TETRA TECH

Mindy S. Ramsey
Director

November 26, 2013

Mr. Frank Whittaker
WV Purchasing Division
2019 Washington Street, East
Charleston, WV 25305

EOI#:	DEP16379
Title:	Expression of Interest Professional Engineering Services to Provide Total Maximum Daily Loads for the Impaired Streams in the Tygart Valley River Watershed
Opening Date:	November 27, 2013
Opening Time:	1:30 PM

Dear Mr. Whittaker:

Tetra Tech, Inc. is pleased to submit our proposal in response to West Virginia Department of Environmental Protection's Expression of Interest number DEP16379 for Total Maximum Daily Loads (TMDLs) for impaired streams in the in the Tygart Valley River Watershed. We have thoroughly enjoyed working closely with WVDEP's TMDL Program over the past ten years as it has grown into one of the nation's premier TMDL programs.

We hope that our proposal and qualifications demonstrate our significant experience and continued commitment to providing high quality TMDL support for West Virginia. Our experience in developing TMDLs and the tools that streamline the TMDL development process is unmatched by any other firm. We emphasize the use of TMDLs in supporting the broader environmental programs of the state and answering practical watershed planning questions. This approach to TMDL development requires that we not presume the use of a specific approach or set of modeling tools, but that we instead select or develop necessary tools that answer the appropriate management questions depending upon the watershed, pollutant sources, and policy.

In our proposal, we have identified a core group of staff, all of whom have extensive TMDL development experience, and many who have directly supported West Virginia over the past ten years. I will serve as the Project Manager located in our Charleston Office to facilitate communication and maximize our efficiency in meeting project needs.

We appreciate the opportunity to present our qualifications to West Virginia and we look forward to providing support for this project. If you should have any questions, please feel free to contact me at 304-414-0054 x 100.

Sincerely,

Mindy S. Ramsey

Mindy S. Ramsey

Tetra Tech, Inc.
803 Quarrier Street, Suite 400
Charleston, WV 25301
Tel 304.414.0054 Fax 304.720.2334 www.tetratech.com

State of West Virginia
Department of Administration
Purchasing Division
2019 Washington Street East
Post Office Box 50130
Charleston, WV 25305-0130

Solicitation

NUMBER	PAGE
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ADDRESS CORRESPONDENCE TO ATTENTION OF:
FRANK WHITTAKER
304-558-2316

VENDOR
RFQ COPY
TYPE NAME/ADDRESS HERE
Tetra Tech, Inc
803 Quarrier Street, Suite 400
Charleston, WV 25301

SHIP TO
ENVIRONMENTAL PROTECTION
DEPARTMENT OF
DIV OF WATER AND WASTE MGT
601 57TH STREET SE
CHARLESTON, WV
25304 304-926-0499

DATE PRINTED
11/05/2013

BID OPENING DATE: 11/27/2013 BID OPENING TIME 1:30PM

LINE	QUANTITY	UOP	CAT. NO.	ITEM NUMBER	UNIT PRICE	AMOUNT
0001	1	LS		493-09		

WATER, WASTE WATER AND SOIL SAMPLE ANALYSIS

EXPRESSION OF INTEREST

THE WEST VIRGINIA PURCHASING DIVISION, FOR THE AGENCY, THE WEST VIRGINIA DEPARTMENT OF ENVIRONMENTAL PROTECTION, IS SOLICITING EXPRESSIONS OF INTEREST FROM QUALIFIED FIRMS TO PROVIDE PROFESSIONAL ENGINEERING SERVICES TO PROVIDE TOTAL MAXIMUM DAILY LOADS (TMDLS) FOR THE IMPAIRED STREAMS IN THE TYGART VALLEY RIVER WATERSHED PER THE FOLLOWING BID REQUIREMENTS AND ATTACHED SPECIFICATIONS.

****** THIS IS THE END OF RFQ DEP16379 ****** TOTAL:

SIGNATURE
TELEPHONE 703-385-1973
DATE NOVEMBER 20, 2013
TITLE Director
FEIN 954148514
ADDRESS CHANGES TO BE NOTED ABOVE

WHEN RESPONDING TO SOLICITATION, INSERT NAME AND ADDRESS IN SPACE ABOVE LABELED 'VENDOR'

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TABLE OF CONTENTS:

SECTION ONE: GENERAL INFORMATION

1. **PURPOSE:** The Acquisition and Contract Administration Section of the Purchasing Division ("Purchasing Division") is soliciting Expression(s) of Interest ("EOI" or "Bids") for the West Virginia Department of Environmental Protection (WVDEP), from qualified firms to provide architectural/engineering services ("Vendors") as defined herein.

2. **PROJECT:** The mission or purpose of the project for which bids are being solicited is to provide Total Maximum Daily Loads (TMDLs) for the impaired streams in the Tygart Valley River Watershed.

3. **SCHEDULE OF EVENTS:**

Release of the EOI.....	**11/6/2013**
Addendum Issued.....	TBD
Expressions of Interest Opening Date.....	**11/27/2013**
Estimated Date for Interviews.....	TBD

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SECTION TWO: INSTRUCTIONS TO VENDORS SUBMITTING BIDS

Instructions begin on the next page.

INSTRUCTIONS TO VENDORS SUBMITTING BIDS

1. **REVIEW DOCUMENTS THOROUGHLY:** The attached documents contain a solicitation for bids. Please read these instructions and all documents attached in their entirety. These instructions provide critical information about requirements that if overlooked could lead to disqualification of a Vendor's bid. All bids must be submitted in accordance with the provisions contained in these instructions and the Solicitation. Failure to do so may result in disqualification of Vendor's bid.

2. **MANDATORY TERMS:** The Solicitation may contain mandatory provisions identified by the use of the words "must," "will," and "shall." Failure to comply with a mandatory term in the Solicitation will result in bid disqualification.

3. **PREBID MEETING:** The item identified below shall apply to this Solicitation.

   [✓] A pre-bid meeting will not be held prior to bid opening.

   [ ] A **NON-MANDATORY PRE-BID** meeting will be held at the following place and time:

   [ ] A **MANDATORY PRE-BID** meeting will be held at the following place and time:

   All Vendors submitting a bid must attend the mandatory pre-bid meeting. Failure to attend the mandatory pre-bid meeting shall result in disqualification of the Vendor's bid. No one person attending the pre-bid meeting may represent more than one Vendor.

   An attendance sheet provided at the pre-bid meeting shall serve as the official document verifying attendance. The State will not accept any other form of proof or documentation to verify attendance. Any person attending the pre-bid meeting on behalf of a Vendor must list on the attendance sheet his or her name and the name of the Vendor he or she is representing. Additionally, the person attending the pre-bid meeting should include the Vendor's E-Mail address, phone number, and Fax number on the attendance sheet. It is the Vendor's responsibility to locate the attendance sheet and provide the required information. Failure to complete the attendance sheet as required may result in disqualification of Vendor's bid.

All Vendors should arrive prior to the starting time for the pre-bid. Vendors who arrive after the starting time but prior to the end of the pre-bid will be permitted to sign in, but are charged with knowing all matters discussed at the pre-bid.

Questions submitted at least five business days prior to a scheduled pre-bid will be discussed at the pre-bid meeting if possible. Any discussions or answers to questions at the pre-bid meeting are preliminary in nature and are non-binding. Official and binding answers to questions will be published in a written addendum to the Solicitation prior to bid opening.

4. **VENDOR QUESTION DEADLINE:** Vendors may submit questions relating to this Solicitation to the Purchasing Division. Questions must be submitted in writing. All questions must be submitted on or before the date listed below and to the address listed below in order to be considered. A written response will be published in a Solicitation addendum if a response is possible and appropriate. Non-written discussions, conversations, or questions and answers regarding this Solicitation are preliminary in nature and are non-binding.

Question Submission Deadline: 11/19/2013

Submit Questions to: Frank Whittaker
2019 Washington Street, East
Charleston, WV 25305
Fax: 304-558-4115
Email: frank.m.whittaker@wv.gov

5. **VERBAL COMMUNICATION:** Any verbal communication between the Vendor and any State personnel is not binding, including that made at the mandatory pre-bid conference. Only information issued in writing and added to the Solicitation by an official written addendum by the Purchasing Division is binding.

6. **BID SUBMISSION:** All bids must be signed and delivered by the Vendor to the Purchasing Division at the address listed below on or before the date and time of the bid opening. Any bid received by the Purchasing Division staff is considered to be in the possession of the Purchasing Division and will not be returned for any reason. The bid delivery address is:

Department of Administration, Purchasing Division
2019 Washington Street East
Charleston, WV 25305-0130

The bid should contain the information listed below on the face of the envelope or the bid may not be considered:

SEALED BID
BUYER: _____
SOLICITATION NO.: _____
BID OPENING DATE: _____
BID OPENING TIME: _____
FAX NUMBER: _____

In the event that Vendor is responding to a request for proposal, the Vendor shall submit one original technical and one original cost proposal plus _____ convenience copies of each to the Purchasing Division at the address shown above. Additionally, the Vendor should identify the bid type as either a technical or cost proposal on the face of each bid envelope submitted in response to a request for proposal as follows:

BID TYPE: ☐ Technical
☐ Cost

7. **BID OPENING:** Bids submitted in response to this Solicitation will be opened at the location identified below on the date and time listed below. Delivery of a bid after the bid opening date and time will result in bid disqualification. For purposes of this Solicitation, a bid is considered delivered when time stamped by the official Purchasing Division time clock.

Bid Opening Date and Time: 11/27/2013 at 1:30 pm

Bid Opening Location: Department of Administration, Purchasing Division
2019 Washington Street East
Charleston, WV 25305-0130

8. **ADDENDUM ACKNOWLEDGEMENT:** Changes or revisions to this Solicitation will be made by an official written addendum issued by the Purchasing Division. Vendor should acknowledge receipt of all addenda issued with this Solicitation by completing an Addendum Acknowledgment Form, a copy of which is included herewith. Failure to acknowledge addenda may result in bid disqualification. The addendum acknowledgement should be submitted with the bid to expedite document processing.

9. **BID FORMATTING:** Vendor should type or electronically enter the information onto its bid to prevent errors in the evaluation. Failure to type or electronically enter the information may result in bid disqualification.

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Submit:

One original, plus one convenience copy and one copy on CD to:

Purchasing Division
2019 Washington Street, East
P.O. Box 50130
Charleston, WV 25305-0130

The outside of the envelope or package(s) should be clearly marked:
Buyer: 23
Req#: DEP16379

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SECTION THREE: PROJECT SPECIFICATIONS

1. **Location:** Agency is located at 601 57th Street SE, Charleston, WV 25304 and the Project will address impaired waters in the Tygart Valley River watershed and will be administered in Charleston, WV.

2. **Background:** The West Virginia Department of Environmental Protection, Division of Water and Waste Management (DWWM), is responsible for the protection, restoration, and enhancement of the State's waters, and for Total Maximum Daily Load (TMDL) development in West Virginia. Section 303(d) of the Federal Clean Water Act and the U.S. Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (40 CFR Part 130) require states to identify waters not meeting state water quality standards and to develop TMDLs for these waters. A TMDL establishes the maximum allowable pollutant loading for a stream to meet the applicable standard, allocates that load among pollutant contributors, and provides a basis for taking actions needed to restore water quality.

   WVDEP is committed to implementing a TMDL development process that reflects the requirements of TMDL regulations, provides for the achievement of water quality standards, and ensures that adequate stakeholder participation is achieved in the process.

   TMDLs are stream-specific and may involve any parameter for which numeric or narrative water quality criterion exists. West Virginia's most common impairments are those related to mine drainage, bacterial contamination, and biological impairment. For streams impaired by mine drainage, TMDL development may be required with respect to the State's numeric water quality criteria for iron, aluminum, manganese, selenium, or pH. TMDLs for bacterial contamination must be based upon the State's numeric water quality criteria for fecal coliform bacteria. Another common impairment for which TMDL development may be necessary involves acidic atmospheric deposition based upon the State's pH numeric water quality criterion. TMDL development may or may not be requested for biologically impaired waters. WVDEP may request identification of significant biological stressors even if biological TMDL development is not pursued. TMDLs may be needed for any pollutant for which a numeric water quality criterion is established, or for other pollutants determined to be causative stressors of biological impairment.

   The WVDEP will develop TMDLs in concert with a geographically-based approach to water resource management in West Virginia known as the Watershed Management Framework. Adherence to the framework ensures efficient and systematic accomplishment of statewide TMDL development. As such, each TMDL to be developed will correspond to specific geographical areas, within which impaired waters will be geographically nested into TMDL subwatersheds. The details for this TMDL development project will be accomplished through a

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specific work directive to the selected Vendor.

Prior to Vendor involvement, the WVDEP will perform rigorous pre-TMDL monitoring at strategic locations in impaired or potentially impaired waters. Actual monitoring locations will vary based on the drainage pattern of studied watersheds. Station locations will attempt to characterize the extent of impairment. For impairments related to numeric water quality criteria, monthly monitoring will generally be performed for twelve months. Biological monitoring will also be conducted at selected stations to characterize stream health and assess general habitat conditions. Source tracking information will augment pre-TMDL water quality monitoring and biological assessment through the identification and characterization of pollutant sources. The WVDEP will compile the stream monitoring and source tracking information and provide it to the Vendor. The WVDEP will review the results of the pre-TMDL monitoring effort, determine impaired water bodies requiring TMDLs and incorporate this information into the work directive for the TMDL project. WVDEP may also request the Vendor to evaluate model results at delineated subwatershed pour points and, in coordination with WVDEP, present TMDLs for any coded stream for which the modeling demonstrates nonattainment with applicable water quality criteria.

As described in detail in the following section, the Vendor will provide necessary TMDLs in accordance with established deadlines. The work directive under this contract is anticipated to be issued in December 1, 2013 with the TMDLs to be finalized by November 30, 2015.

3. **Qualifications and Experience:** Vendors will provide information regarding its employees, such as staff qualifications and experience in completing similar projects; references; copies of any staff certifications or degrees applicable to this project; proposed staffing plan; descriptions of past projects completed entailing the location of the project, project manager name and contact information, type of project, and what the project goals and objectives where and how they were met.

4. **Project and Goals:** The project goals and objectives are:

General:
Over the TMDL development period (approximately 24 months), the Vendor shall furnish the necessary labor, supervision and resources necessary to develop USEPA approved TMDLs for impaired waters as specified by the WVDEP. The labor, supervision and resources to be provided under this contract shall be for all aspects of TMDL development including, but not limited to, data compilation and formatting, model selection, model development and calibration, allocation scenario development, biological stressor identification, report

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development, public meeting participation, response to USEPA and public comments, and technology transfer/training.

In the TMDL development process, approximately eight months will be allotted for data development, source characterization, and biological stressor identification. During the next twelve months, the Vendor will complete model development and calibration, documentation of the base condition and allocation scenario alternatives, including consideration of stakeholder input to the allocation process, and will develop initial draft TMDL documents. During the subsequent four months, the Vendor will refine and finalize TMDL documents as directed by the WVDEP. Finalization components include revision of initial draft documents as directed by WVDEP, public notice of the draft TMDL, receipt and consideration of public comments, creation of a responsiveness summary that addresses public comments, and USEPA-required revisions as necessary for approval of the TMDL.

Project Description:
The project will require comprehensive water quality assessment and hydrologic modeling of the Tygart Valley River watershed and development of TMDLs that are approvable by US EPA.

Scope of Work:
The Vendor will develop TMDLs for the impaired waters in the Tygart Valley River watershed.

Data Development:
It shall be the Vendor's responsibility to gather and assemble all relevant data as specified by the WVDEP, with details to be determined for each type of TMDL. The WVDEP shall generate recent and comprehensive water quality monitoring data for impaired waters and provide it to the Vendor. The Vendor must be capable of data manipulations in Microsoft® Access and ORACLE® formats in order to facilitate usage of WVDEP's current databases. The WVDEP will assist in the compilation of other available water quality data and pollutant source information as appropriate throughout the contract period. The data and sources necessary to fulfill TMDL development processes will be partitioned as follows:

Information supplied by WVDEP:

- Pre-TMDL water quality monitoring data and locations
- Source tracking data including, but not necessarily limited to, timber harvest and burn area, extent of public and private centralized sewer systems, info on inadequate on-site sewage

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treatment, septic zones, MS4 areas, abandoned mine land disturbances and seep locations and discharge characterization data, agricultural sites, stream bank erosion data, and source photos)

- Steam reach and impaired stream coverage
- Impairment assessments based on water quality monitoring data
- Permitted facility locations and NPDES permit information
- Permitted facility Discharge Monitoring Report data
- Oil and gas well locations
- 911 structures and roads
- Abandoned mining coverage and data
- Bond forfeiture coverage and data

Information gathered by the Vendor:

- Meteorological station locations
- Rainfall
- Temperature
- Wind speed
- Dew point
- Humidity
- Cloud cover
- Soils surveys
- State Soil Geographic Database (STATSGO)
- Soil Survey Geographic Database (SSURGO)
- Pollutant atmospheric deposition data
- Landuse and land cover
- Cataloging Unit boundaries (HUC)
- Historical Stream Flow Record (daily averages)
- Topographic maps (topo quads)
- Digital elevation maps (DEM)
- National Elevation Dataset (NED)
- Roads

Subwatershed Delineation:

In this project, the watershed will be subdivided into "TMDL watersheds". Further subdivision of the watersheds will be scaled to the extent and size of the impaired stream segments such that only one impaired stream is contained in an individual subwatershed. The location of pre-TMDL monitoring stations shall also be considered. Subwatershed delineation will be structured as to conserve pollutants from upstream watersheds to downstream (receiving) watersheds, and will adhere to topographic boundaries. Vendor will provide a subwatershed delineation directory (CD) of the project watersheds that will contain ArcView® shapefiles.

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The project will be developed in ArcView® 9 and at a minimum contain the following four layers:

- Impaired Streams Layer -- Spatial coverage including an attribute table containing impaired stream names, NHD stream code, WV stream code, trout water designation, and fields identifying each impairment.
- Stream Layer -- Spatial coverage including an attribute table containing stream name, WV stream code, NHD stream code.
- Subwatershed Layer -- Spatial coverage including an attribute table containing watershed name, sub ID number, downstream sub ID number, area (M^2 & acres), GNIS ID, GNIS name, final stream name, WV stream code, and WV NHD stream code.
- TMDL Watershed Boundary Layer -- Spatial coverage of the TMDL watershed(s) including an attribute table containing watershed name.

NPDES Permit Summary Report:
It is very important that all permitted point sources be correctly located and represented in the model in order to develop accurate TMDLs. The Vendor shall provide an NPDES permit data summary report for the project watershed. This permit summary report will identify and characterize the NDPES data associated with permitted point sources in the watershed. The permit summary report will contain two parts: mining-related permit summary spreadsheets (in a Microsoft® Excel filterable format) and non-mining related permit summary spreadsheets (in a Microsoft® Excel filterable format). These summaries will be submitted to WVDEP on a CD.

Mining permit data and the Division of Mining and Reclamation's (DMR) hydrologic protection unit GIS coverage (hpu.shp) will be provided to the Vendor from WVDEP's Environmental Resource Information System (ERIS) database. The hpu.shp GIS coverage will be used to determine the location of the mining-related NPDES permitted outlets. The ERIS database system will provide the effluent type, permit limits and discharge data for the permitted outlets. WVDEP will develop a comprehensive list of mining-related NPDES permitted outlets in the watershed, including permit number, permit type, outlet ID, outlet location (latitude and longitude), effluent type code, effluent limits, total and disturbed drainage area (for precipitation induced discharges), and continuous flow data (for pumped or constant discharges). This information will provide the basis for representing mining related discharge flows as either continuous flow or precipitation driven in the model.

Non-mining point sources include, but are not necessarily limited to the following: discharges from publicly-owned treatment works (POTWs), POTW collection systems overflows, privately owned sewage treatment plant discharges, discharges from industrial wastewater

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treatment facilities, and registrations under the Multi-sector Stormwater, Municipal Separate Storm Sewer System (MS4), and Construction Stormwaterr general permits, WVDEP's OWRNPDES GIS coverage will be used to determine the locations of the non-mining permitted sources and describe permit information such as discharge characteristics, permit limits, and discharge data, which will be obtained from WVDEP's ERIS database. These two datasets will be combined to generate the non-mining related permit summary list for each type of source and will provide the permit number, facility name, responsible party, permit type, outlet ID, outlet location (latitude and longitude), the watershed in which the outlet is located, outlet status (open/closed), the start and end dates for the outlet, and the parameters of interest for which limits are found (including flow, chemical concentrations and pH).

Pollutant Source Summary:
The Vendor shall provide a pollutant source report in a CD directory containing an ArcView® project that spatially represents the potential sources of stream impairments in the watershed. The project will contain a unique layer for each impairment type (metals, bacteria, or others). Within each view, shapefiles will be presented that represent potential point and nonpoint pollutant sources, watershed physiographic data, and the monitoring data required for modeling. The shapefiles will be represented with appropriate symbols in the view legend and physical and observed details will be presented in the attribute table associated with each shapefile. A descriptive document (or legend) will also be submitted with the pollutant source report that explains in detail the contents of each project, view, and shapefile. The Arcview® pollutant source report will include the following layers, where appropriate:

Watershed Physiographic Data:
Subwatershed Delineations -- Created by the subwatershed delineation process described in the above Subwatershed Delineation section. The attribute table will include the subwatershed ID number, stream name, stream code and next downstream reach.

Stream Reach -- Spatial representation of all WVDEP digitized streams in the watershed

Impaired Streams – Spatial coverage of the subset of WVDEP's stream reach file identifying impaired streams in the watershed. The attribute table will contain fields that indicate all pollutants for which each stream is impaired.

Roads – The extent of roads in project watersheds will be spatially represented through a combination of wv_roads.shp, TIGER/line files from the U.S. Census Bureau (2011) and vendor-digitized unpaved roads found on topographical maps and aerial photos.

Towns – Spatial coverage including locations and names of towns and municipalities in the watershed.

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Soils – Spatial soil classification incorporating USGS STATSGO information.

Landuse (USGS 2006 NLCD, or equivalent)

Structures -- Spatial coverage based on information collected through the 911 initiatives. The point coverage includes all buildings and structures on a countywide basis to reflect development that has occurred after landuse data set was created.

Monitoring Data:
WAB Stations -- Spatial coverage to include locations of all WVDEP Watershed Assessment Branch (WAB) in-stream monitoring stations. The attribute table will include the station ID, stream name, stream code, location coordinates and monitoring results.

Additional Monitoring Stations -- Spatial coverage to include locations of all other water quality monitoring stations provided to WVDEP by permittees or other sources, if applicable. The attribute table will include the data provider, stream name, stream code, location coordinates and monitoring results.

Weather Stations -- Spatial coverage to include locations of weather stations (including precipitation gages and surface airways stations) within and surrounding the watershed. The attribute table will include the station name and ID, period of record, elevation, and location.

USGS Gage Stations -- Spatial coverage of USGS Gage Stations located within and surrounding the project watersheds. The attribute table will include the gage name and ID, period of record and location.

Potential Point Sources:
DWWM NPDES Permits -- Spatial coverage to include a summary of the non-mining permit limit information for NPDES permitted outlets. The attribute table will include the permit #, outlet #, effluent type, limits and other relevant information.

Mining NPDES Permits -- Spatial coverage to summarize mining permit limit information for NPDES permitted outlets. The attribute table will include the permit #, outlet #, effluent type, limits and other relevant information.

Permitted Mining Areas -- Spatial coverage displaying permitted area of mining operations.

Valley Fills -- Spatial coverage displaying valley fills from mountaintop removal coal operations.

Potential Nonpoint Sources:

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AML Area -- Spatial coverage displaying locations and areas of AML surface disturbances.

AML Highwall -- Spatial coverage to include locations of AML highwalls.

AML Portals (WVDEP) -- Spatial coverage to include locations of AML portals.

Oil and Gas Wells -- Spatial coverage to include locations and status of oil and gas well operations.

Marcellus Shale wells – Spatial coverage to include locations and status of the Marcellus Shell drilling operations

Bond Forfeiture Sites -- Spatial coverage to include locations and status of bond forfeiture sites.

Harvested Forest Info - Spatial coverage to include locations of forest harvest operations based upon information provided by the WV Division of Forestry. The attributes table will include registration number, start date, end date, landing areas, skid/haul road areas, and total logging areas.

Burned Forest Info -- Spatial coverage to include locations of burned forest areas based upon information provided by the WV Division of Forestry. The attributes table will include the date of burn and the total area burned

Additional Information Generated by WVDEP Source Tracking:
AML Seeps -- Spatial coverage to include sample locations taken during WVDEP source tracking efforts. The attributes table includes the site description and the analytical results for each sample.

AML Disturbances -- Spatial coverage to include additional AML areas identified during WVDEP source tracking efforts. The attributes table will include the site description of each AML, associated PADS#, and other relevant information.

Stream bank evaluation sites - Spatial coverage to include the locations of pin study stations where stream bank erosion was measured. The attributes table will include the amount of measured erosion and erosion potential evaluations at each site.

Sewered Areas -- Spatial coverage that shows the boundaries of private and publicly owned centralized sewage collection systems.

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Septic Zones -- Spatial coverage that includes zones of septic system failure rates derived from hydrogeological characteristics within the watershed.

MS4 Permits -- Spatial coverage that shows Municipal Separate Storm Sewer System boundaries.

Agricultural Sites -- Spatial coverage showing evaluations of pasture intensity, runoff potential, and acres of riparian zone pasture compiled on a subwatershed basis.

Watershed Model:
The Vendor must use the Load Simulation Program in C^{++}/Mining Data Analysis System (LSPC/MDAS), or an equivalent, modeling system to develop WVDEP TMDLs for streams that are in violation of West Virginia water quality standards. The Vendor shall use nonproprietary models, model codes, and tools (i.e. those in the public domain for TMDL development). In addition, Vendor shall also provide adequate technical transfer of all models, model codes, tools, and relevant data to WVDEP personnel without restriction to distribution. The modeling and data management process must provide the following:

- Simulation of watershed hydrology using hourly local meteorological data
- Simultaneous modeling of numerous (+500) subwatersheds
- Simulation of relevant pollutant source loading and in-stream response under a range of flow conditions for existing, baseline, and TMDL scenarios. The model must calibrate for existing conditions, but be able to be modified to allow for baseline and allocation scenarios
- Evaluations of compliance with all water quality criteria, considering exposure duration and exceedance frequency components
- Representation of loading processes for both point and nonpoint sources as either precipitation driven or constant discharge, as appropriate
- Representation of atmospheric deposition
- Representation of pollutant build-up/washoff rates for various landuse categories
- Representation of pollutants transferred from upstream watersheds to receiving (downstream) watersheds in a conservative manner
- Incorporation of a graphical interface that supports GIS functions
- Representation of in-stream dissolved metals stemming from total metal source inputs, atmospheric acid deposition and watershed buffering capacity, prescription of total

metal allocations that result in compliance with dissolved metal water quality criteria, and distinction of allocations for atmospheric and land-based sources

- Presentation of allocations in an acceptable manner (usable by WVDEP) through a post-processing system that provides waste load allocations (WLAs) to individual point sources and load allocations (LA) to categories of non-point sources
- Storage of all geographic, modeling, and point source permit data in a Microsoft® Access or equivalent database and text file formats to provide for efficient manipulation of data

Model Hydrology Calibration:
The Vendor shall perform a calibration of the utilized model(s) with respect to hydrological prediction and provide a report showing the results. The hydrology calibration shall involve the comparison of model results with in-stream flow measurements at selected locations and subsequent adjustment of the hydrologic parameters. The calibration period will be based on the availability of weather and flow data collected during the same time period. The model hydrology calibration must entail the following:

- Incorporation of in-stream flow data from USGS flow gaging stations throughout the watershed. In watersheds without USGS flow gaging stations, the hydrology calibration will be performed on a nearby watershed with similar characteristics and well-documented land uses. This calibration will be supplemented by instantaneous flow measurements from pre-TMDL monitoring.

- Utilization of hydrologic data selected with respect to the following criteria:
  - Completeness of the weather data available for the selected period
  - Adequacy of low-flow and high-flow years
  - Consistency of selected period with key model inputs
- Achievement of the overall goals of the calibration (to decrease the error between the simulated and observed flows) in the following order:
  - Maintenance of annual water balance
  - Representation of seasonal and monthly flow volumes
  - Representation of base-flow conditions
  - Representation of storm events
- Report presentation on a CD containing worksheets that represent the observed and modeled data, graphs and tables designed to assess the goodness-of-fit, and a statistical analysis of the calibration. Calibration shall be performed on a reasonable number of subwatersheds to assure scientific validity of the process.

Model Water Quality Calibration:

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The Vendor shall perform a water quality calibration for all pollutants of concern at multiple locations throughout the watersheds. This calibration will consist of executing the watershed model, comparing time series water quality output with available water quality observation data, and adjusting water quality parameters within a reasonable range. In-stream concentrations from the model are to be compared directly with observed data. The objective is to best simulate observed concentrations at low flow, mean flow, and storm peaks at representative water quality monitoring stations.

The water quality calibration shall be presented on a CD and contain worksheets that represent the observed and modeled output data, graphs and tables designed to assess the goodness-of-fit, and a statistical analysis of the calibration. Calibration shall be performed on a reasonable number of subwatersheds to assure scientific validity of the process.

Biological Stressor Identification:
Stressor identification will be accomplished by a weight-of-evidence/best professional judgment approach that incorporates evaluation of field narratives and available information on water chemistry, habitat, and biological assemblages. The Vendor will build upon the stressor identification methodologies and threshold criteria developed in the previous TMDL projects. The use of biological information, particularly statistical diagnostic resources developed in concert with DEP biologists, will be used in the stressor identification processes to increase the effectiveness of the identification of significant biological stressors. The Vendor will utilize and integrate the abiotic and biotic information relating to stream health to formulate a candidate list of biological stressors for DEP review. Typical stressors include pH/metals toxicity, sedimentation, organic enrichment, and ionic stress; however, additional stressors may be encountered and will require diagnosis via stressor identification processes, including statistical modeling. The use of developed and tested diagnostic resources (e.g. statistical models) to enhance biological stressor identification, including stressor identification diagrams which correlate likely stressors to trends evidenced in biological communities will be necessary. The Vendor shall have experience with statistical model(s) which assign probabilities for likely stressors impacting biological assemblages based on genus and/or species-level taxonomy.

Additionally, the Vendor will adhere to the following protocol for biological stressor identification:

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- Thorough review of DEP/WAB database for all information related to biological impacts including water chemistry data, physical habitat assessments, field narratives, and taxonomic information.
- Review of source tracking data to provide guidance and direction as to stressor identification pathways.
- The Vendor will assist WVDEP personnel in the selection of appropriate reference watersheds for use in stressor identification and to support the total iron surrogate approach discussed in the following section. WVDEP will provide an initial list of potential reference watersheds based on knowledge of the watersheds, biological condition, similarity to impaired watersheds, and best professional judgment.

The Vendor will assemble biological stressor identification resources for use in a decision meeting with WVDEP in which significant stressors will be jointly determined. The Vendor will incorporate all research/findings, both statistical and taxonomic, into a stressor identification report that includes the results of consensus decisions emanating from the joint stressor identification meeting.

Sediment/Metals Relationships
TMDLs relative to numeric water quality criteria for iron will require the control of iron loading from sediment-producing sources and biological stress due to sedimentation may be resolved by attainment of total iron water quality criteria. As such, the Vendor will be required to examine potential sediment/iron (TSS-to-Fe) relationships at the subwatershed scale and document/quantify areas where positive correlations exist.

Allocations:
The Vendor and WVDEP will collaborate on an overall allocation strategy from which wasteload and load allocations shall be developed. The Vendor will provide waste load allocations (WLAs) to individual point sources and load allocations (LAs) to specific categories of non-point sources. These allocations will be provided on a CD with filterable spreadsheets. The allocations will include a margin of safety, seasonality considerations, analysis of background conditions, and future growth allocations, if requested by the WVDEP. Generally, the allocations must be reasonable and the prescribed reductions cannot be more stringent than the background conditions. The Vendor and WVDEP will select the target date for the finalization of an overall allocation strategy during the project kick-off meeting. WVDEP and Vendor will cooperate as necessary to ensure that the strategy is finalized with ample time for the completion of the Preliminary Draft TMDL deliverable by its scheduled due date.

TMDL Report Development:
The TMDL reports to be submitted during the course of this contract shall be subject to the federal regulatory requirements for the development of an approvable TMDL as specified at 40

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CFR 130, and any applicable EPA Region III guidance. The Vendor will be responsible for all document revisions at various points in the process, from draft stages until final document approval. WVDEP shall direct the Vendor to make report revisions when necessary.

The TMDL reports should allow the general public to understand existing impairments and the corrective actions necessary to restore water quality. Information should also be presented in formats that maximize the usefulness of the TMDL to agencies and programs responsible for implementation. The WVDEP and Vendor will cooperate in the development of a report format that meets those needs.

Prior to submission of all internal draft reports, the Vendor will perform a thorough technical review for accuracy of content, general grammatical correctness, and graphical representation.

Status Report and Other Meetings:
The Vendor and WVDEP will hold regular project status meetings. The meetings will be conducted by conference call or in-person at WVDEP headquarters. In discussion/solving of complex issues, the Vendor will be required to come to WVDEP headquarters (typically twice per month). Additionally, the Vendor and WVDEP staff will tour the TMDL development project watershed. Watershed tours typically consist of one or two day events.

Public Participation Meetings:

The Vendor will participate in up to two public meetings at locations near the TMDL watershed(s), which will be determined at a later date. These meetings will be arranged by the WVDEP. The meeting will be a status update, reviewing general TMDL concepts, water quality standards, and the process of TMDL development for the impaired streams within the project watershed. Other topics may include the selection and calibration of TMDL models, description of the base conditions, and general allocation strategies. The second meeting will occur following the development of the draft TMDLs and notice of their availability for comment. During this meeting, WVDEP and Vendor will provide a brief overview of the substantive components of the TMDLs, and facilitate interaction between the stakeholders and the WVDEP. The purpose of the meeting is to educate the stakeholders so they can make informed comments on the draft TMDLs. At least three (3) working days prior to each meeting, the Vendor shall provide any proposed presentation material to the WVDEP for review.

Response to Public Comment:
WVDEP and Vendor will prepare a responsiveness summary document during the TMDL finalization step in the process. The responsiveness summary shall answer questions posed by stakeholders, identify revisions of the draft TMDL that resulted from stakeholder input, and explain decisions regarding public comments that did not result in TMDL revision. WVDEP will address comments related to agency policy or procedures and the Vendor will address

technical issues as necessary. Additional revisions may be required by the Vendor in regard to comments provided by USEPA during TMDL approval.

Vendor MUST complete the attached Consultant Qualification Questionnaire (CQQ)

Vendor must provide a detailed description of technical proficiency and necessary resources to accomplish described TMDLs within established timeframes. If the Vendor intends to subcontract work, similar information must be provided for the subcontractor. Vendor will be evaluated on the following categories of organizational and management resources necessary to complete the project:

A. Organization
The Vendor will be evaluated according to company resources, including the types of environmental services performed, length of time in business, in-house capabilities, amount of resources and equipment available for direct attention to this project, location of primary office and number of full and part-time employees with experience and responsibilities appropriate to this work assignment.

B. Resources
Vendor's description of hardware, software, licenses, databases, models/programs, contacts and other resources available to accomplish the project requirements will be evaluated.

C. Personnel
Vendor will be evaluated on the personnel that will be assigned to this project. The Vendor's submission for evaluation should include titles, education, and work experience.

D. Project Management
Vendor will be evaluated on a description of a management plan that supports personnel and project activities within the organization and coordinates with the WVDEP to achieve timely TMDL development within budgetary constraints. Vendor will also be evaluated on any unique qualities that demonstrate an enhanced ability of the organization to meet the TMDL development requirements of WVDEP.

5. **Oral Presentations (Agency Option):** The Agency has the option of requiring oral presentations of all Vendors participating in the EOI process. If this option is exercised, it would be listed in the Schedule of Events (Section 1.3) of this EOI. During oral presentations, Vendors may not alter or add to their submitted proposal but only clarify

information. A description of the materials and information to be presented is provided below:

5.1. Materials and Information Required at Oral Presentation:

The format for the interviews will be a 30-60 minute PowerPoint presentation consisting, at a minimum, of the following:

- TMDL development methodology relating to the proposed project
- Corporate/personnel experience as it relates to the proposed project
- Proposed project management plan
- Key personnel available for the proposed work
- Proposed subcontractors
- Product quality control
- Project cost control

SECTION FOUR: VENDOR PROPOSAL, EVALUATION, & AWARD

1. **Economy of Preparation:** EOI's should be prepared simply and economically, providing a straightforward, concise description of firm's abilities to satisfy the requirements and goals and objectives of the EOI. Emphasis should be placed on completeness and clarity of content. The response sections should be labeled for ease of evaluation.

2. **BIDS MUST NOT CONTAIN PRICE QUOTATIONS:** The State shall select the best value solution according to §5G-1-3 of the West Virginia State Code. In accordance with the Code requirements, no "price" or "fee" information is requested or permitted in the bid response.

3. **Evaluation and Award Process:** Expressions of Interest for projects estimated to cost $250,000 or more will be evaluated and awarded in accordance with West Virginia Code §5G-1-3. That Code section requires the following:

   3.1. **Required Elements of EOI Response**: The director of purchasing shall encourage such firms engaged in the lawful practice of the profession to submit an expression of interest, which shall include a statement of qualifications, and performance data and may include anticipated concepts and proposed methods of approach to the project.

   3.2. **Public Advertisement:** All EOI requests shall be announced by public notice published as a Class II legal advertisement in compliance with the provisions of West Virginia Code §59-3-1 et seq.

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3.3. **Selection Committee Evaluation & Negotiation:** A committee comprised of three to five representatives of the agency initiating the request shall:

3.3.1. evaluate the statements of qualifications and performance data and other material submitted by the interested firms and select three firms which in their opinion are the best qualified to perform the desired service.

3.3.2. conduct interviews with each firm selected and the conduct discussions regarding anticipated concepts and the proposed methods of approach to the assignment.

3.3.3. rank in order of preference no less than three professional firms deemed to be the most highly qualified to provide the services required, and shall commence scope of service and price negotiations with the highest qualified professional firm.

3.3.4. Should the agency be unable to negotiate a satisfactory contract with the professional firm considered to be the most qualified, at a fee determined to be fair and reasonable, price negotiations with the firm of second choice shall commence. Failing accord with the second most qualified professional firm, the committee shall undertake price negotiations with the third most qualified professional firm.

3.3.5. Should the agency be unable to negotiate a satisfactory contract with any of the selected professional firms, it shall select additional professional firms in order of their competence and qualifications and it shall continue negotiations in accordance with this section until an agreement is reached.

3.4. **Vendor Ranking:** All evaluation criteria is defined in the Procurement Specifications section and based on a 100 point total score. Points shall be assigned based upon the Vendor's response to the evaluation criteria as follows:

• Qualifications and experience	25 Points Possible
• Approach and methodology for meeting Goals and Objectives	35 Points Possible
• Management and Resources	20 Points Possible
• Oral Interview	20 Points Possible
Total	100

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SECTION FIVE: TERMS AND CONDITIONS

Terms and conditions begin on the next page.

Special Terms and Conditions:

GENERAL TERMS AND CONDITIONS:

1. **CONTRACTUAL AGREEMENT:** Issuance of a Purchase Order signed by the Purchasing Division Director, or his designee, and approved as to form by the Attorney General's office constitutes acceptance of this Contract made by and between the State of West Virginia and the Vendor. Vendor's signature on its bid signifies Vendor's agreement to be bound by and accept the terms and conditions contained in this Contract.

2. **DEFINITIONS:** As used in this Solicitation/Contract, the following terms shall have the meanings attributed to them below. Additional definitions may be found in the specifications included with this Solicitation/Contract.

   2.1 **"Agency"** or **"Agencies"** means the agency, board, commission, or other entity of the State of West Virginia that is identified on the first page of the Solicitation or any other public entity seeking to procure goods or services under this Contract.

   2.2 **"Contract"** means the binding agreement that is entered into between the State and the Vendor to provide the goods and services requested in the Solicitation.

   2.3 **"Director"** means the Director of the West Virginia Department of Administration, Purchasing Division.

   2.4 **"Purchasing Division"** means the West Virginia Department of Administration, Purchasing Division.

   2.5 **"Purchase Order"** means the document signed by the Agency and the Purchasing Division, and approved as to form by the Attorney General, that identifies the Vendor as the successful bidder and Contract holder.

   2.6 **"Solicitation"** means the official solicitation published by the Purchasing Division and identified by number on the first page thereof.

   2.7 **"State"** means the State of West Virginia and/or any of its agencies, commissions, boards, etc. as context requires.

   2.8 **"Vendor"** or **"Vendors"** means any entity submitting a bid in response to the Solicitation, the entity that has been selected as the lowest responsible bidder, or the entity that has been awarded the Contract as context requires.

3. **CONTRACT TERM; RENEWAL; EXTENSION:** The term of this Contract shall be determined in accordance with the category that has been identified as applicable to this Contract below:

☑ **Term Contract**

Initial Contract Term: This Contract becomes effective on award

and extends for a period of one (1) year(s).

Renewal Term: This Contract may be renewed upon the mutual written consent of the Agency, and the Vendor, with approval of the Purchasing Division and the Attorney General's office (Attorney General approval is as to form only). Any request for renewal must be submitted to the Purchasing Division Director thirty (30) days prior to the expiration date of the initial contract term or appropriate renewal term. A Contract renewal shall be in accordance with the terms and conditions of the original contract. Renewal of this Contract is limited to two (2) successive one (1) year periods. Automatic renewal of this Contract is prohibited. Notwithstanding the foregoing, Purchasing Division approval is not required on agency delegated or exempt purchases. Attorney General approval may be required for vendor terms and conditions.

Reasonable Time Extension: At the sole discretion of the Purchasing Division Director, and with approval from the Attorney General's office (Attorney General approval is as to form only), this Contract may be extended for a reasonable time after the initial Contract term or after any renewal term as may be necessary to obtain a new contract or renew this Contract. Any reasonable time extension shall not exceed twelve (12) months. Vendor may avoid a reasonable time extension by providing the Purchasing Division Director with written notice of Vendor's desire to terminate this Contract 30 days prior to the expiration of the then current term. During any reasonable time extension period, the Vendor may terminate this Contract for any reason upon giving the Purchasing Division Director 30 days written notice. Automatic extension of this Contract is prohibited. Notwithstanding the foregoing, Purchasing Division approval is not required on agency delegated or exempt purchases, but Attorney General approval may be required.

Release Order Limitations: In the event that this contract permits release orders, a release order may only be issued during the time this Contract is in effect. Any release order issued within one year of the expiration of this Contract shall be effective for one year from the date the release order is issued. No release order may be extended beyond one year after this Contract has expired.

☐ **Fixed Period Contract:** This Contract becomes effective upon Vendor's receipt of the notice to proceed and must be completed within days.

☐ **One Time Purchase:** The term of this Contract shall run from the issuance of the Purchase Order until all of the goods contracted for have been delivered, but in no event shall this Contract extend for more than one fiscal year.

☐ **Other:** See attached.

4. **NOTICE TO PROCEED:** Vendor shall begin performance of this Contract immediately upon receiving notice to proceed unless otherwise instructed by the Agency. Unless otherwise specified, the fully executed Purchase Order will be considered notice to proceed

5. **QUANTITIES:** The quantities required under this Contract shall be determined in accordance with the category that has been identified as applicable to this Contract below.

☐ **Open End Contract:** Quantities listed in this Solicitation are approximations only, based on estimates supplied by the Agency. It is understood and agreed that the Contract shall cover the quantities actually ordered for delivery during the term of the Contract, whether more or less than the quantities shown.

☑ **Service:** The scope of the service to be provided will be more clearly defined in the specifications included herewith.

☐ **Combined Service and Goods:** The scope of the service and deliverable goods to be provided will be more clearly defined in the specifications included herewith.

☐ **One Time Purchase:** This Contract is for the purchase of a set quantity of goods that are identified in the specifications included herewith. Once those items have been delivered, no additional goods may be procured under this Contract without an appropriate change order approved by the Vendor, Agency, Purchasing Division, and Attorney General's office.

6. **PRICING:** The pricing set forth herein is firm for the life of the Contract, unless specified elsewhere within this Solicitation/Contract by the State. A Vendor's inclusion of price adjustment provisions in its bid, without an express authorization from the State in the Solicitation to do so, may result in bid disqualification.

7. **EMERGENCY PURCHASES:** The Purchasing Division Director may authorize the Agency to purchase goods or services in the open market that Vendor would otherwise provide under this Contract if those goods or services are for immediate or expedited delivery in an emergency. Emergencies shall include, but are not limited to, delays in transportation or an unanticipated increase in the volume of work. An emergency purchase in the open market, approved by the Purchasing Division Director, shall not constitute of breach of this Contract and shall not entitle the Vendor to any form of compensation or damages. This provision does not excuse the State from fulfilling its obligations under a One Time Purchase contract.

8. **REQUIRED DOCUMENTS:** All of the items checked below must be provided to the Purchasing Division by the Vendor as specified below.

☐ **BID BOND:** All Vendors shall furnish a bid bond in the amount of five percent (5%) of the total amount of the bid protecting the State of West Virginia. The bid bond must be submitted with the bid.

☐ **PERFORMANCE BOND:** The apparent successful Vendor shall provide a performance bond in the amount of . The performance bond must be issued and received by the Purchasing Division prior to Contract award. On construction contracts, the performance bond must be 100% of the Contract value.

☐ **LABOR/MATERIAL PAYMENT BOND:** The apparent successful Vendor shall provide a labor/material payment bond in the amount of 100% of the Contract value. The labor/material payment bond must be issued and delivered to the Purchasing Division prior to Contract award.

In lieu of the Bid Bond, Performance Bond, and Labor/Material Payment Bond, the Vendor may provide certified checks, cashier's checks, or irrevocable letters of credit. Any certified check, cashier's check, or irrevocable letter of credit provided in lieu of a bond must be of the same amount and delivered on the same schedule as the bond it replaces. A letter of credit submitted in lieu of a performance and labor/material payment bond will only be allowed for projects under $100,000. Personal or business checks are not acceptable.

☐ **MAINTENANCE BOND:** The apparent successful Vendor shall provide a two (2) year maintenance bond covering the roofing system. The maintenance bond must be issued and delivered to the Purchasing Division prior to Contract award.

☑ **WORKERS' COMPENSATION INSURANCE:** The apparent successful Vendor shall have appropriate workers' compensation insurance and shall provide proof thereof upon request.

☑ **INSURANCE:** The apparent successful Vendor shall furnish proof of the following insurance prior to Contract award and shall list the state as a certificate holder:

☑ **Commercial General Liability Insurance:**
$1,000,000.00 or more.

☐ **Builders Risk Insurance:** builders risk – all risk insurance in an amount equal to 100% of the amount of the Contract.

☑ $2,000,000.00 Aggregate

☑ $1,000,000.00 Automobile Liability

☑ $1,000,000.00 Professional Liability

☑ WV Code 23-4-2 (Mandolidis)

☐

The apparent successful Vendor shall also furnish proof of any additional insurance requirement contained in the specifications prior to Contract award regardless of whether or not that insurance requirement is listed above.

☐ **LICENSE(S) / CERTIFICATIONS / PERMITS:** In addition to anything required under the Section entitled Licensing, of the General Terms and Conditions, the apparent successful Vendor shall furnish proof of the following licenses, certifications, and/or permits prior to Contract award, in a form acceptable to the Purchasing Division.

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The apparent successful Vendor shall also furnish proof of any additional licenses or certifications contained in the specifications prior to Contract award regardless of whether or not that requirement is listed above.

9. **LITIGATION BOND:** The Director reserves the right to require any Vendor that files a protest of an award to submit a litigation bond in the amount equal to one percent of the lowest bid submitted or $5,000, whichever is greater. The entire amount of the bond shall be forfeited if the hearing officer determines that the protest was filed for frivolous or improper purpose, including but not limited to, the purpose of harassing, causing unnecessary delay, or needless expense for the Agency. All litigation bonds shall be made payable to the Purchasing Division. In lieu of a bond, the protester may submit a cashier's check or certified check payable to the Purchasing Division. Cashier's or certified checks will be deposited with and held by the State Treasurer's office. If it is determined that the protest has not been filed for frivolous or improper purpose, the bond or deposit shall be returned in its entirety.

10. **ALTERNATES:** Any model, brand, or specification listed herein establishes the acceptable level of quality only and is not intended to reflect a preference for, or in any way favor, a particular brand or vendor. Vendors may bid alternates to a listed model or brand provided that the alternate is at least equal to the model or brand and complies with the required specifications. The equality of any alternate being bid shall be determined by the State at its sole discretion. Any Vendor bidding an alternate model or brand should clearly identify the alternate items in its bid and should include manufacturer's specifications, industry literature, and/or any other relevant documentation demonstrating the equality of the alternate items. Failure to provide information for alternate items may be grounds for rejection of a Vendor's bid.

11. **EXCEPTIONS AND CLARIFICATIONS:** The Solicitation contains the specifications that shall form the basis of a contractual agreement. Vendor shall clearly mark any exceptions, clarifications, or

other proposed modifications in its bid. Exceptions to, clarifications of, or modifications of a requirement or term and condition of the Solicitation may result in bid disqualification.

12. LIQUIDATED DAMAGES: Vendor shall pay liquidated damages in the amount for

This clause shall in no way be considered exclusive and shall not limit the State or Agency's right to pursue any other available remedy.

13. ACCEPTANCE/REJECTION: The State may accept or reject any bid in whole, or in part. Vendor's signature on its bid signifies acceptance of the terms and conditions contained in the Solicitation and Vendor agrees to be bound by the terms of the Contract, as reflected in the Purchase Order, upon receipt.

14. REGISTRATION: Prior to Contract award, the apparent successful Vendor must be properly registered with the West Virginia Purchasing Division and must have paid the $125 fee if applicable.

15. COMMUNICATION LIMITATIONS: In accordance with West Virginia Code of State Rules §148-1-6.6, communication with the State of West Virginia or any of its employees regarding this Solicitation during the solicitation, bid, evaluation or award periods, except through the Purchasing Division, is strictly prohibited without prior Purchasing Division approval. Purchasing Division approval for such communication is implied for all agency delegated and exempt purchases.

16. FUNDING: This Contract shall continue for the term stated herein, contingent upon funds being appropriated by the Legislature or otherwise being made available. In the event funds are not appropriated or otherwise made available, this Contract becomes void and of no effect beginning on July 1 of the fiscal year for which funding has not been appropriated or otherwise made available.

17. PAYMENT: Payment in advance is prohibited under this Contract. Payment may only be made after the delivery and acceptance of goods or services. The Vendor shall submit invoices, in arrears, to the Agency at the address on the face of the purchase order labeled "Invoice To."

18. UNIT PRICE: Unit prices shall prevail in cases of a discrepancy in the Vendor's bid.

19. DELIVERY: All quotations are considered freight on board destination ("F.O.B. destination") unless alternate shipping terms are clearly identified in the bid. Vendor's listing of shipping terms that contradict the shipping terms expressly required by this Solicitation may result in bid disqualification.

20. INTEREST: Interest attributable to late payment will only be permitted if authorized by the West Virginia Code. Presently, there is no provision in the law for interest on late payments.

21. PREFERENCE: Vendor Preference may only be granted upon written request and only in accordance with the West Virginia Code § 5A-3-37 and the West Virginia Code of State Rules. A Resident Vendor Certification form has been attached hereto to allow Vendor to apply for the preference. Vendor's

failure to submit the Resident Vendor Certification form with its bid will result in denial of Vendor Preference. Vendor Preference does not apply to construction projects.

22. **SMALL, WOMEN-OWNED, OR MINORITY-OWNED BUSINESSES:** For any solicitations publicly advertised for bid on or after July 1, 2012, in accordance with West Virginia Code §5A-3-37(a)(7) and W. Va. CSR § 148-22-9, any non-resident vendor certified as a small, women-owned, or minority-owned business under W. Va. CSR § 148-22-9 shall be provided the same preference made available to any resident vendor. Any non-resident small, women-owned, or minority-owned business must identify itself as such in writing, must submit that writing to the Purchasing Division with its bid, and must be properly certified under W. Va. CSR § 148-22-9 prior to submission of its bid to receive the preferences made available to resident vendors. Preference for a non-resident small, women-owned, or minority owned business shall be applied in accordance with W. Va. CSR § 148-22-9.

23. **TAXES:** The Vendor shall pay any applicable sales, use, personal property or any other taxes arising out of this Contract and the transactions contemplated thereby. The State of West Virginia is exempt from federal and state taxes and will not pay or reimburse such taxes.

24. **CANCELLATION:** The Purchasing Division Director reserves the right to cancel this Contract immediately upon written notice to the vendor if the materials or workmanship supplied do not conform to the specifications contained in the Contract. The Purchasing Division Director may cancel any purchase or Contract upon 30 days written notice to the Vendor in accordance with West Virginia Code of State Rules § 148-1-7.16.2.

25. **WAIVER OF MINOR IRREGULARITIES:** The Director reserves the right to waive minor irregularities in bids or specifications in accordance with West Virginia Code of State Rules § 148-1-4.6.

26. **TIME:** Time is of the essence with regard to all matters of time and performance in this Contract.

27. **APPLICABLE LAW**: This Contract is governed by and interpreted under West Virginia law without giving effect to its choice of law principles. Any information provided in specification manuals, or any other source, verbal or written, which contradicts or violates the West Virginia Constitution, West Virginia Code or West Virginia Code of State Rules is void and of no effect.

28. **COMPLIANCE**: Vendor shall comply with all applicable federal, state, and local laws, regulations and ordinances. By submitting a bid, Vendors acknowledge that they have reviewed, understand, and will comply with all applicable law.

29. **PREVAILING WAGE:** On any contract for the construction of a public improvement, Vendor and any subcontractors utilized by Vendor shall pay a rate or rates of wages which shall not be less than the fair minimum rate or rates of wages (prevailing wage), as established by the West Virginia Division of Labor under West Virginia Code §§ 21-5A-1 et seq. and available at http://www.sos.wv.gov/administrative-law/wagerates/Pages/default.aspx. Vendor shall be responsible for ensuring compliance with prevailing wage requirements and determining when prevailing wage

requirements are applicable. The required contract provisions contained in West Virginia Code of State Rules § 42-7-3 are specifically incorporated herein by reference.

30. **ARBITRATION:** Any references made to arbitration contained in this Contract, Vendor's bid, or in any American Institute of Architects documents pertaining to this Contract are hereby deleted, void, and of no effect.

31. **MODIFICATIONS**: This writing is the parties' final expression of intent. Notwithstanding anything contained in this Contract to the contrary, no modification of this Contract shall be binding without mutual written consent of the Agency, and the Vendor, with approval of the Purchasing Division and the Attorney General's office (Attorney General approval is as to form only). **No Change shall be implemented by the Vendor until such time as the Vendor receives an approved written change order from the Purchasing Division.**

32. **WAIVER:** The failure of either party to insist upon a strict performance of any of the terms or provision of this Contract, or to exercise any option, right, or remedy herein contained, shall not be construed as a waiver or a relinquishment for the future of such term, provision, option, right, or remedy, but the same shall continue in full force and effect. Any waiver must be expressly stated in writing and signed by the waiving party.

33. **SUBSEQUENT FORMS:** The terms and conditions contained in this Contract shall supersede any and all subsequent terms and conditions which may appear on any form documents submitted by Vendor to the Agency or Purchasing Division such as price lists, order forms, invoices, sales agreements, or maintenance agreements, and includes internet websites or other electronic documents. Acceptance or use of Vendor's forms does not constitute acceptance of the terms and conditions contained thereon.

34. **ASSIGNMENT**: Neither this Contract nor any monies due, or to become due hereunder, may be assigned by the Vendor without the express written consent of the Agency, the Purchasing Division, the Attorney General's office (as to form only), and any other government agency or office that may be required to approve such assignments. Notwithstanding the foregoing, Purchasing Division approval may or may not be required on certain agency delegated or exempt purchases.

35. **WARRANTY**: The Vendor expressly warrants that the goods and/or services covered by this Contract will: (a) conform to the specifications, drawings, samples, or other description furnished or specified by the Agency; (b) be merchantable and fit for the purpose intended; and (c) be free from defect in material and workmanship.

36. **STATE EMPLOYEES:** State employees are not permitted to utilize this Contract for personal use and the Vendor is prohibited from permitting or facilitating the same.

37. **BANKRUPTCY**: In the event the Vendor files for bankruptcy protection, the State of West Virginia may deem this Contract null and void, and terminate this Contract without notice.

38. [RESERVED]

39. **CONFIDENTIALITY**: The Vendor agrees that it will not disclose to anyone, directly or indirectly, any such personally identifiable information or other confidential information gained from the Agency, unless the individual who is the subject of the information consents to the disclosure in writing or the disclosure is made pursuant to the Agency's policies, procedures, and rules. Vendor further agrees to comply with the Confidentiality Policies and Information Security Accountability Requirements, set forth in http://www.state.wv.us/admin/purchase/privacy/default.html.

40. **DISCLOSURE:** Vendor's response to the Solicitation and the resulting Contract are considered public documents and will be disclosed to the public in accordance with the laws, rules, and policies governing the West Virginia Purchasing Division. Those laws include, but are not limited to, the Freedom of Information Act found in West Virginia Code § 29B-1-1 et seq.

    If a Vendor considers any part of its bid to be exempt from public disclosure, Vendor must so indicate by specifically identifying the exempt information, identifying the exemption that applies, providing a detailed justification for the exemption, segregating the exempt information from the general bid information, and submitting the exempt information as part of its bid but in a segregated and clearly identifiable format. Failure to comply with the foregoing requirements will result in public disclosure of the Vendor's bid without further notice. A Vendor's act of marking all or nearly all of its bid as exempt is not sufficient to avoid disclosure and WILL NOT BE HONORED. Vendor's act of marking a bid or any part thereof as "confidential" or "proprietary" is not sufficient to avoid disclosure and WILL NOT BE HONORED. In addition, a legend or other statement indicating that all or substantially all of the bid is exempt from disclosure is not sufficient to avoid disclosure and WILL NOT BE HONORED. Vendor will be required to defend any claimed exemption for nondisclosure in the event of an administrative or judicial challenge to the State's nondisclosure. Vendor must indemnify the State for any costs incurred related to any exemptions claimed by Vendor. Any questions regarding the applicability of the various public records laws should be addressed to your own legal counsel prior to bid submission.

41. **LICENSING:** In accordance with West Virginia Code of State Rules §148-1-6.1.7, Vendor must be licensed and in good standing in accordance with any and all state and local laws and requirements by any state or local agency of West Virginia, including, but not limited to, the West Virginia Secretary of State's Office, the West Virginia Tax Department, West Virginia Insurance Commission, or any other state agency or political subdivision. Upon request, the Vendor must provide all necessary releases to obtain information to enable the Purchasing Division Director or the Agency to verify that the Vendor is licensed and in good standing with the above entities.

42. **ANTITRUST:** In submitting a bid to, signing a contract with, or accepting a Purchase Order from any agency of the State of West Virginia, the Vendor agrees to convey, sell, assign, or transfer to the State of West Virginia all rights, title, and interest in and to all causes of action it may now or hereafter acquire under the antitrust laws of the United States and the State of West Virginia for price fixing and/or unreasonable restraints of trade relating to the particular commodities or services purchased or acquired

by the State of West Virginia. Such assignment shall be made and become effective at the time the purchasing agency tenders the initial payment to Vendor.

43. **VENDOR CERTIFICATIONS:** By signing its bid or entering into this Contract, Vendor certifies (1) that its bid was made without prior understanding, agreement, or connection with any corporation, firm, limited liability company, partnership, person or entity submitting a bid for the same material, supplies, equipment or services; (2) that its bid is in all respects fair and without collusion or fraud; (3) that this Contract is accepted or entered into without any prior understanding, agreement, or connection to any other entity that could be considered a violation of law; and (4) that it has reviewed this RFQ in its entirety; understands the requirements, terms and conditions, and other information contained herein. Vendor's signature on its bid also affirms that neither it nor its representatives have any interest, nor shall acquire any interest, direct or indirect, which would compromise the performance of its services hereunder. Any such interests shall be promptly presented in detail to the Agency.

    The individual signing this bid on behalf of Vendor certifies that he or she is authorized by the Vendor to execute this bid or any documents related thereto on Vendor's behalf; that he or she is authorized to bind the Vendor in a contractual relationship; and that, to the best of his or her knowledge, the Vendor has properly registered with any State agency that may require registration.

44. **PURCHASING CARD ACCEPTANCE:** The State of West Virginia currently utilizes a Purchasing Card program, administered under contract by a banking institution, to process payment for goods and services. The Vendor must accept the State of West Virginia's Purchasing Card for payment of all orders under this Contract unless the box below is checked.

    ☑ Vendor is not required to accept the State of West Virginia's Purchasing Card as payment for all goods and services.

45. **VENDOR RELATIONSHIP:** The relationship of the Vendor to the State shall be that of an independent contractor and no principal-agent relationship or employer-employee relationship is contemplated or created by this Contract. The Vendor as an independent contractor is solely liable for the acts and omissions of its employees and agents. Vendor shall be responsible for selecting, supervising, and compensating any and all individuals employed pursuant to the terms of this Solicitation and resulting contract. Neither the Vendor, nor any employees or subcontractors of the Vendor, shall be deemed to be employees of the State for any purpose whatsoever. Vendor shall be exclusively responsible for payment of employees and contractors for all wages and salaries, taxes, withholding payments, penalties, fees, fringe benefits, professional liability insurance premiums, contributions to insurance and pension, or other deferred compensation plans, including but not limited to, Workers' Compensation and Social Security obligations, licensing fees, *etc.* and the filing of all necessary documents, forms and returns pertinent to all of the foregoing. Vendor shall hold harmless the State, and shall provide the State and Agency with a defense against any and all claims including, but not limited to, the foregoing payments, withholdings, contributions, taxes, Social Security taxes, and employer income tax returns.

