrients	Sewage Treatment Plant Surface Water Studies	JMU
					x		x		x		x		x		2.3 - 2.4, 5.2 -5.3	Nitrate, Nitrite, Nitrogen	VADEQ Surface Water	VADEQ
			x	x	x		x	x	x	x	x	x	x	x	2.3, 5.1	THg, MeHg, Nutrients, Other Analytes	Phase II Ecostudy	URS
		2011		x				x		x		x			3.5	THg, MeHg, Other Analytes	Phase II Ecostudy	URS
			x		x		x		x		x		x		3.5	THg, MeHg, Other Analytes	VADEQ Surface Water	VADEQ
							x								4.2, 5.4	THg, MeHg	Floodplain Ponds Investigation	URS

Appendix B
Ecological Study Data Matrix
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

RIVER REACH	DATA TYPE	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	RELATIVE RIVER MILE	MAIN PARAMETERS	PROJECT NAME / DESCRIPTION	SOURCE(S)
Biological Monitoring / Assessments																		
Aquatic Vegetation / Algae																		
RRM 1 - 6	Tissue	2005							x						2.0, 5.0	THg, MeHg	Periphyton Assessment	VIMS
		2006					x	x							5.2	THg, MeHg, δN15, δC13	Trophic Transfer Study	VIMS
										x					2.0, 3.0, 4.2, 5.2	THg, MeHg	Phase I Ecostudy: Macrophytes	URS
							x			x				x	2.0, 3.0, 4.2, 5.2	THg, MeHg	Phase I Ecostudy: Periphyton	URS
		2007		x											2.0, 3.0, 4.2, 5.2	THg, MeHg	Phase I Ecostudy: Periphyton	URS
							x		x						2.0, 5.2	THg, MeHg, δN15, δC13	Trophic Transfer Study	VIMS
		2008						x		x					1.1, 2.1, 5.4	THg, MeHg, δN15, δC13	VIMS Sed and Periphyton Study 2008	VIMS
Aquatic Invertebrates																		
RRM 1 - 6	Population / Community	2006					x			x				x	5.2		Phase I Ecostudy	URS
		2007		x											5.2		Phase I Ecostudy	URS
		2010				x									3.5		Phase II Ecostudy: Sediment Quality Triad	URS
		2011					x	x							3.5		Phase II Ecostudy: Benthic Colonization Study	URS
	Feeding	2010						x		x		x			3.5	δN15, δC13	Phase II Ecostudy: Basal Resource Utilization Study	URS
	Tissue	2002											x		1.2, 1.4, 1.8, 2.0, 2.5, 2.8, 3.3, 3.7, 4.2, 4.7, 5.0	THg	Clam Tissue Study	JMU, EMU
		2003											x		1.2, 1.8, 2.5, 5	THg, MeHg	Clam Tissue Study	JMU, EMU
						x									1.2, 2.2	THg, MeHg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Spring Sampling)	VT
									x						1.2, 2.2	THg, MeHg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Summer Sampling)	VT
												x		x	1.2, 2.2	THg, MeHg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Fall Sampling)	VT
		2006					x	x							5.2	THg, MeHg, δN15, δC13	Trophic Transfer Study	VIMS
							x			x				x	2.0, 3.0, 4.2, 5.2	THg, MeHg	Phase I Ecostudy: Asian Clams and Aquatic Insects	URS
					x	x	x	x	x	x	x	x	x	x	2.0, 3.0, 4.2, 5.2	THg, MeHg, PAHs, Other Analytes	Phase I Ecostudy: Crayfish	URS
		2007		x											2.0, 3.0, 4.2, 5.2	THg, MeHg	Phase I Ecostudy: Asian Clams and Aquatic Insects	URS
			x	x											2.0, 3.0, 4.2, 5.2	THg, MeHg, PAHs, Other Analytes	Phase I Ecostudy: Crayfish	URS
							x								2.0, 5.2	THg, MeHg, δN15, δC13	Trophic Transfer Study	VIMS
		2009					x			x					3.5	THg, δN15, δC13	Phase II Ecostudy: Aquatic Insect Metamorphosis Study	URS
							x	x							3.5	THg, MeHg	Phase II Ecostudy: Asian Clam Uptake Study	URS
		2010						x		x					3.5	THg, MeHg	Phase II Ecostudy: Aquatic Invertebrates Uptake Study	URS
	Toxicity	2010					x								3.5		Phase II Ecostudy: Laboratory Sediment Bioassays for Sediment Quality Triad	URS
Fish																		
RRM 1 - 6	Population / Community	2006					x			x					5.2		Phase I Ecostudy	URS
		2010					x				x				3.5		Phase II Ecostudy	URS
	Stomach Contents	2010					x				x	x			3.5	THg, MeHg	Phase II Ecostudy: Bass, Sunfish, and Forage Fish	URS
	Tissue	2001				x									2.4	THg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
		2002				x									1.37, 2.4, 4.9	THg, MeHg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
		2003				x	x								1.2, 2.2	THg, MeHg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Spring Sampling)	VT
									x						1.2, 2.2	THg, MeHg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Summer Sampling)	VT
												x			1.2, 2.2	THg, MeHg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Fall Sampling)	VT
		2005				x	x								1.37, 2.4, 4.9	THg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
		2006					x			x					2.0, 3.0, 4.2, 5.2	THg, MeHg	Phase I Ecostudy: Forage Fish	URS
		2007				x									1.37, 2.4, 4.9	THg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
							x								2.0, 5.2	THg, MeHg, δN15, δC13	Trophic Transfer Study	VIMS
		2010					x				x	x			3.5	THg, MeHg	Phase II Ecostudy: Bass	URS
							x				x	x			3.5	THg, MeHg	Phase II Ecostudy: Forage Fish	URS
							x				x				3.5	THg, MeHg	Phase II Ecostudy: Sunfish	URS
		2011					x								3.5	THg, MeHg	Phase II Ecostudy: Bass	URS
							x								4.2, 5.4	THg, MeHg	Floodplain Ponds Investigation	URS
Herpetofauna																		
RRM 1 - 6	Tissue	2007			x	x	x								2.0, 5.0	THg, MeHg	Mercury Bioaccumulation in Amphibians: Nondestructive Indices of Exposure, Maternal Transfer, and Reproductive Effects	VT
Terrestrial Invertebrates																		
RRM 1 - 6	Tissue	2003				x									1.2	THg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Spring Sampling)	VT
									x						1.2, 2.2	THg, MeHg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Summer Sampling)	VT
												x			1.2, 2.2	THg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Fall Sampling)	VT
		2006										x	x	x	1.0, 2.1, 2.4, 5.0	THg, MeHg	Survey of the Mercury Content of Earthworms	JMU
		2008					x	x							3.0, 5.1	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Spiders	WMU
Birds																		
RRM 1 - 6	Blood	2005					x	x	x						NS	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Birds	WMU
	Blood, Feather, Egg	2007				x	x								2.0, 5.0	THg	Pilot Assessment of Methyl-Mercury Availability to Mallards	BRI
	Blood, Wing, Feather, Egg	2006				x	x	x	x	x					1.7, 2.0, 2.4, 2.7, 3.0, 4.1, 5.1	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Birds	WMU
		2007					x	x	x						1.7, 2.0, 2.4, 2.7, 3.0, 4.1, 5.1	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Birds	WMU
		2008					x	x	x						1.7, 2.0, 2.4, 2.7, 3.0, 4.1, 5.1	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Birds	WMU
	Tissue, Liver	2008									x		x	x	2.6, 4.3	THg, MeHg, Total Solids	VADEQ Waterfowl Samples	VADEQ
		2010										x			3.0, 5.1, 5.6	THg, MeHg, Total Solids	VADEQ Waterfowl Samples	VADEQ
Mammals																		
RRM 1 - 6	Blood, Skin, Fur	2007						x							2.0	THg, MeHg	Pilot Assessment of Methyl-Mercury Availability to Bats	BRI

Appendix B
Ecological Study Data Matrix
Long-Term Monitoring Baseline Report
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RIVER REACH	DATA TYPE	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	RELATIVE RIVER MILE	MAIN PARAMETERS	PROJECT NAME / DESCRIPTION	SOURCE(S)
Habitat and Geophysical Characterizations																		
RRM 6 - 16	Discharge Characterization	2009						x	x	x			x		8.5	Q (cfs)	Phase II Ecostudy: Physical Loading Study	URS
		2010						x							11.8	Q (cfs)	Phase II Ecostudy: Physical Loading Study	URS
	Habitat Characterization	2005									x				7.1		Phase I Ecostudy: Phase I Site Characterization	URS
		2006									x				11.8		Phase I Ecostudy: Phase I Site Characterization	URS
		2009						x							8.5		Phase II Ecostudy: Phase II Site Characterization	URS
					x										8.5, 8.8		Phase II Ecostudy: Phase II Site Characterization	URS
		2010				x									11.8		Phase II Ecostudy: Phase II Site Characterization	URS
	Morphology Assessment	2005													NS		Comprehensive Geomorphological Study: Geomorphic Characterization and Annual Sediment Budget for Silt and Clay	UD
		2006													NS		Comprehensive Geomorphological Study: Geomorphic Characterization and Annual Sediment Budget for Silt and Clay	UD
		2007							x						NS		Comprehensive Geomorphological Study: Reconnaissance Investigation of Floodplain Deposits Formed Through Channel Migration	UD
		2011							x						NS		Substrate and Aquatic Macrophyte Mapping	URS
Physical and Chemical Monitoring / Assessments																		
RRM 6 - 16	Soil	2003				x	x					x			11.0 - 11.2, 11.4 - 11.7	THg	Forestry Center Soil	DuPont, UE
													x		11.5 - 11.6	THg	Forestry Center Garden	DuPont
		2004						x							9.8 - 10.0, 11.6 - 11.7	THg	Floodplain Hg Sampling	UE
								x							9.9 - 10	THg	Floodplain Hg Sampling	UE
		2005			x										11.5 - 11.6	THg	Water Sampling	UE
											x				9.9 - 10	THg, MeHg	Core Sampling	UE
		2006						x			x				13.2 - 13.3	THg, MeHg, Mn, Fe, LOI	Flux Chamber Study (Loading)	DuPont
											x		x		7.6, 9.8, 11.7, 13.9	THg, MeHg	Survey of the Mercury Content of Earthworms	JMU
							x								9.7 - 9.8	THg, MeHg, LOI, Other Analytes	Crimora Hot Spot	UE
									x						9.7 - 9.9	THg, MeHg, LOI, Other Analytes	Turner Crimora Sediments	UE
		2007										x			7.4 - 7.5, 8.1 - 8.2, 8.5 - 8.6, 8.8 - 8.9, 9.9 - 10, 12.8 - 12.9	THg, MeHg, VOCs	Fine Grained Sediment Study	UD
															7.4, 7.7, 8.8, 9.8, 11.6, 13.1, 15.4	THg, MeHg	Comprehensive Geomorphological Study: LiDAR Study for Bank Erosion and Mercury Content	UD
		2008		x	x	x									6.1 - 16.0	THg	Phase II Ecostudy: Floodplain Soil Investigation	URS
				x	x		x	x							7.4 - 7.5, 7.7 - 7.8, 8.0 - 8.1, 8.2 - 8.3, 8.4 - 8.9, 9.2 - 9.3, 9.4 - 9.6, 9.7 - 9.8, 13.1 - 13.2 , 13.7 -13.8, 15.3 -15.4	THg, MeHg	Comprehensive Geomorphological Study: LiDAR Study for Bank Erosion and Mercury Content	UD
															7.4, 7.7, 8.8, 9.8, 11.6, 13.1, 15.4	THg, MeHg	Comprehensive Geomorphological Study: LiDAR Study for Bank Erosion and Mercury Content	UD
		2009			x										8.5	THg	Phase II Ecostudy: River Bank Soil for Phase II Site Characterization	URS
		2010						x	x						11.8	THg, MeHg	Mesocosm Study	JMU
						x									11.8	THg	Phase II Ecostudy: River Bank Soil for Phase II Site Characterization	URS
		2011					x								9.8 - 9.9	THg	Floodplain Soils Investigation	URS
	Sediment	2003									x				11.9 - 12	THg, Metals	VADEQ Historical Floodplain Monitoring	VADEQ
		2005								x					11.5 - 11.6	THg, LOI, Other Analytes	Comprehensive Geomorphological Study: Bank Erosion and Mercury Content	UD
											x				9.9 - 10.0, 11.6 - 11.7	THg, MeHg, LOI, Other Analytes	Transect Program	UE
		2006			x	x	x	x	x	x	x	x	x	x	7.1, 8.7, 11.8, 8.2, 8.4, 8.6, 9.9, 12.7, 12.8	THg, MeHg	Phase I Ecostudy: Interstitial Sediment	URS
		2007								x		x		x	6.2, 7.4, 8.6, 8.7, 9.9, 14.6	THg, MeHg	Phase I Ecostudy: Interstitial Sediment	URS
										x	x				6.5 - 6.6, 7.4 - 7.5, 8.5 - 8.6, 9.4 - 9.6, 10.4 - 10.5, 11.3 - 11.4, 12.3 - 12.4, 13.2 -13.3, 14.2 -14.3, 15.2 -15.3	THg, Other Metals	VADEQ Sediment Sampling	VADEQ
			x	x											7.1, 8.7, 11.8, 13.1, 14.6	THg, MeHg	Phase I Ecostudy: Interstitial Sediment	URS
												x			7.4, 8.2, 8.4, 8.6, 9.9, 12.7, 12.8	THg, MeHg	Phase I Ecostudy: Channel Margin Deposit Cores for Phase I Site Characterization	URS
		2008		x		x		x		x		x			6.2, 7.4, 8.6, 8.7, 9.9, 14.6	THg, MeHg	Phase II Ecostudy: Interstitial Sediment	URS
		2009			x										8.5, 8.8	THg	Phase II Ecostudy: Near-Bank Sediment for Phase II Site Characterization	URS
		2010				x									11.8	THg, MeHg, PCBs, PAHs, Herbicides, Pesticides, Other Analytes	Phase II Ecostudy: Interstitial Sediment for Sediment Quality Triad	URS
						x									11.8	THg	Phase II Ecostudy: Near-Bank Sediment for Phase II Site Characterization	URS
	Ground Water	2006					x								11.5 - 11.6	THg	Forest Station Ground Water	UE
		2007	x	x											11.5 - 11.7	THg	Turner Wells and Ultra	UE
		2009			x										6.1 - 16.0	Spatial Analysis	River Corridor Infrared Thermal Imaging	SITS
	Pore Water	2006							x						11.5 - 11.6	THg	Bank Flux Pore Water and Surface Water	UE
												x			11.5 - 11.6	THg	Turner Pore / Well Water I	UE
		2007							x						9.7 - 9.8, 11.5 - 11.6	MeHg	Turner Spin Pore Waters	UE
		2008						x							9.8 - 9.9	Fe, Mn	Turner Hyporheic Samples	UE
		2009						x	x	x			x		8.5	THg, MeHg	Phase II Ecostudy: Physical Loading Study	URS
		2010						x							11.8	THg, MeHg	Phase II Ecostudy: Physical Loading Study	URS
	Surface Water	2002								x					9.8 - 9.9	Nutrients, TSS, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
								x							9.8 - 9.9	THg, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
		2003							x		x			x	9.8 - 9.9	Nutrients, TSS, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
		2004								x					6 - 6.1, 7.4 - 7.5, 9.9 - 10, 11.6 - 11.7	THg, MeHg, TSS	Hg Speciation Study	UE
				x		x		x	x		x		x		9.8 - 9.9	Nutrients, TSS, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
												x			9.8 - 9.9	THg, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
											x				9.9 - 10, 11.6 - 11.7	THg, MeHg, TSS	Flood Sampling	UE
		2005			x										10.7 - 10.8	THg, Metals, Nutrients, Other Analytes	VADEQ Probability Monitoring	VADEQ
												x			11.5 - 11.6	THg	Forest Station Groundwater	UE
					x		x		x		x		x		11.6 - 11.7	Nutrients, Hg, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
			x												11.6 - 11.7	TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
					x										6 - 6.1, 6.2 - 6.3, 6.4 - 6.5, 6.5 - 6.6, 6.8 - 6.9, 7 - 7.1, 7.2 - 7.3, 7.4 - 7.5, 7.7 - 7.8, 7.8 - 7.9, 8.1 - 8.2, 8.5 - 8.6, 8.7 - 8.8, 8.9 - 9, 9.2 - 9.3, 9.5 - 9.6, 9.6 - 9.7, 9.7 - 9.8, 9.8 - 9.9	THg, MeHg, Metals, TSS, Other Analytes	Water Sampling	UE
							x								6 - 6.1, 6.8 - 6.9, 7.7 - 7.8, 8.7 - 8.8, 9.6 - 9.7, 10.1 - 10.2, 10.4 - 10.5, 10.8 - 10.9, 11.3 - 11.4, 11.6 - 11.7, 12 - 12.1, 12.4 - 12.5, 12.9 - 13, 13.2 - 13.3, 13.7 - 13.8, 14.1 - 14.2, 14.7 - 14.8, 15.3 - 15.4	THg, MeHg, TSS	Water Sampling	UE
											x				6 - 6.1, 9.7 - 9.8, 9.9 - 10, 11.6 - 11.7	THg, MeHg, TSS	Transect Program	UE
							x								9.8 - 9.9	Nutrients, E. Coli, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring	VADEQ
			x												9.8 - 9.9	Nutrients	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
				x											9.9 - 10, 11.6 - 11.7	THg, MeHg, TSS	Surface Water/Sediments	UE
		2006						x		x			x		9.9	THg, MeHg	Phase I Ecostudy: Storm Event Loading	URS
			x		x		x		x		x		x		11.6 - 11.7	Nutrients, Bacteria, THg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
								x			x				13.2 - 13.3	THg, MeHg, Mn, Fe, LOI	Flux Chamber Study (Loading)	DuPont
					x	x	x	x	x	x	x	x	x	x	7.1, 8.7, 11.8, 13.1, 14.6	THg, MeHg	Phase I Ecostudy	URS
							x								9.7 - 9.9	THg, MeHg	Crimora Hot Spot	UE
									x				x		9.7 - 9.9	THg, MeHg	Crimora Surface Waters	UE
		2007			x										9.9	THg, MeHg	Phase I Ecostudy: Storm Event Loading	URS
						x									11.5 - 11.6	THg	Turner Uptake Study	UE
			x		x		x		x		x		x		11.6 - 11.7	Nutrients, Bacteria, THg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
										x		x		x	6.2, 7.4, 8.6, 8.7, 9.9, 14.6	THg, MeHg	Phase I Ecostudy	URS
												x			6.7, 7.2, 8.8, 9.6	THg, MeHg	Phase II Ecostudy: Targeted Tributary Loading Study	URS
			x	x		x	x								7.1, 8.7, 11.8, 13.1, 14.6	THg, MeHg	Phase I Ecostudy	URS
			x	x											9.7 - 9.9	THg, MeHg	Crimora Surface Waters	UE
		2008	x		x		x		x		x		x		11.6 - 11.7	Nutrients, Bacteria, THg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
							x								6.2, 12.8	THg, MeHg	Phase II Ecostudy: Benthic Flux Study (Loading)	URS
				x				x		x		x			6.2, 7.4, 8.6, 8.7, 9.9, 14.6	THg, MeHg	Phase II Ecostudy	URS
										x					6.2, 7.4, 8.7, 12.8	THg, MeHg	Phase II Ecostudy: Benthic Flux Study (Loading)	URS
							x								6.7, 7.2, 8.6, 8.8, 9.9	THg, MeHg	Phase II Ecostudy: Targeted Tributary Loading Study	URS
			x	x	x	x	x	x	x	x	x	x	x	x	9.8 - 9.9	Nutrients, Bacteria	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
		2009								x					8.5	THg, MeHg	Phase II Ecostudy: Benthic Flux Study (Loading)	URS
								x	x	x			x		8.5	THg, MeHg	Phase II Ecostudy: Physical Loading Study	URS
			x												11.6 - 11.7	Nutrients, Bacteria, THg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
				x			x			x					6.2, 7.4, 8.6, 8.7, 9.9, 14.6	THg, MeHg	Phase II Ecostudy	URS
			x												9.8 - 9.9	Nutrients, Bacteria	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
		2010						x	x						11.8	THg, MeHg	Mesocosm Study	JMU
								x							11.8	THg, MeHg	Phase II Ecostudy: Physical Loading Study	URS
									x	x					11.8	THg, MeHg, Nutrients	Sewage Treatment Plant Surface Water Studies	JMU
			x	x	x		x	x	x	x	x	x	x	x	6.2, 7.4, 8.6, 8.7, 9.9, 14.6	THg, MeHg, Nutrients, Other Analytes	Phase II Ecostudy	URS
					x		x		x		x		x		9.8 - 9.9	Nitrate, Nitrite, Nitrogen	VADEQ Surface Water	VADEQ
		2011		x				x		x		x			11.8	THg, MeHg	Phase II Ecostudy	URS
			x		x		x		x		x		x		11.8	THg, MeHg	VADEQ Surface Water	VADEQ
							x								6.9, 7.7, 9.4, 9.6	THg, MeHg	Floodplain Ponds Investigation	URS

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Biological Monitoring / Assessments																		
Aquatic Vegetation / Algae																		
RRM 6 - 16	Tissue	2006								x					7.1	THg, MeHg	Phase I Ecostudy: Macrophytes	URS
							x			x				x	7.1	THg, MeHg	Phase I Ecostudy: Periphyton	URS
							x	x							11.8	THg, MeHg, δN15, δC13	Trophic Transfer Study	VIMS
		2007		x											7.1	THg, MeHg	Phase I Ecostudy: Periphyton	URS
							x		x						8.7, 11.8	THg, MeHg, δN15, δC13	Trophic Transfer Study	VIMS
		2008						x		x					11.6	THg, MeHg, δN15, δC13	VIMS Sed and Periphyton Study 2008	VIMS
		2010						x	x	x					11.8	THg, MeHg	Mesocosm Study	JMU
Aquatic Invertebrates																		
RRM 6 - 16	Population / Community	2006					x			x				x	11.8, 14.6		Phase I Ecostudy	URS
		2007		x											11.8, 14.6		Phase I Ecostudy	URS
		2010				x									11.8		Phase II Ecostudy: Sediment Quality Triad	URS
		2011					x	x							11.8		Phase II Ecostudy: Benthic Colonization Study	URS
	Feeding	2010						x		x		x			11.8	δN15, δC13	Phase II Ecostudy: Basal Resource Utilization Study	URS
	Tissue	2003											x		11.6	THg, MeHg	Clam Transplant Study	JMU, EMU
						x									11.6	THg, MeHg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Spring Sampling)	VT
									x						11.6	THg, MeHg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Summer Sampling)	VT
												x		x	11.6	THg, MeHg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Fall Sampling)	VT
		2004	x		x		x	x							11.6	THg, MeHg	Clam Transplant Study	JMU, EMU
		2006					x	x							11.8	THg, MeHg, δN15, δC13	Trophic Transfer Study	VIMS
							x			x				x	7.1, 8.7, 11.8, 13.1, 14.6	THg, MeHg	Phase I Ecostudy: Asian Clams and Aquatic Insects	URS
					x	x	x	x	x	x	x	x	x	x	7.1, 8.7, 11.8, 13.1, 14.6	THg, MeHg, PAHs, Other Analytes	Phase I Ecostudy: Crayfish	URS
		2007		x											7.1, 8.7, 11.8, 13.1, 14.6	THg, MeHg	Phase I Ecostudy: Asian Clams and Aquatic Insects	URS
			x	x											7.1, 8.7, 11.8, 13.1, 14.6	THg, MeHg, PAHs, Other Analytes	Phase I Ecostudy: Crayfish	URS
							x		x						8.7, 11.8	THg, MeHg, δN15, δC13	Trophic Transfer Study	VIMS
		2009					x			x					8.5, 11.8	THg, δN15, δC13	Phase II Ecostudy: Aquatic Insect Metamorphosis Study	URS
							x	x							8.5	THg, MeHg	Phase II Ecostudy: Asian Clam Uptake Study	URS
		2010						x		x					11.8	THg, MeHg	Phase II Ecostudy: Aquatic Invertebrates Uptake Study	URS
	Toxicity	2010								x					11.8		Phase II Ecostudy: Field Microcosm Study	URS
							x								11.8		Phase II Ecostudy: Laboratory Sediment Bioassays for Sediment Quality Triad	URS
Fish																		
RRM 6 - 16	Population / Community	2006					x			x					11.8, 14.6		Phase I Ecostudy	URS
		2010					x				x				11.8		Phase II Ecostudy	URS
	Stomach Contents	2010					x				x	x			11.8		Phase II Ecostudy: Bass, Sunfish, and Forage Fish	URS
	Tissue	2002				x									9.8	THg, MeHg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
		2003				x									11.6	THg, MeHg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Spring Sampling)	VT
									x						11.6	THg, MeHg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Summer Sampling)	VT
												x			11.6	THg, MeHg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Fall Sampling)	VT
		2005				x									9.9	THg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
		2006					x			x					7.1, 8.7, 11.8, 13.1, 14.6	THg, MeHg	Phase I Ecostudy: Forage Fish	URS
		2007				x									11.6	THg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
							x								8.7, 11.8	THg, MeHg, δN15, δC13	Trophic Transfer Study	VIMS
		2009					x				x				11.8	THg, MeHg	Phase II Ecostudy: Bass	URS
		2010					x				x	x			11.8	THg, MeHg	Phase II Ecostudy: Bass	URS
							x				x	x			11.8	THg, MeHg	Phase II Ecostudy: Forage Fish	URS
							x				x				11.8	THg, MeHg	Phase II Ecostudy: Sunfish	URS
		2011					x								6.9, 7.7, 9.4, 9.6	THg, MeHg	Floodplain Ponds Investigation	URS
							x								11.8	THg, MeHg	Phase II Ecostudy: Bass	URS
Herpetofauna																		
RRM 6 - 16	Tissue	2006					x	x	x						9.7, 12.8, 13.7	THg, MeHg, δN15, δC13	Turtle Study	VT
		2007			x	x	x								9.0, 11.0, 13.0, 14.0, 16.0	THg, MeHg	Mercury Bioaccumulation in Amphibians: Nondestructive Indices of Exposure, Maternal Transfer, and Reproductive Effects	VT
		2008			x	x									9.0	THg, MeHg	Mercury Bioaccumulation in Amphibians: Nondestructive Indices of Exposure, Maternal Transfer, and Reproductive Effects	VT
		2009				x									9.0, 14.0	THg, MeHg	Mercury Bioaccumulation in Amphibians: Nondestructive Indices of Exposure, Maternal Transfer, and Reproductive Effects	VT
Terrestrial Invertebrates																		
RRM 6 - 16	Tissue	2003				x									11.6	THg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Spring Sampling)	VT
									x						11.6	THg, MeHg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Summer Sampling)	VT
												x			11.6	THg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Fall Sampling)	VT
		2006									x		x		7.6, 9.8, 11.7, 13.9	THg, MeHg	Survey of the Mercury Content of Earthworms	JMU
		2007					x	x	x						8.6, 9.6, 11, 11.4, 12, 14.3, 14.8	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Spiders	WMU
		2008					x	x							9.6, 11.4, 14.5	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Spiders	WMU
Birds																		
RRM 6 - 16	Blood	2005					x	x	x						NS	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Birds	WMU
	Blood, Feather	2007				x	x								11.0	THg	Pilot Assessment of Methyl-Mercury Availability to Mallards	BRI
	Blood, Feather, Egg	2007				x	x								17.0	THg	Pilot Assessment of Methyl-Mercury Availability to Mallards	BRI
	Blood, Wing, Feather, Egg	2006				x	x	x	x	x					8.6, 9.0, 9.5, 9.6, 11.0, 11.4, 11.5, 11.8, 12.0, 12.1, 13.8, 14.3, 14.4, 14.5, 14.8, 15.5	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Birds	WMU
		2007		x		x	x	x	x	x	x			x	8.6, 9.0, 9.5, 9.6, 11.0, 11.4, 11.5, 11.8, 12.0, 12.1, 13.8, 14.3, 14.4, 14.5, 14.8, 15.5	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Birds	WMU
		2008				x	x	x	x						8.6, 9.0, 9.5, 9.6, 11.0, 11.4, 11.5, 11.8, 12.0, 12.1, 13.8, 14.3, 14.4, 14.5, 14.8, 15.5	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Birds	WMU
	Tissue, Liver	2008									x		x	x	7.0, 7.6, 8.5, 8.9, 11.0, 12.8 14.5, 15.4	THg, MeHg, Total Solids	VADEQ Waterfowl Samples	VADEQ
		2010										x			7.8, 8.3, 10.8	THg, MeHg, Total Solids	VADEQ Waterfowl Samples	VADEQ
Mammals																		
RRM 6 - 16	Blood, Muscle, Fur	2008													10.0, 12.0, 14.5, 16.0, 16.7	THg, MeHg	Pilot Assessment of Methyl-Mercury Availability to Muskrat and Shrews	BRI
	Blood, Skin, Fur	2007						x							12.0, 16.0	THg, MeHg	Pilot Assessment of Methyl-Mercury Availability to Bats	BRI
	Tissue, Liver	2010			x										11.8	THg, MeHg	VADEQ White Tailed Deer Samples	VADEQ

Appendix B
Ecological Study Data Matrix
Long-Term Monitoring Baseline Report
Former DuPont Waynesboro Site, Area of Concern 4