46. **INDEMNIFICATION:** The Vendor agrees to indemnify, defend, and hold harmless the State and the Agency, their officers, and employees from and against: (1) Any claims or losses for services rendered

by any subcontractor, person, or firm performing or supplying services, materials, or supplies in connection with the performance of the Contract; (2) Any claims or losses resulting to any person or entity injured or damaged by the Vendor, its officers, employees, or subcontractors by the publication, translation, reproduction, delivery, performance, use, or disposition of any data used under the Contract in a manner not authorized by the Contract, or by Federal or State statutes or regulations; and (3) Any failure of the Vendor, its officers, employees, or subcontractors to observe State and Federal laws including, but not limited to, labor and wage and hour laws.

47. **PURCHASING AFFIDAVIT:** In accordance with West Virginia Code § 5A-3-10a, all Vendors are required to sign, notarize, and submit the Purchasing Affidavit stating that neither the Vendor nor a related party owe a debt to the State in excess of $1,000. The affidavit must be submitted prior to award, but should be submitted with the Vendor's bid. A copy of the Purchasing Affidavit is included herewith.

48. **ADDITIONAL AGENCY AND LOCAL GOVERNMENT USE:** This Contract may be utilized by and extends to other agencies, spending units, and political subdivisions of the State of West Virginia; county, municipal, and other local government bodies; and school districts ("Other Government Entities"). This Contract shall be extended to the aforementioned Other Government Entities on the same prices, terms, and conditions as those offered and agreed to in this Contract. If the Vendor does not wish to extend the prices, terms, and conditions of its bid and subsequent contract to the Other Government Entities, the Vendor must clearly indicate such refusal in its bid. A refusal to extend this Contract to the Other Government Entities shall not impact or influence the award of this Contract in any manner.

49. **CONFLICT OF INTEREST:** Vendor, its officers or members or employees, shall not presently have or acquire any interest, direct or indirect, which would conflict with or compromise the performance of its obligations hereunder. Vendor shall periodically inquire of its officers, members and employees to ensure that a conflict of interest does not arise. Any conflict of interest discovered shall be promptly presented in detail to the Agency.

50. **REPORTS:** Vendor shall provide the Agency and/or the Purchasing Division with the following reports identified by a checked box below:

☑ Such reports as the Agency and/or the Purchasing Division may request. Requested reports may include, but are not limited to, quantities purchased, agencies utilizing the contract, total contract expenditures by agency, etc.

☐ Quarterly reports detailing the total quantity of purchases in units and dollars, along with a listing of purchases by agency. Quarterly reports should be delivered to the Purchasing Division via email at purchasing.requisitions@wv.gov.

51. **BACKGROUND CHECK:** In accordance with W. Va. Code § 15-2D-3, the Director of the Division of Protective Services shall require any service provider whose employees are regularly employed on the grounds or in the buildings of the Capitol complex or who have access to sensitive or critical information

to submit to a fingerprint-based state and federal background inquiry through the state repository. The service provider is responsible for any costs associated with the fingerprint-based state and federal background inquiry.

After the contract for such services has been approved, but before any such employees are permitted to be on the grounds or in the buildings of the Capitol complex or have access to sensitive or critical information, the service provider shall submit a list of all persons who will be physically present and working at the Capitol complex to the Director of the Division of Protective Services for purposes of verifying compliance with this provision.

The State reserves the right to prohibit a service provider's employees from accessing sensitive or critical information or to be present at the Capitol complex based upon results addressed from a criminal background check.

Service providers should contact the West Virginia Division of Protective Services by phone at (304)558-9911 for more information.

52. **PREFERENCE FOR USE OF DOMESTIC STEEL PRODUCTS:** Except when authorized by the Director of the Purchasing Division pursuant to W. Va. Code § 5A-3-56, no contractor may use or supply steel products for a State Contract Project other than those steel products made in the United States. A contractor who uses steel products in violation of this section may be subject to civil penalties pursuant to W. Va. Code § 5A-3-56. As used in this section:

    a. "State Contract Project" means any erection or construction of, or any addition to, alteration of or other improvement to any building or structure, including, but not limited to, roads or highways, or the installation of any heating or cooling or ventilating plants or other equipment, or the supply of and materials for such projects, pursuant to a contract with the State of West Virginia for which bids were solicited on or after June 6, 2001.

    b. "Steel Products" means products rolled, formed, shaped, drawn, extruded, forged, cast, fabricated or otherwise similarly processed, or processed by a combination of two or more or such operations, from steel made by the open heath, basic oxygen, electric furnace, Bessemer or other steel making process.

    The Purchasing Division Director may, in writing, authorize the use of foreign steel products if:

    a. The cost for each contract item used does not exceed one tenth of one percent (.1%) of the total contract cost or two thousand five hundred dollars ($2,500.00), whichever is greater. For the purposes of this section, the cost is the value of the steel product as delivered to the project; or

    b. The Director of the Purchasing Division determines that specified steel materials are not produced in the United States in sufficient quantity or otherwise are not reasonably available to meet contract requirements.

53. PREFERENCE FOR USE OF DOMESTIC ALUMINUM, GLASS, AND STEEL: In Accordance with W. Va. Code § 5-19-1 et seq., and W. Va. CSR § 148-10-1 et seq., for every contract or subcontract, subject to the limitations contained herein, for the construction, reconstruction, alteration, repair, improvement or maintenance of public works or for the purchase of any item of machinery or equipment to be used at sites of public works, only domestic aluminum, glass or steel products shall be supplied unless the spending officer determines, in writing, after the receipt of offers or bids, (1) that the cost of domestic aluminum, glass or steel products is unreasonable or inconsistent with the public interest of the State of West Virginia, (2) that domestic aluminum, glass or steel products are not produced in sufficient quantities to meet the contract requirements, or (3) the available domestic aluminum, glass, or steel do not meet the contract specifications. This provision only applies to public works contracts awarded in an amount more than fifty thousand dollars ($50,000) or public works contracts that require more than ten thousand pounds of steel products.

The cost of domestic aluminum, glass, or steel products may be unreasonable if the cost is more than twenty percent (20%) of the bid or offered price for foreign made aluminum, glass, or steel products. If the domestic aluminum, glass or steel products to be supplied or produced in a "substantial labor surplus area", as defined by the United States Department of Labor, the cost of domestic aluminum, glass, or steel products may be unreasonable if the cost is more than thirty percent (30%) of the bid or offered price for foreign made aluminum, glass, or steel products.

This preference shall be applied to an item of machinery or equipment, as indicated above, when the item is a single unit of equipment or machinery manufactured primarily of aluminum, glass or steel, is part of a public works contract and has the sole purpose or of being a permanent part of a single publ. works project. This provision does not apply to equipment or machinery purchased by a spending unit for use by that spending unit and not as part of a single public works project.

All bids and offers including domestic aluminum, glass or steel products that exceed bid or offer prices including foreign aluminum, glass or steel products after application of the preferences provided in this provision may be reduced to a price equal to or lower than the lowest bid or offer price for foreign aluminum, glass or steel products plus the applicable preference. If the reduced bid or offer prices are made in writing and supersede the prior bid or offer prices, all bids or offers, including the reduced bid or offer prices, will be reevaluated in accordance with this rule.

ADDITIONAL TERMS AND CONDITIONS (Architectural and Engineering Contracts Only)

1. **PLAN AND DRAWING DISTRIBUTION:** All plans and drawings must be completed and available for distribution at least five business days prior to a scheduled pre-bid meeting for the construction or other work related to the plans and drawings.

2. **PROJECT ADDENDA REQUIREMENTS:** The Architect/Engineer and/or Agency shall be required to abide by the following schedule in issuing construction project addenda:

    a. The Architect/Engineer shall prepare any addendum materials for which it is responsible, and a list of all vendors that have obtained drawings and specifications for the project. The Architect/Engineer shall then send a copy of the addendum materials and the list of vendors to the State Agency for which the contract is issued to allow the Agency to make any necessary modifications. The addendum and list shall then be forwarded to the Purchasing Division buyer by the Agency. The Purchasing Division buyer shall send the addendum to all interested vendors and, if necessary, extend the bid opening date. Any addendum should be received by the Purchasing Division at least fourteen (14) days prior to the bid opening date.

3. **PRE-BID MEETING RESPONSIBILITIES:** The Architect/Engineer shall be available to attend any pre-bid meeting for the construction or other work resulting from the plans, drawings, or specifications prepared by the Architect/Engineer.

4. **AIA DOCUMENTS:** Contracts for architectural and engineering services will be governed by the AIA document B101-2007, as amended by the Supplementary Conditions for the State of West Virginia, in addition to the terms and conditions contained herein when procured under Chapter 5G of the West Virginia Code.

5. **GREEN BUILDINGS MINIMUM ENERGY STANDARDS:** In accordance with West Virginia Code § 22-29-4, all new building construction projects of public agencies that have not entered the schematic design phase prior to July 1, 2012, or any building construction project receiving state grant funds and appropriations, including public schools, that have not entered the schematic design phase prior to July 1, 2012, shall be designed and constructed complying with the ICC International Energy Conservation Code, adopted by the State Fire Commission, and the ANSI/ASHRAE/IESNA Standard 90.1-2007: *Provided*, That if any construction project has a commitment of federal funds to pay for a portion of such project, this provision shall only apply to the extent such standards are consistent with the federal standards.

WEST VIRGINIA DEPARTMENT OF ENVIRONMENTAL PROTECTION
TMDL VENDOR QUALIFICATION QUESTIONNAIRE — Attachment A

PROJECT NAME	DATE (DAY, MONTH, YEAR)	FEIN
Tygart Valley River Watershed TMDL Project	27, November, 2013	954148514

1. FIRM NAME	2. HOME OFFICE BUSINESS ADDRESS	3. FORMER FIRM NAME
Tetra Tech, Inc.	10306 Eaton Place, Suite 340 Fairfax, VA 22030	N/A

4. HOME OFFICE TELEPHONE	5. ESTABLISHED (YEAR)	6. TYPE OWNERSHIP	
(703) 385-6000	1966	~~Individual~~ **Corporation** ~~Partnership~~ ~~Joint Venture~~	

7. PRIMARY TMDL DEVELOPMENT OFFICE: ADDRESS/ TELEPHONE/ PERSON IN CHARGE/ NO.OF TMDL DEVELOPMENT PERSONNEL IN OFFICE

803 Quarrier Street, Suite 400 / (304) 414-0054 / Mindy Ramsey, Director / 8 TMDL development personnel in office
Charleston, WV 25301

8. NAMES OF PRINCIPAL OFFICERS OR MEMBERS OF FIRM	8a. NAME, TITLE, & TELEPHONE NUMBER - OTHER PRINCIPALS
Leslie Shoemaker, Ph.D., Vice President	Jon Ludwig, Deputy Project Manager, (703) 385-1973

9. PERSONNEL BY DISCIPLINE

1	CONTRACT ADMINISTRATOR(S)	6	WATERSHED ANALYST(S)	—	OTHER (LIST BELOW)
2	PROGRAM MANAGER(S)	4	SOILS SPECIALIST(S)	—	_____
3	PROJECT MANAGER(S)	3	TECHNICAL EXPERT(S)	—	_____
1	QA/QC MANAGER(S)	3	TECHNICAL WRITER(S)	—	_____
5	BIOLOGICAL ANALYST(S)	3	OUTREACH SPECIALIST(S)		
4	MODEL DEVELOPER(S)	6	SENIOR WATER RESOURCE ENGINEER(S)		

41 TOTAL PERSONNEL

Note: If needed, Tetra Tech has over 50 additional highly qualified staff to support this project.

10. DO YOU NEED ADDITIONAL EMPLOYEES TO FULFILL THE REQUIREMENTS OF THIS CONTRACT? **X NO**

11. OUTSIDE KEY CONSULTANTS/SUB-CONSULTANTS ANTICIPATED TO BE USED. Attach "TMDL Vendor Qualification Questionnaire".

NAME AND ADDRESS:	SPECIALTY:	WORKED WITH BEFORE
NOT APPLICABLE	**NOT APPLICABLE**	_____ Yes **NOT APPLICABLE** _____ No
NAME AND ADDRESS:	SPECIALTY:	WORKED WITH BEFORE _____ Yes _____ No
NAME AND ADDRESS:	SPECIALTY:	WORKED WITH BEFORE _____ Yes _____ No
NAME AND ADDRESS:	SPECIALTY:	WORKED WITH BEFORE _____ Yes _____ No
NAME AND ADDRESS:	SPECIALTY:	WORKED WITH BEFORE _____ Yes _____ No
NAME AND ADDRESS:	SPECIALTY:	WORKED WITH BEFORE _____ Yes _____ No
NAME AND ADDRESS:	SPECIALTY:	WORKED WITH BEFORE _____ Yes _____ No
NAME AND ADDRESS:	SPECIALTY:	WORKED WITH BEFORE _____ Yes _____ No

12. A. Is your firm experienced in development of TMDLs for total recoverable metals?

YES

A.1 Provide names and number of projects.

Tetra Tech began developing TMDLs in WV in 1998 initially supporting USEPA Region 3 and has directly worked with WVDEP since 2002 to develop various technical approaches for total recoverable metals TMDLs throughout WV. For EPA and WVDEP, Tetra Tech has developed **1,874** EPA approved total recoverable metals TMDLs in 29 WV projects. In addition, Tetra Tech has developed hundreds more in other states and EPA Regions. See Table III-1 of the proposal that accompanies this questionnaire. The table below displays the total recoverable metals TMDLs approved or under development for WVDEP since 2002.

WV Hydrologic Group	Status	Total Recoverable Metals TMDLs
A (Upper Kanawha & Upper Ohio North Watersheds)	USEPA Approved	63
B (Coal River, Lower Kanawha & North Branch Potomac Watersheds)	USEPA Approved	139
C (Gauley River Watershed)	USEPA Approved	60
D (New River & Little Kanawha Watersheds)	USEPA Approved	17
E (Upper Ohio South, Dunkard Creek, Camp Creek & Youghiogheny Watersheds)	USEPA Approved	32
B2 (Elk River & Lower Kanawha Watersheds)	USEPA Approved	406
C2 (Middle Ohio North & Middle Ohio South Watersheds)	USEPA Approved	91
D2 (Monongahela Watershed)	Under Development	56
E2 (West Fork Watershed)	Under Development	109
A3 (Upper Kanawha, Upper Ohio North, South Branch Potomac, & Shenandoah)	Under Development	97
TOTAL WEST VIRGINIA TMDLS DEVELOPED FOR WVDEP (SINCE 2002)		**1070**

A detailed description of Tetra Tech's TMDL experience is described in **Section 3** of the proposal that accompanies this questionnaire.

A.2 Provide an example TMDL for total recoverable metals.

Two (2) USEPA approved total recoverable metals TMDL projects are provided as examples (on CD-ROM) in **Appendix C** of the proposal that accompanies this questionnaire. The two projects include:

- Total Maximum Daily Loads for Selected Streams in the Upper Ohio South Watershed, West Virginia
- Total Maximum Daily Loads for Selected Streams in the Elk River Watershed, West Virginia

A.3 Provide a detailed description of the methodology to develop a total recoverable metals TMDL as per EOI.

A detailed description of the total recoverable metals TMDL methodology is presented in **Section 1** of the proposal that accompanies this questionnaire.

12. B. Is your firm experienced in development of TMDLs for pH/dissolved metals?

YES

B.1 Provide names and number of projects.

Tetra Tech began developing TMDLs in WV in 1998 initially supporting USEPA Region 3 and has directly worked with WVDEP since 2002 to develop various technical approaches for pH/dissolved metals TMDLs throughout WV. For EPA and WVDEP, Tetra Tech has developed **656** EPA approved pH/dissolved aluminum TMDLs in 25 WV projects. In addition, Tetra Tech has developed hundreds more in other states and EPA Regions. See Table III-1 of the proposal. The table below displays the pH/dissolved metals TMDLs approved or under development for WVDEP since 2002.

WV Hydrologic Group	Status	pH/Dissolved Metals TMDLs
A (Upper Kanawha & Upper Ohio North Watersheds)	USEPA Approved	80
B (Coal River, Lower Kanawha & North Branch Potomac Watersheds)	USEPA Approved	91
C (Gauley River Watershed)	USEPA Approved	75
D (New River Watershed)	USEPA Approved	9
E (Upper Ohio South, Dunkard Creek , Camp Creek & Youghiogheny Watersheds)	USEPA Approved	14
B2 (Elk River, Lower Kanawha Watersheds)	USEPA Approved	44
D2 (Monongahela Watershed)	Under Development	50
E2 (West Fork Watershed)	Under Development	12
A3 (Upper Kanawha, Upper Ohio North, South Branch Potomac, & Shenandoah)	Under Development	16
TOTAL WEST VIRGINIA TMDLS DEVELOPED FOR WVDEP (SINCE 2002)		**391**

A detailed description of Tetra Tech's TMDL experience is described in **Section 3** of the proposal that accompanies this questionnaire.

B.2 Provide an example TMDL for pH/dissolved metals.

Two (2) USEPA approved total recoverable metals TMDL projects are provided as examples (on CD-ROM) in **Appendix C** of the proposal that accompanies this questionnaire. The two projects include:

- Total Maximum Daily Loads for Selected Streams in the Upper Ohio South Watershed, West Virginia
- Total Maximum Daily Loads for Selected Streams in the Elk River Watershed, West Virginia

B.3 Provide a detailed description of the methodology to develop a pH/dissolved metals TMDL as per EOI.

A detailed description of the pH/dissolved metals TMDL methodology is presented in **Section 1** of the proposal that accompanies this questionnaire.

12.C. Is your firm experienced in development of TMDLs for fecal coliform bacteria?

YES

C.1 Provide names and number of projects.

Tetra Tech began developing TMDLs in WV in 1998 initially supporting USEPA Region 3 and has directly worked with WVDEP since 2002 to develop various technical approaches for fecal coliform TMDLs throughout WV. For EPA and WVDEP, Tetra Tech has developed **836** EPA approved fecal coliform TMDLs in 23 WV projects. In addition, Tetra Tech has developed hundreds more in other states and EPA Regions. See Table III-1 of the proposal. The table below displays the fecal coliform TMDLs approved or under development for WVDEP since 2002.

WV Hydrologic Group	Status	Fecal Coliform Bacteria TMDLs
A (Upper Kanawha & Upper Ohio North Watersheds)	USEPA Approved	54
B (Coal River, Lower Kanawha & North Branch Potomac Watersheds)	USEPA Approved	102
C (Gauley River & Potomac Direct Drains Watersheds)	USEPA Approved	54
D (New River, Greenbrier River, James River & Little Kanawha Watersheds)	USEPA Approved	128
E (Upper Ohio South, Dunkard Creek, Camp Creek & Youghiogheny Watersheds)	USEPA Approved	101
B2 (Elk River, Lower Kanawha & North Branch Potomac Watersheds)	USEPA Approved	192
C2 (Middle Ohio North & Middle Ohio South Watersheds)	Under Development	164
D2 (Monongahela Watershed)	Under Development	65
E2 (West Fork Watershed)	Under Development	175
A3 (Upper Kanawha, Upper Ohio North, South Branch Potomac, & Shenandoah)	Under Development	52
TOTAL WEST VIRGINIA TMDLS DEVELOPED FOR WVDEP (SINCE 2002)		**1087**

A detailed description of Tetra Tech's TMDL experience is described in **Section 3** of the proposal that accompanies this questionnaire.

C.2 Provide an example TMDL for bacteria.

Three (3) USEPA approved fecal coliform bacteria TMDL projects are provided as examples (on CD-ROM) in **Appendix C** of the proposal that accompanies this questionnaire. The three projects include:

- Total Maximum Daily Loads for Selected Streams in the Upper Ohio South Watershed, West Virginia
- Total Maximum Daily Loads for Selected Streams in the Elk River Watershed, West Virginia
- Total Maximum Daily Loads for Selected Streams in the North Branch Potomac River Watershed, West Virginia

C.3 Provide a detailed description of the methodology to develop a fecal coliform bacteria TMDL as per EOI.

A detailed description of the fecal coliform bacteria TMDL methodology is presented in **Section 1** of the proposal that accompanies this questionnaire.

12. D. Is your firm experienced in biological stressor identification and development of TMDLs for biological impairments?

YES

D.1 Provide names and number of projects.

Tetra Tech began developing TMDLs in WV in 1998 initially supporting USEPA Region 3 and has directly worked with WVDEP since 2002 to develop various technical approaches for biological TMDLs throughout WV. For EPA and WVDEP, Tetra Tech has developed **437** EPA approved biological TMDLs in 18 WV projects. In addition, Tetra Tech has developed several more in other states and EPA Regions. See Table III-1 of the proposal. The table below displays the biological TMDLs approved for WVDEP since 2002. Development of biological TMDLs has been suspended; however, biological stressor identification has been performed for **224** additional streams in D2, E2, and A3 watershed groups to identify if pollutant TMDLs may address biological impacts.

WV Hydrologic Group	Status	Biological TMDLs
A (Upper Kanawha & Upper Ohio North Watersheds)	USEPA Approved	45
B (Coal River, Lower Kanawha & North Branch Potomac Watersheds)	USEPA Approved	48
C (Gauley River & Potomac Direct Drains Watersheds)	USEPA Approved	35
D (New River & James River Watersheds)	USEPA Approved	25
E (Upper Ohio South, Dunkard Creek , Camp Creek & Youghiogheny Watersheds)	USEPA Approved	51
B2 (Elk River, Lower Kanawha & North Branch Potomac Watersheds)	USEPA Approved	95
C2 (Middle Ohio North & Middle Ohio South Watersheds)	USEPA Approved	77
TOTAL WEST VIRGINIA TMDLS DEVELOPED FOR WVDEP (SINCE 2002)		**376**

A detailed description of Tetra Tech's TMDL experience is described in **Section 3** of the proposal that accompanies this questionnaire.

D.2 Provide an example TMDL for biological impairment.

Three (3) USEPA approved biological TMDLs are provided as examples (on CD-ROM) in **Appendix C** of the proposal that accompanies this questionnaire. The three projects include:

- Total Maximum Daily Loads for Selected Streams in the Upper Ohio South Watershed, West Virginia
- Total Maximum Daily Loads for Selected Streams in the Elk River Watershed, West Virginia
- Total Maximum Daily Loads for Selected Streams in the North Branch Potomac River Watershed, West Virginia

D.3 Provide a detailed description of the methodology to develop a biological impairment TMDL as per EOI.

A detailed description of the biological stressor identification process and biological TMDL methodology is presented in **Section 1** of the proposal that accompanies this questionnaire.

12. E. Describe you firm's management plan that supports personnel and project activities within the organization and coordinates with the WVDEP to achieve timely TMDL development within budgetary constraints as per EOI.

Working directly with WVDEP for more than 10 years, Tetra Tech has demonstrated the ability to manage and coordinate highly technical TMDL development activities within project budgets and timelines. Our exceptional performance includes:

- $7.05M/12 task orders
- Deadlines always met
- No budget overruns/requested change orders
- Constantly developing tools to improve efficiency/reduce costs

A detailed description of Tetra Tech's management capabilities and available resources to support this project is presented in **Section 2** of the proposal that accompanies this questionnaire.

12.F. Describe your firm's experience with the LSPC/MDAS or equivalent modeling system in TMDL development. Provide names and number of projects for which this type of modeling system was employed.

Tetra Tech developed the LSPC/MDAS model specifically for TMDL development in West Virginia. Tetra Tech has modeled over 28 individual USGS 8 Digit Hydrologic Unit Codes in West Virginia using LSPC/MDAS, and over 70 projects using LSPC/MDAS in various states throughout the country. A detailed description of Tetra Tech's familiarity with LSPC/MDAS model can be found in **Section 1** and three examples that demonstrate successful application of LSPC/MDAS are provided in **Appendix C** of the proposal that accompanies this questionnaire.

13. PERSONAL HISTORY STATEMENT OF PRINCIPALS AND ASSOCIATES **RESPONSIBLE FOR TMDL DEVELOPMENT PROJECTS** (Insert additional copies as necessary)

NAME & TITLE (Last, First, Middle Int.)	YEARS OF EXPERIENCE		
	In EPA-approved TMDL development	In TMDL-related projects	With modeling system(s), e.g., LSPC, MDAS, etc…
Shoemaker, Leslie, Ph.D.	22	22	22

Brief Explanation of Responsibilities
Dr. Shoemaker will provide contractual oversight for the WVDEP contract, ensure that adequate staff and resources are dedicated, and provide technical review and direction to maintain quality and consistency of performance. She will work closely with the management team to allocate resources and identify work teams for performance of specific projects.

EDUCATION (Degree, Year, Specialization)
Ph.D., 1990, Agricultural Engineering
M.Eng., 1984, Agricultural Engineering
B.A., 1979, Mathematics

MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS American Society of Civil Engineers. Reviewer, Journal of Environmental Engineering. American Society of Agricultural Engineers. American Water Resources Association. Soil and Water Conservation Society.

REGISTRATION (Type, Year, State) None

13. PERSONAL HISTORY STATEMENT OF PRINCIPALS AND ASSOCIATES **RESPONSIBLE FOR TMDL DEVELOPMENT PROJECTS**

NAME & TITLE (Last, First, Middle Int.)	YEARS OF EXPERIENCE		
	In EPA-approved TMDL development	In TMDL-related projects	With modeling system(s), e.g., LSPC, MDAS, etc…
Ludwig, Jon, C.	13	13	13

Brief Explanation of Responsibilities
Mr. Ludwig will support Ms. Ramsey and Dr. Shoemaker in assigning staff, monitoring individual task orders, and representing Tetra Tech in selected technical matters. Mr. Ludwig, working from our Fairfax, VA, office, will coordinate closely with Ms. Ramsey and WVDEP Project Managers to ensure that projects are meeting all technical and schedule objectives.

EDUCATION (Degree, Year, Specialization)
M.S., 1997, Environmental Pollution Control
B.S., 1995, Environmental Science

MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS American Water Resource Association. Water Environment Federation.

REGISTRATION (Type, Year, State) None

13. PERSONAL HISTORY STATEMENT OF PRINCIPALS AND ASSOCIATES **RESPONSIBLE FOR TMDL DEVELOPMENT PROJECTS**

NAME & TITLE (Last, First, Middle Int.)	YEARS OF EXPERIENCE		
	In EPA-approved TMDL development	In TMDL-related projects	With modeling system(s), e.g., LSPC, MDAS, etc…
Ramsey, Mindy	4	4	4

Brief Explanation of Responsibilities
Ms. Ramsey is the director of Tetra Tech's Charleston, WV office and will serve as the local day-to-day point of contact to WVDEP and will work closely with the WVDEP Project Manager to maintain clear, focused direction of the project. She will work closely with the Program Manager and Deputy Project Managers to staff projects and maintain communication between all parties.

EDUCATION (Degree, Year, Specialization) M.S., 2002, Biological Sciences
B.S., 1996, Biology

MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS	REGISTRATION (Type, Year, State)
None	None

13. PERSONAL HISTORY STATEMENT OF PRINCIPALS AND ASSOCIATES **RESPONSIBLE FOR TMDL DEVELOPMENT PROJECTS**

NAME & TITLE (Last, First, Middle Int.)	YEARS OF EXPERIENCE		
	In EPA-approved TMDL development	In TMDL-related projects	With modeling system(s), e.g., LSPC, MDAS, etc…
Parker, Andrew	17	17	17

Brief Explanation of Responsibilities
Mr. Parker will support Mr. Ludwig and Dr. Shoemaker in assigning staff, monitoring individual task orders, and representing Tetra Tech in selected technical matters. Mr. Parker, working from our Fairfax, VA, office, will coordinate closely with Mr. Ludwig and WVDEP project managers to ensure that projects are meeting all technical and schedule objectives.

EDUCATION (Degree, Year, Specialization) M.E., 1996, Environmental Engineering
B.S., 1995, Civil Engineering

MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS	REGISTRATION (Type, Year, State)
American Society of Civil Engineers	Engineer in Training, 1996, Virginia

13. PERSONAL HISTORY STATEMENT OF PRINCIPALS AND ASSOCIATES **RESPONSIBLE FOR TMDL DEVELOPMENT PROJECTS**

NAME & TITLE (Last, First, Middle Int.)	YEARS OF EXPERIENCE		
	In EPA-approved TMDL development	In TMDL-related projects	With modeling system(s), e.g., LSPC, MDAS, etc…
Smith, Jonathan, P.E.	8	8	8

Brief Explanation of Responsibilities
Mr. Smith will support Mr. Ludwig and Dr. Shoemaker in assigning staff, monitoring individual task orders, and representing Tetra Tech in selected technical matters. Mr. Smith will coordinate closely with Tetra Tech and WVDEP project managers to ensure that projects are meeting all technical and schedule objectives.

EDUCATION (Degree, Year, Specialization) B.S., 1995, Biological & Agricultural Engineering

MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS	REGISTRATION (Type, Year, State)
American Public Works Association, NC Chapter. Envirocert International.	Professional Engineer, 2011, West Virginia #19285 Certified Professional in Erosion and Sedimentation Control, 2005, North Carolina #4111 Certified Professional in Storm Water Quality, 2010, North Carolina #0048

13. PERSONAL HISTORY STATEMENT OF PRINCIPALS AND ASSOCIATES **RESPONSIBLE FOR TMDL DEVELOPMENT PROJECTS**

NAME & TITLE (Last, First, Middle Int.)	YEARS OF EXPERIENCE		
	In EPA-approved TMDL development	In TMDL-related projects	With modeling system(s), e.g., LSPC, MDAS, etc…
Beckman, John, F.	8	8	8

Brief Explanation of Responsibilities
Mr. Beckman will provide leadership for all tasks associated with bacteria TMDLs under this contract, coordinating technical tasks closely with the Project Manager. Mr. Beckman will work closely with WVDEP TMDL staff to refine technical approaches for WV Fecal Coliform Bacteria TMDLs. He will also lead subwatershed delineation and hydrology calibration tasks.

EDUCATION (Degree, Year, Specialization) M.E.M., 1998, Environmental Management
B.A., 1994, Biology

MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS	REGISTRATION (Type, Year, State)
Southern Appalachian Botanical Society.	None

13. PERSONAL HISTORY STATEMENT OF PRINCIPALS AND ASSOCIATES **RESPONSIBLE FOR TMDL DEVELOPMENT PROJECTS**

NAME & TITLE (Last, First, Middle Int.)	YEARS OF EXPERIENCE		
	In EPA-approved TMDL development	In TMDL-related projects	With modeling system(s), e.g., LSPC, MDAS, etc…
Matsuzuru, Yoichi	13	13	13

Brief Explanation of Responsibilities
Mr. Matsuzuru will lead all tasks associated with Dissolved Metals/pH TMDLs under this contract and will work closely with the Project Manager to provide technical solutions for dissolved metals/acidity issues that may occur. He will also work closely with Ms. Christina Mellors developing and refining technical approaches with the total metals/sediment TMDLs.

EDUCATION (Degree, Year, Specialization) M.E.M., 1999, Water Resources
B.S., 1990, Applied Chemistry

MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS None

REGISTRATION (Type, Year, State) None

13. PERSONAL HISTORY STATEMENT OF PRINCIPALS AND ASSOCIATES **RESPONSIBLE FOR TMDL DEVELOPMENT PROJECTS**

NAME & TITLE (Last, First, Middle Int.)	YEARS OF EXPERIENCE		
	In EPA-approved TMDL development	In TMDL-related projects	With modeling system(s), e.g., LSPC, MDAS, etc…
Mellors, Christina, E.	11	11	11

Brief Explanation of Responsibilities
Ms. Mellors will lead all tasks associated with Total Metals/Sediment TMDLs under this contract, coordinating closely with the Project Manager and Dr. Medine and Dr. Zhang to continue to evolve the technical representation of the total metals and sediment in the MDAS model. She will work to develop highly detailed technical approaches to incorporate mining permits and erosion-related sediment sources in the MDAS model.

EDUCATION (Degree, Year, Specialization) M.S., 1998, Environmental Science
B.S., 1995, Chemical Engineering

MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS None

REGISTRATION (Type, Year, State) None

13. PERSONAL HISTORY STATEMENT OF PRINCIPALS AND ASSOCIATES **RESPONSIBLE FOR TMDL DEVELOPMENT PROJECTS**

NAME & TITLE (Last, First, Middle Int.)	YEARS OF EXPERIENCE		
	In EPA-approved TMDL development	In TMDL-related projects	With modeling system(s), e.g., LSPC, MDAS, etc…
Wandling, Julie, A.	4	12	4

Brief Explanation of Responsibilities
Ms. Wandling will lead all data development tasks under this contract and will coordinate and communicate with the Project Manager, the various TMDL leads, and WVDEP staff to develop the most recent and accurate watershed data necessary to construct the TMDL models. She will also participate in subwatershed delineation tasks and in developing the permit summary report.

EDUCATION (Degree, Year, Specialization) B.S., 1998, Biology

MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS	REGISTRATION (Type, Year, State)
None	None

13. PERSONAL HISTORY STATEMENT OF PRINCIPALS AND ASSOCIATES **RESPONSIBLE FOR TMDL DEVELOPMENT PROJECTS**

NAME & TITLE (Last, First, Middle Int.)	YEARS OF EXPERIENCE		
	In EPA-approved TMDL development	In TMDL-related projects	With modeling system(s), e.g., LSPC, MDAS, etc…
Wilkes, Sam, P.	10	10	10

Brief Explanation of Responsibilities
Mr. Wilkes will lead all tasks associated with Biological TMDL development under this contract. He will coordinate and communicate with the Project Manager and WVDEP biologists in all aspects of biological TMDL development, such as stressor identification, threshold value development, statistical model development, QA/QC, data management, biological workshop, training modules, and presentations for WVDEP staff.

EDUCATION (Degree, Year, Specialization) M.S., 2003, Environmental Science & Policy
B.S., 1996, Earth & Environmental Science

MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS	REGISTRATION (Type, Year, State)
Society of Wetland Scientists. Trout Unlimited.	Professional Wetland Scientist (#00001395), 2003 (Recertified 2008). Certified Forest Stand Delineator and Conservation Planner, 2003, Maryland.

13. PERSONAL HISTORY STATEMENT OF PRINCIPALS AND ASSOCIATES **RESPONSIBLE FOR TMDL DEVELOPMENT PROJECTS**

NAME & TITLE (Last, First, Middle Int.)	YEARS OF EXPERIENCE		
	In EPA-approved TMDL development	In TMDL-related projects	With modeling system(s), e.g., LSPC, MDAS, etc…
Zhang, Hua, Ph.D.	7	10	12

Brief Explanation of Responsibilities
Dr. Zhang will support Dr. Medine with tasks associated with Dissolved Metals/pH TMDLs under this contract and will work closely with the Project Manager to provide technical solutions for dissolved metals/acidity issues that may occur. He will also_work closely with Ms. Christina Mellors developing and refining technical approaches with the total metals/sediment TMDLs.

EDUCATION (Degree, Year, Specialization)
Ph.D., 2006, Soil Science
M.S., 2002, Soil Science
B.S., 1999, Environmental Management

MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS
Soil Science Society of America. American Geophysics Union

REGISTRATION (Type, Year, State) None

13. PERSONAL HISTORY STATEMENT OF PRINCIPALS AND ASSOCIATES **RESPONSIBLE FOR TMDL DEVELOPMENTS PROJECTS**

NAME & TITLE (Last, First, Middle Int.)	YEARS OF EXPERIENCE		
	In EPA-approved TMDL development	In TMDL-related projects	With modeling system(s), e.g., LSPC, MDAS, etc…
Zheng, Lei, Ph.D.	10	10	15

Brief Explanation of Responsibilities
Dr. Zheng's work will focus on identifying environmental stressors impairing biological condition of macroinvertebrates in West Virgina streams to help the WVDEP develop Total Maximum Daily Loads for biologically impaired streams. Ongoing research topics include weighted averaging for tolerance development and a dirty null reference model with discriminant functional analysis for stressor identification.

EDUCATION (Degree, Year, Specialization)
Ph.D., 2003, Ecology, Evolutionary Biology, and Behavior
M.A., 1991, Botany
B.S., 1988, Botany

MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS None

REGISTRATION (Type, Year, State) None

14. PROVIDE A LIST OF SOFTWARE AND EQUIPMENT AVAILABLE IN THE PRIMARY OFFICE WHICH WILL BE USED TO COMPLETE TMDL DEVELOPMENT SERVICES

Desktop Access Data Processing Hardware	Quantity
High Capacity Network Server	27
IBM-Compatible PC	275
Macintosh PC (Power Mac, etc.)	1
Notebook/Laptop IBM-Compatible PC	112
Windows 2003/2008 Internet Server with FTP and Web Site support	12
Linux Internet Server with FTP and Web Site Support support	15
Hewlett-Packard DesignJet 5000 Color Plotter (60" wide)	1
Hewlett-Packard 8000N, 8100N	2
Xerox ColorCube Printers / Copiers	2
Xerox WorkCenter Printer / Copiers	3

Database Software

- Oracle /10i/11g
- MySQL
- MSSQL Server/Enterprise 2005/2008/2012
- Microsoft Office 2003/2007/2010
- Microsoft Project 2003/2007/2010
- Microsoft Visio 2008/2010
- Microsoft Visual Studio 2008/2010/2012
- MS Visual Studio Ultimate 2010
- MS Office One Note 2007
- MS SharePoint

Statistical Software

- Statistica 6.1

Web Development Software

- Dreamweaver MX 2004
- Macromedia Studio MX
- Lotus Domino Lotus Notes
- Microsoft Front Page
- Fireworks
- Flash
- Photoshop
- JDeveloper
- Drupal

Programming Language Compilers

- Compaq Visual Fortran 6.6
- Intel Visual Fortran Compiler
- Sun Java Studio
- Digital Visual FORTRAN
- Visual Basic 5.0
- Pascal 7.0, DOS and Windows
- Visual C++ 5.0, 6.0
- Visual Studio v6.0
- Visual Studio 2010/2012
- Borland C++ 4.5
- Visual Source Café
- SPARC Works C++
- Visual KAP Parallel Computing
- Borland JBuilder 2.0, 3.0

14. PROVIDE A LIST OF SOFTWARE AND EQUIPMENT AVAILABLE IN THE PRIMARY OFFICE WHICH WILL BE USED TO COMPLETE TMDL DEVELOPMENT SERVICES (Continued)

GIS Development and Data Processing Hardware and Software	Quantity
IBM-Compatible Workstation/Laptop	285
40TB Mass Storage	4
Overland Tape Drive LTO-4 20TB	1
CD/DVD Writers	2
ESRI ArcGIS Desktop Advanced 10.2	8
ESRI ArcGIS Desktop Standard 10.2	10
ESRI ArcGIS Desktop Basic 10.2	26
ESRI ArcGIS 3D Analyst	1
ESRI Spatial Analyst 10	16
ArcGIS for Server Enterprise 10	2

15. CURRENT PROJECTS/ACTIVITIES IN WHICH YOUR FIRM IS PRESENTLY INVOLVED

PROJECT NAME, TYPE AND LOCATION	NAME AND ADDRESS OF OWNER	NATURE OF YOUR FIRM'S RESPONSIBILITY	ESTIMATED PROJECT COST	PERCENT COMPLETE
TMDL Development for WV Group A3 Watershed (Upper Kanawha, Upper Ohio North, South Branch Potomac, and Shenandoah)	WVDEP DWWM, 601-57th Street, Charleston, WV 25304-2345	Prime Contractor - TMDL Development Lead	$565,866	45%
TMDL Development for WV Group E2 Watershed (West Fork River)	WVDEP DWWM, 601-57th Street, Charleston, WV 25304-2345	Prime Contractor - TMDL Development Lead	$574,954	70%
TMDL Development for WV Group D2 Watershed (Tributaries of the Monongahela River)	WVDEP DWWM, 601-57th Street, Charleston, WV 25304-2345	Prime Contractor - TMDL Development Lead	$536,524	90%
EPA Region 1 - TMDL development support for Lake Champlain	USEPA Region 1, 5 Post Office Square, Boston, MA 02109-3912	Prime Contractor	$845,133	89%
EPA Region 3 - TMDL development and related support in West Virginia, Pennsylvania, Delaware, Maryland and Virginia; Chesapeake Bay TMDL and WIP development support	USEPA Region 3, 1650 Arch Street, Philadelphia, PA 19103	Prime Contractor	$1,410,867	59%
EPA Region 4 - TMDL development, watershed model development and hydrodynamic model development for waters in Kentucky and Florida; TMDL and model training in North Carolina	USEPA Region 4, 61 Forsyth Street SW, Atlanta, GA 30303	Prime Contractor	$330,003	59%
EPA Region 5 - TMDL development and related support in Illinois, Indiana, Michigan, Ohio, Minnesota, and Wisconsin(e.g., TMDL development, TMDL implementation plans, methodologies for permitting Great Lakes nutrient dischargers, Section 319 support)	USEPA Region 5, 77 West Jackson Blvd, Chicago, IL 60604	Prime Contractor	$750,000	35%
EPA Region 8 - TMDL development and related support in Montana (e.g., TMDL development, monitoring, water quality modeling)	USEPA Region 8, Montana Office, Federal Building, 10 W. 15th Street, Suite 3200, Helena, MT 59626	Prime Contractor	$1,269,838	61%

15. CURRENT PROJECTS/ACTIVITIES IN WHICH YOUR FIRM IS PRESENTLY INVOLVED (Continued)

PROJECT NAME, TYPE AND LOCATION	NAME AND ADDRESS OF OWNER	NATURE OF YOUR FIRM'S RESPONSIBILITY	ESTIMATED PROJECT COST	PERCENT COMPLETE
EPA Region 10 - TMDL development and related support in Alaska, Washington, Oregon and Idaho (TMDL development, TMDL model peer review, TMDL review/revision)	USEPA Region 10, 1200 6th Ave, Suite 900, Seattle, WA 98101	Prime Contractor	$542,160	11%
EPA Region 8 - TMDL development and related support in Montana (e.g., TMDL development, Category 4b assessments, nutrient TMDL target development)	USEPA Region 8, Montana Office, Federal Building, 10 W. 15th Street, Suite 3200, Helena, MT 59626	Prime Contractor	$2,640,018	62%
EPA Region 10 - TMDL development and related support in Alaska, Washington, Oregon and Idaho (TMDL development, TMDL model peer review, TMDL review/revision)	USEPA Region 10, 1200 6th Ave, Suite 900, Seattle, WA 98101	Prime Contractor	$1,763,630	38%
EPA Region 9 - TMDL development and related support in California, Arizona, and Hawaii; NPDES permit development (individual, general, and stormwater) in California and Arizona; and water quality standards support in California (natural conditions, use attainability, and whole effluent toxicity training)	USEPA Region 9, 75 Hawthorne Street, San Francisco, CA 94105	Prime Contractor	$5,247,165	53%
City of San Diego - TMDL and implementation plan development (TMDL reviews, TMDL development, modeling, and assessment) in numerous inland and coastal waters in San Diego	City of San Diego, Storm Water Department, 9370 Chesapeake Drive, Suite 100, San Diego, CA 92123	Prime Contractor	$719,708	4%

TOTAL NUMBER OF PROJECTS: 13

TOTAL ESTIMATED PROJECT COSTS: $17,195,866

16. CURRENT ACTIVITIES ON WHICH YOUR FIRM IS SERVING AS A SUB-CONSULTANT TO OTHERS

PROJECT NAME, TYPE AND LOCATION	NATURE OF FIRMS RESPONSIBILITY	NAME AND ADDRESS OF OWNER	ESTIMATED COMPLETION DATE	ESTIMATED PROJECT COST $0.00	
				ENTIRE PROJECT	YOUR FIRM'S RESPONSIBILITY
Not Applicable, Tetra Tech not currently serving as sub-consultant					
	Not Applicable				
		Not Applicable			
			Not Applicable		
				Not Applicable	
					Not Applicable

17. COMPLETED WORK WITHIN LAST 5 YEARS IN WHICH YOUR FIRM WAS THE DESIGNATED FIRM OF RECORD				
PROJECT NAME, TYPE AND LOCATION	NAME AND ADDRESS OF OWNER	ESTIMATED PROJECT COST	YEAR	EPA APPROVED?
TMDL Development for WV Group C2 Watersheds (Middle Ohio North & South Watersheds)	WVDEP DWWM, 601-57th Street, Charleston, WV 25304-2346	$594,995	2013	Yes
TMDL Development for WV Group B2 Watershed (North Branch Potomac, Elk, and Lower Kanawha)	WVDEP DWWM, 601-57th Street, Charleston, WV 25304-2346	$657,990	2011	Yes
TMDL Development for WV Group A2 (Cheat)	USEPA Region 3, 1650 Arch Street, Philadelphia, PA 19103; WVDEP DWWM, 601-57th Street, Charleston, WV 25304-2346	$586,912	2010	Yes
TMDL Development for WV Group E Watersheds (Upper Ohio South, Dunkard Creek, Camp Creek, and Youghiogheny Watersheds)	WVDEP DWWM, 601-57th Street, Charleston, WV 25304-2345	$643,750	2009	Yes
EPA Region 2 - TMDL development in New Jersey, Puerto Rico and U.S. Virgin Islands; monitoring to support TMDL development in U.S. Virginia Islands	USEPA REGION 2, 290 Broadway, New York, NY 10007-1866	$212,444	2008-2012	Yes
EPA Region 3 - TMDL development and related support in West Virginia, Pennsylvania, Delaware, Maryland and Virginia; Chesapeake Bay TMDL and WIP development support	USEPA Region 3, 1650 Arch Street, Philadelphia, PA 19103	$8,541,368	2009-2013	Yes
EPA Region 4 - TMDL development in South Carolina, Florida and Alabama; TMDL model training; hydrodynamic and water quality modeling for TMDL development	USEPA Region 4, 61 Forsyth Street SW, Atlanta, GA 30303	$1,947,793	2008-2013	Yes
EPA Region 5 - TMDL development and related support in Illinois, Indiana, Michigan, Ohio, Minnesota, and Wisconsin(e.g., TMDL development, Category 4b assessments, nutrient TMDL target development, TMDL modeling training, TMDL development training)	USEPA Region 5, 77 West Jackson Blvd, Chicago, IL 60604	$2,646,948	2009-2013	Yes

17. COMPLETED WORK WITHIN LAST 5 YEARS IN WHICH YOUR FIRM WAS THE DESIGNATED FIRM OF RECORD (Continued)				
PROJECT NAME, TYPE AND LOCATION	NAME AND ADDRESS OF OWNER	ESTIMATED PROJECT COST	YEAR	EPA APPROVED?
EPA Region 6 - TMDL development in Louisiana and Arkansas; TMDL development for dissolved oxygen (DO), nutrient, and turbidity impairments in the Grand Lake O' the Cherokees Watershed, which includes the Neosho River, the Spring River, and the Elk River in Arkansas, Kansas, Missouri, and Oklahoma	USEPA Region 6, Fountain Place, Suite 1200, 1445 Ross Avenue, Dallas, TX 75202	$1,394,494	2008-2013	Yes
EPA Region 8 - TMDL development and related support in Montana (e.g., TMDL development, modeling, 303d asssessments, monitoring, Category 4b assessments)	USEPA Region 8, Montana Office, Federal Building, 10 W. 15th Street, Suite 3200, Helena, MT 59626	$3,112,418	2009-2013	Yes
EPA Region 9 - TMDL development and related support in California, Arizona, and Hawaii (e.g., TMDL development, model development, impaired waters assessment, public meetings, and training); NPDES permit development (individual, general, and stormwater) in California and Arizona; and water quality standards support in California (natural conditions, use attainability, and whole effluent toxicity training)	USEPA Region 9, 75 Hawthorne Street, San Francisco, CA 94105	$7,171,837	2009-2013	Yes
EPA Region 10 - TMDL development and related support in Alaska, Washington, Oregon and Idaho (TMDL development, TMDL model peer review, TMDL review/revision)	USEPA Region 10, 1200 6th Ave, Suite 900, Seattle, WA 98101	$3,305,346	2008-2013	Yes
Minnesota PCA - TMDL development and related support in Minnesota (e.g., TMDL development, modeling, implementation planning)	Minnesota Pollution Control Agency, 520 Lafayette Road North, St. Paul, MN 55155	$105,092	2008-2010	Yes
Montana DEQ - TMDL and model development	Montana Department of Environmental Quality, 1520 E. Sixth Avenue, P.O. Box 200901, Helena, MT 59620	$110,010	2007-2012	Yes
City of San Diego – TMDL development (TMDL reviews, TMDL development, modeling, and assessment) in numerous inland and coastal waters in San Diego; monitoring to support TMDL development for coastal streams; development of TMDL implementation plans	City of San Diego, Storm Water Department, 9370 Chesapeake Drive, Suite 100, San Diego, CA 92123	$2,126,880	2009-2012	Yes

18. COMPLETED WORK WITHIN LAST 5 YEARS ON WHICH YOUR FIRM HAS BEEN A SUB-CONSULTANT TO OTHER FIRMS (INDICATE PHASE OF WORK FOR WHICH YOUR FIRM WAS RESPONSIBLE)

PROJECT NAME, TYPE AND LOCATION	NAME AND ADDRESS OF PRIMARY FIRM	ESTIMATED PROJECT COST OF YOUR FIRM'S PORTION	YEAR	EPA APPROVED?	CLIENT NAME AND ADDRESS
Not Applicable, Tetra Tech has not been sub-consultant to other firms					
	Not Applicable				
		Not Applicable			
				Not Applicable	
					Not Applicable

19. Use this space to provide any additional information or description of resources supporting your firm's qualifications to perform work for the WVDEP's TMDL Program.

Over the past 14 years, Tetra Tech has developed more than 4,000 approved TMDLs throughout West Virginia, initially supporting USEPA to meet strict consent decree deadlines, and subsequently assisting WVDEP with its own program. Over 2,150 of these TMDLs have been developed directly supporting WVDEP with nearly 800 more TMDLs currently under development. Since 2002, Tetra Tech has worked closely with WVDEP's TMDL Program to provide highly technical and innovative solutions, including the Mining Data Analysis System (MDAS), which have helped WVDEP's TMDL Program become a national leader in TMDL development.

20. The foregoing is a statement of facts.

Signature: Jon C. Ludwig Title: DIRECTOR Date: NOVEMBER 20, 2013

Printed Name: JON C. LUDWIG

RFQ No. DEP16379

STATE OF WEST VIRGINIA
Purchasing Division

PURCHASING AFFIDAVIT

MANDATE: Under W. Va. Code §5A-3-10a, no contract or renewal of any contract may be awarded by the state or any of its political subdivisions to any vendor or prospective vendor when the vendor or prospective vendor or a related party to the vendor or prospective vendor is a debtor and: (1) the debt owed is an amount greater than one thousand dollars in the aggregate; or (2) the debtor is in employer default.

EXCEPTION: The prohibition listed above does not apply where a vendor has contested any tax administered pursuant to chapter eleven of the W. Va. Code, workers' compensation premium, permit fee or environmental fee or assessment and the matter has not become final or where the vendor has entered into a payment plan or agreement and the vendor is not in default of any of the provisions of such plan or agreement.

DEFINITIONS:

"Debt" means any assessment, premium, penalty, fine, tax or other amount of money owed to the state or any of its political subdivisions because of a judgment, fine, permit violation, license assessment, defaulted workers' compensation premium, penalty or other assessment presently delinquent or due and required to be paid to the state or any of its political subdivisions, including any interest or additional penalties accrued thereon.

"Employer default" means having an outstanding balance or liability to the old fund or to the uninsured employers' fund or being in policy default, as defined in W. Va. Code § 23-2c-2, failure to maintain mandatory workers' compensation coverage, or failure to fully meet its obligations as a workers' compensation self-insured employer. An employer is not in employer default if it has entered into a repayment agreement with the Insurance Commissioner and remains in compliance with the obligations under the repayment agreement.

"Related party" means a party, whether an individual, corporation, partnership, association, limited liability company or any other form or business association or other entity whatsoever, related to any vendor by blood, marriage, ownership or contract through which the party has a relationship of ownership or other interest with the vendor so that the party will actually or by effect receive or control a portion of the benefit, profit or other consideration from performance of a vendor contract with the party receiving an amount that meets or exceed five percent of the total contract amount.

AFFIRMATION: By signing this form, the vendor's authorized signer affirms and acknowledges under penalty of law for false swearing (*W. Va. Code* §61-5-3) that neither vendor nor any related party owe a debt as defined above and that neither vendor nor any related party are in employer default as defined above, unless the debt or employer default is permitted under the exception above.

WITNESS THE FOLLOWING SIGNATURE:

Vendor's Name: Tetra Tech, Inc.

Authorized Signature: _____ Date: 11/13/2013

State of Virgina

County of Fairfax, to-wit:

Taken, subscribed, and sworn to before me this 13 day of November, 2013.

My Commission expires September 30, 2017.

AFFIX SEAL HERE

NOTARY PUBLIC _____

ANGELA KAY MARCIANO
NOTARY PUBLIC
REGISTRATION # 7233114
COMMONWEALTH OF VIRGINIA
MY COMMISSION EXPIRES
SEPTEMBER 30, 2017

CERTIFICATION AND SIGNATURE PAGE

By signing below, I certify that I have reviewed this Solicitation in its entirety; understand the requirements, terms and conditions, and other information contained herein; that I am submitting this bid or proposal for review and consideration; that I am authorized by the bidder to execute this bid or any documents related thereto on bidder's behalf; that I am authorized to bind the bidder in a contractual relationship; and that to the best of my knowledge, the bidder has properly registered with any State agency that may require registration.

Tetra Tech, Inc.
(Company)

(Authorized Signature)

JON C. LUDWIG, DIRECTOR
(Representative Name, Title)

703-385-1973 304-720-2334
(Phone Number) (Fax Number)

NOVEMBER 20, 2013
(Date)

ADDENDUM ACKNOWLEDGEMENT FORM
SOLICITATION NO.: DEP16379

Instructions: Please acknowledge receipt of all addenda issued with this solicitation by completing this addendum acknowledgment form. Check the box next to each addendum received and sign below. Failure to acknowledge addenda may result in bid disqualification.

Acknowledgment: I hereby acknowledge receipt of the following addenda and have made the necessary revisions to my proposal, plans and/or specification, etc.

Addendum Numbers Received:
(Check the box next to each addendum received)

- ☐ Addendum No. 1
- ☐ Addendum No. 2
- ☐ Addendum No. 3
- ☐ Addendum No. 4
- ☐ Addendum No. 5
- ☐ Addendum No. 6
- ☐ Addendum No. 7
- ☐ Addendum No. 8
- ☐ Addendum No. 9
- ☐ Addendum No. 10

I understand that failure to confirm the receipt of addenda may be cause for rejection of this bid. I further understand that any verbal representation made or assumed to be made during any oral discussion held between Vendor's representatives and any state personnel is not binding. Only the information issued in writing and added to the specifications by an official addendum is binding.

Tetra Tech, Inc.
Company

Authorized Signature

NOVEMBER 26, 2013
Date

NOTE: This addendum acknowledgement should be submitted with the bid to expedite document processing.

CERTIFICATE OF LIABILITY INSURANCE

DATE(MM/DD/YYYY) 11/12/2013

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER Aon Risk Insurance Services West, Inc. Los Angeles CA Office 707 Wilshire Boulevard Suite 2600 Los Angeles CA 90017-0460 USA	CONTACT NAME: PHONE (A/C. No. Ext): (866) 283-7122 FAX (A/C. No.): (800) 363-0105 E-MAIL ADDRESS:

INSURER(S) AFFORDING COVERAGE		NAIC #
INSURER A:	National Union Fire Ins Co of Pittsburgh	19445
INSURER B:	The Insurance Co of the State of PA	19429
INSURER C:	Lexington Insurance Company	19437
INSURER D:	AIG Europe Limited	AA1120841
INSURER E:		
INSURER F:		

INSURED
Tetra Tech, Inc.
10306 Eaton Place, Suite 340
Fairfax VA 22030 USA

COVERAGES **CERTIFICATE NUMBER:** 570051966452 **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS. **Limits shown are as requested**

INSR LTR	TYPE OF INSURANCE	ADDL INSR	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
A	GENERAL LIABILITY X COMMERCIAL GENERAL LIABILITY CLAIMS-MADE X OCCUR X X,C,U Coverage GEN'L AGGREGATE LIMIT APPLIES PER: POLICY X PRO-JECT X LOC			GL5142623	10/01/2013	10/01/2014	EACH OCCURRENCE DAMAGE TO RENTED PREMISES (Ea occurrence) MED EXP (Any one person) PERSONAL & ADV INJURY GENERAL AGGREGATE PRODUCTS - COMP/OP AGG	$2,000,000 $1,000,000 $10,000 $2,000,000 $4,000,000 $4,000,000
A	AUTOMOBILE LIABILITY X ANY AUTO ALL OWNED AUTOS SCHEDULED AUTOS X HIRED AUTOS X NON-OWNED AUTOS			CA 327 52 65	10/01/2013	10/01/2014	COMBINED SINGLE LIMIT (Ea accident) BODILY INJURY (Per person) BODILY INJURY (Per accident) PROPERTY DAMAGE (Per accident)	$2,000,000
D	X UMBRELLA LIAB X OCCUR EXCESS LIAB CLAIMS-MADE DED X RETENTION $100,000			TH1300027	10/01/2013	10/01/2014	EACH OCCURRENCE AGGREGATE	$10,000,000 $10,000,000
B B B	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY ANY PROPRIETOR / PARTNER / EXECUTIVE OFFICER/MEMBER EXCLUDED? Y/N N / N/A (Mandatory in NH) If yes, describe under DESCRIPTION OF OPERATIONS below			WC15656017 WC15656011 WC15656012	10/01/2013 10/01/2013 10/01/2013	10/01/2014 10/01/2014 10/01/2014	X WC STATU-TORY LIMITS OTH-ER E.L. EACH ACCIDENT E.L. DISEASE-EA EMPLOYEE E.L. DISEASE-POLICY LIMIT	$1,000,000 $1,000,000 $1,000,000
C	Contractor Prof			028182375 Prof/Poll Liab	10/01/2013	10/01/2014	Each Clain Agggregate	$5,000,000 $5,000,000

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (Attach ACORD 101, Additional Remarks Schedule, if more space is required)

RE: DEP 16379. West Virginia Department of Environmental Protection is included as Additional Insured as required by written contract, but limited to the operations of the Insured under said contract, with respect to the General Liability and Automobile Liability policies. A Waiver of Subrogation is granted in favor of West Virginia Department of Environmental Protection as required by written contract but limited to the operations of the Insured under said contract, with respect to the General Liability, Automobile Liability and Worker's Compensation policy.

CERTIFICATE HOLDER

West Virginia Department of
Environmental Protection
Attn: David Montali
601 57th Street
Charleston WV 25304 USA

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE

Victoria K. Mesa

Holder Identifier :

Certificate No : 570051966452

Expression of Interest to Provide Professional Engineering Services for Total Maximum Daily Loads in the Tygart Valley River Watershed

EOI Number DEP16379

Submitted by:

Tetra Tech, Inc.
803 Quarrier Street
Suite 400
Charleston, West Virginia 25301

Submitted to:

Department of Administration, Purchasing Division
2019 Washington Street East
Charleston, WV 25305-0130

Contents

I. Methodology

Tetra Tech has played a substantial role in Total Maximum Daily Load (TMDL) development in West Virginia, initially supporting U.S. Environmental Protection Agency (USEPA) to meet strict consent decree deadlines for more than 400 waters impaired by acid mine drainage (AMD) throughout the state. Since 2002, Tetra Tech has worked closely with West Virginia Department of Environmental Protection (WVDEP) through Purchase Order Nos. DEP12147, DEP13860, DEP15231, DEP15530 and DEP15990 to undergo a successful transition from a supporting role in the USEPA TMDL development efforts into full programmatic responsibility. During this time, WVDEP and Tetra Tech have found a unique way to integrate large-scale, watershed based TMDLs with fine-scale, highly technical methodologies that produce "implementable" TMDLs in a cost-effective manner. By coupling these TMDL development efforts with a fully-integrated watershed management program, West Virginia's has grown into one of the nation's premier TMDL programs. The scope and magnitude of these TMDLs has required WVDEP to set very aggressive schedules for the projects to be developed simultaneously. It is critical that these schedules are maintained as new TMDL projects begin each year, increasing the workload as the program cycles through the five hydrologic groups.

Supporting WVDEP's TMDL development efforts for over 10 years, Tetra Tech has successfully met aggressive project schedules while maintaining project budgets. Tetra Tech has completed over 2,150 USEPA approved TMDLs in West Virginia, in addition to over 800 TMDLs currently under development, while working directly for WVDEP. The success in meeting aggressive schedules and workloads is due to the exemplary efforts of Tetra Tech staff (shown in Section II.C) and our proven approach for effective project management (described in Section II.D).

Successfully completing the work directive within project timelines and budgets will require that several pollutant specific TMDL methodologies be developed simultaneously. Careful organization of the many detailed analyses associated with the methodologies is critical to meet project timelines and budgets. In the following sections, we have included TMDL methodology descriptions for total recoverable metals, dissolved metals/acidity, and bacteria impairments that contain each of the technical components listed in this solicitation. In addition, a description for stressor identification in streams with biological impacts is provided in order to demonstrate our extensive experience to perform this task if requested. An organization flowchart for the entire TMDL development process is included at the end of this section.

I.A. Data Development

Tetra Tech has been working with WVDEP for over 10 years to build efficiencies in the transfer and use of watershed data. A tremendous amount of data is required to build fine-scale watershed models that take into account all potential point and nonpoint pollutant sources. Tetra Tech modelers have developed database and spreadsheet tools to speed the transfer of data concerning mining and non-mining permits that are incorporated as point sources in the TMDL model. Likewise, GIS tools and protocols have been cooperatively developed to efficiently apply nonpoint source information such as streambank erosion and agricultural source tracking to modeled subwatersheds. Pre-TMDL water quality monitoring data must be systematically applied to calibrate models accurately. Tetra Tech modelers are also adept at using publicly available physiographic datasets like USGS topographic maps, stream gage data, and landuse coverages to build the most hydrologically representative watershed models possible.

Tetra Tech uses data from all available sources to develop TMDLs. Relevant data encompass physical, chemical, biological, and demographic characteristics of TMDL watersheds. Information concerning both disturbed and undisturbed streams in TMDL watersheds is significant. At the very beginning of the TMDL development process, an exhaustive search will be made to solicit all available data from all watershed stakeholders. Table I.A-1 lists various TMDL stakeholders matched with a summarized overview of the type of data they contribute. Stakeholders who contribute their data become cognizant of the TMDL process, which can lead to increased understanding of the long-term goals and regulatory implications of TMDL implementation.

Table I.A-1. TMDL Stakeholder Data Contributions

Stakeholder	Data Type
Cities and Counties	▪ 911 addressable structures and roads ▪ POTW effluent data ▪ MS4 areas ▪ CSO
Mining industry	▪ 308 water quality monitoring data
Multi-Resolution Land Characteristics Consortium National Land Cover Database (NLCD 2006)	▪ Landuse and land cover
National Oceanic and Atmospheric Administration, National Climatic Data Center (NOAA-NCDC)	▪ Meteorological station locations ▪ Rainfall ▪ Temperature ▪ Wind speed ▪ Dew point ▪ Humidity ▪ Cloud cover
U.S. Army Corps of Engineers	▪ Lakes and Dams ▪ Dam discharge data
U.S. Department of Agriculture (USDA), Natural Resources Conservation Service	▪ Soils surveys ▪ State Soil Geographic Database (STATSGO) ▪ Soil Survey Geographic Database (SSURGO)
U.S. Census Bureau	▪ Political Boundaries ▪ Cities/populated places ▪ TIGER Roads ▪ Population change ▪ Demographics and Economic Activity
USDA Forest Service	▪ Timber harvest data
U.S. Environmental Protection Agency	▪ STORET water quality database ▪ Water quality monitoring station locations ▪ Federal standards and regulations ▪ Clean Air Interstate Rule (atmospheric deposition)

Stakeholder	Data Type
U.S. Geological Survey (USGS)	▪ Cataloging Unit boundaries (HUC) ▪ Historical Stream Flow Record (daily averages) ▪ Topographic maps (topo quads) ▪ Digital Orthophoto Quarter Quadrangle (DOQQ) ▪ Digital elevation maps (DEM) ▪ National Elevation Dataset (NED) ▪ National Hydrologic Dataset Stream Reach (NHD)
WVDEP	▪ Applicable water quality standards ▪ Nonpoint Source Management Plans ▪ OWRNPDES data (non-mining) ▪ HPU data (mining NPDES) ▪ Abandoned mining coverage and data ▪ Discharge Monitoring Report data ▪ Oil and gas operations coverage ▪ Marcellus Shale operations coverage ▪ Section 303(d) list of impaired water bodies ▪ Water quality monitoring station locations ▪ TMDL source tracking data ▪ Sewered area and septic zones ▪ Best management practices ▪ Pre-TMDL monitoring data ▪ Streambank erosion study data ▪ Impaired Streams
West Virginia Division of Forestry	▪ Timber harvest data ▪ Burned areas ▪ Skid roads and landings
West Virginia Division of Natural Resources (DNR)	▪ Wildlife information
West Virginia University	▪ Roads

Data retrieval from stakeholders is only the beginning of the data development process. Tetra Tech will review all raw data for accuracy. Suspect data will be identified through an exhaustive QA/QC process that includes the identification of spatial, temporal, and statistical outliers as they pertain to impaired streams and TMDL watersheds. Tetra Tech will use Microsoft® Access databases to manage the large volume of data to be received from existing WVDEP databases as well as other sources of information. For over 10 years, Tetra Tech has worked extensively with WVDEP databases including the Watershed Assessment Branch database (WABbase), and has the demonstrated skill to transfer and manipulate data in a Microsoft® Access database environment.

The following sections describe in detail all of the data used to develop TMDLs.

I.A.1. Subwatershed Delineation

Subwatershed delineation refers to the subdivision of the watershed into smaller, discrete subwatersheds for modeling and analysis. The subdivision of the subject watersheds will be scaled to the extent and size of the impaired stream segments such that only one impaired stream segment is contained in an individual subwatershed unit. An example subwatershed delineation is provided in Appendix A.

Before delineation is begun, the location, stream name, stream code and impairment status of all streams will be verified. Any stream whose impairment status is questionable will be considered to be impaired for the purpose of the delineation so that the delineation is as inclusive as possible. The location of pre-TMDL monitoring stations and other water quality monitoring stations will also be verified prior to delineation to maximize spatial symmetry between monitoring stations and modeled stream reaches.

The subdivision of watersheds will begin with the 12 digit hydrological unit (HUC) watersheds. In order to represent watershed loadings and the resulting concentrations of pollutants of concern, each watershed will be divided into hydrologically connected subwatersheds. Model subwatershed boundaries are derived from topographic hydrologic boundaries. The delineation will incorporate detail from 1:24,000 scale USGS topographic maps, stream connectivity (from USGS's National Hydrography Dataset [NHD] stream coverage), the impairment status of modeled streams, and monitoring station locations. The subwatershed delineation is not only a key step in the creation of the model, but also establishes a geographic framework useful for assigning load reductions and developing future TMDL implementation efforts.

Upon completion of the subwatershed delineation, the subwatershed units will then be labeled with project name, final stream name, stream code, TMDL watershed name, major stream grouping (HUC 8, HUC 10, HUC 12), GNIS ID, GNIS name, and will be assigned a subwatershed identification number. Subwatersheds will be numbered sequentially from the most downstream subwatershed unit to the headwaters. The subwatershed network connectivity is also generated at this time and included in the attributes of the subwatershed delineation shapefile. The connectivity identifies the immediate downstream subwatershed for each subwatershed unit and is the basis by which the stream network is represented in the model for the routing of pollutants, therefore it is crucial that the connectivity be free from error in order for the model to run properly. Next, the areas for each subwatershed unit will be calculated in square meters and acres. A modeled reach consisting of one representative stream segment for each subwatershed unit will also be generated at this time. The modeled reach is used to calculate stream channel properties for configuration of the Mining Data Analysis System (MDAS) model. The process of labeling the subwatersheds and generating the modeled reach also serves as a review to ensure that the impaired streams are labeled correctly, that the structure of the stream network is preserved in the delineation, and that each impaired segment has been isolated.

The subwatershed delineation deliverable will be submitted in a CD directory with shapefiles compatible with the latest version of ArcGIS, representing the subwatershed delineation, TMDL watersheds, impaired streams, modeled reach, and NHD streams reach coverage. If necessary, a revised WAB monitoring station location shapefile will be included if discrepancies in monitoring station location data are discovered during the subwatershed delineation process. A separate document detailing any questionable or conflicting information encountered during the review of the stream reach and monitoring station shapefiles and impairment listings will be submitted along with the subwatershed delineation. Table I.A-2 lists the shapefiles that may be included in the subwatershed delineation deliverable.

Table I.A-2. Subwatershed Delineation Spatial Data

Shapefile	Description
Subwatershed Delineation	Spatial representation of the subwatershed delineation. The attributes table will include the project name, TMDL watershed name, subwatershed ID number, downstream sub ID number, area in square meters, area in acres, GNIS ID, GNIS name, final stream name, WV stream code, and WV NHD stream code.
Streams	Spatial representation of all digitized streams in the watershed. Coverage originates from WVDEP's most up to date version of NHD Stream Reach. The attributes table will include stream name, WV stream code, and NHD stream code.
Impaired Streams	WVDEP's latest NHD stream reach file modified to highlight impaired streams. The attribute table will contain fields that indicate all pollutants for which each stream is impaired as determined by the TMDL work directive list. The attribute table will also include the impaired stream name, NHD stream code, WV stream code, and trout designation.

Shapefile	Description
Modeled Reach	Spatial representation of the modeled reach. The attributes tables will include the subwatershed ID number, downstream subwatershed ID number, WV NHD stream code, final stream name, WV Code, hydrologic unit code categories (HUC 8, HUC 10, and HUC 12), watershed name, and length of reach segment in meters.
TMDL Watershed Boundary	Spatial representation of the TMDL watershed boundaries. The attribute table will contain the TMDL watershed name.

I.A.2. NPDES Permit Summary Report

It is crucial that permitted point sources be represented correctly in the model in order to develop a defensible TMDL. To that end, a Permit Summary Report will be submitted to WVDEP that identifies and characterizes the NDPES data associated with permitted point sources in each watershed. Tetra Tech works collaboratively with WVDEP to spatially review the latest OWRNPDES GIS coverages (outlets and permits shapefiles) against the subwatershed delineation, streams layer, and the aerial images. The OWRNPDES GIS coverages are then joined to the subwatershed delineation to tag each outlet with the appropriate modeled subwatershed number to facilitate processing using the Permit Summary Report Database developed by Tetra Tech. This database generates the permit sub type tables that will be used to enter permit details for the outlets. Once all data gaps are resolved, Tetra Tech will coordinate a meeting with WVDEP representatives to thoroughly review the data and determine the modeling methodology for each outlet. The meeting will result in the approval of the Permit Summary Report Database which then will be used to create the final Permit Summary Report Excel Spreadsheets, which will consist of a mining-related permit summary spreadsheet, and a non-mining related permit summary spreadsheet. These summaries will be submitted on a CD in a Microsoft® Excel filterable spreadsheet format. An example Permit Summary Report is provided in Appendix A.

WVDEP Division of Mining and Reclamations' hpu.shp GIS coverage will be used to determine the location of the mining-related NPDES permitted outlets. The effluent type, permit limits and discharge data for these outlets can be acquired from West Virginia's ERIS database system. However, additional information is needed to characterize the mining activities for representation in the model. Tetra Tech has created a customized interactive spreadsheet tool to aid WVDEP Division of Water and Waste Management (DWWM) personnel in the collection of mining-related permit data. This enables SMCRA Article 3 mining permit details to be related back to NPDES permits at the outlet level for representation in the model. This tool is used to generate a comprehensive list of the mining-related NPDES permitted outlets in the watershed, including permit number, permit type, outlet ID, outlet location (latitude and longitude), effluent type code, effluent limits, total and disturbed drainage area (for precipitation induced discharges), and continuous flow data (for pumped or constant discharges). This information provides the basis for representing mining related discharge flows as either pumped or precipitation-driven in the model.

WVDEP's OWRNPDES GIS coverages (outlets and permits shapefiles) will be used to determine the locations of the non-mining permitted sources; and detailed permit information such as discharge characteristics, permit limits and discharge data will be obtained from WVDEP's ERIS database. Tetra Tech has created a customized database tool to aid WVDEP DWWM personnel in querying the OWRNPDES GIS coverage to break out the permit types into tables as follows: HAU, IND POTW, IND Other, IND POTW Collection, Sewage General, Car Wash, Groundwater Remediation, Water Treatment Plants, IND Industrial, Solid Waste Landfill Applications, Stormwater Industrial GP, Construction Stormwater GP (this information comes from the OWRNPDES Permits shapefile coverage), Mining

Bathhouse Outlets, and WVDOH+MUN. These two datasets will be combined to generate the non-mining related permit summary list, which will provide the permit number; facility name; responsible party; permit type; outlet ID; outlet location (latitude and longitude); the watershed in which the outlet is located; outlet status (open/closed); the start and end dates for the outlet; and the parameters of interest for which limits are found, including flow, chemical concentrations and pH.

The Permit Summary Report will not only provide a comprehensive list of the permitted point sources in a subwatershed but also will identify any data gaps in the detailed permit information necessary to accurately represent the outlets in the model. Tetra Tech will work with WVDEP to obtain any missing information. Tetra Tech has a great deal of experience querying WVDEP's ERIS database, which it has access to through a virtual private network connection from its Charleston, WV office. This enables Tetra Tech to verify any questionable permit information in real time. For example, Tetra Tech reviews each major facility's permit in ERIS to better understand the outlet details, wastewater characteristics, and to identify questions to discuss with the WVDEP NPDES permit writers.

Significant details are frequently absent from the permit's outlet information in ERIS. For example, a stormwater outlet may actually be internal in nature, contributing its stormwater to another outlet of its permit, or even a completely different permit. Tetra Tech's knowledge of the NPDES permitting process and the WVDEP's ERIS database aid in identifying these data gaps to properly model each outlet. Discharge limits are helpful for identifying the parameters of concern, the average concentrations discharged, and the flow of each outlet (design or measured). In many cases, outfalls with stormwater contributions will discharge to a sedimentation pond. These outlets are often comingled with process water, non- contact cooling water, and sometimes even sanitary wastewater. The flow of the outlet is not monitored at its point of discharge to the pond, but at the outlet of the pond to the receiving stream. Discharge monitoring reports may be used to determine how often the ponds themselves have been reported to discharge, making it possible to derive the average monthly flow discharged to the stream. In some cases, sedimentation ponds may not discharge unless there is a large rain event, which means the outlet is characterized as stormwater and should be considered precipitation-driven. Likewise, an outlet may have monthly flows reported with limitations (non-benchmark values). In this situation, wastewater flows may not be best represented as stormwater. In this case, it would be best to employ a continuous flow, which can be derived by using an average of the reported average monthly flow data, or from the flow capacity of the treatment structure as identified in the permittee's application.

I.A.3. Pollutant Source Report

Working closely with WVDEP and interested stakeholders, Tetra Tech will develop an accurate and detailed assessment of all possible pollutant sources in these watersheds. The results of this assessment will be presented in a Pollutant Source Report. The Pollutant Source Report is the starting point for MDAS model configuration. All of the datasets required for model setup are represented in the Pollutant Source Report: from the subwatershed delineation to the pollutant sources to the meteorological data that drives the model. Preparing the Pollutant Source Report not only provides a spatial representation of the source information available pertaining to the subject watershed but also provides an opportunity to systematically format all of the data required for model configuration and to identify any data gaps that need to be filled. An example Pollutant Source Report is provided in Appendix A.

Tetra Tech has extensive knowledge of the datasets available pertaining to potential pollutant sources throughout West Virginia and neighboring states. Tetra Tech staff have spent years cultivating relationships with the staff of WVDEP and other organizations who can provide further details regarding sources. Most notably are the WVDEP personnel responsible for watershed source tracking and those with knowledge of permit details and the ERIS database system. Tetra Tech has worked closely with WVDEP source tracking personnel in order to streamline the data collection process so that the

appropriate type and amount of source data is collected. Over the years, Tetra Tech has developed relationships with WVDEP personnel in various departments related to the permitting of mining and non-mining related sources. Not only does Tetra Tech know whom to contact in order to obtain the necessary information, but also WVDEP personnel are familiar with Tetra Tech's specific data needs. This provides for greater efficiency in gathering source data within the time constraints of WVDEP's TMDL development schedule.

After the Permit Summary Report Excel Spreadsheets have been reviewed, Tetra Tech will begin to prepare the Pollutant Source Report. Once complete, Tetra Tech will coordinate a meeting with WVDEP representatives to thoroughly review the data and approve the information as the final deliverable. The Pollutant Source Report will be submitted in a CD directory containing an ArcGIS project that spatially represents the potential sources of stream impairments in the watershed. A separate project will be created for each watershed and each project will contain a separate view for each impairment type (metals, bacteria, or other impairment). Within each view, shapefiles will be presented that represent potential point and nonpoint pollutant sources, watershed physiographic data, and monitoring data required for modeling. The shapefiles are primarily statewide coverages that Tetra Tech processes using GIS, clipping by watershed and then labeling features with the identifying information for the individual subwatershed unit in which they are located. These shapefiles will be represented with appropriate symbols in the view legend and physical and observed details will be presented in the attributes table associated with each shapefile. A descriptive document (or legend) will also be submitted with the Pollutant Source Report that explains in detail the contents of each project, view, and shapefile.

I.A.4. Watershed Physiographic Data

Tetra Tech builds MDAS models using GIS shapefiles that represent watershed physiographic features such as topographic elevation and stream networks. These features provide a geographic framework within which the pollutant sources can be viewed and assessed. Shapefiles will include the subwatershed delineation, reach network, and impaired reaches. The inclusion of features such as towns and road networks will help to orient reviewers and TMDL implementers. Soil type classification will be included to identify areas within the watershed that may have different soil properties and thus, different hydrologic properties. The landuse grid, which serves to provide the user with an overview of the land cover and to what degree the land is disturbed in the watershed, is the basis for creating the modeled landuse categories and calculating associated areas for model input. NLCD 2006 is the most up to date landuse grid coverage available for the state of West Virginia. Table I.A-3 lists the shapefiles describing watershed physical features that may be included in the Pollutant Source Report.

Table I.A-3. Pollutant Source Report Spatial Data

Shapefile	Description
Subwatershed Delineation	Created by the subwatershed delineation process described in Section I.A.1. The attribute table will include the project name, TMDL watershed name, subwatershed ID number, downstream sub ID number, area in square meters, area in acres, GNIS ID, GNIS name, final stream name, WV stream code, and WV NHD stream code.
Stream Reach	Spatial representation of all digitized streams in the watershed. The coverage will originate from most up to date version of NHD Stream Reach shapefile. The attribute table will includes stream name, WV stream code, and NHD stream code.
Impaired Streams	WVDEP's latest NHD Stream Reach file modified by Tetra Tech to highlight all of the impaired water bodies in the watershed. The attribute table will contain fields that indicate all pollutants for which each stream is impaired as determined by the TMDL work directive list. The attribute table will also include project name, TMDL watershed name, impaired stream name, NHD stream code, WV stream code, and trout designation.
Roads	Based on previous experience, the wv_roads.shp coverage from WCMS is incomplete. This coverage will be supplemented with the TIGER/line files from the U.S. Census Bureau (2009) and unmapped jeep trails found on the topographical maps and aerial photos.
Towns	Includes locations and names of town and municipalities in the watershed. Coverage originates from wvppl.shp in WCMS.
Soils	Soil classification by type (MUID), represented as polygons. Coverage originates from USGS STATSGO database.
Landuse – NLCD 2006	This is a grid coverage of the National Land-Cover Database. The coverage is comprised of 30x30 meter grid cells each identified by landuse category.
911 Coverages (if available)	Coverages are based on information collected through the 911 emergency response mapping initiatives. The point coverages include all buildings and structures on a countywide basis. Tetra Tech may use this coverage update the modeled landuse to reflect population growth.

I.A.5. Monitoring Data

To develop a valid model, a variety of monitoring data is required. Meteorological data such as precipitation, wind speed, potential evapotranspiration, cloud cover, temperature, and dewpoint drive model hydrology. Each subwatershed unit is assigned a weather station based on proximity, which requires that weather stations outside of the subject watershed be identified. USGS flow gages provide stream flow measurements that are used as a target in model hydrology calibration. If an appropriate USGS flow gage does not exist in the watershed, a reference watershed approach will be used for hydrology calibration. This requires identifying and analyzing data from USGS gage stations outside of the watershed, and sometimes outside of West Virginia. Pre-TMDL monitoring stations provide water quality data that is used as a target in model water quality calibration. Monitoring data provided by the WVDEP Division of Mining and Reclamation is used to characterize mining sources. Spatial representation of the various types of monitoring stations in the Pollutant Source Report will allow Tetra Tech and WVDEP to determine whether sufficient monitoring data exists and to identify any data gaps that need to be filled before modeling proceeds.

Tetra Tech is continually looking to identify ways in which monitoring data can be better integrated into the TMDL model setup process. Tetra Tech has worked with WVDEP to improve the spatial representation of pre-TMDL monitoring station locations; to include more detailed field notes in the WAB sampling data; and to begin assessing streambank erosion potential for aid in sediment and metals

modeling. Tetra Tech has worked with WVDEP in the past to clarify data inconsistencies and augment monitoring datasets, and will continue to do so going forward. Table I.A-4 lists the shapefiles that describe monitoring data sources that may be included in the Pollutant Source Report.

Table I.A-4. Pollutant Source Report Water Quality Monitoring Data

Shapefile	Description
WAB Stations	Includes locations of all WAB instream monitoring stations. The attribute table will include the station ID, stream name, stream code, and location coordinates. Coverage is based on latest WAB stations shapefile provided by WVDEP.
Additional Monitoring Stations	Includes locations of additional water quality monitoring stations provided by various stakeholder groups such as: permittees, watershed groups, environmental groups, or other data sources. The attribute table will include the permit #, stream name, stream code, and location coordinates. Coverage is based on data submitted to WVDEP for evaluation during the development of the 303 (d) list.
Weather Stations	Includes locations of weather stations (including precipitation gages and surface airways stations) within and surrounding the watershed. The attribute table will include the station name and ID, period of record, elevation, and location.
USGS Gage Stations	Includes locations of the USGS gages within or surrounding the project watersheds. The attribute table will include the gage ID, station name, period of record, flow rate, drainage area, and location.

I.A.6. Potential Point Sources

I.A.6.a. Fecal Coliform Point Sources

The most significant fecal coliform point sources are the permitted discharges from sewage treatment plants. These facilities (including publicly and privately owned treatment works, combined sewer overflows, home aeration units, sewage package plants, WVDOH municipal sewage plants, and mine bathhouses) are regulated by NPDES permits. Permits require effluent disinfection and compliance with strict fecal coliform limitations (200 counts/100 milliliters [average monthly] and 400 counts/100 ml [maximum daily]). However, noncompliant discharges and collection system overflows can contribute loadings of fecal coliform bacteria to receiving streams. WVDEP's OWRNPDES GIS coverage shows the locations of NPDES permitted sources of fecal coliform bacteria. Tetra Tech will obtain the most up to date version of this coverage for inclusion in the Pollutant Source Report.

Tetra Tech is aware that new permits may be issued between the time that the Pollutant Source Report is submitted and the model is fully calibrated. Tetra Tech will work closely with WVDEP to establish a means by which the most current permits are included in the calibrated model. Table I.A-5 lists the shapefiles that describe point sources that may be included in the Pollutant Source Report.

Table I.A-5. Pollutant Source Report Permitted Point Source Data

Shapefile	Description
OWR Non-Mining NPDES Outlets	Includes a summary of the fecal coliform related permit limit information for each of the OWRNPDES permit outlets. Coverage originates from the latest OWRNPDES.shp and permit information retrieved from ERIS by WVDEP. The attribute table includes the permit, outlet, and the permit details for modeling purposes such as: design flow, land cover information and areas, and permit limits.
CSO Outlets	Locations of the NPDES permitted facilities that have CSO outlets. Coverage originated from latest OWRNPDES.shp. Where applicable, delineation of MS4s versus CSO drainage areas.
MS4 Permits	Coverage includes the areas associated with Municipal Separate Storm Sewer Systems.

I.A.6.b. Metals Point Sources

Metals point sources are classified by the mining- and non-mining-related permits issued by WVDEP. Untreated mining-related discharges from deep, surface, and other mines typically have low pH values (i.e., they are acidic) and contain high concentrations of metals (iron, aluminum, and manganese). For this reason, mining-related activities are commonly issued NPDES discharge permits that contain effluent limits for total iron, total manganese, nonfilterable residue, and pH. Most permits also include effluent monitoring requirements for total aluminum. WVDEP Division of Mining and Reclamation maintains a spatial coverage of the mining-related NPDES permit outlets. Tetra Tech will obtain the most up to date version of this coverage for inclusion in the Pollutant Source Report.

WVDEP DWWM controls water quality impacts from point source discharges from non-mining activities through the issuance of NPDES permits. WVDEP's OWRNPDES GIS coverages (permits and outlets shapefiles) show the locations of these sources. Non-mining point sources of metals may include the wastewater discharges from water treatment plants and industrial manufacturing operations. In addition, the discharges from construction activities that disturb more than one acre of land are legally defined as point sources. The sediment introduced from such discharges can contribute metals. All other non-mining NPDES permits (i.e., the wastewater discharges) must discharge at a pH between 6.0 and 9.0. Based on the types of activities and the minimal flow of most of these discharges, these permitted non-mining sources are usually believed to be negligible, however, they will be included in the pollutant source summary and the model.

Tetra Tech is aware that new permits may be issued between the time that the Pollutant Source Report is submitted and the model is fully calibrated. Tetra Tech will work closely with WVDEP to establish a means by which the most current permits are included in the calibrated model. Table I.A-6 lists the shapefiles that describe point sources that may be included in the Pollutant Source Report.

Table I.A-6. Pollutant Source Report Permitted Point Source Data

Shapefile	Description
OWR Non-Mining NPDES Outlets	Includes a summary of the metals related non-mining permit limit information for each of the OWRNPDES permit outlets. Coverage originates from the latest OWRNPDES.shp and permit information retrieved from ERIS by WVDEP. The attribute table includes the permit, outlet, and the permit details for modeling purposes such as: design flow, disturbed areas, land cover information and areas, and permit limits.
Mining NPDES Outlets	Summarizes the mining-related NPDES outlets. The attribute table includes the permit, outlet, effluent type and the permit information for each outlet. Coverage originates from the latest hpu.shp and from information provided by WVDEP DWWM in the interactive tool Tetra Tech has developed to collect mining outlet information.

Shapefile	Description
Bond Forfeiture Sites	Includes locations and status of bond forfeiture sites. Coverage created based on information from the Office of Special Reclamation in WVDEP Division of Land Restoration.
Permitted Mining Areas	Includes area coverage of the surface mining operations. Coverage originates from the latest perbd.shp provided by WVDEP.
Valley Fills	Includes area coverage of valley fills from mountaintop removal coal operations. Coverage originates from the latest vallf.shp provided by WVDEP.

I.A.7. Potential Nonpoint Sources

I.A.7.a. Fecal Coliform Nonpoint Sources

In addition to permitted sources, non-permitted (nonpoint) sources contribute fecal coliform bacteria loads to impaired streams in a watershed. The nonpoint fecal coliform sources in a watershed are represented differently in the model depending on their type and behavior. Potential nonpoint fecal coliform sources include wildlife, grazing livestock, residential/urban runoff and failing septic systems.

Frequently, nonpoint sources are characterized by build-up and wash-off processes. On the land surface, fecal coliform bacteria accumulate over time and wash off during rain events. As the runoff transports the sediment over the land surface, more fecal coliform bacteria are collected and carried to the stream. While the concentrations of bacteria are increasing, some bacteria are also dying. The net loading into the stream is determined by the local watershed hydrology. Nonpoint sources are represented in the model as land-based runoff from the landuse categories. Fecal coliform accumulation rates (in number per acre per day) can be calculated for each landuse based on all sources contributing fecal coliform bacteria to the land surface. Wildlife and grazing livestock contribute to landuses in the watershed such as forest, grassland, pasture and urban/residential. Failing septic systems, straight pipes conveying raw sewage, and wildlife contribute fecal coliform bacteria to residential/urban lands. These contributions are a nonpoint source via the build-up and wash-off of coliform bacteria from both pervious and impervious surfaces in industrial areas, on paved roads, and in residential areas. Direct discharges from livestock may be a significant source of bacteria in receiving streams, depending on the number of livestock with stream access in the watershed.

Failing septic systems represent non-permitted (nonpoint) sources that can contribute fecal coliforms to receiving water bodies through surface or subsurface flow. Fecal coliform contributions from failing septic system and discharges will be represented in the model by flows and concentrations, which will be quantified on the basis of the following information:

- Areas not served by public sewer.
- Number of failing septic systems in each subwatershed.
- Estimated population served by the septic systems (calculated from census data, source tracking information provided by the WVDEP and 911 coverages).
- An average daily discharge in gallons of wastewater/person/day.
- Estimated septic effluent concentration reaching the stream.

Tetra Tech will thoroughly review the nonpoint source data it receives before including it in the Pollutant Source Report and transform the data where necessary to enhance spatial representation. For example, an analysis of the information submitted for agricultural sites will be performed to determine whether direct deposition by livestock should be included as a nonpoint source in the model. A more complex site

analysis will be performed for residential areas. Table I.A-7 lists the shapefiles that describe nonpoint sources that may be included in the Pollutant Source Report.

Table I.A-7. Pollutant Source Report Nonpoint Source Data

Shapefile	Description
Landuse – NLCD 2006	This is a grid coverage of the National Land-Cover Database. The coverage is comprised of 30x30 meter grid cells. The NLCD 2006 will be loaded to show each of the landuses identified in the NLCD coverage.
911 coverages	These are coverages provided by WVDEP based on information collected through the 911 initiatives. The point coverage includes all buildings and structures on a countywide basis. May be used to provide house counts in unsewered areas and to update residential landuse in areas that have recently undergone significant residential development.

I.A.7.b. Metals and Sediment Nonpoint Sources

In addition to point sources, nonpoint sources can contribute to water quality impairments related to metals and pH. Abandoned mine lands (AML) contribute AMD, which produces low pH and high metals concentrations in surface and subsurface water. Similarly, facilities that forfeited their bonds and abandoned operations can be a significant source of metals and low-pH. Also, land disturbing activities that introduce excess sediment are additional nonpoint sources of metals. Previous modeling efforts have revealed that certain sediments contain high levels of aluminum and iron - and to a lesser extent, manganese (Watts et al. 1994). Land disturbance can increase sediment loading to impaired waters, and the control of sediment-producing sources might be necessary to meet water quality criteria for metals during high-flow conditions. Potential sediment-related nonpoint sources of metals are forestry operations, oil and gas operations, Marcellus shale operations, roads, agriculture, and barren lands.

Tetra Tech will thoroughly review the nonpoint source data it receives before including it in the Pollutant Source Report and transform the data where necessary to enhance spatial representation. Table I.A-8 lists the shapefiles that describe nonpoint sources that may be included in the Pollutant Source Report.

On July 12, 2011, Acting Governor Earl Ray Tomblin signed an executive order to make the WVDEP establish emergency rules to regulate Marcellus Shale operations until long term rules can be developed. On August 22, 2011, these emergency rules were codified in Title 35 CSR Series 8. Because shale gas drilling operations are a relatively new nonpoint source for West Virginia, Tetra Tech has been working in coordination with WVDEP Office of Oil and Gas to characterize permits for current TMDL development. It is important to differentiate Marcellus wells from regular oil and gas wells because of the increased size of the land disturbance from Marcellus well pad construction. Well pad size and land disturbance information have been gathered to characterize sediment and metals contributions. Tetra Tech will continue to work with WVDEP as shale gas drilling regulations are developed. The extent of Marcellus drilling consists of approximately 200 permitted wells located mostly within the western portion of the Tygart Valley River watershed.

Table I.A-8. Pollutant Source Report Nonpoint Source Data

Shapefile	Description
AML Portals (WVDEP)	Includes locations of AML portals. Coverage originates from the latest aml_pnt.shp.
AML Highwall	Includes locations of AML highwalls. Coverage originates from the latest aml_line.shp.
AML Area	Includes locations and areas of AML surface disturbances. Coverage originates from the latest aml_poly.shp.

Shapefile	Description
Oil and Gas Wells	Includes locations and status of oil and gas well operations. Coverage originates from the latest oog.shp.
Marcellus Shale Wells	Includes the locations and status of the Marcellus Shale drilling operations. Coverage originates from the latest ERIS Wells.shp
Harvested Forest	Includes locations of forest harvest operations. The attributes table includes the registration number, start date, end date, landing (areas) haul road (acres), total logging area (acres) and calculated radius (meters). Coverage created based on the coordinates from the harvested forest information provided by WV Division of Forestry.
Burned Forest	Includes locations of burned forest areas. The attributes table includes date of burn, total area burned (acres), and the calculated radius. Coverage created based on the coordinates from burned forest information provided by WV Division of Forestry.

I.A.8. WVDEP Source Tracking

As part of its preparation for TMDL development, WVDEP staff conduct site visits to all impaired streams to identify any previously unknown pollutant sources in the watersheds and to collect additional data needed for source characterization and model setup. In fecal coliform impaired streams, the source tracking efforts by WVDEP DWWM may identify additional sources such as unpermitted discharges and failing septic systems, or gather supplemental information such as sewer coverages, failing septic data, pasture areas and livestock counts. In metals impaired streams, the source tracking efforts by WVDEP DWWM and the Office of Abandoned Mine Lands and Reclamation may identify additional AML sources (discharges, seeps, portals, culverts, refuse piles, diversion ditches, and ponds). Field data, such as GPS locations, water samples, and flow measurement can be collected to locate these sources and characterize their impact on water quality. Tetra Tech works closely with WVDEP source tracking personnel in order to streamline the data collection process so that the appropriate type and amount of data are collected. When necessary, Tetra Tech personnel have accompanied WVDEP source tracking personnel in the field to assist with the identification and characterization of sources. Tetra Tech's involvement in the source tracking process is extremely important to source characterization as it leads to enhanced data collection and more accurate representation in MDAS. Table I.A-9 lists the shapefiles that describe source tracking data that may be included in the Pollutant Source Report.

Table I.A-9. Pollutant Source Report Source Tracking Data

Shapefile	Description
Septic Zones	Coverage created by WVDEP from the source tracking efforts. The coverage includes seasonal flow and septic system failure rates for separate zones within the watershed.
Sewered Areas	Coverage created by WVDEP and includes the aerial coverage of local PSDs
Unsewered Areas	Coverage created by WVDEP from the source tracking efforts. The attribute table includes the number of unsewered houses per stream segment.
Sewage Overflow Events	Coverage created from information provided on the source tracking data spreadsheet created by WVDEP. Attributes include the locations and sewage overflow events.
Agricultural Source Tracking Sites	Coverage created from the potential fecal coliform bacteria sources that were identified during WVDEP source tracking efforts. The attribute table includes the category for the source, a description of the type of source, size and runoff potential.
AML Seeps Source Tracking	Coverage created from the sample locations taken during WVDEP source tracking efforts. The attribute table includes the site description and the analytical

Shapefile	Description
	results for each sample.
MS4 Permits	This coverage includes areas/outlets associated with Municipal Separate Storm Sewer Systems (MS4).
AML Disturbances Source Tracking	Coverage created from the identified AML areas during WVDEP source tracking efforts. The attribute table includes the site description of each AML, associated PADS#, and ranks the runoff potential.
Sediment Source Tracking	Coverage created from the potential sediment sources identified during WVDEP source tracking efforts. The attribute table includes rankings of potential sediment impacts for the following sources: AML, Oil-Gas, Unmapped Roads, Agriculture, Metal Hydroxides, Bank Erosion, and Residential areas.
Pin Study Stations	This coverage shows the locations of the pin study stations where stream bank erosion was measured by WVDEP.

I.B. Watershed Modeling

I.B.1. Model

I.B.1.a. Model Selection

The selection criteria for a specific watershed model should be based on technical, regulatory, and stakeholder-specified considerations. Given Tetra Tech's experience addressing these considerations in West Virginia's watersheds, MDAS is proposed for watershed modeling. MDAS was developed by Tetra Tech and USEPA specifically for TMDL application in West Virginia to facilitate large scale, data intensive watershed modeling applications. MDAS is particularly applicable to support TMDL development for areas affected by AMD and other point and nonpoint pollution sources. MDAS is non-proprietary model, and its code is open for inspection. Modification of the model and/or additional model development can easily be done in-house, as Tetra Tech developed and maintains the model code. The system integrates the following:

- Graphical interface
- Data storage and management system
- Dynamic watershed model
- Data analysis/post-processing system

The MDAS graphical interface supports basic GIS functions, including electronic geographic data importation and manipulation. Key geographic datasets include stream networks, landuse, flow and water quality monitoring station locations, weather station locations, and permitted facility locations. The data storage and management system functions as a database and supports storage of all data pertinent to TMDL development, including water quality observations, flow observations, and Discharge Monitoring Reports (DMRs) from permitted facilities, as well as stream and watershed characteristics used for modeling.

The dynamic watershed model simulates nonpoint source flow and pollutant loading as well as instream flow and pollutant transport, and it is capable of representing time-variable point source contributions. This component is most critical to TMDL development because it provides the linkage between source contributions and instream response. It is capable of simulating flow; the behavior of sediment, total recoverable metals, bacteria, nutrients, pesticides, and other conventional pollutants including chlorides and sulfates; temperature; and pH for pervious and impervious lands and for water bodies.

A relational Microsoft® Access database serves as the framework for watershed data management. A key advantage of MDAS' development framework is that it has no inherent limitations in terms of modeling size or upper limit of model operations imposed by architecture. In addition, the Microsoft® Visual C++ programming architecture allows for seamless integration with modern-day, widely available software such as Microsoft® Access and Excel (Figure I.B-1). Another key advantage of MDAS is that it can be customized to fit West Virginia's individual TMDL development needs.

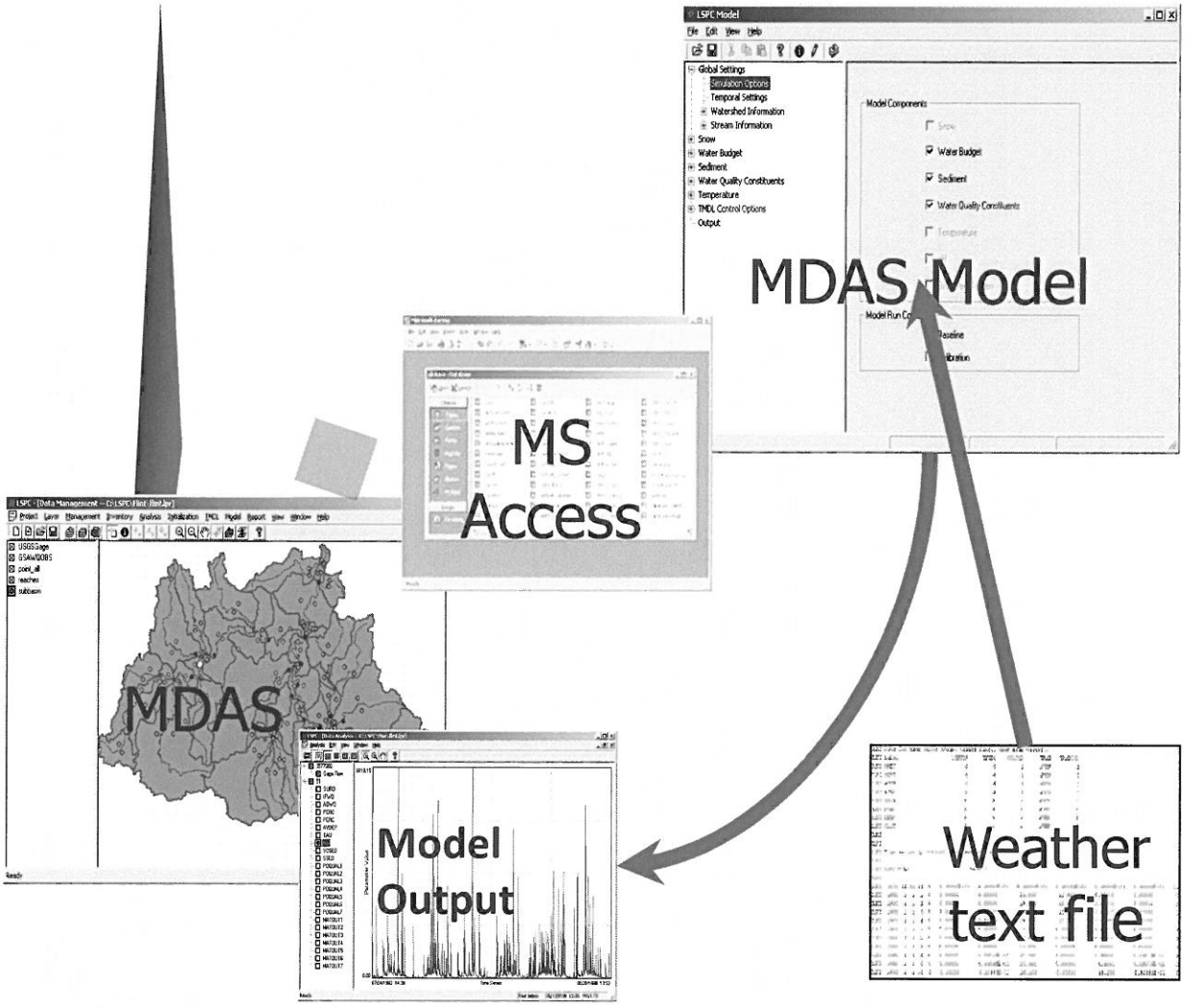

Figure I.B-1. MDAS Model Features

Advantages to choosing MDAS as the watershed model for this project include:

- Simulates watershed hydrology using hourly local meteorological data.
- Presents no inherent limitations regarding the size and number of subwatersheds and streams that can be modeled at any given time.
- Simulates all of the necessary pollutants on land and instream under a range of flow conditions.
- Is calibrated for existing conditions, while it can be modified to allow for baseline and allocation scenarios.
- Applies to rural and urban watersheds.
- Because of the small time-step, it can be used to evaluate compliance with varying water quality criteria, including exposure duration and exceedance frequency components.
- MDAS allows for representation of loading processes for both point and nonpoint sources as either precipitation-driven or constant discharge, as appropriate.
- MDAS allows for representation of pollutant build-up/wash-off rates and/or representative event mean concentrations (EMCs) for various landuse categories.

- Stream network connectivity allows for instream transfer of pollutants from upstream to downstream watersheds.
- MDAS has a unique graphical interface which supports GIS functions.
- MDAS allows for representation of instream dissolved metals.
- Easy to use post-processing tools allow for presentation of allocations in a user-friendly manner.
- A comprehensive modeling framework using the proposed MDAS approach facilitates the development of TMDLs not only for this project, but also for potential future projects to address other impairments throughout the modeled watersheds.
- Allows for customization of algorithms and sub-routines to accommodate the particular needs of the project.
- Time-variable nature of the modeling will enable a straightforward evaluation of the cause-effect relationship between source contributions and waterbody response and direct comparison with relevant water quality criteria.
- Proposed modeling tools are free and publicly available. This is advantageous for distributing the model to interested stakeholders and among government agencies.
- Approved by the USEPA for use in TMDLs.
- Model includes both surface runoff and baseflow (groundwater) conditions.
- Provides storage of all geographic, modeling, and point source permit data in a Microsoft® Access database and text file formats to provide for efficient manipulation of data.
- Provides post-processing and analytical tools designed specifically to support TMDL development and reporting requirements.

I.B.1.b. Fecal Coliform Model Setup

During model setup Tetra Tech will format the subwatershed, stream reaches, and point source data for input into MDAS. Meteorological conditions are the driving force for nonpoint source transport processes in watershed modeling. Hourly precipitation, temperature, dew point, evapotranspiration, cloud cover, and other relevant weather data will be obtained for those stations inside and around the watersheds of concern. The available weather data will be analyzed for completeness, and if any periods of time are missing from the preferred station, best available data from neighboring stations will be used to fill data gaps. Once the weather datasets are complete, MDAS air files will be prepared to run the model. Weather data will be validated during hydrology calibration. Tetra Tech modelers will use the same MDAS air file for all pollutant models, whether fecal coliform, metals, or ionic stress.

The model will be configured using the MDAS model database to simulate modeled point and nonpoint pollutant sources, as well as general hydrologic characteristics of the modeled subwatersheds and TMDL streams. Development of the modeled landuse from GIS coverages is the next step in model setup. The modeled landuse will be developed taking into account the sources of the pollutants of concern. The fecal coliform modeled landuse will start with a base landuse GIS shapefile such as the NLCD 2006. This coverage will be modified to incorporate WVDEP source tracking information. For instance, areas of high concentrations of livestock (agricultural intensity) or fecal runoff potential; differences between grasslands versus pastures; new residential development; and other nonpoint pollutant sources not described on the original coverage will be taken into account. A roads analysis will also be performed using polylines from sources such as TIGER, WVRoads, and USGS topographic maps. Roads will be classified as either paved or unpaved. In addition, an analysis of the percent imperviousness of urban/residential areas will be performed. MS4 areas that occur in TMDL watersheds will be delineated using information obtained from WVDEP, WVDOH, and local city engineers.

Besides precipitation-driven discharges, other direct discharges are modeled. In the case of the fecal coliform modeling, failing septic systems, NPDES permitted outlets with fecal coliform discharges,

CSOs, and other special cases (e.g., Sanitary Sewer Overflows (SSOs) or known sludge piles) will be modeled.

Upon completion of landuse manipulation and point source input configuration, additional information required for model setup will be prepared, including inputs of reach geometry and routing, watershed physical information (e.g. slopes, length of overland flow, elevation), and weather station assignment for each subwatershed. Assignment of point sources to reaches will also be prepared for addition to the MDAS database. Finally, Tetra Tech will provide technical transfer of all models, modeling tools, and data used during the development of the TMDLs. Nothing in the models, modeling tools, databases, etc., will be restricted in its distribution.

I.B.1.c. Total Metals and Sediment Model Setup

To explicitly model nonpoint sources in the sediment and metals impaired watersheds, additional landuses need to be represented in the model beyond the modified fecal landuse described in I.B.1.b. These landuses will represent both point and nonpoint precipitation-driven sources. With each hydrologic group, Tetra Tech has worked to create a customized landuse set that represents the sources within the subject watersheds and will continue to do so for this project; for example Tetra Tech most recently collaborated with WVDEP personnel to determine how best to represent Marcellus Shale gas wells in watersheds where they represent a significant landuse. The metals modeled landuses for TMDLs that Tetra Tech has developed for WVDEP typically include the following: conventional oil and gas wells, unpaved roads, burned forests, harvested forest / skid roads, revoked mines, and AML / highwall.

Precipitation-driven point sources within the metals model are typically related to mining activities and stormwater permits. Information from WVDEP's permit databases and spreadsheets that will be specifically designed for this purpose will be used to develop the permitted landuse coverage. Besides precipitation-driven discharges, other direct discharges will be modeled such as AML seeps, pumped discharges from mines, and non-mining NPDES permits

In addition to anthropogenic sources, metals and sediment contributions from groundwater and streambank erosion will also be considered in the modeling process. In the case of naturally occurring parameters, such as manganese, aluminum and iron, groundwater contributions will be modeled according to the individual characteristics of the land and its corresponding area.

Tetra Tech has worked with WVDEP to develop a method to consistently assess bank erosion potential at each sampling station using a twofold approach: 1) qualitative assessment, rating vegetative cover and soil characteristics (e.g., erodibility); and 2) quantitative evaluation through an erosion pin study. The qualitative vegetative cover assessment is based on the 2011 National Agriculture Imagery Program aerial photography. Each subwatershed is assigned a qualitative value between 1 and 3, with 1 being the best observed bank vegetative cover and 3 having the least coverage. Tetra Tech and WVDEP have found that while vegetative cover is one of the most important factors controlling bank stability, soils characteristic data available through SSURGO may provide additional insight into the streambank erosion rates that can be applied to all subwatersheds. Tetra Tech will use these data to further refine the subwatershed representation in the model.

To quantitatively assess streambank sediment loading, Tetra Tech will use results from field experiments conducted by WVDEP at selected instream sampling stations using bank erosion pins. Erosion pins are embedded into representative sections of the streambanks and the exposure surface is surveyed periodically and after storm events to assess streambank erosion rates at each site. In addition, WVDEP measures stream channel cross section geometry at each site and collects soil samples for analysis of particle size distribution and iron content. Tetra Tech will then calculate the amount of soil material

eroded or deposited at each site using measured erosion depth. The total amount of sediment eroded from stream channels will be calculated from results of all pin erosion sites along the stream reach. This streambank sediment loading calculated from erosion pin study will be used in combination with the qualitative vegetative cover score for the comprehensive assessment of stream bank sediment loading in the entire watershed. The results will be used to calibrate streambank erosion sediment loading parameters.

Upland sediment loading is simulated based on the mathematical description of the soil detachment process and the sediment transport along the surface slopes. Spatial variation of the soil erodibility will be included in the model using the information retrieved from statewide soils database. Statistical analyses using pre-TMDL monitoring data collected throughout the subject watersheds will be performed to establish the correlation between metals loads and sediment loads and to evaluate spatial variability. The results will then be applied to the sediment-producing landuses during the water quality calibration phase of the MDAS.

I.B.1.d. pH and Dissolved Metals Model Setup

As noted in previous work for WVDEP, the majority of water quality impairment relates to mine drainage, bacterial contamination, and general biological impairment. The development of TMDLs is needed to address the typical stressors and water quality impairment due to pH, metal toxicity, and sedimentation in the Tygart River Valley watershed. Specifically, TMDL modeling capabilities will address water quality criterions for iron, aluminum, manganese, selenium, and pH. The modeling must address low flow, mean flow, and storm peaks at multiple locations throughout the basin and permit a comparison of model output with observed data from representative water quality monitoring stations. The TMDL model will determine instream dissolved metals and pH due to total metal inputs from point and nonpoint sources, with prescribed pollutant allocations to result in compliance with water quality criteria. The need to regulate and manage the environmental impacts from mining requires methods that encompass the inherent complexity of the myriad chemical interactions in the environmental media.

We propose to utilize the recently updated version of the MDAS model for TMDL development for dissolved metals and pH. The updates included coupling MDAS with the USEPA's watershed Loading Simulation Program in C++ (LSPC) (USEPA 2009) to dynamically simulate dissolved ions that influence pH. The LSPC/MDAS model will simulate complex loading processes within the watersheds and advanced chemical reactive transport processes within the streams and, thus, include the complex interactions between the land, the atmosphere, and surface and groundwater. For example, the LSPC/MDAS model will include sediment sources, atmospheric deposition, streambank erosion, and landuse source attributes and the affected instream chemical dynamics that result in observed water quality for dissolved metals and pH.

The model possesses the following capabilities that will provide a scientifically sound representation of the watershed loading and transport system and a sound development of TMDLs and allocation scenarios:

- Simulate hydrologic variations due to time variable weather patterns and the related transient saturation or unsaturated condition of the surface/subsurface
- Simulate time variable chemical loadings from various sources in the watershed
- Simulate geochemical interactions within a stream channel
- Provide model results with a broad range of spatial and temporal scales
- Evaluate source loading abatement scenarios for water quality control/management design

The conceptualization of the current LSPC/MDAS model (Figure I.B-1) illustrates the relationship of the land processes and loading mechanisms that leads to the calculated edge of stream condition at various locations within the watershed. The edge of stream condition is transferred into the MDAS model for subsequent instream calculations. The modeling for instream metals, including iron, aluminum, manganese, and selenium, along with pH, requires a comprehensive approach for simulating the interactions between dissolved, adsorbed, and precipitated chemical species that necessarily includes the simulation of major ions (e.g., calcium, sulfate, carbonate). The stream components in MDAS include the dominant processes regulating the interactions and transport of major ions, metals, adsorbing materials, and mineral phases. Reactions between the water column and the streambed are represented along with the reactions governing the distribution of dissolved and particulate chemicals. All significant chemical species for TMDL development in the subject watersheds will be included in the MDAS database with a chemical system based on major ions, iron, aluminum, manganese, selenium, adsorption/desorption to oxides and clays, precipitated chemicals, and mineral phases.

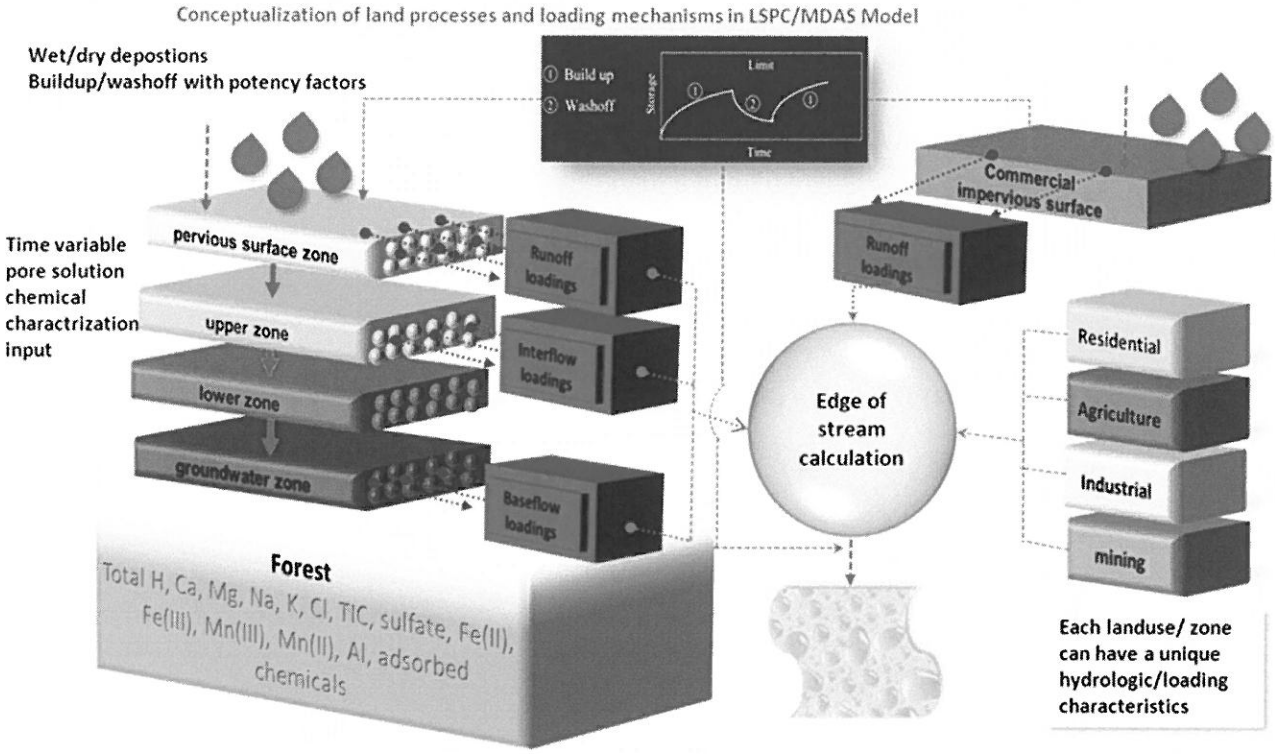

Figure I.B-2. Land components of LSPC-MDAS model

MDAS's geochemical reactions within the channel are based on thermodynamics and chemical kinetics. The foundation, based on MINTEQA2/MINEQL, is an equilibrium calculation for the major reactions that define the chemical composition of the stream reach during a given time step. Most speciation reactions are fast relative to the time step and the equilibrium assumption is reasonable. However, for certain reactions, such as the oxidation of ferrous iron to ferric iron or the adsorption of metals on iron oxyhydroxides, reactions may be limited by the kinetics, and not necessarily reach equilibrium. The major limitation of the equilibrium approach is mitigated in MDAS by incorporating simultaneous equilibrium and kinetic (non-equilibrium) calculations within the same computational time step, leading to more precise spatial and temporal representations of non-equilibrium solution conditions for certain processes.

To simulate and attain realistic stream chemical conditions, the model includes a variety of chemical reactions to support various stream conditions affected by anthropogenic or natural sources:

- Chemical speciation, including trace metals
- Acid/base chemical reactions and pH simulations
- CO_2 gas degassing/ingassing kinetics in rivers and lakes
- Redox kinetics including potential photoreduction/microbial oxidation
- Kinetic mineral precipitation/dissolution
- Adsorption/desorption based on diffuse double layer (DDL) modeling
- Cation adsorption/desorption on clay surfaces represented by cation exchange capacity
- Aging/burial of active/inactive sediment layers related to sediment deposition from the water column and scour from the stream bed

The precipitation/dissolution and the adsorption/desorption reactions both occur in the water column and streambed sediments. The heat loading into the stream from land and point sources is also considered and can be simulated. The resulting stream temperature is used for all temperature-dependent chemical reactions occurring within the stream. The stream components represented in MDAS are shown in Figure I.B-3.

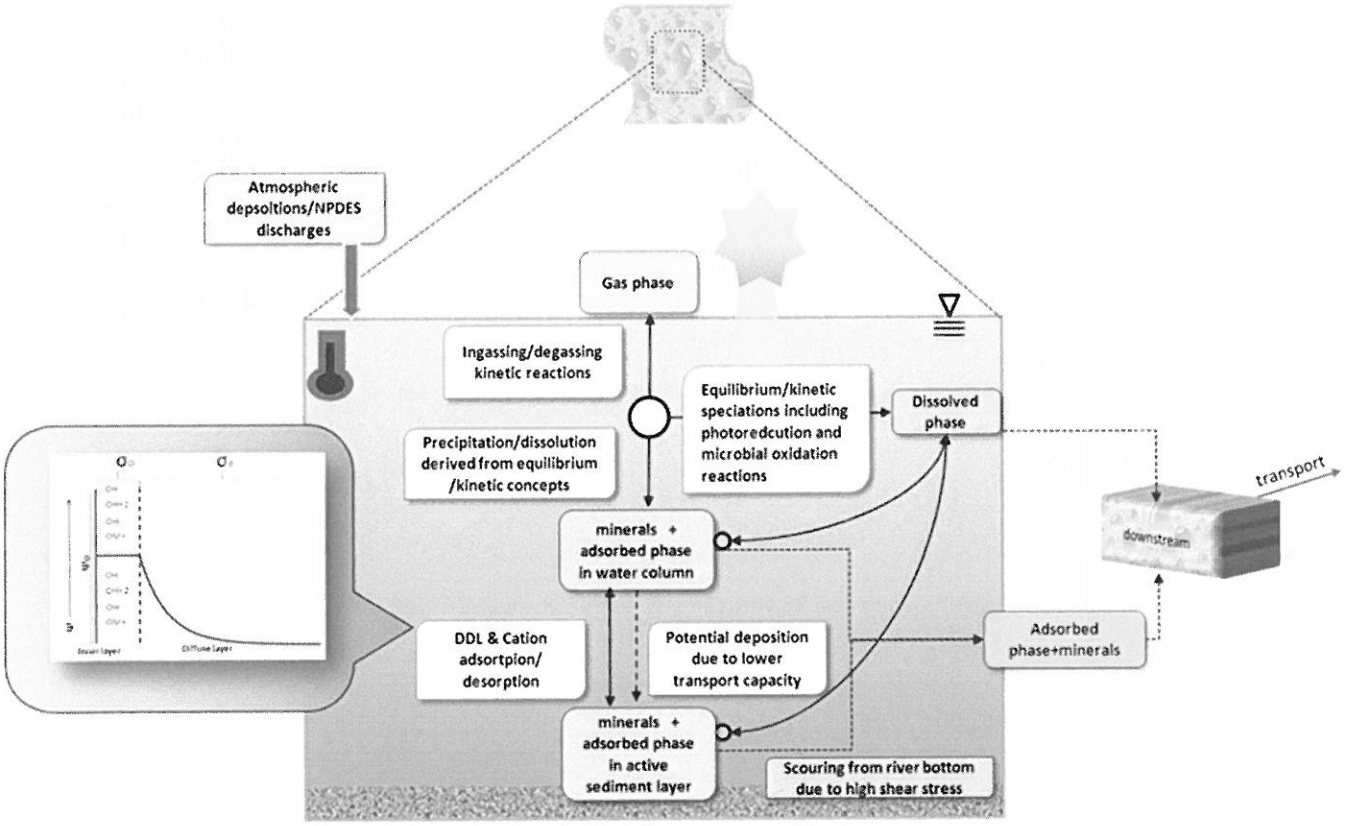

Figure I.B-3. Stream components in MDAS

This capability of LSPC/MDAS and our experience in model development/application will assure WVDEP that Tetra Tech is capable of meeting, fulfilling, and exceeding required TMDL development functions for pH and dissolved metals. Modification of the model and/or additional model development can be done in-house, as Tetra Tech developed and maintains the model code. MDAS is a non-proprietary model, and its code is open for inspection.

I.B.2. Hydrology Calibration

After the MDAS model is configured, model calibration will be performed. Model calibration will be focused on two main areas: hydrology and water quality. Pollutant concentrations are strongly influenced by stream flow. High flows and low flows can dilute or intensify instream concentrations of modeled pollutants. Strongly predictive hydrologic calibration allows the MDAS model to accurately calculate pollutant time-step instream concentrations and yearly average loads. Therefore, in TMDL model development it is critical to calibrate hydrologic models so that they closely predict observed stream flow observations.

To begin the hydrology calibration process, Tetra Tech will use the best available weather and land cover data as core model inputs. Gaps in weather data completeness will be addressed using statistical methods, including Meteorological Data Analysis and Preparation Tool (MetADAPT) software available from the USEPA Region 4 TMDL Toolbox. Tetra Tech will also obtain USGS gaging station data for streams in TMDL watersheds. Instantaneous flow measurements collected during pre-TMDL monitoring and WAB stream surveys will also be used when appropriate. In the event that USGS gaging stations are not present in the TMDL watershed, model hydrology will be calibrated to a nearby watershed with similar weather patterns and landuse characteristics. Model parameters will initially be set to the best available literature values within scientifically accepted ranges.

Hydrologic calibration will be achieved by adjusting model parameters so that model output matches observed stream flow within an acceptable range of variability. Upon completion of hydrology calibration, Tetra Tech will submit a hydrology calibration deliverable featuring a statistical analysis of model output goodness-of-fit under a variety of seasonal conditions and flow regimes.