RIVER REACH	DATA TYPE	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	RELATIVE RIVER MILE	MAIN PARAMETERS	PROJECT NAME / DESCRIPTION	SOURCE(S)
Habitat and Geophysical Characterizations																		
RRM 16 - 24	Discharge Characterization	2000	x	x	x	x	x	x	x	x	x	x	x	x	16.5	Q (cfs)	Daily River Discharge (Harriston)	USGS
		2001	x	x	x	x	x	x	x	x	x	x	x	x	16.5	Q (cfs)	Daily River Discharge (Harriston)	USGS
		2002	x	x	x	x	x	x	x	x	x	x	x	x	16.5	Q (cfs)	Daily River Discharge (Harriston)	USGS
		2003	x	x	x	x	x	x	x	x	x	x	x	x	16.5	Q (cfs)	Daily River Discharge (Harriston)	USGS
		2004	x	x	x	x	x	x	x	x	x	x	x	x	16.5	Q (cfs)	Daily River Discharge (Harriston)	USGS
		2005	x	x	x	x	x	x	x	x	x	x	x	x	16.5	Q (cfs)	Daily River Discharge (Harriston)	USGS
		2006	x	x	x	x	x	x	x	x	x	x	x	x	16.5	Q (cfs)	Daily River Discharge (Harriston)	USGS
		2007	x	x	x	x	x	x	x	x	x	x	x	x	16.5	Q (cfs)	Daily River Discharge (Harriston)	USGS
		2008	x	x	x	x	x	x	x	x	x	x	x	x	16.5	Q (cfs)	Daily River Discharge (Harriston)	USGS
		2009	x	x	x	x	x	x	x	x	x	x	x	x	16.5	Q (cfs)	Daily River Discharge (Harriston)	USGS
								x	x	x			x		23.5	THg, MeHg	Phase II Ecostudy: Physical Loading Study	URS
		2010	x	x	x	x	x	x	x	x	x	x	x	x	16.5	Q (cfs)	Daily River Discharge (Harriston)	USGS
	Habitat Characterization	2005									x				19.0, 22.4		Phase I Ecostudy: Phase I Site Characterization	URS
		2006									x				19.0, 22.4		Phase I Ecostudy: Phase I Site Characterization	URS
		2009			x			x							23.5		Phase II Ecostudy: Phase II Site Characterization	URS
	Morphology Assessment	2005													NS		Comprehensive Geomorphological Study: Geomorphic Characterization and Annual Sediment Budget for Silt and Clay	UD
		2006													NS		Comprehensive Geomorphological Study: Geomorphic Characterization and Annual Sediment Budget for Silt and Clay	UD
Physical and Chemical Monitoring / Assessments																		
RRM 16 - 24	Soil	2004						x							19.7 - 19.8, 22.0 - 22.1, 23.9 - 24.0	THg	Floodplain Hg Sampling	UE
		2006										x			19.8, 24.0	THg, MeHg	Survey of the Mercury Content of Earthworms	JMU
		2007													19.8, 22.3, 22.6, 23.1	THg, MeHg	Comprehensive Geomorphological Study: LiDAR Study for Bank Erosion and Mercury Content	UD
		2008		x	x	x									16.1 - 24.0	THg	Phase II Ecostudy: Floodplain Soil Investigation	URS
															19.8, 22.3, 22.6, 23.1	THg, MeHg	Comprehensive Geomorphological Study: LiDAR Study for Bank Erosion and Mercury Content	UD
				x		x	x								22.3 - 22.4, 22.6 - 22.7, 23.1 - 23.2, 23.4 - 23.5	THg, MeHg	Comprehensive Geomorphological Study: Bank Erosion and Mercury Content	UD
		2009			x										23.5	THg	Phase II Ecostudy: River Bank Soil for Phase II Site Characterization	URS
		2011					x								23.1 - 23.4, 23.4 - 23.5	THg	Floodplain Soils Investigation	URS
	Sediment	2003									x				16.4 - 16.5	THg, Metals	VADEQ Historical Floodplain Monitoring	VADEQ
		2005									x				16.5 - 16.6, 22.0 - 22.1	THg, MeHg, LOI, Other Analytes	Transect Program	UE
		2006			x	x	x	x	x	x	x	x	x	x	19.0, 22.4	THg, MeHg	Phase I Ecostudy: Interstitial Sediment	URS
		2007								x					17.1 - 17.2, 18.2 - 18.3, 19.2 - 19.3, 20.2 - 20.3, 21.2 - 21.3, 22.1 - 22.2, 23.0 - 23.1, 23.8 - 23.9	THg, Other Metals	VADEQ Sediment Sampling	VADEQ
			x	x											19.0, 22.4	THg, MeHg	Phase I Ecostudy: Interstitial Sediment	URS
		2009			x										23.5	THg	Phase II Ecostudy: Near-Bank Sediment for Phase II Site Characterization	URS
		2010				x									23.5	THg, MeHg, PCBs, PAHs, Herbicides, Pesticides, Other Analytes	Phase II Ecostudy: Interstitial Sediment for Sediment Quality Triad	URS
	Ground Water	2009			x										16.1 - 24.0	Spatial Analysis	River Corridor Infrared Thermal Imaging	SITS
	Pore Water	2007							x						23.8 - 23.9	MeHg	Turner Spin Pore Waters	UE
		2009						x	x	x			x		23.5	THg, MeHg	Phase II Ecostudy: Physical Loading Study	URS
	Surface Water	2000		x	x	x	x	x	x	x	x	x	x	x	16.4 - 16.5	Nutrients, TSS, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
										x		x		x	16.4 - 16.5	THg, Metals, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
		2001		x		x		x		x		x			16.4 - 16.5	THg, Metals, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
			x	x	x	x	x	x	x		x			x	16.4 - 16.5, 22 - 22.1	Nutrients, TSS, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
		2002		x		x		x	x	x	x	x	x	x	16.4 - 16.5, 22 - 22.1	Nutrients, TSS, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
			x		x			x		x		x		x	16.4 - 16.5, 22 - 22.1	THg, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
		2003		x		x		x		x		x			16.4 - 16.5	THg, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
			x	x	x	x	x	x	x		x			x	16.4 - 16.5, 22 - 22.1	Nutrients, TSS, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
		2004	x		x		x		x		x		x		16.4 - 16.5	Nutrients, TSS, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
			x	x		x		x		x	x	x			16.4 - 16.5, 22 - 22.1	THg, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
										x					16.5 - 16.6, 19.8 - 19.9	THg, MeHg, TSS	Hg Speciation Study	UE
											x				16.5 - 16.6, 22 - 22.1	THg, MeHg, TSS	Flood Sampling	UE
		2005					x								16.0 - 16.1, 16.5 - 16.6, 17.2 - 17.3, 17.8 - 17.9, 18.4 - 18.5, 19.0 - 19.1, 19.7 - 19.8, 20.2 - 20.3, 20.8 - 20.9, 21.4 - 21.5, 22.1 - 22.2, 22.7 - 22.8, 23.2 - 23.3, 23.9 - 24	THg, MeHg, TSS	Water Sampling	UE
					x		x		x			x	x	x	16.4 - 16.5	Nutrients, E. Coli, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring	VADEQ
			x												16.4 - 16.5	Nutrients	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
					x				x					x	16.4 - 16.5	THg, TSS	VADEQ Storm Sampling	VADEQ
					x		x		x		x		x		16.4 - 16.5, 22 - 22.1	Nutrients, Hg, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
			x												16.4 - 16.5, 22 - 22.1	TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
				x											16.5 - 16.6, 19.8 - 19.9, 22 - 22.1	THg, MeHg, TSS	Surface Water/Sediments	UE
											x				16.5 - 16.6, 19.8 - 19.9, 22 - 22.1, 23.9 - 24	THg, MeHg, TSS	Transect Program	UE
		2006	x			x	x		x		x		x		16.4 - 16.5	Nutrients, Bacteria	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
				x		x									16.4 - 16.5	Nutrients, Bacteria, THg, Other Analytes	VADEQHIST Fishkill	VADEQ
			x												16.4 - 16.5	THg, TSS	VADEQHIST Storm	VADEQ
			x		x		x		x		x		x		16.4 - 16.5, 22.0 - 22.1	Nutrients, Bacteria, THg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
										x			x		16.5, 19.5, 23.9	THg, MeHg	Phase I Ecostudy: Storm Event Loading	URS
								x							16.5, 23.9	THg, MeHg	Phase I Ecostudy: Storm Event Loading	URS
					x	x	x	x	x	x	x	x	x	x	19.0, 22.4	THg, MeHg	Phase I Ecostudy	URS
		2007								x		x		x	16.5	THg, MeHg	Phase I Ecostudy	URS
			x	x		x	x								19.0	THg, MeHg	Phase I Ecostudy	URS
			x	x	x	x	x	x							16.4 - 16.5	Nutrients, Bacteria	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
					x	x									16.4 - 16.5, 19.7 - 19.8	Nutrients, Bacteria, THg, Other Analytes	VADEQHIST Fishkill	VADEQ
			x		x		x		x		x		x		16.4 - 16.5, 22.0 - 22.1	Nutrients, Bacteria, THg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
					x										16.5, 19.5, 23.9	THg, MeHg	Phase I Ecostudy: Storm Event Loading	URS
		2008		x				x		x		x			16.5, 19.9, 23.9	THg, MeHg	Phase II Ecostudy	URS
			x		x		x		x		x		x		16.4 - 16.5, 22.0 - 22.1	Nutrients, Bacteria, THg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
		2009						x	x	x			x		23.5	THg, MeHg	Phase II Ecostudy: Physical Loading Study	URS
				x			x			x					16.5, 19.9, 23.9	THg, MeHg	Phase II Ecostudy	URS
			x												16.4 - 16.5	Nutrients, Bacteria	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
			x												16.4 - 16.5, 22.0 - 22.1	Nutrients, Bacteria, THg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
		2010							x	x					23.4	THg, MeHg, Nutrients	Sewage Treatment Plant Surface Water Studies	JMU
			x												16.5, 19.9, 23.9	THg, MeHg, Nutrients, Other Analytes	Phase II Ecostudy	URS
				x	x		x	x	x	x	x	x	x	x	16.5, 23.9	THg, MeHg, Nutrients, Other Analytes	Phase II Ecostudy	URS
					x		x		x		x		x		16.4 - 16.5, 23.8 - 23.9	Nitrate, Nitrite, Nitrogen	VADEQ Surface Water	VADEQ
		2011		x				x		x		x			23.5	THg, MeHg	Phase II Ecostudy	URS
			x		x		x		x		x		x		23.5	THg, MeHg	VADEQ Surface Water	VADEQ
							x								17.1, 17.3, 17.5, 22.1	THg, MeHg	Floodplain Ponds Investigation	URS
Biological Monitoring / Assessments																		
Aquatic Vegetation / Algae																		
RRM 16 - 24	Tissue	2006					x	x							19.0	THg, MeHg, δN15, δC13	Trophic Transfer Study	VIMS
										x					19.0, 22.4	THg, MeHg	Phase I Ecostudy: Macrophytes	URS
							x			x				x	19.0, 22.4	THg, MeHg	Phase I Ecostudy: Periphyton	URS
		2007					x		x						22.4	THg, MeHg, δN15, δC13	Trophic Transfer Study	VIMS
				x											19.0, 22.4	THg, MeHg	Phase I Ecostudy: Periphyton	URS
		2008						x		x					22.1	THg, MeHg, δN15, δC13	VIMS Sed and Periphyton Study 2008	VIMS
Aquatic Invertebrates																		
RRM 16 - 24	Population / Community	2006					x			x				x	19.0, 22.4		Phase I Ecostudy	URS
		2007		x											19.0, 22.4		Phase I Ecostudy	URS
		2010				x									23.5		Phase II Ecostudy: Sediment Quality Triad	URS
		2011					x	x							23.5		Phase II Ecostudy: Benthic Colonization Study	URS
	Feeding	2010						x		x		x			23.5	δN15, δC13	Phase II Ecostudy: Basal Resource Utilization Study	URS
	Tissue	2003											x		24.0	THg, MeHg	Clam Tissue Study	JMU, EMU
		2006					x	x							19.0	THg, MeHg, δN15, δC13	Trophic Transfer Study	VIMS
							x			x				x	19.0, 22.4	THg, MeHg	Phase I Ecostudy: Asian Clams and Aquatic Insects	URS
					x	x	x	x	x	x	x	x	x	x	19.0, 22.4	THg, MeHg	Phase I Ecostudy: Crayfish	URS
		2007					x								22.4	THg, MeHg, δN15, δC13	Trophic Transfer Study	VIMS
				x											19.0, 22.4	THg, MeHg	Phase I Ecostudy: Asian Clams and Aquatic Insects	URS
			x	x											19.0, 22.4	THg, MeHg	Phase I Ecostudy: Crayfish	URS
		2009					x			x					22.1	THg, δN15, δC13	Phase II Ecostudy: Aquatic Insect Metamorphosis Study	URS
							x	x							23.5	THg, MeHg	Phase II Ecostudy: Asian Clam Uptake Study	URS
		2010						x		x					23.5	THg, MeHg	Phase II Ecostudy: Aquatic Invertebrates Uptake Study	URS
	Toxicity	2010					x								23.5		Phase II Ecostudy: Laboratory Sediment Bioassays for Sediment Quality Triad	URS
Fish																		
RRM 16 - 24	Population / Community	2006					x			x					19.0, 22.4		Phase I Ecostudy	URS
		2010					x				x				23.5		Phase II Ecostudy	URS
	Stomach Contents	2010					x				x	x			23.5		Phase II Ecostudy: Bass, Sunfish, and Forage Fish	URS
	Tissue	2002				x									19.8	THg, MeHg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
		2005				x									19.8	THg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
		2006					x			x					19.0, 22.4	THg, MeHg	Phase I Ecostudy: Forage Fish	URS
		2007					x								22.4	THg, MeHg, δN15, δC13	Trophic Transfer Study	VIMS
						x									16.5, 22.1	THg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
		2009					x				x				23.5	THg, MeHg	Phase II Ecostudy: Bass	URS
		2010					x				x	x			23.5	THg, MeHg	Phase II Ecostudy: Forage Fish	URS
							x				x				23.5	THg, MeHg	Phase II Ecostudy: Sunfish	URS
							x				x				NS	THg, MeHg	Phase II Ecostudy: Bass	URS
		2011					x								17.1, 17.3, 17.5, 22.1	THg, MeHg	Floodplain Ponds Investigation	URS
							x								23.5	THg, MeHg	Phase II Ecostudy: Bass	URS
Herpetofauna																		
RRM 16 - 24	Tissue	2006					x	x							16.7, 20.1	THg, MeHg, δN15, δC13	Turtle Study	VT
		2007				x	x								20.0, 22.0	THg, MeHg	Mercury Bioaccumulation in Amphibians: Nondestructive Indices of Exposure, Maternal Transfer, and Reproductive Effects	VT
		2008				x									20.0	THg, MeHg	Mercury Bioaccumulation in Amphibians: Nondestructive Indices of Exposure, Maternal Transfer, and Reproductive Effects	VT
Terrestrial Invertebrates																		
RRM 16 - 24	Tissue	2006										x			19.8, 24.0	THg, MeHg	Survey of the Mercury Content of Earthworms	JMU
		2007					x	x							17.4, 19.6, 19.8, 21.9, 23.8		Examining the Fate and Effects of Mercury Contamination on Spiders	WMU
		2008					x	x							19.8, 21.9, 23.8		Examining the Fate and Effects of Mercury Contamination on Spiders	WMU
Birds																		
RRM 16 - 24	Blood	2005					x	x	x						NS	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Birds	WMU
	Blood, Feather, Egg	2007				x	x								20.0, 24	THg	Pilot Assessment of Methyl-Mercury Availability to Mallards	BRI
	Blood, Wing, Feather, Egg	2006				x	x	x	x	x				x	17.4, 18.6, 19.6, 19.8, 21.9, 23.8	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Birds	WMU
		2007	x			x	x	x	x	x				x	17.4, 18.6, 19.6, 19.8, 21.9, 23.8	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Birds	WMU
		2008				x	x	x							17.4, 18.6, 19.6, 19.8, 21.9, 23.8	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Birds	WMU
	Tissue, Liver	2008									x		x	x	16.2, 19.1	THg, MeHg, Total Solids	VADEQ Waterfowl Samples	VADEQ
Mammals																		
RRM 16 - 24	Blood, Skin, Fur	2006							x	x					17.0, 18	THg, MeHg	Pilot Assessment of Methyl-Mercury Availability to Bats	BRI

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Habitat and Geophysical Characterizations																		
Reference	Discharge Characterization	2000	x	x	x	x	x	x	x	x	x	x	x	x	-2.7	Q (cfs)	Daily River Discharge (Near Waynesboro)	USGS
		2001	x	x	x	x	x	x	x	x	x	x	x	x	-2.7	Q (cfs)	Daily River Discharge (Near Waynesboro)	USGS
		2002	x	x	x	x	x	x	x	x	x	x	x	x	-2.7	Q (cfs)	Daily River Discharge (Near Waynesboro)	USGS
		2003	x	x	x	x	x	x	x	x	x	x	x	x	-2.7	Q (cfs)	Daily River Discharge (Near Waynesboro)	USGS
		2004	x	x	x	x	x	x	x	x	x	x	x	x	-2.7	Q (cfs)	Daily River Discharge (Near Waynesboro)	USGS
		2005	x	x	x	x	x	x	x	x	x	x	x	x	-2.7	Q (cfs)	Daily River Discharge (Near Waynesboro)	USGS
		2006	x	x	x	x	x	x	x	x	x	x	x	x	-2.7	Q (cfs)	Daily River Discharge (Near Waynesboro)	USGS
		2007	x	x	x	x	x	x	x	x	x	x	x	x	-2.7	Q (cfs)	Daily River Discharge (Near Waynesboro)	USGS
		2008	x	x	x	x	x	x	x	x	x	x	x	x	-2.7	Q (cfs)	Daily River Discharge (Near Waynesboro)	USGS
		2009	x	x	x	x	x	x	x	x	x	x	x	x	-2.7	Q (cfs)	Daily River Discharge (Near Waynesboro)	USGS
		2010	x	x	x	x	x	x	x	x	x	x	x	x	-2.7	Q (cfs)	Daily River Discharge (Near Waynesboro)	USGS
	Precipitation Monitoring	2000	x	x	x	x	x	x	x	x	x	x	x	x	MR		Daily Precipitation Volume (Staunton Sewage Treatment Plant)	NOAA
		2001	x	x	x	x	x	x	x	x	x	x	x	x	MR		Daily Precipitation Volume (Staunton Sewage Treatment Plant)	NOAA
		2002	x	x	x	x	x	x	x	x	x	x	x	x	MR		Daily Precipitation Volume (Staunton Sewage Treatment Plant)	NOAA
		2003	x	x	x	x	x	x	x	x	x	x	x	x	MR		Daily Precipitation Volume (Staunton Sewage Treatment Plant)	NOAA
		2004	x	x	x	x	x	x	x	x	x	x	x	x	MR		Daily Precipitation Volume (Staunton Sewage Treatment Plant)	NOAA
		2005	x	x	x	x	x	x	x	x	x	x	x	x	MR		Daily Precipitation Volume (Staunton Sewage Treatment Plant)	NOAA
		2006	x	x	x	x	x	x	x	x	x	x	x	x	MR		Daily Precipitation Volume (Staunton Sewage Treatment Plant)	NOAA
		2007	x	x	x	x	x	x	x	x	x	x	x	x	MR		Daily Precipitation Volume (Staunton Sewage Treatment Plant)	NOAA
		2008	x	x	x	x	x	x	x	x	x	x	x	x	MR		Daily Precipitation Volume (Staunton Sewage Treatment Plant)	NOAA
		2009	x	x	x	x	x	x	x	x	x	x	x	x	MR		Daily Precipitation Volume (Staunton Sewage Treatment Plant)	NOAA
		2010	x	x	x	x	x	x	x	x	x	x	x	x	MR		Daily Precipitation Volume (Staunton Sewage Treatment Plant)	NOAA
	Habitat Characterization	2005									x				NR - 01		Phase I Ecostudy: Phase I Site Characterization	URS
		2006									x				NR - 01		Phase I Ecostudy: Phase I Site Characterization	URS
		2007											x		MR - 01		Phase I Ecostudy: Phase I Site Characterization	URS
		2010			x	x									MR - 01		Phase II Ecostudy: Phase II Site Characterization	URS
					x										MR - 01		Phase II Ecostudy: Phase II Site Characterization	URS
Physical and Chemical Monitoring / Assessments																		
Reference Site	Soil	2003										x			-0.6 - -0.5, -0.5 - -0.4, -0.1 - -0.0	THg	Greenway Sampling	UE
		2006										x			-1.5	THg, MeHg	Survey of the Mercury Content of Earthworms on the South River Virginia Floodplain	JMU
											x				-2.6 - -2.5	THg, MeHg, LOI	Flux Chamber Study (Loading)	DuPont
		2010						x	x						NR	THg, MeHg	Mesocosm Study	JMU
	Sediment	2003			x								x		-4.1 - -4.2	THg, Metals, VOCs	VADEQ Historical Floodplain Sediments	VADEQ
													x		-4.1 - -4.2	VOCs, Pesticides, PCBs	VADEQ Probability Monitoring	VADEQ
		2004					x								-0.5 - -0.1	THg, Other Analytes	Sediment Sampling	UE
		2005								x					-2.7 - -2.8	THg, LOI, Other Analytes	Comprehensive Geomorphological Study: Bank Erosion and Mercury Content	UD
											x				-2.7 - -2.8	THg, MeHg, LOI, Other Analytes	Transect Program	UE
		2006										x			-1.0 , -0.7	THg, MeHg	Mercury Source Tracing and Mechanistic Source Studies	RTG, UE
					x	x	x	x	x	x	x	x	x	x	NR - 01	THg, MeHg	Phase I Ecostudy: Interstitial Sediment	URS
					x	x	x	x	x	x	x	x	x	x	NR - 02	THg, MeHg	Phase I Ecostudy: Interstitial Sediment	URS
					x	x	x	x	x	x	x	x	x	x	SR - 01	THg, MeHg	Phase I Ecostudy: Interstitial Sediment	URS
		2007								x					0 - -0.1	THg, Other Metals	VADEQ Sediment Sampling	VADEQ
			x	x											NR - 01	THg, MeHg	Phase I Ecostudy: Interstitial Sediment	URS
			x	x											NR - 02	THg, MeHg	Phase I Ecostudy: Interstitial Sediment	URS
			x	x											SR - 01	THg, MeHg	Phase I Ecostudy: Interstitial Sediment	URS
		2010				x									MR - 01	THg, MeHg, PCBs, PAHs, Herbicides, Pesticides, Other Analytes	Phase II Ecostudy: Interstitial Sediment for Sediment Quality Triad	URS
						x									SR - 01	THg, MeHg, PCBs, PAHs, Herbicides, Pesticides, Other Analytes	Phase II Ecostudy: Interstitial Sediment for Sediment Quality Triad	URS
	Pore Water	2006										x			-1.0 , -0.7	THg, MeHg	Mercury Source Tracing and Mechanistic Source Studies	RTG, UE
		2007		x											-0.6 - -0.5, -0.4 - -0.3, -0.2 - -0.1, -0.1 - 0.0	THg	Turner Plant Reach Pore Water and Surface Water	UE
	Surface Water	2000	x	x	x	x	x	x	x	x	x	x	x	x	-2.7 - -2.8	Nutrients, TSS, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
		2001											x		-1.6 - -1.7, -0.7 - -0.8	THg, Metals, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
			x	x	x	x	x	x		x		x		x	-2.7 - -2.8	Nutrients, TSS, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
		2002	x		x			x		x		x		x	-1.6 - -1.7, -0.7 - -0.8	THg, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
				x		x		x	x		x		x		-2.7 - -2.8	Nutrients, TSS, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
		2003								x					-0.8 - -0.7, -0.6 - 0.0	THg, TSS, Other Analytes	VADEQ Historical Intensive 2	VADEQ
				x		x		x		x		x			-1.6 - -1.7, -0.7 - -0.8	THg, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
													x		-4.1 - -4.2	Pesticides	VADEQ Historical Sediments	VADEQ
			x		x		x		x		x			x	-4.1 - -4.2, -2.7 - -2.8	Nutrients, TSS, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
		2004										x			-0.4 - -0.5	THg	Cutback Survey Sampling	UE
			x												-0.4 - -0.5	THg, TSS	VADEQ Historical Intensive 2 (Follow Up)	VADEQ
			x	x		x		x		x		x			-1.6 - -1.7, -0.7 - -0.8	THg, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
										x					-2.7 - -2.8	THg, MeHg, TSS	Hg Speciation Study	UE
				x		x		x	x	x	x	x	x	x	-2.7 - -2.8	Nutrients, TSS, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
											x				-2.7 - -2.8, -0.4 - -0.5	THg, MeHg, TSS	Flood Sampling	UE
		2005					x								-0.4 - -0.5	THg, MeHg, TSS	Water Sampling	UE
					x		x		x		x		x		-1.6 - -1.7, -0.7 - -0.8	Nutrients, Hg, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
			x												-1.6 - -1.7, -0.7 - -0.8	TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
											x				-2.7 - -2.8	THg, MeHg, TSS	Concurrent Sampling	RTG
					x	x	x	x	x	x	x		x	x	-2.7 - -2.8	Nutrients, E. Coli, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring	VADEQ
			x												-2.7 - -2.8	Nutrients	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
											x				-2.7 - -2.8	THg, TSS	VADEQ Storm Sampling	VADEQ
			x	x											-2.7 - -2.8, -0.4 - -0.5	THg, MeHg, TSS	Surface Water/Sediments	UE
											x				-2.7 - -2.8, -0.4 - -0.5	THg, MeHg, TSS	Transect Program	UE
					x										-2.7 - -2.8, -0.4 - -0.5	THg, MeHg, Metals, TSS, Other Analytes	Water Sampling	UE
		2006						x			x				-1.0	THg, MeHg	Flux Chamber Study (Loading)	DuPont
												x			-1.0 , -0.7	THg, MeHg	Mercury Source Tracing and Mechanistic Source Studies	RTG, UE
			x		x		x		x		x		x		-1.7 - -1.6, -0.8 - -0.7	Nutrients, Bacteria, THg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
												x			-2.8 - -2.7	THg, MeHg	Turner Wells / Turner Wells and Extract	UE
			x	x	x	x	x	x		x	x	x	x	x	-2.8 - -2.7	Nutrients, Bacteria	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
											x	x			-2.8 - -2.7, -0.8 - -0.7, -0.6 - -0.5, -0.5 - -0.4, -0.1 - 0.0	THg	Turner Plant Reach Pore Water and Surface Water	UE
					x	x	x	x	x	x	x	x	x	x	NR - 01	THg, MeHg	Phase I Ecostudy	URS
					x	x	x	x	x	x	x	x	x	x	NR - 02	THg, MeHg	Phase I Ecostudy	URS
					x	x	x	x	x	x	x	x	x	x	SR - 01	THg, MeHg	Phase I Ecostudy	URS
								x		x			x		SR - 01	THg, MeHg	Phase I Ecostudy: Storm Event Loading	URS
		2007	x		x		x		x		x		x		-1.7 - -1.6, -0.8 - -0.7	Nutrients, Bacteria, THg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
			x		x	x			x	x	x	x		x	-2.8 - -2.7	Nutrients, Bacteria	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
				x											-2.8 - -2.7, -0.8 - -0.7, -0.5 - -0.4, -0.4 - -0.3	THg	Turner Plant Reach Pore Water and Surface Water	UE
		2007	x	x											NR - 01	THg, MeHg	Phase I Ecostudy	URS
			x	x											NR - 02	THg, MeHg	Phase I Ecostudy	URS
			x	x		x	x								SR - 01	THg, MeHg	Phase I Ecostudy	URS
					x										SR - 01	THg, MeHg	Phase I Ecostudy: Storm Event Loading	URS
		2008	x		x		x		x		x		x		-1.7 - -1.6, -0.8 - -0.7	Nutrients, Bacteria, THg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
			x	x	x	x	x	x	x	x	x	x	x	x	-2.8 - -2.7	Nutrients, Bacteria	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
														x	NS	Temperature	Analysis of South River Temperatures	JMU
		2009	x												-1.7 - -1.6, -0.8 - -0.7	Nutrients, Bacteria, THg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
			x	x											-2.8 - -2.7	Nutrients, Bacteria	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
				x			x			x					SR - 01	THg, MeHg	Phase II Ecostudy	URS
		2010			x		x		x		x		x		-2.8 - -2.7	Nitrate, Nitrite, Nitrogen	VADEQ Surface Water	VADEQ
			x	x	x		x	x	x	x	x	x	x	x	SR - 01	THg, MeHg, Nutrients, Other Analytes	Phase II Ecostudy	URS