The MDAS hydrology algorithm follows a strict conservation of mass, with various compartments available to represent different aspects of the hydrologic cycle and maintenance of the annual water balance. Sources of water are direct rainfall or snowmelt. Potential sinks from a land segment are total evapotranspiration, flow to deep groundwater aquifers, and outflow to a stream reach. From the reach perspective, sources include land outflow (runoff and baseflow), direct precipitation, or flow routed from upstream reaches. Sinks include surface evaporation, mechanical withdrawals, or reach outflow. Tetra Tech also has the capability to develop model algorithms to capture the specific dynamics of snow accumulation, evaporation, and meltwater runoff. Snow is an important hydrologic variable to consider, especially when modeling high elevations in West Virginia watersheds.

A well-calibrated model can predict stream flow over a wide range of climatic conditions and seasonal changes, including base flow and storm events. Tetra Tech will select calibration time periods based upon an examination of annual precipitation variability and the availability of observed precipitation and streamflow data. The period will be determined to represent a range of hydrologic conditions: low, mean, and high flow. Calibration for these conditions is necessary to ensure that the model will accurately predict a range of conditions over time periods beyond the calibration time period.

Key considerations in the hydrology calibration will include the overall water balance, the high flow-low flow distribution, storm event flows, and seasonal variation. At least two criteria for goodness-of-fit will be used for calibration: graphical comparison and the relative error method. Calibration will be performed

on a reasonable number of subwatersheds to insure adherence to scientific principles. Graphical comparisons are extremely useful for judging the results of model calibration; time-variable plots of observed versus modeled flow provide insight into the model's representation of storm hydrographs, baseflow recession, time distributions, and other pertinent factors often overlooked by statistical comparisons. The model's accuracy will primarily be assessed through interpretation of the time-variable plots. The relative error method will be used to support the goodness-of-fit evaluation through a quantitative comparison. A small relative error indicates a better goodness-of-fit for calibration.

After calibrating hydrology at multiple locations, independent sets of hydrologic parameters will be developed and applied to the remaining subwatersheds in the basin. A validation of these hydrologic parameters will be made through a comparison of model output to observed data at additional locations in the watershed. The validation locations are expected to represent larger watershed areas and essentially validate application of the hydrologic parameters derived from the calibration of smaller subwatersheds. Validation will be assessed in a similar manner to calibration.

Tetra Tech has successfully calibrated hydrology in over 20 different MDAS models in West Virginia watersheds. In fact, Tetra Tech has prior experience calibrating hydrology in the Tygart Valley River watershed for a past TMDL project. Tetra Tech has developed calibration spreadsheet tools customized to interpret MDAS model output. Sample output from one of these tools is presented in Figure I.B-4. Calibration tools give Tetra Tech modelers the capability to achieve model calibration in a comprehensive and highly efficient manner. Customized calibration analysis also facilitates technical review by WVDEP staff and USEPA TMDL reviewers. Hydrology calibration results will be presented on a CD containing calibration tools described above and will contain worksheets that represent the observed data and modeled output, with graphs and tables designed to assess the goodness-of-fit of the calibration, and a statistical analysis of the calibration. Daily, monthly, and annual flow volumes will be considered. An example of the hydrology calibration deliverable from West Virginia Hydrologic Group C2 TMDL is presented in Appendix A.

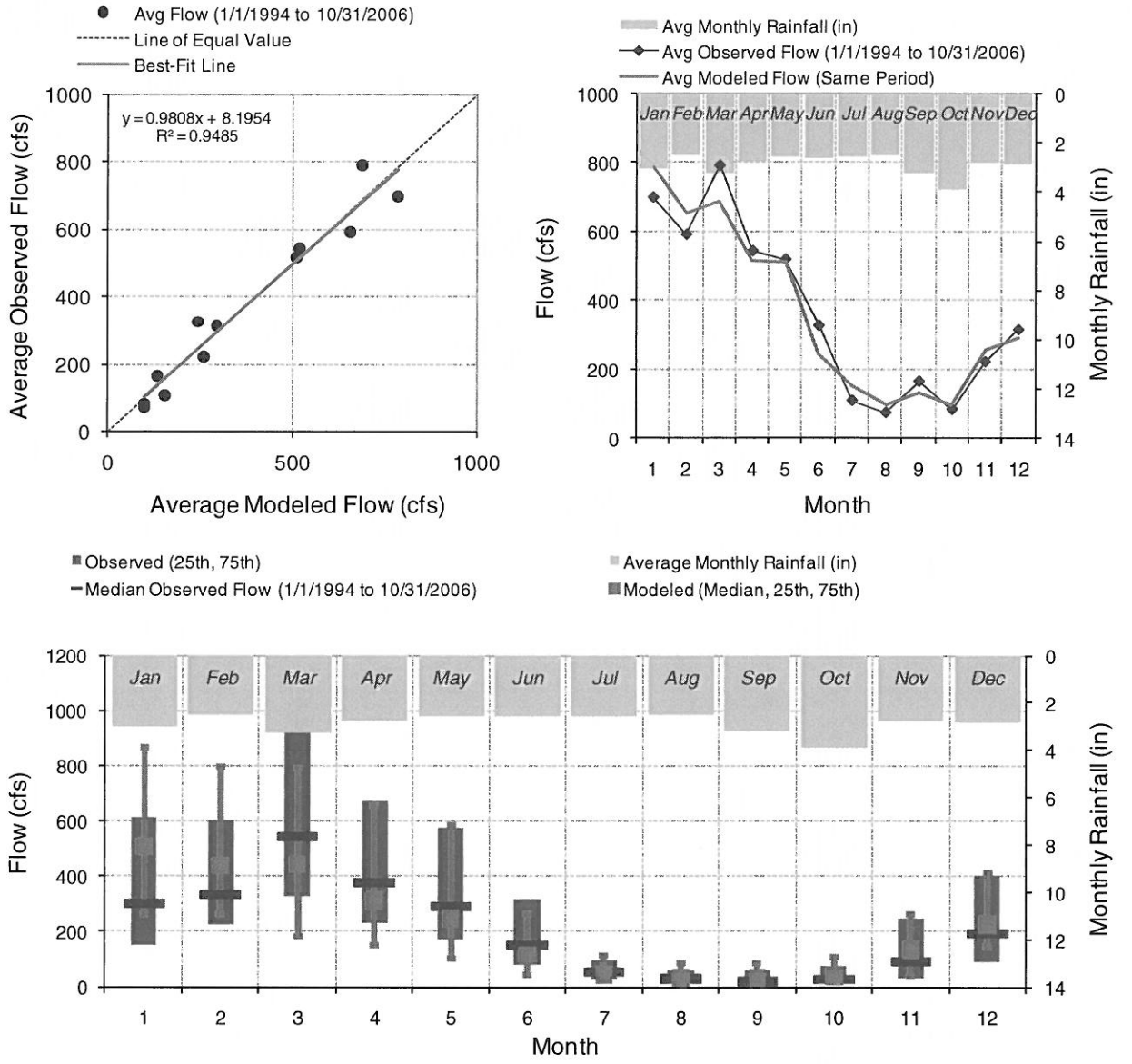

Figure I.B-4. Example Hydrology Calibration Spreadsheet Tools

I.B.3. Model Water Quality Calibration

After hydrology calibration is finalized, water quality calibration for all pollutants of concern will be performed at multiple locations throughout the watersheds. Water quality calibration refers to the adjustment or fine-tuning of modeling parameters related to water quality to reproduce instream observations. Available monitoring data in the watershed will be identified and assessed for application to calibration. Monitoring stations with data that represent a range of hydrologic conditions, source types, and pollutants will be selected. The time-period for water quality calibration will be selected based on the availability of the observed data and their relevance to the current conditions in the watershed. The period should include various wet and dry conditions.

In the broadest sense, calibration will consist of executing the watershed model, comparing time series water quality output with available water quality observation data, and adjusting water quality parameters

within a reasonable range. The main objective of the water quality calibration will be to best simulate low-flow, mean-flow, and storm events at representative water quality monitoring stations throughout the watershed. Upon completion of the calibration at selected locations, the calibrated dataset containing parameter values for modeled sources and pollutants will be complete. This dataset will be applied to areas for which calibration data are not available.

Water Quality Calibration results will be presented on a CD and will contain worksheets that represent the observed data and modeled output, with graphs and tables designed to assess the goodness-of-fit of the calibration, and a statistical analysis of the calibration. Calibration will be performed on a significant number of watersheds to ensure the scientific validity of the process. An example of the water quality calibration deliverable from the West Virginia Hydrologic Group B2 TMDL project is presented in Appendix A.

I.B.3.a. Fecal Coliform Water Quality Calibration

The water quality parameters that will be adjusted to obtain a calibrated model are the build-up and wash-off of fecal coliform bacteria from the subwatershed acreages associated with fecal coliform producing landuses. The direct load estimates from failing septic systems can also be adjusted for fecal coliform concentration. Landuse-specific parameters that are relevant for calibration of fecal coliform bacteria are the build-up rate and wash-off limit parameters. Essentially, the build-up relates to the rate at which the amount of fecal coliform (in counts per acre) accumulates on the land surface every day during dry conditions. The wash-off parameters are used to guide the model in the relative rate of detachment and transport of the accumulated mass from the land segment to the stream during runoff conditions. This is generally expressed as inches of runoff that would be required to mobilize certain percent of the stored mass on the surface. Starting values for these parameters will be taken from previous models, literature, peer-recommended ranges, and Tetra Tech's Fecal Coliform Loading Estimation Spreadsheet. Background values will be derived from storm sampling events in undisturbed locations.

Septic discharges will be modeled as direct discharges to the reaches, with estimated flows and concentrations. Flow values will be estimated using unsewered house counts and septic failure rates. Tetra Tech has also worked with WVDEP staff to improve failing septics analysis by incorporating 911 emergency response GIS data to identify unsewered homes in TMDL watersheds. Septic concentrations will be calculated using fecal coliform loads derived from low-flow instream water quality data for locations only affected by septics during low flow conditions. These calculated loads will then be applied to the estimated septic flows, to obtain an average septic discharge concentration.

After initial parameter values have been established, the model will be run, and comparisons will be made with observed fecal coliform water quality data for several representative locations in the watershed. The fecal coliform bacteria calibration will be focused on matching trends identified during the water quality analysis. Daily average instream fecal coliform bacteria concentrations from the MDAS model will be compared directly with observed data collected during WVDEP's pre-TMDL monitoring efforts as shown in Figure I.B-5.

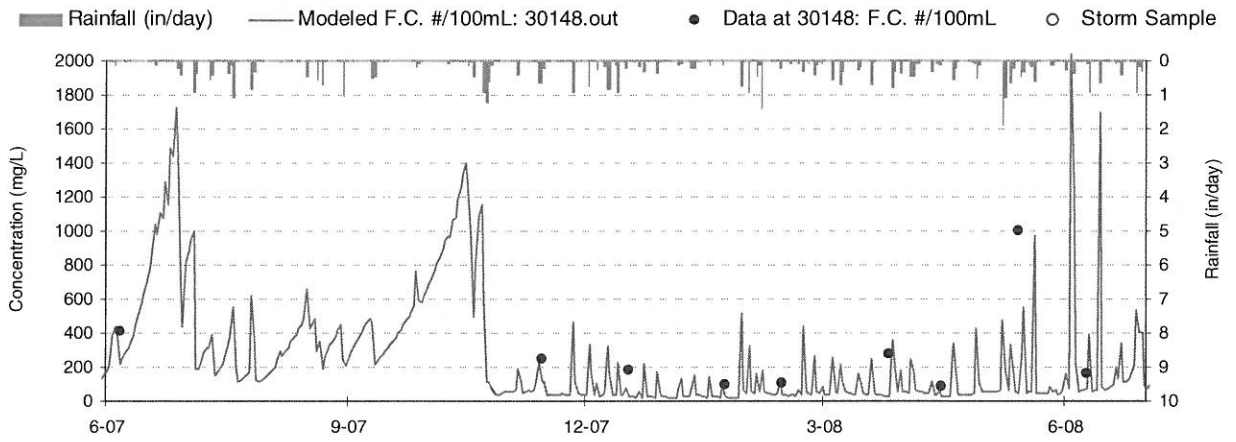

Figure I.B-5. Fecal coliform concentration: model output vs. observed data

I.B.3.b. Metals Water Quality Calibration and Iron-Sediment Relationship

The first step in the metals water quality calibration is the determination of the sediment-metals relationship, which may vary throughout the subject watershed. Potency factors are region-specific parameters that account for the pounds of a particular metal generated for each ton of sediment produced. The values for the potency factors will be determined by analysis of TSS and metals data. Land-based sediment calibration consisted of adjusting the coefficient in the sediment wash-off equation (KSER) for each landuse. The landuses will be parameterized according to their sediment-producing capabilities. In addition to the sediment-generated metals, any additional non-sediment related loading will be estimated. Parameters that are used are SOQC, IOQC, and AOQC. These define the concentration of non-sediment related metals by landuse for surface runoff, interflow, and groundwater, respectively.

To establish reasonable ranges of values for use in the metals water quality calibration for mining landuses, DMR and storm monitoring data will be analyzed. Metals loading for sediment producing landuses will be assumed to be exclusively dependent on the sediment loads and their potency factors. Reasonable water quality parameters for AML will be derived from statistical analysis of AML water quality data from source tracking efforts. Parameters for background conditions will be based on observed water quality data from undisturbed monitored locations. Starting values for other non-monitored sources will be taken from previous models, literature, and peer-recommended ranges.

The approach taken to calibrate water quality will focus on matching trends identified during the water quality analysis. Hourly instream concentrations from the model will be compared directly with observed data. Observed data from WVDEP's pre-TMDL monitoring efforts and data submitted by various mining companies throughout the watershed will be used for calibration. The objective will be to best simulate the metals concentration and loading at low flow, mean flow, and storm peaks at representative water quality monitoring stations. The representative stations will be selected based on location and loading source type.

I.B.3.c. pH and Dissolved Metals Water Quality Calibration

Historical mining activities are an important consideration in the development of dissolved aluminum and pH TMDLs. AMD is drainage that flows from open or deep mines and coal refuse piles. The formation of

AMD is a function of geology, hydrology, and mining technologies used at the site. It tends to be highly acidic and to contain high concentrations of dissolved metals. These metals remain dissolved until the pH of the water increases to the level at which the metals precipitate out. AML seeps will be modeled as direct, continuous-flow sources in the model. AML and other land-based sources will be modeled using representative average concentrations for the surface, interflow and groundwater portions of the water budget.

Atmospheric deposition data will be obtained from the USEPA Office of Air Quality Planning and Standards at Research Triangle Park, North Carolina. The data are a result of air quality modeling in support of the CAIR. The data include concentrations of sulfate and nitrogen oxides in wet and dry deposition. For the technical information on these data, see the Technical Support Document for the Final Clean Air Interstate Rule—Air Quality Modeling (USEPA, 2005c). National Atmospheric Deposition Program (NADP) monitoring data will be also used to characterize the extent of atmospheric deposition in the watershed. Atmospheric deposition inputs and parameters will be calibrated using monitoring data from streams without impact of AMD or other significant sources of acidity load.

To simulate the biogeochemical process across the watershed and instream waters, the chemical reaction parameters will be calibrated using the comprehensive water quality monitoring data. The monitoring stations on streams without influence of AMD will be identified first to calibrate the atmospheric deposition module of the MDAS model. After the chemical reaction parameters will be calibrated to water quality data in those background or reference subwatersheds, water flow and chemistry data of AMD seeps will be added in the model as point source time series. The MDAS model will be further calibrated to the water quality data observed in the subwatersheds influenced by those AMD sources.

I.B.4. Biological Stressor Identification

Beginning in the TMDL Group A, Tetra Tech collaborated with WVDEP biologist to establish a methodology to effectively identify significant stressors to biological communities. Biological TMDLs were developed for TMDL Groups through C2. Although WVDEP has suspended biological TMDL development while investigating their impairment listing methodology, Tetra Tech has provided stressor identification (SI) support for WVDEP to evaluate and arrive at the causative stressors for which specific pollutants TMDL may resolve impacts indicated through biological monitoring data. Table I.B-1 provides a summary of previous TMDL Groups with the number of streams that have been evaluated by the SI process to date. WVDEP may request that the stressor identification continue and expand the analysis to include other biological assemblages. The following section describes the existing stressor identification methodology, Tetra Tech will use if requested. Tetra Tech will work closely with the WVDEP to make necessary modification to the stressor identification process to include indices data from any biological assemblage of concern, including benthic macroinvertebrates and fish communities if available. Technical Experts, listed in Section II.C. Personnel, such as Jeroen Gerritsen, have lead or contributed to biological indices, TMDL development, impairment and implementation studies that utilize multiple data sources including fish communities. These experiences will enable Tetra Tech to build upon the existing SI framework to include the best available data in decision making and future TMDL development.

Review and Modify Stressor Threshold Values, Stressor-Response Estimation

In order to begin the stressor identification process, Tetra Tech would recommend reviewing the associations between candidate stressors and biological metrics, and to infer thresholds of biological impairment for each stressor based on current data. Working with WVDEP biologists, Tetra Tech will use the reference approach and the stressor-response relationships between biological metrics and candidate

stressors to infer thresholds of biological response to stressors. The large West Virginia dataset will enable Tetra Tech to examine the biological patterns along a particular gradient of interest.

Table I.B-1. Number of Evaluated Biological SI Streams by Group

TMDL Group	Total Number of SI Streams
A	45
B	48
C	35
D	25
E	51
A2	25
B2	95
C2	77
D2	50
E2	138
A3	36
TOTAL	**628**

I.B.4.a. Data Analysis and Review from WABbase

To begin the SI process, Tetra Tech will review data sources, most importantly, WVDEP's WABbase, warehoused in an Oracle platform with a Microsoft® Access relational database interface. Guided by the comprehensive SI conceptual model, which represents all potential causes and sources of stress leading to potentially impacted biological assemblages, Tetra Tech will identify all WABbase data that are available to inform our analysis of the likelihood of each candidate cause potentially impacting biological assemblages based on genus or species-level taxonomy in each stream.

Building on our experience working with WABbase and WVDEP biologists, Tetra Tech will conduct a thorough review of each data element in WABbase and construct and test queries that select and export all potentially pertinent data related to biological stress. These queries will capture data from all geographic locations that were sampled on biologically assessed streams as well as on tributaries of those streams. For each comprehensive set of sites for a biologically assessed subwatershed, the queried dataset will combine all available data relating to biological community conditions, water quality, physical habitat, and geographic data.

As part of the data review, Tetra Tech will conduct multiple quality assurance and quality control steps to assure the completeness and accuracy of data used for the SI analysis. Tetra Tech will review all station location information for sites within the biologically assessed watersheds and subwatersheds for consistency and accuracy. Tetra Tech will continue to work with WVDEP to resolve any data quality issues that arise during the review of the data.

I.B.4.b. Stressor Conceptual Model

During extensive experience working with WVDEP to develop USEPA-approved TMDLs and conduct stressor identification, Tetra Tech has developed a comprehensive conceptual model of candidate causes of biological impact (Figure I.B-6). This conceptual model provides the linkage between potential impact

causes, their sources, and the pathway by which each stressor can impact the biological community. Sources, impairment causes, and the resulting effects of the biological community depend on the stream or watershed in question. In some cases, biological degradation can be linked to a single stressor; in other situations, multiple stressors are responsible. This conceptual stressor pathway model will be reviewed based on consultation with WVDEP and updated as necessary to capture additional potential sources of concern particular to the watersheds in each TMDL development group.

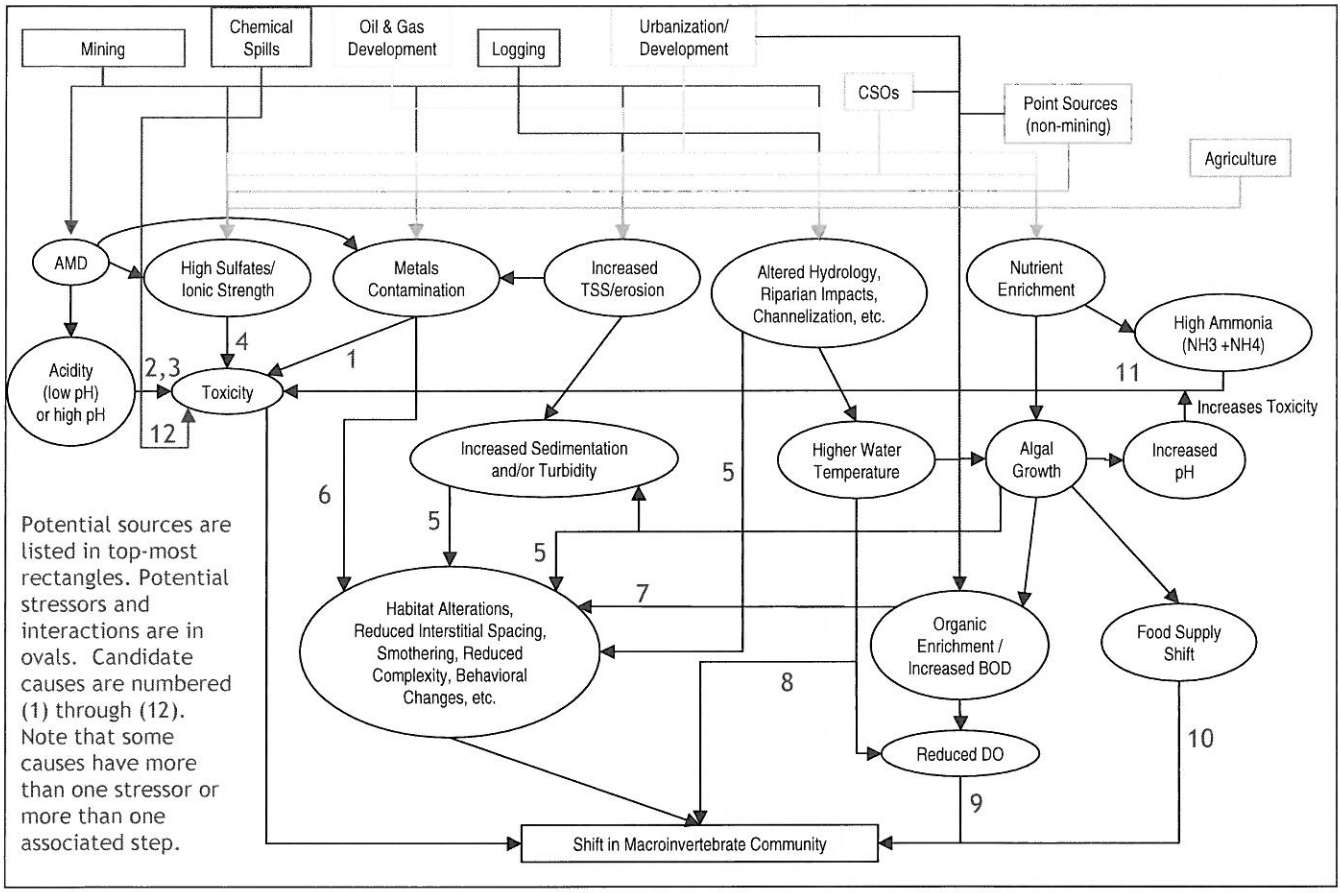

Figure I.B-6. Conceptual model of candidate causes used in Stressor Identification

Tetra Tech will schedule and organize a biological SI meeting with WVDEP to review and discuss the details of the strength of evidence approach. This meeting will enable WVDEP and Tetra Tech to discuss the biological assemblages and for WVDEP to approve or modify the stressor threshold values and conceptual model. The meeting also allows Tetra Tech to have a better understanding of the types of causative stressors that may be responsible for the biological community in particular watersheds.

Customized SI Database

During the preparation and review of analytical data the enormous volume of information can become overwhelming. To assist in the decision making and strength of evidence process of past SI projects, Tetra Tech developed a Microsoft® Access database to house all the data and create summary tables. The database builds from the chemistry, biological data, rapid bioassessment protocol data and sampler comments provided by WVDEP. Subsequent queries format the data and begin to evaluate and normalize the data against water quality criteria and threshold values. Once the data has been normalized using a 1-6

scale for each parameter averages can be calculated by stream and by sampling station. The database has been designed so that it can be included into WVDEP's WABbase and can be modified and expanded to incorporate changes in water quality criteria, updated threshold criteria, or expanded to include additional water quality parameters in the future. Database features include, but are not limited to:

- Quality control to compare the work directive list to the WAB sample data to ensure that sample data and work directive list correspond to each other.
- Summary results for the biologically assessed streams on the work directive list, including other identified impairments.
- A table to record the significant biological each biologically assessed stream as determined by the strength of evidence and best professional judgment from the WVDEP and Tetra Tech biologists during the SI Workshop.

The final SI deliverable consists of the compilation of data review, analysis, summarizing data, organizing a strength-of-evidence approach and the culmination of a best professional judgment decision made in collaboration between WVDEP and Tetra Tech biologists. Tetra Tech will work with the WVDEP to further improve the decision making process.

The SI results will be incorporated into a biological section for each TMDL report and the technical report. The technical documentation includes a detailed technical description of the SI process and the SI results are included as a technical report appendix.

An example of the SI summary database for Hydrologic Group C2 (Middle Ohio River North and South Watersheds) is included in Appendix A, SI Database folder.

I.B.5. Sediment-Metals Relationship

Previous TMDL modeling by Tetra Tech for WVDEP indicates that the relatively high iron content of the soils in the West Virginia watersheds is a significant factor in iron water quality criterion non-attainment. Closely related to clay deposits, iron in soils can become mobilized through precipitation-induced runoff and eventually be delivered to streams. Iron can also become entrained in stream waters via erosion processes that worsen as stream energy (discharge) increases. Therefore, modeled extreme precipitation events or a series of significant storms may result in elevated instream TSS and non-attaining iron concentrations.

Iron loads are delivered to the tributaries with surface runoff, subsurface flows, and direct point sources. Sediment-producing landuses and bank erosion are also sources of iron because iron is associated with sediment. MDAS provides mechanisms for representing all of these various pathways of pollutant delivery. A detailed water quality analysis will be performed using statistically-based load estimates with observed flow and instream monitoring data. The confidence in the calibration process increases with the quantity and quality of the monitoring data.

Iron and TSS concentrations from pre-TMDL monitoring will be used to develop a metals-sediment correlation. Statistical analyses using monitoring data collected in the subject watersheds will be performed to establish the correlation between metals loads and sediment loads and to evaluate spatial variability. The results will be then applied to the sediment-producing landuses during the water quality calibration phase of MDAS. An example result of the correlation analysis is shown in Figure I.B-7.

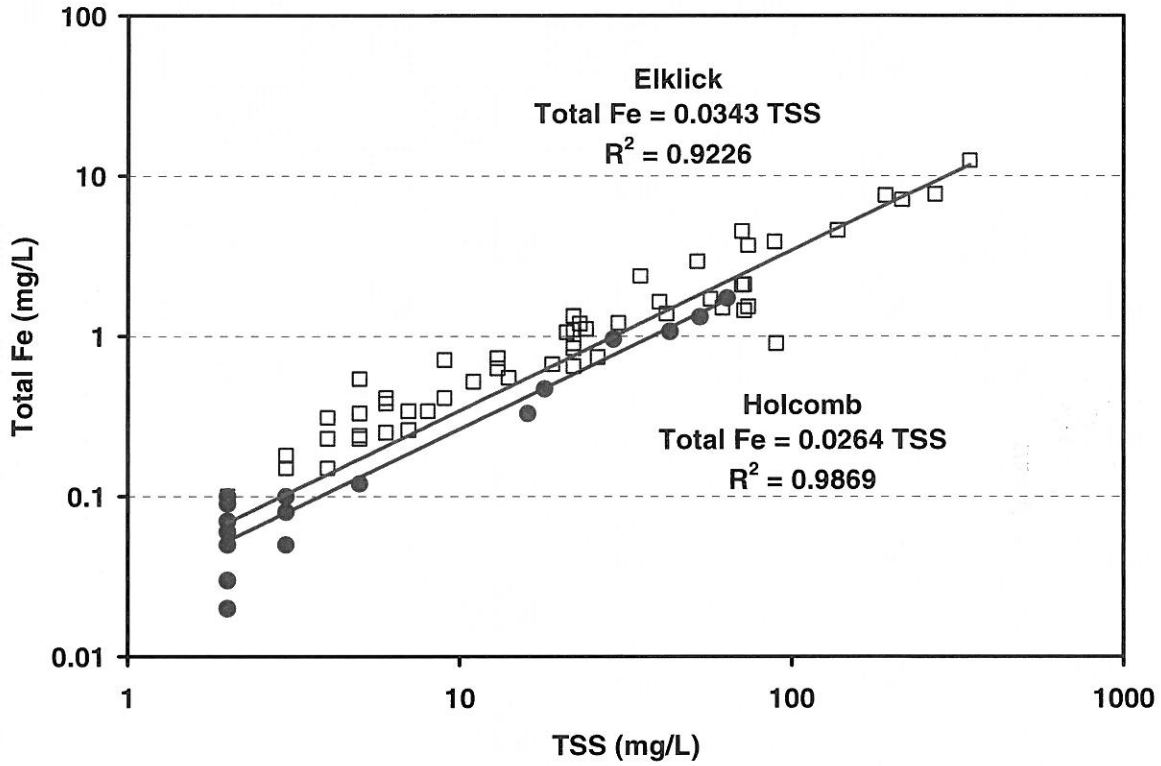

Figure I.B-7. Metals-sediment correlation

Sediment will be simulated based on the mathematical description of the soil detachment process and the sediment transport along the surface slopes. Spatial variation of the soil erodibility will be included in the model using the information retrieved from the soil database. In addition, non-sediment-related iron land-based sources will be modeled using average concentrations for the surface, interflow and groundwater portions of the water budget.

I.B.5.a. Streambank Erosion

The MDAS streambank erosion model is a function of stream flow and bank stability. The bank erosion algorithms of MDAS are based on the scour erosion algorithms of HSPF. The bank erosion rate per unit area is defined as a function of: bank flow volume above a specified threshold, the bank erodible area, the coefficient of scour for the bank soil, and an optional exponent for non-linearity. The streambank soil matrix is assumed to be unlimited, and bank scour is defined uniquely for each stream segment. Each stream segment will have a user-specified flow threshold above which streambank erosion may occur. The bank scouring process is a power function dependent on high-flow events, defined as exceeding the flow threshold. The coefficient of scour for the bank soil can be determined by calibration, where modeled bank erosion sediment loads are compared with loads calculated from the pin study and kber values are adjusted iteratively. Streambank erosion is represented as a unique source independent of other upland-associated erosion sources.

The wetted perimeter and reach length represent ground area covered by water (Figure I.B-8). The erodible wetted perimeter is equal to the difference between the actual wetted perimeter and wetted perimeter during threshold flow conditions. The bank erosion rate per unit area is multiplied by the erodible perimeter and the reach length to obtain the estimate of sediment mass eroded corresponding to

the stream segment. The erodible perimeter changes for each flow value, and accounts for bank area exposed to flowing water (which is available for erosion). The bank erosion flow threshold limits the bank erosion process to instances when that flow is exceeded (extreme events).

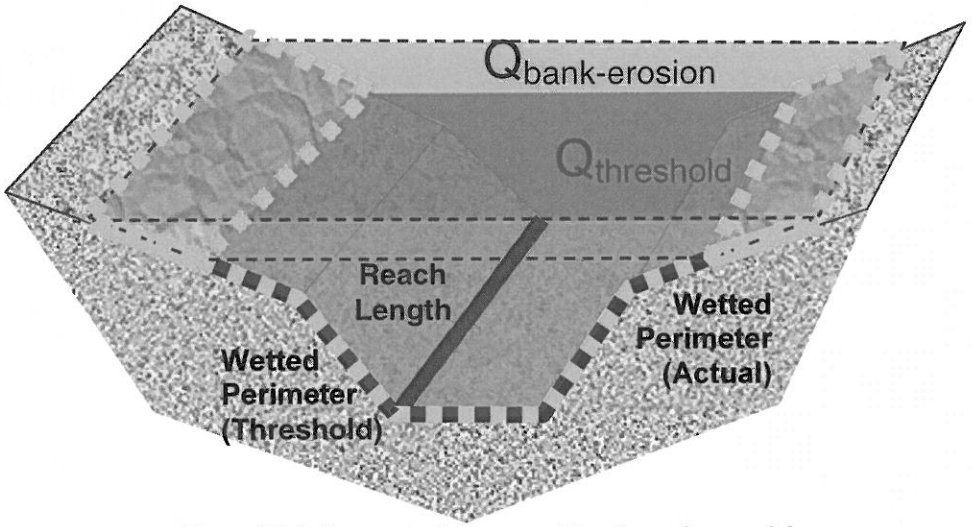

Figure I.B-8. Conceptual diagram of bank erosion model

Tetra Tech will use the results of ongoing WVDEP streambank erosion data collection efforts as described in I.B.1.c.Total Metals and Sediment Model Setup.

The WVDEP erosion pin study will provide Tetra Tech modelers with a quantitative assessment of streambank erosion contributions to stream sediment loads at bank erosion pin sites. The results from representative stream reaches will be used in conjunction with the assessed values of vegetative cover for the analysis of spatial variation in bank stability across the entire watershed. Stream sediment loading rates obtained from bank erosion pin assessments will be used as calibration endpoints for adjusting the MDAS stream bank erosion parameter. The bank erosion parameters will then be applied to the modeled stream reaches for the accurate simulation of streambank sediment loading throughout the watershed.

I.B.6. Allocations

Tetra Tech, with the help and guidance of WVDEP, will develop allocations that meet and exceed required TMDL components. Tetra Tech will simulate baseline loading conditions, define endpoints for the pollutants of concern, establish limits of source loading alternatives, and consider critical conditions in the allocation process. Following WVDEP's direction, Tetra Tech will utilize a strategy that accounts for and accomplishes a realistic prioritization of pollutant sources with allowable deviation after sensitivity analysis of sources and flow conditions. Allocations will be performed to meet pollutant specific water quality criteria, including an explicit margin of safety (MOS) (WVDEP typically assigns a 5% MOS). Allocations will target load reductions for the most significant sources whereby allocations to precipitation-induced sources will not be more stringent than concentrations of equivalent pollutants resulting from background conditions, and allocations to point sources will not be more stringent than numerical water quality criteria. Final allocations will be presented with pollutant sources identified as to whether they are considered load allocations (LAs) or waste load allocations (WLAs).

WVDEP will be asked to provide a general allocation order, which will guide Tetra Tech in making the necessary reductions to meet fecal coliform endpoints in the priority sequence that WVDEP establishes for each watershed. To aid in the development of allocations, Tetra Tech will provide WVDEP with a baseline output viewer tool that it has developed for making rapid comparisons between baseline (un-reduced) and allocated (reduced) model scenarios. An example of an output viewer tool is included in Appendix A.

I.B.6.a Fecal Coliform Allocations

The fecal coliform TMDL endpoint will be based on the instantaneous acute water quality criterion where not more than 10 percent of all samples taken in a given month can exceed 400 counts/100mL and the chronic 30-day geometric mean of 200 counts/100mL, minus an explicit margin of safety. The approach to allocations to fecal coliform bacteria sources will start with a universal 100% reduction to untreated human sewage sources (failing septics). Using the watershed approach (headwaters will be analyzed first, with pollutant loads transferred to downstream watersheds), Tetra Tech will reduce land-based fecal sources following WVDEPs allocation strategy to meet the TMDL endpoint. Loads from CSOs will be reduced in a manner consistent with the waste water treatment system's Long Term Control Plan. Loads from MS4 communities will be identified in allocation tables and summarized by municipal jurisdiction. Tetra Tech will provide WVDEP with a filterable spreadsheet with modeled unit area loading results by subwatershed and landuse.

I.B.6.b Metals Allocations (Including Metals-Related Sediment Allocations)

The total iron TMDL endpoint for warm-water streams will be based on the chronic 4-day average of 1.5 mg/L minus an explicit margin of safety (MOS) (WVDEP typically assigns a 5% MOS). The endpoint for trout streams will be derived in the same manner, but using the chronic 4-day average of 1.0 mg/L. If, under the most stringent and unachievable allocation scenarios, modeling output does not ensure troutwater criterion attainment, Tetra Tech will work closely with WVDEP to propose phased implementation of the TMDLs under which the source allocations necessary to universally achieve an interim iron water quality target. The approach to allocations for total recoverable metals sources will be guided by WVDEP's allocation order. Tetra Tech will make necessary reductions to meet metals endpoints in the priority sequence that WVDEP establishes for each watershed. Using the watershed approach, Tetra Tech will reduce metals sources (including sediment-related metals sources) using WVDEP's allocation strategy to meet the TMDL endpoints. Given the established total iron/sediment relationship described in Section I.B.5, total iron TMDLs will serve as a surrogate for biologically impaired streams where sedimentation is determined as a stressor. Tetra Tech will verify that sediment loadings resulting from total iron TMDLs are equal or more protective than a traditional sediment TMDL using the reference watershed approach. Tetra Tech will assist WVDEP in the selection of the reference watershed when presented with a list of potential streams.

After completion of the initial allocation run, Tetra Tech will submit preliminary results, and ask WVDEP to review and directs changes. Tetra Tech will update the allocations according to WVDEP's input. Finally, allocation databases will be prepared with model output from baseline and allocation conditions. These databases will have queries that automatically prepare and format TMDL related allocation tables.

The resulting allocations will be presented on a CD as filterable spreadsheets that identify pollutant-specific and subwatershed-specific baseline and TMDL loadings for individual point sources and categories of point sources.

I.B.6.c pH and Dissolved Metals Allocations

For watersheds impaired by dissolved aluminum, sources of total iron will be reduced first because existing instream total iron concentrations can significantly reduce pH and consequently increase dissolved aluminum concentrations. If the dissolved aluminum TMDL endpoint is not attained after source reductions to iron, the total aluminum source loadings will be reduced based on the methodology described above. The MDAS output will be compared directly with the TMDL endpoint. If predicted dissolved aluminum concentrations exceed the TMDL endpoint, the total aluminum sources represented in MDAS will be reduced. For subwatersheds with acidic atmospheric deposition sources and low watershed buffering capacity and no AML sources, acidity load reductions will be prescribed (via alkalinity addition) to the extent necessary to attain pH criteria at the subwatershed outlet. For subwatersheds with historical mining sources present, the predicted acid loads from atmospheric deposition will be first offset by alkalinity addition then the total aluminum loading from AMLs will be reduced to the extent necessary to attain dissolved aluminum water quality criteria.

For subwatersheds with active mining sources and AML present, the aluminum loadings from AML sources will be reduced until compliance with criteria will be attained, or to the maximum practical extent. If further reductions will be necessary or in subwatersheds with active mining point sources and no AML, the point source loadings will be reduced until criteria will be attained. All sources will be represented and provided allocations in terms of the total aluminum loadings that are necessary to attain the dissolved aluminum water quality criteria. WLAs will be developed for active mining point sources in dissolved aluminum impaired waters.

I.C. TMDL Report Development

I.C.1. Report Outline

For each TMDL watershed, Tetra Tech will develop a comprehensive TMDL report package that provides technical information sufficient to meet or exceed federal regulatory (40 CFR 130) requirements and USEPA Region III guidance for TMDL approval. The report package will list impaired streams, identify pollutant sources, and enumerate the pollutant reductions needed to achieve state water quality criteria for each of the impaired segments. Reports will also be designed to be useful resources for TMDL implementation efforts by responsible agencies and programs. The TMDL report package will consist of a general report with appendices, a technical report with appendices, and an interactive ArcGIS project that displays TMDL results in a spatial format. Report appendices will be in standard file formats such as Microsoft® Excel spreadsheets and Adobe PDF files that do not require special hardware or software to view. The entire report package will be presented in digital form on a CD-ROM. This format allows for cost-effective distribution of the report to state agency personnel, stakeholders, and the concerned public. This format also allows for easy uploading to the WVDEP website. Example TMDL packages are provided in Appendix C.

Tetra Tech has produced 16 sets of TMDL reports for the WVDEP over the past 11 years. Through multiple drafts of each TMDL report, a report format has evolved that successfully meets both client expectations and USEPA regulatory requirements. Report structure and contents of the public report, technical report, and interactive ArcGIS project are discussed in detail below.

The general report will consist of a main section, allocation Microsoft® Excel spreadsheet appendices and a supporting ArcGIS project. The main section will describe the overall TMDL development process for the TMDL watershed, identify impaired streams, and outline the source assessment of pollutants and biological stressors. It will also describe the modeling process and TMDL allocations. The general report will list measures that will be taken to ensure that the TMDLs are met. The TMDL report will also include spreadsheets that provide detailed source allocations and reductions associated with successful TMDL scenarios. The contents of the general report will consist of information organized into sections shown below. Report design will be flexible to accommodate the impairments found in each TMDL watershed. Relevant sections describing impairment-specific TMDLs will be added or deleted as necessary.

The technical report will describe in detail the methodology Tetra Tech uses to develop TMDLs. Information in the technical report will satisfy all USEPA regulatory requirements for review, thus leading to final TMDL approval. Emphasis will be placed on providing a thorough explanation of MDAS watershed model setup, calibration, and post-allocation output. Biological TMDL development and the SI process will also be described.

The technical report will also have appendices that provide supplementary graphs and spreadsheets that document the methodology described in the technical report. Appendices to the technical report will be provided as needed to describe relevant watershed features and document model development. The number of appendices per technical report is expected to be approximately eleven, based on the appendices needed for previously completed West Virginia TMDLs. Past technical report appendices have included the following information:

- Modeled landuse tables for fecal coliform and metals
- Failing septic analysis
- TSS/Metals correlation spreadsheet

- Harvested and burned forest areas
- Modeled road descriptions
- NPDES permit descriptions
- Model water quality and hydrology calibration results
- Water quality data (chemical and biological)
- Storm water permitting and MS4 discussion
- SI summary information
- 303(d) list impairments no longer effective

The interactive GIS application will be in an ArcGIS project format. The ArcGIS project will allow the user to view spatial data in detail, magnify features of interest, and identify attributes of individual features. This project will be included on the report CD-ROM.

The spatial data featured in the ArcGIS project will be organized as in Table I.C-1. Topographic maps and stream coverages will orient users, and help them find impaired streams and TMDL watersheds. Features such as AML highwalls and bond forfeiture sites will show pollutant sources. Tetra Tech is currently moving toward an online ArcGIS TMDL tool that will allow the user to view and utilize TMDL information more easily than the ArcGIS on CD-ROM format. Files will also be accessible for users to download to their own personal computers and ArcGIS-compatible software, if desired.

Table I.C-1. Example of Interactive GIS Project Shapefiles

Watershed Coverages	▪ Pre-TMDL Monitoring Sites ▪ MDAS modeled subwatersheds ▪ Impaired Streams ▪ Streams ▪ NLCD 2006 Landuse ▪ USGS 100K Topographic Map
Metals TMDL Coverages	▪ Bond Forfeiture Sites ▪ AML Discharges ▪ AML Areas ▪ AML Highwalls ▪ Valley Fill Areas ▪ Mining NPDES Outlets
Fecal TMDL Coverages	▪ Fecal POTW Discharges ▪ Agricultural Intensity ▪ Agricultural Runoff Potential ▪ MS4 Areas
Sediment TMDL Coverages	▪ Oil and Gas Wells ▪ Marcellus Shale Wells ▪ Logging Operations ▪ Burned Forest

I.C.2. Preliminary Draft TMDL Report

Tetra Tech has worked closely with WVDEP TMDL staff for over 10 years to edit TMDL reports to client specifications. After modeling all impaired streams in the TMDL watershed, Tetra Tech will generate a preliminary draft TMDL report. This report will be submitted to WVDEP in digital format on CD-ROM, or via a restricted-access Internet ftp site. The preliminary draft report will consist of a

complete report outline with supporting text and appendices, minus any report text of regulatory nature that is the responsibility of WVDEP.

Tetra Tech will receive WVDEP comments on the preliminary draft report during the period of time between the report submittal and the final draft deliverable due date. Excellent communication between Tetra Tech and WVDEP has increased efficiency in the report editing process. Tetra Tech's local presence in Charleston, WV allows Tetra Tech technical staff to work face-to-face with the WVDEP client to execute last-minute document edits when necessary. Tetra Tech will make WVDEP edits and prepare a draft final report to be distributed for public comment.

I.D. Status Report and Other Meetings

In addition to providing bi-monthly progress reports, Tetra Tech will hold project status meetings on a monthly basis, either in-person at WVDEP headquarters, or via conference call. When complex issues arise, Tetra Tech has found that the fastest route to resolution entails visiting WVDEP's offices for an in person meeting. Meeting face to face provides both parties with an opportunity to review pertinent data and facilitates discussion. For the same reasons, project deliverables will be handed over in person. Tetra Tech will contact the WVDEP staff member(s) responsible for reviewing the deliverable to set up a meeting, during which the deliverable will be presented and discussed. This will facilitate WVDEP's review of the deliverables and keep the project running on schedule.

With each TMDL project, Tetra Tech makes staff available to tour the project watershed. Not only do the tours provide the modelers with intimate knowledge of the physical characteristics of the watershed and pollutant sources, it also provides an opportunity to identify new sources or those that need further investigation.

I.E. Public Participation Meetings

Tetra Tech will assist WVDEP with coordinating and facilitating public meetings to explain TMDL development. Tetra Tech will be available to participate in these meetings at any time and any location necessary during the TMDL process. The meetings will be designed to broaden the public's and stakeholders' understanding of the TMDL development process. Tetra Tech will prepare visual aids such as slides and customized ArcView projects for the presentations, when needed. Personnel who are intimately involved with the various aspects of TMDL development will be available to explain model components, model development, source characterization, data development, model results for both baseline and TMDL conditions and the impacts of various potential allocation scenarios. Tetra Tech has an extraordinary amount of experience in presenting our work in a public forum. Tetra Tech's presence and understanding of the concerns related to TMDL development from both a regulatory and affected party perspective will help facilitate interaction between stakeholders and WVDEP.

Tetra Tech will also be available for public meetings to discuss draft TMDL results at any time and any location necessary, providing the same services and support required for the stakeholder input meetings described above. Personnel who are intimately involved with TMDL development will be available to provide detailed information regarding the substantive components of the TMDL and to take comments from concerned stakeholders. Tetra Tech will work with WVDEP in order to provide meetings that are informative and will facilitate stakeholder involvement. Prior experience in such meetings gives Tetra Tech an understanding of the types of comments and questions that will be posed at meetings concerning draft TMDL documents and enables them to help orient stakeholders and facilitate comments on the draft TMDL.

Tetra Tech will also provide support to WVDEP during the public review and comment period by answering any technical questions posed by stakeholders and addressing any revisions to the draft TMDL as a result of stakeholder input. Policy questions or issues will be addressed by WVDEP and included in the documents once provided in electronic format to Tetra Tech.

I.F. Response to Public Comment

I.F.1. Address Comments

Tetra Tech will receive and address individual public comments on the draft final report. Public comments will be incorporated into the final document. Tetra Tech is experienced in addressing comments from a wide spectrum of West Virginia stakeholders, from industry to local watershed groups. Tetra Tech is fully prepared to defend its technical approach and TMDL results to any watershed stakeholder. Tetra Tech will prepare a responsiveness summary that will address stakeholder questions, and point to changes in the document that resulted from those questions. Tetra Tech will also provide detailed explanations to those comments that did not lead to revisions to the TMDL report. Questions or comments pertaining to state policy will be addressed by WVDEP and provided to Tetra Tech in electronic format to be included in the TMDL document response summary.

I.F.2. Final Draft TMDL Report

Upon conclusion of the editing process, Tetra Tech will submit a final TMDL report suitable for USEPA review and TMDL approval. This final report will incorporate all comments from watershed stakeholders, plus any additional comments from WVDEP. The report will be submitted in digital format on CDROM. Submittal date will be determined by the project timetable.

I.F.3. TMDL Records Retention

Tetra Tech will provide a complete administrative record for each TMDL watershed on CD-ROM to WVDEP and the USEPA upon receipt of the USEPA's final approval letter and decision rational documentation. Tetra Tech will archive all files pertaining to TMDL development and retain them for a minimum of five years. Files will be stored electronically and will be available upon request within 10 days of receiving such a request from WVDEP.

I.F.4. Schedule

Tetra Tech recognizes the need for a detailed schedule due to the relatively short timeframe in which the TMDLs are to be developed. Tetra Tech will work closely with WVDEP at the beginning of the TMDL process to develop a timeline and deliverable schedule for the steps outlined in Sections I.A,I.B, and I.C that will lead to a valid, defensible TMDL that can be approved in a timely manner. Tetra Tech has extensive experience developing TMDLs within a very short period of time and has developed a methodology for achieving that efficiently. The TMDL process is primarily a series of steps that build upon each other, leading to interim deliverables. This process begins with the review of the work directive and ends with the issuance of final reports. Although the TMDL process is primarily cumulative in nature, throughout the process there are a number of side steps that can be worked on while interim deliverables are being reviewed. Tetra Tech technical personnel will be available to meet with WVDEP as they review and provide comment on all interim deliverables. This provides for a constant flow of work throughout the contract period and maximizes efficiency throughout the review process.

An important aspect of the schedule is the review and QA/QC of datasets as they are introduced into the process. Tetra Tech recognizes that it will be working with statewide datasets, which, due to their large size, are bound to contain inconsistencies and random error. Because the TMDL development process is cumulative in nature, any errors that are not immediately identified will be propagated to each successive step in the process. Given the technical complexity and the timeframe within which these TMDLs are to be developed, having to go back and correct errors, no matter how minor, could result in future deadlines

not being met. Therefore, Tetra Tech will spend the time necessary to assist WVDEP in identifying and correcting any errors in its datasets as TMDL development proceeds in order that the final product is delivered on time.

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II. Management and Resources

As requested in the Expression of Interest (EOI), this section discusses Tetra Tech's management capabilities and available resources to support this project. Specifically, this section presents information on the following:

- **Organization**—discusses Tetra Tech's history and background, including services, size and office locations.
- **Resources**—describes hardware, software and other resources available to support this project.
- **Personnel**—presents the experience and qualifications of the proposed Tetra Tech team.
- **Project Management**—describes Tetra Tech's approach to project management.

II.A. Organization

Tetra Tech, Inc.

Founded in 1966, Tetra Tech, Inc. is a leading provider of specialized environmental management consulting and technical services. We develop innovative, successful, and cost-effective solutions to complex environmental problems for public and private clients. Tetra Tech's success is a result of several factors, starting with technical skills in a wide range of disciplines and including a commitment to open, honest communication about project performance with clients, which fosters partnerships that enable us to meet fast-track schedules and stay within budget. Tetra Tech's vision for growth and diversification to meet clients' needs has been another key to our success. As environmental policies and regulations have changed the ways our clients do business, Tetra Tech has hired national experts and acquired firms that are knowledgeable in those areas and has put their skills to work. The result is that today, as a publicly owned company, we have 350 offices with over 14,000 employees worldwide. More important than our size, however, is that Tetra Tech is rated consistently by the industry as one of the most financially stable, top-quality environmental engineering firms. This year marked the ***ninth*** consecutive year in which Tetra Tech was ranked 1st in the top U.S. water firms by *Engineering News-Record*. Tetra Tech also was ranked #1 in Water Supply/Treatment, Solid Waste, Environmental Management, and Wind Energy. In addition, *Engineering News-Record* ranked Tetra Tech #4 in their "The Top 200 Environmental Firms" and #8 overall in their "The Top 500 Design Firms" issues.

Key Environmental Services of Tetra Tech's Water Resource Center

- TMDL Development
- Watershed Management
- Physical, Chemical and Biological Monitoring
- Stormwater Assessment and Management
- Watershed Modeling
- Hydrodynamic and Water Quality Modeling
- Environmental Tool and Systems Development

Tetra Tech was originally founded to provide engineering services related to waterways, harbors and coastal areas. Our reputation as a national leader in the water resources arena was forged through our early coastal water quality efforts and was solidified in the early 1980s when we established the Water Resources Center and were awarded the first in a series of national watershed assessment and management contracts with the USEPA Office of Water. For over 20 years the Water Resources Center has been USEPA's prime contractor in support of their watershed and water quality programs, as demonstrated through our continuous service as USEPA's national contractor through more than eight contract re-competes. In fact, we have never lost a contract with USEPA in which we were the incumbent contractor—a direct indicator of the consistent high quality of our products and our ability to identify and implement evolving technologies and trends. In addition to our national role in developing watershed and water quality management tools and practices, the Water Resources Center has been asked by other federal agencies (e.g., U.S. Army Corps of Engineers [USACE]), more than 40 states, and numerous local and municipal agencies to provide technical assistance in designing and implementing watershed and water quality related programs and plans for their waters. In response to these requests, the Water Resources Center has grown from a core staff of 40 professionals in 1992 to more than 250 professional scientists and engineers in 2013. These staff are located in offices across the United States, but all report to central management in the Center's headquarters in Fairfax, Virginia. Our growth and office diversification has been a direct result of the increased requests for our services and demonstrates our ability to adapt to our clients' needs. For example, the Center opened our Charleston, West Virginia, office in July 2002 to provide local support to WVDEP in the development of TMDLs. Since then, Tetra Tech management and technical staff have contributed to more than $7 million worth of work for WVDEP, resulting in more than 2,500 completed TMDLs in addition to nearly 800 ongoing TMDLs.

Our Charleston, West Virginia office will be the primary office for this project and will be supported by staff in our Fairfax, Virginia; Owings Mills, Maryland; Cleveland, Ohio; and San Diego, California offices, as necessary. Table II-A-1 summarizes the office locations expected to support this project and the associated number of employees. Resources and equipment available to support this project are described in the following section (II.B. Resources).

Table II-A-1. Tetra Tech Offices

Office Location	Number of Employees
Charleston, West Virginia	8
Fairfax, Virginia (excluding offices listed in this table)	152
Owings Mills, Maryland	32
Atlanta, Georgia	21
Research Triangle Park, North Carolina	15
San Diego, California	14
Cleveland, Ohio	10

II.B. Resources

This section provides information on the support services and equipment capabilities for the offices proposed to support this project.

The Fairfax, Virginia office has five contract administrators dedicated to tracking the financial status of contracts and ensuring Tetra Tech meets all contractual requirements. Activities of the contracts management staff include accessing and distributing weekly financial reports to the Tetra Tech Project Manager, issuing subcontractor agreements, tracking and administering subcontracts, and generating and submitting progress reports and invoices. We also have several administrative support staff who perform a variety of administrative duties, such as answering phones, arranging conference calls and package delivery, processing expense reports and invoices, and photocopying.

Tetra Tech has several accounts with overnight delivery services to ensure timely delivery of important products. We have accounts with Federal Express, United Parcel Service and DHL.

Tetra Tech maintains an account with Verizon services for our teleconferencing and web conferencing needs. Teleconferencing and web conferencing for an unlimited number of attendees can be arranged immediately using Microsoft® LiveMeeting.

Tetra Tech maintains state-of-the-art computing facilities, equipment, and software (Tables II-B-1 through II-B-7) to support our clients' needs for project management, information management, data and geospatial analysis, database management, mathematical modeling, literature searches, Internet access, file maintenance and storage, document production, and graphics generation.

Tetra Tech's printing and reproduction resources are listed in Table II-B-1. Tetra Tech also has extensive document and graphics production capabilities. For example, our Fairfax, VA office maintains a fully equipped publications and graphics department with six full time staff, skilled in both PC and Macintosh systems. Our desktop publishing and graphics specialists consistently produce high-quality environmental reports, brochures, posters, handbooks, documents, and multimedia products. Tetra Tech's publications and graphics department has the capability to generate multicolor or black-and-white maps, graphs, presentation charts, viewgraphs, 35mm slides, 36-inch-wide color posters, and other audiovisual materials using a wide range of type styles and page formats. We have expertise in developing and maintaining Internet-ready documents and functional, database-driven web sites for USEPA and other federal agencies. We are capable of producing layout, coding, scripting, graphics, production/editing, database setup, and output reports for the Internet.

Tetra Tech's computer hardware and systems capabilities are also listed in Table II-B-1. Tetra Tech uses electronic communication systems to facilitate data transmission, e-mail, and Internet access. We maintain intra-office and Internet connectivity and an Internet Server that hosts a File Transfer Protocol (FTP) site and a World Wide Web (WWW) site. Tetra Tech maintains full 24-channel T1 direct access to the Internet for rapid and reliable external electronic communications in all of its offices, including the Charleston, WV location.

Software applications used by Tetra Tech for statistical, database and web development are listed in Table II-B-2, for computer programming are listed in Table II-B-3, for GIS development and data processing are listed in Table II-B-4 and for environmental modeling are listed in Table II-B-5.

Our GIS resources include fully equipped GIS and computer-aided design (CAD) laboratories. Desktop GIS is widely used by our scientists and engineers on a daily basis to support our projects. More intensive

GIS processing is achieved using ESRI's ArcGIS Desktop Standard, Basic and Advanced Version 10, customized MapObjects applications, and dedicated systems. Tetra Tech programmers are currently developing ArcGIS Server web-based GIS projects to make interactive TMDL maps available to stakeholders and the general public. Tetra Tech also uses a variety of database platforms and software tools. Our broad information technology expertise includes proficiency in Oracle and Microsoft SQLServer, MS Access databases; operating systems such as VMware, Linux and Windows; and programming languages C++, Visual Basic, Java, .NET, ArcView Avenue, and Arc/Info AML. Tetra Tech also utilizes virtual server operating systems and cloud computing using VMware Esx Server.

Other support functions include Tetra Tech's accounts with numerous online information services, including GIS data repositories, and personnel with familiarity and experience searching a wide variety of databases, including USEPA's STORET and U.S. Geological Survey (USGS) National Water Information System (NWIS). We also have easy access to a host of major national libraries, including USGS, U.S. Department of Agriculture (USDA), USEPA, National Oceanic and Atmospheric Administration (NOAA), and a large number of academic and public libraries. Tetra Tech also can connect directly to the mainframe at USEPA's National Computer Center in Research Triangle Park, NC, with desktop access provided through a cluster controller. Tetra Tech has extensive experience using the expansive processing and storage resources available at USEPA's computer center. Furthermore, Tetra Tech has direct access to WVDEP's ERIS database through a virtual private network connection from their Charleston, WV office, enabling Tetra Tech to verify any questionable permit information in real time.

Table II-B-2. Desktop Access Data Processing Hardware

Equipment	Quantity
High Capacity Network Server	27
IBM-Compatible PC	275
Macintosh PC (Power Mac, etc.)	1
Notebook/Laptop IBM-Compatible PC	112
Windows 2003/2008 Internet Server with FTP and Web Site support	12
Linux Internet Server with FTP and Web Site Support support	15
Hewlett-Packard DesignJet 5000 Color Plotter (60" wide)	1
Hewlett-Packard 8000N, 8100N	2
Xerox ColorCube Printers / Copiers	2
Xerox WorkCenter Printer / Copiers	3

Table II-B-3. Statistical, Database, and Web Development Software Packages

Database Software	Statistical Software	Web Development Software
▪ Oracle /10i/11g ▪ MySQL ▪ Postgres ▪ MSSQL Server/Enterprise 2005/2008/2012 ▪ Microsoft Office 2003/2007/2010 ▪ Microsoft Project 2003/2007/2010 ▪ Microsoft Visio 2008/2010 ▪ Microsoft Visual Studio 2008/2010/2012 ▪ MS Visual Studio Ultimate 2010 ▪ MS Office One Note 2007 ▪ MS SharePoint	▪ Statistica 6.1	▪ Dreamweaver MX 2004 ▪ Macromedia Studio MX ▪ Lotus Domino Lotus Notes ▪ Microsoft Front Page ▪ Fireworks ▪ Flash ▪ Photoshop ▪ Jdeveloper ▪ Drupal

Table II-B-4. Programming Language Compilers

Compilers		
▪ Compaq Visual Fortran 6.6 ▪ Intel Visual Fortran Compiler ▪ Sun Java Studio ▪ Digital Visual FORTRAN	▪ Pascal 7.0, DOS and Windows ▪ Visual C++ 5.0, 6.0 ▪ Visual Studio v6.0 ▪ Visual Studio 2010, 2012 ▪ Borland C++ 4.5 ▪ Visual Basic 5.0	▪ Visual Source Café ▪ SPARC Works C++ ▪ Visual KAP Parallel Computing ▪ Borland JBuilder 2.0, 3.0

Table II-B-5. GIS Development and Data Processing Hardware and Software

Equipment	Quantity
IBM-Compatible Workstation/Laptop	285
40TB Mass Storage	4
Overland Tape Drive LTO-4 20TB	1
CD/DVD Writers	2
ESRI ArcGIS Desktop Advanced 10.2	8
ESRI ArcGIS Desktop Standard 10.2	10
ESRI ArcGIS Desktop Basic 10.2	26
ESRI ArcGIS 3D Analyst	1
ESRI Spatial Analyst 10	16
ArcGIS for Server Enterprise 10	2

Table II-B-6. Environmental Computer Models and Systems used by Tetra Tech

Model Category	Model Name
Ecological	IFIM, HEP
Watershed Runoff	HSPF, NPSM, LSPC, MDAS, SWMM, HEC-1, TR-20, PSURM, WSTT, GWLF, AGNPS, P8, SWAT
Thermal Fate	EFDC, TRANQUAL, HSPF, DISPER, ELA
River Hydraulics	HEC-2, HEC-RAS, WSPRO, FESWMS-2DH, DAMBREAK, DWOPER, UNET
Hydrodynamics	EFDC, CAFE, TEA, CE-QUAL-W2, TABS-2, FESWMS-2DH, DYNHYD5, MIT-DNM, RMA
Discharge Plume	CORMIX, USEPA Plume Models
Mixing Zone	CORMIX, EFDC, TEA/ELA, CAFE/DISPER
Eutrophication	QUAL2E, WASP, CE-QUAL-W2, CE-QUAL-RIV1, RIVHW, EFDC, BATHTUB, LAKE2K
Toxic Fate	TOX15, SMPTOX, RIVRISK, AMMTOX, TOXCALC
Sediment Transport and Scour	TABS-2, STUDH, HEC-6, QUASED, HEC-RAS, EFDC
Ground Water	MODFLOW, MOC, PLASM, Random Walk, GLEAMS

II.C. Personnel

Tetra Tech will administer the proposed contract from the Charleston, WV office of Tetra Tech's TMDL and Water Resources Center. Figure II-C-1 shows the proposed program management organization. It features a core management team of dedicated senior managers who have clearly defined management roles to ensure timely, high-quality, cost-effective performance under the contract. In addition, it shows the staffing plan of key Technical Leads, who will guide support staff in the completion of each aspect of the TMDL development.