Appendix B
Ecological Study Data Matrix
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RIVER REACH	DATA TYPE	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	RELATIVE RIVER MILE	MAIN PARAMETERS	PROJECT NAME / DESCRIPTION	SOURCE(S)
Biological Monitoring / Assessments																		
Aquatic Vegetation / Algae																		
Reference Site	Tissue	2005							x						-4.1	THg, MeHg	Periphyton Assessment	VIMS
		2006								x					NR - 01	THg, MeHg	Phase I Ecostudy: Macrophytes	URS
							x			x				x	NR - 01	THg, MeHg	Phase I Ecostudy: Periphyton	URS
										x					NR - 02	THg, MeHg	Phase I Ecostudy: Macrophytes	URS
							x			x				x	NR - 02	THg, MeHg	Phase I Ecostudy: Periphyton	URS
										x					SR - 01	THg, MeHg	Phase I Ecostudy: Macrophytes	URS
							x			x				x	SR - 01	THg, MeHg	Phase I Ecostudy: Periphyton	URS
		2007		x											NR - 01	THg, MeHg	Phase I Ecostudy: Periphyton	URS
				x											NR - 02	THg, MeHg	Phase I Ecostudy: Periphyton	URS
				x											SR - 01	THg, MeHg	Phase I Ecostudy: Periphyton	URS
Aquatic Invertebrates																		
Reference Site	Population / Community	2006					x			x				x	NR - 01		Phase I Ecostudy	URS
							x			x				x	NR - 02		Phase I Ecostudy	URS
							x			x				x	SR - 01		Phase I Ecostudy	URS
		2007		x											NR - 01		Phase I Ecostudy	URS
				x											NR - 02		Phase I Ecostudy	URS
				x											SR - 01		Phase I Ecostudy	URS
		2010				x									MR - 01		Phase II Ecostudy: Sediment Quality Triad	URS
						x									SR - 01		Phase II Ecostudy: Sediment Quality Triad	URS
		2011					x	x							MR - 01		Phase II Ecostudy: Benthic Colonization Study	URS
							x	x							SR - 01		Phase II Ecostudy: Benthic Colonization Study	URS
	Tissue	2002											x		-1.8, -0.7	THg	Clam Tissue Study	JMU, EMU
		2003											x		-1.8	THg, MeHg	Clam Tissue Study	JMU, EMU
						x									NR	THg, MeHg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Spring Sampling)	VT
		2004					x		x						NR	THg, MeHg	Clam Transplant Study	JMU, EMU
		2006					x			x				x	NR - 01	THg, MeHg	Phase I Ecostudy: Asian Clams and Aquatic Insects	URS
					x	x	x	x	x	x	x	x	x	x	NR - 01	THg, MeHg, PAHs, Other Analytes	Phase I Ecostudy: Crayfish	URS
							x			x				x	NR - 02	THg, MeHg	Phase I Ecostudy: Asian Clams and Aquatic Insects	URS
					x	x	x	x	x	x	x	x	x	x	NR - 02	THg, MeHg, PAHs, Other Analytes	Phase I Ecostudy: Crayfish	URS
							x			x				x	SR - 01	THg, MeHg	Phase I Ecostudy: Asian Clams and Aquatic Insects	URS
					x	x	x	x	x	x	x	x	x	x	SR - 01	THg, MeHg, PAHs, Other Analytes	Phase I Ecostudy: Crayfish	URS
		2007		x											NR - 01	THg, MeHg	Phase I Ecostudy: Asian Clams and Aquatic Insects	URS
			x	x											NR - 01	THg, MeHg, PAHs, Other Analytes	Phase I Ecostudy: Crayfish	URS
				x											NR - 02	THg, MeHg	Phase I Ecostudy: Asian Clams and Aquatic Insects	URS
			x	x											NR - 02	THg, MeHg, PAHs, Other Analytes	Phase I Ecostudy: Crayfish	URS
				x											SR - 01	THg, MeHg	Phase I Ecostudy: Asian Clams and Aquatic Insects	URS
			x	x											SR - 01	THg, MeHg, PAHs, Other Analytes	Phase I Ecostudy: Crayfish	URS
	Toxicity	2010					x								MR - 01		Phase II Ecostudy: Laboratory Sediment Bioassays for Sediment Quality Triad	URS
										x					NR - 01		Phase II Ecostudy: Field Microcosm Study	URS
										x					NR - 02		Phase II Ecostudy: Field Microcosm Study	URS
										x					SR - 01		Phase II Ecostudy: Field Microcosm Study	URS
							x								SR - 01		Phase II Ecostudy: Laboratory Sediment Bioassays for Sediment Quality Triad	URS
Fish																		
Reference Site	Population / Community	2006					x			x					NR - 01		Phase I Ecostudy	URS
							x			x					NR - 02		Phase I Ecostudy	URS
							x			x					SR - 01		Phase I Ecostudy	URS
		2010					x				x				MR-01		Phase II Ecostudy	URS
							x				x				SR - 01		Phase II Ecostudy	URS
	Tissue	2001				x									-0.7	THg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
		2002				x									-0.7	THg, MeHg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
						x									NR	THg, MeHg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
		2003				x									NR	THg, MeHg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Spring Sampling)	VT
		2005				x	x								-0.7	THg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
						x									NR	THg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
		2006					x			x					NR - 01	THg, MeHg	Phase I Ecostudy: Forage Fish	URS
							x			x					NR - 02	THg, MeHg	Phase I Ecostudy: Forage Fish	URS
							x			x					SR - 01	THg, MeHg	Phase I Ecostudy: Forage Fish	URS
		2007				x									-0.7	THg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
						x									NR	THg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
Herpetofauna																		
Reference Site	Tissue	2007			x	x	x								-1.0, -2.0	THg, MeHg	Mercury Bioaccumulation in Amphibians: Nondestructive Indices of Exposure, Maternal Transfer, and Reproductive Effects	VT
		2008			x	x									-1.0	THg, MeHg	Mercury Bioaccumulation in Amphibians: Nondestructive Indices of Exposure, Maternal Transfer, and Reproductive Effects	VT
Terrestrial Invertebrates																		
Reference Site	Tissue	2006										x			-1.5	THg, MeHg	Survey of the Mercury Content of Earthworms on the South River Virginia Floodplain	JMU
		2007					x								NR	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Spiders	WMU
		2008					x								NR	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Spiders	WMU
Birds																		
Reference Site	Blood	2005					x	x	x						NS	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Birds	WMU
	Blood, Feather	2007				x	x								MR	THg	Pilot Assessment of Methyl-Mercury Availability to Mallards	BRI
	Blood, Feather, Egg	2007				x	x								NR	THg	Pilot Assessment of Methyl-Mercury Availability to Mallards	BRI
	Blood, Wing, Feather, Egg	2006				x	x	x	x						MR	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Birds	WMU
						x	x	x	x						NR	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Birds	WMU
		2007				x	x	x	x						MR	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Birds	WMU
							x	x	x						NR	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Birds	WMU
		2008					x	x							MR	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Birds	WMU
							x	x							NR	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Birds	WMU
Mammals																		
Reference Site	Blood, Skin, Fur	2007							x	x					MR	THg, MeHg	Pilot Assessment of Methyl-Mercury Availability to Bats	BRI
		2008						x	x	x					MR	THg, MeHg	Pilot Assessment of Methyl-Mercury Availability to Bats	BRI
	Tissue, Liver	2010				x									MR	THg, MeHg	VADEQ White Tailed Deer Samples	VADEQ

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Habitat and Geophysical Characterizations																		
SFS	Habitat Characterization	2005									x				SFS - 1		Phase I Ecostudy: Phase I Site Characterization	URS
		2006									x				SFS - 1		Phase I Ecostudy: Phase I Site Characterization	URS
Physical and Chemical Monitoring / Assessments																		
SFS	Soil	2004										x			31 - 32	THg	Cutback Survey Sampling	UE
		2006					x								40 - 41	THg	VADEQ Probability Monitoring	VADEQ
								x							26 - 27, 72 - 73, 121 - 122	THg	VADEQ Fish Kill Sediment Sampling	VADEQ
	Sediment	2003											x		40 - 41	VOCs, Pesticides, PCBs	VADEQ Probability Monitoring	VADEQ
		2005									x				24 - 25, 34 - 35	THg, MeHg, LOI, Other Analytes	Transect Program	UE
											x				30 - 31, 32 - 33	THg, MeHg, LOI, Other Analytes	McGaheysville Dam Samples	UE
		2006			x	x	x	x	x	x	x	x	x	x	SFS - 1	THg, MeHg	Phase I Ecostudy: Interstitial Sediment	URS
		2007	x	x											SFS - 1	THg, MeHg	Phase I Ecostudy: Interstitial Sediment	URS
										x	x				26 - 27, 33 - 34, 40 - 41, 43 - 44, 50 - 51, 55 - 56, 57 - 58, 65 - 66, 72 - 73, 75 - 76, 79 - 80, 86 - 87, 91 - 92, 95 - 96, 103 - 104, 106 - 107, 110 - 111, 115 - 116, 121 - 122, 125 - 126	THg, Other Metals	VADEQ Sediment Sampling	VADEQ
	Ground Water	2009			x										NS	Spatial Analysis	River Corridor Infrared Thermal Imaging	SITS
	Surface Water	2003									x	x	x	x	26 - 27, 48 - 49, 65 - 66, 72 - 73, 121 - 122, 125 - 126	Nutrients, E. Coli, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring	VADEQ
												x			48 - 49, 72 - 73, 94 - 95	Nutrients, Hg, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
		2004									x				24 - 25	THg, MeHg, TSS	Flood Sampling	UE
										x					24 - 25, 30 - 31, 32 - 33	THg, MeHg, TSS	Hg Speciation Study	UE
			x		x		x	x	x	x	x	x	x	x	26 - 27, 48 - 49, 65 - 66, 72 - 73, 79 - 80, 121 - 122, 125 - 126	Nutrients, E. Coli, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring	VADEQ
			x	x		x		x		x		x			26 - 27, 48 - 49, 72 - 73, 94 - 95	Nutrients, Hg, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
		2005			x										24 - 25	THg, MeHg, Metals, TSS, Other Analytes	Water Sampling	UE
				x											24 - 25	THg, MeHg, TSS	Surface Water/Sediments	UE
											x				24 - 25, 30 - 31, 32 - 33, 34 - 35	THg, MeHg, TSS	Transect Program	UE
			x	x	x	x	x	x	x	x	x	x	x	x	26 - 27, 48 - 49, 65 - 66, 72 - 73, 79 - 80, 121 - 122, 125 - 126	Nutrients, E. Coli, Other Analytes	VADEQ Historical Ambient Water Quality Monitoring	VADEQ
			x		x		x		x		x		x		26 - 27, 48 - 49, 94 - 95	Nutrients, Hg, TSS, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
		2006		x	x	x	x	x	x	x	x	x	x	x	26 - 27, 33 - 34, 72 - 73, 121 - 122	Nutrients, Bacteria, THg, Other Analytes	VADEQHIST Fishkill	VADEQ
			x		x		x		x		x		x		26 - 27, 48 - 49, 94 - 95	Nutrients, Bacteria, THg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
				x		x		x		x		x		x	26 - 27, 72 - 73, 121 - 122	Nutrients, Bacteria	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
						x	x						x		40 - 41, 72 -73	Nutrients, Bacteria, THg, Other Analytes	VADEQ Historical Probability Monitoring	VADEQ
					x	x	x	x	x	x	x	x	x	x	SFS - 1	THg, MeHg	Phase I Ecostudy	URS
		2007	x	x	x	x	x	x	x	x					26 - 27, 33 - 34, 72 - 73, , 121 - 122	Nutrients, Bacteria, THg, Other Analytes	VADEQHIST Fishkill	VADEQ
			x	x	x	x	x	x	x	x	x	x	x	x	26 - 27, 48 - 49, 72 - 73, 79 - 80, 115 - 116, 121 - 122	Nutrients, Bacteria	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
			x		x		x		x		x		x		26 - 27, 48 - 49, 94 - 95	Nutrients, Bacteria, THg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
			x	x											SFS-1	THg, MeHg	Phase I Ecostudy	URS
		2008	x		x		x		x		x		x		26 - 27, 48 - 49, 94 - 95	Nutrients, Bacteria, THg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
			x	x	x	x	x	x	x	x	x	x	x	x	26 - 27, 72 - 73, 79 - 80, 115 - 116, 121- 122	Nutrients, Bacteria	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
					x	x	x								33 - 34	Nutrients, Bacteria, THg, Other Analytes	VADEQHIST Fishkill	VADEQ
		2009	x												26 - 27, 48 - 49, 94 - 95	Nutrients, Bacteria, THg, Other Analytes	VADEQ Historical Bimonthly Clean Hg	VADEQ
				x											26 - 27, 72 - 73	Nutrients, Bacteria	VADEQ Historical Ambient Water Quality Monitoring Samples	VADEQ
Biological Monitoring / Assessments																		
Aquatic Vegetation / Algae																		
SFS	Tissue	2003							x						92.6	THg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Summer Sampling)	VT
		2006								x					SFS - 1	THg, MeHg	Phase I Ecostudy: Macrophytes	URS
							x			x				x	SFS - 1	THg, MeHg	Phase I Ecostudy: Periphyton	URS
		2007		x											SFS - 1	THg, MeHg	Phase I Ecostudy: Periphyton	URS
Aquatic Invertebrates																		
SFS	Population / Community	2006					x			x				x	SFS - 1		Phase I Ecostudy	URS
		2007		x											SFS - 1		Phase I Ecostudy	URS
	Tissue	2003				x									92.6	THg, MeHg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Spring Sampling)	VT
									x						92.6	THg, MeHg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Summer Sampling)	VT
												x		x	92.6	THg, MeHg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Fall Sampling)	VT
		2006					x			x				x	SFS - 1	THg, MeHg	Phase I Ecostudy: Asian Clams and Aquatic Insects	URS
					x	x	x	x	x	x	x	x	x	x	SFS - 1	THg, MeHg, PAHs, Other Analytes	Phase I Ecostudy: Crayfish	URS
		2007		x											SFS - 1	THg, MeHg	Phase I Ecostudy: Asian Clams and Aquatic Insects	URS
			x	x											SFS - 1	THg, MeHg, PAHs, Other Analytes	Phase I Ecostudy: Crayfish	URS
Fish																		
SFS	Population / Community	2006					x			x					SFS - 1		Phase I Ecostudy	URS
	Tissue	2001					x								135, 144.5, 160	THg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
		2002				x	x		x			x			27.9, 49.7, 65.0, 77.5, 93.0, 108.7, 124.3, 144.5, 160.0	THg, MeHg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
		2003	x												27.9	THg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
						x									92.6	THg, MeHg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Spring Sampling)	VT
									x						92.6	THg, MeHg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Summer Sampling)	VT
												x			92.6	THg, MeHg	Uptake of Mercury and Relationships of Food Habits of Selected Species (Fall Sampling)	VT
		2005				x	x								27.9, 49.7, 65.0, 77.5, 93.0, 108.7, 124.3, 144.5	THg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
		2006					x			x					SFS - 1	THg, MeHg	Phase I Ecostudy: Forage Fish	URS
		2007			x	x									27.9, 49.7, 65.0, 77.5, 93.0, 108.7, 124.3, 144.5, 160.0	THg	VADEQ Fish Fillet Tissue Hg Monitoring	VADEQ
Herpetofauna																		
SFS	Tissue	2007					x								34.0	THg, MeHg	Mercury Bioaccumulation in Amphibians: Nondestructive Indices of Exposure, Maternal Transfer, and Reproductive Effects	VT
Birds																		
SFS	Blood	2005					x	x	x						NS	THg, MeHg	Examining the Fate and Effects of Mercury Contamination on Birds	WMU

NOTES:

The records presented in this table were obtained from the URS Master Database from 2000 to 2011 and from the South River Science Team Web Server (2006-2010). Research conducted by outside organizations was compiled to the fullest extent possible, however, some studies may not be represented. Relative River Miles (RRM) are determined by the streamline distance downstream (+), or distance upstream (-) of the footbridge located in downtown Waynesboro, VA. The locations reported are based on the coordinates or site descriptions provided in the source dataset and may not be fully comprehensive. For sites in the Middle River (MR) and North River (NR), no specific RRM is provided.

NS = Not Specified; SFS = South Fork Shenandoah River; *Analytes*: LOI = Loss on Ignition; MeHg = Methyl Mercury; δN15/ δC13 = Stable Isotopes; PAHs = Polyaromatic Hydrocarbons; PCBs = Polychlorinated Biphenyls; THg = Total Mercury; TOC = Total Organic Carbon; TSS = Total Suspended Solids; VOCs = Volatile Organic Compounds

DuPont = E. I. du Pont de Nemours and Company; EMU = Eastern Mennonite Univ.; JMU = James Madison Univ.; NOAA = National Oceanic and Atmospheric Admin.; RTG = Ralph Turner Geosciences; SITS = Stockton Infrared Thermographic Services; UD = Univ. of Delaware; UE = Unique Environmental

URS = URS Corporation; USEPA = US Environmental Protection Agency; USGS = US Geologic Survey; VADEQ = VA Dept. of Environmental Quality; VIMS = Virginia Institute of Marine Science; VT = Virginia Tech

Appendix C

2016 Angler Survey

Angler Survey on the South River and South Fork Shenandoah River - 2016

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March 3rd, 2017

Purpose of 2016 Angler Survey

Angler surveys were conducted on the South River in 2005 and 2011 to determine angler knowledge of the fish consumption advisory that was initially posted in 1977. Considering the fish consumption advisory for mercury extends downstream through the South Fork Shenandoah River to Front Royal, the 2016 angler survey was designed to include both the South River and South Fork Shenandoah River. The South River Science Team (SRST) outreach program strives to inform anglers and the general population of the fish consumption advisories on these rivers. The results of the 2016 angler survey illustrate the fish consumption advisory knowledge of anglers throughout the entire advisory section. It also was useful in collecting angling preferences, effort, pressure, fish harvest and general satisfaction of river users.

Introduction

The South River and South Fork Shenandoah River in northwestern Virginia (Figure 1) are heavily used by anglers and recreational enthusiasts. The South River begins in southern Augusta County near Greenville, VA and flows north through Waynesboro and Grottoes where it meets the North River to form the South Fork Shenandoah River. The South Fork Shenandoah River has been recognized nationally for its Smallmouth Bass fishery. The South Fork flows north 97 river miles until it is joined by the North Fork Shenandoah at Front Royal to form the Shenandoah River. The Shenandoah River Watershed is considered fairly influential in the Chesapeake Bay Watershed. The South River and South Fork Shenandoah River both bring considerable economic revenue to surrounding localities. The South River offers several fishable stocked trout fishing opportunities in the Waynesboro area and the South Fork Shenandoah River offers multiple species for angling including Sunfish, Largemouth Bass, Channel Catfish, Muskellunge and most notably Smallmouth Bass. Only trout in South River and Muskellunge in the South Fork Shenandoah River are stocked annually. Access to the South Fork Shenandoah River is considered good with access points generally every 5 - 10 river miles. Access to the South River is mostly limited to local government properties near Waynesboro and Grottoes.

Industrial effluent has impacted the Shenandoah River and its tributaries since the early 1900's. The presence of mercury contamination in fish tissue was discovered in the 1970's. In 1977 fish consumption advisories were established and listed by the Virginia Department of Health on both the South River and South Fork Shenandoah River. The elevated levels of mercury in fish tissue have restricted the consumption of wild fish species by anglers in the South Fork Shenandoah River and

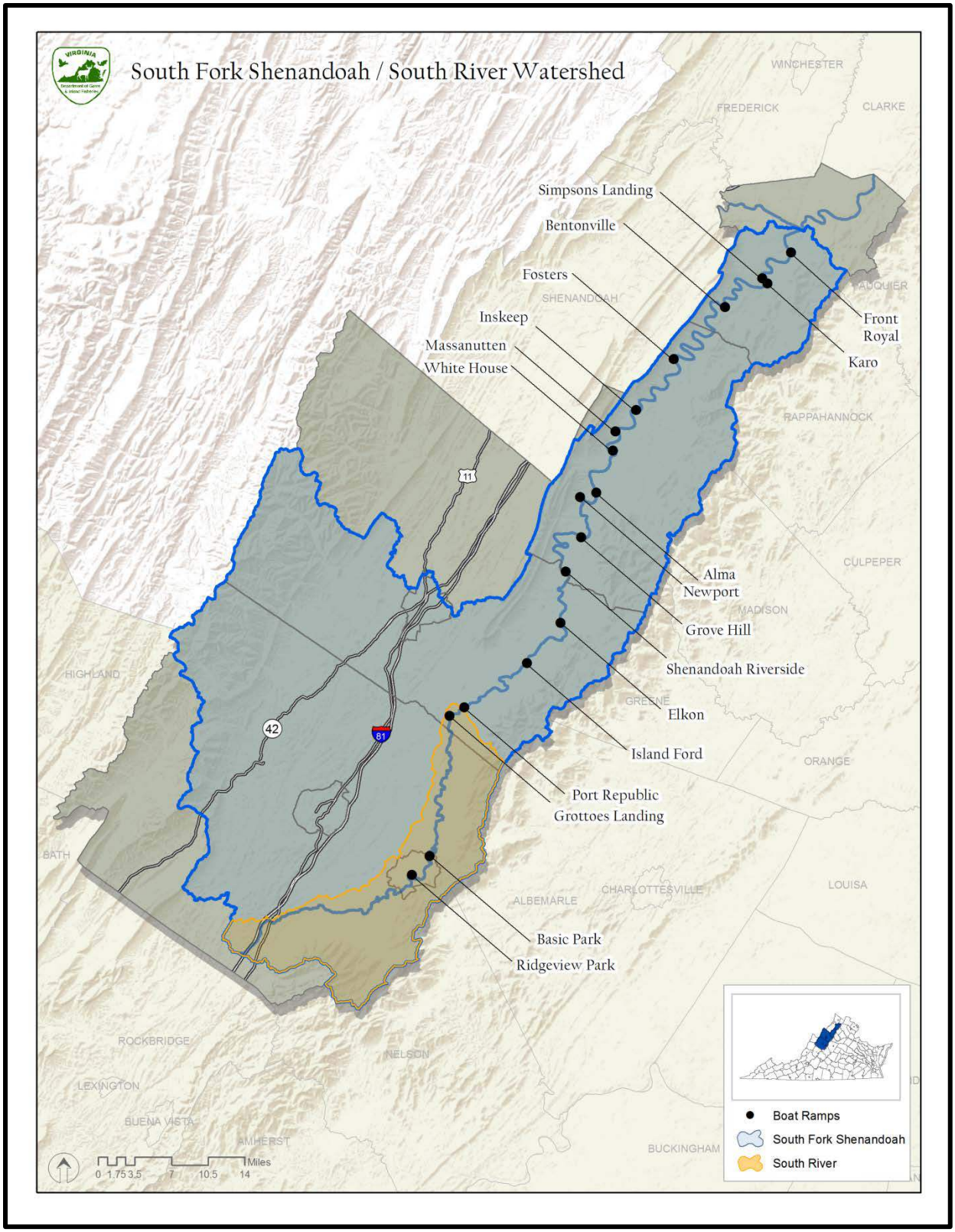

Figure 1. Location of South River and South Fork Shenandoah River Watersheds.

consuming any fish from the South River is not recommended. In 2000, the SRST was developed to review the mercury contamination issue and have since completed and continue to implement mercury contamination research and remediation measures.

The Virginia Department of Game and Inland Fisheries (VDGIF) has a long history of conducting angler surveys on larger river systems throughout the Commonwealth. However, given the limited access and size there was not an angler survey conducted on the South River until 2005, then a follow up survey was implemented in 2011. These surveys were initiated by the SRST to determine angler knowledge of the fish consumption advisories. Some of the results of these surveys are presented and compared to the 2016 survey in this report.

The South Fork Shenandoah River has had angler surveys conducted from the 1960's to present. However, some of the earlier surveys did not collect the same data as surveys in the last 20 years. Therefore, fewer comparisons from recent surveys to older surveys are available. In 1997 VDGIF District Fisheries Biologist Darrell Bowman designed a very extensive angler survey of the South Fork Shenandoah and Shenandoah Rivers. It was a roving (on-water kayak/canoe) survey that covered from April 1st through October 31st. Aerial flights were also used to help validate the accuracy of on-water angler counts. This was an excellent survey that gathered useful baseline information.

In 2008, the South Fork Shenandoah anglers were again surveyed by VDGIF. This time an access point survey design was chosen. This method consists of a creel clerk being stationed at one public access point for the entire survey day (10 different public access points were surveyed throughout the project). VDGIF biologists knew that bank and wade anglers would be underestimated as well as anglers that access the river only from private property. These assumptions became reality as the data from the 2008 survey was compared to the 1997 roving survey. The number of anglers interviewed was 50% less than the roving survey. While biologists felt confident about some of the information obtained from the 2008 access point survey, it was decided that future angler surveys would follow to design of the 1997 roving survey. Consistent survey designs have been instrumental in assisting biologists in comparing trend data over time.

In 2011 another roving survey was conducted on the South Fork Shenandoah River. To ensure comparisons among the 1997, 2011 and some of the data from other past surveys the 2016 survey was conducted as a roving survey. This was also done for the 2016 South River angler survey in order to compare with the 2005 and 2011 surveys. Results presented in this report are compared among the South Fork Shenandoah River and the South River for 2016 and among past years for each river individually.

Methods

The roving angler survey design was used to count and interview anglers on both rivers in 2016. Past angler surveys have indicated that the majority of angling pressure on rivers takes place from May through August. Therefore, the 2016 surveys for both rivers ran from May 1st through September 5th. The end of the survey went until September 5th to include Labor Day weekend river users. Sampling days were randomly chosen among weekdays and weekend days, with a higher probability being given to weekend days. The survey day was broken into two 6-hour time periods (AM-9:00am to 3:00pm; PM-3:00pm to 9:00pm). A higher probability was chosen for selecting the PM time period as anglers that had been fishing for several hours were more valuable to interview. River reaches were selected based

on past surveys and the distance the creel clerks could float in the time period. Four college students were hired as creel clerks and used kayaks to conduct the survey. Only one river reach was floated per survey day for each river and all anglers encountered were asked a series of interview questions for the South River and the South Fork. The clerks interviewed anglers in boats, wading, and on the bank. Anglers that could not be interviewed for various reasons were counted. Clerks also recorded the number of non- anglers they witnessed using the river during the survey float. These were typically individuals in canoes, kayaks, tubes, or just swimming/wading in the river. Creel clerks conducted the surveys no matter weather conditions. However, some scheduled days were missed on both rivers due to dangerously high flows. All interview data were entered into Microsoft EXCEL and SAS was used for statistical analysis.

The South River surveys in 2005 (14 days per month avg.) and 2011 (12 day per month avg.) both averaged over 10 surveys per month. In 2016 the river was scheduled to be surveyed 18 times per month (except September) to obtain statistically valid data. Five river reaches were selected to survey from Constitution Park in Waynesboro to Port Republic boat landing (Table 1). Probabilities were set higher for Reach number one near Constitution Park and Reach number five near Grand Caverns and Grottoes as they were more likely to have anglers present due to trout stocking. Anglers were asked a set of questions specific to South River (Appendix A).

Table 1. South River reaches sampled during the 2016 angler survey.

Reach No.	Reach Name	River	River Miles	Probability
1	DuPont to Dooms	South	5	0.25
2	Dooms to Crimora	South	5	0.2
3	Crimora to Wesley Church	South	4.5	0.15
4	Wesley Ch. to G. Caverns	South	5.8	0.15
5	G. Caverns to Port Rep.	South	4.2	0.25

The South Fork Shenandoah angler surveys in 1997 and 2008 covered 11 days per month and the 2011 survey was scheduled for 12 days per month. In 2016 the river was scheduled to be surveyed 22 times per month (except September) to obtain statistically valid data. Ten river reaches were selected to survey from Island Ford to Luray Avenue in Front Royal (Table 2). Uniform probabilities were used when randomly selecting survey reaches. Some of the reaches were identical to the reaches used in the 1997 survey and 9 of 10 reaches were identical to the 2011 survey on the South Fork. Anglers were asked a set of question specific to the South Fork Shenandoah River (Appendix B).

Table 2. South Fork Shenandoah River reaches sampled during the 2016 angler survey.

Reach No.	Reach Name	River	River Miles
1	Island Ford to Elkton	South Fork	6.9
2	Elkton to Shenandoah	South Fork	6.6
3	Shenandoah to Grove Hill	South Fork	8.9
4	Newport to Whitehouse	South Fork	8.5
5	Luray Dam Pool	South Fork	3.0
6	Inskeep to Bealers Ferry	South Fork	7.0
7	Bealers Ferry to Seakford	South Fork	7.5
8	Compton to Bentonville	South Fork	10.0
9	Bentonville to Karo	South Fork	8.4
10	Karo to Front Royal	South Fork	6.6

South River Results

South River - Creel Clerk Effort

A roving angler survey was conducted on South River (Waynesboro to Port Republic) from May 1st to September 5th, 2016 covering approximately 24.5 river miles. The creel clerks spent 46 days on the river interviewing anglers in 2016. August was most heavily sampled, with 13 trips; May and September had a limited number of samples. Unsafe river conditions during May limited the number of days that could be sampled and the end of the survey in September only included the Labor Day weekend. During the five month period, 90 angling party interviews were conducted and 70 recreational (other than fishing) parties were documented. A total of 170 individuals were counted; 100 were fishing and 70 were enjoying other forms of river recreation.

South River - Angler Effort

Angler effort (fishing pressure) was estimated at 14,434 angler trips for a total of 25,242 hours of fishing pressure. The average time spent fishing by an angler before being interviewed was 1.75 hours during this survey. There was roughly 33% less fishing pressure in 2016 compared to 2005. Fishing pressure was greatest in May and July. Anglers targeting Smallmouth Bass fished mainly in May and July while trout anglers focused their efforts mostly in May. Fishing from the bank or wading was most popular at 86% of the effort in 2005. This percentage reduced slightly to 79% in 2016, most likely due to the increased popularity of kayaks. The most sought after species was Smallmouth Bass (60%) followed by Largemouth Bass (15%) and then trout (11%). A breakdown of targeted species is illustrated in Figure 2. These results have changed slightly since 2011 when the majority of anglers targeted anything biting.

South River - Angler Characteristics

The dominant angler type on South River in 2016 was an adult with an average age of 38, Caucasian (86%) and male (85%). The next largest ethnic groups were African Americans (9%) and Hispanics (5%). These results are similar to past surveys.

When asked which County or City they were from 49% of anglers answered Augusta County while 43 % were from Rockingham County. Waynesboro residents contributed 16% to the Augusta County total and Grottoes residents contributed 13% to the Rockingham County total. Only 4% were from out of state. The majority (93%) of anglers used spinning gear, while 6% used fly fishing gear and 1% a combination of both gear types. Most anglers (39%) fished South River more than 20 times a year and 26% only fished 1 – 5 times annually.

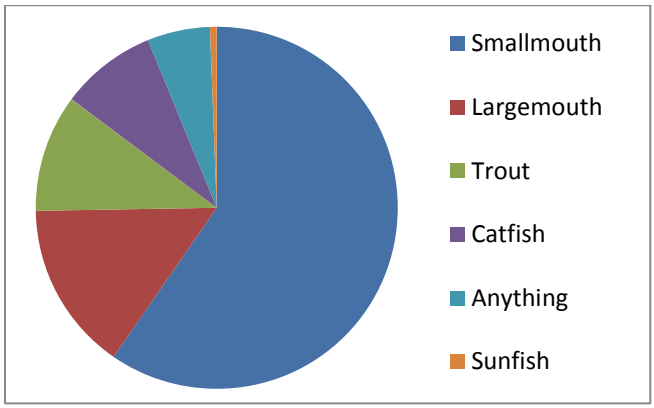

Figure 2. South River angler species preference

What did anglers like about fishing South River? The majority (46%) stated it was a combination of scenery, fishing quality and close to home. Thirty-six percent said they enjoyed fishing South River strictly because it was close to home and 11% fished the area for the scenery. When asked what they disliked about angling in South River, 56% stated pollution and 44% stated other reasons. Eleven percent stated that fishing quality was poor. Angler satisfaction with the South River fishery was good with 89% of anglers indicating they were either "satisfied, moderately satisfied, to greatly satisfied."

South River - Fish Consumption Advisory

One of the main objectives of this study was to determine angler knowledge of the fish consumption advisory that has been imposed on South River (downstream of the DuPont footbridge) since 1977. When asked if they keep their catch only 2% strictly harvested fish and 19% said they practiced a combination of harvest and release. The remaining 79% said they released all fish they caught in 2016 compared to 73% in 2011 and 77% in 2005. The percent of anglers harvesting fish reduced from 25% in 2011 to only 2% in 2016. Of those that released their catch, 55% stated that they practiced catch-and-release fishing, while 28% stated it was from the advisory warnings. In 2005 only 8% of anglers stated they released their catch due to the advisory compared to 14% in 2011. The remaining 17% stated either the fish were too small, they didn't eat fish or for other reasons. Those that harvested some fish and released other typically harvested trout species. This was an observation and not quantitatively captured. Eighty three percent of anglers who harvested fish shared their catch with family and friends. Total catch for all species was estimated at 111,051 for the 2016 survey. Most fish (99%) were released.

Eighty-seven percent of the fishing public knew about the consumption advisory and, when asked whether they knew what the advisory stated, 96% answered correctly. These numbers have steadily increased over the last three angler surveys. Angler knowledge of a consumption advisory on the river increased from 76% in 2005 to 87% in 2011 and remained at 87% in 2016. A more notable increase was angler knowledge that the advisory pertained specifically to mercury. In 2005 only 39% of anglers knew the advisory pertained to mercury. In 2011 that increased to 73% and climbed even higher to 96% in 2016 (Figure 3).

When anglers were asked how they knew about the advisory, 54% got their information from word of mouth and 42% from signage posted along the river. The other 4% received their information from brochures, websites and by other means. In 2005 and 2011 the majority of anglers indicated they obtained their information from signage posted along the river and word of mouth was second.

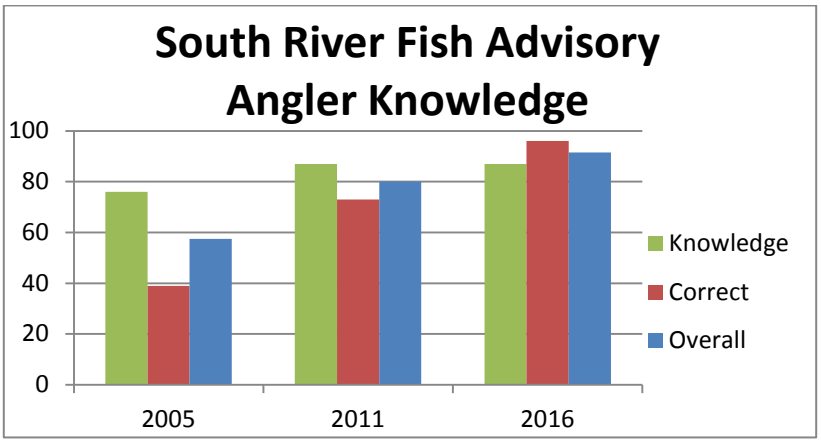

Figure 3. Angler knowledge of the fish consumption advisory on the South River.

South River - Angler Expenditures

Placing a dollar value on a fishery is extremely difficult. Fishermen were asked two questions about their spending habits regarding South River: How much they spent per day on all commodities and How much of that they contributed within 20 miles of the river? Figure 4 summarizes the estimated amount, by month, of angling dollars spent on gas, food, bait, lodging, equipment rental, and other items. The highest amount was spent in July, followed by May and June. The estimated total spent by South River anglers over the survey period in 2016 was $198,810. Seventy-one percent ($141,155) was spent within 20 miles of the river, further emphasizing how the river supports the local economy.

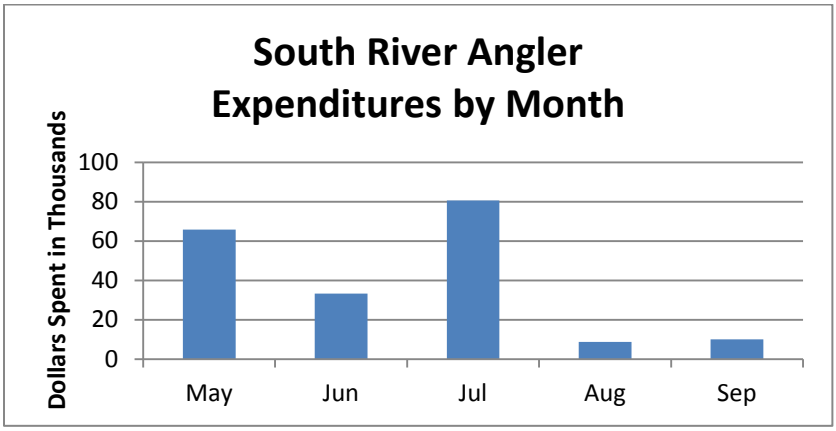

Figure 4. Estimated angler expenditures on South River during the 2016 survey.

South River - Other Users

The primary intent of this survey was to determine angler knowledge of the fish consumption advisory and to estimate fishing pressure and other angling information to help fisheries biologists improve management of the fishery resource. However, a secondary objective was to estimate the number of non-anglers that recreate on the South River. South River attracts many types of recreational users other than anglers. The survey team documented 70 recreational parties that were canoeing, kayaking, other boats (often tubes), swimming or those that fell into the other category. Some of the other category were researchers and college students for classes. Kayakers made up the largest percentage (39%) of non-anglers recreating on the river with other boats (often tubes) making up 27%. The number of non-angling river users was estimated over the course of the survey. A total estimate of 2,542 non-anglers recreated on the South River during the survey. The economic value of these users will be presented in another report.

South River - Smallmouth Bass

Smallmouth Bass were the most sought after species by anglers in 2016 receiving 60% of the fishing effort. Biologists often look at the catch rate (No. fish caught per hour of fishing) as an indicator of the fishing quality. Fisheries professionals across the country consider a good catch rate for some sportfish species to be 1-2 fish per hour. The catch rate for Smallmouth Bass in 2016 was excellent at 4.8 bass per hour which was much greater than 2005 (1.6) or 2011 (0.8) (Figure 5). An estimated 81,515 Smallmouth Bass were caught during the 2016 survey which is an increase from 68,551 in 2005. The majority (86%) were <11" with 14% being in the 11-14" range. There were very few Smallmouth Bass caught greater than 14 inches during the survey. The Smallmouth Bass fishery in the South River could be considered a catch-and-release fishery since 100% of the smallmouths caught by anglers were released during the survey. Obviously the creel clerks didn't interview every angler fishing the river in 2016 and VDGIF acknowledges that some Smallmouth Bass harvest may have occurred that was missed. In 2005 creel

clerks recorded 84 Smallmouth Bass harvested and in 2011 the number dropped to only five Smallmouth Bass. The catch-and-release practice among bass anglers fishing the Shenandoah River Watershed has steadily increased since the 1970's.

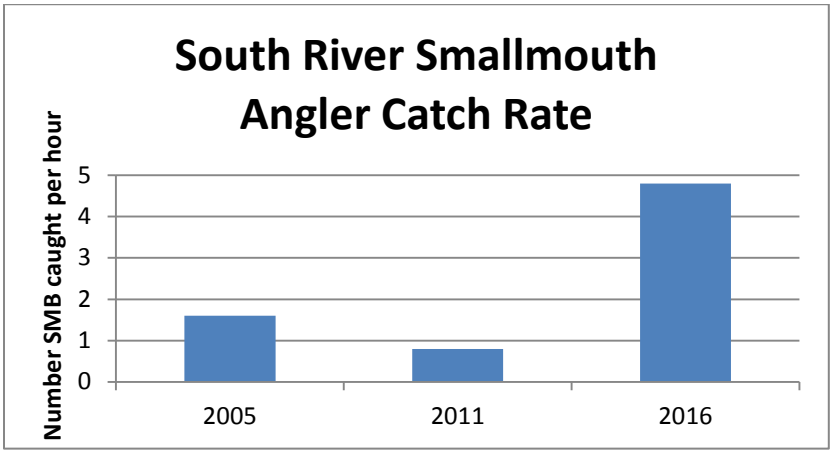

Figure 5. Smallmouth Bass angler catch rate in 2005, 2011 and 2016.

South River - Largemouth Bass

The South River contains a small Largemouth Bass fishery to complement the Smallmouth Bass. The majority of Largemouth Bass are found in the deeper pools. Fifteen percent of the overall fishing effort was directed toward Largemouth Bass in 2016. An estimated 3,349 Largemouth Bass were caught and released by anglers in 2016. Creel clerks did not interview anyone that indicated that they had harvested a largemouth during the survey. As with Smallmouth Bass, it appears that the Largemouth Bass fishery in the South Fork is also predominately catch-and-release.

South River - Trout Fishing

Trout anglers made up 11% of the fishing effort in 2016. The majority (58%) of these anglers were interviewed in the Grand Caverns and Grottoes section of the river. Only three trout anglers were interviewed after May 30th. Angler catch rate of trout was good at 2.3 fish per hour. An estimated 1,184 trout were caught during the 2016 survey period. This number would likely be much higher if a year around survey is conducted on the South River.

South River - Other species

The total catch for all species was estimated at 111,049 fish. The only fish observed harvested were a few trout. Other fish species that were caught by anglers on the South River in 2016 include: Sunfish, Fallfish, White Sucker, Bluehead Chubs and Channel Catfish.

South Fork Shenandoah River Results/Discussion

South Fork - Creel Clerk Effort

A roving angler survey was conducted on South Fork Shenandoah River (Port Republic to Front Royal) from May 1st – September 5th during 2016. Similar roving surveys were conducted in 1997 and 2011 while an access survey was conducted in 2008. Roving surveys were determined to have a better estimation of angler information and will be used in future surveys. There were 287 anglers interviewed over 72.8 miles of the 97 river miles in 2016. The survey reaches in 1997, 2011 and 2016 were very similar. The creel clerks spent 71 days interviewing anglers on the South Fork Shenandoah River in 2016.

July and August were the most heavily sampled, with 21 and 18 trips respectively. May and September had a limited number of samples. Unsafe river conditions during May limited the number of days that could be sampled that month and the end of the survey in September only included the Labor Day weekend. During the five month period there were 957 individuals observed recreating that were not fishing. A total of 1,337 individuals were counted, 380 were fishing and 957 were enjoying other forms of river recreation.

South Fork - Angler Effort

Angler effort (fishing pressure) was estimated at 50,828 angler trips for a total of 98,223 hours of fishing pressure. The average time spent fishing by an angler before being interviewed was 1.93 hours. Fishing pressure increased roughly 18% in 2016 when compared to 2011 on the South Fork. Higher fishing pressure in 1997 is due to extra months sampled. The average fishing pressure over the last three surveys from 2008, 2011 and 2016 is 87,381 hours. So fishing pressure seems to have remained stable over the last 8 years despite periodic fish mortality events (Figure 6).

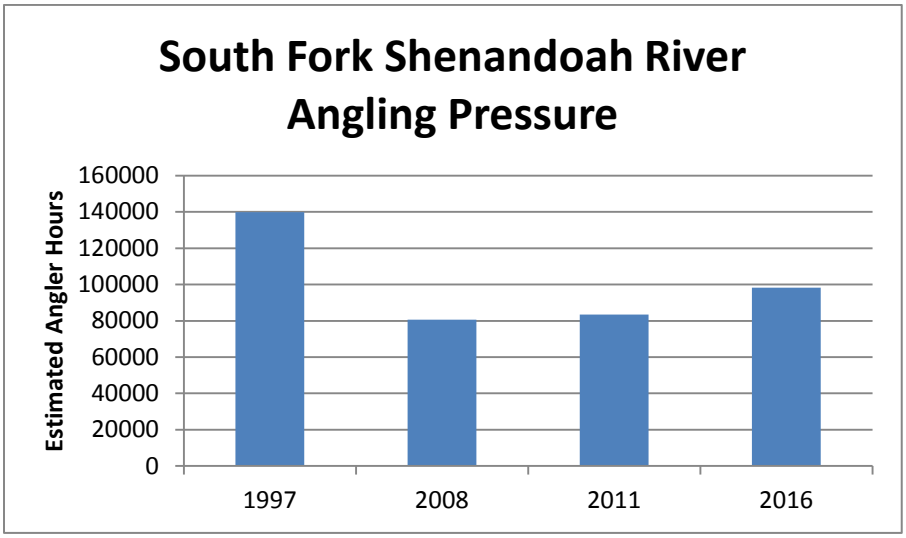

Figure 6. Angler pressure in hours for 1997, 2008, 2011 and 2016

Anglers fishing from the bank or wading comprised 46% of the effort in 1997 and 2011. This percentage reduced slightly to 41% in 2016. The majority (44%) of anglers said the number of their fishing trips had remained the same over the past few years. Thirty-five said their trips had increased while only 14% said they had declined. Six percent were out for their first fishing trip on the South Fork. Of those anglers indicating a decrease in trips the majority (79%) said it was due to less free time. Only 2% of anglers were fishing with a guide. The most sought after species was Smallmouth Bass (67%) followed by Largemouth Bass (12%) and generalist (9%). Seven percent of the anglers were targeting Channel Catfish. The Channel Catfish estimate is likely low because we do not conduct nighttime angler surveys when Channel Catfish are most likely targeted. A breakdown of the species that anglers targeted in 2016 is expressed in (Figure 7). Interviewing anglers electronically through websites or social media may be able to capture Channel Catfish data more accurately in the future.

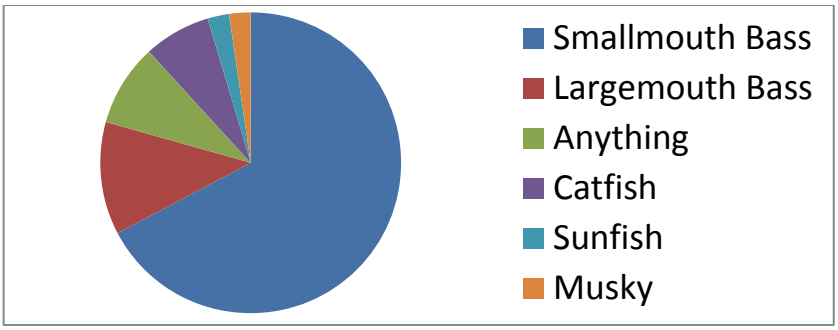

Figure 7. South Fork Shenandoah River angler species preference

South Fork - Angler Characteristics

The dominant angler type on South Fork in 2016 was an adult with an average age of 42, Caucasian (92%) and male (89%). The next largest ethnic groups were Hispanics (5%) and African Americans (3%). These numbers are similar to the 1997 angler survey and the 2016 South River survey.

The South Fork Shenandoah River could be classified as a "local" fishery as the majority (85%) of the anglers interviewed were Virginia residents. When asked which County or City they were from 23% of anglers answered Rockingham County while 20 % were from Page County and 15% were from Warren County. Non-resident anglers contributed 15% to the survey total with 43% originating from Maryland. Most anglers were fishing from watercraft (59%) with 41% of anglers wading or fishing from the bank. This was opposite of South River and may be due to better river access for canoes and kayaks on the South Fork. The bank or boat fishing numbers are similar to the previous surveys in 1997, 2008 and 2011 with a few more boat anglers over time. In 2008 angler satisfaction was fair on the South Fork at 75%. In 2011 this percentage increased to 89%. South Fork angler satisfaction again increased in 2016 with 94% of the anglers interviewed indicating they were either "satisfied, moderately satisfied, to greatly satisfied."

South Fork - Fish Consumption Advisory

One of the main objectives of this study was to determine angler knowledge of the fish consumption advisory that has been imposed since 1977 on South Fork Shenandoah River from Port Republic to Front Royal. In 2016 when anglers were asked if they keep their catch only 1% said they harvested fish, all other anglers practiced catch-and-release. When asked why they practice catch-and-release 56% said it was an ethical choice, 22% believes it helps the population, 13% don't eat fish and 8% stated it was due to the fish consumption advisory. Only one angler said it was due to fish mortality events. While the fish consumption advisory was the main reason why anglers practiced catch-and-release in the South Fork during the 2008 survey (83%), that reason declined to 46% in 2011 and to only 8% in 2016. Although when asked another similar question in the 2016 survey 28% of anglers said the advisory would keep them from harvesting fish.

Only 75% of the South Fork fishing public knew about the consumption advisory compared to 87% on the South River. More anglers (85%) indicated that they were aware of the fish consumption advisory on the South Fork in 2011. The overall number has increased from 46% in 1997 to 75% in 2016 (Figure 8). It's worth noting that 15% of anglers interviewed on the South Fork were from out of state and only 43% of these anglers were aware of the consumption advisory. Only 40% of Hispanic anglers were aware of the fish consumption advisory. However, only one Hispanic angler that was not aware of the advisory was considered a local angler.

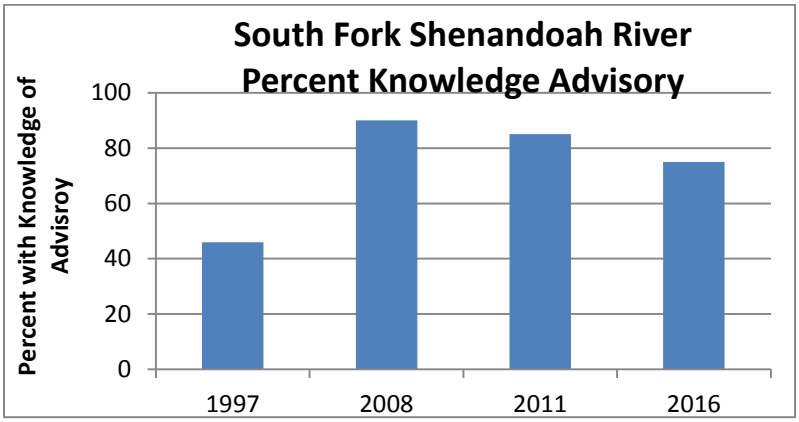

Figure 8. Percent of anglers with knowledge of fish consumption advisory on the South Fork Shenandoah River.

When anglers were asked how they knew about the advisory, 46% received their information from word of mouth, 45% from signage posted along the river and 7% stated they knew of the advisory through the internet. The other 2% received their information from brochures, newspaper and by other means.

South Fork - Angler Expenditures

In 2016 anglers were asked how much money they spent on their fishing trip. That would include expenses for gasoline, food, bait, tackle, canoe rental, lodging etc. Anglers were asked two questions about their spending habits regarding the South Fork Shenandoah River: 1) How much they spent per day on all commodities and 2) How much of that was spent within 30 miles of the river? The highest amount was spent in June, followed by July and August (Figure 9). The estimated total spent by anglers on the South Fork during the survey period was $2,744,161. Eighty percent was spent within 30 miles of the river, further defining the local economic impact ($2.2 million) the fishery contributes.

The South Fork Shenandoah River fishery is very important economically to the Commonwealth and localities. Non-anglers that recreate on the South Fork greatly outnumber fishermen. Additional data about recreational users of the South Fork needs to be analyzed before a better estimate of the economic value of this natural resource can be determined.

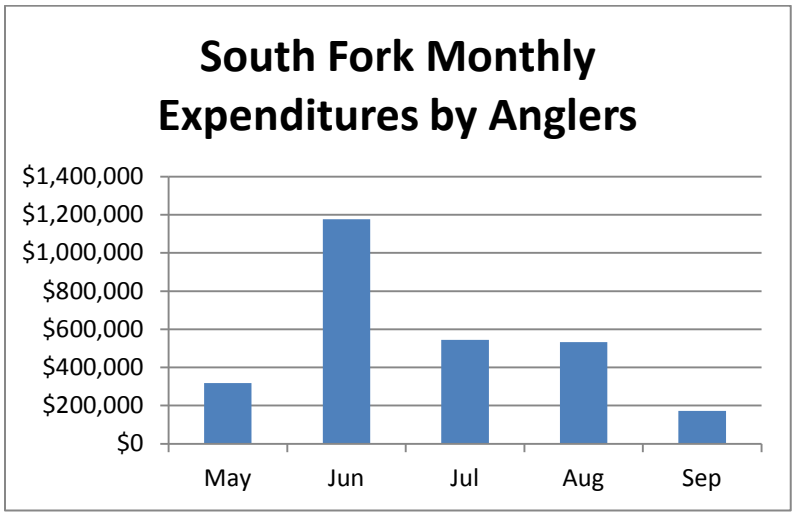

Figure 9. Estimated angler expenditures on South Fork Shenandoah River during the 2016 survey.

South Fork - Other Users

The primary intent of this survey was to determine fish consumption advisory knowledge, to estimate fishing pressure and collect other angling information to help fisheries biologists improve management of the fishery resource. The South Fork Shenandoah River is a huge recreation destination for many Virginia residents and non-residents. Its proximity to the booming Northern Virginia population makes it a hotspot for recreation. Therefore, a secondary objective was to estimate the number of non-anglers that recreate on the South Fork Shenandoah River. Creel clerks were asked to count boats (canoes, kayaks, tubes, jon-boats etc.) and individual people using the river that were not fishing (boating, swimming) each survey day. During the survey period, an estimated 4,595 canoes, 6,830 kayaks, and 8,051 other boats (mostly tubes) carrying non-anglers used the South Fork during the survey period (Figure 10). Adding individuals observed swimming or wading to the people in boats brought the total estimated number of non-anglers recreating in the South Fork during the survey period to 28,701. This number was generated from creel clerks observing 957 non-anglers during the survey. These non-anglers were interviewed by the creel clerks. Results of the economic impact these recreational river users are having on the Commonwealth's economy will be illustrated in a separate report.

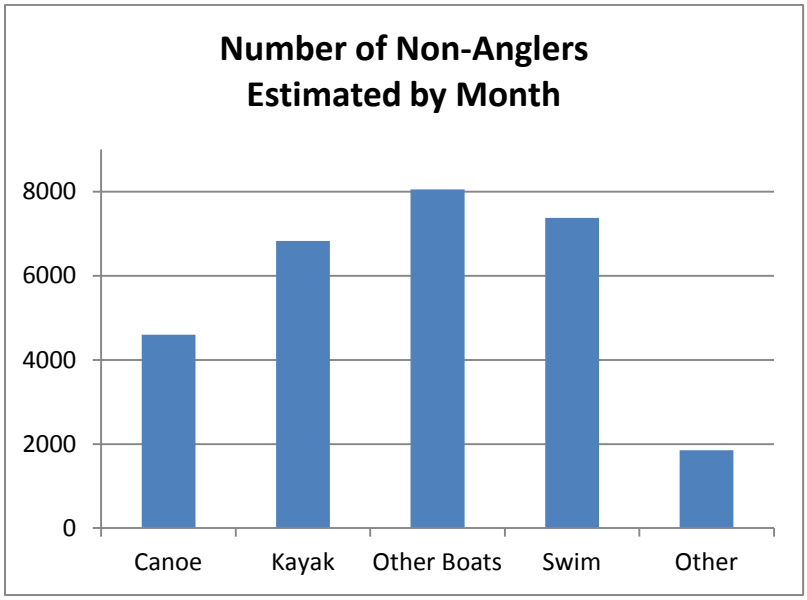

Figure 10. Estimated number of non-angling recreational users on the South Fork Shenandoah River during the 2016 survey.

South Fork - Smallmouth Bass

Smallmouth Bass were the most sought after species by anglers in 2016 receiving 67% of the fishing effort. Smallmouth Bass have remained the preferred species by anglers since the 1997 survey. Biologists often look at the catch rate (No. fish caught per hour of fishing) as an indicator of the fishing quality. The catch rate for Smallmouth Bass in 2016 was 2.3 bass per hour. This has remained relatively consistent since 1997 (Figure 11). An estimated 177,042 Smallmouth Bass were caught during the 2016 survey. The majority 75% were <11" with 19% being in the 11-14" range. Only 6% of the smallmouth caught and released were >14" in length. The sizes and sometimes numbers of Smallmouth Bass caught by anglers in a given year is often a good "picture" of the fish currently in the population. Figure 12 illustrates the size of smallmouth caught in previous angler surveys and Figure 13 indicates how the 2016 catch relates to the size structure of the bass population measured by biologists through electrofishing.

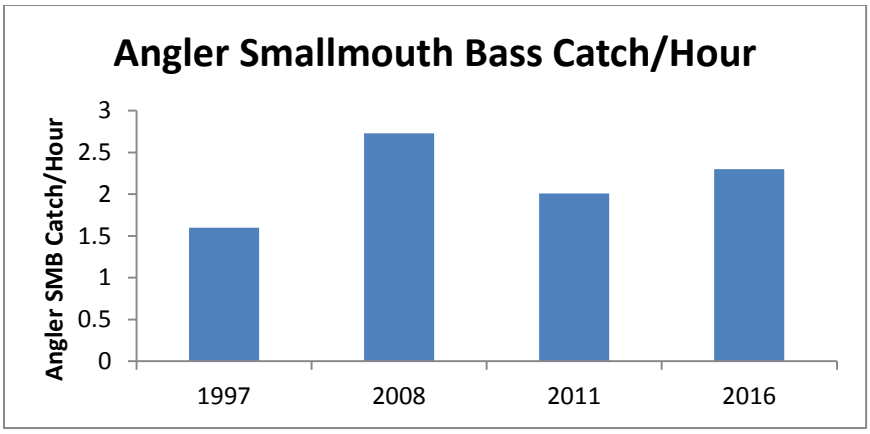

Figure 11. Smallmouth Bass angler catch rate in 1997, 2008, 2011 and 2016 on the South Fork Shenandoah River.

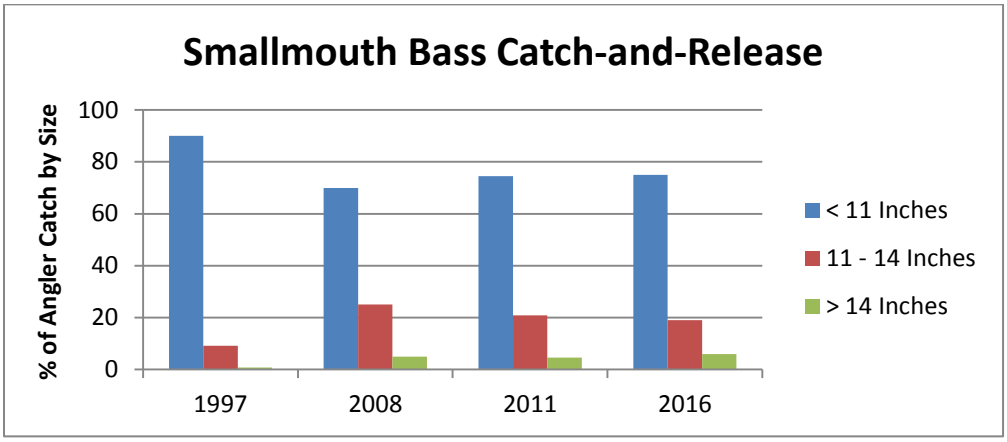

Figure 12. Size of Smallmouth Bass caught and released in 1997, 2008, 2011 and 2016 during the angler surveys on the South Fork Shenandoah River.

The Smallmouth Bass fishery in the South Fork Shenandoah could be considered a catch-and-release fishery since 100% of the catch was released during the 2016 survey. Again, VDGIF acknowledges that not all anglers on the river were interviewed during 2016 so there may have been some harvest that was not recorded, but creel clerks did not observe any Smallmouth Bass harvested. In 2011 almost all of the Smallmouth Bass caught (99%) were released. The catch-and-release practice among bass anglers fishing the South Fork Shenandoah River has steadily increased for varied reasons since the 1970's.

Smallmouth Bass anglers were asked what they would consider being the "perfect day" on the South Fork. We then gave them a series of scenarios indicating the number of fish they caught and the largest smallmouth captured. Forty-two percent of Smallmouth Bass anglers said that their "perfect" day fishing the South Fork Shenandoah would be to catch 5 Smallmouth Bass with the largest being 20 inches long. These results were very similar to the 2011 survey. In 2008 anglers indicated that catching 15 Smallmouth Bass with the largest being 18 inches would be a "perfect" fishing day. Smallmouth Bass anglers were also asked what they considered to be the minimum size of a "quality-size" Smallmouth Bass. They were given multiple choices from 10 to >18 inches. The vast majority of smallmouth anglers indicated bass 10-14 inches are preferred, with most centering on 12 inches. This has remained consistent over the last three angler surveys.

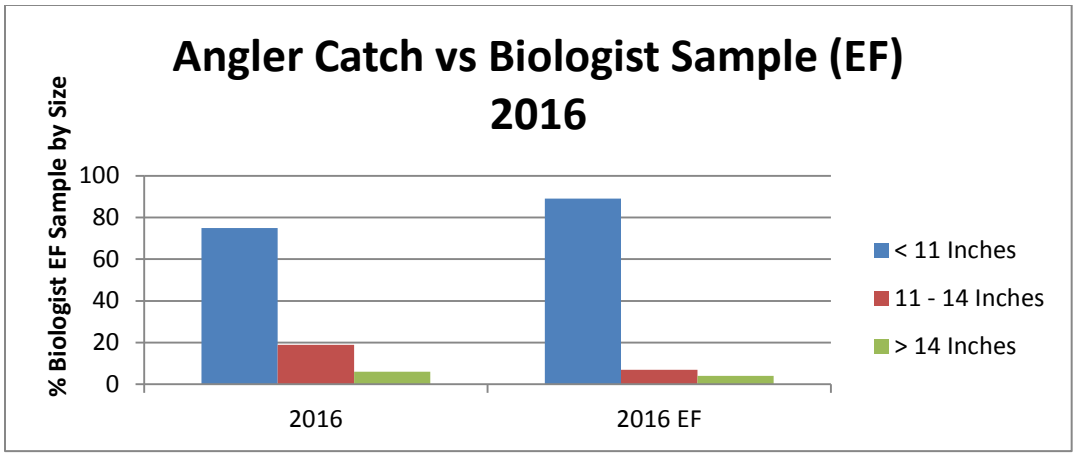

Figure 13. Comparison of 2016 angler catch-and-release of Smallmouth Bass size and biologist electrofishing sample of Smallmouth Bass size.