Our Project Manager, Mindy Ramsey, and key Technical Leads will be located in the Charleston, WV office, and other management staff (Program and Deputy Program Manager, and Deputy Project Managers) will be located in our Fairfax, VA, office. For more than 10 years, the Charleston office has worked on West Virginia TMDL projects, fostering close working relationships with key WVDEP personnel. As demonstrated during this time, we can draw upon our extensive technical expertise and resources from offices throughout the country (Fairfax, VA; Owings Mills, MD; Atlanta, GA; Research Triangle Park, NC; San Diego, CA; and Cleveland, OH) to support the WVDEP TMDL program seamlessly and in an efficient, cost-effective manner. Over 40 staff have contributed to the innovative technical approaches and designs for more than 3,300 West Virginia TMDLs that have been completed or are currently under development through WVDEP contracts. The Project Manager will have the authority to allocate and commit these additional staff to the WVDEP TMDL projects.

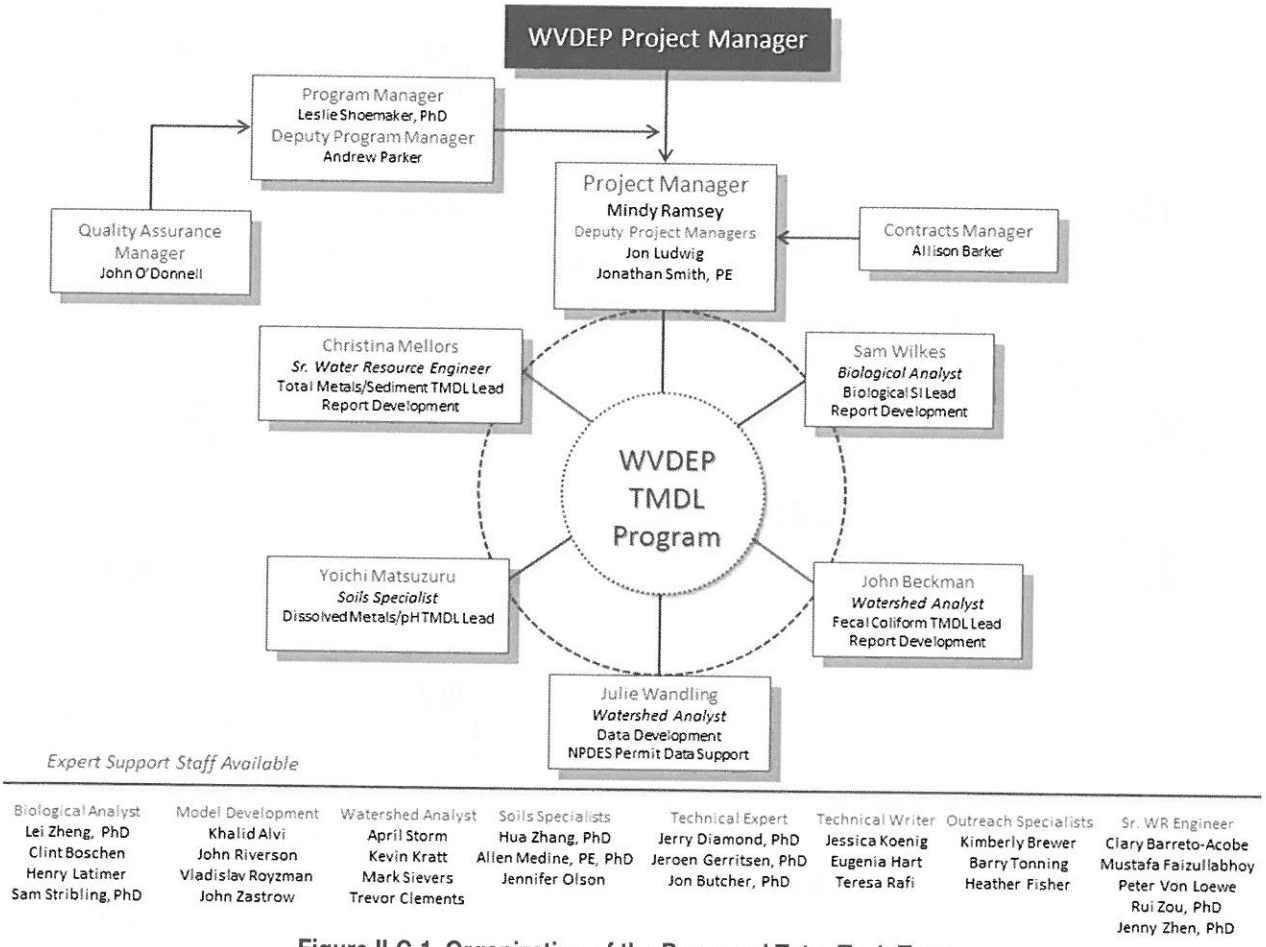


Figure II-C-1. Organization of the Proposed Tetra Tech Team

Core Management Team

Brief descriptions of the roles and qualifications of each member of the Core Management Team follow.

Leslie Shoemaker, Program Manager

Dr. Shoemaker will provide contractual oversight for the WVDEP contract, ensure that adequate staff and resources are dedicated, and provide technical review and direction to maintain quality and consistency of performance. As a Vice President with Tetra Tech, Dr. Shoemaker has the authority to dedicate resources as needed to this contract and identify work teams for performance of specific projects. Dr. Shoemaker has worked for Tetra Tech for over 20 years, continuously supporting the TMDL program, watershed assessment and management, point and nonpoint source analysis, and model development and application. Since 1997, she has been integral to the Tetra Tech support of the West Virginia TMDL program. She served as the project manager for many of the first ever TMDLs for pathogens, metals, nutrients in West Virginia; more recently she served as the Program Manager, providing management and technical oversight for the four previous West Virginia TMDL contracts.

Jon Ludwig, Deputy Project Manager

For 10 years, Mr. Ludwig successfully managed five large WVDEP TMDL contracts ($7M) that contain very aggressive project schedules that progress simultaneously, leading to timely, high-quality, and cost-effective performance. His leadership and energy have produced highly technical and innovative solutions that have helped WVDEP's TMDL Program become a national leader in TMDL development and have resulted in over 2,500 USEPA approved TMDLs. Mr. Ludwig has over 15 years of experience providing technical and management in all areas of water resources and TMDL development and has collaborated closely with WVDEP's TMDL Program Manager for over 13 years, developing practical solutions for complex programmatic TMDL issues. Mr. Ludwig will oversee the Project Manager and provide leadership through programmatic and technical guidance to ensure WVDEP's TMDL Program continues as the national leader in TMDL development.

Mindy Ramsey, Project Manager

Ms. Ramsey is the Director of Tetra Tech's Charleston, WV office and will provide the local day-to-day point of contact to WVDEP and will work closely with the WVDEP Project Manager to maintain clear, focused direction of the project. She will work closely with the Deputy Project Managers, particularly Mr. Jon Ludwig, to staff projects and maintain communication between all parties. She has supported biological TMDL development, document revision, and allocations for the C2 watershed group, and is currently leading the D2, E2, and A3 watershed group TMDL development efforts.

Allison Barker, Contract Administrator

Ms. Barker will report to the Program Manager and will be responsible for financial reports, contract administration, and cost control. She has served as the Contract Administrator for the five previous WVDEP TMDL contracts (Purchase Order No. DEP12147, DEP13860, DEP15231 DEP15530 and DEP15990) and has done so since the project's inception. Ms. Barker is the Contracts Group Manager and a senior contract administrator in Tetra Tech's Fairfax office. She has been extensively involved in negotiating and managing all levels and types of federal and private sector contracts and subcontracts.

John Beckman, Fecal Coliform Bacteria TMDL Lead

Mr. Beckman will provide leadership for all tasks associated with bacteria TMDLs under this contract, coordinating technical tasks closely with the Project Manager. He is a watershed analyst with over 16 years of experience specializing in TMDL development, water quality modeling, data management, GIS analysis, technical writing, and field investigations. Mr. Beckman has worked closely with WVDEP TMDL staff over the last 8 years developing and refining technical approaches for WV Fecal Coliform

Bacteria TMDLs, including characterizing and developing model inputs for failing septic systems, agricultural sources, and various MS4 and CSO communities.

Yoichi Matsuzuru, Dissolved Metals/pH TMDL Lead
Mr. Matsuzuru will lead all tasks associated with Dissolved Metals/pH TMDLs under this contract and will work closely with the Project Manager and Deputy Project Managers to provide technical solutions for dissolved metals/acidity issues that may occur. He will also work closely with Ms. Christina Mellors developing and refining technical approaches with the total metals/sediment TMDLs. Mr. Matsuzuru has extensive experience in constructing watershed water quality models, and is a specialist in developing mathematical models to characterize pollutant transport and chemical reactions. He has led development of chemical reactive transport model codes, as well as the acid rain module in the Mining Data Analysis System (MDAS). He has been extensively involved in TMDL technical development activities throughout the U.S. Most recently, Mr. Matsuzuru has led the development of aluminum and pH TMDLs for selected streams in the Monongahela River Watershed and West Fork River Watershed. He will continue to support model development which will be applied to streams impacted by pH and dissolved metals.

Christina Mellors, Total Metals/Sediment TMDL Lead
Ms. Mellors will lead all tasks associated with Total Metals/Sediment TMDLs under this contract, coordinating closely with the Project Manager and Mr. Yoichi Matsuzuru to continue to evolve the technical representation of the total metals and sediment in MDAS model. Over the past 10 years, she has led total metals/sediment related TMDL projects in WV, working closely WVDEP staff to develop highly detailed technical approaches for representation of mining permits and sediment sources in the MDAS model. She served as the technical lead for the total metals/sediment TMDLs in the Gauley River watershed, which was WVDEP's initial pilot project for representing the dynamic linkage of total iron and sediment in the MDAS model. Ms. Mellors is a Senior Water Resources Engineer and has contributed technically to virtually all of the WV TMDL projects that Tetra Tech has completed since 2002.

John O'Donnell, Quality Assurance Manager
Mr. O'Donnell will report directly to Tetra Tech's Program Manager and will be responsible for all QA activities for the contract, including the implementation and maintenance of the Quality Assurance Project Plan (QAPP). He is Quality Assurance Manager for the Fairfax, VA group offices, serving as Quality Assurance Officer for contracts in the Fairfax office and for Tetra Tech's Biological Research Facility. He has developed office-wide quality assurance program and quality systems and tools to meet quality assurance requirements of diverse contracts in the Fairfax Group offices.

Andrew Parker, Deputy Program Manager
Mr. Parker will support Mr. Ludwig and Ms. Ramsey in assigning staff, monitoring individual task orders, and representing Tetra Tech in selected technical matters. Mr. Parker, working from our Fairfax, VA office, will coordinate closely with Mr. Ludwig, Ms. Ramsey and WVDEP Project Manager to ensure that projects are meeting all technical and scheduled objectives. Mr. Parker is a senior environmental engineer with more than 17 years of experience providing technical and management support to federal, state, regional, municipal, and private clients in the areas of watershed and receiving water modeling, watershed and water quality assessment, water resource planning, and TMDL development.

Jonathan Smith, PE, Deputy Project Manager
Mr. Smith will support Mr. Ludwig and Ms. Ramsey in assigning staff, monitoring individual task orders, and representing Tetra Tech in selected technical matters. He has 17 years of experience in water resources engineering, specializing in stormwater management. Mr. Smith is a professional engineer licensed in West Virginia, as well as a Certified Professional in Stormwater Quality, a Certified

Professional in Erosion and Sedimentation Control, and a LEED-Accredited Professional. He is an expert in stormwater management with the ability to plan, manage, and implement stormwater-related projects for municipal and private clients. As a project manager, Mr. Smith has extensive experience in supplying clients with project deliverables and supervising technical staff. He has completed design and construction oversight for more than 20 stormwater BMPs, including stormwater wetlands, bioretention areas, green roofs, pervious pavement practices, innovative wet ponds, level spreaders, media filters, and a number of water quality retrofits of existing BMPs.

Julie Wandling, Data Development & NPDES Permit Support

Ms. Wandling will lead all data development tasks under this contract and will coordinate and communicate with the Project Manager, the various TMDL leads, and WVDEP staff to develop the most recent and accurate watershed data necessary to construct the TMDL models. Working for WVDEP's Wasteload Allocation program for over 8 years, she has extensive experience with the intricacies of the various NPDEP permits and WVDEP's permit database (ERIS). Over the past four years, she has utilized this valuable experience assisting WVDEP TMDL staff to streamline the permit data retrieval process and facilitate efficient data transfer to Tetra Tech. Ms. Wandling is a watershed analyst with a breadth of knowledge and experience in TMDLs, NPDES permitting, antidegradation implementation, and low flow estimating statistics.

Sam Wilkes, Biological Stressor Identification Lead

Mr. Wilkes will lead all tasks associated with Biological Stressor Identification development under this contract. He will coordinate and communicate with the Project Manager and WVDEP biologists for all biological analyses, such as stressor identification, threshold value development, statistical model development, QA/QC, data management, biological workshop, training modules, and presentations for WVDEP staff. Mr. Wilkes has led WV TMDL biological stressor identification efforts in the past nine TMDL Groups; and by doing so has established significant working relationships with WVDEP biologists over the past 10 years. Mr. Wilkes is a biological analyst and has coordinated additional stressor identification, threshold, and statistical model development with Dr. Jeroen Gerritsen and Dr. Lei Zheng.

Other Key Staff

Table II-C-1 summarizes the qualifications of the key staff identified for supporting this project. This table includes all the required fields identified in the EOI (i.e., titles, education, and work experience). Relevant experience in total recoverable metals, dissolved metals and acidity, bacteria, sediment, and biological TMDLs and associated skills is identified for each of the selected staff. The selected staff have been assigned within the following professional categories:

- Contract Adminstrator
- Program Manager
- Project Manager
- Quality Assurance/Quality Control Manager
- Biological Analyst
- Model Developer
- Watershed Analyst
- Soils Specialist
- Technical Expert
- Technical Writer
- Outreach Specialist
- Senior Water Resource Engineer

The Technical Experts who are identified provide specialized skills in toxicology, modeling, database management, or statistics. Direct experience with TMDL work in West Virginia is indicated in the table by a circle (●). More than 40 of the proposed staff have TMDL related experience in West Virginia and the majority of staff members identified have at least 5 years of experience working on TMDL projects.

> ***Through these highly qualified and dedicated staff members we bring to WVDEP the continuity and quality of support they need to meet the challenges of the upcoming TMDL schedules.***

Focused resumes for the proposed staff are also provided in Appendix B of the proposal.

Table II-C-1. Summary of Experience and Skills of Proposed Staff

Staff	Proposed Role	Highest Degree	Total Years Experience	TMDL Development				Watershed Assessment			Modeling & Data Management					Stressor Identification			Training & Outreach		Regulatory Guidance		
				Total Recoverable Metals TMDLs	Dissolved Metals/pH TMDLs	Bacteria TMDLs	Sediment TMDLs	Pollutant Source Tracking	Biological Assessment	Water Quality Sampling & Analysis	Data Development & GIS	Watershed/Water Quality Modeling	In-stream/Dissolved Metals Modeling	Model System Development	Sediment/Metals Relationship (Fe/TSS)	Conceptual Model Design	Biological Diagnostic/Statistical Modeling	Biological Index/Metric Development	Training/Technology Transfer	Public Outreach	QAPP Development	Water Quality Standards/UAA	Permitting
Leslie Shoemaker	Program Manager	PhD	28	●	●	●	●	●	●	●	●	●	●	●					●	●	●	●	●
Jon Ludwig	Deputy Project Manager	MS	15	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Mindy Ramsey	Project Manager	MS	12					●	●	●	●						●			●		●	
John Beckman	Watershed Analyst	MEM	16		●	●	●	●	□	□	●	●	●		●		●		□	●	□		
Christina Mellors	Senior WR Engineer	MS	17	●		●	●				●	●	●	●	●	●			□	●			□
Andrew Parker	Deputy Program Manager	ME	17	●	●	●	●	□		□	●	●	●	●			□		●	●	●	●	□
Jonathan Smith, PE	Deputy Project Manager	BS	18					□		□	□	□		□		□			□	□			□
Julie Wandling	Watershed Analyst	BS	14	●	●	●	●	●		●	●	●							●	●		●	●
Sam Wilkes	Biological Analyst	MS	17			●	●	●	●	●	●	●		●		●	●		●	●			
Yoichi Matsuzuru	Soils Specialist	MEM	15	●	●	●				●	●	●	●	●		●			□			●	
Hua Zhang	Soils Specialist	PhD	12	●	●	□	●	●	□	●	●	●	●	●	●	●	●	□	□				
Khalid Alvi	Model Development	MS	13	●	●	●	●	□	□	□	□	□	□	□		□							
Allison Barker	Contracts Manager	JD	15	●	●	●	●																
Clary Barreto-Acobe, PE	Senior WR Engineer	MS	11	●	●	●	●				●	●	●	●	●	□			□		□		●
Clint Boschen	Biological Analyst	MS	18		□	●	●	●	●	●	●	●		●		●	●	□	□	□	□	□	□
Kimberly Brewer	Outreach Specialist	MRP	29																	●		●	●

Staff	Proposed Role	Highest Degree	Total Years Experience	TMDL Development				Watershed Assessment			Modeling & Data Management					Stressor Identification			Training & Outreach		Regulatory Guidance		
				Total Recoverable Metals TMDLs	Dissolved Metals/pH TMDLs	Bacteria TMDLs	Sediment TMDLs	Pollutant Source Tracking	Biological Assessment	Water Quality Sampling & Analysis	Data Development & GIS	Watershed/Water Quality Modeling	In-stream/Dissolved Metals Modeling	Model System Development	Sediment/Metals Relationship (Fe/TSS)	Conceptual Model Design	Biological Diagnostic/Statistical Modeling	Biological Index/Metric Development	Training/Technology Transfer	Public Outreach	QAPP Development	Water Quality Standards/UAA	Permitting
Jonathan Butcher, PH	Technical Expert	PhD	27	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐
Trevor Clements	Watershed Analyst	MEM	30			☐	☐	☐		☐		☐				☐			●	☐		☐	☐
Jerry Diamond	Technical Expert	PhD	30						●	●						☐	☐	☐			☐	☐	☐
Mustafa Faizullabhoy, PE	Senior WR Engineer	MS	14	☐	☐	☐	☐				●	●	●	☐		☐							
Heather Fisher	Outreach Specialist	MEM	12			☐	☐		☐		☐	☐							☐	☐			
Jeroen Gerritsen	Technical Expert	PhD	33						●		●					●	●	●	●		☐	☐	
Eugenia Hart	Technical Writer	MS	13	●		●	☐				●	●							☐				
Jessica Koenig	Technical Writer	BA	17			●	☐	☐	☐	☐	●	●	●						☐	☐	☐	☐	
Kevin Kratt	Watershed Analyst	MEM	18	☐	☐	☐	☐	☐	☐	☐	☐	☐				☐			☐	☐		☐	☐
Henry Latimer	Biological Analyst	MS	16	☐	☐			☐	☐	☐						☐					☐	☐	☐
Allen Medine, PE	Soils Specialist	PhD	35	☐	☐			●	☐	☐	●	●	●	●	●		☐		☐	☐	☐	☐	☐
John O'Donnell	Quality Assurance Manager	BS	30							●											●		
Jennifer Olson	Soils Specialist	MS	16			☐	☐	☐	☐	☐	☐	☐							☐	☐			☐
Teresa Rafi	Technical Writer	MA	17	●		●	●			●	●	●							☐	☐			☐
John Riverson	Model Development	MS	14	●		☐					●			●		●							
Vladislav Royzman	Model Development	BS	14			☐					☐	☐		☐									☐

Staff	Proposed Role	Highest Degree	Total Years Experience	TMDL Development				Watershed Assessment			Modeling & Data Management					Stressor Identification			Training & Outreach		Regulatory Guidance		
				Total Recoverable Metals TMDLs	Dissolved Metals/pH TMDLs	Bacteria TMDLs	Sediment TMDLs	Pollutant Source Tracking	Biological Assessment	Water Quality Sampling & Analysis	Data Development & GIS	Watershed/Water Quality Modeling	In-stream/Dissolved Metals Modeling	Model System Development	Sediment/Metals Relationship (Fe/TSS)	Conceptual Model Design	Biological Diagnostic/Statistical Modeling	Biological Index/Metric Development	Training/Technology Transfer	Public Outreach	QAPP Development	Water Quality Standards/UAA	Permitting
Mark Sievers	Watershed Analyst	MS	14	□	□	□	□	●		□	●	□		□					□		□		
April Storm	Watershed Analyst	BS	8					□	□	□	●	□								●			
James Stribling	Biological Analyst	PhD	28						□	□	□					□	□	□	□	□	□		
Barry Tonning	Outreach Specialist	MA	31					□	□	□									●	●	□	●	●
Peter von Loewe	Senior WR Engineer	MS	15	□	□	□				□	□	□	□	□					□		□		
John Zastrow	Model Development	MS	16								□			□					□				
Jenny Zhen	Senior WR Engineer	PhD	12				●			□	●	●		●									
Lei Zheng	Biological Analyst	PhD	15						□	□	□		●				●	●					
Rui Zou	Senior WR Engineer	PhD	20		□	□	□				□	□		□							□		

● Experience in West Virginia □ General experience

II.D. Project Management

Supporting WVDEP's TMDL development efforts over more than 10 years, Tetra Tech has successfully met aggressive project schedules while staying within project budgets. The scope and magnitude of the TMDL program requires WVDEP to set very aggressive project schedules that progress simultaneously. It is critical that these schedules are maintained because new projects begin each year, incrementally increasing the workload as the TMDL program cycles through the five hydrologic groups. This success is not only due to the exceptional performance of key technical staff, but is also the product of strong leadership provided by our core management team. The stability and continuity of our management team has led to timely, high-quality, and cost-effective performance under this contract. Tetra Tech will maintain this successful management structure ensuring a smooth transition to into the proposed contract. Our Program Manager, Dr. Leslie Shoemaker, will continue to provide corporate visibility and national leadership in water resources. Technical oversight will be provided by Deputy Program Manager, Mr. Andrew Parker and Deputy Project Managers Mr. Jon Ludwig and Mr. Jonathan Smith, PE. Moreover Mr. Ludwig will provide guidance and technical expertise to Project Manager, Ms. Mindy Ramsey, to share knowledge of lessons learned over his vast experience, while continuing to work with WVDEP's Program Manager to solve complex programmatic and technical issues to continually improve WVDEP's TMDL Program. Further details regarding our comprehensive management plan is discussed in Section II.D.2

II.D.1. Unique Capabilities offered by the Tetra Tech Team

Tetra Tech would like to highlight four of the unique capabilities we offer WVDEP in meeting the requirements of the TMDL program:

- Experience in managing contracts of similar size and scope
- Breadth of technical skills needed in addressing all facets of the TMDL program
- Ability to mobilize resources to meet quick response requirements and manage large projects
- Experience with similar highly technical projects (project symbiosis)

Many firms have had experience in development of single TMDL projects, but Tetra Tech has direct experience from the past four WV TMDL contracts and with several other contracts similar to this WVDEP solicitation in size and scope (e.g., USEPA, Georgia Environmental Protection Division (EPD), and City of San Diego, CA). To address the challenge of meeting the WVDEP TMDL deadlines, the selected firm must be able to address multiple projects concurrently while maintaining schedules and cost controls. The selected firm will need to have the capacity and trained staff to meet this challenge successfully. Over the past 10 years, Tetra Tech has successfully demonstrated the ability to meet these challenges by maintaining overall schedules and budgets while simultaneously managing up to **nine** large TMDL projects across multiple Hydrologic Groups. Other Tetra Tech clients include USEPA Regions 1, 3, 4, 5, 6, 8, 9, 10, and City of San Diego, CA,. Some examples of contracts of similar size and scope that Tetra Tech is currently managing include:

- USEPA Region 1 TMDL Development ($850,000)
- USEPA Region 3 TMDL Development ($8.5 million)
- USEPA Region 4 TMDL Development and Watershed Model ($1.9 million)
- USEPA Region 5 TMDL Support contract ($2.6 million)
- USEPA Region 9 TMDL Support contract ($7.1 million)
- USEPA Region 8 TMDL Support contract ($3.1 million)
- USEPA Region 10 TMDL Development Support ($3.3 million)

- Georgia EPD ($4.5million)
- City of San Diego, CA ($2.1 million)

The experience gained from managing these past and current contracts will be used to ensure that we have staff qualified to provide support across all of the technical service areas and to provide WVDEP with effective mechanisms for project tracking and management. In addition, WVDEP will have easy access to the very latest technical tools and information developed under these contracts. Tetra Tech believes that every client's needs should be addressed on a project-by-project basis. This individual attention to clients and our production of the highest quality technical work are demonstrated by our continued ability to successfully compete on contracts that are follow-on to work initially done by Tetra Tech.

Summary of Related Skills to Support TMDL Development

Table II-D-1 summarizes the key aspects of the Tetra Tech team's unique qualifications and abilities that will enable us to successfully and effectively meet WVDEP's TMDL and watershed management objectives.

Table II-D-1. Summary of Tetra Tech's Qualifications and Experience

Service Offered	Meeting the Objectives of WVDEP
Public Outreach	▪ Numerous staff trained and dedicated to ensuring that the public and stakeholders have a role in watershed and water quality studies (including TMDLs) ▪ Wrote the popular guide *Getting in Step: A Guide to Effective Outreach in Your Watershed* ▪ Tetra Tech's in-house conference planning department regularly plans and coordinates seminars and conferences for technology transfer purposes. ▪ Experience in TMDL public meetings and training in WV ▪ Technical staff routinely present or facilitate meetings to discuss technical approaches, issues, results, and other options
Water Quality Assessment	▪ Current staff have developed, conducted, and maintained numerous monitoring networks for state and local agencies across the nation ▪ Staff have developed and taught numerous courses on monitoring and data analysis and interpretation methods
Watershed Modeling	▪ Over 70 qualified staff available to support watershed modeling using all public domain models ▪ Staff include developers of numerous watershed models (GWLF, LSPC) and project-specific model interfaces ▪ Staff have provided training in watershed modeling in all 10 USEPA Regions and numerous states ▪ Current staff authored USEPA's *Compendium of Models for TMDL Development* ▪ Proposed staff involved in the design, development, and maintenance/update of USEPA's BASINS and the next generation modeling toolbox
Water Quality Modeling	▪ Over 50 qualified staff available to support water quality modeling for all waterbody types ▪ Staff includes the developers of LSPC/MDAS and EFDC ▪ Staff have developed materials and provided training in water quality modeling principles and application ▪ Developed a toolbox of watershed and water quality models for USEPA Region 4
Watershed Management Measures	▪ Staff have developed and maintain a library (and database) of BMP efficiencies ▪ Staff also include experts in treatment technologies and their efficiencies ▪ Staff includes national experts in permit writing

Service Offered	Meeting the Objectives of WVDEP
GIS	▪ National leader in the development of GIS-based systems and model interfaces ▪ Tetra Tech staff designed and developed systems including BASINS, Watershed Characterization System (WCS), MDAS, and others ▪ All staff fluent in the use of ArcGIS ▪ Staff are familiar with all WV and regional/national data layers
Monitoring Support	▪ Nationally recognized experts in bioassessment and nutrient criteria monitoring plan development ▪ Tetra Tech staff developed the Rapid Bioassessment Protocols ▪ Numerous staff with extensive field monitoring experience for all pollutant and waterbody types ▪ All staff support QAPP development and development of SOPs ▪
Other skills and capabilities we offer that are relevant to scope of work	
Water Quality Standards Evaluations/Toxicity Testing	▪ All staff have a comprehensive understanding of water quality standards ▪ All Tetra Tech staff conduct an impairment confirmation analysis prior to initiating TMDL development–this is part of the Tetra Tech SOP for TMDL development ▪ Tetra Tech staff are nationally-recognized experts on toxicity testing and analysis, including support for the development site-specific criteria ▪ Tetra Tech staff have developed a Use Attainability Analyses (UAA) and guidance
Maintenance of an Administrative Record	▪ Tetra Tech staff develop and maintain an administrative record for all TMDL and NEPA projects ▪ Tetra Tech has developed internal SOPs for the content and format of all administrative record documents
Depth of Staff	▪ Tetra Tech Team has over 100 staff with relevant experience available to support WVDEP ▪ More than 100 additional staff can be made available if needed to support WVDEP ▪ Tetra Tech has unmatched staff depth across all task areas
Permit Support - Permit Writing and Training	▪ Tetra Tech has nationally-recognized experts in Permit Writing and in teaching USEPA's Permit Writer's Course ▪ Tetra Tech staff are currently writing permits for several states, including Alaska, California, and Arizona
System Development	▪ Tetra Tech staff are developing numerous modeling and GIS systems to support state and local TMDL and watershed management programs ▪ Tetra Tech employs more than 25 full-time programmers and database administrators to support our water resources division–this allows our engineers and scientists to focus on conceptual design and testing

Ability to Mobilize Resources and Manage Large Technical Projects

The following examples of recent and current projects are provided to demonstrate how Tetra Tech mobilizes technical personnel to provide federal and state program support.

Support for Chesapeake Bay TMDL Development

Tetra Tech has provided a wide range of technical and managerial support to USEPA Region 3 and the Chesapeake Bay Program Office (CBPO) related to TMDL development efforts for the Chesapeake Bay. Tetra Tech has participated in steering committee and technical team meetings to address critical elements throughout the TMDL development process and has fulfilled numerous tasks related to research, data gathering, statistical analysis, reporting, public outreach, and information technology needs. One of Tetra Tech's key roles has been to lead documentation of the TMDL. To meet this need, Tetra Tech has

prepared the overall report outline, written sections of the report, edited technical sections written by CBPO staff, and completed a number of white papers addressing key considerations.

Tetra Tech has supported the development of Watershed Implementation Plans (WIPs) for the states and the District of Columbia as well as configuration of a TMDL Tracking and Accountability System (TAS). WIP support has been provided directly to each state for state-wide WIPs as well as local, higher resolution WIPs, with the objective being to identify measures and milestones to comply with TMDL allocations.

Over the past 4 years, Tetra Tech has supported WVDEP with various WIP activities including detailed analyses of model output, development of a model output viewer tool, development of management scenarios to evaluate using the model, confirmation of nonpoint and point source representation in the CBPO model, and stakeholder meeting support. Tetra Tech has also participated in planning discussions with WVDEP to determine how stormwater retrofit and offset strategies can be applied to meet the nutrient load reductions prescribed by the Chesapeake Bay TMDL. Currently, Tetra Tech is developing the West Virginia BMP and Land-use Tracking System which allows for BMP tracking (including mobile capabilities) and reporting to BayTAS using the National Environmental Information Exchange Network (NEIEN). This system will provide an online framework for WVDEP to track and monitor post construction stormwater best management practices (BMPs) and land use changes. In addition, the system will allow the West Virginia Department of Agriculture to store and track non-cost share agricultural BMP data.

Manganese Permitting Analysis for Coal River Watershed, WV

Tetra Tech supported WVDEP in the development of metals TMDL development for the Coal River watershed. During the course of TMDL development, USEPA approved a revision to the West Virginia Water Quality Standards that altered the zone of applicability of the manganese water quality criterion for the public water supply designated use. The criterion is now applicable only in the five-mile zone upstream of known public or private water supply intakes used for human consumption. The revision resulted many request letters from coal companies to "back-slide" their current manganese effluent limits to technology-based limits. At the request of WVDEP, Tetra Tech conducted a comprehensive analysis to determine the cumulative effect of this backsliding at various downstream locations in the Coal River watershed where the revised manganese criterion is applicable.

Using the calibrated watershed model that was constructed for TMDL development (MDAS), Tetra Tech ran alternate scenarios to provide solutions and guidance as to which areas of the Coal River watershed could sustain manganese technology-based effluent limits while maintaining compliance with water quality criteria in the effective zones. Results were summarized into graphical displays in an easy to use format so that WVDEP DMR permit writers can address the above mentioned request letters and issue/re-issue permits quickly and efficiently. ***This project was completed simultaneously with TMDL development without additional funding.***

Los Angeles County Regional Model Development

For all coastal watersheds of Los Angeles County, Tetra Tech supported the Los Angeles County Department of Public Works (LACDPW) in the development of a comprehensive watershed management decision support system to assist in water quality improvement planning. This system is based on previously developed HSPF/LSPC models developed by USEPA and the Ventura County Watershed Protection Division to support previous TMDL development and watershed planning efforts, with expanded capability added to address LACDPW planning needs. The system provides:

- Dynamic simulation of watershed hydrology and transport of multiple pollutants
- Evaluation of storm size and return frequencies for identification of management targets

- Dynamic simulation of BMP processes, including both distributed LID and centralized facilities
- Optimization of the most cost-effective combination and designs of BMPs to meet management objectives and achieve water quality improvement
- Load reduction quantification to support TMDL implementation efforts
- Cost estimates for County-wide water quality improvement planning

To achieve these goals, Tetra Tech linked the watershed models to dynamic, process-based BMP models and locally derived BMP cost functions that have evolved through several piloting and testing efforts of SCCWRP, City of Los Angeles, Dr. Bowman Cutter (formerly at UC Riverside), and LACDPW. USEPA Region 9 provided a match to LACDPW's investment in development of the tools, promoting buy-in from regulators. USEPA Region 9 supports the development of such tools that can be used to support TMDL implementation efforts, and has worked collaboratively with LACDPW to include the use of these tools for MS4 permit implementation. Currently, Tetra Tech is utilizing this modeling system to support several MS4 co-permittees to prioritize and optimize BMP implementation efforts.

NPDES Permit Support

Tetra Tech is currently working on a wide range of projects that support various states in permit data collection (including site visits), reasonable potential analysis (RPA) preparation, draft permit development, public comment response, and administrative tasks associated with final permit adoption. Tetra Tech staff have played lead roles in developing key USEPA guidance that affect watershed- and water quality-based decision making, including the *Technical Support Document for Water Quality-Based Toxics Control,* the *Guidance for Water Quality-based Decisions: The TMDL Process,* and the *Watershed-Based NPDES Permitting Implementation Guidance*. Tetra Tech has also served as USEPA's contractor administering and delivering the NPDES Permit Writers Training Course.

Project Symbiosis

Over the past several years, Tetra Tech has supported several highly technical TMDL and watershed management projects similar to those in West Virginia. This provides symbiotic benefits, as technical approaches and tools that are developed for one project, are shared among our other high-end projects to benefit one another. This is possible because several key Tetra Tech staff are involved in these state-of-the-art projects, and there is continuous communication between the project managers of these high-end projects. Lessons learned from one project can, and indeed are, applied to other projects to make them more technically defensible. Two key projects that have benefited West Virginia's TMDL development are the Lake Tahoe and Milwaukee TMDLs, which are described below.

Watershed Management in the Lake Tahoe Basin

Tetra Tech has supported numerous agencies over the past 9 years in developing a watershed modeling framework to support management of the Lake Tahoe Basin and TMDL development to address declining clarity in the lake. The project resulted in a calibrated watershed model, representing source loading at the landuse level and also spatially around the Lake Tahoe basin, to support contributing watershed BMP implementation and dynamic linkage to the Lake Clarity Model. Its design readily enables allocation and TMDL implementation through BMP placement and optimization techniques. Tetra Tech has also supported the Nevada Division of Environmental Protection and Lahontan Regional Water Quality Control Board in fine-tuning the Lake Tahoe Watershed Model and conducting preliminary allocation simulations to support TMDL development. Fine-tuning of the existing model included revision of runoff concentrations by landuse and incorporation of new streambank erosion estimates. Tetra Tech also performed an analysis of imperviousness data that resulted in a series of informative maps indicating pervious percentages by land capability class within major watersheds and intervening zones, by hydrologic transfer area, and by Lake Tahoe Watershed Model subwatersheds.

Tetra Tech has supported a landmark long-range watershed-based planning effort for the MMSD. One purpose of the planning effort is to identify improvements needed for MMSD wastewater treatment facilities to accommodate growth and protect water quality through the year 2020. Tetra Tech has worked with the Modeling Team to build a comprehensive modeling system with linked sewer system models, watershed models, and a nearshore/harbor lake model. The models are now being used by planners to evaluate the potential water quality benefits of a range of implementation measures, such as sewer separation, additional CSO and SSO controls, and both traditional and innovative (e.g., low impact development) BMPs. Tetra Tech also developed a Water Quality Index to distill the vast amount of modeling output into information that can be more easily digested by decision makers. This allows the various planning alternatives to be ranked and prioritized. Tetra Tech also created a Web-accessible Model Viewer to make model output more accessible and functional. The Viewer allows users to evaluate modeling output at various points in the watershed and for different pollutants and scenarios. The Viewer ensures that all planners have access to the same information in the same format so that they can make the most informed decisions.

II.D.2. Project Management Plan

Tetra Tech's proposed project organization and management approach to support WVDEP in the service areas presented in the EOI are based on the development of clearly defined staff roles to ensure timely, high-quality, and cost-effective performance under the contract. The roles of the key personnel presented in section II.C of this proposal include the Program Manager, Project Manager, Deputy Project Managers, QA Manager, and individual leads for technical areas. This Core Management Team will maintain overall responsibility for the day-to-day activities of our technical staff, whose skills and availability greatly exceed that necessary to support WVDEP. The relevant experience and skills of each of the key personnel are outlined in Section II.C and resumes for all staff are included in Appendix B. This section outlines our approach to project organization and management, including:

- Use of Subcontractors
- Cost Control
- Schedule Control
- Project Tracking

II.D.3. Use of Subcontractors

Tetra Tech is proud of the outstanding business relationships we have formed with companies that have a proven ability to provide timely and excellent technical support to our projects. However, because we have staff with expertise in all of the technical service areas, we do not anticipate the need to use subcontractor support under this contract.

Should the need arise to secure the support of other qualified subcontractors, either to provide quick response support or to provide a unique expertise, we will not hesitate to enlist their services. Successful standard procedures are in place to facilitate identification and management of the subcontractors.

II.D.4. Cost Control

Financial control will be ensured by means of Tetra Tech's formalized and computerized management information system, which provides the Tetra Tech Program Manager, Project Manager, Deputy Project Managers, and Technical Leads with up-to-date (weekly) fiscal information for the project. A principal advantage of this system is that it enables managers to obtain financial data quickly and in sufficient

detail for proper decision making. The system is designed to provide both the client and Tetra Tech management with full visibility on the current status and progress of each work item. It identifies potential problem areas before they can jeopardize the success of the project by causing work delays or cost overruns. Weekly charges to each task are provided to the Tetra Tech Program Manager, Project Manager, and Deputy Project Managers. These weekly (Tetra Tech internal) computer printouts include the names and number of hours of staff charging to the contract, computer usage, subcontractors' charges, and purchase commitments.

II.D.5. Schedule Control

Time and schedule control can be a problem as a result of changing priorities that might result from a lack of information, new information, or changes in monitoring activities. Conflicts between workload requests by different programs might also cause some difficulty in scheduling. In the past, these problems have been worked out by contract officers and Tetra Tech by coordinating planning activities. By remaining flexible and maintaining frequent communication with client management and technical staff, we have been able to accommodate changes, substitutions, and reasonable new requests. Tetra Tech has identified staff with availability that exceeds that expected under this contract, ensuring that we can accommodate potential workload surges or new priority efforts. Although Tetra Tech has the benefit of the largest TMDL staff in the country and can therefore adjust to variable workloads and schedule constraints, adherence to the planning process results in a more uniform level of effort and allows better performance.

Scheduling of work is important to all projects. Project schedules are developed by the Tetra Tech Project Manager, Deputy Project Managers, and Technical Leads to define the pathways necessary to meet each project's key milestones and deliverables. These schedules include charts to identify project milestones and delivery dates. This information is shared with the members of the project team to make them aware of when their input is needed by other members of the team. The Tetra Tech Project Manager and Deputy Project Managers hold biweekly conference calls, and require at a minimum monthly reports from Technical Leads. Regular reporting identifying existing and potential problems, and allows for early initiation of corrective actions.

II.D.6. Project Tracking

Tetra Tech has set up a contract management system that performs the necessary financial and performance tracking, and develops progress reports. This contract management system is used for all Tetra Tech contracts of similar size, type, and scope. The system is equally suited to both small and large task order contracts of all types. Tetra Tech has adapted its tracking and reporting systems to meet the needs of the two previous WVDEP TMDL contracts, and intends to maintain, and where appropriate adapt, its tracking and reporting systems to meet the needs of this WVDEP TMDL Support Contract.

Tetra Tech will conform to the EOI reporting requirements through the efforts of dedicated contract management support staff in Fairfax whose job descriptions include fulfilling the tracking and reporting requirements of the contract. These personnel are a contract specialist, Allison Barker, who will report to the Deputy Project Manager, Jon Ludwig, and Project Manager, Mindy Ramsey on all matters regarding contract administration. The job performance ratings of the contract specialists are tied directly to Tetra Tech's contract management performance under the contract. The dedicated contract management staff will conduct the following activities to ensure strict conformance with the West Virginia contract requirements:

- Operate and maintain a computerized (Microsoft® Excel-based) internal tracking system. This system is linked to Tetra Tech's corporate contract accounting system (CODA) to allow weekly inputs of direct labor, other direct costs (ODC), and subcontractor charges, as well as all indirect costs. Reports generated from the inputs are distributed to the Project Manager and Deputy Project Manager on Wednesday following the Sunday close of week. This allows each Project Manager to know, on a real-time basis, how much each staff member is working on each project and track progress toward meeting project milestones.
- Maintain an internal project status tracking system (Microsoft® Excel-based) that tracks, for each project, period of performance, WVDEP Project Manager, and Project Manager, applicable telephone numbers, dollar and LOE amount of original project assignment and each amendment, date received from WVDEP, work plan due date and actual date submitted to WVDEP, date of receipt of approval by WVDEP, and comment column for any unusual conditions or problems.
- In conjunction with the Tetra Tech Program Manager and Project Manager, issue formal letters to designated Tetra Tech or subcontractor Project Managers and request a complete work plan, cost estimates, and schedule and reporting requirements.
- Maintain a filing system for all incoming documentation (work plans, completion reports, monthly reports, technical reports) and all correspondence.
- Prepare a detailed work plan and budget (by task) to guide the execution and assess the technical progress of each task.

Tetra Tech is flexible in reporting formats and procedures and will be happy to discuss any modifications that may be desired.

Difficulties and Resolution

In supporting a large contract we are always prepared to address administrative and technical difficulties. In our current and past contracts, we have successfully anticipated potential difficulties and prevented them during initial planning phases. The experienced Technical Leads assigned from the Project Team will address potential problems in the work plan; if problems arise once the work has begun, they will be addressed immediately. Difficulties and their resolution will be brought to the immediate attention of the Tetra Tech Program Manager and Project Manager and WVDEP Project Manager.

Difficulties encountered and steps taken to solve them will be an important subject of the bi-monthly progress reports to WVDEP, as well as the monthly periodic review meetings and telephone discussions with the WVDEP Project Manager. If any modification of the work schedule is required, WVDEP will be involved as soon as the need is recognized.

Frequent communication will occur among the WVDEP Project Manager and the Tetra Tech Deputy Project Manager, Project Manager and Technical Leads. With these contacts, and by comparing progress on a project against milestones described in the work plan, the Project Manager will become aware, at an early stage, of any difficulties that might require corrective action. Corrective action could include:

- Discussions with the WVDEP Project Manager to negotiate modification in scope, schedule, or deliverables.
- Securing additional commitments of staff time to devote to the assignment.
- Retaining outside consultants to review problems in specialized technical areas.
- Restricting expenditures in any task area.
- Making adjustments in staff.

The Tetra Tech Program Manager or Project Manager may exercise the authority to replace a Technical Lead or staff member if it is in the best interest of the project. Such action will be taken only with the explicit approval of the WVDEP Project Manager. Because Tetra Tech offers in-depth experience and skills, an equally qualified staff replacement can be found for almost any professional involved in a work assignment. Tetra Tech has gained a great deal of experience in addressing the limited number of difficulties that have arisen during past TMDL contracts. Solutions have been developed for most of the difficulties that might be expected under this contract. Specific difficulties that have needed attention and their resolution are described below.

Estimating Required Level of Effort

It is often difficult to estimate the level of effort required to complete a task because all of the information to be collected or reviewed is not available at the time estimates are required. Whenever possible, a preliminary review of available data and data quality will be made to provide a better estimate of required effort. In addition, Tetra Tech has kept careful records of both estimated and actual time required to complete work assignments of similar type and scope to those expected on this contract. This record allows reasonable estimates despite uncertainties.

Effective Project Management and Communication

Our experience with contracts of similar size and scope to the WVDEP EOI has convinced us that the successful development and administration of work assignments depends on effective communications and interactions among the key project positions: the WVDEP Project Manager, the Tetra Tech Deputy Project Manager, Project Manager, and Technical Leads. Effective communications among this group can greatly facilitate and expedite the issuance of project requests, the review of work plans, and the authorization to proceed. If these individuals are working together effectively, projects can be requested, issued, competed, and authorized within a month or less.

If awarded the contract, Jon Ludwig (Deputy Project Manager) and Mindy Ramsey (Project Manager), will seek a joint meeting with the WVDEP Project Manager to facilitate contract administration. Mr. Ludwig and Ms. Ramsey will review with the WVDEP designated representative Project Planning procedures and communication protocols.

Communication with WVDEP during Projects

During the conduct of the project, the appropriate Technical Lead will have the primary day-to-day contact with designated WVDEP technical staff. WVDEP is able to work directly with the person conducting or supervising the project. This results in a much more efficient system than having a single-point contact with only the Program Manager or Project Manager. Any difficulties or problems are reported to the Project Manager for resolution. Multiple points of communication will be provided for coordination between the Tetra Tech Team and WVDEP. The Tetra Tech Project Manager communicates directly with the WVDEP Project Manager and each WV project manager regarding schedules, work assignments, and progress. For example, prior to initiating a scheduled activity, the Project Manager checks with the appropriate WVDEP Project Leader to ensure that there have not been any changes in circumstances or priorities and to verify any special concerns. If there are changes, a discussion is held as soon as possible to modify planned activities. All changes will be properly documented and transmitted in writing to WVDEP. The Project Manager will maintain a procedure of contacting the WVDEP Project Manager at least monthly to ensure that all concerns and problems are addressed or, ideally, are avoided

through early detection. In addition, the Project Manager or Deputy Project Manager will be available within one hour's notice to facilitate communication on all contract issues.

In addition to the proposed management procedures, the success or failure of the management of this work depends on the relationships, interactions, and communications between the WVDEP Project Manager, the WVDEP Project Leaders, and the Tetra Tech Project Manager, Deputy Project Managers, and Technical Leads. Tetra Tech envisions in person meetings and/or phone calls on a weekly (or more frequent) basis, periodic technical memoranda, and at least monthly meetings with the WVDEP Project Manager and Tetra Tech Project Manager, in addition to the standard bi-monthly progress reports. This type of communication is absolutely required in order to involve the WVDEP Project Manager and Project Leaders as true participants in the technical work. Additionally, solid working relationships have already been established by Tetra Tech staff and WVDEP staff, facilitating technical discussions about project activities between Tetra Tech and WVDEP technical personnel. When complex issues arise, Tetra Tech has found it most effective to schedule in person meetings at WVDEP's offices to resolve the issues quickly and efficiently.

Control Mechanisms

Quality Control

Strict adherence to Tetra Tech's Quality Management Plan (QMP) guarantees a high quality of technical performance. Quality control is achieved by Tetra Tech in four ways: careful definition of work assignments to ensure that the project team understands WVDEP's needs, careful selection of staff, monitoring of technical progress and budgetary performance on a continual basis, and review of analyses and reports as necessary in response to critique and comment from the WVDEP Project Manager or other designated person. Team meetings and internal peer review are used to exert quality control based on the professional standards of team members.

Organizational Conflict of Interest Plan

Tetra Tech and each member of its staff are committed to complying fully with the requirements set forth in Subpart 9.5 of the Federal Acquisition Regulations (FAR) regarding COI for all work Tetra Tech performs for state, federal, and other clients. This subpart defines COI as follows:

Because of activities performed or relationship established with other persons, either (1) a person is unable to render impartial assistance or advice to a client, (2) a person's objectivity in performing work for a client is or might be impeded, or (3) a person has an unfair competitive advantage.

Tetra Tech, its employees, and any subcontractors are required to fully comply with contract-specific COI requirements. The Tetra Tech Organizational Conflict of Interest Plan includes the following sections: Corporate Structure; COI Screening Process; Procedures to Avoid, Mitigate, or Neutralize Potential COI; Certifications; Responsibilities; Training; and Subcontractor COI Identification.

All Tetra Tech employees receive training on how to identify actual or potential organizational and personal COI situations, and when and how to disclose such information. In addition, each employee receives a copy of this COI plan along with orientation materials. Tetra Tech also regularly disseminates information concerning COI issues to its employees through "brown bag" seminars, interoffice conference calls, and memoranda. Tetra Tech conducts annual COI awareness training for all employees that includes review of certification language and of any changes that may have occurred in Tetra Tech's COI plan. This training is conducted as part of Tetra Tech's "Code of Business Conduct" awareness

training and certification program. Certification that all employees have read and understand the contents of the current code and plan is retained by Tetra Tech.

Tetra Tech will place the COI flow-down clauses in each subcontract document. If requested by the client, the subcontractor must prepare and follow an appropriate COI plan. Tetra Tech will require that the subcontractor certify that it has prepared and is following its COI plan. Each subcontractor will verbally notify Tetra Tech of any actual or potential COI within 2 working days of receipt of a project order. In addition, each subcontractor must disclose specific COI circumstances to the client.

Management of Personnel Resources

We have structured our proposed team specifically to provide the most highly qualified individuals in the nation to WVDEP. Information on how key personnel resources are organized in "work teams" is presented in the organization chart in Section II.C of this proposal. The information presented in Section II.C clearly demonstrates that Tetra Tech already has identified the highly qualified in-house staff and experts necessary to perform the major requirements of the technical service areas. Personnel have been assigned to each work team based on their experience and familiarity with the technical or program issues to be addressed.

Awareness of West Virginia's Priorities

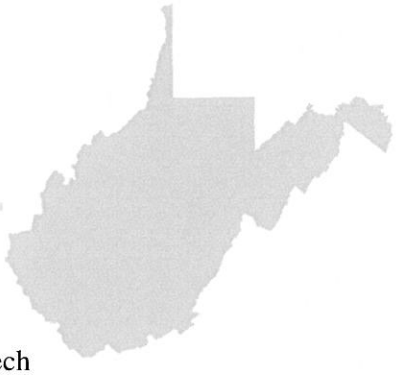
To provide the strongest Technical Leads and key staff on each work assignment, the Tetra Tech Project Manager will work closely with WVDEP to maintain a clear understanding of the contract mission priorities and the schedules in each program area. The Project Manager's ability to project and plan for the work to be performed under the contract will facilitate the smooth initiation and conduct of the assignments when we receive them. The management team of Andrew Parker, Jon Ludwig, and Mindy Ramsey has worked successfully with WVDEP managers in the past and has access to a significant resource pool that can easily accommodate shifts in priority and facilitate assignment of the team's personnel to high-priority, complex assignments.

Monitoring Staff Availability

The Tetra Tech Project Manager will maintain an awareness of staff availability for key project components. She also will monitor schedules for work closely to evaluate the best options for allocating resources. Frequent contact with the Technical Leads will be an additional mechanism to permit optimum allocations of resources and flexibility and to follow project progress.

We have also established (and demonstrated through the past WV TMDL contract mechanisms) the ability to work closely with satellite offices and clients through the use of high speed internet access including FTP sites, project intranet and Internet sites, and email. Close client contact is also maintained through the use of frequent meetings at WVDEP's offices for project updates, and transfer of materials.

III. Experience



Described in this section is Tetra Tech's experience in supporting West Virginia and many other states in TMDL development, with particular emphasis on total recoverable metals, dissolved metals/pH, bacteria, and biological TMDLs. Tetra Tech has supported West Virginia in TMDL development since 1997 through pilot studies, training, methods development, and TMDL studies throughout the state. West Virginia's program has grown into a national leader by integrating large-scale programmatic watershed management concepts with fine-scale, highly technical methodologies that produce "implementable" TMDLs in a cost-effective manner. Tetra Tech is privileged to have supported West Virginia throughout this program evolution, and we look forward to supporting West Virginia as their TMDL program continues to grow towards successful implementation and watershed restoration.

The West Virginia and national experience shown here is the product of the effort of key Tetra Tech staff listed in Section II.C. We have proposed more than 40 staff who have worked on the projects described, 30 of whom have worked directly on West Virginia projects. The experience presented is particularly relevant to the West Virginia TMDL program because it demonstrates the continuity of support we offer to WVDEP. Key staff proposed for this project have long-standing working relationships with WVDEP. Over the past 12 years, our Deputy Project Manager, Mr. Jon Ludwig, has worked closely with WVDEP's Program Manager in all facets of TMDL development. Since 2002, they have worked together on a daily basis to solve many complex programmatic and technical issues to continually improve WVDEP's TMDL Program. Tetra Tech staff in our local Charleston office have worked closely with WVDEP staff to develop new and innovative ways to further strengthen the scientific validity and defensibility of the TMDLs. Based on this experience, we have a unique and comprehensive understanding of WVDEP expectations, recognition of their mission, and respect for their understanding of the waters of the state and their dedication to environmental stewardship.

III.A. Duration of Experience

Tetra Tech is the national leader in the calculation of TMDLs, as well as development of watershed management plans and TMDL implementation plans. Tetra Tech has been a vital, constructive partner to numerous states and USEPA in their efforts to move the TMDL program from an early, narrower focus on point source wasteload allocations to today's more holistic watershed approach. Because we have supported states and USEPA in their implementation of the TMDL program since the early 1980s, Tetra Tech thoroughly understands the web of technical, legal, administrative, and social issues that influence the program and can affect its success. Over the past 16 plus years, we have developed more than 7,200 TMDLs across the United States for all waterbody types and pollutants. Our unmatched breadth of TMDL experience is summarized in Table III-1 and illustrated geographically in Figure III.1.

Table III-1. Tetra Tech's National TMDL Experience

	USEPA Regions										
Pollutant	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Metals	0	0	2320	12	66	40	0	77	100	5	**2620**
pH/Acidity	0	0	391	3	5	0	0	0	2	0	**401**
Bacteria	1	179	698	178	307	68	0	0	109	13	**1553**
Biological	12	0	83	0	12	0	0	0	0	0	**107**
Sediments	1	0	172	262	36	2	1	25	22	1	**522**
Nutrients/Algal Growth	3	0	319	330	334	33	2	25	98	1	**1145**
Pesticides and PCBs	0	0	47	6	11	0	0	0	78	3	**145**
Dissolved Oxygen	0	22	54	196	24	25	1	4	12	9	**347**
Temperature	0	0	2	0	1	0	0	1	5	0	**9**
Ionic Strength	0	0	85	0	61	24	0	11	0	0	**181**
Turbidity/TSS	0	0	8	3	149	10	0	3	7	2	**182**
Other	0	3	7	1	1	0	0	0	13	5	**30**
TOTAL	**17**	**204**	**4186**	**991**	**1007**	**202**	**4**	**146**	**446**	**39**	**7242**

Note: Based on EPA-approved TMDLs included in WATERS as of June 2012. TMDLs are organized and accounted for differently in the WATERS database as compared to the WVDEP TMDL program.
"Other" includes temperature, trash/debris, oil/grease, residues, color

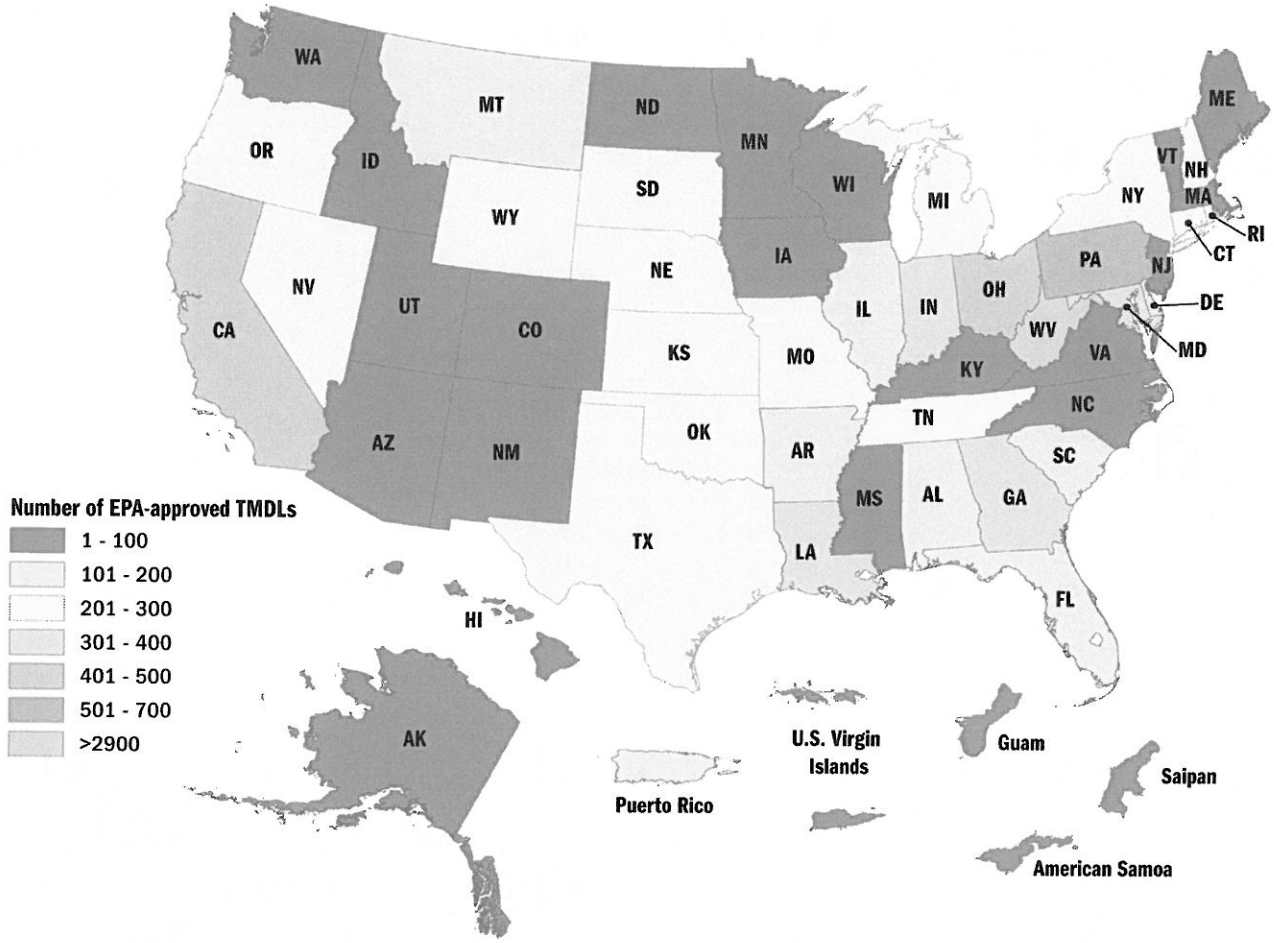


Figure III-1. Tetra Tech's National TMDL Experience

Because of the extent of our involvement, there are few technical issues that we have not encountered, considered, and developed successful solutions to address. In addition, the litigious and controversial nature of many TMDLs requires that our staff have the ability to develop credible approaches and present and defend our approaches and results to regulators and stakeholders in a public forum. We have provided scientifically based analyses and successfully defended our technical conclusions in spite of significant public scrutiny and expert academic and consultant reviews. Our comprehensive national support to the TMDL program over the past decade has included developing the first TMDL guidance document (1991); developing a suite of tools (such as BASINS) designed to aid TMDL developers in performing tasks more efficiently; and developing numerous technical support documents, including primary authorship of the USEPA protocols for developing TMDLs for nutrients, sediment and pathogens. The depth and breadth of our experience over the past decade has allowed us to assemble and train a pool of national experts skilled in all aspects of the TMDL program. We have personnel with unmatched expertise in all activities associated with TMDL analyses, including watershed characterization, data analysis and processing, source assessment, watershed and water quality modeling, allocation analyses, water quality monitoring, implementation plan development and stakeholder facilitation.