South Fork - Largemouth Bass

Unlike other smallmouth rivers across Virginia, the South Fork Shenandoah River harbors a sizeable Largemouth Bass fishery. The Largemouth Bass population has been steadily increasing since the 1970's and currently can comprise 50% of the total black bass population in some reaches of the South Fork. The majority of Largemouth Bass are found in the deeper pools and impounded pools upstream of dams on the South Fork. Twelve percent of the overall fishing effort was directed toward Largemouth Bass in 2016. An estimated 12,134 Largemouth Bass were caught and released by anglers in 2016. Creel clerks did interview a few anglers that indicated that they had harvested a largemouth during the survey. The estimated number of Largemouth Bass harvested during the survey was 327 which was only 2.6% of the total catch. Anglers targeting Largemouth Bass caught just over one fish per hour (Figure 14). As with Smallmouth Bass, it appears that the Largemouth Bass fishery in the South Fork is also predominately catch-and-release.

South Fork - Sunfish

Several species of sunfish are represented in the South Fork Shenandoah River. The two most common sunfish species are the Redbreast Sunfish and Bluegill. Abundance of Rock Bass, pumpkinseed sunfish, and green sunfish is generally lower. The 2016 survey estimated the sunfish catch to be 24,629 during the survey. Sunfish harvest was fairly light with 86% being released. Fishing effort directed at catching sunfish was 2.3% in 2016.

South Fork - Channel Catfish

While catfish can be caught during daylight hours, most anglers fish for them after dark when they are more active. Since the 2016 angler survey was conducted during the day, the estimates for catfishing pressure, catch and harvest is heavily underestimated. VDGIF has never conducted an angler survey at night predominantly due to logistical and safety reasons. An estimated 3,386 Channel Catfish were caught during the survey period, with a large number 51% being harvested. The catch rate for catfish was very good at 2.1 fish per hour. Seven percent of the overall fishing pressure was directed toward catfish in 2016. As expected, the majority of catfish anglers were fishing from shore.

South Fork - Muskellunge

VDGIF began stocking muskellunge in the South Fork Shenandoah River over 20 years ago to provide a "trophy" component to the fishery. A muskellunge habitat survey was conducted on the South Fork in the mid 1990's and annual stockings in the best habitat locations have occurred in the past 15 years. While fish are typically stocked annually, there is some level of natural reproduction occurring. During the past 8 years biologists have studied the Musky population in the South Fork Shenandoah River to estimate the contribution of stocked muskellunge to the population. Approximately 66% of Musky in recent VDGIF surveys come from annual stockings. Therefore, an estimated 34% of Musky collected in the sample spawned naturally in the river. In 2016, an estimated 316 muskellunge were caught by anglers (all were released). Approximately 2% of the overall fishing effort was directed toward muskellunge on the South Fork in 2016. All anglers were asked if they had caught or fished for Musky in the past five years. Eleven percent of the anglers interviewed said that they had caught a Musky in the past five years. Fourteen percent indicated they had fished for Musky in the past 5 years on the South Fork. VDGIF also has anecdotal information that fishing for muskellunge has increased in popularity on the South Fork over the last decade. However, the current angler survey methods do not provide adequate information for VDGIF's muskellunge management needs. As with nighttime Channel Catfish anglers VDGIF will also continue to pursue other ways of gathering Muskellunge angler and effort data.

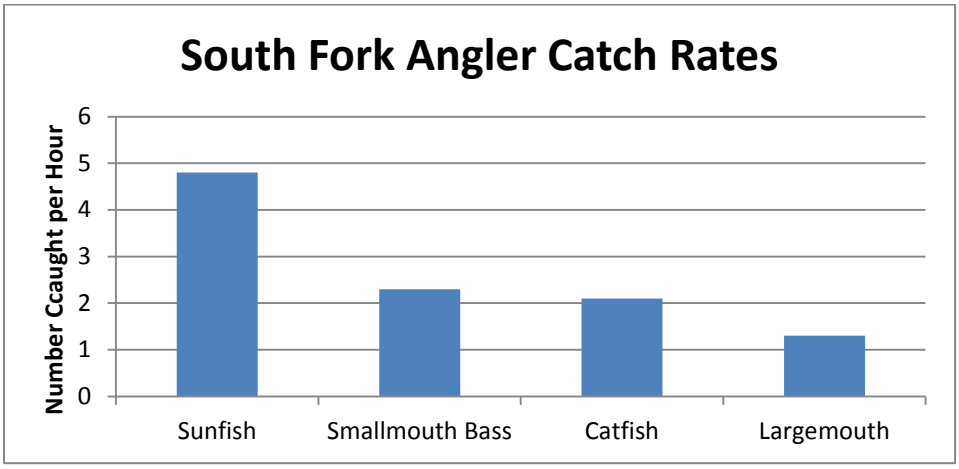

Figure 14. Angler catch rates by species they were targeting

South Fork - Other species

The total catch for all species was estimated at 220,016 fish. Most fish were released, but the most heavily harvested species were sunfish and Channel Catfish, respectively. Other fish species that were caught by anglers in 2016 include: black crappie, Fallfish, White Sucker, and Yellow Bullhead. There was no harvest reported for any of these species and they only contributed one percent of the total catch for all species.

Acknowledgements

I would like to thank creel clerks Collin George, Hunter Ritchie, Jessie Doyle, Lindsey Carpenter and Tony Villeda for their diligence, commitment, and professionalism while conducting this angler survey. They were always reliable, communicated well, and did an outstanding job! I wish them well in their future endeavors. Lastly, this project would not have been possible without the funding provided by DuPont and working with James Madison University for creel clerk administration services.

Appendix A

2016 South River Angler Survey Questionnaire

Date:_____ Interview #:_____ Time:_____ Reach:_____ Verbal Consent _____
Completed Trip: (circle one) Yes / No **Actual Age_____**
First Interview Y N
Is N ask 1-4 and 19-25

1) How long have you been fishing today? _____hours

2) How much longer do you plan on fishing? _____hours

3) Fishing from: a) bank/wade b) powered boat c) kayak d) raft e) canoe f) Other _____

4) Fishing with a guide? Y N

5 In general, how satisfied are you with fishing in the South River?
1 2 3 4 5 (circle one)
Not very Extremely

6) What type of fish are you hoping to catch? If they state "anything" or "doesn't matter" circle *Anything* below and ask them which they would prefer to catch. (circle one) Smallmouth Bass / Trout / Sunfish-Bream-Rockbass-Crappie / Catfish / Largemouth Bass / *Anything* / Other_____

7) Are you: a) Spin Fishing b) Fly Fishing c) Combination

8) Do you keep, release or a combination of keep and release the fish you catch? ___Keep ___Release ___Combination **If Release, go to Question 12.**

****Only ask these questions if they answer Keep or Combination to Question 8.**
9) Do you eat the fish you keep? Yes No **If No, then go to Question 11.**
10) In general, how many and what type of fish from the South River do you eat each month? ____Smallmouth Bass ____Trout ____Sunfish/Bream/Crappie ____Rockbass ____Catfish ____Largemouth Bass ____Other

11) When you keep fish from this river do you share your catch with family or friends? Yes No

****Only ask these questions if they answer Release to Question 8.**
12) How many fish have you released today? ____Smallmouth Bass ____Trout ____Sunfish/Bream/Crappie ____Rockbass ____Catfish ____Largemouth Bass ____Other

13) Ask which of the following reasons do you release the fish? (circle one) Catch-and-Release Angler / Health Advisory / Too Small Already Limited Out / Other

****Resume asking questions to angler.**
14) Do you know there is a fish consumption advisory on this river? Yes No
If no, explain the advisory, hand the angler a brochure explaining the advisory and **continue to Question 17**.

15) If Yes to number 14: How do you know about the fish advisory? (circle one) Facebook / Social Media Posted Advisory Signs / Word of Mouth / Newspaper / Radio / Brochure / Website / Other

16) If Yes to number 14: Do you know what the fish advisory in the river is for?
Answered Correctly / Answered Incorrectly

17) Why do you like to fish the South River? (circle one) Quality of Fishing / Scenery / Close to Home
All of the Above / Other

18) What do you not like about the South River? (circle one) Quality of Fishing / Too Crowded
Pollution / Other

19) How much money did you spend on this fishing trip just today? _____ Give examples: this may include gas, food, drink, bait, lodging, etc.

20) Of this amount, how much did you spend in the immediate area (within 20 miles)?_____

21) How many times per year do you fish on South River?
(circle one) 1 – 5 / 6 – 10 / 11 – 20 / >20

22) Where are you from? City/County_____ State _____ ZIP code_____

<u>Don't Ask – Just answer 23 – 25 on appearance and interview knowledge.</u>

23) (circle one) Male or Female

24) Ethnicity (circle one): White Hispanic Black Arabian Eastern Europe (Russian) Asian Other

25) How many Smallmouth Bass did you catch and release today?

A) _____<11" B) _____ 11-14" C) _____ >14"

How many other fish did you catch and release today?

If you harvested **<u>any</u>** fish, can we please measure them? If no, that's OK.

Species	No. Caught & Released	Species	No. Harvested	Size (mm)

SMB = Smallmouth Bass LMB = Largemouth Bass RDB = Redbreast Sunfish ROB = Rock Bass
BLG = Bluegill PKS = pumpkinseed BLC = black crappie CCF = Channel Catfish YEB = Yellow Bullhead
WAE = walleye MUE = Musky AME = American eel FAF = Fallfish WHS = White Sucker
NHS = N. hogsucker SHR = shorthead redhorse CAP = common carp RBT = Rainbow Trout BRT = Brown Trout
BKT = Brook Trout

Comments:

Appendix B

2016 South Fork Shenandoah River Survey Angler Questionnaire

Date:_____ Interview #:_____ Time:_____ Reach:_____ Verbal Consent _____
Completed Trip: (circle one) Yes / No **Actual Age _____**
First Interview Y N
1) How long have you been fishing today? _____hours **If N ask 1-4 and 25 - 33**

2) How much longer do you plan on fishing? _____hours

3) Fishing from: a) canoe b) powered boat c) kayak d) raft e) bank/wade f) Other _____

4) Fishing with a guide? Y N

5) Has your number of fishing trips increased, decreased, or remained the same in the last few years?
____ Increased _____ Decreased _____ Remained the same _____ First time ever fishing Shenandoah River

Only ask question 6 if they answered "Decreased" for question number 5.

6) What is the **main** reason for this decline? (choose only one**) Only give them these choices if they cannot come up with any reasons of their own.**
_____ Fish Consumption Advisory ____ Fish Kill/Disease ____ Less Free Time _____ Other Reason

7) What type of fish are you hoping to catch? If they state "anything" or "doesn't matter" circle *Anything* below and ask them which they would **prefer** to catch. (circle one) Smallmouth Bass / Sunfish-Bream-Rockbass-Crappie / Catfish / Largemouth Bass / Musky / *Anything* / Other_____

**** Only ask questions 8-10 to anglers who said they were fishing for Smallmouth Bass**
8) Of the following scenarios, which would be the best fishing day for you?
____ I caught 50 Smallmouth Bass, the biggest one was 10 inches long?
____ I caught 30 Smallmouth Bass, the biggest one was 14 inches long?
____ I caught 15 Smallmouth Bass, the biggest one was 18 inches long?
____ I caught 5 Smallmouth Bass, the biggest one was 20 inches long?

9) What do you consider to be the minimum size of a quality Smallmouth Bass?
a) 10" b) 12" c) 14" d) 16" e) 18" or > (circle one)

10) Would you harvest any legal-size Smallmouth Bass? Y N

11) Do you know there is a fish consumption advisory on this river? Y N
If no, explain the advisory, hand the angler a brochure explaining the advisory and **continue to Question 14**

12) If Yes to number 11: How do you know about the fish advisory? (circle one) Facebook / Social Media Posted Advisory Signs / Word of Mouth / Newspaper / Radio / Brochure / Website / Other

13) Do these fish consumption advisories keep you from eating fish from the SF Shenandoah River? Y N

14) Do you ever harvest fish from the SF Shenandoah River? Y N

15) Do you practice catch-and-release of legal-size fish? Y N

16) If Yes, ask which of the following? (circle one) a) Practice the Ethic b) Don't Eat Fish
c) Think it helps the population d) Health Consumption Advisories e) Fish Kill Issues

17) Have you caught any Musky on the SF in the last 5 years, even if you were not fishing for them? Y N
18) Have you fished just for Musky on the SF Shenandoah River in the last 5 years? Y N
Yes: Go to questions 19-24 No: Go to question 25
19) How many days in a year do you fish just for Musky? _____
20) How many hours do you fish for Musky on an average trip? _____
21) Over the past 5 years has your Musky catch rate on the SF Shenandoah River:
Increased Decreased Remained the Same Don't Know / Not Sure
22) Over the past 5 years has your Musky encounter/follow rate on the SF Shenandoah River:
Increased Decreased Remained the Same Don't Know / Not Sure
23) Do you harvest any Musky you catch? Y N
24) How satisfied are you with the Musky fishery in the SF Shenandoah?
Low 1 2 3 4 5 High (circle one)

25) What Virginia County do you live in? _____ZIP code_____

26) If you are a non-resident, what state do you call home? _____ZIP code_____

27) How much money did you spend on this fishing trip just **today**? _____ Give examples: this may include gas, food, drink, bait, lodging, etc.
28) Of this amount, how much did you spend in the immediate area (within 30 miles)?_____

29) In general, how satisfied are you with fishing in the SF Shenandoah River?
1 2 3 4 5 (circle one)
Not very Extremely
Don't Ask – Just answer 29 – 31 on appearance and interview knowledge.
30) (circle one) Male or Female
31) Ethnicity (circle one): White Hispanic Black Arabian Eastern Europe (Russian) Asian Other

32) How many Smallmouth Bass did you catch and release today?

A) _____<11" B) _____ 11-14" C) _____ >14"
How many other fish did you catch and release today?
If you harvested **any** fish, can we please measure them? If no, that's OK.

Species	No. Caught & Released	Species	No. Harvested	Size (mm)

SMB = Smallmouth Bass LMB = Largemouth Bass RDB = Redbreast Sunfish ROB = Rock Bass
BLG = Bluegill PKS = pumpkinseed BLC = black crappie CCF = Channel Catfish YEB = Yellow Bullhead
WAE = walleye MUE = Musky AME = American eel FAF = Fallfish WHS = White Sucker
NHS = N. hogsucker SHR = shorthead redhorse CAP = common carp

Appendix D

Data Verification Module Narratives

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** LONG TERM MON SPIDERS-EARTHWORMS 2014 **Validation Options:** LABSTATS

Validation Reason Code: The result is estimated since the concentration is between the method detection limit and practical quantitation limit.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
BG14-SF31-SOIL-01	07/15/2014	DPC1420-16	Mercury	0.6807	MG/KG	MDL	0.0005	1.2	J	1631		
BG14-SF31-SOIL-02	07/16/2014	DPC1420-17	Mercury	1.0626	MG/KG	MDL	0.0005	1.2	J	1631		
BG14-SF50-SOIL-01	07/15/2014	DPC1420-19	Mercury	0.3282	MG/KG	MDL	0.0005	1.2	J	1631		
BG14-SF50-SOIL-02	07/16/2014	DPC1420-20	Mercury	0.666	MG/KG	MDL	0.0005	1.2	J	1631		
BG14-SF50-SOIL-03	07/16/2014	DPC1420-21	Mercury	0.2534	MG/KG	MDL	0.0005	1.2	J	1631		
BG14-SF66-SOIL-01	08/18/2014	DPC1420-22	Mercury	0.3893	MG/KG	MDL	0.0005	1.2	J	1631		
BG14-SF66-SOIL-02	08/18/2014	DPC1420-23	Mercury	0.4002	MG/KG	MDL	0.0005	1.2	J	1631		
BG14-SF66-SOIL-03	08/18/2014	DPC1420-24	Mercury	0.4529	MG/KG	MDL	0.0005	1.2	J	1631		
BG14-SF85-SOIL-01	08/19/2014	DPC1420-25	Mercury	0.4201	MG/KG	MDL	0.0005	1.2	J	1631		
BG14-SF85-SOIL-02	08/19/2014	DPC1420-26	Mercury	0.4404	MG/KG	MDL	0.0005	1.2	J	1631		
BG14-SF85-SOIL-03	08/19/2014	DPC1420-27	Mercury	0.6683	MG/KG	MDL	0.0005	1.2	J	1631		
BG14-SR-2.7-SOIL-01	07/14/2014	DPC1420-04	Mercury	0.0687	MG/KG	MDL	0.0005	1.2	J	1631		
BG14-SR-2.7-SOIL-02	07/16/2014	DPC1420-05	Mercury	0.0721	MG/KG	MDL	0.0005	1.2	J	1631		
BG14-SR-2.7-SOIL-03	07/16/2014	DPC1420-06	Mercury	0.1586	MG/KG	MDL	0.0005	1.2	J	1631		
BG14-SR-6.2-SOIL-01	07/14/2014	DPC1420-01	Mercury	0.0626	MG/KG	MDL	0.0005	1.2	J	1631		
BG14-SR-6.2-SOIL-02	07/16/2014	DPC1420-02	Mercury	0.0336	MG/KG	MDL	0.0005	1.2	J	1631		
BG14-SR-6.2-SOIL-03	07/16/2014	DPC1420-03	Mercury	0.0457	MG/KG	MDL	0.0005	1.2	J	1631		
EB071514-1	07/15/2014	DPC1415-02	Mercury	4.2e-007	MG/L	MDL	2e-007	5e-007	J	1631		
EB071614-1	07/16/2014	DPC1415-03	Mercury	4.3e-007	MG/L	MDL	2e-007	5e-007	J	1631		

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** VADEQ SURFACE WATER 1/14 **Validation Options:** LABSTATS

Validation Reason Code: High relative percent difference (RPD) observed between field duplicate and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0114-MAIN-A	01/28/2014	7351739	Nitrogen	1.5	MG/L	MDL	0.040	0.10	J	353.2		
SW0114-MAIN-A-D	01/28/2014	7351740	Nitrogen	2.8	MG/L	MDL	0.040	0.10	J	353.2		

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 2/14 **Validation Options:** LABSTATS

Validation Reason Code: The analysis hold time for this sample was exceeded by a factor of 2. The reported non-detect result is unusable.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1Q14-EB-22614	02/26/2014	1409035-29	Total Suspended Solids	0.3	MG/L	MDL	0.3	1.0	R	160.2		
SW1Q14-PORT-B	02/26/2014	1409035-27	Total Suspended Solids	0.3	MG/L	MDL	0.3	1.0	R	160.2		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 2/14 **Validation Options:** LABSTATS

Validation Reason Code: High relative percent difference (RPD) observed between field duplicate and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1Q14-MAIN-A-DZ	02/26/2014	7378150	Dissolved Organic Carbon	3700	UG/L	MDL	500	1000	J	5310 C-2000		
SW1Q14-MAIN-A-Z	02/26/2014	7378148	Dissolved Organic Carbon	1400	UG/L	MDL	500	1000	J	5310 C-2000		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 2/14 **Validation Options:** LABSTATS

Validation Reason Code: Quality review criteria exceeded between the REP (laboratory replicate) and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1Q14-MAIN-B	02/26/2014	1409035-07	Total Suspended Solids	2.7	MG/L	MDL	0.3	1.0	J	160.2		
SW1Q14-PORT-A	02/26/2014	1409035-25	Total Suspended Solids	4.4	MG/L	MDL	0.5	1.8	J	160.2		
SW1Q14-HARR-A	02/26/2014	1409035-21	Total Suspended Solids	5.9	MG/L	MDL	0.3	1.0	J	160.2		
SW1Q14-HARR-B	02/26/2014	1409035-23	Total Suspended Solids	6.3	MG/L	MDL	0.3	1.0	J	160.2		
SW1Q14-HOLS-A	02/26/2014	1409035-13	Total Suspended Solids	4.7	MG/L	MDL	0.3	1.0	J	160.2		
SW1Q14-CRIM-A	02/26/2014	1409035-17	Total Suspended Solids	6.2	MG/L	MDL	0.3	1.0	J	160.2		
SW1Q14-CRIM-B	02/26/2014	1409035-19	Total Suspended Solids	5.8	MG/L	MDL	0.3	1.0	J	160.2		
SW1Q14-HOLS-B	02/26/2014	1409035-15	Total Suspended Solids	5.5	MG/L	MDL	0.3	1.0	J	160.2		
SW1Q14-HOPE-B	02/26/2014	1409035-11	Total Suspended Solids	4.4	MG/L	MDL	0.6	2.0	J	160.2		
SW1Q14-LYND-A	02/26/2014	1409035-01	Total Suspended Solids	6.4	MG/L	MDL	0.3	1.0	J	160.2		
SW1Q14-LYND-B	02/26/2014	1409035-03	Total Suspended Solids	6.3	MG/L	MDL	0.3	1.0	J	160.2		
SW1Q14-MAIN-A	02/26/2014	1409035-05	Total Suspended Solids	4.8	MG/L	MDL	0.3	1.0	J	160.2		
SW1Q14-HOPE-A	02/26/2014	1409035-09	Total Suspended Solids	5.3	MG/L	MDL	0.3	1.0	J	160.2		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 2/14 **Validation Options:** LABSTATS

Validation Reason Code: The result is estimated since the concentration is between the method detection limit and practical quantitation limit.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1Q14-MAIN-B	02/26/2014	1409035-07	Methyl Mercury	0.022	NG/L	MDL	0.020	0.050	J	1630		
SW1Q14-HOPE-B	02/26/2014	1409035-11	Methyl Mercury	0.033	NG/L	MDL	0.020	0.050	J	1630		
SW1Q14-MAIN-A-D	02/26/2014	7378149	Sulfate	4.7	MG/L	MDL	1.5	5.0	J	300.0		
SW1Q14-HOLS-B-Z	02/26/2014	1409035-16	Methyl Mercury	0.037	NG/L	MDL	0.020	0.050	J	1630		
SW1Q14-HOPE-A	02/26/2014	1409035-09	Methyl Mercury	0.038	NG/L	MDL	0.020	0.050	J	1630		
SW1Q14-HOLS-A-Z	02/26/2014	1409035-14	Methyl Mercury	0.044	NG/L	MDL	0.020	0.050	J	1630		

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 6-14 **Validation Options:** LABSTATS

Validation Reason Code: Contamination detected in equipment blank(s). Sample result does not differ significantly from the analyte concentration detected in the associated equipment blank(s).

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW2Q14-CRIM-A-Z	06/19/2014	7509834	Dissolved Organic Carbon	2000	UG/L	MDL	500	1000	B	5310 C-2000		
SW2Q14-HARR-A-Z	06/19/2014	7509836	Dissolved Organic Carbon	1800	UG/L	MDL	500	1000	B	5310 C-2000		
SW2Q14-HOLS-A-Z	06/19/2014	7509832	Dissolved Organic Carbon	1700	UG/L	MDL	500	1000	B	5310 C-2000		
SW2Q14-HOPE-A-Z	06/19/2014	7509830	Dissolved Organic Carbon	1600	UG/L	MDL	500	1000	B	5310 C-2000		
SW2Q14-LYND-A-Z	06/19/2014	7509821	Dissolved Organic Carbon	1700	UG/L	MDL	500	1000	B	5310 C-2000		
SW2Q14-MAIN-A-Z	06/19/2014	7509826	Dissolved Organic Carbon	1700	UG/L	MDL	500	1000	B	5310 C-2000		
SW2Q14-MAIN-A-DZ	06/19/2014	7509828	Dissolved Organic Carbon	1500	UG/L	MDL	500	1000	B	5310 C-2000		
SW2Q14-PORT-A-Z	06/19/2014	7509838	Dissolved Organic Carbon	1900	UG/L	MDL	500	1000	B	5310 C-2000		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 6-14 **Validation Options:** LABSTATS

Validation Reason Code: Associated LCS and/or LCSD analysis had relative percent recovery (RPR) values less than the lower control limit but above 10%. The actual detection limits may be higher than reported.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW2Q14-EB-061914-1-Z	06/19/2014	1426007-30	Methyl Mercury	0.020	NG/L	MDL	0.020	0.050	UJ	1630		
SW2Q14-EB-061914-1	06/19/2014	1426007-29	Methyl Mercury	0.020	NG/L	MDL	0.020	0.049	UJ	1630		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 6-14 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values less than the lower control limit. The actual detection limits may be higher than reported.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW2Q14-MAIN-A-D	06/19/2014	7509827	Phosphorus	0.080	MG/L	MDL	0.080	0.10	UJ	365.1		365.1
SW2Q14-PORT-A	06/19/2014	7509837	Phosphorus	0.080	MG/L	MDL	0.080	0.10	UJ	365.1		365.1
SW2Q14-MAIN-A	06/19/2014	7509822	Phosphorus	0.080	MG/L	MDL	0.080	0.10	UJ	365.1		365.1
SW2Q14-HOPE-A	06/19/2014	7509829	Phosphorus	0.080	MG/L	MDL	0.080	0.10	UJ	365.1		365.1
SW2Q14-LYND-A	06/19/2014	7509820	Phosphorus	0.080	MG/L	MDL	0.080	0.10	UJ	365.1		365.1
SW2Q14-HOLS-A	06/19/2014	7509831	Phosphorus	0.080	MG/L	MDL	0.080	0.10	UJ	365.1		365.1
SW2Q14-HARR-A	06/19/2014	7509835	Phosphorus	0.080	MG/L	MDL	0.080	0.10	UJ	365.1		365.1
SW2Q14-CRIM-A	06/19/2014	7509833	Phosphorus	0.080	MG/L	MDL	0.080	0.10	UJ	365.1		365.1

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 6-14 **Validation Options:** LABSTATS

Validation Reason Code: Quality review criteria exceeded between the REP (laboratory replicate) and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW2Q14-HARR-A	06/19/2014	7509835	Total Suspended Solids	3.00	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW2Q14-HOLS-A	06/19/2014	7509831	Total Suspended Solids	3.14	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW2Q14-LYND-A	06/19/2014	7509820	Total Suspended Solids	3.29	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW2Q14-PORT-A	06/19/2014	7509837	Total Suspended Solids	3.14	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW2Q14-MAIN-A	06/19/2014	7509822	Total Suspended Solids	2.43	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW2Q14-HOPE-A	06/19/2014	7509829	Total Suspended Solids	1.86	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW2Q14-CRIM-A	06/19/2014	7509833	Total Suspended Solids	1.71	MG/L	MDL	1.00	3.00	J	2540 D-1997		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 6-14 **Validation Options:** LABSTATS

Validation Reason Code: Associated LCS and/or LCSD analysis had relative percent recovery (RPR) values less than the lower control limit. The reported result may be biased low.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW2Q14-CRIM-A	06/19/2014	1426007-17	Methyl Mercury	1.47	NG/L	MDL	0.020	0.050	J	1630		
SW2Q14-CRIM-A-Z	06/19/2014	1426007-18	Methyl Mercury	1.16	NG/L	MDL	0.020	0.050	J	1630		
SW2Q14-CRIM-B	06/19/2014	1426007-19	Methyl Mercury	1.39	NG/L	MDL	0.020	0.049	J	1630		
SW2Q14-CRIM-B-Z	06/19/2014	1426007-20	Methyl Mercury	1.14	NG/L	MDL	0.020	0.049	J	1630		
SW2Q14-HARR-A	06/19/2014	1426007-21	Methyl Mercury	1.21	NG/L	MDL	0.020	0.049	J	1630		
SW2Q14-HARR-A-Z	06/19/2014	1426007-22	Methyl Mercury	0.862	NG/L	MDL	0.020	0.050	J	1630		
SW2Q14-HARR-B	06/19/2014	1426007-23	Methyl Mercury	1.35	NG/L	MDL	0.020	0.049	J	1630		
SW2Q14-HOLS-A-Z	06/19/2014	1426007-14	Methyl Mercury	0.703	NG/L	MDL	0.020	0.050	J	1630		
SW2Q14-HARR-B-Z	06/19/2014	1426007-24	Methyl Mercury	0.820	NG/L	MDL	0.020	0.049	J	1630		
SW2Q14-HOLS-A	06/19/2014	1426007-13	Methyl Mercury	1.34	NG/L	MDL	0.020	0.050	J	1630		
SW2Q14-HOLS-B	06/19/2014	1426007-15	Methyl Mercury	1.44	NG/L	MDL	0.020	0.050	J	1630		
SW2Q14-HOLS-B-Z	06/19/2014	1426007-16	Methyl Mercury	0.700	NG/L	MDL	0.020	0.050	J	1630		
SW2Q14-HOPE-A	06/19/2014	1426007-09	Methyl Mercury	0.317	NG/L	MDL	0.020	0.049	J	1630		
SW2Q14-HOPE-B-Z	06/19/2014	1426007-12	Methyl Mercury	0.196	NG/L	MDL	0.020	0.050	J	1630		
SW2Q14-HOPE-B	06/19/2014	1426007-11	Methyl Mercury	0.293	NG/L	MDL	0.020	0.050	J	1630		
SW2Q14-HOPE-A-Z	06/19/2014	1426007-10	Methyl Mercury	0.198	NG/L	MDL	0.020	0.050	J	1630		
SW2Q14-MAIN-A	06/19/2014	1426007-05	Methyl Mercury	0.091	NG/L	MDL	0.020	0.050	J	1630		
SW2Q14-PORT-A-Z	06/19/2014	1426007-26	Methyl Mercury	0.867	NG/L	MDL	0.020	0.050	J	1630		
SW2Q14-MAIN-B	06/19/2014	1426007-07	Methyl Mercury	0.078	NG/L	MDL	0.020	0.049	J	1630		
SW2Q14-PORT-B	06/19/2014	1426007-27	Methyl Mercury	1.21	NG/L	MDL	0.020	0.049	J	1630		
SW2Q14-PORT-B-Z	06/19/2014	1426007-28	Methyl Mercury	0.788	NG/L	MDL	0.020	0.050	J	1630		
SW2Q14-PORT-A	06/19/2014	1426007-25	Methyl Mercury	1.21	NG/L	MDL	0.020	0.050	J	1630		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 6-14 **Validation Options:** LABSTATS

Validation Reason Code: Associated LCS and/or LCSD analysis had relative percent recovery (RPR) values less than the lower control limit. The reported result may be biased low.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW2Q14-MAIN-A-Z	06/19/2014	1426007-06	Methyl Mercury	0.049	NG/L	MDL	0.020	0.050	J	1630		
SW2Q14-LYND-B	06/19/2014	1426007-03	Methyl Mercury	0.046	NG/L	MDL	0.020	0.050	J	1630		
SW2Q14-LYND-B-Z	06/19/2014	1426007-04	Methyl Mercury	0.023	NG/L	MDL	0.020	0.050	J	1630		
SW2Q14-LYND-A	06/19/2014	1426007-01	Methyl Mercury	0.037	NG/L	MDL	0.020	0.050	J	1630		
SW2Q14-LYND-A-Z	06/19/2014	1426007-02	Methyl Mercury	0.028	NG/L	MDL	0.020	0.050	J	1630		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 6-14 **Validation Options:** LABSTATS

Validation Reason Code: The result is estimated since the concentration is between the method detection limit and practical quantitation limit.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW2Q14-MAIN-B	06/19/2014	7509842	Total Suspended Solids	2.90	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW2Q14-MAIN-B-Z	06/19/2014	1426007-08	Methyl Mercury	0.047	NG/L	MDL	0.020	0.049	J	1630		
SW2Q14-LYND-B	06/19/2014	7509841	Total Suspended Solids	2.10	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW2Q14-HOPE-B	06/19/2014	7509843	Total Suspended Solids	2.20	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW2Q14-HARR-B	06/19/2014	7509846	Total Suspended Solids	2.70	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW2Q14-EB-061914-1-Z	06/19/2014	7509840	Calcium	0.0621	MG/L	MDL	0.0334	0.200	J	6010B		3010A
SW2Q14-EB-061914-1-Z	06/19/2014	7509840	Dissolved Organic Carbon	510	UG/L	MDL	500	1000	J	5310 C-2000		
SW2Q14-CRIM-B	06/19/2014	7509845	Total Suspended Solids	1.90	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW2Q14-EB-061914-1	06/19/2014	7509839	Calcium	0.0525	MG/L	MDL	0.0334	0.200	J	6010B		3010A

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** VADEQ SURFACE WATER 7/14 **Validation Options:** LABSTATS

Validation Reason Code: High relative percent difference (RPD) observed between field duplicate and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0714-MAIN-A	07/22/2014	7613783	Nitrogen	3.2	MG/L	MDL	0.20	0.50	J	353.2		
SW0714-MAIN-A-D	07/22/2014	7613784	Nitrogen	0.64	MG/L	MDL	0.040	0.10	J	353.2		

Site: Waynesboro South River **Sampling Program:** VADEQ SURFACE WATER 7/14 **Validation Options:** LABSTATS

Validation Reason Code: Quality review criteria exceeded between the REP (laboratory replicate) and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0714-CRIM-A	07/22/2014	7543108	Nitrogen	0.85	MG/L	MDL	0.040	0.10	J	353.2		
SW0714-HARR-A	07/22/2014	7543109	Nitrogen	0.90	MG/L	MDL	0.040	0.10	J	353.2		
SW0714-HOLS-A	07/22/2014	7543107	Nitrogen	0.75	MG/L	MDL	0.040	0.10	J	353.2		
SW0714-HOPE-A	07/22/2014	7543106	Nitrogen	0.74	MG/L	MDL	0.040	0.10	J	353.2		
SW0714-LYND-A	07/22/2014	7543103	Nitrogen	0.92	MG/L	MDL	0.040	0.10	J	353.2		
SW0714-MAIN-A	07/22/2014	7543104	Nitrogen	0.74	MG/L	MDL	0.040	0.10	J	353.2		
SW0714-MAIN-A-D	07/22/2014	7543105	Nitrogen	0.72	MG/L	MDL	0.040	0.10	J	353.2		
SW0714-PORT-A	07/22/2014	7543110	Nitrogen	0.92	MG/L	MDL	0.040	0.10	J	353.2		

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 8/14 **Validation Options:** LABSTATS

Validation Reason Code: Contamination detected in equipment blank(s). Sample result does not differ significantly from the analyte concentration detected in the associated equipment blank(s).

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW3Q14-LYND-A	08/19/2014	1434038-01	Mercury, low level	0.54	NG/L	MDL	0.10	0.40	B	1631		
SW3Q14-LYND-B	08/19/2014	1434038-03	Mercury, low level	0.60	NG/L	MDL	0.10	0.40	B	1631		
SW3Q14-LYND-A-Z	08/19/2014	1434038-02	Mercury, low level	0.29	NG/L	MDL	0.10	0.40	B	1631		
SW3Q14-LYND-B-Z	08/19/2014	1434038-04	Mercury, low level	0.21	NG/L	MDL	0.10	0.40	B	1631		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 8/14 **Validation Options:** LABSTATS

Validation Reason Code: Quality review criteria exceeded between the REP (laboratory replicate) and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW3Q14-PORT-B	08/19/2014	7571120	Total Suspended Solids	1.30	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW3Q14-HARR-B	08/19/2014	7571119	Total Suspended Solids	2.20	MG/L	MDL	1.00	3.00	J	2540 D-1997		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 8/14 **Validation Options:** LABSTATS

Validation Reason Code: The result is estimated since the concentration is between the method detection limit and practical quantitation limit.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW3Q14-MAIN-A	08/19/2014	7571095	Total Suspended Solids	3.00	MG/L	MDL	2.00	6.00	J	2540 D-1997		
SW3Q14-MAIN-B	08/19/2014	7571115	Total Suspended Solids	2.50	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW3Q14-PORT-A	08/19/2014	7571110	Total Suspended Solids	1.50	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW3Q14-LYND-B	08/19/2014	1434038-03	Methyl Mercury	0.047	NG/L	MDL	0.020	0.050	J	1630		
SW3Q14-LYND-A	08/19/2014	7571093	Total Suspended Solids	2.90	MG/L	MDL	1.00	3.00	J	2540 D-1997		
EB-081914-1	08/19/2014	7571112	Alkalinity, Total	0.98	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW3Q14-CRIM-A	08/19/2014	7571106	Total Suspended Solids	1.50	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW3Q14-CRIM-B	08/19/2014	7571118	Total Suspended Solids	1.40	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW3Q14-HARR-A	08/19/2014	7571108	Total Suspended Solids	2.10	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW3Q14-HOLS-A	08/19/2014	7571104	Total Suspended Solids	2.80	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW3Q14-HOPE-A	08/19/2014	7571102	Total Suspended Solids	2.40	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW3Q14-HOPE-B	08/19/2014	7571116	Total Suspended Solids	2.60	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW3Q14-LYND-A	08/19/2014	1434038-01	Methyl Mercury	0.039	NG/L	MDL	0.020	0.050	J	1630		
SW3Q14-LYND-B	08/19/2014	7571114	Total Suspended Solids	2.10	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW3Q14-LYND-B-Z	08/19/2014	1434038-04	Methyl Mercury	0.025	NG/L	MDL	0.020	0.050	J	1630		

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 10/14 **Validation Options:** LABSTATS

Validation Reason Code: Contamination detected in Method Blank(s). Sample result does not differ significantly from the analyte concentration detected in the associated method blank(s).

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW4Q14-SR23.5-A	10/29/2014	1445033-25	Mercury, low level	18.7	NG/L	MDL	2.55	10.2	B	1631		
SW4Q14-SR23.5-B	10/29/2014	1445033-27	Mercury, low level	18.3	NG/L	MDL	2.55	10.2	B	1631		
SW4Q14-SR2.7-B	10/29/2014	1445033-03RE1	Mercury, low level	0.30	NG/L	MDL	0.10	0.41	B	1631		
SW4Q14-SR2.7-A	10/29/2014	1445033-01RE1	Mercury, low level	0.30	NG/L	MDL	0.10	0.41	B	1631		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 10/14 **Validation Options:** LABSTATS

Validation Reason Code: Dissolved result greater than total and difference outside criteria (Detects).

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
EB-102914-1	10/29/2014	7656329	Calcium	0.0654	MG/L	MDL	0.0334	0.200	J	6010B		3010A
EB-102914-1-Z	10/29/2014	7656330	Calcium	0.124	MG/L	MDL	0.0334	0.200	J	6010B		3010A

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 10/14 **Validation Options:** LABSTATS

Validation Reason Code: The result is estimated since the concentration is between the method detection limit and practical quantitation limit.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW4Q14-SR2.7-A	10/29/2014	7656310	Total Suspended Solids	1.30	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW4Q14-SR2.7-A-Z	10/29/2014	1445033-02	Methyl Mercury	0.024	NG/L	MDL	0.020	0.050	J	1630		
SW4Q14-SR2.7-A-Z	10/29/2014	7656311	Dissolved Organic Carbon	920	UG/L	MDL	500	1000	J	5310 C-2000		
SW4Q14-SR2.7-B	10/29/2014	1445033-03	Methyl Mercury	0.044	NG/L	MDL	0.020	0.050	J	1630		
SW4Q14-SR2.7-B	10/29/2014	7656331	Total Suspended Solids	1.20	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW4Q14-SR2.7-B-Z	10/29/2014	1445033-04	Methyl Mercury	0.030	NG/L	MDL	0.020	0.051	J	1630		
SW4Q14-SR23.5-A-Z	10/29/2014	7656328	Dissolved Organic Carbon	960	UG/L	MDL	500	1000	J	5310 C-2000		
EB-102914-1-Z	10/29/2014	7656330	Sodium	0.294	MG/L	MDL	0.167	1.00	J	6010B		3010A
SW4Q14-SF48-A	10/30/2014	7657916	Total Suspended Solids	1.30	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW4Q14-SF48-B	10/30/2014	7657921	Total Suspended Solids	1.50	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW4Q14-SF94-A	10/30/2014	7657918	Alkalinity, Carb.As CaCO3 At pH 8.3	1.8	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW4Q14-SR0.2-A-DZ	10/29/2014	7656318	Dissolved Organic Carbon	650	UG/L	MDL	500	1000	J	5310 C-2000		
SW4Q14-SR0.2-A-Z	10/29/2014	7656316	Dissolved Organic Carbon	600	UG/L	MDL	500	1000	J	5310 C-2000		
SW4Q14-SR0.2-B	10/29/2014	7656332	Total Suspended Solids	1.00	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW4Q14-SR16.5-A-Z	10/29/2014	7656326	Dissolved Organic Carbon	950	UG/L	MDL	500	1000	J	5310 C-2000		
SW4Q14-SR16.5-B	10/29/2014	7656336	Total Suspended Solids	1.30	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW4Q14-SR2.3-A	10/29/2014	7656319	Total Suspended Solids	1.90	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW4Q14-SR2.3-A-Z	10/29/2014	7656320	Dissolved Organic Carbon	900	UG/L	MDL	500	1000	J	5310 C-2000		
SW4Q14-SR2.3-B	10/29/2014	7656333	Total Suspended Solids	1.60	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW4Q14-SR2.7-A	10/29/2014	1445033-01	Methyl Mercury	0.039	NG/L	MDL	0.020	0.050	J	1630		
SW4Q14-SR5.2-A	10/29/2014	7656321	Total Suspended Solids	1.20	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW4Q14-SR5.2-A-Z	10/29/2014	7656322	Dissolved Organic Carbon	970	UG/L	MDL	500	1000	J	5310 C-2000		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 10/14 **Validation Options:** LABSTATS

Validation Reason Code: The result is estimated since the concentration is between the method detection limit and practical quantitation limit.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW4Q14-SR5.2-B	10/29/2014	7656334	Total Suspended Solids	1.50	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW4Q14-SR9.9-A	10/29/2014	7656323	Total Suspended Solids	1.00	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW4Q14-SR9.9-A-Z	10/29/2014	7656324	Dissolved Organic Carbon	960	UG/L	MDL	500	1000	J	5310 C-2000		

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** LONG TERM MON SPIDERS-EARTHWORMS 2015 **Validation Options:** LABSTATS

Validation Reason Code: The result is estimated since the concentration is between the method detection limit and practical quantitation limit.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
BG0715-SF50-WRM-02	07/29/2015	DPC1509-20	Mercury	716.5	UG/KG	MDL	500	1200	J	1631		
BG0715-SF66-WRM-03	07/29/2015	DPC1509-24	Mercury	876.1	UG/KG	MDL	500	1200	J	1631		
BG0715-SF85-WRM-02	07/29/2015	DPC1509-26	Mercury	1036.3	UG/KG	MDL	500	1200	J	1631		
BG0715-SR-2.7-WRM-02	07/28/2015	DPC1509-05	Mercury	689.1	UG/KG	MDL	500	1200	J	1631		
BG0715-SR-6.2-WRM-01	07/27/2015	DPC1509-01	Mercury	821.7	UG/KG	MDL	500	1200	J	1631		
BG0715-SR-6.2-WRM-02	07/27/2015	DPC1509-02	Mercury	879.6	UG/KG	MDL	500	1200	J	1631		
BG0715-SR-6.2-WRM-03	07/28/2015	DPC1509-03	Mercury	813.6	UG/KG	MDL	500	1200	J	1631		

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** VADEQ SURFACE WATER 1/15 **Validation Options:** LABSTATS

Validation Reason Code: Quality review criteria exceeded between the REP (laboratory replicate) and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0115-SF94-A	01/27/2015	7755910	Nitrate/Nitrite Nitrogen	1.2	MG/L	MDL	0.040	0.10	J	353.2		
SW0115-SR2.7-A	01/28/2015	8233056	Nitrate/Nitrite Nitrogen	0.63	MG/L	MDL	0.040	0.10	J	353.2		

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 4/15 **Validation Options:** LABSTATS

Validation Reason Code: Dissolved result greater than total and difference significantly outside criteria (Detects).

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1Q15-SF94-A	04/29/2015	1518029-37RE2	Mercury, low level	2.18	NG/L	MDL	0.10	0.40	R	1631		
SW1Q15-SF94-A-Z	04/29/2015	1518029-38RE2	Mercury, low level	12.0	NG/L	MDL	0.10	0.40	R	1631		
SW1Q15-SF94-B	04/29/2015	1518029-39RE2	Mercury, low level	2.93	NG/L	MDL	0.10	0.40	R	1631		
SW1Q15-SF94-B-Z	04/29/2015	1518029-40RE2	Mercury, low level	12.8	NG/L	MDL	0.10	0.40	R	1631		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 4/15 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values higher than the upper control limit. The reported result may be biased high.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1Q15-SF94-A	04/29/2015	7872790	Nitrate/Nitrite Nitrogen	1.3	MG/L	MDL	0.040	0.10	J	353.2		
SW1Q15-SF48-A	04/29/2015	7872788	Nitrate/Nitrite Nitrogen	1.3	MG/L	MDL	0.040	0.10	J	353.2		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 4/15 **Validation Options:** LABSTATS

Validation Reason Code: Dissolved result greater than total and difference outside criteria (Detects).

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1Q15-SR0.2-A-Z	04/28/2015	1518029-06	Methyl Mercury	0.065	NG/L	MDL	0.020	0.049	J	1630		
SW1Q15-SF94-B-Z	04/29/2015	1518029-40RE1	Methyl Mercury	0.290	NG/L	MDL	0.024	0.059	J	1630		
SW1Q15-SF94-B	04/29/2015	1518029-39RE1	Methyl Mercury	0.215	NG/L	MDL	0.023	0.059	J	1630		
SW1Q15-SF94-A-Z	04/29/2015	1518029-38RE1	Methyl Mercury	0.328	NG/L	MDL	0.023	0.057	J	1630		
SW1Q15-SF94-A	04/29/2015	1518029-37RE1	Methyl Mercury	0.214	NG/L	MDL	0.025	0.062	J	1630		
SW1Q15-SR2.7-B-Z	04/28/2015	1518029-04	Methyl Mercury	0.078	NG/L	MDL	0.020	0.050	J	1630		
SW1Q15-SR2.7-A	04/28/2015	1518029-01	Methyl Mercury	0.034	NG/L	MDL	0.020	0.049	J	1630		
SW1Q15-SR2.7-B	04/28/2015	1518029-03	Methyl Mercury	0.038	NG/L	MDL	0.020	0.050	J	1630		
SW1Q15-SR0.2-B	04/28/2015	1518029-07	Methyl Mercury	0.043	NG/L	MDL	0.020	0.050	J	1630		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 4/15 **Validation Options:** LABSTATS

Validation Reason Code: High relative percent difference (RPD) observed between field duplicate and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1Q15-SR0.2-A-D	04/28/2015	7872880	Alkalinity, Carb.As CaCO3 At pH 8.3	2.9	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 4/15 **Validation Options:** LABSTATS

Validation Reason Code: High relative percent difference (RPD) observed between MS and MSD samples. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1Q15-SR0.2-A	04/28/2015	7872875	Alkalinity, Total	59.4	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 4/15 **Validation Options:** LABSTATS

Validation Reason Code: Quality review criteria exceeded between the REP (laboratory replicate) and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1Q15-SR2.3-A	04/28/2015	7872882	Alkalinity, Total	59.3	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW1Q15-SR9.9-A	04/28/2015	7872886	Alkalinity, Total	64.5	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
EB-042815-1	04/28/2015	7872892	Alkalinity, Total	0.74	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 4/15 **Validation Options:** LABSTATS

Validation Reason Code: The result is estimated since the concentration is between the method detection limit and practical quantitation limit.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1Q15-SR23.5-A	04/29/2015	7872890	Total Organic Carbon	0.77	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW1Q15-SR5.2-A	04/28/2015	7872884	Total Organic Carbon	0.71	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW1Q15-SR9.9-A	04/28/2015	7872886	Total Organic Carbon	0.63	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW1Q15-SR2.7-A	04/28/2015	7872873	Sulfate	4.5	MG/L	MDL	1.5	5.0	J	300.0		
SW1Q15-SR2.7-A	04/28/2015	7872873	Total Organic Carbon	0.74	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW1Q15-SR0.2-B-Z	04/28/2015	1518029-08	Methyl Mercury	0.031	NG/L	MDL	0.020	0.050	J	1630		
SW1Q15-SR16.5-A	04/28/2015	7872888	Total Organic Carbon	0.76	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW1Q15-SR2.3-A	04/28/2015	7872882	Total Organic Carbon	0.79	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW1Q15-SR0.2-A-D	04/28/2015	7872880	Total Organic Carbon	0.71	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW1Q15-SR0.2-A	04/28/2015	7872875	Total Organic Carbon	0.66	MG/L	MDL	0.50	1.0	J	5310 C-2000		

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 6/15 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values less than the lower control limit. The actual detection limits may be higher than reported.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
EB-062215-1-Z	06/22/2015	7942226	Dissolved Organic Carbon	500	UG/L	MDL	500	1000	UJ	5310 C-2000		
EB-062215-1	06/22/2015	7942225	Alkalinity, Total	0.70	MG CACO3 /L	MDL	0.70	2.0	UJ	2320 B-1997		
SW0615-SR16.5-A	06/22/2015	7942215	Alkalinity, Total	0.70	MG CACO3 /L	MDL	0.70	2.0	UJ	2320 B-1997		
SW0615-SR2.3-A	06/22/2015	7942209	Alkalinity, Total	0.70	MG CACO3 /L	MDL	0.70	2.0	UJ	2320 B-1997		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 6/15 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values higher than the upper control limit. The reported result may be biased high.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0615-SR16.5-A-Z	06/22/2015	7942216	Dissolved Organic Carbon	1100	UG/L	MDL	500	1000	J	5310 C-2000		
SW0615-SF26-A	06/23/2015	7942219	Total Organic Carbon	1.3	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW0615-SF26-A-Z	06/23/2015	7942220	Dissolved Organic Carbon	1600	UG/L	MDL	500	1000	J	5310 C-2000		
SW0615-SF48-A	06/23/2015	7942221	Total Organic Carbon	1.7	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW0615-SF48-A-Z	06/23/2015	7942222	Dissolved Organic Carbon	1900	UG/L	MDL	500	1000	J	5310 C-2000		
SW0615-SR9.9-A-Z	06/22/2015	7942214	Dissolved Organic Carbon	850	UG/L	MDL	500	1000	J	5310 C-2000		
SW0615-SR-2.7-A-Z	06/22/2015	7942201	Dissolved Organic Carbon	900	UG/L	MDL	500	1000	J	5310 C-2000		
SW0615-SR-2.7-A	06/22/2015	7942200	Total Organic Carbon	0.67	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW0615-SR9.9-A	06/22/2015	7942213	Total Organic Carbon	0.70	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW0615-SR5.2-A-Z	06/22/2015	7942212	Dissolved Organic Carbon	600	UG/L	MDL	500	1000	J	5310 C-2000		
SW0615-SR23.5-A-Z	06/22/2015	7942218	Dissolved Organic Carbon	790	UG/L	MDL	500	1000	J	5310 C-2000		
SW0615-SR23.5-A	06/22/2015	7942217	Total Organic Carbon	0.76	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW0615-SR0.2-A-Z	06/22/2015	7942206	Dissolved Organic Carbon	510	UG/L	MDL	500	1000	J	5310 C-2000		
SW0615-SR2.3-A	06/22/2015	7942209	Total Organic Carbon	0.50	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW0615-SR16.5-A	06/22/2015	7942215	Total Organic Carbon	0.99	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW0615-SR2.3-A-Z	06/22/2015	7942210	Dissolved Organic Carbon	640	UG/L	MDL	500	1000	J	5310 C-2000		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 6/15 **Validation Options:** LABSTATS

Validation Reason Code: Dissolved result greater than total and difference outside criteria (Detects).

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0615-SR9.9-A	06/22/2015	7942213	Magnesium	9.76	MG/L	MDL	0.0167	0.100	J	6010B		3010A
SW0615-SR9.9-A	06/22/2015	7942213	Potassium	2.33	MG/L	MDL	0.133	0.500	J	6010B		3010A
SW0615-SR9.9-A	06/22/2015	7942213	Sodium	7.64	MG/L	MDL	0.167	1.00	J	6010B		3010A
SW0615-SR9.9-A	06/22/2015	7942213	Calcium	26.4	MG/L	MDL	0.0334	0.200	J	6010B		3010A
SW0615-SF26-A	06/23/2015	7942219	Magnesium	13.9	MG/L	MDL	0.0167	0.100	J	6010B		3010A
SW0615-SF26-A	06/23/2015	7942219	Potassium	3.21	MG/L	MDL	0.133	0.500	J	6010B		3010A
SW0615-SF26-A	06/23/2015	7942219	Calcium	44.1	MG/L	MDL	0.0334	0.200	J	6010B		3010A
SW0615-SF26-A-Z	06/23/2015	7942220	Magnesium	15.9	MG/L	MDL	0.0167	0.100	J	6010B		3010A
SW0615-SF26-A-Z	06/23/2015	7942220	Potassium	3.55	MG/L	MDL	0.133	0.500	J	6010B		3010A
SW0615-SF26-A-Z	06/23/2015	7942220	Calcium	49.4	MG/L	MDL	0.0334	0.200	J	6010B		3010A
SW0615-SF48-A	06/23/2015	1526022-33	Methyl Mercury	0.383	NG/L	MDL	0.019	0.049	J	1630		
SW0615-SR9.9-A-Z	06/22/2015	7942214	Magnesium	11.2	MG/L	MDL	0.0167	0.100	J	6010B		3010A
SW0615-SR9.9-A-Z	06/22/2015	7942214	Potassium	2.62	MG/L	MDL	0.133	0.500	J	6010B		3010A
SW0615-SR9.9-A-Z	06/22/2015	7942214	Sodium	8.79	MG/L	MDL	0.167	1.00	J	6010B		3010A
SW0615-SR9.9-A-Z	06/22/2015	7942214	Calcium	30.1	MG/L	MDL	0.0334	0.200	J	6010B		3010A

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 6/15 **Validation Options:** LABSTATS

Validation Reason Code: Quality review criteria exceeded between the REP (laboratory replicate) and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0615-SR16.5-A	06/22/2015	7942215	Total Suspended Solids	5.00	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0615-SR2.3-A	06/22/2015	7942209	Chloride	11.3	MG/L	MDL	1.0	2.0	J	300.0		
SW0615-SR2.3-A	06/22/2015	7942209	Total Suspended Solids	3.00	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0615-SR0.2-A-D	06/22/2015	7942207	Chloride	9.5	MG/L	MDL	1.0	2.0	J	300.0		
SW0615-SR23.5-A	06/22/2015	7942217	Chloride	9.6	MG/L	MDL	1.0	2.0	J	300.0		
SW0615-SR23.5-A	06/22/2015	7942217	Total Suspended Solids	26.9	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0615-SR5.2-A	06/22/2015	7942211	Chloride	13.4	MG/L	MDL	1.0	2.0	J	300.0		
SW0615-SR5.2-A	06/22/2015	7942211	Total Suspended Solids	5.70	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0615-SR9.9-A	06/22/2015	7942213	Chloride	13.0	MG/L	MDL	1.0	2.0	J	300.0		
SW0615-SR9.9-A	06/22/2015	7942213	Total Suspended Solids	5.50	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0615-SR-2.7-A	06/22/2015	7942200	Chloride	7.6	MG/L	MDL	1.0	2.0	J	300.0		
SW0615-SR0.2-A	06/22/2015	7942202	Chloride	9.5	MG/L	MDL	1.0	2.0	J	300.0		
SW0615-SF26-A	06/23/2015	7942219	Chloride	20.7	MG/L	MDL	1.0	2.0	J	300.0		
SW0615-SF48-A	06/23/2015	7942221	Chloride	19.6	MG/L	MDL	1.0	2.0	J	300.0		
SW0615-SF94-A	06/23/2015	7942223	Chloride	16.2	MG/L	MDL	1.0	2.0	J	300.0		
SW0615-SR-2.7-A	06/22/2015	7942200	Total Suspended Solids	1.40	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0615-SR0.2-A-D	06/22/2015	7942207	Total Suspended Solids	3.79	MG/L	MDL	3.00	9.00	J	2540 D-1997		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 6/15 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values less than the lower control limit but above the rejection limit. The reported result may be biased low.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0615-SR2.3-A-Z	06/22/2015	1526022-10	Methyl Mercury	0.284	NG/L	MDL	0.020	0.050	J	1630		
SW0615-SR2.3-B-Z	06/22/2015	1526022-12	Methyl Mercury	0.213	NG/L	MDL	0.020	0.050	J	1630		
SW0615-SR16.5-A-Z	06/22/2015	1526022-22	Methyl Mercury	1.24	NG/L	MDL	0.020	0.050	J	1630		
SW0615-SR16.5-B-Z	06/22/2015	1526022-24	Methyl Mercury	0.645	NG/L	MDL	0.020	0.050	J	1630		
SW0615-SR0.2-A	06/22/2015	7942202	Alkalinity, Total	116	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW0615-SR0.2-A-D	06/22/2015	7942207	Alkalinity, Total	115	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW0615-SR23.5-A	06/22/2015	7942217	Alkalinity, Total	100	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW0615-SR23.5-A-Z	06/22/2015	1526022-26	Methyl Mercury	1.00	NG/L	MDL	0.020	0.049	J	1630		
SW0615-SR23.5-B-Z	06/22/2015	1526022-28	Methyl Mercury	0.974	NG/L	MDL	0.020	0.050	J	1630		
SW0615-SR5.2-A-Z	06/22/2015	1526022-14	Methyl Mercury	0.659	NG/L	MDL	0.019	0.048	J	1630		
SW0615-SR5.2-B-Z	06/22/2015	1526022-16	Methyl Mercury	0.697	NG/L	MDL	0.020	0.049	J	1630		
SW0615-SF94-A	06/23/2015	7942223	Alkalinity, Total	131	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW0615-SF94-A-Z	06/23/2015	7942224	Dissolved Organic Carbon	1600	UG/L	MDL	500	1000	J	5310 C-2000		
SW0615-SR-2.7-A	06/22/2015	7942200	Alkalinity, Total	64.8	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW0615-SF26-A	06/23/2015	7942219	Alkalinity, Total	58.3	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW0615-SF26-A-Z	06/23/2015	1526022-30	Methyl Mercury	0.280	NG/L	MDL	0.020	0.049	J	1630		
SW0615-SF26-B-Z	06/23/2015	1526022-32	Methyl Mercury	0.246	NG/L	MDL	0.020	0.050	J	1630		
SW0615-SF48-A	06/23/2015	7942221	Alkalinity, Total	158	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW0615-SF48-A-Z	06/23/2015	1526022-34	Methyl Mercury	0.511	NG/L	MDL	0.020	0.049	J	1630		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 6/15 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values less than the lower control limit but above the rejection limit. The reported result may be biased low.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0615-SF48-B-Z	06/23/2015	1526022-36	Methyl Mercury	0.340	NG/L	MDL	0.020	0.049	J	1630		
SW0615-SR9.9-A	06/22/2015	7942213	Alkalinity, Total	48.6	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW0615-SR9.9-A-Z	06/22/2015	1526022-18	Methyl Mercury	1.35	NG/L	MDL	0.020	0.049	J	1630		
SW0615-SR9.9-B-Z	06/22/2015	1526022-20	Methyl Mercury	1.21	NG/L	MDL	0.020	0.050	J	1630		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 6/15 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values less than the rejection level. The reported result may be biased low.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0615-SR5.2-A	06/22/2015	7942211	Alkalinity, Total	102	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 6/15 **Validation Options:** LABSTATS