III.B. Quantity/Quality of Past Projects

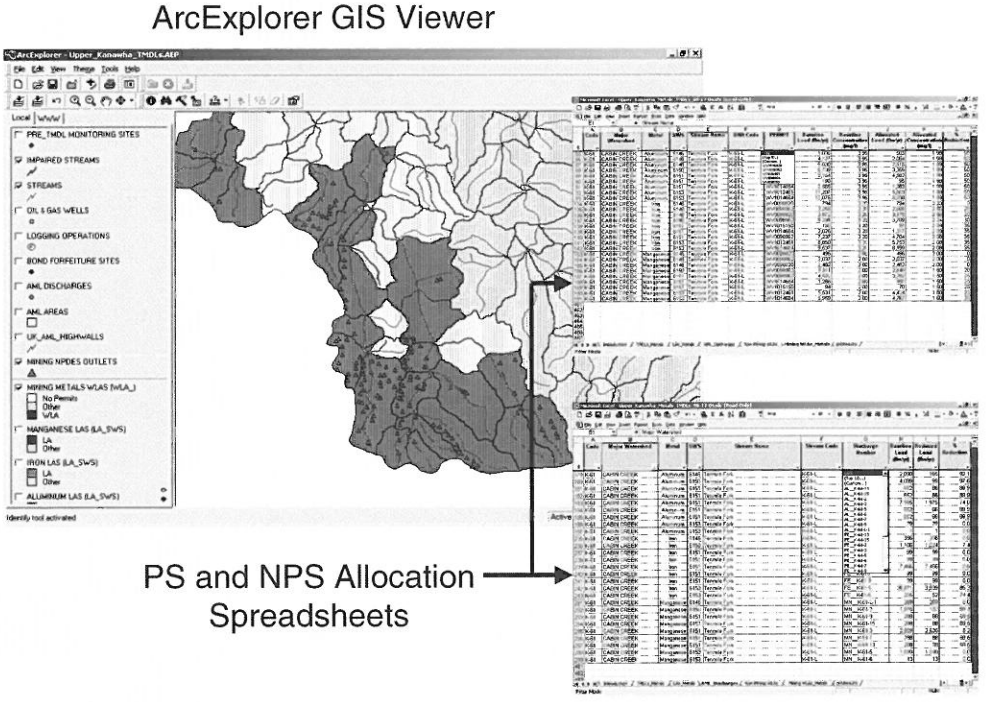
Over the past 13 years, Tetra Tech has developed more than 3,600 TMDLs throughout West Virginia, initially supporting USEPA to meet strict consent decree deadlines (and subsequently assisting WVDEP with its own program (including 195 TMDLs in the Upper Kanawha and 46 TMDLs in the Upper Ohio River North watersheds). Over 2,150 of these TMDLs have been developed directly supporting WVDEP over the past 10 years, and there are more than 1,200 TMDLs currently under development. These projects have resulted in watershed models that cover over 91 percent of the state, as illustrated in Figure III-2 in Section III.C. Through these diverse projects, Tetra Tech has compiled an incredible depth of West Virginia-specific resources, literature and data that can be used to further strengthen the scientific validity and defensibility of future TMDL development efforts. Tetra Tech's West Virginia TMDL development experience is illustrated in Table III-2.

Table III-2. Tetra Tech's West Virginia TMDL Experience

Year or Hydrologic Group	Status	Number of Streams	Total Recoverable Metals	Dissolved Metals	Acidity/pH	Bacteria	Biological	Sediment
Developed for USEPA								
1998	USEPA Approved	9	3	0	0	5	0	4
1999	USEPA Approved	6	4	4	0	0	0	3
2000	USEPA Approved	7	12	0	0	0	0	1
2001	USEPA Approved	183	447	0	96	0	0	0
2002	USEPA Approved	147	396	0	69	2	0	0
2004	USEPA Approved	58	121	12	17	2	36	0
2010 (A2)	USEPA Approved	99	83	66	79	32	25	7
TOTAL		509	1066	82	261	41	61	15
Developed for WVDEP								
A	USEPA Approved	106	63	50	30	54	45	16
B	USEPA Approved	190	139	53	38	102	48	25
C	USEPA Approved	125	60	31	44	54	35	26
D	USEPA Approved	136	17	5	4	128	25	20
E	USEPA Approved	114	32	6	8	101	51	37
B2	USEPA Approved	476	406	19	25	192	95	66
C2	USEPA Approved	173	91	0	0	164	77	65
D2	Under Development	99	56	25	25	65		27
E2	Under Development	202	109	6	6	175		133
A3	Under Development	80	97	10	6	52		
TOTAL		**1701**	**1070**	**205**	**186**	**1035**	**376**	**415**
TOTAL WEST VIRGINIA TMDLS		**2210**	**2136**	**287**	**447**	**1076**	**437**	**430**

As demonstrated throughout this proposal, Tetra Tech and WVDEP have worked closely together to identify and create unique ways to integrate large-scale, watershed based TMDLs with fine-scale, highly technical methodologies that produce "implementable" TMDLs in a cost-effective manner. This watershed based approach to TMDL development is comprehensive and typically includes all known impairments in a watershed. TMDL development includes a multi-faceted modeling approach to address **total recoverable metals, dissolved metals, acidity (pH), and bacteria impairments**.

Tetra Tech and WVDEP also have designed the "TMDL on CD" concept where all relevant TMDL information (TMDL reports and appendices, technical documentation, and supporting data) is included on a CD-ROM. To further improve the "usability" of the TMDLs, Tetra Tech and WVDEP developed a series of interactive tools to provide TMDL implementation guidance. These tools are designed to simplify and assist "implementers" (nonpoint source staff and permit writers) in using the TMDLs to develop watershed plans and issue/renew permits. An interactive ArcGIS project allows the user to explore the spatial relationships of the source assessment data, as well as further details related to the data. Users are also able to "zoom in" on streams and other features of interest. In addition, spreadsheet tools (in Microsoft® Excel format) were developed to provide the data used during the TMDL development process, and the detailed source allocations associated with successful TMDL scenarios. These tools provide guidance for selection of implementation projects as well as for permit issuance and are also included on the TMDL Project CD. To date, these concepts have been applied for completed TMDL projects in Hydrologic Groups A, B, C, D, E, A2, B2, and C2; and are currently under development for the Monongahela (D2), West Fork River (E2), Upper Ohio North (A3), Upper Kanawha (A3), Shenandoah (A3), and South Branch Potomac (A3) watersheds.



We have included the TMDL Project CDs for Elk River, North Branch Potomac, and Upper Ohio South watersheds as examples in Appendix C.

Table III-3 summarizes the pollutant specific TMDLs for the each of these example projects.

Table III-3. West Virginia Pollutant-specific TMDLs for Example TMDLs Presented in Appendix C

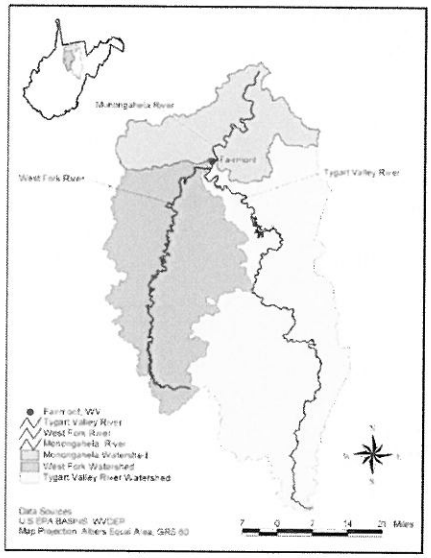
Watershed	Number of Streams	Dissolved Aluminum	Total Iron	Total Manganese	pH	Chlorides	Biological	Bacteria	Sediment
Elk River Watershed	195	16	189	0	20	0	44	79	24
North Branch Potomac Watershed	22	0	0	0	0	0	8	22	0
Upper Ohio South Watershed	75	1	29	1	1	4	20	66	12
TOTAL	**292**	**17**	**218**	**1**	**21**	**4**	**72**	**167**	**36**

To further demonstrate our TMDL development experience, we have included the following descriptions of several related projects.

Mining TMDLs for Tygart River Watershed West Virginia
Client: USEPA Region 3

In response to court ordered schedules for TMDL establishment, Tetra Tech developed TMDLs for mining-related impairments due to metals (iron, aluminum, manganese) and pH in West Virginia, in close coordination with WV DEP and EPA Region 3. TMDLs were developed for the Buckhannon, Tygart, Cheat, Elk, Monongahela, Stony, Tug, Dunloup, West Fork and Guyandotte watersheds. The effort involved development of innovative modeling techniques to address a variety of case specific requirements related to water quality criteria, water use designations, source pollution conveyance methods, and permitting. To incorporate these multiple facets, Tetra Tech developed a comprehensive modeling and analysis system - MDAS (Mining Data Analysis System). Tetra Tech also provided support for public meetings, technical meetings and training sessions to help support public acceptance of the new methods.

Tetra Tech developed mining related TMDLs for the Tygart Valley River Watershed. Tetra Tech took the technical lead in most areas, including recommending targeted stream monitoring, managing permit information, analyzing abandoned mine land data, developing a model, defining a consistent allocation procedure, developing TMDL reports, and presenting the TMDL results to the public. TMDLs resulting from the approach were technically defensible, approved by EPA, and consistent with WV permitting processes.



Using MDAS, Tetra Tech simulated instream flow and water quality conditions throughout the Tygart Valley River watershed for a 6 year period. The watershed modeling process involved the segmentation of the watershed into 1007 hydrologic subunits; compilation of meteorological, land use, stream and land use specific hydrology and pollutant data; calibration of MDAS/HSPC hydrology and water quality; and generation of nonpoint source and in stream flows and pollutant loadings. Many of the impaired segments were small nested tributaries and had various water use designations that require specific acute and chronic numeric criteria. Over 300 permitted mining discharges, in multiple phases of reclamation (exhibiting various water quality conditions) were represented as point sources that simulated characteristics of precipitation driven discharges. Final TMDL allocations were assigned to more than 1,000 subwatersheds and over 80 individual mining facilities and resulted in the development of over 150 individual TMDLs for the watershed. The MDAS model also provided a basis for permit analyses which ultimately will support future re mining and growth issues as they arise.

Ohio River Bacteria TMDL Development
Client: USEPA Region 5

Tetra Tech is currently in the process of supporting USEPA in the development of a bacteria TMDL for the Ohio River. The Ohio River Basin covers more than 200,000 square miles extending over six states, from east to west including West Virginia, Pennsylvania, Kentucky, Ohio, Indiana and Illinois. Based on the 2006 303(d) report, 475 miles are impaired for contact recreation by bacteria. Tetra Tech prepared a QAPP in accordance with USEPA guidance (including recommending a modeling approach and a means for comparing the multiple pathogen criteria); is helping Region 5 to facilitate a Ohio River Pathogen TMDL Coordinators Workgroup; and is compiling and assessing available data for the Ohio River as well as for important sources of bacteria such as tributaries, combined sewer overflows, sanitary sewer overflows and urban stormwater. Once all available data have been compiled and organized, Tetra Tech will be setting up and calibrating a hydrodynamic and water quality model of the river to support the TMDL. Tetra Tech also supported USEPA and the states in a series of six public kickoff meetings held in January 2009.

Metals TMDL Development for the Kiskiminetas-Conemaugh River Watershed, PA
Client: USEPA Region 3 and Pennsylvania Department of Environmental Protection

Stream reaches in the Kiskiminetas River and Conemaugh River watersheds in southwestern Pennsylvania are included on the state's 2008 Section 303(d) list due to various impairments, including metals, pH, and sediment. Tetra Tech developed TMDLs in the Kiskiminetas-Conemaugh River watershed to address the water quality problems associated with abandoned mine drainage, land erosion, bank modification, and various other causes. The coordinated efforts of Tetra Tech teams compiled information necessary for completing mining related TMDLs to satisfy Consent Decree deadlines for two eight digit HUC watersheds.

The project involved extensive efforts to gather NPDES permit information for thousands of municipal and industrial wastewater treatment facilities and mining facilities. GIS data related to abandoned mine lands were compiled and incorporated into a customized landuse coverage for use in setting up a Mining Data Analysis System (MDAS) model of the watershed. A substantial amount of available monitoring data in the watershed was identified and assessed for calibrating the hydrology, sediment, and water quality predictions of the MDAS model. Statistical analyses using pre-TMDL monitoring data collected throughout the Kiskiminetas-Conemaugh River watershed were performed to establish the correlation between metals loads and sediment loads and to evaluate spatial variability. The calibrated model provides the basis for simulating baseline conditions, which represent existing nonpoint source loadings and point sources loadings at permit limits.

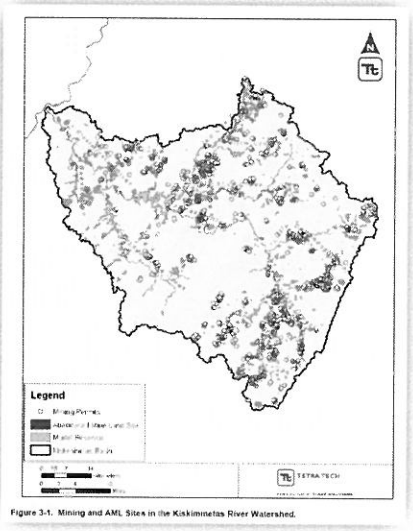


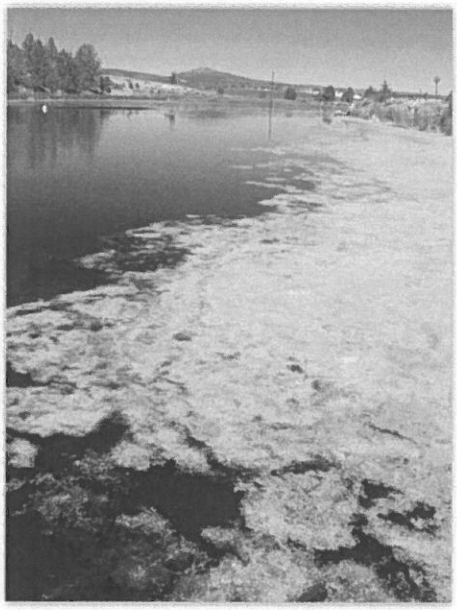
Figure 3-1. Mining and AML Sites in the Kiskiminetas River Watershed.

Modeled subwatershed loadings were iteratively reduced to estimate the load reductions required to meet instream concentration targets

for total metals (iron, aluminum, and manganese). Iron reductions were used as a surrogate for sediment reductions and dissolved aluminum reductions were used as a surrogate for pH TMDLs. Streams placed on Pennsylvania's Section 303(d) list with a designated use of high quality or exceptional value are subject to additional protection pursuant to the state's anti-degradation policy. Long-term loads based on the TMDL allocations were identified, as well as median and maximum allowable daily loads. WLAs were assigned to permitted municipal, industrial, and mining facilities and municipal separate storm sewer systems (MS4s) that discharge in the watershed. LAs were assigned to nonpoint sources including drainage from abandoned mine lands. ***The Kiskiminetas River Watershed TMDL project is provided as an example TMDL in Appendix C.***

Modeling and Monitoring for the Klamath and Lost River Basins
Client: USEPA Region 10 and USEPA Region 9

Tetra Tech has led efforts to develop hydrodynamic and water quality models and conduct physical, chemical, and biological monitoring efforts in the Klamath and Lost River Basins over the past 7 years to support TMDL development. The Klamath and Lost Rivers are included on Oregon and California's 303(d) lists for dissolved oxygen, nutrients, chlorophyll a, temperature, fecal coliform, pH, and ammonia. The Klamath River watershed covers an area of approximately 15,722 square miles in Oregon and California. The headwaters of the Klamath River originate in the Cascade Mountains and the river flows to the southwest toward its confluence with the Pacific Ocean. Downstream of Upper Klamath Lake the river contains a series of dams used for hydropower generation and flood control. The Lost River is a tributary to the Klamath River. Since the early 1900s, extensive flood diversion and irrigation facilities have been constructed throughout the Lost River basin. Modification of the natural hydrology has hydrologically-connected the Lost River to the Klamath River for the past century through a series of pumps, canals, drains, and impoundments.



Initial efforts focused on developing a comprehensive database of water quality data for the basin and summarizing historical and current conditions. After accessing, compiling, and analyzing a multitude of data records from federal, state, regional, local, and private entities, independent modeling approaches for the Lost and Klamath Rivers to meet TMDL requirements were proposed. A multiple-domain CE-QUAL-W2 model of the Lost River was developed and calibrated. The model includes 12 waterbodies, consisting of linked rivers and reservoirs from upstream to downstream. The system also includes the Klamath Wildlife Refuge and contributions from over 230,000 irrigated acres (via drains and canals) and dynamically simulates hydrodynamic and water quality processes (chemical and biological). Also developed was a dynamic modeling framework for the Klamath River composed of a series of one-dimensional RMA models for riverine segments, two-dimensional CE-QUAL-W2 models for impoundments, and a three-dimensional EFDC model for the estuary. Both modeling systems were peer-reviewed by modeling experts from federal agencies, academia, and private consulting firms.

To support calibration of both dynamic models, a series of physical, chemical, and biological sampling events (including SOD and macrophyte/periphyton monitoring) at over 30 independent sites were conducted. The calibrated models were used to evaluate a series of management scenarios for this highly contentious area. The primary focus of the management scenarios was to identify plausible options for

achieving both Oregon and North Coast RWQCB water quality criteria. Lost River scenarios evaluated the impacts of agricultural land nutrient reductions and reservoir management on water quality conditions. Scenarios for the Klamath River involved an evaluation of point source impacts, nonpoint source reductions, reductions from the upstream Upper Klamath Lake, and reservoir operations on water quality. The modeling and data collection effort required very close coordination with the states and USEPA to meet the needs of the many entities involved, including federal agencies, tribes, municipalities, private interest groups, landowners, and reservoir owners and operators.

Watershed Management in the Lake Tahoe Basin
Clients: University of California – Davis, Nevada Department of Environmental Protection, and California Lahontan Regional Water Quality Control Board

Tetra Tech has supported UC–Davis, Lahontan Regional Water Quality Control Board (RWQCB), Nevada Division of Environmental Protection (DEP), U.S. Forest Service, and Tahoe Regional Planning Agency in developing a watershed modeling framework to support management of the Lake Tahoe Basin to address declining lake clarity. Tetra Tech integrated results from diverse studies in meteorologic data analysis, geographic information systems (GIS), best management practices (BMPs), stream sediment, and stormwater sampling into a comprehensive and customized watershed model of the basin using the Loading Simulation Program in C++ (LSPC). The model provides a platform for water quality management in the entire basin, evaluating the implications of management scenarios for urbanized and growing areas and managed forest regions. It will help the many parties involved make informed decisions before allocating funds to mitigate pollution and improve Lake Tahoe's clarity.

Tetra Tech used LSPC, a modeling framework developed by Tetra Tech for USEPA to support large, complex watershed modeling applications. Tetra Tech incorporated data from a number of concurrent research efforts, including a satellite-derived high-resolution impervious cover layer, site-specific stormwater monitoring data, and locally observed Snow Telemetry data to develop a representative hydrology and water quality model. In addition to detailed snow and hydrology prediction, algorithms relating land cover, slope, and pollutant loading provided a credible basis for generating representative sediment and nutrient loading estimates. The project resulted in a calibrated watershed model, representing source loading at the land use level and spatially around the basin, to support BMP implementation and dynamic linkage to the Lake Clarity Model. The Tahoe Research Group has used the model to educate stakeholders on the impact of land use decisions on hydrology, water quality, and lake clarity.

The modeling effort concluded that the primary source category groups of clarity-reducing pollutants included: (1) urban runoff, (2) forest upland erosion, (3) atmospheric deposition, and (4) stream channel erosion. With more than $1.5 billion estimated as the cost to restore lake clarity, a premium is placed on developing informative decision support analyses. For each source category group, a team of local experts was assembled to take the lead on quantifying the nature of pollutant loading, identifying and evaluating a range of potential management options and quantifying potential pollutant removal benefits and associated capital and operations and maintenance costs.

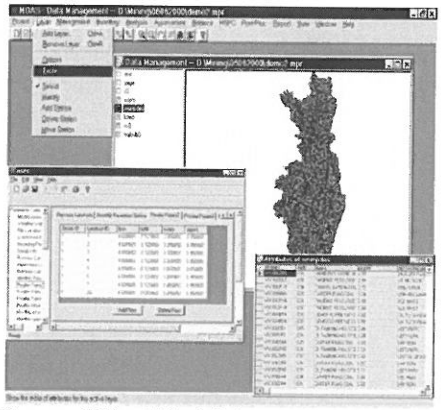
Following this expert-led effort to characterize potential pollutant reduction opportunities and associated cost information for the primary sources identified, a meta-heuristic optimization technique was applied to evaluate the costs-benefits and selection trade-offs among controls associated with the various pollutant sources. This optimization approach helped to prioritize management actions from a basin-wide perspective.

Tetra Tech is currently supporting the implementation effort by developing analytical approaches and tools for a comprehensive progress tracking and pollutant trading system. These tools support the

computation of the project-specific benefit of BMP management, the assignment of load reduction credits, and the progressive tracking of implementation actions as they occur in the watershed. The overall effort has delivered a comprehensive approach that quantitatively measures watershed actions in terms of progress toward meeting established load allocation targets

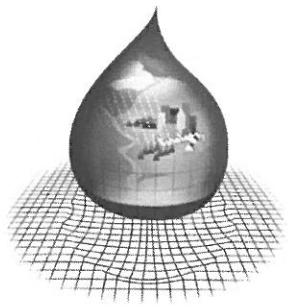
III.C. Water Quality Model Experience

Since its inception, Tetra Tech has developed and applied models to support informed environmental decision-making. We have focused on performing studies and implementing solutions that use the watershed as an analytical framework and are designed in close coordination with the client and appropriate stakeholder groups. By developing and applying modeling and analysis tools, we provide constructive and practical solutions to all types of water management issues. Tetra Tech has significant experience developing and applying linked modeling systems for the express purpose of TMDL development and implementation as well as watershed and water quality management, stormwater management, and source water protection. Although our experience with detailed modeling is unique, we promote the use of simple yet scientifically defensible methods to respond cost-effectively to the needs for watershed, water quality and water resources management, while providing easy-to-understand analyses to promote stakeholder and public involvement and acceptance.



To meet West Virginia's need to develop hundreds of TMDLs for mining-impaired waters, Tetra Tech developed the Mining Data Analysis System (MDAS). MDAS is developed around HSPF and includes graphics/visualization interfaces, data management/inventory/ analysis, nonpoint source modeling, and TMDL analysis and post-processing. Tetra Tech has since applied MDAS to develop thousands of TMDLs.

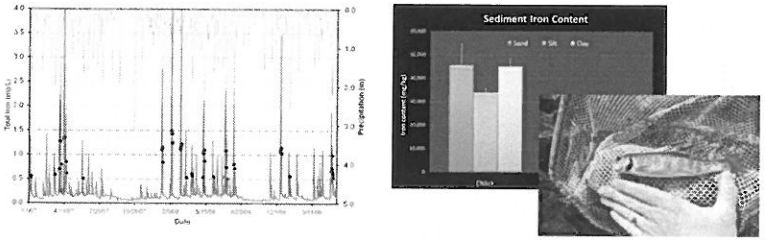
Tetra Tech modelers understand that there is not a one-size fits all approach for modeling to support watershed and water resources management. When deciding which model to apply, it is necessary to understand the local issues and consider any unique environmental features that affect watershed and water quality processes and conditions. The members of our staff are intimately familiar with all public domain models endorsed by USEPA and the USACE and have practical experience in each. Because our staff regularly supports modeling in most states, as well as model and interface development for USEPA, states and local municipalities, we thoroughly understand the strengths and limitations of available mathematical models and their ranges of application. In fact, Tetra Tech staff wrote USEPA's *Compendium of Tools for Watershed Assessment and TMDL Development* (EPA841-B-97-006), as well as the USEPA ORD's *TMDL Model Evaluation and Research Needs* (EPA/600/R-05/149), a review of more than 60 process-based models and an evaluation of their applicability, strengths and weaknesses. Because we "wrote the book" on models—twice—and we rely primarily on public domain models, we are able to provide our clients with unbiased model selection recommendations based on the strengths and limitations of available models—a practice unique to Tetra Tech.



Tetra Tech developed USEPA's Modeling Toolbox—a revolutionary modeling system that integrates watershed loading models, receiving water models, and database and visualization systems into a streamlined assessment package. The Toolbox provides users with the ability to dynamically simulate flow, transport and water quality processes in all types of surface water environments.

By designing and conducting thousands of modeling studies throughout the United States, Tetra Tech has unmatched experience in successfully applying watershed and water quality models to support the analysis of complex environmental problems and evaluate long-term management goals. We develop custom applications from simple to complex and for hydrodynamics, watershed, receiving water, groundwater, mixing zones and hydrology and hydraulics.

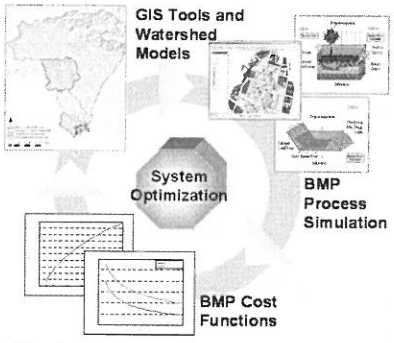
Tetra Tech combines our practical modeling experience with our understanding of our clients' needs and growing trends to create innovative modeling tools and systems that are more user-friendly and accessible. In the mid-1990s Tetra Tech developed for USEPA the BASINS modeling system—a powerful GIS-based system integrating national environmental datasets, analytical tools, and USEPA-supported watershed and receiving water models. Since then, Tetra Tech has developed a number of comprehensive modeling systems, model interfaces and supporting analytical tools. We have built a number of interfaces that link data, reporting, modeling and tracking needs as part of ongoing management systems. Because of our understanding of the environmental processes represented by models, our in-depth knowledge of available modeling systems and related data, and our technical capabilities for designing and developing tools, we have the unique ability to identify a need and design a tool or system to fulfill that need. In addition, we emphasize transferring modeling capabilities to users through the exclusive use of public domain modeling software, on-site model installation and training workshops, and continued phone- and Internet-based technical support and troubleshooting.



Working with WVDEP, Tetra Tech developed a high-resolution hydrology and water quality model (MDAS) for two small trout streams in WV to determine the range(s) of total iron concentrations that occur in viable trout waters as a result of precipitation induced runoff. Results are being used to support WVDEP's pursuit of coldwater fisheries water quality criterion revision.

A model is only as good as the data it is built on. Tetra Tech also recognizes that the model is only as good as the person who runs it. Our modelers not only have extensive experience with all types of models, they have a fundamental understanding of the physical, chemical and biological processes affecting watershed and waterbody conditions—allowing us to successfully apply any model in the context of real-world environmental conditions. This is essential for the responsible and accurate selection and application of models for watershed and water resource management. Our staff's extensive experience with all types of models also eliminates any learning curve, allowing us to more efficiently complete projects. Having run models for a wide range of climates, locations and challenging situations, we can also avoid common modeling pitfalls and mistakes and produce the best results in a cost-effective manner.

For all coastal watersheds of Los Angeles County, Tetra Tech developed a comprehensive watershed management decision support system based on previously developed HSPF/LSPC models to assist in water quality improvement planning. Specifically, the system provides:



- Dynamic simulation of watershed hydrology & transport of multiple pollutants
- Evaluation of storm size & frequencies for identification of management target
- Dynamic simulation of BMP processes, including both distributed LID & centralized facilities
- Optimization of the most cost-effective combination of BMPs design
- Load reduction quantification to support TMDL implementation
- Cost estimates for county-wide water quality improvement planning

Figure III-2 illustrates the West Virginia basins where Tetra Tech has performed modeling to support TMDL development, resulting in watershed models that cover more than 91 percent of the state. Table III-4 also displays the models for which Tetra Tech has practical experience.

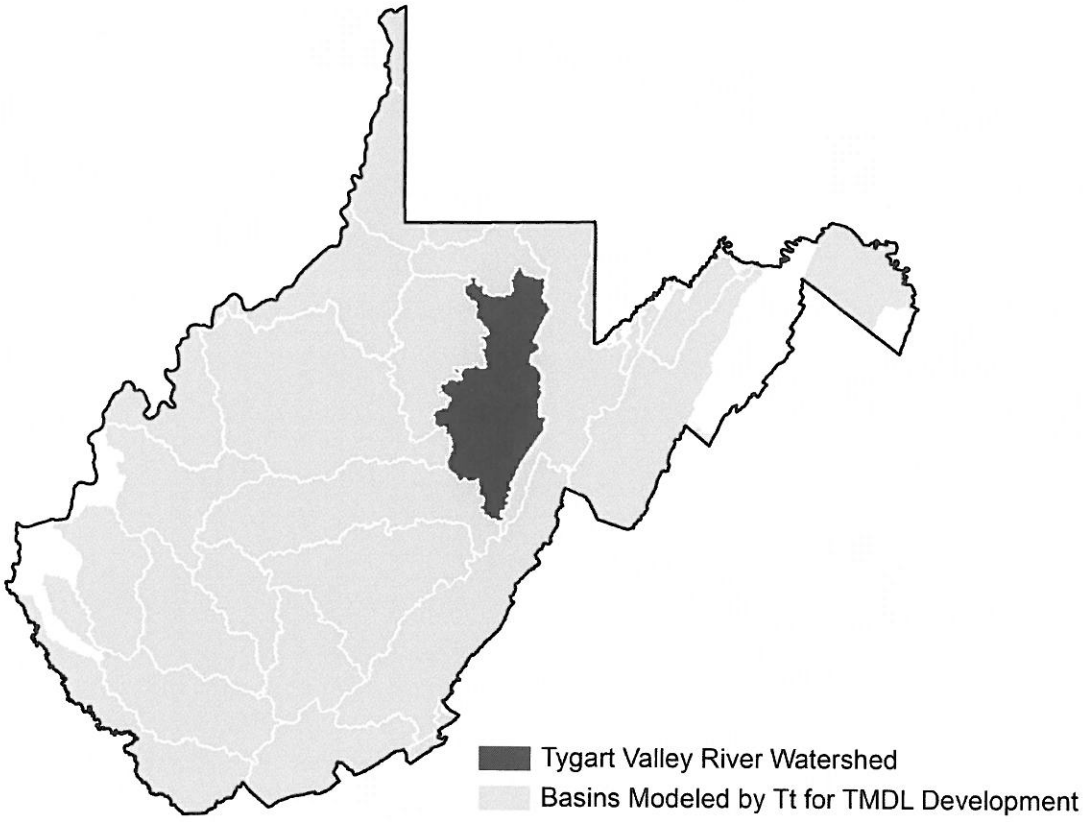


Figure III-2. West Virginia basins in which Tetra Tech has conducted watershed and water quality modeling

Table III-4. Environmental Computer Models and Systems Used by Tetra Tech

Model Category	Model Name
Ecological	IFIM, HEP
Watershed Runoff	HSPF, NPSM, LSPC, MDAS, SWMM, HEC-1, TR-20, PSURM, WSTT, GWLF, AGNPS, P8, SWAT
Thermal Fate	EFDC, TRANQUAL, HSPF, DISPER, ELA
River Hydraulics	HEC-2, HEC-RAS, WSPRO, FESWMS-2DH, DAMBREAK, DWOPER, UNET
Hydrodynamics	EFDC, CAFE, TEA, CE-QUAL-W2, TABS-2, FESWMS-2DH, DYNHYD5, MIT-DNM, RMA
Discharge Plume	CORMIX, USEPA Plume Models
Mixing Zone	CORMIX, EFDC, TEA/ELA, CAFE/DISPER
Eutrophication	QUAL2E, WASP, CE-QUAL-W2, CE-QUAL-RIV1, RIVHW, EFDC, BATHTUB, LAKE2K
Toxic Fate	TOX15, SMPTOX, RIVRISK, AMMTOX, TOXCALC
Sediment Transport and Scour	TABS-2, STUDH, HEC-6, QUASED, HEC-RAS, EFDC
Ground Water	MODFLOW, MOC, PLASM, Random Walk, GLEAMS

III.D. Entities for which Tetra Tech Has Developed TMDLs

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TETRA TECH, INC.

Khalid Alvi, PE

Model Development

EDUCATION

M.E., Civil Engineering, Asian Institute of Technology, Bangkok, Thailand, 1999

B.E., Civil Engineering, University of Engineering and Technology, Lahore, Pakistan, 1993

YEARS OF EXPERIENCE

Total: 13

With Tetra Tech: 10

LICENSES & CERTIFICATIONS

P.E., Professional Engineer, Commonwealth of Virginia, 2010

A.S.C.E., American Society of Civil Engineers

KEY AREAS OF EXPERIENCE

- Watershed modeling
- Watershed management
- Model development
- Water quality assessment
- Environmental data management and analysis
- Geospatial data management and analysis
- Technical project management

Mr. Alvi is an environmental engineer with over 10 years of experience in the field of water resources. His comprehensive experience includes preparing system design documents, system requirement analysis, and model formulation and development. Mr. Alvi's expertise also include statistical flow analysis, water balance, mass balance, data processing, data analysis, hydrodynamic and water quality modeling. He possesses extensive experience in the application of GIS-based watershed models. He works with computer programmers and watershed modelers to produce quality designs, applications and software. Mr. Alvi is currently leading the development of a decision support system for the EPA's Office of Research and Development: a System for Urban Stormwater Treatment and Analysis INtegration (*SUSTAIN*) to develop, evaluate, optimize, select, and place BMP options in various watershed scales based on cost and effectiveness.

Selected Project Experience

Load Simulation Program in C++ (LSPC). LSPC is a watershed modeling system based on HSPF algorithms along with additional BMP algorithms, soil chemical reactions, and stream bank erosion processes. Mr. Alvi is the technical lead and is responsible for components of the model development. Mr. Alvi was responsible for testing, debugging, and fixing the issues related to the model performance; implementing soil chemical reaction module to simulate the solute transport and transformation; implementing BMP algorithms for disinfection units by introducing the pollutant concentration limit and load reduction controls on monthly basis; implementing sediment transport algorithms; coding the modeling processes using visual C++ programming language; and modifying the model on project needs basis.

System for Urban Stormwater Treatment and Analysis INtegration (*SUSTAIN*) for EPA's Office of Research and Development. *SUSTAIN* is an evaluation and decision making tool for placement of stormwater BMPs at the strategic locations in a watershed to address a variety of stormwater management planning questions on: (1) developing TMDL implementation plans, (2) identifying management practices to achieve pollutant reductions in an area under an MS4 stormwater permit, (3) determining upstream source control strategies for reducing volume and peak flows to CSO systems, and (4) evaluating the benefits of distributed BMP implementation on water quantity and quality in urban streams. Mr. Alvi is supporting the development of various system components and helping the project manager and the EPA project officer in managing the project. He is the technical lead in providing the technical support to the end users of the released *SUSTAIN* version 1.0 software. He is also organizing and conducting the informational and hands-on-training workshops on *SUSTAIN* in USEPA Regions 5, 9, and 10.

The Watershed Information System (WIS) for the Prince George's County, Maryland. A GIS based system to facilitate and streamline the data management, retrieval, and reporting capabilities needed to support the development of Watershed Restoration Action Strategies (WRAS) throughout the state of Maryland. Mr. Alvi is responsible and has a leading role for the following components of the system development: designing the ArcGIS interface for the system; preparing the requirement analysis for the project; assisting in developing the personal geodatabase, in processing the stream corridor assessment data, and processing the other ArcGIS vector and raster datasets; designing the word document templates for the watershed characterization reports; designing a simple

approach for watershed prioritization ranking based on the pollutant loading and stream corridor assessment summary; and helping in managing the project tasks and working closely with the ArcGIS programmer.

Watershed Model Preprocessing Tools for Fairfax County Stormwater Planning Division, VA. A set of preprocessing tools using the GIS data were developed for the Fairfax County Stormwater Planning Division to streamline the watershed model inputs. Mr. Alvi's major contributions to this project include: modifying the EPA's STEPL model to include the variable landuse type and to automate the data entry in the spreadsheet; writing/modifying python language scripts for processing the GIS data to extract the required information from the GIS layers for the watershed model; and developing a standalone editing/modifying utility for SWMM5 input file to automate the updating watershed parameters

Grid Based Watershed Mercury Loading Model (GBMM) for EPA Region 4. The model simulates the spatial and temporal dynamics of mercury on watershed level for both point and non-point sources. Mr. Alvi's major contributions include the following components of the model development: designing the ArcGIS interface for the simulation model; coding the watershed processes using raster algebra library in visual C++ programming language; helping in managing the project tasks and working closely with the ArcGIS programmer; assisting with the development of the technical design document and user's manual; and helping to write the technical conference paper/poster to disseminate the new grid-based modeling approach.

Best Management Practice Decision Support System (BMPDSS) for the Prince George's County, Maryland. Mr. Alvi managed and was responsible for the following components of the system development: designing the ArcGIS interface for the BMP and Conduit simulation modules; implementing the STREAM simulation module based on SWMM algorithms; coding the watershed processes using visual C++ programming language; assisting in checking water balance and mass balance for the BMP simulation module and updating the system; and helping in managing the project tasks and working closely with the ArcGIS programmer.

Best Management Practice Decision Support System for the State of Vermont. This application is a BMP simulation system built on the Prince George's County's BMPDSS. Mr. Alvi was responsible for the following components of the system enhancements: updating the STREAM simulation module based on the latest SWMM algorithms; enhancing the scatter search component of the OPTIMIZATION module; enhancing the groundwater component for stream base flow calculation; enhancing the multiple weir and multiple orifice calculations in the BMP module; adding the stage-volume functional table in the BMP module; and coding the BMP processes using visual C++ programming language.

Watershed Model Development for Los Angeles County Department of Public Works, CA. The development of countywide pollutant reduction measures for urban runoff and stormwater quality improvements is an ongoing project with LA County. Mr. Alvi possesses an IT leading role in this project for GIS data pre/post processing and for updating/developing the models - Load Simulation Program in C++ (LSPC) and the Best Management Practices Decision Support System (BMPDSS), which are modeling tools used to meet the project needs.

TETRA TECH, INC.

Allison Barker

Contracts Manager

EDUCATION

J.D., Suffolk University Law School, 1998

B.A., English, University of Connecticut, 1995

YEARS OF EXPERIENCE

Total: 15

With Tetra Tech: 14

LICENSES & CERTIFICATIONS

Certified Federal Contracts Manager

Member of National Contract Management Association (NCMA)

TRAINING

Contract Administration (seminar), National Contract Management Association

Government Contract Law (seminar) National Contract Management Association

Federal Acquisition Regulation (seminar) National Contract Management Association

KEY AREAS OF EXPERIENCE

- State and Local Government Contracts

Ms. Barker is the Contracts Group manager and a senior contract administrator in Tetra Tech's Fairfax office. She has many years of contracts experience covering the full spectrum of contractual activities from proposal preparation through contract close out. She has been extensively involved in the following areas: proposal preparation; negotiating and managing all levels and types of federal and private sector contracts and subcontracts; all aspects of financial reporting; interfacing with contracting officers; supervising and training of junior personnel; and drafting of contracts, subcontracts, consultant agreements and teaming agreements. She has a thorough knowledge of the FAR and currently has her CFCM (Certified Federal Contracts Manager) certification.

Selected Project Experience

Contract Aministrator. Currently serves as contract administrator for most of the Tetra Tech Fairfax office's commercial and state and local government contracts. Reviews all contracts for issues that need to be negotiated prior to signature. Prepares subcontracts as needed. Reviews all invoices submitted for accuracy on each project administered. Conducts monthly analysis of project status reports. Monitors all projects, tracking their budgets and costs incurred through weekly accounting reports to ensure there are no cost overruns and following the status of work plan due dates, stop work dates, and periods of performance. Trains new contracts department staff on all aspects of Tetra Tech's contract administration. Assists other contract administrators on Tetra Tech's large EPA CPFF contracts and where Tetra Tech is a subcontractor on EPA prime contracts. Reviews Tetra Tech outgoing invoices on contracts for accuracy before billing them to clients.

Responsible for the preparation of cost proposals. Reviews RFPs, coordinates with the technical staff, works with subcontractors, and reviews all cost information prior to processing it into a final proposal format.

Served as contract administrator for four multi year, multimillion-dollar CPFF contracts with the U.S. Environmental Protection Agency. Most contracts involved more than 8 major subcontractors and several consultants. Responsible for monitoring over 100 work assignments tracking their budgets and costs incurred through weekly accounting reports to ensure there are no cost overruns and following the status of work plan due dates, stop work dates, and periods of performance; and ensuring that all deadlines are met. Reviewed all contract modifications processed by EPA and coordinated frequently with EPA Contract Officers and Project Officers. Worked with work assignment task leaders to ensure that work plans and progress reports are submitted to EPA in a timely manner.

Prepared monthly financial reports for EPA on each work assignment, including dollars allocated, dollars spent per month, and dollars spent to date. Also worked with subcontractors on contract issues, contract ceilings, work plan approvals, monthly financial reports, status of work being conducted, and budget status. Reviews all subcontractor and vendor ODC invoices for accuracy prior to their being submitted to the accounts payable department. Reviewed and processed all Tetra Tech outgoing invoices on the contracts she managed for accuracy before the billing department sends them to EPA.

TETRA TECH, INC.

Clary Barreto, PE

Senior Water Resource Engineer

EDUCATION

M.S., Civil and Environmental Engineering, Massachusetts Institute of Technology, 2001

B.S., Civil Engineering, University of Puerto Rico, Mayaguez, 1999

YEARS OF EXPERIENCE

Total: 11

With Tetra Tech: 11

LICENSES & CERTIFICATIONS

Professional Engineer, Virginia, No. 0402040657

KEY AREAS OF EXPERIENCE

- Pollutant source assessment
- Environmental data analysis
- Watershed hydrology and stormwater
- Watershed runoff quality
- Development and application of computer models
- TMDL development and implementation
- Watershed management plan development
- Tool development

Ms. Barreto is a licensed professional engineer with 10 years of professional experience and two years of research experience in the areas of hydrology, hydrodynamics, water quality, sediment transport, coastal processes and groundwater. She has developed and applied computer models to simulate the fate and transport of pollutants in streams, lakes, estuaries and coastal regions. Ms. Barreto has been a technical lead on a number of large-scale modeling efforts and at times directs the work of several junior staff. She has excellent data management and modeling skills and has developed new data analysis and water quality calibration techniques. Ms. Barreto assisted with the development of the Loading Simulation Program in C++ (LSPC) and BASINS. She has worked independently and as part of teams to accomplish time-sensitive tasks. Her experience also includes writing TMDL documents, watershed management plans, water quality sampling plans, and training courses. Ms. Barreto is knowledgeable in the use of ArcView GIS, Microsoft Access, Mining Data Analysis System (MDAS), LSPC, BASINS, HSPF, GWLF, QUAL2K, HEC-HMS, HEC-RAS and MODFLOW. She has experience programming in C++, FORTRAN, and MATLAB. Ms. Barreto is also fluent in English and Spanish.

Selected Project Experience

West Virginia Metals TMDLs Development. For West Virginia Department of Environmental Protection, gathered, compiled and prepared relevant data for characterization and modeling of the Coal River, Lower Kanawha and North Branch Potomac watersheds. Set-up MDAS models, calibrated hydrology and metals (iron, aluminum and manganese), and guided staff in the TMDL allocation process. Also helped develop selenium TMDLs for a several impaired headwaters streams. Analyzed available data, and prepared loading curves to relate selenium loads to flow conditions. Because no flow gages were available on these streams, she used modeled daily flow output from the MDAS model. Furthermore, prepared mining and non-mining NPDES permit relational databases, and refined her previously developed method of modeling mining permitted areas and outlets. Guided junior staff in the land use adjustment process, where a new land use coverage is produced accounting for land-based sources of metals, like mining operations, oil and gas wells, forest harvest, unpaved roads, among others. Also prepared comprehensive TMDL scenario databases where all of the project information can be accessed and queried. For the Gauley River and Potomac Direct Drains watersheds, has been teaching other junior staff in Tetra Tech's West Virginia office how to set-up, run and calibrate MDAS.

Lake Tahoe, CA & NV TMDL Development. For the Lahontan Regional Water Quality Control Board, working on the development and application of a watershed model capable of simulating sediment and nutrient inputs to Lake Tahoe. Calibrated the snow, hydrology and water quality components of the LSPC watershed model. Working with the client, gathered data, documents and references to develop Tahoe's land-use specific loading ratios for sediment and nutrient in surface runoff. Performed a thorough analysis of data available for water quality calibration, and she modeled and calibrated the fate and transport of sediments and nutrients from the individual sub-watersheds to the lake. Modeled upland erosion using the sediment module of LSPC, and used existing data and previous research to estimate stream channel erosion component. Analyzed the

results of existing condition run, and presented them to the client. Working with the client to develop management scenarios.

Montana TMDL Support. For USEPA Region 8, team leader for the development of metals TMDLs in the Lake Helena watershed, Montana. Prepared sections of the watershed characterization report, helped develop a sampling and analysis plan, and performed a water quality impairment status analysis for the metals-listed segments. She developed an LSPC watershed model for cadmium, copper, lead, zinc, and arsenic. Model set-up, hydrology and water quality calibration, and TMDL allocations are completed, and the TMDL is currently on public notice.

Milwaukee LSPC Model Training. As part of a team of three Tetra Tech staff, taught a 1-day LSPC introductory training course for our Milwaukee clients. Prepared model set-up and hydrology calibration exercises for this training.

Sediment and Nutrient TMDLs, Pennsylvania. For USEPA Region 3, wrote the TMDL report for two sediment and nutrients impaired segments of the upper Brush Run in the Chartiers Creek watershed, Pennsylvania. Currently working on the development of sediment and nutrients TMDLs for the lower segment of this stream.

BASINS for Puerto Rico and Virgin Islands. For USEPA Region 2, assisted on the development of a customized BASINS system for Puerto Rico and the Virgin Islands. Also prepared and taught 4-day BASINS training course for the Environmental Quality Board of Puerto Rico and the Department of Environmental Protection of the Virgin Islands staff. The training includes watershed and receiving water models. Was also the technical lead and technical manager in the development of nutrients and fecal coliform bacteria watershed model for the Loiza River in Puerto Rico.

Fecal Bacteria TMDLs, South Carolina. For USEPA Region 4, task leader for the development of fecal coliform bacteria TMDLs for five impaired waterbodies in the Twelve Mile Creek watershed, South Carolina. Used the Watershed Characterization System of USEPA Region 4 to aid in the data analysis and source assessment, and LSPC to model the hydrology and water quality of the impaired streams.

West Virginia Metals TMDLs Development. For USEPA Region 3, had a lead technical role in the development of pH and metals TMDLs for 64 impaired streams in the Tug Fork of the Big Sandy River (located in the border of West Virginia, Kentucky and Virginia). Evaluated data and pollutant sources to determine the relationships between in-stream metal concentrations to both acid mine drainage and suspended sediments. Developed a new system to organize mining and NPDES permits information. Used the Mining Data Analysis System to simulate flow and concentrations of iron, aluminum and manganese in the streams.

Support for Environmental Impact Statement. For the U.S. Army Corps of Engineers, assisted in the development of an Environmental Impact Statement to address the environmental and socio-economic consequences of large-scale development projects in coastal Mississippi. Activities included the use of existing studies and monitoring data to evaluate the spatial and temporal extent of pathogen and sedimentation problems in coastal Mississippi for the past 3 decades. She estimated point and non-point source loadings to evaluate the relative contribution of both fecal coliform bacteria and sediment from the different land-use types. Ms. Barreto established a trend analysis relating changes in land uses to changes in water quality. This project involved extensive use of data processing skills and extensive use of Microsoft Access and its statistical package.

Sediment Loads Modeling. For the Mobile Bay National Estuary Program, used the Loading Simulation Program in C++ (LSPC) to model sediment loads from the Mobile River watershed to Mobile Bay and the distribution of loadings throughout the contributing drainage area. The project involved simulating the production and removal of sediment from land segments, and the transport, deposition, and scour of sediment in the stream channels.

TETRA TECH, INC.

John Beckman

Watershed Analyst

EDUCATION

M.E.M., Environmental Management, Duke University, 1998

B.A., Biology, University of California – Santa Cruz, 1994

YEARS OF EXPERIENCE

Total: 16

With Tetra Tech: 13

TRAINING

Rosgen Level 1 Training, Applied Fluvial Geomorphology, 2006

Habitat Evaluation Procedures Workshop, Virginia Tech Continuing Education, 2002

Grass, Rush and Sedge Identification Workshop, West Virginia Natural Heritage Program,1999

Core Heritage Program Methodology Training, The Nature Conservancy,1999

KEY AREAS OF EXPERIENCE

- TMDL development
- Watershed modeling
- Water quality field studies
- Land use analysis and GIS
- Watershed data management
- Technical writing/editing
- Stream restoration evaluation and design
- Botanical surveys

Mr. Beckman is an environmental scientist specializing in TMDL development and natural resources inventory. He has 16 years of professional experience performing scientific research, analysis, and large scale field surveys. Mr. Beckman leads the Tetra Tech fecal coliform TMDL development efforts for the West Virginia DEP. His duties include water quality modeling, data management, GIS analysis, technical writing, field investigations, and public outreach support. Mr. Beckman also has experience in the state of West Virginia participating in stream ecology and botanical studies.

Selected Project Experience

TMDLs for the South Branch Potomac, Upper Kanawha, and Upper Ohio North Watersheds, WV. For the WVDEP, led fecal coliform TMDL development for watershed group A3. Gathered hydrologic data and built MDAS model. Calibrated MDAS watershed models for hydrology and water quality. Developed model inputs for failing septic systems, MS4 areas, and agricultural sources. Modeled point-source permitted fecal coliform discharges. Developed TMDL load allocations and pollutant reductions for both point and nonpoint sources.

TMDLs for the West Fork River Watersheds, WV. For the WVDEP, led fecal coliform TMDL development for watershed group E2. Built MDAS watershed model through analysis of hydrology, land cover, and elevation datasets. Conducted MDAS watershed model calibration for hydrology and water quality parameters. Performed iron-sediment correlation and streambank erosion calibration. Represented fecal coliform and iron point-source discharges in the MDAS model. Developed TMDL load allocations and pollutant reductions fecal coliform sources.

TMDLs for the Monongahela River Watershed, WV. For the WVDEP, led fecal coliform TMDL development for watershed group D2. Constructed a hydrologic model using GIS analysis and database techniques. Calibrated MDAS watershed models for hydrology and water quality. Developed model inputs for CSOs, failing septic systems, MS4 areas, and agricultural sources. Incorporated point-source permitted fecal coliform discharges into the watershed model. Developed TMDL load allocations and pollutant reductions for both point and nonpoint sources.

TMDLs for the Middle Ohio North and South Watersheds, WV. For the WVDEP, led fecal coliform TMDL development for watershed group C2. Performed GIS analysis to delineate model subwatersheds and manage pollutant source data. Built and calibrated MDAS watershed models. Developed CSO and MS4 model inputs. Incorporated permitted fecal coliform discharges into the watershed model, and developed TMDL load allocations and pollutant reductions for both point and nonpoint sources.

TMDLs for the Lower Kanawha Watershed, Elk River, and Patterson Creek, WV. For the WVDEP, led fecal coliform TMDL development for watershed group B2. Used hydrologic and topographic GIS data to delineate model subwatersheds. Built and calibrated MDAS watershed models. Incorporated permitted discharges into the watershed model, and developed TMDL load allocations and pollutant reductions for both point and nonpoint sources. Met with wastewater treatment plant operators and city engineers to develop CSO and MS4 model inputs.

Trout Water Iron Modeling Project, WV. For the WVDEP, participated in model development efforts to investigate total iron concentrations in two trout streams,

Elklick Run and Holcomb Run, both headwater streams in the Gauley River Watershed. Performed fieldwork to collect soil samples and estimate streambank erosion. Set up watershed model, compiled meterological data, and prepared preliminary draft report.

TMDLs for the Cheat River Watershed, WV. For the WVDEP, led fecal coliform TMDL development for impaired streams in the Cheat River Watershed (watershed group A2). Performed GIS analysis to delineate model subwatersheds and manage pollutant source data. Built and calibrated MDAS watershed models. Incorporated permitted discharges into the watershed model, and developed TMDL load allocations and pollutant reductions for both point and nonpoint sources. Attended public meetings to present TMDL results.

TMDLs for the Upper Ohio South, Dunkard Creek, Youghiogheny Tributaries, and Camp Creek Watersheds, WV. For the WVDEP, led fecal coliform TMDL development for watershed group E. Delineated model subwatersheds using GIS. Built and calibrated MDAS watershed models for hydrology and water quality. Modeled CSO point sources and MS4 areas. Incorporated permitted discharges into the watershed model, and developed TMDL load allocations and pollutant reductions for both point and nonpoint sources. Made figures and edited reports.

TMDLs for New River and Greenbrier River Watersheds, WV. For the WVDEP, served as TMDL development team member for watershed group D. Participated in the Stressor Identification workshop for biological TMDLs. Used GIS to delineate model subwatersheds. Built and calibrated MDAS watershed models. Developed TMDL load allocations and pollutant reductions. Assisted with agricultural pollution source tracking field surveys in impaired watersheds.

TMDLs for Gauley River and Potomac Direct Drains Watersheds, WV. For the WV DEP, served as TMDL development team member for watershed group C. Used watershed data to build MDAS models for fecal coliform and sediment. Performed hydrology calibration, water quality calibration, and load allocations for the Potomac Direct Drains watersheds models. Edited technical reports, and collected data for streambank erosion field studies.

TMDLs for Coal River, Lower Kanawha, and North Branch Potomac Watersheds, WV. For the WVDEP, served as TMDL development team member for watershed group B. Performed GIS analysis to contribute to the pollutant source reports for the three TMDL watersheds. Produced ArcInfo GIS project displaying TMDL results as part of the public TMDL report. Edited text and made figures for the public and technical TMDL reports.

Source Water Protection Field Surveys, WV. For the West Virginia Department of Health and Human Resources, Source Water Assessment and Protection Program, led field surveys to verify potential contaminant sources for 100 drinking water systems. Served as primary point of contact for subcontractors and off-site field staff. Organized field data using GIS and MS Access databases.

Perennial Streams Survey, West Virginia. Field botanist for USACE Huntington District project to assess hydrogeomorphology of headwater streams and vegetative characteristics of headwater riparian areas in southern West Virginia. Used field methods to determine canopy, shrub, and herbaceous percent cover and tree species. Surveyed bank angle, longitudinal profile, and streambank erosion. Used GPS to navigate to sites and record survey features.

Wetlands Baseline Survey, ND. For the Turtle Mountain Band of the Chippewa, developed survey protocol and sampled over 100 wetlands on tribal lands. Identified dominant vegetation, wildlife species, benthic substrate, invasive species, and anthropogenic disturbance. Designed MS Access database and ArcView GIS project to track and present survey results.

Wadeable Streams Assessment, NH, VT, ME. For the USEPA Office of Water, served on a field crew to sample over 50 streams in New Hampshire, Vermont, and Maine to study stream ecology and geomorphology. Collected water chemistry samples and benthic macroinvertebrate specimens; also measured stream flow, substrate, vegetative cover, large woody debris, and fish habitat.

Environmental Restoration Feasibility Study, Powderly Creek, Pennsylvania; USACE, Baltimore District. Performed wetland vegetation field surveys for this environmental restoration feasibility study. Used Evaluation for Planned Wetlands ecologic modeling methodology to calculate functional values of degraded wetlands. Developed a planting plan to restore native vegetation to degraded wetland and upland habitats.

Invasive Plant Survey and Mapping, U.S. Army, Southeastern United States. Primary Investigator for invasive plant survey and mapping projects at five U.S. Army installations, including Blossom Point, Maryland; Radford, Virginia; Milan, Tennessee; Anniston, Alabama; and Redstone Arsenal, Alabama. Identified invasive and native plant species. Used GPS/GIS, digital photography, and other field methods to delineate invasive plant infestations. Ranked observed species by threat potential and made recommendations for control.

TETRA TECH, INC.

Clint Boschen

Biological Analyst

EDUCATION

M.S., Biological Sciences, Florida State University – Tallahassee, FL, 1996

B.S., Biology, Virginia Polytechnic Institute and State University (Virginia Tech) – Blacksburg, VA, 1991

YEARS OF EXPERIENCE

Total: 18

With Tetra Tech: 13

PROFESSIONAL AFFILIATIONS

Water Environment Federation

KEY AREAS OF EXPERIENCE

- Biological and bacteria TMDL development
- Stressor identification
- Watershed management plan development
- Watershed modeling and stormwater implementation
- Water quality monitoring and bioassessment
- State regulatory experience (Virginia DEQ)

Mr. Boschen has more than 12 years of professional experience in water quality planning programs, stream and lake assessment, wetland permitting and mitigation, water quality and biological sampling, and watershed modeling studies. He is a member of the water resources division of the Tetra Tech office in Fairfax, Virginia and has managed several TMDL and water resource projects for USEPA Regions 2 and 3, Virginia DEQ, and Fairfax County, Virginia. He is has supported the development of biological TMDLs for West Virginia DEP and has led biological TMDL and stressor identification studies for watersheds in Virginia and West Virginia. Mr. Boschen has experience with all aspects of the Clean Water Act, including wetland and stream protection programs (Sections 404 and 401), water quality standards, NPDES, water quality planning, and TMDLs. As an Environmental Engineer with Virginia DEQ, Mr. Boschen supported NPDES permit activities and modeling studies, performed assessments of water quality data and assisted in the production of the biennial 305(b) and 303(d) reports. His responsibilities also included coordination and management of nonpoint source pollution studies, management of the regional Virginia Water Protection Permit program (CWA, Section 401), and technical support to monitoring and regulatory programs. Mr. Boschen has extensive academic and research experience in the areas of aquatic pollution biology, fisheries ecology, and systems ecology.

Selected Project Experience

Biological TMDL Development for West Virginia Streams. For WVDEP, served as the project manager for the development of biological TMDLs for streams in the Upper Ohio, Upper Kanawha, Lower Kanawha, Coal River, and North Branch Potomac watersheds in West Virginia. Coordinated stressor identification studies involving the analysis of available water quality, habitat, and biological data to determine the primary causes of impairment for each listed stream. Also participated in stressor identification studies for the Gauley River and Potomac Direct Drains watersheds. Stressor identification incorporated statistical analyses of pollutant-biological response relationships, literature reviews, and additional data collection to help identify and evaluate candidate causes of biological impairment. Assisted in the development of novel statistical approaches and diagnostic tools that utilize biological data to help identify benthic community stressors (tolerance value and "dirty null" models). He coordinated the development of TMDLs for identified stressors (pollutants) using a reference watershed approach and selected water quality/watershed modeling systems (MDAS, GWLF, etc.). TMDLs were developed for excessive sedimentation, metals contamination, acidity, and other problems which have been linked to observed biological impacts. Has presented TMDL and Stressor Identification approaches at several conferences, including the Mid-Atlantic Aquatic Biologists Workshop 2001/2003/2005 (Cacapon, WVa), WEF TMDL 2005 (Philadelphia, PA), AWRA 2002 (Philadelphia, PA), WEF Watersheds 2002 (Fort Lauderdale, FL), and SETAC 2001 (Baltimore, MD).

Nutrient and Sediment Modeling Workshop. For USEPA Region 3, developed and taught a nutrient and sediment modeling workshop. This 4-day workshop was given to water resource planning and TMDL staff from state regulatory agencies (Virginia, West Virginia, Delaware, and Pennsylvania).

Elk River TMDL Development, WV. For WVDEP and USEPA Region 3, participated in the development of mining TMDLs for the Elk River Basin in West

Virginia. Provided watershed and water quality data analyses to determine correlations between sedimentation and metals loading. Also assisted in watershed modeling activities, including sediment source representation and TMDL calculations.

Development of Watershed Loading Models. Led the development of GWLF model enhancements for sediment and nutrient modeling. Helped design an enhanced set of GWLF tools and capabilities to support TMDL development in West Virginia, Virginia, and other states. This work included the development of a GIS-based extension that rapidly creates GWLF input files, extended subwatershed modeling capabilities, a methodology to estimate stream channel erosion/deposition loads, and enhanced TMDL allocation tools.

Biological and Bacteria TMDL Development for Virginia Streams. For the Virginia Department of Environmental Quality (VADEQ) and USEPA Region 3, served as the Project Manager for the development of biological and bacteria TMDLs for streams in the Potomac-Shenandoah, Tennessee-Big Sandy, Roanoke, and James River Basins. Developed watershed/water quality models to determine the reductions necessary to meet state water quality standards. USEPA's BASINS model and Tetra Tech's Loading Simulation Program in C++ (LSPC) model were used to develop TMDLs for fecal coliform bacteria and *E. coli*. Significant stakeholder involvement and bacteria source assessment studies were used to accurately represent bacteria sources and development meaningful load allocations for implementation. Stressor identification was used to identify the pollutants of concern and other factors responsible for impacts to aquatic life in impaired streams. The stressor identification process involved the review of water and sediment quality data, toxicity test results, and physical processes (i.e. hydromodification, riparian buffer disturbance, etc.) to determine the primary causes of impairment. Developed regionally-calibrated bioassessment indicies to evaluate stream conditions in impaired and reference watersheds. Coordinated the development of a stream routing module that calculates bank erosion and stream channel deposition to evaluate the effects of stream processes on pollutant loads. The Generalized Loading Functions (GWLF) model was used to determine acceptable loads for pollutants of concern (e.g. sediment, phosphorus, metals, etc.) and load allocations to meet aquatic life requirements.

Roanoke River PCB TMDL Development. For VADEQ and USEPA Region 3, leading the development of PCB TMDLs for the Roanoke River Basin. Developed a historical data review and designed a monitoring plan and Quality Assurance Project Plan (QAPP) to help identify potential PCB sources in the watershed and collect additional data for TMDL development. Watershed modeling methods are currently being developed to address PCB sources in the watershed. Mr. Boschen presented existing data and project objectives to stakeholder groups and at public meetings.