Validation Reason Code: The result is estimated since the concentration is between the method detection limit and practical quantitation limit.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0615-SF94-A	06/23/2015	7942223	Total Suspended Solids	2.50	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0615-SR0.2-A	06/22/2015	7942202	Total Suspended Solids	4.80	MG/L	MDL	2.00	6.00	J	2540 D-1997		
EB-062215-1	06/22/2015	7942225	Magnesium	0.0195	MG/L	MDL	0.0167	0.100	J	6010B		3010A
EB-062215-1	06/22/2015	7942225	Sodium	0.261	MG/L	MDL	0.167	1.00	J	6010B		3010A
EB-062215-1	06/22/2015	7942225	Calcium	0.0896	MG/L	MDL	0.0334	0.200	J	6010B		3010A
SW0615-SR-2.7-A-Z	06/22/2015	1526022-02	Methyl Mercury	0.031	NG/L	MDL	0.019	0.048	J	1630		
SW0615-SR-2.7-A-Z	06/22/2015	1526022-02	Mercury, low level	0.31	NG/L	MDL	0.10	0.40	J	1631		
SW0615-SR-2.7-A	06/22/2015	1526022-01	Methyl Mercury	0.031	NG/L	MDL	0.020	0.050	J	1630		
EB-062215-1-Z	06/22/2015	7942226	Magnesium	0.0185	MG/L	MDL	0.0167	0.100	J	6010B		3010A
EB-062215-1-Z	06/22/2015	7942226	Sodium	0.270	MG/L	MDL	0.167	1.00	J	6010B		3010A
EB-062215-1-Z	06/22/2015	7942226	Calcium	0.0729	MG/L	MDL	0.0334	0.200	J	6010B		3010A
SW0615-SR2.7-B	06/22/2015	1526022-03	Methyl Mercury	0.026	NG/L	MDL	0.020	0.050	J	1630		
SW0615-SR2.7-B	06/22/2015	7945455	Total Suspended Solids	1.20	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0615-SR2.7-B-Z	06/22/2015	1526022-04	Methyl Mercury	0.025	NG/L	MDL	0.020	0.049	J	1630		
SW0615-SR2.7-B-Z	06/22/2015	1526022-04	Mercury, low level	0.32	NG/L	MDL	0.10	0.40	J	1631		

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 8/15 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values higher than the upper control limit. The reported result may be biased high.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0815-SF26-A	08/26/2015	8027188	Nitrate/Nitrite Nitrogen	1.3	MG/L	MDL	0.040	0.10	J	353.2		
SW0815-SF48-A-Z	08/26/2015	8027191	Dissolved Organic Carbon	1100	UG/L	MDL	500	1000	J	5310 C-2000		
SW0815-SF26-A-Z	08/26/2015	8027189	Dissolved Organic Carbon	1200	UG/L	MDL	500	1000	J	5310 C-2000		
SW0815-SF48-A	08/26/2015	8027190	Nitrate/Nitrite Nitrogen	1.2	MG/L	MDL	0.040	0.10	J	353.2		
SW0815-SR-2.7-A	08/25/2015	8027169	Nitrate/Nitrite Nitrogen	0.53	MG/L	MDL	0.040	0.10	J	353.2		
SW0815-SR0.2-A	08/25/2015	8027171	Nitrate/Nitrite Nitrogen	0.57	MG/L	MDL	0.040	0.10	J	353.2		
SW0815-SR0.2-A-D	08/25/2015	8027176	Nitrate/Nitrite Nitrogen	0.57	MG/L	MDL	0.040	0.10	J	353.2		
SW0815-SR2.3-A	08/25/2015	8027178	Nitrate/Nitrite Nitrogen	0.58	MG/L	MDL	0.040	0.10	J	353.2		
SW0815-SR16.5-A	08/25/2015	8027184	Nitrate/Nitrite Nitrogen	0.54	MG/L	MDL	0.040	0.10	J	353.2		
SW0815-SR23.5-A	08/25/2015	8027186	Nitrate/Nitrite Nitrogen	0.64	MG/L	MDL	0.040	0.10	J	353.2		
SW0815-SR9.9-A	08/25/2015	8027182	Nitrate/Nitrite Nitrogen	0.54	MG/L	MDL	0.040	0.10	J	353.2		
SW0815-SR5.2-A	08/25/2015	8027180	Nitrate/Nitrite Nitrogen	0.59	MG/L	MDL	0.040	0.10	J	353.2		
SW0815-SR5.2-A-Z	08/25/2015	8027181	Dissolved Organic Carbon	570	UG/L	MDL	500	1000	J	5310 C-2000		
SW0815-SR9.9-A-Z	08/25/2015	8027183	Dissolved Organic Carbon	620	UG/L	MDL	500	1000	J	5310 C-2000		
SW0815-SR16.5-A-Z	08/25/2015	8027185	Dissolved Organic Carbon	620	UG/L	MDL	500	1000	J	5310 C-2000		
SW0815-SR2.3-A-Z	08/25/2015	8027179	Dissolved Organic Carbon	530	UG/L	MDL	500	1000	J	5310 C-2000		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 8/15 **Validation Options:** LABSTATS

Validation Reason Code: Quality review criteria exceeded between the REP (laboratory replicate) and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0815-SF94-B	08/26/2015	8027218	Total Suspended Solids	1.10	MG/L	MDL	1.00	3.00	J	2540 D-1997		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 8/15 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values less than the lower control limit but above the rejection limit. The reported result may be biased low.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0815-SR-2.7-A	08/25/2015	8027169	Alkalinity, Total	117	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW0815-SR0.2-A	08/25/2015	8027171	Alkalinity, Total	108	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 8/15 **Validation Options:** LABSTATS

Validation Reason Code: The result is estimated since the concentration is between the method detection limit and practical quantitation limit.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0815-SR9.9-A	08/25/2015	8027182	Total Suspended Solids	2.20	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0815-SR9.9-A	08/25/2015	8027182	Total Organic Carbon	0.54	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW0815-SR9.9-B	08/25/2015	8027213	Total Suspended Solids	2.30	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0815-SR23.5-A	08/25/2015	8027186	Total Suspended Solids	2.90	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0815-SR23.5-A	08/25/2015	8027186	Total Organic Carbon	0.58	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW0815-SR16.5-A	08/25/2015	8027184	Total Organic Carbon	0.51	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW0815-SR2.3-A	08/25/2015	8027178	Total Suspended Solids	2.90	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0815-SR2.3-A	08/25/2015	8027178	Total Organic Carbon	0.53	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW0815-SR2.3-B	08/25/2015	8027211	Total Suspended Solids	4.07	MG/L	MDL	2.00	6.00	J	2540 D-1997		
SW0815-SR0.2-A-Z	08/25/2015	1536011-06	Methyl Mercury	0.048	NG/L	MDL	0.020	0.050	J	1630		
SW0815-SR0.2-B	08/25/2015	8027210	Total Suspended Solids	2.70	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0815-SR0.2-A	08/25/2015	8027171	Total Suspended Solids	2.60	MG/L	MDL	2.00	6.00	J	2540 D-1997		
SW0815-SR-2.7-A-Z	08/25/2015	1536011-02	Mercury, low level	0.35	NG/L	MDL	0.10	0.40	J	1631		
SW0815-SR-2.7-B-Z	08/25/2016	1536011-04	Mercury, low level	0.30	NG/L	MDL	0.10	0.40	J	1631		
SW0815-SR-2.7-A	08/25/2015	8027169	Total Suspended Solids	1.90	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0815-SF48-A	08/26/2015	8027190	Total Suspended Solids	1.50	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0815-SF48-B	08/26/2015	8027217	Total Suspended Solids	2.40	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0815-SR-2.7-A	08/25/2015	1536011-01	Methyl Mercury	0.029	NG/L	MDL	0.020	0.050	J	1630		
SW0815-SF26-A	08/26/2015	8027188	Total Suspended Solids	2.70	MG/L	MDL	1.00	3.00	J	2540 D-1997		
EB-082615-1	08/26/2015	8027207	Magnesium	0.0284	MG/L	MDL	0.0167	0.100	J	6010B		3010A
EB-082615-1	08/26/2015	1536011-41	Mercury, low level	0.11	NG/L	MDL	0.10	0.40	J	1631		
EB-082615-1-Z	08/26/2015	8027208	Magnesium	0.0271	MG/L	MDL	0.0167	0.100	J	6010B		3010A

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 11/15 **Validation Options:** LABSTATS

Validation Reason Code: Contamination detected in equipment blank(s). Sample result does not differ significantly from the analyte concentration detected in the associated equipment blank(s).

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1015-SF26-A	11/05/2015	1546030-29	Methyl Mercury	0.215	NG/L	MDL	0.020	0.051	B	1630		
SW1015-SF26-B	11/05/2015	1546030-31	Methyl Mercury	0.237	NG/L	MDL	0.020	0.049	B	1630		
SW1015-SF48-A	11/05/2015	1546030-33	Methyl Mercury	0.227	NG/L	MDL	0.020	0.051	B	1630		
SW1015-SF48-B	11/05/2015	1546030-35	Methyl Mercury	0.257	NG/L	MDL	0.020	0.050	B	1630		
SW1015-SF94-A	11/05/2015	1546030-37	Methyl Mercury	0.141	NG/L	MDL	0.020	0.050	B	1630		
SW1015-SF94-B	11/05/2015	1546030-39	Methyl Mercury	0.146	NG/L	MDL	0.020	0.049	B	1630		
SW1015-SF94-B-Z	11/05/2015	1546030-40	Methyl Mercury	0.162	NG/L	MDL	0.020	0.051	B	1630		
SW1015-SR2.3-A	11/04/2015	1546030-09	Methyl Mercury	0.091	NG/L	MDL	0.019	0.049	B	1630		
SW1015-SR2.3-A-Z	11/04/2015	1546030-10	Methyl Mercury	0.075	NG/L	MDL	0.020	0.050	B	1630		
SW1015-SR2.3-B	11/04/2015	1546030-11	Methyl Mercury	0.087	NG/L	MDL	0.020	0.049	B	1630		
SW1015-SR2.3-B-Z	11/04/2015	1546030-12	Methyl Mercury	0.073	NG/L	MDL	0.019	0.049	B	1630		
SW1015-SR2.7-B-Z	11/04/2015	1546030-04	Mercury, low level	0.45	NG/L	MDL	0.10	0.40	B	1631		
SW1015-SR5.2-A	11/04/2015	1546030-13	Methyl Mercury	0.164	NG/L	MDL	0.020	0.049	B	1630		
SW1015-SR5.2-B	11/04/2015	1546030-15	Methyl Mercury	0.247	NG/L	MDL	0.020	0.049	B	1630		
SW1015-SR5.2-B-Z	11/04/2015	1546030-16	Methyl Mercury	0.146	NG/L	MDL	0.019	0.048	B	1630		
SW1015-SR9.9-A	11/04/2015	1546030-17	Methyl Mercury	0.440	NG/L	MDL	0.020	0.050	B	1630		
SW1015-SR9.9-B	11/04/2015	1546030-19	Methyl Mercury	0.453	NG/L	MDL	0.020	0.050	B	1630		
SW1115-SR2.7-A	11/18/2015	1546030-01RE1	Methyl Mercury	0.027	NG/L	MDL	0.023	0.058	B	1630		
SW1015-SR2.7-B-Z	11/04/2015	1546030-04RE1	Methyl Mercury	0.035	NG/L	MDL	0.024	0.060	B	1630		
SW1015-SR2.7-A-Z	11/04/2015	1546030-02	Mercury, low level	0.33	NG/L	MDL	0.10	0.40	B	1631		
SW1015-SR2.7-B	11/04/2015	1546030-03RE1	Methyl Mercury	0.037	NG/L	MDL	0.023	0.058	B	1630		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 11/15 **Validation Options:** LABSTATS

Validation Reason Code: Contamination detected in equipment blank(s). Sample result does not differ significantly from the analyte concentration detected in the associated equipment blank(s).

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1015-SR0.2-B-Z	11/04/2015	1546030-08	Methyl Mercury	0.029	NG/L	MDL	0.020	0.049	B	1630		
SW1015-SR0.2-A	11/04/2015	1546030-05RE1	Methyl Mercury	0.040	NG/L	MDL	0.024	0.061	B	1630		
SW1015-SR0.2-A-Z	11/04/2015	1546030-06	Methyl Mercury	0.031	NG/L	MDL	0.020	0.050	B	1630		
SW1015-SR0.2-B	11/04/2015	1546030-07	Methyl Mercury	0.031	NG/L	MDL	0.020	0.050	B	1630		
EB-110415-1-Z	11/05/2015	1546030-42RE1	Methyl Mercury	0.033	NG/L	MDL	0.023	0.058	B	1630		
EB-110415-1-Z	11/05/2015	1546030-42	Mercury, low level	0.14	NG/L	MDL	0.10	0.40	B	1631		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 11/15 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values less than the lower control limit. The actual detection limits may be higher than reported.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1015-SF48-A	11/05/2015	8124578	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1
SW1015-SF26-A	11/05/2015	8124576	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1
EB-110415-1	11/05/2015	8124582	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1
EB-110415-1	11/05/2015	8124582	Alkalinity, Total	0.70	MG CACO3 /L	MDL	0.70	2.0	UJ	2320 B-1997		
SW1015-SR0.2-A-D	11/04/2015	8124564	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1
SW1015-SR0.2-A	11/04/2015	8124559	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1
SW1015-SR16.5-A	11/04/2015	8124572	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1
SW1015-SR2.3-A	11/04/2015	8124566	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1
SW1015-SR23.5-A	11/04/2015	8124574	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1
SW1015-SR5.2-A	11/04/2015	8124568	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1
SW1015-SR9.9-A	11/04/2015	8124570	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 11/15 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values higher than the upper control limit. The reported result may be biased high.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1115-SR2.7-A	11/18/2015	8146554	Nitrate/Nitrite Nitrogen	0.75	MG/L	MDL	0.040	0.10	J	353.2		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 11/15 **Validation Options:** LABSTATS

Validation Reason Code: Dissolved result greater than total and difference outside criteria (Detects).

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1015-SF94-A-Z	11/05/2015	1546030-38	Methyl Mercury	0.166	NG/L	MDL	0.020	0.051	J	1630		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 11/15 **Validation Options:** LABSTATS

Validation Reason Code: Quality review criteria exceeded between the REP (laboratory replicate) and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1015-SR9.9-A	11/04/2015	8124570	Nitrate/Nitrite Nitrogen	0.69	MG/L	MDL	0.040	0.10	J	353.2		
SW1015-SR5.2-A	11/04/2015	8124568	Nitrate/Nitrite Nitrogen	0.64	MG/L	MDL	0.040	0.10	J	353.2		
SW1015-SR23.5-A	11/04/2015	8124574	Nitrate/Nitrite Nitrogen	0.67	MG/L	MDL	0.040	0.10	J	353.2		
SW1015-SR2.3-A	11/04/2015	8124566	Nitrate/Nitrite Nitrogen	0.62	MG/L	MDL	0.040	0.10	J	353.2		
SW1015-SR16.5-A	11/04/2015	8124572	Nitrate/Nitrite Nitrogen	0.67	MG/L	MDL	0.040	0.10	J	353.2		
SW1015-SR2.7-A	11/04/2015	8124557	Nitrate/Nitrite Nitrogen	0.57	MG/L	MDL	0.040	0.10	J	353.2		
SW1015-SR0.2-A	11/04/2015	8124559	Nitrate/Nitrite Nitrogen	0.64	MG/L	MDL	0.040	0.10	J	353.2		
SW1015-SR0.2-A-D	11/04/2015	8124564	Nitrate/Nitrite Nitrogen	0.64	MG/L	MDL	0.040	0.10	J	353.2		
SW1015-SF26-A	11/05/2015	8124576	Nitrate/Nitrite Nitrogen	1.4	MG/L	MDL	0.040	0.10	J	353.2		
SW1015-SF48-A	11/05/2015	8124578	Nitrate/Nitrite Nitrogen	1.2	MG/L	MDL	0.040	0.10	J	353.2		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 11/15 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values less than the lower control limit but above the rejection limit. The reported result may be biased low.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1015-SR5.2-A	11/04/2015	8124568	Alkalinity, Total	74.8	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW1015-SR23.5-A	11/04/2015	8124574	Alkalinity, Total	70.0	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW1015-SR2.3-A	11/04/2015	8124566	Alkalinity, Total	65.1	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW1015-SR2.7-A	11/04/2015	8124557	Alkalinity, Total	54.1	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW1015-SR16.5-A	11/04/2015	8124572	Alkalinity, Total	69.2	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW1015-SF94-A	11/05/2015	8124580	Alkalinity, Total	88.0	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW1015-SR0.2-A-D	11/04/2015	8124564	Alkalinity, Total	62.3	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW1015-SF26-A	11/05/2015	8124576	Alkalinity, Total	117	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW1015-SF48-A	11/05/2015	8124578	Alkalinity, Total	103	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 11/15 **Validation Options:** LABSTATS

Validation Reason Code: The result is estimated since the concentration is between the method detection limit and practical quantitation limit.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
EB-110415-1-Z	11/05/2015	8124583	Calcium	0.0673	MG/L	MDL	0.0333	0.200	J	6010B		3010A
SW1015-SF48-A	11/05/2015	8124578	Total Suspended Solids	1.40	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1015-SF48-A	11/05/2015	8124578	Total Organic Carbon	0.72	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW1015-SF26-A	11/05/2015	8124576	Total Suspended Solids	1.70	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1015-SF26-A	11/05/2015	8124576	Total Organic Carbon	0.75	MG/L	MDL	0.50	1.0	J	5310 C-2000		
EB-110415-1	11/05/2015	1546030-41	Mercury, low level	0.11	NG/L	MDL	0.10	0.40	J	1631		
EB-110415-1	11/05/2015	8124582	Calcium	0.0772	MG/L	MDL	0.0333	0.200	J	6010B		3010A
SW1015-SR0.2-A-DZ	11/04/2015	8124565	Dissolved Organic Carbon	920	UG/L	MDL	500	1000	J	5310 C-2000		
SW1015-SR0.2-B	11/04/2015	8124585	Total Suspended Solids	1.50	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1015-SR0.2-A-Z	11/04/2015	8124563	Dissolved Organic Carbon	980	UG/L	MDL	500	1000	J	5310 C-2000		
SW1015-SF48-B	11/05/2015	8124592	Total Suspended Solids	1.30	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1015-SR16.5-B	11/04/2015	8124589	Total Suspended Solids	1.00	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1015-SR2.3-A-Z	11/04/2015	8124567	Dissolved Organic Carbon	960	UG/L	MDL	500	1000	J	5310 C-2000		
SW1015-SR2.7-A	11/04/2015	8124557	Total Suspended Solids	1.10	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1015-SR2.7-A	11/04/2015	8124557	Total Organic Carbon	0.61	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW1015-SR16.5-A	11/04/2015	8124572	Total Suspended Solids	2.50	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1015-SR16.5-A	11/04/2015	8124572	Total Organic Carbon	0.62	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW1015-SR2.3-A	11/04/2015	8124566	Total Organic Carbon	0.57	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW1015-SR2.7-B	11/04/2015	8124584	Total Suspended Solids	1.50	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1015-SR23.5-A	11/04/2015	8124574	Total Organic Carbon	0.54	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW1015-SR5.2-B	11/04/2015	8124587	Total Suspended Solids	1.40	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1015-SR5.2-A	11/04/2015	8124568	Total Suspended Solids	1.20	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1015-SR5.2-A	11/04/2015	8124568	Total Organic Carbon	0.57	MG/L	MDL	0.50	1.0	J	5310 C-2000		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 11/15 **Validation Options:** LABSTATS

Validation Reason Code: The result is estimated since the concentration is between the method detection limit and practical quantitation limit.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1015-SR9.9-B	11/04/2015	8124588	Total Suspended Solids	1.30	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1015-SR9.9-A	11/04/2015	8124570	Total Suspended Solids	1.30	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1015-SR9.9-A	11/04/2015	8124570	Total Organic Carbon	0.59	MG/L	MDL	0.50	1.0	J	5310 C-2000		

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** VADEQ SURFACE WATER 11/15 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values higher than the upper control limit. The reported result may be biased high.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1115-SF26-A	11/17/2015	8146562	Nitrate/Nitrite Nitrogen	1.3	MG/L	MDL	0.040	0.10	J	353.2		
SW1115-SF48-A	11/17/2015	8146563	Nitrate/Nitrite Nitrogen	1.1	MG/L	MDL	0.040	0.10	J	353.2		
SW1115-SR0.2-A	11/18/2015	8146555	Nitrate/Nitrite Nitrogen	0.73	MG/L	MDL	0.040	0.10	J	353.2		
SW1115-SR0.2-A-D	11/18/2015	8146556	Nitrate/Nitrite Nitrogen	0.73	MG/L	MDL	0.040	0.10	J	353.2		
SW1115-SR16.5-A	11/17/2015	8146560	Nitrate/Nitrite Nitrogen	0.74	MG/L	MDL	0.040	0.10	J	353.2		
SW1115-SR2.3-A	11/18/2015	8146557	Nitrate/Nitrite Nitrogen	0.76	MG/L	MDL	0.040	0.10	J	353.2		
SW1115-SR23.5-A	11/17/2015	8146561	Nitrate/Nitrite Nitrogen	0.78	MG/L	MDL	0.040	0.10	J	353.2		
SW1115-SR5.2-A	11/18/2015	8146558	Nitrate/Nitrite Nitrogen	0.77	MG/L	MDL	0.040	0.10	J	353.2		
SW1115-SR9.9-A	11/18/2015	8146559	Nitrate/Nitrite Nitrogen	0.80	MG/L	MDL	0.040	0.10	J	353.2		

Site: Waynesboro South River **Sampling Program:** VADEQ SURFACE WATER 11/15 **Validation Options:** LABSTATS

Validation Reason Code: Quality review criteria exceeded between the REP (laboratory replicate) and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1115-SF94-A	11/17/2015	8146564	Nitrate/Nitrite Nitrogen	0.68	MG/L	MDL	0.040	0.10	J	353.2		

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** LONG TERM MON FISH TISSUE 2016 **Validation Options:** LABSTATS

Validation Reason Code: The result is estimated since the concentration is between the method detection limit and practical quantitation limit.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
BGFL16-SF106-SMB-06P	10/05/2016	DPC1613-06	Mercury	1035.2	UG/KG	MDL	0.5	1200	J	1631		
BGFL16-SF106-SMB-07P	10/05/2016	DPC1613-07	Mercury	944.2	UG/KG	MDL	0.5	1200	J	1631		
BGFL16-SF106-SMB-08P	10/05/2016	DPC1613-08	Mercury	792	UG/KG	MDL	0.5	1200	J	1631		
BGFL16-SF106-SMB-10P	10/05/2016	DPC1613-10	Mercury	1045.1	UG/KG	MDL	0.5	1200	J	1631		
BGFL16-SF115-SMB-01P	09/28/2016	DPC1613-23	Mercury	628.8	UG/KG	MDL	0.5	1200	J	1631		
BGFL16-SF115-SMB-02P	09/28/2016	DPC1613-24	Mercury	1158.1	UG/KG	MDL	0.5	1200	J	1631		
BGFL16-SF115-SMB-04P	09/28/2016	DPC1613-26	Mercury	723	UG/KG	MDL	0.5	1200	J	1631		
BGFL16-SH143-SMB-01P	10/06/2016	DPC1613-12	Mercury	413.9	UG/KG	MDL	0.5	1200	J	1631		
BGFL16-SH143-SMB-02P	10/06/2016	DPC1613-13	Mercury	415.5	UG/KG	MDL	0.5	1200	J	1631		
BGFL16-SH143-SMB-05P	10/06/2016	DPC1613-16	Mercury	511.1	UG/KG	MDL	0.5	1200	J	1631		
BGFL16-SH143-SMB-06P	10/06/2016	DPC1613-17	Mercury	373.7	UG/KG	MDL	0.5	1200	J	1631		
BGFL16-SH143-SMB-07P	10/06/2016	DPC1613-18	Mercury	438.8	UG/KG	MDL	0.5	1200	J	1631		
BGFL16-SH143-SMB-08P	10/06/2016	DPC1613-19	Mercury	552.3	UG/KG	MDL	0.5	1200	J	1631		
BGFL16-SH143-SMB-09P	10/06/2016	DPC1613-20	Mercury	428.1	UG/KG	MDL	0.5	1200	J	1631		
BGFL16-SH143-SMB-10P	10/06/2016	DPC1613-21	Mercury	221.7	UG/KG	MDL	0.5	1200	J	1631		

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** LONG TERM MON BIOTA-SEDIMENT 2016 **Validation Options:** LABSTATS

Validation Reason Code: The result is estimated since the concentration is between the method detection limit and practical quantitation limit.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
BGFL16-SF26.6-ALG-01	10/17/2016	DPC1615-46	Mercury	647.8	UG/KG	MDL	500	1200	J	1631		
BGFL16-SR0.1-ALG-01	10/18/2016	DPC1615-10	Mercury	868.1	UG/KG	MDL	500	1200	J	1631		
BGFL16-SR11.8-ALG-02	10/19/2016	DPC1615-29	Mercury	949.1	UG/KG	MDL	500	1200	J	1631		
BGFL16-SR11.8-ALG-03	10/19/2016	DPC1615-30	Mercury	935.8	UG/KG	MDL	500	1200	J	1631		
EB-061616-4	06/16/2016	1627014-04	Mercury, low level	0.11	NG/L	MDL	0.10	0.40	J	1631		

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** VADEQ SURFACE WATER 1/16 **Validation Options:** LABSTATS

Validation Reason Code: Quality review criteria exceeded between the REP (laboratory replicate) and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0116-SF26-A	02/01/2016	8233064	Nitrate/Nitrite Nitrogen	1.8	MG/L	MDL	0.040	0.10	J	353.2		
SW0116-SF48-A	02/01/2016	8233065	Nitrate/Nitrite Nitrogen	1.4	MG/L	MDL	0.040	0.10	J	353.2		
SW0116-SR0.2-A	02/02/2016	8233057	Nitrate/Nitrite Nitrogen	0.62	MG/L	MDL	0.040	0.10	J	353.2		
SW0116-SR0.2-A-D	02/02/2016	8233058	Nitrate/Nitrite Nitrogen	0.63	MG/L	MDL	0.040	0.10	J	353.2		
SW0116-SR16.5-A	02/01/2016	8233062	Nitrate/Nitrite Nitrogen	0.74	MG/L	MDL	0.040	0.10	J	353.2		
SW0116-SR2.3-A	02/02/2016	8233059	Nitrate/Nitrite Nitrogen	0.58	MG/L	MDL	0.040	0.10	J	353.2		
SW0116-SR23.5-A	02/01/2016	8233063	Nitrate/Nitrite Nitrogen	0.87	MG/L	MDL	0.040	0.10	J	353.2		
SW0116-SR5.2-A	02/02/2016	8233060	Nitrate/Nitrite Nitrogen	0.56	MG/L	MDL	0.040	0.10	J	353.2		
SW0116-SR9.9-A	02/02/2016	8233061	Nitrate/Nitrite Nitrogen	0.60	MG/L	MDL	0.040	0.10	J	353.2		

Site: Waynesboro South River **Sampling Program:** VADEQ SURFACE WATER 1/16 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values less than the lower control limit but above the rejection limit. The reported result may be biased low.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0116-SF94-A	02/01/2016	8233066	Nitrate/Nitrite Nitrogen	1.5	MG/L	MDL	0.040	0.10	J	353.2		

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 4/16 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values less than the lower control limit. The actual detection limits may be higher than reported.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
EB-042516-1	04/25/2016	8355432	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1
EB-042516-1	04/25/2016	8355432	Alkalinity, Total	0.70	MG CACO3 /L	MDL	0.70	2.0	UJ	2320 B-1997		
SW0416-SF26-A	04/26/2016	8355426	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1
SW0416-SF48-A	04/26/2016	8355428	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1
SW0416-SF94-A	04/26/2016	8355430	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1
SW0416-SR0.2-A	04/25/2016	8355409	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1
SW0416-SR0.2-A-D	04/25/2016	8355414	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1
SW0416-SR16.5-A	04/25/2016	8355422	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1
SW0416-SR23.5-A	04/25/2016	8355424	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1
SW0416-SR9.9-A	04/25/2016	8355420	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 4/16 **Validation Options:** LABSTATS

Validation Reason Code: Dissolved result greater than total and difference outside criteria (Detects).