Bacteria TMDL Development for Shellfish Waters in New Jersey. For USEPA Region 2 and the New Jersey Department of Environmental Protection (NJDEP), led the development of TMDLs for shellfish impaired waters. Developed a comprehensive data analysis and TMDL approach to assess water quality conditions in shellfish waters along the entire New Jersey coastline from Sandy Hook to Delaware Bay. Bacteria source loads were estimated using the Watershed Treatment Model (WTM) and other methods in order to determine the load reductions necessary to improve water quality conditions and potentially re-open these areas to shellfishing. This study included the analysis of water quality data and watershed modeling for 111 shellfish areas in six different watershed management regions. A total of 48 TMDLs were developed as a result.

Bacteria TMDL Development for Lakes in New Jersey. For USEPA Region 2 and NJDEP, serving as the Project Manager for the development of bacteria TMDLs for recreational lakes in New Jersey. County and township health department data are currently being assessed to determine bacteria levels in all small to medium-sized recreational lakes in New Jersey. TMDLs will be developed for approximately 77 lakes using a statistically-based approach, which incorporates a watershed loading model to estimate land-based loads.

Watershed Planning Support Services, Fairfax County, VA. For the Fairfax County Department of Public Works and Environmental Services, Co-Project Manager for the development of watershed planning protocols and technical tools. Tetra Tech is assisting the County in developing watershed plans for all 30 watersheds, including the development of watershed models (SWMM and HEC-RAS) and providing additional technical support. Assisting County staff in addressing stormwater planning needs, stormwater permit requirements, and Chesapeake Bay nutrient and sediment reduction goals.

TETRA TECH, INC.

Kimberly Brewer, AICP

Outreach Specialist

EDUCATION

MRP, City and Regional Planning, University of North Carolina, 1985

BA, Economics, Wake Forest University, 1981

YEARS OF EXPERIENCE

Total: 29

With Tetra Tech: 17

PROFESSIONAL AFFILIATIONS

American Planning Association

American Institute of Certified Planners

KEY AREAS OF EXPERIENCE

- Watershed Management Planning
- Stakeholder Facilitation and Mediation
- Sustainable Water Practices
- Program Implementation Support
- Outreach

Throughout her 28 years of water resources planning and management experience, Ms. Brewer has coupled technical and policy analysis with stakeholder facilitation/mediation to develop innovative, cost-effective watershed management and green design strategies. She leads Tetra Tech's conflict resolution team, WateResolve, which has facilitated more than 25 complex, multi-party water resource projects to consensus. As a planning consultant, she has assisted in conducting numerous state and local watershed management studies, pioneered approaches for low-impact design, and co-designed the U.S. Environmental Protection Agency's Watershed Academy. She was a principal co-author of the Handbook for Developing Watershed Plans to Restore and Protect Our Waters (USEPA, 2008). She has assisted several states in developing watershed management frameworks, including the State of West Virginia. She also assisted WVDEP in developing its Antidegradation Implementation Procedures. Ms. Brewer was a co-investigator and co-author for the joint Electric Power Research Institute (EPRI)/WERF project on Case Studies for the New Water Infrastructure Management Paradigm to help communities develop sustainable approaches to water management. Prior to consulting, Ms. Brewer worked 11 years in local, state, and regional agencies, gaining extensive experience in program development and management in the areas of water resource protection. Ms. Brewer's experience working with government agencies and diverse stakeholder groups, along with her practical experience studying and implementing cost-effective innovations, allows her to understand different perspectives and to design strategies that meet multiple objectives. Her projects have incorporated onsite performance standards, low-impact development design, conservation offsets, phosphorus banking, and other innovative techniques.

Selected Project Experience

McDowell Creek Watershed Management. For Mecklenburg County and Town of Huntersville, NC, worked with staff and advisory boards to develop management goals, targets, and strategies for managing new development centered on low-impact development design and performance standards. Assisted in developing stormwater management ordinance and water quality design manual, unanimously adopted January 2003.

Beaver Lake Watershed Management Strategy. Co-facilitator and lead planner for the Beaver Lake watershed management planning process for Northwest Arkansas Council focused on restoration of streams designated as impaired waters and protection of regional drinking water supply. Designed mediation/facilitation process. Co-facilitated diverse 22 member Policy Advisory Group, including development and adoption of goals, objectives, and long-term water quality targets, and evaluation of management alternatives, and adoption of management strategy. Co-facilitated focus groups. Provided link to Tetra Tech's technical scoping and assessment team. Assisted in developing management alternatives. Wrote consensus strategy document which included a land conservation program, stream restoration, and a voluntary developer lake protection certification program.

Los Angeles County TMDL Implementation Plans. Assisted in developing multi-pollutant TMDL Implementation Plans for the Ballona Creek and the Los Angeles River in Los Angeles County, California, including local program review, regulatory review for BMPs recommended, implementation strategy development, and implementation plan.

Agua Hedionda Watershed Management Plan. Lead facilitator and watershed planner for the Agua Hedionda Lagoon watershed in Southern California. Project involved development of a comprehensive watershed management plan guided by a diverse citizen advisory group, industry, state, local, and federal agencies. Facilitated adoption of goals, objectives, and prioritization criteria to guide selection and location of best management practices. Conducted consensus building process in evaluation of alternatives. Provided link to Tetra Tech's fact finding and assessment team for the project. Reported technical assessments to the group. Adopted July 2008.

Lake Maumelle Watershed Management Plan. Co-facilitated Policy Advisory Council and Technical Advisory Council in developing goals, objectives, and long-term water quality targets for the Lake Maumelle water supply, as well as evaluating and selecting the preferred management options; co-led public education and outreach efforts; provided link to Tetra Tech's fact finding and technical assessment teams and reported results to the Councils, conducted small group mediation on select issues, led in writing the Management Plan and implementation strategy which was unanimously adopted by the Central Arkansas Commission in February 2007. Management strategy included requirements for development performance standards for pollutant runoff, low-impact development design, land conservation offsets, and sustainable management of decentralized wastewater systems.

Charlotte-Mecklenburg Post-Construction Ordinance Development. For Mecklenburg County Phase II jurisdictions and the City of Charlotte, NC, co-facilitated development of county-wide post-construction ordinance. Facilitated development of goals, objectives, long-term water quality targets, and decision criteria. Presented Tetra Tech's scoping and watershed assessment; facilitated stakeholder development of alternative management measures and selection of a preferred option, and assisted in developing post-construction ordinance provisions, including water quality performance standards, open space requirements, and off-site mitigation . Conducted mediation on select issues. Ordinance unanimously adopted by 22-member stakeholder committee.

City of High Point Deep River 1 Watershed Assessment Plan. For the City of High Point, NC, mediated development of alternative strategy to state mandated water supply protection regulations. Stakeholder included environmentalists, businesses, industry, state and local officials. Developed consensus on decision criteria to evaluate alternative strategies. Assisted group in crafting alternative strategies. Facilitated evaluation and selection of alternatives. Provided link to Tetra Tech's technical water quality team and reported assessment results. Mediated discussions between City and state water quality agency to reach consensus. The Plan, which was unanimously approved by the City, County, and State, involves an innovative Phosphorus Banking program as well as low impact development (LID) education and incentives and provides higher levels of protection than the state mandated standards. Won NCAPA Award for Plan Implementation for Multiple Jurisdictions.

Rockdale County Watershed Assessment and Master Plan. For Rockdale County GA, co-facilitated a diverse 23-member stakeholder group to develop and adopt a comprehensive watershed master plan for the County to meet state loading limits to a regional drinking water supply. Led in development of management plan objectives; of indicators and targets; evaluation of alternative management approaches; and management plan development.

Upper Neuse Watershed Management Plan. Lead planner and facilitator in developing watershed management plans to address water supply protection and habitat impacts in eight drinking water supply watersheds. Plans were tailored for local governments to meet adopted goals and measurable targets, and include onsite performance standards for stormwater management. Included planning and participating in a two-day low-impact design workshop for local elected officials and staff, developers, and designers.

Cane Creek Reservoir Watershed Study. For Orange Water and Sewer Authority NC, worked with a diverse community advisory committee. Assisted in developing and tailoring measurable indicators to guide the local watershed study; designing the economic impact analysis; and developing, evaluating, and screening watershed management options. Assisted in presenting and writing the study findings.

Handbook for Developing Watershed Plans to Restore and Protect Our Waters. Co-author of a guidance document prepared for the U.S. Environmental Protection Agency's Office of Water. Wrote or edited numerous sections addressing the overall approach to watershed management, how to scope a watershed planning effort, setting goals and management objectives, developing indicators and targets, identifying promising management options, evaluating and selecting best management measures, designing an implementation program, and how to track implementation progress and adapt accordingly.

TETRA TECH, INC.

Jonathan Butcher, PH

Technical Expert

EDUCATION

Ph.D., Civil and Environmental Engineering (Water Resources), Duke University, 1989

M.E.M., Water Resources, Duke University School of Forestry and Environmental Studies, 1984

B.A., Harvard College, 1973

YEARS OF EXPERIENCE

Total: 27

With Tetra Tech: 17

LICENSES & CERTIFICATIONS

1995, Professional Hydrologist, Registered by the American Institute of Hydrology, Certificate #1087

PROFESSIONAL AFFILIATIONS

American Institute of Hydrology (Registered Professional Hydrologist)

American Water Resources Association (Reviewer for JAWRA)

North Carolina Water Resources Association

American Society of Civil Engineers

American Geophysical Union

Water Environment Federation

North American Lake Management Society

Society of Environmental Toxicology and Chemistry

KEY AREAS OF EXPERIENCE

- Hydrodynamic and pollutant transport modeling
- Pollutant source assessment
- Watershed hydrology and stormwater
- TMDL development and implementation
- Environmental risk assessment
- Watershed management plan development
- BMP evaluation and design

Dr. Butcher is a registered Professional Hydrologist and environmental engineer with over twenty four years experience in watershed planning, risk assessment, and the development, application, and communication of hydrologic, hydraulic, and water quality models. Dr. Butcher has led technical efforts to support state and local governments in a variety of TMDL, wasteload allocation, watershed modeling, and water body restoration and protection studies. He was the technical lead for projects to develop nutrient loading and response models for Jordan Lake (NC) and is currently leading the development of 20 large-scale watershed models across the US to evaluate hydrologic impacts of climate change. Dr. Butcher's research interests also include development of TMDLs to address narrative criteria for sediment and nutrients. He is experienced in use of numerous lake, river, and estuarine hydrodynamic, hydrologic, and water quality models, and has conducted flow, sediment, DO, nutrient, algae, and toxics modeling on a variety of river systems ranging from the Santa Margarita River in southern California to the Hudson River in New York. Dr. Butcher has been a lead author for several EPA Office of Water and Water Environment Research Foundation guidance documents.

Selected Project Experience

Louisville Linked HSPF/SWMM Models. Lead Scientist and Modeling QC Officer for a multi-year project to simulate urban CSO watersheds impaired by bacterial contamination and low dissolved oxygen. Modeling includes integration of the SWMM model for combined sewers with the HSPF watershed model. HSPF provides inputs to the combined sewer system and receives outputs from SWMM to complete simulation of stream segments upstream of the Ohio River backwater. To address reversing and stagnant flows in the backwater area, the HSPF and SWMM output is fed forward to a RIV-1/WASP modeling pair to yield a complete model of the Beargrass Creek watershed. This tool addresses the needs of both TMDL development and capital improvement projects to meet the Integrated Overflow Abatement Plan.

Milwaukee Metropolitan Sewer District (MMSD) 2020 Planning Study. Modeling lead for the MMSD 2020 study. Developed comprehensive watershed models for the Milwaukee area and supported TMDL development (1,100 mi^2). HSPF is used as the basic model framework; however, loading rates from individual land areas are tuned to replicate estimates developed using SWAT (for agricultural land) and SLAMM (for developed urban land), as directed by Wisconsin DNR. A variety of agricultural management practice/soil combinations are simulated in SWAT and used to interpret equivalent buildup/washoff parameters for simulation in HSPF. The watershed models are linked with CSO and receiving water models in the estuary and near shore lake area. The modeling system was used to evaluate alternatives under future land use conditions that include various levels of sewer separation and watershed BMPs retrofits and new development practices. Alternatives were evaluated based on multiple indicators including CSO overflows, sediment, nutrients, and pathogens.

Black River TMDL SWAT Models. Developed and calibrated a SWAT model to support TSS and nutrient TMDLs in the Black River, Ohio. Analyzed multiple scenarios for a variety of agricultural management practices. Linked SWAT to CE-QUAL-W2 model of the harbor.

Chicod Creek Fecal Coliform TMDL. For NC DWQ, led project to develop fecal coliform TMDL for Chicod Creek, an agricultural watershed in eastern NC. The watershed contains a large number of confined animal operations and drained agriculture. Analysis of existing data demonstrates that the impact of animal operations on coliform loads has declined significantly as a result of efforts to implement waste management plans. Used load duration curve approach with statistical confidence limits to evaluate needed incremental reductions to achieve standards.

Jordan Lake TMDL Watershed Model. For NC DWQ, led project to model watershed nutrient loads from a 1700 square mile watershed to support development of TMDL for chlorophyll a. The watershed contains a wide mix of land uses, from rapidly growing cities and suburbs to row crop agriculture. To address nonpoint loading from this large watershed we combined sub-watershed estimates of nutrient load generation using the Generalized Watershed Loading Functions (GWLF) model with the stream transport/attenuation component of the USGS SPARROW model.

Clarks Creek DO TMDL. Supporting USEPA Region 10 and Washington Ecology in the development of an implementation-ready DO TMDL for Clarks Creek in Puyallup. This spring-fed tributary of the Puyallup River is an important spawning and rearing area for salmon, but is also threatened by low DO, caused in part by the overgrowth of waterweed (*Elodea nuttallii*) and sediment oxygen demand. Conditions that promote macrophyte growth include nutrient and sediment loads and the removal of riparian cover. A key objective of the DO TMDL is the development of a strategic implementation plan for attaining DO standards, including recommendations on specific locations and practices that will most effectively reduce stressors associated with urban stormwater, hatchery discharges, agricultural runoff, and instream/riparian improvements.

Lake Pepin TMDL Implementation. Leading a project for USEPA Region 5 to model benefits and cost-effectiveness of management alternatives to achieve the sediment and nutrient loading targets specified in the TMDL for Lake Pepin (Mississippi River) as well as to evaluate opportunities for nitrogen load reduction relative to management of Gulf of Mexico hypoxia. Project involves use of field and small watershed models (e.g., DRAINMOD-SWAT) to evaluate management options and provide input to large-scale HSPF watershed models.

Tongue River TMDL Models. Senior modeler supporting USEPA in development of LSPC simulation models to simulate TDS, SAR, and nutrients throughout the Tongue River Planning Area in Montana and Wyoming, an area affected by saline discharges from coalbed methane production. Developed innovative methods to incorporate discharges to ephemeral streams, leaching and deposition of salts in soils, and the influence of stockponds.

Alamo Lake Mercury TMDL. Led the lake modeling component of a mercury TMDL for Alamo Lake in western Arizona. Combined HEC-5 reservoir simulation with WASP/TOXI water quality model and grid-based mercury loading model.

McPhee, Narraguinnep, and Sanchez Reservoir Mercury TMDLs. For EPA Region 8, project leader to develop mercury TMDLs for three reservoirs in southern Colorado. These rural watersheds are impacted by atmospheric deposition and past mining activities. Developed linked watershed and dynamic lake response models to estimate load allocations to achieve fish tissue concentration targets. Analyzed wet and dry mercury deposition and conducted HYSPLIT reverse particle tracing air modeling to identify near-field sources.

Arivaca and Peña Blanca Mercury TMDLs. Developed approved mercury TMDLs for two Arizona lakes. Arivaca and Peña Blanca Lakes are man-made impoundments located in southern Arizona and operated for public recreation and fisheries. Both lakes were placed on Arizona's 303(d) list due to fish consumption guidelines for mercury. The objective of the TMDLs is to establish the allowable loads of mercury to each lake that are consistent with attaining acceptable mercury concentrations in fish tissue.

Region 9 Sediment TMDLs. Assisted EPA Region 9 to develop clean sediment TMDLs for the Garcia, South Fork Trinity, and Navarro watersheds. These TMDLs, based on narrative standards, rely on the risk assessment paradigm to develop quantitative goals. Provided technical analysis, review, and critique of proposed management strategies for several California watersheds impaired by sediment loading, including analysis of geomorphological response of streams to instream and upland management of sediment and flows. Also participated in the development of draft protocols for completing sediment TMDLs.

High Rock Lake TMDL Water Quality Data Review. For NC DWQ, conducted a review of existing monitoring and modeling efforts on High Rock Lake, a run-of-the river impoundment of the Yadkin River impaired by turbidity and eutrophication. Developed conceptual model, model quality objectives, and data quality objectives to guide the future assessment and TMDL development process. Now serving as project manager to EPA for development of linked HSPF and WASP models to estimate the TMDL.

TETRA TECH, INC.

Trevor Clements

Watershed Analyst

EDUCATION

M.E.M., Water Resource Systems Analysis, Duke University, 1983 (3-2 Program)

B.A., Political Science, Environmental Conservation, Augustana College, IL, 1982

YEARS OF EXPERIENCE

Total: 30

With Tetra Tech: 17

PROFESSIONAL AFFILIATIONS

American Water Resources Association

Water Environment Federation

KEY AREAS OF EXPERIENCE

- Watershed assessment
- Watershed management plan development
- Stakeholder facilitation
- Public involvement
- Low impact development
- BMP evaluation
- Protocol development
- TMDL development
- Regulatory reviews
- Program development

Mr. Clements has 30 years of experience in the assessment and management of surface water quality. He has become one of the nation's leading experts in comprehensive watershed management by working with numerous local, state, and federal agencies to develop integrated frameworks. From a technical standpoint, Mr. Clements has worked on researching and developing watershed approaches, managing modeling and assessment analyses, conducting watershed studies, evaluating sustainable management practices, drafting watershed management plans, supporting NPDES permitting processes, and developing monitoring programs. As an educator, his work has included developing training and outreach materials and conducting educational forums. He has also achieved national recognition for his skills in facilitating intensive work group sessions and partner meetings, trouble-shooting framework development and implementation barriers, facilitating stakeholder involvement, and refining program roles and procedures.

Before becoming a consultant, Mr. Clements was Chief of the Technical Support Branch for North Carolina's Division of Water Quality (DWQ) with oversight of the Surface Water Modeling, TMDL, NPDES Wasteload Allocation, and Pretreatment Programs. His 10 years of experience with DWQ include areas of standards, monitoring, assessment, modeling, planning, permitting, enforcement, and pollution prevention. Mr. Clements has expert knowledge of state program requirements and operations mandated by the Clean Water Act. He has extensive experience in the field of surface water quality modeling, with particular emphasis on the use of fate and transport simulations to develop TMDLs, wasteload allocations, and nonpoint source load allocations.

Selected Project Experience

Handbook for Developing Watershed Plans to Restore and Protect Our Waters. Co-author of a guidance document prepared for USEPA's Office of Water. Wrote or edited numerous sections addressing the overall approach to watershed management, how to scope a watershed planning effort, setting goals and management objectives, developing indicators and targets, identifying promising management options, evaluating and selecting best management measures, designing an implementation program, and how to track implementation progress and adapt accordingly.

North Carolina Local Watershed Plans. For the North Carolina Ecosystem Enhancement Program (NCEEP), managed contracts for local watershed plans to be developed in six areas of the state, three in the Upper Cape Fear River Basin, one in the Neuse River Basin, one in the Upper Yadkin River Basin, and one in the Catawba River Basin. The planning process involves scoping greatest threats to watershed function, performing detailed assessment of key indicators for function of concern, prioritizing and targeting areas for management, working with stakeholders to identify cost-effective management solutions, and documenting recommendations in local watershed management plans. Emphasis is placed on locating and prioritizing restoration opportunities and stormwater BMP retrofit sites. Five of the plans have been completed, and catchment plans for the sixth targeted watershed are in development.

Watershed Academy. Co-managed initial design and development of a National Watershed Academy for USEPA Office of Water. Helped USEPA watershed team establish Academy goals, audiences, themes, curricula, course development schedule, and training session schedules. Led development of three core courses,

Statewide Watershed Management; Watershed Management: The Executive Short Course, and *Applied Watershed Management*. Also managed initial development of the Academy training website, an internet-based system for information transfer and distance learning. Co-authored or directed development of several distance learning modules for the website, covering watershed planning, monitoring, modeling, and best management practices. Provided course instruction for states and USEPA regions and support to the Interagency Watershed Training Cooperative.

Framework for Watershed Management. Co-principal investigator for research and development of a framework to serve as a national model for linking local, state, and federal watershed management efforts through complementary protocols. Co-authored report (WERF 93-IRM-4) describing the essential elements of a watershed management approach based on the experience working with watershed management practitioners, stakeholder surveys, and a national stakeholder workshop. Conducted for the Water Environment Research Foundation.

Louisville MSD Resource Management Approach Development. Co-facilitated a conceptual outline for transition of operations for the Louisville Jefferson County Metropolitan Sewer District (MSD) to a watershed-based resource management approach. Key program elements and decision-making are to be based on linked goals, indicators, and targets so that benefits to the environment are maximized per program dollar expended. Program components included CSOs, SSOs, and MS4 related projects.

Upper Neuse River Basin Association Watershed Approach. Co-facilitated a process to link watershed management efforts for an association of 14 local jurisdictions to North Carolina's basinwide management approach. Included facilitation of Policy Guidance and Technical Advisory Committees and preparation of a document describing the consensus framework. The framework is in its seventh year of implementation and is running strong.

State Watershed Management Framework Facilitation. Led framework facilitation for North Carolina, Nebraska, Georgia, Texas, Kentucky, and Mississippi. Provided assistance to South Carolina, Washington, Delaware, Idaho, New Jersey, Florida, Oregon, Minnesota, Tennessee and West Virginia (note: each was a separate project). Led efforts to scope changes that needed to be made in resource agency operations to support watershed-based management, facilitated development of frameworks to support the new operating processes, documented findings, and advised on implementation. Most work sponsored by USEPA Office of Water, with some joint funding from states.

Information Transfer Documents Regarding State Framework Development. Co-authored *Watershed Protection: A Statewide Approach* document for USEPA Office of Water describing common components, issues states are likely to encounter, methods for resolving issues, and general recommendations for statewide framework development. Co-authored document *Statewide Watershed Management Facilitation* for USEPA Office of Water describing types of support, key considerations, and state facilitation experiences.

Mecklenburg County Phase II Post-Construction Ordinance Development. Managed project for Mecklenburg County and its Phase II municipal partners (Charlotte, Cornelius, Davidson, Huntersville, Mathews, Mint Hill, and Pineville) to develop basis for new post-construction ordinance that would address water quality, cumulative and secondary impacts, and hydrology related issues (flooding and stream channel instability). Led Tetra Tech facilitation of a 23 member Stakeholder Committee and panel of 14 local staff in developing and evaluating alternative management options upon which to base the ordinance requirements. Supervised development of modeling and costing tools to support large-scale assessment of hydrologic and water quality impacts from anticipated future development for 33 named watersheds, and evaluation of the impacts of alternative post-construction controls. Developed and evaluated representative design options for 8 residential, 7 non-residential, and 3 mixed-use land use categories for each alternative evaluated. Conducted specialty research to help staff and stakeholders address challenging technical and policy issues, and developed ideas for innovative options to mitigate potential implementation obstacles. Prepared an audience-friendly Executive Summary and detailed technical reports for the two phases of the project.

Town of Cary Town Center Stormwater Management Plan. Project Officer for effort to develop a watershed based stormwater management plan for the Town of Cary Town Center. Area is proposed for high density commercial and residential redevelopment to support regional rail service and help address sprawl. Tetra Tech conducted environmental and engineering analyses, testing alternative BMPs for environmental and cost effectiveness, and supporting policy analysis and recommendations for the plan.

TETRA TECH, INC.

Jerry Diamond, Ph.D.

Technical Expert

EDUCATION

Ph.D., Ecology and Stream Biology, University of North Carolina, 1984

M.S., General Science, Stream Ecology, Oregon State University, 1976

B.A., Biology, cum laude, Case Western Reserve University, 1973

YEARS OF EXPERIENCE

Total: 30

With Tetra Tech: 20

KEY AREAS OF EXPERIENCE

- Water quality criteria and standards
- Use Attainability Analyses
- Water and sediment quality assessments
- Ecological risk assessments
- Environmental toxicology

Dr. Jerry Diamond is a Principal ecologist and a Director of ecotoxicology at Tetra Tech with 30 years of experience in environmental toxicology, ecological risk assessments, water quality assessments, and criteria and standards. He has developed and managed over 300 environmental risk assessments involving a variety of chemicals and over 40 site-specific or region-specific criteria studies for a variety of chemicals including several metals and sulfate. He has been an invited peer reviewer of criteria data and analyses for US EPA, Environment Canada, and several States and he has designed and directed many studies under NPDES, and ESA. Dr. Diamond is an Editor of Aquatic Toxicology for the international journal *Environmental Toxicology and Chemistry,* and he has served frequently as an Expert Witness for the Department of Justice and EPA in ecology, ecotoxicology, and ecological risk assessment and was appointed as a Technical Expert by EPA's Office of Science and Technology regarding the development of water quality criteria.

Selected Project Experience

Biological and Physicochemical Evaluation of North Branch Potomac River. Project leader for a large-scale study of the North Branch Potomac basin for the U.S. Army Corps of Engineers, Baltimore District, including both stream and reservoir sampling and analysis. Directed field sampling, quality assurance procedures, and final reporting of the study. Fish, plankton, and benthic sampling upstream, within, and downstream of reservoirs in West Virginia, Maryland, Pennsylvania, and New York were performed and related to aquatic chemistry and geophysical data. Evaluated water quality of the reservoirs and the ability of the reservoirs to mitigate upstream acid mine drainage. The modified sampling program and statistical analysis design developed in this project were used as a model for future studies of the North Branch and other large rivers in the Baltimore District.

Clinch River, VA Watershed Ecological Risk Assessment. Worked with an interagency workgroup in formulating the risk assessment, designing risk analyses, obtaining and collating data from a variety of sources, and conducting and presenting the risk analyses and risk characterization. Designed and implemented risk analyses and risk characterization for federally listed mussel and fish species in the basin and provided vulnerability analyses for certain known listed species sites. Provided statistical analyses of GIS data on native mussel, macro-invertebrate, and fish populations in the watershed, developed innovative methods for evaluating multiple stressor effects, and participated in public meetings. Used a variety of statistical approaches to define relationships between land use activities, instream habitat quality, and native mussels and fish. Results of analyses were presented in public workshops, international scientific conferences, peer-reviewed journal articles, and in an EPA report (EPA-600-R-01-050).

Natural Condition Standard Guidance Development and Training. Project Manager developing statistical approaches, QA/QC requirements, permit implementation, and other aspects of new guidance for natural condition-based water quality standards (NCBWQS) in Alaska, the first rigorous treatment of such standards anywhere in the U.S. Worked with ADEC and EPA Region 10 staff to identify concerns, technical issues, and to define defensible solutions regarding data requirements, associated QA necessary, and statistical treatment of water quality data. Assisted ADEC in developing the NCBWQS guidance document and

address comments from stakeholders. Led a training workshop for ADEC staff in using the NCBWQS approach, including development and presentation of a spreadsheet tool for calculating NCBWQS. Used data from streams in mining areas as case studies illustrating the use of the NCBWQS approach. Helped develop presentation materials for public workshops on the guidance and gave workshops in Fairbanks, Juneau, and Anchorage.

Recreational Use Attainability Analyses and Data Collection, Missouri, Iowa. Project Manager for EPA Region 7 and EPA-OST project supporting UAAs for over 200 sites in Iowa and Missouri. Developed a streamlined field protocol and UAA framework to clearly identify information/data needs for a given site, sufficiently document whether the use has existed or is attainable, and accompanying quality assurance protocols to support the administrative record. Used available state information and mapping information to help prioritize potential recreational opportunities at each site and streamline field survey and assessment work. Results were compiled in separate assessment reports for each site that the states used in their UAAs.

NEPA and EIS Sand and Gravel River Mining, Pittsburgh, PA. Project Manager of a large NEPA and EIS project that was used by the Pittsburgh District Army Corps of Engineers to determine whether permits should be reissued for commercial sand and gravel dredging in the Allegheny and upper Ohio Rivers. Duties included project management, preparation of technical documents, strategic planning, methodology development, stakeholder meeting facilitation, and addressing stakeholder comments. An ecological risk assessment framework was used to screen potential effects of various dredging scenarios on aquatic life and drinking water supplies and to focus field studies and additional data collection activities. Used GIS to map and analyze habitat effects on a variety of sensitive fish and endangered freshwater mussels in the study area. Designed the sampling program used by the dredging industry, Pennsylvania DEP, Army Corps, and West Virginia, Ohio, and Penssylvania biologists to assess threatened and endangered mussel distribution in the Allegheny and Ohio Rivers. Collated and interpreted information in all resource areas (biological, economic, cultural, hydrological) and used multivariate analyses of mussel species, habitat, and spatial information to determine effects of dredging on mussel abundance and distribution. GIS analyses were used to project potential effects of different dredging scenarios (permit conditions) on fish species, including several state listed species.

Evaluation of Ecological Risks and Toxics Bioavailability Information, Coeur d'Alene Lake, ID. Expert witness and ecotoxicologist consultant for Department of Interior (DOI) and Bureau of Indian Affairs (BIA) for litigation regarding relicensing of Post Falls Dam, ID. Reviewed and evaluated documents prepared by the power company and its consultants, Coeur d'Alene Tribe and their consultants, technical literature pertaining to metal bioavailability, site-specific information developed by EPA for the Bunker Hill superfund site upstream and Coeur d'Alene River, and other relevant supporting materials supplied by the power company or Bureau of Indian Affairs. Synthesized available toxics information and qualitatively evaluated ecological risk potential due to project operations. Prepared direct testimony in the form of an expert report, which provided an expert opinion and scientific support regarding critical data and information gaps in assessing ecological risk due to project operations, and the need for additional monitoring during the next 50 year license period. Assisted DOI and BIA attorneys develop cross-examination strategies for power company expert witnesses. Testified at the hearing in Spokane, WA on behalf of DOI and BIA.

Review of National Water Quality Criteria. Reviewed recent toxicological data for USEPA as part of their revised selenium criteria development for aquatic life and wildlife. Invited peer reviewer of Environment Canada's methodology for national ammonia criteria development. Invited expert on ammonia toxicity and threshold development for City of Winnipeg and Saskatchewan Province study of the Red River, Canada. Reviewed toxicological data as part of EPA's reassessment of ammonia criteria. Participated in an international harmonization study directed by World Health Organization designed to compare and contrast the way in which different developed countries develop water quality criteria and risk assessment thresholds given the same data sets for different chemicals. Applied both Office of Water and Office of Pollution Prevention and Toxics (TSCA) methodologies to a range of chemicals including metals and various organic compounds having different amounts of relevant data available.

Development of Dissolved Oxygen Criteria for Terrebonne Basin, LA. Led dissolved oxygen criteria development for EPA Region 6 on behalf of Louisiana DEP for the Terrebonne Basin, a large coastal watershed with historic violations of the state DO standard. Reviewed and compiled existing water quality and biological information collected by LDEP, evaluated dissolved oxygen data on a daily and seasonal basis, and applied a natural condition methodology developed for Alaska DEC that relies on reference condition DO regimes to calculate criteria and allowable exceedence frequencies. Prepared the technical report and discussed finding and recommendations with EPA and the state.

TETRA TECH, INC.

Mustafa Faizullabhoy, PE

Senior Water Resource Engineer

EDUCATION

M.S., Environmental Engineering, Old Dominion University, 1998

B.S., Civil Engineering, Osmania University – India, 1995

YEARS OF EXPERIENCE

Total: 14

With Tetra Tech: 13

LICENSES & CERTIFICATIONS

Professional Engineer, Virginia, No. 0402 039154

PROFESSIONAL AFFILIATIONS

North American Lake Management Society

KEY AREAS OF EXPERIENCE

- Surface Water Quality Modeling and Control
- Watershed hydrology and stormwater
- Watershed runoff quality
- TMDL development and implementation
- Tool development
- Information management system development

Mr. Faizullabhoy is a water resources environmental engineer with more than 12 years of professional experience in the areas of water quality modeling, hydrologic and hydraulic modeling, and storm water management planning and design. He has developed and applied a variety of computational methodologies for water quality modeling. He specializes in the field of hydrodynamic modeling, surface water quality modeling, contaminant transport, data analysis and statistics, and environmental sustainability, with particular emphasis on lake and reservoir modeling. Mr. Faizullabhoy's experience also includes spreadsheet and database programming for managing, analyzing, and summarizing complex data sets. He has an in-depth understanding of environmental data and their scientific use for screening level analysis, as well as for more rigorous analysis using various modeling applications. He has also hands-on experience in spreadsheet/database programming, computer language programming (FORTRAN, Visual Basic), and geographic information systems (GIS).

Selected Project Experience

Lake Wallenpaupack, PA, TMDL. For the USEPA, Region 3, lead modeler for a nutrient TMDL for Lake Wallenpaupack in eastern Pennsylvania. Used LAKE2K, a one-dimensional water quality model. Also developed a mercury TMDL for the lake using a simplified spreadsheet model to estimate TMDL loads.

Shenandoah River, VA, PCBs TMDL. For USEPA Region 3, developed a customized steady state, sediment water column interaction model for PCBs in the Shenandoah River, VA. The model used a time variable approach to model the Millville Reservoir in WV, downstream of the Shenandoah River, to predict the concentration of PCBs with time. This easy to use spreadsheet tool was used to evaluate various load reduction scenarios from point sources in the river and also evaluate the contribution of sediment as a source into the water column.

Lost River, OR/CA, Modeling and TMDL. For the USEPA Regions 9 and 10, Oregon DEQ and the North Coast Regional Water Quality Control Board (RWQCB), assisting in the Lost River modeling effort. A fundamental element of the TMDLs is the development of a hydrodynamic and water quality model that can assist in determining loading capacities, load allocations, and waste load allocations for each river. Duties included compilation of available data from the various agencies; evaluation of monitoring data to identify the extent, location, and timing of water quality impairments. Assisted with the model development - bathymetry generation using historical as-built plans for each of the 12 waterbodies. Developed a series of routines in VBA in Excel to process/automate the data from various sources/agencies to generate input time varying boundary and initial conditions for the W2 model.

Virginia Benthic TMDLs. For USEPA Region 3 and Virginia Department of Environmental Quality, developed benthic TMDLs for three creeks (Cedar Creek, Hall/Byers creek, and Hutton Creek) draining to the North Fork Holston river. The streams are in Washington County, VA and drain predominantly agricultural areas. Used a methodology that incorporates a reference watershed approach for identifying benthic community stressors and approximate TMDL endpoints. Modeled impaired and reference watersheds to determine the conditions necessary to support a healthy benthic community. Project involved setup and calibration of the GWLF model, statistical data analysis, and GIS mapping/analysis.

New Jersey Bacteria TMDLs. For the USEPA Region 2 developed an analytical framework template for development of the Fecal Coliform Bacteria TMDL for Shellfish in New Jersey. Used the statistical rollback method to analyze the log-normal distribution of fecal coliform counts and derive the corresponding reductions for the TMDL. This data driven statistical method uses data from several locations along the NJ shoreline. Also developed a customized spreadsheet tool for the shellfish sites to assess reductions for the various criteria, check for log-normality by plotting probability density functions and generate customized log probability plots in the MS Excel environment. Provided critical technical support to help evaluate data statistically per client needs and requirements to allow for selection of the approach to achieve the desired goal.

U.S. Virgin Islands Bacteria TMDLs. For the USEPA Region 2, developed an innovative spreadsheet tool to evaluate bacterial concentration for four bays - Benner Bay, Limetree Bay, Magens Bay, and Mangrove Bay in the U. S. Virgin Islands. The Tidal Prism model approach was incorporated into the MS Excel environment. This project required working on a fast paced schedule (within a span of a couple of weeks) with limited data and at times new and critical data for the model, accommodating the clients needs right up to the TMDL and report deadlines.

Louisiana TMDLs. For USEPA Region 6, managed and developed 64 TMDLs for fecal coliform, chlorides, sulfates, total dissolved solids (TDS), turbidity, total suspended solids (TSS), sedimentation, and siltation for selected subsegments in the Terrebonne, Red River, and Sabine River Basins in Louisiana. Utilized a load duration approach to compute the TMDLs for each pollutant and its corresponding percent reduction for each subsegment in the subbasins. Created a customized spreadsheet template to facilitate TMDL calculations and allocations. Was involved in all phases of the project from approach development to report writing and data analysis. Worked on a quick-turnaround schedule (within a span of a month) with limited data and at times new and critical data for the model, accommodating the clients' needs right up to the TMDL and report deadlines.

Eel River, CA, Temperature TMDLs. For USEPA Region 9, managed the temperature TMDL modeling for the North Fork Eel River, CA. Was technical lead in the development of a Qual2E-SHADE modeling system, comprised of a GIS-based SHADE model with pre-and post processors and a customized Qual2E model (Q2ESHADE) with inbuilt pre-and post processors for TMDL development. The model allows for running scenarios based on varying vegetation characteristics and can be run either with the SHADE model stand alone or in tandem with the in-stream Qual2e model. Used the modeling system to predict temperatures throughout the entire North Fork Eel River system and assess relationships with riparian vegetation characteristics and topography. Involved in all phases of the project, including client interaction, system design, data needs, data analysis and modeling.

San Diego Creek and Newport Bay, CA, Toxics TMDLs. For the USEPA Region 9, assisted in the development of the TMDL for Toxic Pollutants in San Diego Creek and Newport Bay, CA. Main contribution involved data analysis and developing a loading capacity spreadsheet model. The sediment/biota/water column interaction for the suite of organochlorines (DDT, PCBs, Chlordane, Dieldrin and Toxaphene) and metals (Cr and Hg) pollutants were simulated in a spreadsheet model. Involved in all phases of the project: extensive literature review, data needs, data analysis and modeling. The final product was a customized model that could be used to evaluate the loadings for the organochlorines and metals.

Haiwee Reservoir, CA, Copper TMDL. For the Lahontan RWQCB and USEPA Region 9, assisted in the development of the Haiwee Reservoir Copper Model. Developed a conceptual model for the sediment water column interaction for copper in the reservoir. Involved in all phases of the project: extensive literature review, data needs, data analysis and modeling. The final product was a customized dynamic model that could be used to evaluate copper application and various management scenarios. This model will ultimately be used to develop a TMDL for the reservoir.

Patuxent Reservoirs, MD, Watershed Management. For the Washington Suburban Sanitary Commision (WSSC) performed a eutrophication modeling study for the two Patuxent Reservoirs, Triadelphia and Rocky Gorge, located in Maryland. Used CE-QUAL-W2 a two-dimensional, longitudinal/vertical (laterally averaged), hydrodynamic and water quality model, to predict how changes in the Patuxent Reservoir Watershed model will affect water quality in the Triadelphia and Rocky Gorge Reservoirs. This linked watershed and reservoirs model was used to evaluate various endpoint scenarios and landuse based scenarios in both the reservoirs.

TETRA TECH, INC.

Heather Fisher, AICP

Outreach Specialist

EDUCATION

M.E.M., Resource Economics and Policy, Nicholas School of the Environment, Duke University, 2002

B.A., Pre-professional Zoology and Environmental Studies, Ohio Wesleyan University, 1999

YEARS OF EXPERIENCE

Total: 12

With Tetra Tech: 11

LICENSES & CERTIFICATIONS

American Institute of Certified Planners, 2007

TRAINING

Planning Law and Ethics, Centralina Council of Governments, December 2008.

Riparian Vegetation Workshop, North Carolina State University, October 2007.

Invasive Plant Ecology and Management Workshop, North Carolina State University, October 2007.

KEY AREAS OF EXPERIENCE

- Watershed planning
- Surface water quality assessment
- Green Infrastructure/Low Impact Development design (soil infiltration systems)
- Decision analysis
- Cost-benefit analysis

Heather Fisher is a certified planner with over 10 years of experience in water resources planning and management. With Tetra Tech, she has played significant roles in TMDLs and TMDL implementation plans, including data analysis, source assessment, modeling support, management strategies, and cost estimates. She has the ability to lead planning efforts and has experience developing decision-making frameworks, presenting assessment results, and facilitating stakeholder meetings. She has developed and calibrated SWAT and BATHTUB models and has extensive Geographic Information Systems (GIS) experience.

Selected Project Experience

LA County TMDL Implementation Plans. Led the development of a cost-benefit analysis for structural and nonstructural pollutant reduction strategies for multiple TMDLs within the LA County unincorporated areas of the Ballona Creek and LA River watersheds. Led the development of implementation schedules and played a major role in the identification and evaluation of nonstructural strategies.

Illinois TMDL Implementation Plan Support. Provided expertise on cost estimates and cost-effectiveness for watershed specific TMDL implementation plans. Cost-effectiveness analyses were developed for multi-watershed, multi-parameter TMDLs. Research and cost estimation involved the relative costs of nonpoint source BMPs, in-lake management techniques, shoreline stabilization, and stream restoration options.

Santa Clara/San Gabriel Lake nutrient TMDLs. Performing updates to BATHTUB model input and providing future BMP scenario support to EPA Region IX.

Region 7 TMDL Training. Developed Power Point presentations and handout materials to train USEPA Region 7 staff on the use of BATHTUB models for TMDL development. Discussed data sources, input files, formatting, output files, post processing steps, and methodology for TMDL calculations.

Lake Hiawatha TMDL. Conducted BATHTUB model set-up and calibration for the Lake Hiawatha Total Phosphorus TMDL.

Florida Lakes Nutrient Criteria. Conducted BATHTUB model set-up and calibration to support nutrient criteria development.

Black River SWAT Model. Co-developed and calibrated a SWAT modeling application for the Black River drainage in the Ohio Corn Belt to support nutrient and sediment TMDL development. Assisted in modeling scenarios for the management of agricultural land and point sources in the watershed.

North Carolina TMDL Development (NC). Co-developed fecal coliform and turbidity TMDLs for the East Fork of the Deep River and fecal coliform TMDLs for Richland, Muddy, and Newfound Creeks. Performed TMDL source assessments and flow duration analyses to estimate the existing and target loads. Interviewed local officials for information on sewer problems and local stormwater efforts.

Gills Creek Dissolved Oxygen and Fecal ColiformTMDLs. For SC DHEC, conducted source assessment and supported water quality analysis, model input, and report writing.

Gills Creek Watershed Management Plan. For Richland County, SC, led the Gills Creek Watershed Management Plan development. In addition to her leadership role, she researched costs and benefits of management opportunities and developed methods for identification of critical area selection based on input from the local governments and other stakeholders. She also conducted the source assessment for the watershed management plan.

Milwaukee Metropolitan Sewer District 2020 Facilities Plan. Developed scoring methods for management alternatives. Develop one approach to test how alternatives to meet the goals of the plan, and developed a second approach to illustrate the differences between the alternatives. Designed spreadsheet to provide a user-friendly display of the scores and to facilitate data updates.

Mecklenburg County Post-Construction Ordinance. Developed and carried out methods to compare construction costs and cost-effectiveness across stormwater regulation scenarios. Designed cost estimation spreadsheet tool for BMPs, treatment train components, and other site infrastructure. Co-developed decision making tools for the protection of streams within Mecklenburg County and two water supply lakes, Mountain Island Lake and Lake Wylie. Researched current cost data literature on BMP construction and maintenance costs.

Cary Town Center Area Plan. Developed fiscal impact analysis of stormwater control facility alternatives that address regulatory requirements and local watershed protection objectives, including downstream water supply protection. Evaluated compliance of conceptual site designs to nutrient loading target. Co-developed an evaluation matrix for policy, funding, and financing options. Compiled land use, pollutant loading, and engineering analyses into a comprehensive report.

Lake Maumelle Watershed Assessment. Served as researcher, analyst, and facilitator for comprehensive watershed management plan to protect Lake Maumelle water supply for Central Arkansas Water. Developed land use projections and wrote guidance for improved best management practices under agriculture, forestry, and residential land uses. Developed cost estimates for management options. Co-facilitated public meetings on watershed management options. Wrote and compiled documentation for watershed and implementation plans.

Southern California Low Impact Development Manual. Provided technical review of draft manual.

North Carolina LID Manual. Member of NC Low Impact Development Manual workgroup. Developing cost-benefit analysis case studies to be included in the manual. Providing technical review of the manual.

California Ocean Protection Council Statewide LID Policy. Conducted a comprehensive, nationwide survey of state and local Low Impact Development (LID) requirements to support the development of the Ocean Protection Council's grant program and statewide LID requirements.

BCDCOG Low Impact Development Project. Developed a cost-benefit evaluation of low impact and conventional stormwater treatment designs for a proposed residential development for the Berkeley-Charleston-Dorchester Council of Governments in South Carolina. Evaluated pollutant load removal and cost effectiveness for four LID scenarios using the Site Evaluation Tool.

Beaver Lake Watershed Management Plan. Co-developed an analysis to compare cost-effectiveness of management options across multiple sectors, land uses, and pollutant sources. Provided an essential decision-making tool, which was used to develop and test management scenarios and achieve stakeholder consensus. Also supported SWAT model output data processing.

Fairfax County Watershed Management Planning. Providing recommendations and guidance to county stormwater staff on countywide watershed assessment methods. Co-facilitated the establishment of goals, objectives, and indicators. Developed recommended assessment, decision-making, and progress-tracking methods that use watershed condition indicators to measure achievement of goals and objectives. Providing updates to the county's watershed management planning development standards that incorporate the countywide methods and ensure consistency of contractor deliverables.

USACE Neuse Restoration Feasibility Study. Conducted outreach and facilitated partner meetings to evaluate potential restoration opportunities and local cost-share availability for the Army Corps of Engineers Wilmington District. Developed a basin-wide screening methodology for stream, wetland, and buffer restoration sites. Provided prioritization recommendations to Corps representatives and stakeholders.

TETRA TECH, INC.

Jeroen Gerritsen, Ph.D

Technical Expert

EDUCATION

Ph.D., Ecology, The Johns Hopkins University, Baltimore, 1978

M.S., Ecology, The Johns Hopkins University, Baltimore, 1976

B.S., Environmental Studies, Antioch College, Yellow Springs, OH, 1974

YEARS OF EXPERIENCE

Total: 33

With Tetra Tech: 21

PROFESSIONAL AFFILIATIONS

North American Benthological Society

Ecological Society of America

Society for Environmental Toxicology and Chemistry

Estuarine Research Federation

North American Lake Management Society

KEY AREAS OF EXPERIENCE

- Stressor identification research
- Stressor-response investigations
- Statistical data analysis
- Bioassessment and biocriteria development
- TMDL development
- Tool development
- Information management system development

Dr. Gerritsen has over 30 years of experience in aquatic environmental sciences, including basic and applied research, teaching, environmental assessment, and project management. His technical abilities include statistical design and analysis, systems ecology and modeling, ecological risk assessment, limnology, wetlands ecology, estuarine ecology, and plant-nutrient relationships. He has directed multidisciplinary investigations and has contributed technical expertise to impact assessment and regulatory review, effects of acidic deposition, and design and analysis of environmental monitoring programs. He has broad field experience in lakes of North America and Europe; in streams, wetlands, and estuaries of the continental United States; and in the North Atlantic ocean.

Selected Project Experience

Biological Criteria Development. For USEPA Office of Water, Project Manager for developing biological sampling and analysis methods to tier designated aquatic life uses in state and tribal water quality standards. He directed technical support and scientific input to develop sound scientific principles for establishing biological and disturbance gradients that would serve as a framework for tiered designations. These tiered uses reflect the biological quality attainable for a given system and eventually integrate biocriteria with water quality criteria. Tasks and subprojects have included the following:

- Served on technical experts panel and participated in workgroup and panel meetings that developed the Biological Condition Gradient (BCG), which in the scientific foundation for tiered aquatic life uses.
- Provided scientific documentation for support of concepts developed by the workgroup.
- Facilitated several regional and national workshops to test and evaluate the biological condition gradient developed by the technical experts panel.
- Developed methods to translate the conceptual model of the BCG to a quantitative assessment methodology using biological assessment data.
- Project manager for organizing and editing the USEPA guidance document on Tiered Aquatic Life Use (EPA-822-R-05-001). Tetra Tech scientists were principal authors of several key chapters on technical implementation of quantitative assessment in the TALU framework, and on development of the Generalized Stressor Gradient (GSG).

Continuing as Project Manager to provide technical leadership and support in regional projects and workshops to develop quantitative applications of the BCG, the GSG, and tiered aquatic life uses. Tasks currently underway include: application of the quantitative assessment methodology in New Jersey, New England, Pennsylvania, and Rocky Mountain region; conceptual development and application to estuaries; assessing state programs with respect to critical elements required for effective biomonitoring; definition and measurement of the stressor gradient in Southeastern states; and regional applications in each USEPA region.

A Stream Condition Index for West Virginia Wadeable Streams. Dr. Gerritsen directed the development of the West Virginia Stream Condition Index (2000) for West Virginia DEP and USEPA Region 3. Tetra Tech scientists analyzed West

Virginia's early stream biomonitoring data (1996-98) to develop the first version of the WVSCI, currently used by West Virginia for bioassessment and biocriteria.

Stressor Identification Guidance Document. Project manager for preparing and editing the *Stressor Identification Guidance Document* (EPA/822/B-00/025) for identifying and evaluating stressors of aquatic systems, for USEPA Office of Research and Development (ORD). The guidance provides diagnostic approaches for using biological indicators in conjunction with other ecological data to identify and prioritize multiple stressors causing impairment. Member of the workgroup developing the guidance document, reviewed chapter drafts prepared by ORD scientists, and prepared draft case study chapter on the Presumpscot River. Tt assembled, revised, and edited the complete guidance document, made further revisions based on reviewers' comments, and prepared the final copy.

Identification of Stressors Causing Ecological Degradation in West Virginia Streams. As part of comprehensive TMDL development for impaired streams of West Virginia, directed the Stressor Identification, which used USEPA's Stressor Identification guidance, above. From benthic macroinvertebrate monitoring data, West Virginia DEP identified streams that were biologically impaired in West Virginia. Tetra Tech developed a conceptual model for ecological stream impairment in the region, and is evaluating the stressor-response hypotheses of the conceptual model. Using West Virginia's statewide monitoring database, directed the development of multivariate statistical models to assess the relative importance of stressors affecting the biological community. These were combined with site-specific information through techniques of ecological epidemiology identified in USEPA's Stressor Identification guidance to identify the stressors most likely to have caused the ecological degradation observed in each stream. Because of the large number of streams and large WV database, Tetra Tech was able to streamline many of the procedures in the SI Guidance.

Case Studies Identifying the Causes of Biological Impairment in Streams. Based on the strength of the stressor identification for the West Virginia TMDL program, was invited with WVDEP to participate in a writing workshop designed to evaluate applications of the USEPA's Stressor Identification (SI) guidance. At this workshop, case studies were analyzed, revised and used to document the use of SI for determining the causes of biological impairment in streams. Tetra Tech technical experts will contribute writing and editing of case study drafts developed during the workshop.

Assessment of Aquatic Effects of Mountaintop Mining in West Virginia. For an environmental impact statement on mountaintop mining /valley fill being developed by USEPA Office of Research and Development, integrated biological data collected by USEPA and coal mining companies in 5 watersheds. Using statistical quality control procedures, he determined the compatibility of the biological data sets collected by different agencies and consultants. Developed a statistical analysis plan approved by all (frequently contentious) participants (USEPA and the mining companies), and included procedures for taking into account the effects of confounding factors, such as seasonality, spatial autocorrelation, and the effects of other stressors not associated with coal mining (residential and agricultural runoff). Supervised the analysis of fish data to identify stressors and sources of stress on fish communities of West Virginia streams. Directed preparation and coauthored several chapters of the EIS being prepared by USEPA/ORD.

Statistical Methods for Biocriteria Development: Draft Guidance Document. Biological indexes developed by Tetra Tech and others require a variety of statistical tools to develop and calibrate the models. Directed preparation of a statistical methods guidance document targeted specifically at biomonitoring agencies of States and Tribes, to explain statistical methods used in indexes, requirements for different methods, and guidance on selecting the most appropriate methods for the specific situation of an agency. Tetra Tech developed several alternative biological indexes using both univariate and multivariate approaches, to be case study applications, using the same database, to guide readers through alternative approaches. Principal author of approximately half of the draft guidance document.

TETRA TECH, INC.

Eugenia Hart

Technical Writer

EDUCATION

M.S., Wetlands and Water Resources, State University of New York College of Environmental Science and Forestry, 2000

B.S., Natural Resources and Environmental Science, Purdue University, 1996

YEARS OF EXPERIENCE

Total: 13

With Tetra Tech: 11

KEY AREAS OF EXPERIENCE

- Pollutant source assessment
- Watershed runoff quality
- TMDL development and implementation
- Watershed management plan development
- Technical writing

Ms. Hart is an environmental scientist with over ten years of professional experience. She provides general and technical support on projects for the USEPA's Assessment and Watershed Protection Division to implement the Total Maximum Daily Load (TMDL) Program under Clean Water Act section 303(d). These projects have included technical development of TMDLs and public outreach related to TMDL development, as well as development of guidance documents for TMDL development. Ms. Hart also provides general and technical support for various projects related to watershed and water quality assessment and management, including literature searches, research, data compilation and analysis, and technical writing.

Selected Project Experience

Cheat River and Tygart Valley River TMDLs, WV. Supported USEPA Region 3 with the development of mining TMDLs for the Cheat River and Tygart Valley River watersheds in West Virginia. Provided technical writing and editorial support for the draft and final documents. Developed a training manual for the Mining Data Analysis System (MDAS) model used in TMDL development for the Tygart Valley River watershed. The MDAS is a system to support point and nonpoint source modeling for acid mine drainage leading to TMDL development. The training manual was used for a MDAS training session for USEPA Region 3 and West Virginia Department of Environmental Protection.

Unnamed Tributary to the Monongahela River TMDLs, WV. Supported USEPA Region 3 with the development of iron and manganese TMDLs for the Unnamed Tributary to the Monongahela River in West Virginia due to runoff from two adjacent Superfund sites. Worked with USEPA Region 3's Superfund division to gather water quality data collected by Superfund in the watershed. Developed iron and manganese TMDLs for the Unnamed Tributary based on the Superfund data.

Fourpole Creek TMDL Development, WV. Supported USEPA Region 3 with TMDL development for the Fourpole Creek watershed in Huntington, West Virginia. The project included development of TMDLs for fecal coliform bacteria and aluminum impairments in an urban watershed. The aluminum impairment was associated with high levels of sediment entering the waterbody from highly urbanized areas and multiple construction sites in the watershed. The fecal coliform bacteria impairment was mainly due to urban sources including illicit sewer connections and septic failure. The project included setup and calibration of the MDAS watershed model as well as the development of TMDLs. Worked with USEPA and West Virginia Department of Environmental Protection to develop an allocation scenario that would enable the fecal coliform bacteria loads from urbanized areas to be incorporated into a future MS4 permit for the City of Huntington.

Benthic TMDL Development for Virginia Watersheds, VA. Provided support to USEPA Region 3 in benthic TMDL development for the Muddy Creek, Pleasant Run, Mill Creek, and Holmans Creek watersheds in Virginia. Impairments to the benthic communities in these watersheds were caused by increased levels of sediment and nutrients. TMDLs were developed for the watersheds using the Generalized Watershed Loading Functions (GWLF) model based on pollutant loadings to a reference watershed.

Nutrient TMDL for Muddy Run, PA. For USEPA Region 3, supported the development of a nutrient TMDL for Muddy Run, Pennsylvania. Examined current land use activities and management practices within the watershed to identify potential sources of nutrient loading. Located a reference watershed for use in determining TMDL endpoints. Used the AVGWLF model to determine existing loads in reference watershed and used those loads as the TMDL endpoint. AVGWLF was also use to determine the existing loads from the impaired watershed and Excel spreadsheets were used for the calculation of the necessary allocations to the nutrient sources in the watershed. The project required extensive use of the AVGWLF model, including manipulation of spatial data in ArcView.

Wissahickon Creek Sediment TMDLs, PA. Supported USEPA Region 3 in the development of sediment TMDLs for the Wissahickon watershed in Pennsylvania. The Wissahickon is a high profile watershed located partially in the city of Philadelphia. The high sediment loads to the watershed were mainly due to the large amounts of urban land in the watershed that contribute to higher in-stream flows due to the lack of vegetation in the watershed to slow runoff. Used ArcView software to create a GIS project for the watershed and used local GIS coverages to locate an adequate reference watershed for Wissahickon Creek because Pennsylvania currently does not have numeric criteria for sediment. Used the reference watershed approach and the Generalized Watershed Loading Functions (GWLF) model. All sediment loads from land were allocated to MS4 permits for each of the municipalities within the watershed.

Fecal Coliform Bacteria TMDLs for the Blackwater River and Choctawhatchee River, FL. For USEPA Region 4, developed 4 fecal coliform bacteria TMDLs for tributary and mainstem segments in the Blackwater River and Choctawhatchee River watersheds, Florida. Collected and evaluated background information and available water quality data and watershed information to identify potential sources of fecal coliform bacteria. Using USEPA's BASINS modeling system, performed continuous hydrologic and water quality simulations for the watersheds containing the four section 303(d)-listed segments. Established modeled existing conditions and TMDL allocation. Specific activities included organization and analysis of water quality and flow data for over 100 monitoring stations; compilation and manipulation of extensive amounts of spatial data in BASINS and ArcView (e.g., land use, monitoring locations, point source information, etc.); collection and evaluation of watershed and source information (e.g., agricultural information, Census of Agriculture data, Census data, PCS data); development of all model input files; and preparation of TMDL reports.

Hurricane Creek Watershed TMDL Development, AL. Supported USEPA Region 4 with TMDL development for three streams in the Hurricane Creek watershed in Alabama. The project included data collection and watershed characterization for the watershed, which is impaired by metals and turbidity due to acid mine drainage from heavy coal mining and fecal coliform bacteria due to agricultural sources. The project included setup and calibration of the LSPC watershed model for the purpose of developing the TMDLs, as well as producing a modeling document to address the setup and calibration processes.

Flint Creek Watershed TMDL Development, AL. Supported USEPA Region 4 with TMDL development for the Flint Creek watershed in Alabama. The project included development of TMDLs for fecal coliform impairments due to heavy agricultural activities in the watershed. The project included setup and calibration of the LSPC watershed model for the purpose of developing the TMDLs. LSPC was also used to develop allocation scenarios for the watershed that resulted in meeting the TMDL.

Browne Lake TMDL Development, UT. Provided technical support for the development of TMDLs in Utah for USEPA Region 8. The project included developing dissolved oxygen and phosphorus TMDLs for Browne Lake in the Uinta Mountains in northern Utah. The impaired lake was located in a rural watershed that was negatively impacted by a forest fire in the 1980s. The watershed loading of phosphorus to the lake was determined using GWLF. The output from GWLF was then used as input to the PHOSMOD steady-sate lake model to simulate phosphorus and dissolved oxygen concentrations in Browne Lake at critical conditions. Conducted public meeting to present the TMDL results to stakeholders in the watershed.

Nonpoint Sources assessment and Management Plan for the Narragansett Indian Tribe, RI. Currently supporting the Narragansett Indian Tribe with a Nonpoint Source Assessment and Watershed Management Plan for the watersheds on their Reservation in Rhode Island. The Nonpoint Source Assessment and Management Plan will be used by the Tribe to apply to USEPA for section 319 funding to implement best management practices throughout the Reservation. The assessment includes analysis of all available water quality data in the watersheds and determining potential nonpoint sources to the waterbodies based on the available data.

TETRA TECH, INC.

Jessica Koenig

Technical Writer

EDUCATION

B.A., Environmental Science, University of Virginia, 1996

YEARS OF EXPERIENCE

Total: 17

With Tetra Tech: 16

KEY AREAS OF EXPERIENCE

- TMDL development
- Watershed management
- Surface water quality assessment
- Development of water program guidance documents and training
- Project management

Ms. Koenig is an environmental scientist with over 15 years of professional experience providing general and technical support on projects for the EPA's total maximum daily load (TMDL) program. Ms. Koenig has managed and participated in the development of hundreds of TMDLs throughout the country, with approaches ranging from spreadsheet, mass-balance analyses to detailed hydrologic and water quality modeling. In addition to developing TMDLs, Ms. Koenig has provided extensive programmatic support for EPA and states, including development of national and state-specific guidance documents for TMDL development and related issues and development and presentation of TMDL training courses. She has supported EPA with key TMDL program issues, such as supporting EPA's response to comments on the *Proposed Revisions to the Water Quality Planning and Management Regulation* (40 CFR 130, August 23, 1999), developing guidance to support consistency with a DC District court ruling requiring daily loads in TMDLs, developing guidance and training to better integrate TMDLs with NPDES stormwater permits, and providing research and guidance support for challenging listing topics (e.g., invasive species). For the past 10 years, she has been managing technical support and development of TMDLs for EPA Region 10, including development of TMDLs in Alaska, Idaho, and Washington for a range of pollutants (nutrients, dissolved oxygen, fecal coliform, TSS, petroleum, sediment toxicity, metals, debris and seafood residue). Ms. Koenig has also managed several TMDLs in Idaho, Utah, Delaware, Florida, Virginia, Pennsylvania and West Virginia.