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0416-SR0.2-A	04/25/2016	8355409	Sodium	4.42	MG/L	MDL	0.167	1.00	J	6010B		3010A

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 4/16 **Validation Options:** LABSTATS

Validation Reason Code: High relative percent difference (RPD) observed between field duplicate and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0416-SR0.2-A-DZ	04/25/2016	8355415	Sodium	4.37	MG/L	MDL	0.167	1.00	J	6010B		3010A
SW0416-SR0.2-A-Z	04/25/2016	8355419	Sodium	5.43	MG/L	MDL	0.167	1.00	J	6010B		3010A

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 4/16 **Validation Options:** LABSTATS

Validation Reason Code: Quality review criteria exceeded between the REP (laboratory replicate) and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0416-SF94-A	04/26/2016	8355430	Nitrate/Nitrite Nitrogen	1.2	MG/L	MDL	0.040	0.10	J	353.2		
SW0416-SF26-A	04/26/2016	8355426	Total Suspended Solids	3.50	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0416-SF26-B	04/26/2016	8355441	Total Suspended Solids	3.50	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0416-SF48-B	04/26/2016	8355442	Total Suspended Solids	2.20	MG/L	MDL	1.00	3.00	J	2540 D-1997		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 4/16 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values less than the lower control limit but above the rejection limit. The reported result may be biased low.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0416-SR5.2-A	04/25/2016	8355418	Alkalinity, Total	100	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW0416-SR0.2-A	04/25/2016	8355409	Alkalinity, Total	98.1	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW0416-SR0.2-A-D	04/25/2016	8355414	Alkalinity, Total	98.3	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW0416-SF94-A	04/26/2016	8355430	Alkalinity, Total	139	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW0416-SF48-A	04/26/2016	8355428	Alkalinity, Total	147	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW0416-SF26-A	04/26/2016	8355426	Alkalinity, Total	155	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 4/16 **Validation Options:** LABSTATS

Validation Reason Code: The result is estimated since the concentration is between the method detection limit and practical quantitation limit.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0416-SF48-A	04/26/2016	8355428	Total Suspended Solids	2.50	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0416-SF94-A-Z	04/26/2016	8355431	Dissolved Organic Carbon	570	UG/L	MDL	500	1000	J	5310 C-2000		
SW0416-SF94-B	04/26/2016	8355443	Total Suspended Solids	1.60	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0416-SR0.2-A	04/25/2016	1618034-11	Methyl Mercury	0.047	NG/L	MDL	0.020	0.049	J	1630		
EB-042516-1	04/25/2016	1618034-05	Mercury, low level	0.20	NG/L	MDL	0.10	0.40	J	1631		
SW0416-SF94-A	04/26/2016	8355430	Total Suspended Solids	1.80	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0416-SR0.2-B	04/25/2016	8355435	Total Suspended Solids	1.80	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0416-SR0.2-B-Z	04/25/2016	1618034-14	Methyl Mercury	0.045	NG/L	MDL	0.020	0.050	J	1630		
SW0416-SR0.2-A-Z	04/25/2016	1618034-12	Methyl Mercury	0.045	NG/L	MDL	0.020	0.049	J	1630		
SW0416-SR0.2-A-D	04/25/2016	8355414	Total Organic Carbon	0.95	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW0416-SR0.2-A	04/25/2016	8355409	Total Suspended Solids	2.00	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0416-SR0.2-A	04/25/2016	8355409	Total Organic Carbon	0.93	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW0416-SR16.5-A	04/25/2016	8355422	Total Suspended Solids	1.50	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0416-SR16.5-A	04/25/2016	8355422	Alkalinity, Carb.As CaCO3 At pH 8.3	0.95	MG CACO3 /L	MDL	0.70	2.0	J	2320 B-1997		
SW0416-SR16.5-B	04/25/2016	8355439	Total Suspended Solids	2.00	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0416-SR2.3-A	04/25/2016	8355416	Total Suspended Solids	1.90	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0416-SR2.3-B	04/25/2016	8355436	Total Suspended Solids	2.10	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0416-SR2.7-A	04/25/2016	8355407	Total Suspended Solids	1.30	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0416-SR2.7-A	04/25/2016	8355407	Total Organic Carbon	0.95	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW0416-SR2.7-A-Z	04/25/2016	1618034-08	Mercury, low level	0.31	NG/L	MDL	0.10	0.40	J	1631		
SW0416-SR2.7-B	04/25/2016	8355434	Total Suspended Solids	1.30	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0416-SR2.7-B-Z	04/25/2016	1618034-10	Mercury, low level	0.33	NG/L	MDL	0.10	0.40	J	1631		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 4/16 **Validation Options:** LABSTATS

Validation Reason Code: The result is estimated since the concentration is between the method detection limit and practical quantitation limit.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0416-SR5.2-B	04/25/2016	8355437	Total Suspended Solids	2.50	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0416-SR9.9-A	04/25/2016	8355420	Total Suspended Solids	2.10	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0416-SR9.9-B	04/25/2016	8355438	Total Suspended Solids	2.50	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0416-SR23.5-A	04/25/2016	8355424	Total Suspended Solids	2.40	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0416-SR23.5-B	04/25/2016	8355440	Total Suspended Solids	1.70	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0416-SR5.2-A	04/25/2016	8355418	Total Suspended Solids	2.20	MG/L	MDL	1.00	3.00	J	2540 D-1997		

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** VADEQ SURFACE WATER 5/16 **Validation Options:** LABSTATS

Validation Reason Code: Quality review criteria exceeded between the REP (laboratory replicate) and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0516-SF94-A	05/09/2016	8382742	Nitrate/Nitrite Nitrogen	0.65	MG/L	MDL	0.040	0.10	J	353.2		

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 6/16 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values less than the lower control limit. The actual detection limits may be higher than reported.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
EB-062116-1	06/21/2016	8444868	Alkalinity, Total	1.7	MG CACO3 /L	MDL	1.7	5.0	UJ	2320 B-1997		
SW0616-SR0.2-A-D	06/21/2016	8444850	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1
SW0616-SR2.3-A	06/21/2016	8444852	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1
SW0616-SR2.7-A	06/21/2016	8444843	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 6/16 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values higher than the upper control limit. The reported result may be biased high.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0616-SR2.7-A	06/21/2016	8444843	Nitrate/Nitrite Nitrogen	0.86	MG/L	MDL	0.040	0.10	J	353.2		
SW0616-SR2.3-A	06/21/2016	8444852	Nitrate/Nitrite Nitrogen	0.77	MG/L	MDL	0.040	0.10	J	353.2		
SW0616-SR5.2-A	06/21/2016	8444854	Nitrate/Nitrite Nitrogen	0.80	MG/L	MDL	0.040	0.10	J	353.2		
SW0616-SR9.9-A	06/21/2016	8444856	Nitrate/Nitrite Nitrogen	0.79	MG/L	MDL	0.040	0.10	J	353.2		
SW0616-SR0.2-A-D	06/21/2016	8444850	Nitrate/Nitrite Nitrogen	0.82	MG/L	MDL	0.040	0.10	J	353.2		
SW0616-SR16.5-A	06/21/2016	8444858	Nitrate/Nitrite Nitrogen	0.89	MG/L	MDL	0.040	0.10	J	353.2		
SW0616-SF26-A	06/22/2016	8444862	Nitrate/Nitrite Nitrogen	2.5	MG/L	MDL	0.040	0.10	J	353.2		
SW0616-SF48-A	06/22/2016	8444864	Nitrate/Nitrite Nitrogen	2.0	MG/L	MDL	0.040	0.10	J	353.2		
SW0616-SF48-A	06/22/2016	8444864	Total Organic Carbon	1.0	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW0616-SR0.2-A	06/21/2016	8444845	Nitrate/Nitrite Nitrogen	0.82	MG/L	MDL	0.040	0.10	J	353.2		
SW0616-SR23.5-A	06/21/2016	8444860	Nitrate/Nitrite Nitrogen	0.87	MG/L	MDL	0.040	0.10	J	353.2		
SW0616-SR23.5-A	06/21/2016	8444860	Total Organic Carbon	0.54	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW0616-SR16.5-A	06/21/2016	8444858	Total Organic Carbon	0.94	MG/L	MDL	0.50	1.0	J	5310 C-2000		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 6/16 **Validation Options:** LABSTATS

Validation Reason Code: Quality review criteria exceeded between the REP (laboratory replicate) and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0616-SF94-A	06/22/2016	8444866	Nitrate/Nitrite Nitrogen	1.7	MG/L	MDL	0.040	0.10	J	353.2		
EB-062116-1	06/21/2016	8444868	Nitrate/Nitrite Nitrogen	0.047	MG/L	MDL	0.040	0.10	J	353.2		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 6/16 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values less than the lower control limit but above the rejection limit. The reported result may be biased low.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0616-SR16.5-A	06/21/2016	8444858	Alkalinity, Total	100	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
SW0616-SR2.3-A	06/21/2016	1627013-09RE1	Methyl Mercury	0.437	NG/L	MDL	0.023	0.057	J	1630		
SW0616-SR2.3-A	06/21/2016	8444852	Alkalinity, Total	108	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
SW0616-SR2.3-B	06/21/2016	1627013-11RE1	Methyl Mercury	0.425	NG/L	MDL	0.022	0.055	J	1630		
SW0616-SR2.7-A	06/21/2016	8444843	Alkalinity, Total	107	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
SW0616-SR23.5-A	06/21/2016	8444860	Alkalinity, Total	100	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
SW0616-SR5.2-A	06/21/2016	1627013-13RE1	Methyl Mercury	1.06	NG/L	MDL	0.022	0.056	J	1630		
SW0616-SR5.2-A	06/21/2016	8444854	Alkalinity, Total	107	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
SW0616-SR5.2-B	06/21/2016	1627013-15RE1	Methyl Mercury	0.816	NG/L	MDL	0.022	0.054	J	1630		
SW0616-SR9.9-A	06/21/2016	8444856	Alkalinity, Total	107	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
SW0616-SR0.2-A-D	06/21/2016	8444850	Alkalinity, Total	109	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
SW0616-SR0.2-B	06/21/2016	1627013-07RE1	Methyl Mercury	0.114	NG/L	MDL	0.023	0.056	J	1630		
SW0616-SF26-A	06/22/2016	8444862	Alkalinity, Total	162	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
SW0616-SF48-A	06/22/2016	8444864	Alkalinity, Total	147	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
SW0616-SF94-A	06/22/2016	8444866	Alkalinity, Total	125	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
SW0616-SR0.2-A	06/21/2016	1627013-05RE1	Methyl Mercury	0.136	NG/L	MDL	0.022	0.054	J	1630		
SW0616-SR0.2-A	06/21/2016	8444845	Alkalinity, Total	107	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 6/16 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values less than the lower control limit but above the rejection limit. The reported result may be biased low.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0616-SR2.7-B	06/21/2016	1627013-03RE1	Methyl Mercury	0.033	NG/L	MDL	0.022	0.055	J	1630		
SW0616-SR2.7-A	06/21/2016	1627013-01RE1	Methyl Mercury	0.046	NG/L	MDL	0.022	0.054	J	1630		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 6/16 **Validation Options:** LABSTATS

Validation Reason Code: The result is estimated since the concentration is between the method detection limit and practical quantitation limit.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0616-SR0.2-B	06/21/2016	8444871	Total Suspended Solids	1.20	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0616-SR0.2-A-D	06/21/2016	8444850	Total Suspended Solids	1.60	MG/L	MDL	1.00	3.00	J	2540 D-1997		
EB-062116-1	06/21/2016	8444868	Calcium	0.0641	MG/L	MDL	0.0382	0.200	J	6010B		3010A
SW0616-SR2.7-A-Z	06/21/2016	1627013-02RE1	Methyl Mercury	0.028	NG/L	MDL	0.022	0.055	J	1630		
SW0616-SR2.7-A-Z	06/21/2016	1627013-02	Mercury, low level	0.34	NG/L	MDL	0.10	0.40	J	1631		
SW0616-SR2.7-B	06/21/2016	8444870	Total Suspended Solids	1.30	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0616-SR2.7-B-Z	06/21/2016	1627013-04RE1	Methyl Mercury	0.030	NG/L	MDL	0.023	0.057	J	1630		
SW0616-SR2.7-B-Z	06/21/2016	1627013-04	Mercury, low level	0.31	NG/L	MDL	0.10	0.40	J	1631		
SW0616-SR2.7-A	06/21/2016	8444843	Total Suspended Solids	1.70	MG/L	MDL	1.00	3.00	J	2540 D-1997		

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** VADEQ SURFACE WATER 7/16 **Validation Options:** LABSTATS

Validation Reason Code: Quality review criteria exceeded between the REP (laboratory replicate) and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0716-SF26-A	07/11/2016	8476763	Nitrate/Nitrite Nitrogen	2.4	MG/L	MDL	0.040	0.10	J	353.2		
SW0716-SF48-A	07/11/2016	8476764	Nitrate/Nitrite Nitrogen	2.2	MG/L	MDL	0.040	0.10	J	353.2		
SW0716-SF94-A	07/11/2016	8476765	Nitrate/Nitrite Nitrogen	2.1	MG/L	MDL	0.040	0.10	J	353.2		
SW0716-SR0.2-A	07/12/2016	8476756	Nitrate/Nitrite Nitrogen	0.82	MG/L	MDL	0.040	0.10	J	353.2		
SW0716-SR0.2-A-D	07/12/2016	8476757	Nitrate/Nitrite Nitrogen	0.82	MG/L	MDL	0.040	0.10	J	353.2		
SW0716-SR16.5-A	07/11/2016	8476761	Nitrate/Nitrite Nitrogen	1.8	MG/L	MDL	0.040	0.10	J	353.2		
SW0716-SR2.3-A	07/12/2016	8476758	Nitrate/Nitrite Nitrogen	0.82	MG/L	MDL	0.040	0.10	J	353.2		
SW0716-SR2.7-A	07/12/2016	8476755	Nitrate/Nitrite Nitrogen	0.86	MG/L	MDL	0.040	0.10	J	353.2		
SW0716-SR23.5-A	07/11/2016	8476762	Nitrate/Nitrite Nitrogen	1.0	MG/L	MDL	0.040	0.10	J	353.2		
SW0716-SR5.2-A	07/12/2016	8476759	Nitrate/Nitrite Nitrogen	0.88	MG/L	MDL	0.040	0.10	J	353.2		
SW0716-SR9.9-A	07/12/2016	8476760	Nitrate/Nitrite Nitrogen	0.95	MG/L	MDL	0.040	0.10	J	353.2		

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 8/16 **Validation Options:** LABSTATS

Validation Reason Code: Dissolved result greater than total and difference outside criteria (Detects).

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0816-SF48-A-Z	08/26/2016	1636022-34	Methyl Mercury	0.141	NG/L	MDL	0.020	0.049	J	1630		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 8/16 **Validation Options:** LABSTATS

Validation Reason Code: Quality review criteria exceeded between the REP (laboratory replicate) and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0816-SF26-A	08/26/2016	8559640	Nitrate/Nitrite Nitrogen	1.8	MG/L	MDL	0.040	0.10	J	353.2		
SW0816-SF48-A	08/26/2016	8559642	Nitrate/Nitrite Nitrogen	1.6	MG/L	MDL	0.040	0.10	J	353.2		
SW0816-SF48-A	08/26/2016	8559642	Total Organic Carbon	3.9	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW0816-SF94-A	08/26/2016	8559644	Total Organic Carbon	2.3	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW0816-SR0.2-A	08/25/2016	8559623	Nitrate/Nitrite Nitrogen	0.80	MG/L	MDL	0.040	0.10	J	353.2		
SW0816-SR0.2-A-D	08/25/2016	8559628	Nitrate/Nitrite Nitrogen	0.76	MG/L	MDL	0.040	0.10	J	353.2		
SW0816-SR16.5-A	08/25/2016	8559636	Nitrate/Nitrite Nitrogen	0.85	MG/L	MDL	0.040	0.10	J	353.2		
SW0816-SR2.3-A	08/25/2016	8559630	Nitrate/Nitrite Nitrogen	0.71	MG/L	MDL	0.040	0.10	J	353.2		
SW0816-SR2.7-A	08/25/2016	8559621	Nitrate/Nitrite Nitrogen	0.75	MG/L	MDL	0.040	0.10	J	353.2		
SW0816-SR23.5-A	08/25/2016	8559638	Nitrate/Nitrite Nitrogen	0.89	MG/L	MDL	0.040	0.10	J	353.2		
SW0816-SR5.2-A	08/25/2016	8559632	Nitrate/Nitrite Nitrogen	0.80	MG/L	MDL	0.040	0.10	J	353.2		
SW0816-SR9.9-A	08/25/2016	8559634	Nitrate/Nitrite Nitrogen	0.77	MG/L	MDL	0.040	0.10	J	353.2		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 8/16 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values less than the lower control limit but above the rejection limit. The reported result may be biased low.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0816-SF26-A	08/26/2016	8559640	Alkalinity, Total	167	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
SW0816-SF48-A	08/26/2016	8559642	Alkalinity, Total	157	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
SW0816-SF94-A	08/26/2016	8559644	Alkalinity, Total	150	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
SW0816-SR0.2-A	08/25/2016	8559623	Alkalinity, Total	114	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
SW0816-SR0.2-A-D	08/25/2016	8559628	Alkalinity, Total	115	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
SW0816-SR16.5-A	08/25/2016	8559636	Alkalinity, Total	119	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
SW0816-SR2.3-A	08/25/2016	8559630	Alkalinity, Total	115	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
SW0816-SR2.7-A	08/25/2016	8559621	Alkalinity, Total	116	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
SW0816-SR23.5-A	08/25/2016	8559638	Alkalinity, Total	121	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
SW0816-SR5.2-A	08/25/2016	8559632	Alkalinity, Total	121	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
SW0816-SR9.9-A	08/25/2016	8559634	Alkalinity, Total	121	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
EB-082516-1	08/25/2016	8559647	Alkalinity, Total	4.5	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 8/16 **Validation Options:** LABSTATS

Validation Reason Code: The result is estimated since the concentration is between the method detection limit and practical quantitation limit.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0816-SR9.9-A-Z	08/25/2016	8559635	Dissolved Organic Carbon	910	UG/L	MDL	500	1000	J	5310 C-2000		
SW0816-SR9.9-B	08/25/2016	8559653	Total Suspended Solids	1.30	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0816-SR9.9-A	08/25/2016	8559634	Total Suspended Solids	1.80	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0816-SR5.2-A-Z	08/25/2016	8559633	Dissolved Organic Carbon	990	UG/L	MDL	500	1000	J	5310 C-2000		
SW0816-SR5.2-A	08/25/2016	8559632	Total Suspended Solids	2.80	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0816-SR23.5-A-Z	08/25/2016	8559639	Dissolved Organic Carbon	890	UG/L	MDL	500	1000	J	5310 C-2000		
SW0816-SR23.5-B	08/25/2016	8559655	Total Suspended Solids	1.30	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0816-SR23.5-A	08/25/2016	8559638	Total Suspended Solids	2.00	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0816-SR2.7-A	08/25/2016	8559621	Total Suspended Solids	2.40	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0816-SR2.7-A-Z	08/25/2016	8559622	Dissolved Organic Carbon	520	UG/L	MDL	500	1000	J	5310 C-2000		
SW0816-SR2.7-B	08/25/2016	8559649	Total Suspended Solids	1.80	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0816-SR2.3-B	08/25/2016	8559651	Total Suspended Solids	1.50	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0816-SR2.3-A	08/25/2016	8559630	Total Suspended Solids	1.90	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0816-SR16.5-A-Z	08/25/2016	8559637	Dissolved Organic Carbon	840	UG/L	MDL	500	1000	J	5310 C-2000		
SW0816-SR16.5-B	08/25/2016	8559654	Total Suspended Solids	1.50	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0816-SR16.5-A	08/25/2016	8559636	Total Suspended Solids	2.30	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0816-SR0.2-A-DZ	08/25/2016	8559629	Dissolved Organic Carbon	820	UG/L	MDL	500	1000	J	5310 C-2000		
SW0816-SR0.2-A-Z	08/25/2016	8559627	Dissolved Organic Carbon	690	UG/L	MDL	500	1000	J	5310 C-2000		
SW0816-SR0.2-A	08/25/2016	8559623	Total Suspended Solids	2.00	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0816-SF94-A	08/26/2016	8559644	Total Suspended Solids	1.10	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW0816-SF48-A	08/26/2016	8559642	Total Suspended Solids	2.40	MG/L	MDL	1.00	3.00	J	2540 D-1997		
EB-082516-1	08/25/2016	8559647	Magnesium	0.0234	MG/L	MDL	0.0190	0.100	J	6010B		3010A
EB-082516-1	08/25/2016	1636022-41RE1	Mercury, low level	0.30	NG/L	MDL	0.10	0.40	J	1631		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 8/16 **Validation Options:** LABSTATS

Validation Reason Code: The result is estimated since the concentration is between the method detection limit and practical quantitation limit.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
EB-082516-1-Z	08/25/2016	8559648	Calcium	0.0980	MG/L	MDL	0.0382	0.200	J	6010B		3010A

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 8/16 **Validation Options:** LABSTATS

Validation Reason Code: The result is estimated since the concentration is between the method detection limit and practical quantitation limit.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0816-SR2.7-A-Z	08/25/2016	1636022-02	Mercury, low level	0.17	NG/L	MDL	0.10	0.40	J	1631		
SW0816-SR2.7-B-Z	08/25/2016	1636022-04	Mercury, low level	0.13	NG/L	MDL	0.10	0.40	J	1631		

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** VADEQ SURFACE WATER 9/16 **Validation Options:** LABSTATS

Validation Reason Code: Quality review criteria exceeded between the REP (laboratory replicate) and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW0916-SF26-A	09/21/2016	8620739	Nitrate/Nitrite Nitrogen	1.2	MG/L	MDL	0.040	0.10	J	353.2		
SW0916-SF48-A	09/21/2016	8620740	Nitrate/Nitrite Nitrogen	1.3	MG/L	MDL	0.040	0.10	J	353.2		
SW0916-SR0.2-A	09/23/2016	8620732	Nitrate/Nitrite Nitrogen	0.65	MG/L	MDL	0.040	0.10	J	353.2		
SW0916-SR0.2-A-D	09/23/2016	8620733	Nitrate/Nitrite Nitrogen	0.65	MG/L	MDL	0.040	0.10	J	353.2		
SW0916-SR16.5-A	09/21/2016	8620737	Nitrate/Nitrite Nitrogen	0.77	MG/L	MDL	0.040	0.10	J	353.2		
SW0916-SR2.3-A	09/23/2016	8620734	Nitrate/Nitrite Nitrogen	0.65	MG/L	MDL	0.040	0.10	J	353.2		
SW0916-SR2.7-A	09/23/2016	8620731	Nitrate/Nitrite Nitrogen	0.69	MG/L	MDL	0.040	0.10	J	353.2		
SW0916-SR23.5-A	09/21/2016	8620738	Nitrate/Nitrite Nitrogen	0.72	MG/L	MDL	0.040	0.10	J	353.2		
SW0916-SR5.2-A	09/23/2016	8620735	Nitrate/Nitrite Nitrogen	0.75	MG/L	MDL	0.040	0.10	J	353.2		
SW0916-SR9.9-A	09/23/2016	8620736	Nitrate/Nitrite Nitrogen	0.73	MG/L	MDL	0.040	0.10	J	353.2		

DVM Narrative Report

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 10/16 **Validation Options:** LABSTATS

Validation Reason Code: Contamination detected in equipment blank(s). Sample result does not differ significantly from the analyte concentration detected in the associated equipment blank(s).

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1016-SR2.7-A-Z	10/18/2016	1644005-02	Mercury, low level	0.23	NG/L	MDL	0.10	0.40	B	1631		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 10/16 **Validation Options:** LABSTATS

Validation Reason Code: Associated LCS and/or LCSD analysis had relative percent recovery (RPR) values less than the lower control limit but above 10%. The actual detection limits may be higher than reported.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
EB-101816	10/18/2016	1644005-43	Methyl Mercury	0.020	NG/L	MDL	0.020	0.051	UJ	1630		
EB-101816-Z	10/18/2016	1644005-44	Methyl Mercury	0.020	NG/L	MDL	0.020	0.049	UJ	1630		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 10/16 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values less than the lower control limit. The actual detection limits may be higher than reported.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
EB-101816	10/18/2016	8657027	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1
EB-101816	10/18/2016	8657027	Alkalinity, Total	1.7	MG CACO3 /L	MDL	1.7	5.0	UJ	2320 B-1997		
SW1016-SF94-A	10/19/2016	8657025	Phosphorus	0.050	MG/L	MDL	0.050	0.10	UJ	365.1		365.1

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 10/16 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values higher than the upper control limit. The reported result may be biased high.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1016-SF94-A	10/19/2016	8657025	Total Organic Carbon	1.2	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW1016-SF48-A-Z	10/19/2016	8657024	Dissolved Organic Carbon	1000	UG/L	MDL	500	1000	J	5310 C-2000		
SW1016-SR23.5-A-Z	10/18/2016	8657020	Dissolved Organic Carbon	510	UG/L	MDL	500	1000	J	5310 C-2000		
SW1016-SR9.9-A-Z	10/18/2016	8657016	Dissolved Organic Carbon	510	UG/L	MDL	500	1000	J	5310 C-2000		
SW1016-SF48-A	10/19/2016	8657023	Total Organic Carbon	0.78	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW1016-SF26-A	10/18/2016	8657021	Total Organic Carbon	0.81	MG/L	MDL	0.50	1.0	J	5310 C-2000		
SW1016-SR16.5-A-Z	10/18/2016	8657018	Dissolved Organic Carbon	560	UG/L	MDL	500	1000	J	5310 C-2000		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 10/16 **Validation Options:** LABSTATS

Validation Reason Code: Quality review criteria exceeded between the REP (laboratory replicate) and parent sample. The reported result may be imprecise.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1016-SR0.2-A	10/18/2016	8657004	Nitrate/Nitrite Nitrogen	0.98	MG/L	MDL	0.040	0.10	J	353.2		
SW1016-SR16.5-A	10/18/2016	8657017	Nitrate/Nitrite Nitrogen	0.90	MG/L	MDL	0.040	0.10	J	353.2		
SW1016-SF26-A	10/18/2016	8657021	Nitrate/Nitrite Nitrogen	1.5	MG/L	MDL	0.040	0.10	J	353.2		
SW1016-SF26-B	10/18/2016	8657036	Total Suspended Solids	12.0	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1016-SF48-A	10/19/2016	8657023	Nitrate/Nitrite Nitrogen	1.3	MG/L	MDL	0.040	0.10	J	353.2		
SW1016-SR5.2-A	10/18/2016	8657013	Nitrate/Nitrite Nitrogen	0.93	MG/L	MDL	0.040	0.10	J	353.2		
SW1016-SR9.9-A	10/18/2016	8657015	Nitrate/Nitrite Nitrogen	0.86	MG/L	MDL	0.040	0.10	J	353.2		
SW1016-SR2.3-A	10/18/2016	8657011	Nitrate/Nitrite Nitrogen	0.99	MG/L	MDL	0.040	0.10	J	353.2		
SW1016-SR0.2-A-D	10/18/2016	8657009	Nitrate/Nitrite Nitrogen	0.91	MG/L	MDL	0.040	0.10	J	353.2		
SW1016-SR2.7-A	10/18/2016	8657002	Nitrate/Nitrite Nitrogen	0.86	MG/L	MDL	0.040	0.10	J	353.2		
SW1016-SR23.5-A	10/18/2016	8657019	Nitrate/Nitrite Nitrogen	0.86	MG/L	MDL	0.040	0.10	J	353.2		
SW1016-SR23.5-B	10/18/2016	8657035	Total Suspended Solids	1.10	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1016-SR9.9-A	10/18/2016	8657015	Total Suspended Solids	1.00	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1016-SR9.9-B	10/18/2016	8657033	Total Suspended Solids	1.50	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1016-SR2.7-B	10/18/2016	8657029	Total Suspended Solids	1.30	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1016-SF26-A	10/18/2016	8657021	Total Suspended Solids	2.70	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1016-SR16.5-A	10/18/2016	8657017	Total Suspended Solids	2.10	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1016-SR16.5-B	10/18/2016	8657034	Total Suspended Solids	1.40	MG/L	MDL	1.00	3.00	J	2540 D-1997		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 10/16 **Validation Options:** LABSTATS

Validation Reason Code: Associated LCS and/or LCSD analysis had relative percent recovery (RPR) values less than the lower control limit. The reported result may be biased low.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1016-SF48-B-Z	10/19/2016	1644005-36	Methyl Mercury	0.181	NG/L	MDL	0.020	0.051	J	1630		
SW1016-SF94-A	10/19/2016	1644005-37	Methyl Mercury	0.200	NG/L	MDL	0.020	0.051	J	1630		
SW1016-SF94-A-Z	10/19/2016	1644005-38	Methyl Mercury	0.087	NG/L	MDL	0.020	0.049	J	1630		
SW1016-SF94-B	10/19/2016	1644005-39	Methyl Mercury	0.178	NG/L	MDL	0.020	0.050	J	1630		
SW1016-SF94-B-Z	10/19/2016	1644005-40	Methyl Mercury	0.184	NG/L	MDL	0.020	0.050	J	1630		
SW1016-SF26-B-Z	10/18/2016	1644005-32	Methyl Mercury	0.201	NG/L	MDL	0.020	0.051	J	1630		
SW1016-SF48-A	10/19/2016	1644005-33	Methyl Mercury	0.233	NG/L	MDL	0.020	0.050	J	1630		
SW1016-SF48-A-Z	10/19/2016	1644005-34	Methyl Mercury	0.175	NG/L	MDL	0.020	0.051	J	1630		
SW1016-SF48-B	10/19/2016	1644005-35	Methyl Mercury	0.247	NG/L	MDL	0.020	0.050	J	1630		

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 10/16 **Validation Options:** LABSTATS

Validation Reason Code: Associated MS and/or MSD analysis had relative percent recovery (RPR) values less than the lower control limit but above the rejection limit. The reported result may be biased low.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1016-SF48-A	10/19/2016	8657023	Alkalinity, Total	158	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
SW1016-SF48-A	10/19/2016	8657023	Phosphorus	0.050	MG/L	MDL	0.050	0.10	J	365.1		365.1

Site: Waynesboro South River **Sampling Program:** PHASE II ECO QTRLY SAMP 10/16 **Validation Options:** LABSTATS

Validation Reason Code: The result is estimated since the concentration is between the method detection limit and practical quantitation limit.

Field Sample ID	Date Sampled	Lab Sample ID	Analyte	Result	Units	Type	MDL	PQL	Validation Qualifier	Analytical Method	Pre-prep	Prep
SW1016-SR2.7-A	10/18/2016	8657002	Total Suspended Solids	1.30	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1016-SR2.7-A-Z	10/18/2016	1644005-02	Methyl Mercury	0.020	NG/L	MDL	0.019	0.049	J	1630		
SW1016-SR0.2-B	10/18/2016	8657030	Total Suspended Solids	2.10	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1016-SR2.3-A	10/18/2016	8657011	Total Suspended Solids	1.30	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1016-SR2.3-B	10/18/2016	8657031	Total Suspended Solids	1.20	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1016-SR2.7-A	10/18/2016	1644005-01	Methyl Mercury	0.021	NG/L	MDL	0.020	0.049	J	1630		
SW1016-SR2.7-B	10/18/2016	1644005-03	Methyl Mercury	0.032	NG/L	MDL	0.020	0.050	J	1630		
SW1016-SR2.7-B-Z	10/18/2016	1644005-04	Methyl Mercury	0.021	NG/L	MDL	0.020	0.050	J	1630		
SW1016-SR2.7-B-Z	10/18/2016	1644005-04	Mercury, low level	0.23	NG/L	MDL	0.10	0.40	J	1631		
SW1016-SF48-B	10/19/2016	8657037	Total Suspended Solids	1.60	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1016-SF48-A	10/19/2016	8657023	Total Suspended Solids	1.50	MG/L	MDL	1.00	3.00	J	2540 D-1997		
SW1016-SF48-A	10/19/2016	8657023	Alkalinity, Carb.As CaCO3 At pH 8.3	4.6	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		
EB-101816-Z	10/18/2016	1644005-44	Mercury, low level	0.12	NG/L	MDL	0.10	0.40	J	1631		
SW1016-SF26-A	10/18/2016	8657021	Phosphorus	0.059	MG/L	MDL	0.050	0.10	J	365.1		365.1
SW1016-SR0.2-A	10/18/2016	8657004	Phosphorus	0.052	MG/L	MDL	0.050	0.10	J	365.1		365.1
SW1016-SR0.2-A	10/18/2016	8657004	Total Suspended Solids	2.20	MG/L	MDL	2.00	6.00	J	2540 D-1997		
SW1016-SF94-A	10/19/2016	8657025	Alkalinity, Carb.As CaCO3 At pH 8.3	1.9	MG CACO3 /L	MDL	1.7	5.0	J	2320 B-1997		