Selected Project Experience

National TMDL Guidance Development. Has managed or supported development of all of the major EPA publications providing guidance to TMDL practitioners, as well as a number of state-specific guidance documents. Managing and serving as primary author of EPA's *Handbook for Developing Watershed TMDLs* and is a primary author of *TMDLs to Stormwater Permits Handbook* for EPA Region 5 and EPA Headquarters. Managed the development and was primary author of a technical document, *Options for Expressing Daily Loads in TMDLs*, on identifying daily load expressions for TMDLs developed with non-daily allocations (to be consistent with a recent court ruling that TMDLs that are not expressed as "daily" loads do not comply with the Clean Water Act). Developed and presented a webcast based on the guidance. Co-managed and served as primary author for the development of EPA's *Protocol for Developing Pathogen Total Maximum Daily Loads (TMDLs)* (EPA841-R-00-002). Also supported development of the sediment and nutrient protocols (EPA841-B-99-004, EPA841-B-99-007).

TMDL Training. Supported development of original Watershed 103: Training for TMDL Practitioners' through EPA's Watershed Academy. Recently updated training materials and presented the course to EPA Region 3 staff. The 2-day course included an overview of the TMDL program, TMDL elements, steps in the TMDL development process, modeling techniques, recommendations for reviewing TMDLs, and several region-specific case studies.

TMDL Development in Alaska. Managed the development of 40 percent of Alaska's approved TMDLs for EPA Region 10 and Alaska DEC and is currently managing the development of TMDLs for Dutch Harbor, Iliuliuk Harbor, Skagway Harbor, and Pullen Creek. Managed support to Alaska for review of listing methodologies and design of monitoring programs to evaluate impaired waters.

Recent examples of projects include: Managing the development of TMDLs to address petroleum impairments in the bottom sediments of Dutch and Iliuliuk Harbors in the Aleutian Islands and Skagway Harbor in Southeast Alaska. Managed development of TMDLs to address impairment by sediment and low interstitial dissolved oxygen in Jordan Creek in Juneau and impairments from metals accumulated in streambed sediments in Pullen Creek in Skagway. Managed the development of fecal coliform TMDLs for nine streams and three lakes in Anchorage. Also developed delisting document for bacteria for Cheney Lake. Managed development of a TMDL for fecal coliform in Pederson Hill Creek in Juneau using a load duration approach. Managed the development of residues and sediment toxicity TMDLs using site-specific qualitative assessment and supported the dissolved oxygen TMDL in Ward Cove using WASP. Managed development of a residues TMDL for Thorne Bay consistent with Ward Cove.

Watershed and TMDL Program Support for EPA Region 10. Has managed TMDL-related and watershed-related support for EPA Region 10 for the past 10 years. Support has included the management and development of dozens of TMDLs throughout Alaska, Idaho, and Washington. Managed several projects to design and implementation of monitoring programs to evaluate waterbody impairment and support TMDL development (e.g., Skagway Harbor, AK; Chena River basin, AK; Black Lake, ID; Coquille River, OR; northern Idaho microbial source tracking; Pend Oreille River/Lake, ID). Managed a review of state listing methodologies to support Alaska in developing their own methodologies for bacteria, turbidity and petroleum. Manages the development of Nonpoint Source Success Stories and documentation to meet National Water Program Guidance performance measures (WQ-10 and SP-12) for water quality improvement for all Region 10 states. Managed several projects to conduct expert third-party peer review of models developed by the states (e.g., Puget Sound, WA; Coquille River, OR; Lake Whatcom, WA). Managed the development of nutrient and sediment TMDLs for the Coeur d'Alene Tribe in northern Idaho. Developing a guidance document on using microbial source tracking to support TMDL development and implementation.

TMDL Guidance for California. Supported the development of *A Process for Addressing Impaired Waters in California*, a technical and programmatic guidance document developed for the State Water Resources Control Board. The document provides information on identifying and performing appropriate technical analyses and approaches and regulatory actions for addressing waters that do not meet support designated uses. Managed the development of a companion technical module for bacteria TMDLs that provides detailed information and "how-to" guidance relevant to developing TMDLs for the specific pollutants.

EPA ORD Model Review. For EPA ORD, coordinated the development of a comprehensive guidance document (*TMDL Model Evaluation and Research Needs*, EPA/600/R-05/149) on the applicability of models for TMDL development and implementation. Project involved the review of more than 60 process-based modeling systems used for TMDL development, including allocation of loads and evaluate of management practices. Managed the activities of more than 15 experts reviewing models for model capabilities and features, input/output, strengths and limitations, hardware/software requirements, supporting linkages, calibration considerations and associated uncertainty, and pre- and post-processing capabilities. Coordinated the development of factsheets for all models reviewed and managed the overall organization and production of the final document.

Development of EPA's Watershed Handbook. Served as a primary author of *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* (EPA 841-B-08-002), which provides comprehensive information and guidance on developing and implementing watershed plans to restore and protect water quality. Authored several chapters including those on gathering data and information; data analysis to identify sources and causes; estimating pollutant loads; and setting goals and identifying necessary load reductions.

Utah TMDL Support. For EPA Region 8, managed the development of TMDLs and site-specific criteria for TDS in five streams in the Duchesne River watershed. Project included extensive data analysis for approximately and a field survey to identify and evaluate potential sources. The TMDLs were based on a statistical data analysis and load duration curves identifying allowable TDS loads under varying flow conditions and were used to identify potential management practices for each impaired subwatershed. Managed development of TDS TMDLs for salinity for Uinta River and Dry Gulch Creek using a similar approach. The Uinta and Duchesne TMDLs both involved extensive coordination with representatives from EPA Region 8, Utah DEQ, the Ute Indian Tribe, USFS, BLM, and local water conservancy districts and included support and presentations for multiple stakeholder and public meetings. Also managed the development of phosphorus and dissolved oxygen TMDLs for two reservoirs in Utah using GWLF and PHOSMOD to establish watershed nutrient loadings and simulate inlake nutrient and dissolved oxygen dynamics.

TETRA TECH, INC.

Kevin Kratt

Watershed Analyst

EDUCATION

M.E.M., Water and Air Resources, Duke University, 1995

B.S., Business Economics, Miami University, 1992

YEARS OF EXPERIENCE

Total: 18

With Tetra Tech: 18

PROFESSIONAL AFFILIATIONS

Water Environment Federation

TRAINING

Applied Fluvial Geomorphology Short Course, Pagosa Springs, CO, 1997

KEY AREAS OF EXPERIENCE

- TMDL Development
- Watershed planning
- Surface water quality assessment
- Green Infrastructure/Low Impact Development
- Project Management

Mr. Kratt has been with Tetra Tech for more than 15 years. He is the director of the Cleveland, OH Water Resources office, and is the coordinator for TMDL projects in the Midwest. Mr. Kratt is a water resources scientist and provides technical and project management support for various watershed studies for federal, state, and local government clients. His areas of expertise include TMDL policy and development, watershed and water quality assessment, watershed and water quality modeling, water quality standards interpretation, implementation planning, and development of federal water policy guidance documents. Mr. Kratt has been supporting U.S. EPA and Midwest states with TMDL issues since the mid-1990's, including support for TMDL review and tracking, early FACA support related to the direction of the program, and most recently through organizing and facilitating a weeklong workshop for EPA Region 5 states to provide a forum for information sharing related to ongoing and new TMDL requirements. Mr. Kratt is familiar with most of the loading and receiving water quality models used for watershed management, including their strengths and weaknesses for various applications. He is also familiar with a wide range of both urban and rural best management practices and their effectiveness at improving hydrologic and water quality conditions. He has managed several large-scale watershed modeling projects and one of his specialties is explaining complex technical and regulatory water quality issues to the general public. Mr. Kratt is also involved with important national and regional TMDL issues, such as the implications of the recent DC District court ruling requiring daily loads, efforts to better integrate TMDLs with NPDES stormwater permits, and TMDL implementation tracking.

Selected Project Experience

Director of Tetra Tech's TMDL Activities in Region 5. Coordinates all Region 5 TMDL-related task orders under Region 5's Division of Water Contract as well as EPA's National Watershed Contract. Through these contracts Mr. Kratt has managed or participated in the development of more than 1,000 approved TMDLs within the region. He works closely with EPA, Tt project managers, and subcontractor staff to ensure all projects are completed in an efficient and cost effective manner.

Stormwater TMDL Activities. Mr. Kratt is supporting EPA's development of the draft "TMDLs to Stormwater Permits Handbook" for EPA, including preparing a comprehensive assessment of models that can be used for urban BMP optimization and selection to address stormwater impairments. Mr. Kratt is also managing all aspects of this project, which includes developing training material for the Handbook, preparing stormwater "fact sheets" for EPA Region 1. Mr. Kratt is also serving as QA Officer for three pilot stormwater TMDLs in the upper Midwest that were initiated under this project. The technical analyses from these efforts are being used to guide stormwater BMP implementation, low impact development strategies, and wetlands enhancement / restoration activities.

TMDL Guidance. Served as project manager for EPA's *Protocol for Developing Nutrient TMDLs: First Edition* and supported development of the sediment and pathogen protocols. The protocols were developed at the request of EPA Regions and States as a means of providing currently available information on establishing TMDLs for the most frequent causes of water quality impairment. They provide a step-by-step description of the TMDL development process and include case study examples that illustrate key components of each step.

Ohio River Pathogen TMDL Development. Mr. Kratt is currently supporting EPA Region 5 with the development of pathogen TMDLs for the Ohio River. Mr. Kratt is leading a Tetra Tech team of modelers and water resource scientists that prepared a project QAPP, is compiling and assessing data, providing sampling recommendations, choosing an appropriate technical approach, and conducting two-dimensional modeling of the river.

Clermont County Watershed Management. Served as deputy project manager for Tetra Tech's contract with Clermont County, Ohio. This was a multi-year project to develop and implement a comprehensive water resources management program for the County. Mr. Kratt managed the preparation of a watershed characterization report evaluating land use impacts on the water resources of Clermont County, managed the application of a customized water resource model, and assisted the county with the development of a community-led, third party TMDL. Mr. Kratt also managed the development of a Site Assessment Tool for the County to evaluate the impacts of new housing developments on water quality and quantity. The Site Assessment Tool allows users to input specific BMP design specifications to evaluate their ability to control individual storms.

Wabash River TMDLs. Mr. Kratt served as project manager for the development of nutrient, temperature, and *E. coli* TMDLs for the Wabash River in Indiana and Illinois. The Wabash River watershed is extremely large (more than 11,700 square miles total) and impairments are associated with both agricultural and urban areas. There are more than 130 NPDES dischargers to the Wabash River, including a number of communities with CSOs. Tetra Tech set up and calibrated the CE-QUAL-RIV1 model for the Wabash River and then used it to identify appropriate load allocations. The TMDL report was approved by USEPA in September 2006.

Lake Michigan Shoreline TMDL. Served as project manager for the development of an *E.coli* TMDL for the Indiana shoreline of Lake Michigan. This was the first ever TMDL developed and approved for one of the Great Lakes. Tetra Tech applied the three-dimensional Environmental Fluid Dynamics Code (EFDC) model to evaluate the effects of wind, waves, tributary loadings, and other factors on *E. coli* concentrations along the near shore and subsequent beach closures. The EFDC model was used to evaluate the degree to which existing sources of *E. coli* needed to be reduced to meet water quality standards during the summer recreational season. The most significant sources of *E. coli* were found to vary by beach, but included tributary loadings, seagulls, and failing nearshore septic systems. The TMDL report was approved by EPA in September 2004.

Ohio TMDL Support. Mr. Kratt has provided technical and project management support to Ohio EPA for more than twenty TMDL and watershed studies throughout the state. Pollutants addressed by these TMDLs include metals, nutrients, pathogens, sediments, dissolved oxygen, and TDS. Models used to develop the TMDLs have included the Simple Method, BATHTUB, load duration curves, GWLF, SWAT, and HSPF. Mr. Kratt is thoroughly familiar with Ohio's water quality standards and assessment process, including the use of fish and benthic macroinvertebrate biocriteria and the Qualitative Habitat Evaluation Index (QHEI), and has worked with Ohio EPA to develop quantitative relationships between water chemistry, habitat conditions, flow conditions, and the health of aquatic communities.

Illinois TMDL Support. Mr. Kratt has provided technical and project management support to IEPA for more than nine years for TMDL projects located throughout the state. He has served as project manager for the development of more than 130 EPA-approved TMDLs in Illinois, which represents 43 percent of the total number of statewide approved TMDLs as of May 27, 2010. He has also managed projects that led to the de-listing of another 30 waterbody/pollutant combinations.Mr. Kratt is very familiar with the key issues affecting TMDL development within Illinois, such as the focus on using simple approaches, the characteristics of primarily agricultural watersheds, only developing TMDLs for pollutants with water quality standards, and TMDL pace issues. Mr. Kratt is also experienced in implementing IEPA's staged approach to TMDL development and has helped the Agency present modeling and TMDL results at numerous public meetings.

Minnesota TMDL Support. Mr. Kratt has provided project management support to MPCA for more than four years for the following TMDL projects: Lower Vermillion River, Groundhouse River, and Minnesota River. Mr. Kratt is also currently supporting MPCA on the Stormwater Nondegradation Analysis Project (SNAP) that will provide information for the development of rules to ensure Minnesota's waters meet the standard of "nondegradation". Mr. Kratt also supported EPA Region 5 and MPCA to develop a case study evaluating the draft Nine Lakes TMDL in Minnesota, which focused on the integration of stormwater NPDES permitting issues and TMDL development.

Wisconsin TMDL Support. Served as project manager for the development of sediment and temperature TMDLs for Squaw Creek and Stillwell Creek in west-central Wisconsin. Tetra Tech worked closely with USEPA and DNR to develop all necessary TMDLs and developed a customized spreadsheet model to evaluate the impact of a large cranberry operation on Stillwell Creek sediment and temperature conditions.

TETRA TECH, INC.

Henry Latimer

Biological Analyst

EDUCATION

M.S., Biology, Aquatic Ecotoxicology, Virginia Polytechnic Institute and State University, 1999

B.S., Biology, Mary Washington College, 1995

YEARS OF EXPERIENCE

Total: 16

With Tetra Tech: 10

PROFESSIONAL AFFILIATIONS

Society for Environmental Toxicology and Chemistry

KEY AREAS OF EXPERIENCE

- Water quality criteria and standards
- Use attainability analyses
- Ecological risk assessment
- Whole effluent toxicity
- Toxicity identification evaluations
- Ecological assessment
- Biological evaluations, threatened and endangered species

Mr. Latimer is a Senior Scientist at Tetra Tech with over 15 years experience using ecotoxicological tools to evaluate anthropogenic impacts on aquatic ecosystems. He has worked extensively in the evaluation of toxic effects of metals, organic compounds (e.g., PCBs and dioxin), and other stressors in both sediments and the water column on individuals and communities throughout the United States. This experience has included evaluation of the potential for bioaccumulation of mercury and selenium in ecosystems ranging from high elevation streams in the Columbia River Drainage containing migratory salmonids to lower elevation, warm-water systems. In assessing the ecological risk of organic toxins, he has modeled the site-specific dietary dose and bioaccumulation of polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and dioxins in several species of freshwater fish. Mr. Latimer has developed, modified, and implemented aquatic water column (WET), and sediment toxicity test methods using numerous test species in both fresh and saltwater. He served as the Director of a large aquatic toxicology laboratory for four years prior to joining Tetra Tech and specializes in not only compliance testing, but also TIE/TRE investigations, research, and site-assessment. He has developed site-specific water quality criteria for a number of different metals using water-effects ratio, and non-resident species deletions procedures, as well as updates of USEPA guidance documents. Additionally, he has been extensively involved with reviewing and commenting on NPDES permits and compliance data from dischargers in states throughout the United States.

Selected Project Experience

Bioaccumulation Assessments. Designed and implemented studies to investigate the potential, actual, or predicted bioaccumulation of selenium and mercury, PCBs, PAHs, or dioxins/furans in fish and aquatic invertebrates. These studies were performed in high altitude mountain streams containing migratory salmonids (Se and Hg), an Alaskan stream in the vicinity of a proposed mixing zone for effluent from a metal mine (Hg), in a Plains stream in Colorado receiving multiple inputs from oil refineries and municipal treatment plants (Se), and in the tidal Delaware river in the vicinity of a superfund site (PCBs, PAHs, dioxins/furans).

Sediment Toxicology. Designed and participated in studies to evaluate the potential toxic contribution of organic and inorganic compounds present in stream and reservoir sediments from site throughout the U.S. These studies used a number of different species of invertebrate and fish in both standard and research-grade whole sediment and sediment elutriate tests conducted both in the laboratory and in situ.

Whole Effluent Toxicity Testing. Used WET testing in evaluation of a wide variety of municipal and industrial discharges, as well as ambient conditions. Overseen and participated in testing with numerous different invertebrate, fish, and algae species in compliance testing, non-compliance investigations (e.g., TIE/TRE investigations), and research-grade freshwater and saltwater testing. Has provided technical oversight on well over 1,000 WET tests. Designed and implemented both manipulated- and synthetic-effluent studies to identify, isolate, and/or predict compounds responsible for toxicity observed in permitted discharges. Used site-specific information to recommend appropriate test methods and species for use in routine monitoring of industrial and municipal effluents. Also, participated in a

meeting with other professionals involved in compliance WET testing with the US USEPA in January 2001, to comment on proposed changes to WET testing methods prior to issuance of those new guidance documents.

Ecological Impact Assessment/Risk Assessment. In support of an ERA at a Superfund Site in Delaware, modeled bioaccumulation of PAHs, PCBs, and dioxins through the food web to fish receptors and compared predicted tissue residues to literature toxicity thresholds to assess risk. Participated in an ERA involving landfills draining to a stream system on an Air Force Base in Maryland for which the contaminants of concern included metals, PAHs, pesticides, and PCBs.

Mixing Zones. Has worked extensively in evaluating the potential ecological impact of mixing zones downstream of mining discharges in both Idaho and Alaska. Using modeled dilution ratios under various discharge and flow regimes, he predicted the concentrations of priority pollutants and the potential effects of the discharge at various points in the stream. Evaluated effect endpoints included avoidance behavior by trout and salmon (including Federally Threatened species), as well as toxicity to fish and invertebrates. Additionally, coauthored mixing zone guidance for permit writers for the states of Idaho and Alaska.

Site-specific Water Quality Criteria. Developed site-specific water quality criteria for aluminum, cadmium, copper, lead, selenium, and zinc through use of the non-resident deletion procedure, water-effects ratio methodology, and correction of USEPA water quality criteria documents. Several of these studies were supported by use attainability analyses (UAA), which Mr. Latimer developed and/or participated in.

Use Attainability Analysis. Conducted UAAs and studies in support of UAAs in both plains and high-altitude streams in Colorado. Has assisted USEPA Region 7 in development of primary contact recreational UAA protocols for Iowa and Missouri. Then managed the study to complete UAAs on more than 200 different streams in Iowa and Missouri.

NPDES Permit Review and Support. Has interpreted, reviewed, and commenting on NPDES permits for dischargers throughout the United States. This work has focused on whole effluent toxicity (WET) conditions and limits, pollutant limits, and mixing zones. Further, he has assisted State of California Regional Water Quality Control Boards in writing portions of specific permits and to craft language for general permits.

TETRA TECH, INC.

Jon Ludwig

Deputy Project Manager

EDUCATION

M.S., Environmental Pollution Control, The Pennsylvania State University, 1997

B.S., Environmental Science, Widener University, 1995

YEARS OF EXPERIENCE

Total: 15

With Tetra Tech: 13

PROFESSIONAL AFFILIATIONS

American Water Resource Association

Water Environment Federation

KEY AREAS OF EXPERIENCE

- Extensive West Virginia TMDL experience (>4,000 TMDLs)
- Extensive knowledge of WVDEP TMDL Program goals & objectives
- Extensive knowledge of WVDEP NPDES permits
- Project management
- Watershed assessment & planning
- MDAS/LSPC Watershed Modeling
- Pollutant source assessment
- GIS spatial analysis

Mr. Ludwig is a director of Tetra Tech's Water Resource Group located in Fairfax, VA and Charleston, WV. He supervises a team of engineers and scientists focusing on watershed planning and management, environmental model development and application, and environmental monitoring and assessment. He is a senior environmental scientist with over 15 years of experience providing technical and management support to federal, state, regional, and private clients in the areas of water resources, watershed and water quality assessment, watershed modeling, and Total Maximum Daily Load (TMDL) development. Mr. Ludwig has successfully managed large, multi-million dollar contracts with federal and state clients, including West Virginia Department of Environmental Protection (WVDEP). Working closely with WVDEP's TMDL Program Manager over the past 11 years, he has provided leadership and energy to produce highly technical and innovative solutions that have helped WVDEP's TMDL Program become a national leader in TMDL development. Mr. Ludwig has extensive experience implementing various hydrologic and water quality models and has played instrumental role in the technical development of the Mining Data Analysis System (MDAS), a dynamic watershed tool that has been customized for watershed assessment and TMDL development efforts in West Virginia. Additionally, he has reviewed National Pollutant Discharge Elimination System (NPDES) permits and assessed measures taken to model the effects of discharge to stream systems. He has also conducted a series of training courses to support USEPA and various states (WV, PA, KY, AZ) in modeling and TMDL development. Courses included bacteria, sediment, mining, and TMDL report writing.

Selected Project Experience

Statewide West Virginia TMDL Development Support for WVDEP Since 2002, served as project manager for statewide TMDL development support contracts with WVDEP. These comprehensive watershed studies include development of TMDLs for total iron, total manganese, dissolved aluminum, pH, selenium, chlorides, fecal coliform bacteria, and biological impairments in streams throughout West Virginia including West Fork, Monongahela Tributaries, Middle Ohio North and South, Elk River, Upper and Lower Kanawha River, North Branch/Potomac River, Upper Ohio North and South, Dunkard Creek, Youghiogheny River, Coal River, Gauley River, Potomac River Direct Drains, Cheat River, Greenbrier River, New River, Little Kanawha River, and James River watersheds. To date, Mr. Ludwig has served as project manager for the development of over 1,900 EPA approved TMDLs in West Virginia with more than 600 currently under development.

Re-Evaluation of the Cheat River Watershed TMDLs in West Virginia. In support of WVDEP and USEPA EPA Region 3, served as project manager for re-evaluation of the Cheat River Watershed. Tetra Tech developed and calibrated mining data analysis system MDAS water quality models for pH, total iron, dissolved aluminum, manganese and fecal coliform bacteria. The model dynamically simulated stream acidity results from multiple sources including acid precipitation caused by sulfur and nitrogen emissions, as well as acid mine drainage (AMD) with very high concentrations of sulfate and dissolved metals (Fe and Al) from abandoned coal mining sites in the region.

West Virginia Iron Troutwater Modeling Study. In support of WVDEP, served as project manager for a high-resolution hydrology and water quality modeling

study for two small trout streams in the Gauley River watershed, WV. The MDAS model was applied to simulate in-stream flow and water quality conditions to determine the range(s) of total iron concentrations that occur in viable trout waters as a result of precipitation induced runoff. Currently, results of this study are currently being used to refine existing approaches to total iron/sediment TMDLs and to support WVDEP's pursuit of coldwater fisheries water quality criterion revision.

West Virginia TMDL Development Support for USEPA Region 3. For USEPA Region 3, served as project manager for the development of over 1,000 pH and metals TMDLs in West Virginia including the Tygart Valley River, Monongahela River, West Fork River, Tug Fork River, and Guyandotte watersheds. Provided lead role both technically and administratively in the evaluation of data and pollutant sources to assess and determine relationships between acid mine drainage and in-stream metals concentrations. Developed various technical approaches related to mining impacts (nonpoint and point sources) on metals loading and applied the Mining Data Analysis System (MDAS), a dynamic watershed modeling tool, to develop TMDLs throughout West Virginia. TMDL development addressed a variety of case-specific requirements related to water quality criteria, water use designations, source pollution conveyance methods, and permitting in large-scale watersheds. Applied the Environmental Fluid Dynamics Code (EFDC), a 3 dimensional hydrodynamic model, to develop TMDLs for the Monongahela River mainstem. Documented the technical approaches and compiled TMDL results in a final report. Led public meetings and prepared responses to written public comments.

TMDL Development Support for USEPA. Currently providing management and technical oversight and client coordination for multiple TMDL development projects including Lake Champlain TMDL Redevelopment (USPA R1); Wissahickon Creek, PA Nutrient TMDLs, and, DC Toxics TMDLs Redevelopment (USEPA R3); and Ohio River Pathogen TMDL (USEPA R5).

Source Water Protection Plan Support for WV DHHR. Currently managing two support contracts with WV DHHR's Source Water Protection Technical Help Program (SWPTHP) by implementing source water protection activities for 104 community public water supply systems in the Beckley, Philippi, and Kearneysville Districts. Source water protection activities include public meetings and facilitation with local stakeholders followed by a survey of potential contaminant sources. Site-specific reports for each CPWS system are being developed and will include a summary of the PCS survey, management plan, contingency plan, and identification of potential funding sources.

Pennsylvania TMDL Development Support for USEPA Region 3. Served as project manager and lead technical advisor for TMDL development in Pennsylvania, including Kiskiminetas River Watershed (metals and pH), Chartiers Creek (metals), Brush Run (nutrients and siltation), Plum Run (nutrients and siltation), and Glanraffan (metals and Suspended Solids). Developed various technical approaches using the MDAS, AVGWLF and WARMF models to address metals, nutrients and siltation impairments in western PA watersheds. Documented and presented results in public meetings and prepared responses to written public comments.

Hydrologic Optimization Study for Sherridon Orphan Mine Reclamation Project. Served as project manager for a hydrologic modeling study to optimize diversion of streamflow from Sherlett Creek into Camp Lake in northern Manitoba, Canada. Reclamation efforts at the Sherridon Orphan Mine site consisted of depositing neutralized acid rock tailings into Camp Lake while maintaining a minimum water depth cover to ensure water quality. A linked modeling system consisting of Loading Simulation Program C++ (LSPC) and CEQUAL W2 was developed to optimize streamflow diversion and to inform engineering design for multiple weirs in Sherlett Creek and Camp Lake.

Left Hand Creek Watershed TMDL and Remediation Alternatives Analysis. In support of US EPA Region 8, served as project manager to developed dissolved metals TMDLs for the Left Hand Creek watershed. Tasks included developing an in-stream chemical transport model to simulated water quality under critical flow conditions and assign loading to specific abandoned mine sources. The customized in-stream model includes 1-D transport model was used to dynamically simulate dissolved zinc, cadmium, copper, and lead in three reaches of the Left Hand Creek watershed.

Dissolved Metals Transport Modeling for California Gulch, CO. In support of Colorado Department of Human Health and Environment, serving as Project Manager for dissolved metals transport modeling in the California Gulch watershed. Tetra Tech is developing an in-stream chemical transport model to evaluate remedial effectiveness scenarios of various mining reclamation activities in the California Gulch watershed. The customized in-stream model will include 1-D transport model equipped with sediment transport routines coupled with a dynamic chemical speciation model to simulate dissolved zinc and cadmium in California Gulch and the Upper Arkansas River.

TETRA TECH, INC.

Yoichi Matsuzuru

Soils Specialist

EDUCATION

M.E.M., Water Resources, Duke University, 1999

B.S., Applied Chemistry, Okayama University of Science, 1990

Post Baccalaureate water quality studies, University of Hawaii ,1996

YEARS OF EXPERIENCE

Total: 15

With Tetra Tech: 13

LICENSES & CERTIFICATIONS

Certificate from Duke University on New Advances on Ecological Risk Assessment, 1999

PROFESSIONAL AFFILIATIONS

American Chemical Society

International Association of Geochemistry

TRAINING

Eastern Completed EPA training for Storm Water Management Model (SWMM), 1999

Completed EPA training for BASINS model, 1999

KEY AREAS OF EXPERIENCE

- Watershed hydrology and water quality modeling
- Aqueous geochemical modeling
- TMDL development
- Computer programming
- Model and tool development

Mr. Matsuzuru is an environmental scientist with more than 15 years of experience in dealing with a variety of water resource issues for federal, state, and local government clients. He has extensive experience in constructing watershed and stream water quality models, and developing mathematical transport and chemical reaction models. He has led development of chemical reactive transport model codes, as well as modifications/updates of in the Mining Data Analysis System (MDAS) codes. He is a proficient computer programmer using languages such as Visual Basic Application and FORTRAN, and is a skilled programmer in C++. He has been extensively involved in technical TMDL development activities throughout the U.S. He has managed numerous small to large-scale watershed modeling and stream water quality modeling projects as a technical lead.

Selected Project Experience

Monongahela River Watershed TMDLs, West Virginia. For the WVDEP, served as technical lead for the development of pH, aluminum, and manganese TMDLs for the tributaries to the Monongahela River Watershed in West Virginia. Constructed an MDAS model to perform continuous hydrologic and water quality simulations for impaired streams in the watershed. Performed statistical analysis on water quality data to evaluate site conditions and source loadings. Researched application of MDAS modeling to streams with high concentrations of dissolved inorganic chemicals in the Monongahela and Upper Kanawha River Watersheds.

Iron and Manganese lake/sediment modeling studies, Alaska. Conducted the lake water impairments modeling due to highly contaminated lake bottom sediments. The site was contaminated due to historical landfills located adjacent to the lakes. Constructed the current conditions of Lake water influenced by the contaminated sediments. Subsequently, provided the remediation scenarios for the sediments and the leachate loadings that could meet the water quality standard for total iron and manages. USGS's PHREEQC and NETPATH model were applied to conduct the modeling study.

Model Development, Department of Environmental Protection, West Virginia. Developed an in-stream chemical speciation model with a parameter optimization function. The model simulates in-stream concentrations of inorganic chemical species, and is capable of simulating chemical concentrations in multiple streams on a watershed scale. It couples watershed model outputs with US EPA's geochemical computational code, MINTEQ, to simulate the dissolved component of the total metal concentrations. The model optimizes model parameters using a random search method to automatically calibrate the model against available observed data. The model was applied to Upper Guyandotte River watershed, which included 450 modeled subwatersheds.

Model Development, EPA Region 3, Maryland. Developed subsurface and in-stream water quality model to address acidity loadings from atmospheric deposition and surface runoff. In order for the models to estimate in-stream pH, six submodels were developed; the subsurface chemical reaction model, the aqueous chemical reaction model, sulfate subsurface and instream reaction models, nitrogen subsurface and instream transformation model. The aqueous model was configured so acid loadings from different sources, such as mining, NPDES and wetlands.

Gills Creek Watershed LSPC modeling for Nutrients and Bacteria TMDLs, South Carolina. Served as technical lead to develop total maximum daily loads

(TMDLs) for the Gills Creek watershed for the South Carolina Department of Health and Environmental Control (SCDHEC) and the Richland County Department of Public Works. The Loading Simulation Program C++ (LSPC) and Sediment Flux Model were used for hydrologic calibration and establishing loadings for pollutants causing fecal coliform and dissolved oxygen impairments .

Chagrin River BMP Studies, Ohio. Developed and implemented BMP scenarios under stormwater influence of Chagrin River watershed. Several scenarios were tested with Loading Simulation Program C++(LSPC) and its BMP module and implementing two BMPs; detention pond and infiltration detention pond for subwatersheds within Chagrin River Watershed.

Nutrients, Dissolved Oxygen, and pH TMDLs, Illinois. Developed nutrients and dissolved oxygen TMDLs for more than 25 impaired segments using Qual2K model. Nonpoint source and point source loadings were estimated to assign assimilative capacity to streams. Calculated total H loadings and required additional alkalinity to meet pH standard for abandoned mine affected streams by using MINEQL+.

California Gulch remediation modeling study, Colorado DPHE. Co-developed reactive transport model for California Gulch in CO. The model can be used for a single river reach or a river with multiple tributaries. The model simulates one class of suspended sediment in the river system. A toxic sub-model for rivers and sediment is developed based on equilibrium theory and is coupled with the contaminants transport model and the suspended sediment transport model. Chemical reactions among contaminants and also the exchanges of contaminants between the water column and the bottom sediment are simulated. The bottom sediment is represented by a single sediment layer.

Conceptual Model Development, South Florida Water Management District, Florida. Developed sixteen conceptual models for nutrients, including nitrogen and phosphorus, and trace metals in both oxic and anoxic conditions of the wetlands. The models were ranked from the highest data intensive model to the lowest data required conceptual model to identify type of data required to run the highly complex model to less complex models. The project identifies natural processes to be incorporated into an appropriate model for the system in the Everglades wetlands.

Wabash River Bacteria and Nutrients TMDLs, Illinois and Indiana. Developed statistical watershed loading tool. The tool estimate daily loadings of pollutants from watersheds based on available observed flow and water quality data, and the results are compared and confirmed with observed data. The estimated loading and actual measured loadings from more than 150 subwatersheds was input into EPD-RIV-1 model (one dimensional hydrodynamic and water quality model) and hydrology, and water quality parameters such as temperature, nutrients and fecal coliform are being calibrated.

Boulder Creek Watershed TMDLs, Department of Environmental Quality, Arizona. Technical lead for the TMDL development for the Boulder Creek, AZ watershed. Developed a reactive transport model to develop total maximum daily loads (TMDL) of arsenic, lead, copper, manganese, beryllium and zinc for Boulder Creek. The watershed model, LSPC was used to simulate the hydrologic system of the watershed and daily flow rates in the creek. The chemical speciation model couples steady state flow with a geochemical model, MINEQL, in order to construct a longitudinal steady state metals concentration profile along Boulder Creek. The model incorporates major chemical reactions, such as acid/base reactions, precipitations/dissolutions, and adsorptions by hydrous ferric oxide. Identified sources, such as three major tailing piles, an adit and groundwater contributions along the creek, were incorporated into the model. After the model was calibrated, loading reductions necessary to achieve water quality standard from each source were identified.

French Gulch Watershed TMDLs, Department of Environmental Quality, Arizona. Technical Lead for the development of TMDLs for the French Gulch Watershed in Arizona. Estimated required metal (copper, lead, zinc, and manganese) loading reductions for the French Gulch Watershed to meet the applicable in-stream water quality standards. Flow and load duration curve methods were developed for each individual subwatershed. The method takes into account all relevent source contributions, such as surface runoff and metals loadings from groundwater. Loading contributions from these different sources were considered for both the high and low flow conditions of the creek. The potential affects due to well discharges within the watershed were also incorporated into the watershed model, LSPC, to adjust the daily flow rates in the creek accordingly. Dissolved metals were simulated from available observed total metals data using modified MINTEQ code. Developed a post processing computer program written in FORTRAN and Visual Basic that generates visual loading results at each subwatershed.

TETRA TECH, INC.

Allen Medine, PhD, PE

Soils Specialist

EDUCATION

Ph.D., Environmental Engineering, Utah State University, Logan (w/chemistry minor), 1980

M.S., Civil Engineering, University of California, Berkeley, 1973

B.S., Civil Engineering, University of Illinois, Urbana, 1972

YEARS OF EXPERIENCE

Total: 35

With Tetra Tech: 2

LICENSES & CERTIFICATIONS

Professional Civil Engineer, California (2011, No. 114531)

Professional Engineer, Colorado (1994, No. 29856)

Board Certified Environmental Engineer (BCEE), American Academy of Environmental Engineers, Hazardous Waste Certification (1999, 98-20077)

PROFESSIONAL AFFILIATIONS

American Society of Civil Engineers

Water Environment Federation

American Chemical Society

KEY AREAS OF EXPERIENCE

- Water Quality, Contaminant Fate and Geochemical Modeling
- Natural Resource Restoration
- Contaminant Loading Analyses
- Sediment Investigations and Remediation
- Industrial Water Chemistry
- Remedial Design and Costs
- Waste Site Investigations, Characterization, Environmental Forensics
- Bankruptcy Environmental Evaluations / Cost Estimating
- Litigation Strategy, Negotiations, Testimony

Dr. Medine has over 30 years of professional experience in civil/environmental engineering and environmental chemistry/geochemistry. His experience includes seven years of teaching and research in Civil and Environmental Engineering; substantial, complex Project Management experience; and Expert Technical Support experience. He has worked on a wide variety of multi-disciplinary environmental engineering and environmental science projects at over 70 waste sites (in all EPA regions) and provided a wide range of technical support at over five-dozen Superfund sites.

Dr. Medine has been committed to technology transfer and research in surface water, sediment, and groundwater quality management for over 30 years, including the development, testing, and application of modeling to attain water quality goals. His expertise includes hazardous waste management, watershed management and restoration of damaged ecosystems, behavior of toxic substances in the environment, hydrologic and sediment transport modeling, geochemical modeling, water quality and contaminant transport modeling, river basin hydrology, geomorphology, and regulations and procedures pertaining to the Clean Water Act (CWA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Resource Conservation and Recovery Act (RCRA), and Natural Resource Damage Assessment (NRDA).

Selected Project Experience

West Virginia TMDL Development Support for WVDEP and EPA. Served as a technical resource in the modifications and application of the loading simulation and geochemical models (LSPC-MDAS) to evaluate ionic composition and metals fate and transport in the Upper Kanawha River. Developed various technical data related to mining impacts (nonpoint and point sources) on metals loading and input data to evaluate impacts of iron, aluminum, cations/anions, and pH in support of water quality concerns.

Geochemical Modeling for Clearfield Creek, Pennsylvania to Support Metals and pH Impairment. Served as a technical expert in the geochemical modeling effort to predict and evaluate the water quality conditions of Clearfield Creek and Sugar Run in response to the modified flow and pollutant loading from the mine discharges. The use of MINTEQA2 provided the ability to quantify the distribution of dissolved species, which can provide insight on the potential toxic conditions. The geochemical evaluation of the impact of the Cresson Acid Mine Drainage Project on the in-stream water quality of Clearfield Creek evaluated the existing and expected water quality conditions based on the mine drainage treatment alternatives, the model uncertainty, and underscored the impacts of mine water discharges on regulating the surface water quality of Clearfield Creek and Sugar Run. Recommendations included the development of an Integrated Reactive Transport Model (LSPC-MDAS) would permit an assessment of flow conditions, point and non-point loadings, geochemical interactions, precipitation and groundwater interactions throughout Clearfield Creek.

Geochemical Modeling and Field Evaluation for Selenium Characterization and Migration Research for Keller Bliesner Engineering. Provided engineering support, research and characterization of selenium releases from natural soils and migration to sensitive ecological environments. Other tasks included development of a conceptual model for contaminant transport and environmental chemistry support for the development of a numeric groundwater transport model to predict

selenium migration for a 200-square-mile irrigation project in the southwest and development and installation of a field-scale program for selenium migration control methods.

Geochemical Modeling Support to National Risk Management Research Lab (NRMRL) for USEPA. Long-time consultant to the USEPA's Risk Reduction Engineering Laboratory (RREL), now known as the NRMRL in Cincinnati, OH, and has recently provided technical support to USEPA Region VIII on the Summitville Mine site and the Clear Creek/Central City Superfund Site. This technical support has included the development of the Metal Exposure and Transformation Assessment Model (META4), the metal speciation submodel to be used with the WASP4 modeling system. The model was developed to predict water quality improvement resulting from numerous remedial action scenarios, and to provide a more realistic tool for the determination of TMDLs to meet water quality standards. The model was also applied at the Clear Creek/Central City Superfund Site which included an assessment of contaminant source areas, total daily maximum watershed and source area loadings, transformation processes, pathways, and receptor exposure analysis.

Drinking Water Protection Projects for City of Thornton, Colorado. Supported the City of Thornton on drinking water infrastructure and sources through expert technical services on Regulation 31, Regulation 38, nitrate Total Maximum Daily Load (TMDL) assessment for the South Platte River, the Englewood Water Rights Case, the Denver Case, and other issues on an as-needed basis. The work involved data analysis, strategy meetings, document review, preparing testimony for the Water Quality Control Commission, and offering testimony before the Commission.

Expert Support to EPA at Upper and Middle Silver Creek, Richardson Flat Tailings Superfund Site, Utah. Expert engineer for site characterization, remedial investigation support, field data collection and laboratory QA, and implementation of characterization and evaluation of work conducted by others under Utah's Voluntary Cleanup Program in the Park City, Utah area. The technical support focused on the evaluation of source, transport and fate of metals, including arsenic, cadmium, lead, and zinc, throughout the area in surface waters, sediments, and groundwater.

Litigation Support and Expert Testimony for U.S. Department of Justice, Environmental Defense Section (EDS) and the Environmental Enforcement Section (ENRD). Supported the U.S. Government on over 50 major Superfund / CERCLA sites throughout the U.S for the last 20 years in areas such as contaminant source, transport and fate; remedial design, technology and cost analysis; historical releases; sediment transport and dredging; environmental forensics; liability and apportionment; surface water and groundwater modeling, bankruptcy environmental liabilities; National Contingency Plan (NCP) compliance; and natural resource damages. Projects involved substantial state-of-the-art research, interpretation of complex subjects, and application of advanced analyses to prepare opinions for the court. Developed and applied numerical contaminant transport modeling in conjunction with GIS systems to integrate large quantities of environmental data to evaluate waste treatment location / volumes, transport pathways, soil erosion, groundwater contaminant migration and fate, cost evaluations, sediment and floodplain dynamics, and historical natural contaminant loadings and maximum daily loadings to meet water quality needs.

Litigation Support and Expert Testimony for Various Private Law Firms. Supported private firms on the source, release, transport, and fate of a variety of toxic chemicals at the Upper Columbia River Basin, eastern Washington (2011, metals); Lakewood, Colorado Groundwater TCE site; Quality Metal Products (1999, TCE, degradation products); and at the Lowry Landfill Superfund Site, City of Lakewood v. Various Insurance Companies.

Potentially Responsible Party (PRP) Activities Under the Technical Enforcement Support (TES) IV and Aircraft Reporting and Compliance System (ARCS) Programs for USEPA. Project manager and senior environmental engineer for technical oversight; provided coordination of technical review of all RI/FS and RD/RA documents at 9 major Superfund sites including mining sites and organic chemical sites (technical review included review of feasibility studies, RD planning documents, site characterization plans, QA/QC plans, fate and transport studies, modeling, remedial designs, and technology demonstration plans).

Model Testimg and Workshops for the Environmental Research Laboratory (ERL) in Athens, GA for USEPA. Provided technical support on chemical modeling of environmental systems, testing of new USEPA models, peer review of modeling applications, and workshops on the MINTEQA2 equilibrium speciation model.

Remedial Investigation and Risk Assessment Support at the Weldon Spring Site Remedial Action Project, MO for U.S. Department of Energy. As an engineer with Jacobs Engineering Group (JEG), coordinated the Remedial Investigation Report with a staff of 35 for the Weldon Spring site, a DOE Mixed Waste Installation (uranium, thallium, radium, radon, TNT, DNT, PCBs, toluene, metals), and provided senior support on the risk assessment, data validation, and applicable technologies for remedial action.

TETRA TECH, INC.

Christina Mellors

Senior Water Resource Engineer

EDUCATION

M.S., Environmental Science, Drexel University, 1998

B.S., Chemical Engineering, Carnegie Mellon University, 1994

YEARS OF EXPERIENCE

Total: 17

With Tetra Tech: 11

KEY AREAS OF EXPERIENCE

- Watershed modeling
- TMDL development
- Pollutant source assessment
- Watershed hydrology
- Water quality assessment
- Data management tool development

Ms. Mellors provides technical support to federal and state clients in the areas of watershed modeling, water quality assessment and management, and Total Maximum Daily Load (TMDL) development. Her duties include research, data compilation and analysis, data analysis in GIS, and technical writing. She has experience with BASINS, LSPC and the Mining Data Analysis System (MDAS), a dynamic watershed tool that has been customized for watershed assessment and TMDL development efforts in West Virginia. In addition to her graduate and undergraduate studies, Ms. Mellors has extensive knowledge and experience dealing with environmental issues on the state government level as an employee of the Virginia Department of Environmental Quality. During that time she regularly dealt with EPA Region 3 in support of RCRA permitting and corrective action activities. Ms. Mellors also has professional experience as a consultant providing engineering services to the specialty chemical and pharmaceutical industries. She is currently serving as technical lead for development of West Virginia's watershed implementation plan for the Chesapeake Bay TMDL for WVDEP.

Selected Project Experience

Metals and Sediment TMDLs for the Upper Kanawha, Upper Ohio North, South Branch Potomac, & Shenandoah Rivers, WV. For the WVDEP Division of Water and Waste Management, currently serving as technical lead for metals and sediment TMDL development. Incorporating mining and non-mining iron and sediment sources into the MDAS watershed model.

Metals and Sediment TMDLs for the Monongahela River and West Fork River, WV. Currently serving as technical lead for metals and sediment TMDL development for the Monongahela and West Fork River watersheds, West Virginia for WVDEP Division of Water and Waste Management. Integrated point and nonpoint sources of iron and sediment into a comprehensive watershed model. Developing Load Allocations and Waste Load Allocations for sources such as abandoned mine lands, acid mine drainage seeps, bond forfeitures, surface and deep mines, construction and industrial stormwater, agricultural and urban runoff.

Metals and Sediment TMDLs for the Middle Ohio South, Middle Ohio North, and Elk River, WV. Served as technical lead for metals and sediment TMDL development for the Middle Ohio South and North River watersheds and Elk River watershed,, West Virginia for WVDEP Division of Water and Waste Management. Developed an approach for modeling and calibrating streambank erosion to pin study locations throughout the watershed using MDAS.

Metals and Fecal Coliform TMDLs for the Greenbrier River, James River, Little Kanawha River, Upper and Lower New River Watersheds, WV. Served as technical lead for metals TMDL development for the Little Kanawha River watershed and the Upper and Lower New River watersheds, West Virginia for WVDEP Division of Water and Waste Management. Provided technical oversight and guidance for the development of fecal coliform TMDLs for the Greenbrier River and James River watersheds, West Virginia.

Metals, Sediment and Fecal Coliform TMDLs for the Gauley River and Potomac Direct Drains Watersheds, WV. Served as technical lead for metals and sediment TMDL development for the Gauley watershed, West Virginia. Provided technical oversight and guidance for the development of fecal coliform TMDLs for the Gauley watershed, West Virginia and sediment and fecal coliform TMDLs for the Potomac Direct Drains watershed, West Virginia for WVDEP Division of

Water and Waste Management. Developed an approach for modeling sediment and sediment related metals using MDAS.

Fecal Coliform TMDLs for the Coal River Watershed, WV. Served as technical lead for fecal coliform TMDL development for 83 streams in the Coal River watershed, West Virginia for WVDEP Division of Water and Waste Management. Documented the approaches and compiled findings in a final report.

Metals, Fecal Coliform and Sediment TMDLs for the Coal River, Lower Kanawha River, and North Branch of the Potomac River Watersheds, WV. Provided technical support for TMDL development for metals, fecal coliform and biological impairments for 175 streams in the Coal River, Lower Kanawha River, and North Branch of the Potomac River watersheds in West Virginia. Developed approaches and tools to quantify pollutant loadings from mining permits while working closely with WVDEP.

Fecal Coliform TMDLs for the Guyandotte River Watershed, WV. Served as technical lead for fecal coliform TMDL development for the Guyandotte River watershed, West Virginia, for USEPA Region 3. Documented the approaches and compiled findings in a final report and participated in public meetings.

Metals and Fecal Coliform TMDLs for the Upper Kanawha River and Upper Ohio River North Watersheds, WV. Served as technical lead in the development of fecal coliform TMDLs and provided technical support for the development of metals TMDLs for the Upper Kanawha and Upper Ohio North watersheds in West Virginia. Documented the approaches and compiled findings in a final report and participated in public meetings.

Source Water Protection Field Surveys, WV. For the West Virginia Department of Health and Human Resources, Source Water Assessment and Protection Program, developed a database to track and manage project data and generate system-specific source water protection plans for over 100 community water systems in West Virginia.

Chartiers Creek, PA and Cheat River, WV. Provided technical support for WVDEP TMDL projects as well as USEPA Region 3 TMDL projects in Chartiers Creek and the Cheat River.

Virginia Department of Environmental Quality. Wrote, reviewed and issued permits, closure plans and corrective action documents for hazardous waste management (treatment, storage and disposal) facilities throughout the state of Virginia in accordance with RCRA and Virginia State Hazardous Waste Regulations. Worked closely with the US Navy to develop a Research Demonstration and Development permit for an experimental plasma arc hazardous waste treatment unit at US Naval Station Norfolk. Performed extensive reviews and analyses of all sampling data submitted in support of solid and hazardous waste permitting activities and to demonstrate closure of hazardous waste management units. Worked with RCRA facilities throughout Virginia to develop groundwater and human exposure environmental indicators for RCRA corrective action. Regularly engaged in public participation activities related to permit approval and issuance for both solid and hazardous waste facilities. In addition to those activities required by law, met with various local interest groups and concerned citizens to educate them about the requirements of RCRA and state regulations and has facilitated meetings between facility owner/operators and the public to resolve issues related to facility operation.

TETRA TECH, INC.

John O'Donnell

Quality Assurance Manager

EDUCATION

B.S., Business Administration, Glendale University, 2009

YEARS OF EXPERIENCE

Total: 30

With Tetra Tech: 10

KEY AREAS OF EXPERIENCE

- Quality Assurance/Quality Control (QA/QC)
- Quality Assurance Project Plans (QAPP)
- Quality Management Plans (QMP)
- Standard Operating Procedures (SOP)
- Laboratory, field, and system audits

Mr. O'Donnell is an Environmental Quality Assurance Chemist with 30 years of experience providing technical and project management, and quality assurance support to federal, state, and municipal clients throughout the United States. Mr. O'Donnell currently serves as Quality Assurance Officer on a number of EPA contracts and on individual work assignments and task orders. He is responsible for the overall management of quality system for Tetra Tech's Fairfax center offices. He has developed, refined, and maintained Quality System components including the organizational Quality Management Plan (QMP), contract-specific Quality Control Plans (QCPs), Standard Operating Procedures (SOPs), procedural and technical training and documentation systems, and project and system audit protocols, as well as project specific Quality Assurance Project Plans (QAPPs). Mr. O'Donnell has been supporting EPA Headquarters, EPA Regions, and states with TMDL issues since 2003, including development of QAPPs in support of TMDL development. Mr. O'Donnell's areas of expertise include Quality System Development, including preparation of QMPs, QAPPs, SOPs, and other documents; conducting laboratory, field, and system audits; reviewing and validating environmental data; and performing data analysis and usability assessments. Mr. O'Donnell has experience and training in environmental data validation, analytical laboratory auditing, project management, quality assurance, health and safety, chemical hygiene, and personnel management and supervision gained through on-the-job training and technical courses, seminars, and conferences.

Selected Project Experience

Regional and state TMDL Support. Mr. O'Donnell has provided technical and QA support in the development of quality system guidance for: Illinois EPA for TMDL projects on Little Vermilion River, and Salt Fork; for Indiana Department of Environmental Management on South Fork Wildcat Creek, and Busseron Creek watersheds; and for Minnesota Pollution Control Agency on Lower Vermillion River; for Ohio EPA. Routine QA support included development or oversight of the development of quality assurance guidance (QAPPs) for TMDL development, as well as QAPPs for any primary data collection conducted to address gaps in temporal or spatial characterizations.

Klamath River Basin Monitoring and Hydrodynamic and Water Quality Modeling Support (QA Chemist; Oregon and California, U.S.A.; 2004 - 2007). Oversaw the primary data collection efforts for Oregon, California, and USEPA in the 15,700 mi2 Klamath and Lost River Basins. Assisted in the design of a comprehensive monitoring plan to conduct a series of sampling events that included physical, chemical, and biological monitoring (including Sediment Oxygen Demand and periphyton surveys) at over 30 independent sites throughout the semi-arid, high desert region of the basin. Developed procurement documents and relevant technical specifications to address laboratory analysis of surface water samples collected in the basins, conducted negotiations with qualified respondents and developed detailed statements of work for award of the subsequent subcontract agreement. Assisted with the development of quality system documents to describe the requirements of the monitoring design and subsequent field data collection operations (sampling and analysis plan or SAP), and developed the detailed quality assurance project plan (QAPP) for review and approval.

Conducted field and laboratory procedural reviews concurrent with the first field mobilization to ensure complete understanding of field sampling protocols and laboratory requirements to optimize data quality for this important data collection, and retained primary oversight for field and laboratory activities throughout the data collection, including providing technical direction for selection of corrective action in instances of non-conformance in measurement system performance. Primary laboratory measurements were conducted for nutrient and bacteriological impairments, as well as to characterize overall oxygen budget within the system. Continuing support to modeling staff in interpretation of analytical measurement data and reports for monitoring conducted within the basin by other stakeholders.

Brazos River Basin (Basin Group D) Dissolved Oxygen TMDL Study (QA Chemist; Texas, U.S.A.; 2001 - 2005). A water quality and biological monitoring plan was developed and formalized in a project Sampling and Analysis Plan (SAP) to provide the necessary data to assess the status of impaired streams for modeling studies, Use Attainability Analyses (UAA), and TMDL development. A Quality Assurance Project Plan (QAPP) was developed to govern monitoring studies (biological and habitat assessments), laboratory analyses, data management, and reporting. Physical, biological, and chemical monitoring were conducted in 2003 and 2004 in two of the three creeks suspected to be impaired for DO. Stream segments were regularly monitored over two years. In support of the QA function, the QAPP and SAP were revised and updated to reflect revised TCEQ program monitoring objectives and to reflect revised scope (elimination of one of the three segments proposed for detailed investigation). Detailed Statements of Work were developed to contractually direct quality requirements of the laboratory service subcontractors, and annual on-site (field) sampling procedural reviews and laboratory technical project audits were conducted to ensure attainment of project goals, compliance with program requirements, and to verify adequacy of procedures and documentation. Procedural review and audit reports were prepared detailing observed deficiencies (findings), required corrective actions, and recommendations (observations).

Water Quality Monitoring for USEPA Region 2 in the U.S. Virgin Islands (QA Chemist; St. Thomas and St. John, U.S. Virgin Islands; Spring 2007). Developed and implemented quality system documents to support the primary data collection for the dissolved oxygen and overall oxygen budget (including sediment oxygen demand, respiration, diffusion, and productivity) investigation within St. Thomas Harbor in St. Thomas and Coral Bay on St. John in the US Virgin Islands (the approved project QAPP). Conducted field procedural reviews for sample collection and in situ field measurements conducted within the study areas, and continued to support modeling staff in the interpretation and use of field and laboratory analytical results. Under this task order, Tetra Tech selected a field investigation team internationally recognized for their specialization in oxygen budget monitoring design and measurement.

TETRA TECH, INC.

Jennifer Olson, PG

Soils Specialist

EDUCATION

M.S., Water Resources Science, University of Minnesota, 2005

B.S., Hydrogeology and Environmental Geology, University of Minnesota ,1997

YEARS OF EXPERIENCE

Total: 16

With Tetra Tech: 4

LICENSES & CERTIFICATIONS

Licensed Professional Geologist (P.G.) — Minnesota, #44077

TRAINING

Systematic Development of Informed Consent, Institute for Participatory Management and Planning , 2005

Better Site Design Techniques Workshop, Center for Watershed Protection, 2003

P8 Urban Catchment Model Training, Instructor John Panuska, WI DNR, 2002

KEY AREAS OF EXPERIENCE

- Total Maximum Daily Load and water quality studies
- Watershed planning
- Stormwater and green infrastructure
- Surface and groundwater interactions

Ms. Olson is a water resource scientist with broad experience in watershed and water quality planning and management. She has extensive experience in developing Total Maximum Daily Load studies and has worked closely with stakeholders and municipalities to develop successful implementation programs. Ms. Olson also has background in green infrastructure practices including utilizing the US EPA's SUSTAIN model to determine cost-effective solutions to water quality problems. Ms. Olson also has experience with surface and groundwater interactions, designing and implementing comprehensive monitoring programs, and regulatory analysis and implementation of regulatory programs.

Selected Project Experience

Lower Grand Total Maximum Daily Load Study. A TMDL is currently underway for the Lower Grand River in northeastern Ohio for biological and pathogen impairments. A "Flow Regime TMDL" is being proposed to address the impacts of stormwater and reduced baseflow on biology in the watershed. Ms. Olson is currently leading the technical team on development of this US EPA funded TMDL. The TMDL will result in attainment flow duration curves based on a reference watershed approach.

US EPA Compendium of Nutrient TMDLs. Ms. Olson is the lead author on the US EPA's Compendium of Nutrient TMDLs, currently underway. Compendium development has included interviews with US EPA Regional TMDL staff to gain insight into typical approaches and methods being used across the country to develop nutrient TMDLs. A review of over 50 nutrient TMDLs is also being completed to further evaluate the recent approaches being used. Results will be summarized, along with the pros and cons on the various approaches, challenges being faced, and lessons learned from each of the Regions. Ms. Olson is also working with the US EPA on developing a workshop on Nutrient TMDLs scheduled for early 2011.

Silver Lake Total Maximum Daily Load Study and Implementation Plan. Ms. Olson served as the project manager and primary author of the Silver Lake TMDL (Ramsey County, MN) which was approved by the US EPA in 2010. This TMDL utilized a linked StormNET hydrologic and hydraulic model and P8-UCM to simulate the urban conditions and effectiveness of existing BMPs in the Silver Lake watershed. A Bathtub model was then constructed to simulate the in-lake response which was calibrated with long term monitoring data. Stormwater was the primary source of nutrients to the lake, and as part of implementation planning, programs and projects were identified through an MS4 driven stakeholder process to achieve the necessary reductions in phosphorus loads to the lake and meet water quality standards. Implementation activities included regional water quality ponding, numerous small scale bioretention and rain garden BMPs, an active chemical treatment facility to treat stormwater, and in-lake chemical treatment.

Pope County Total Maximum Daily Load Study and Implementation Plan. Ms. Olson supported the Minnesota Pollution Control Agency (MPCA) on development of a multiple lake TMDL study in west central Minnesota. This primarily agricultural watershed included eight lakes impaired by excess nutrients. Ms. Olson was the primary author on the TMDL. This TMDL included several permitted point sources, a CAFO site that was out of compliance, and significant internal loading issues. Ms. Olson worked closely with NPDES permitting staff at the MPCA as well as with the permittes to develop reasonable strategies to reduce

nutrient loadings. Ms. Olson also led a stakeholder involvement process which included representatives from the agricultural community, municipal and state agency staff, watershed organizations, lakeshore owners, and private interests.

Carnelian –Maine St. Croix Watershed District (CMSWD) Multi-Lake TMDL. Ms. Olson was the project manager on the first two phases of a multi-lake nutrient TMDL in Washington County, Minnesota, working closely with the MPCA, local watershed organization, and soil and water conservation district. The TMDL included a comprehensive monitoring program including plankton and macrophytes, sediment, water column, flow and bathymetry. Land use based GIS analysis and in-lake response modeling was used to evaluate existing conditions. Ms. Olson led a public involvement process that included over 100 land owners in addition to technical and political stakeholders.

Milwaukee Metropolitan Sewer District (MMSD) Green Infrastructure Analysis and SUSTAIN Modeling. As part of long-range planning efforts, the MMSD has been evaluating the role that green infrastructure can play in reducing CSOs and improving water quality. Tetra Tech utilized the US EPA's SUSTAIN model to determine the cost-effectiveness and optimized suite of green infrastructure techniques for use in the combined sewer area. Ms. Olson provided model input data and conceptual green infrastructure design details for the SUSTAIN modeling effort and served as a liaison between the SUSTAIN modeling team, project planners, and economists working on a complementary Triple Bottom Line analysis.

Stormwater Pollution Prevention. Ms. Olson managed the development of a series of guidance documents and factsheets for the MPCA which focused on integrating pollution prevention with the NPDES stormwater program. A guidance document was developed for MS4s that included twenty-five pollution prevention techniques including storm drain stenciling, sweeping programs, reducing impervious surfaces, urban forestry, establishing an infiltration standards, and rainwater reuse. The guidance included selection tools to assist MS4 communities with choosing the most appropriate pollution prevention measures based on pollutants addressed by each practice and applicable minimum control measures. Fact sheets were also developed for the construction stormwater program related to the most common permit violations including SWPPP development and specific aspects of erosion control. Fact sheets were also developed for several industrial sectors that included guidance on how to meet new Multi-sector General Permit requirements.

Watershed Planning. Ms. Olson has extensive experience with watershed planning and water quality implementation planning studies. She has conducted overall watershed management plan development including developing plan content, committee facilitation, and project management. Watershed plans typically include issues identification, goals and policy development, inventory of resources, and implementation activities. She has also assisted watershed organizations with development of funding mechanisms including stormwater utilities and has assisted stakeholder groups and local government units with grant writing.

Surface and Groundwater Interactions. Ms. Olson has extensive experience on large scale planning efforts, with an emphasis on integrating groundwater planning into overall watershed planning. She is responsible for design and management of complex water surface and groundwater interaction studies, providing technical assistance and expertise for surface water and stormwater design projects and providing expertise in determining lake, stream, and natural resource interactions with groundwater resources. She also provides groundwater and soils related expertise, specifically related to evaluating soils and groundwater characteristics for BMP design.

Stormwater Infiltration and Green Infrastructure Practices. Ms. Olson provides expertise in conceptual design and review of stormwater infiltration facilities including sighting of practices based on local conditions, collecting and analyzing data on soils and groundwater resources, and applying appropriate infiltration rates to design. She also has extensive experience with large and small scale green infrastructure monitoring programs and data interpretation. Ms. Olson has also worked closely with the US EPA's SUSTAIN model to determine cost effective strategies using green infrastructure practices to achieve water quality goals.

TETRA TECH, INC.

Andrew Parker

Deputy Program Manager

EDUCATION

M.E., Environmental Engineering, University of Virginia, 1996

B.S., Civil Engineering, University of Virginia, 1995

YEARS OF EXPERIENCE

Total: 17

With Tetra Tech: 17

LICENSES & CERTIFICATIONS

Engineer in Training, Virginia

PROFESSIONAL AFFILIATIONS

American Society of Civil Engineers

KEY AREAS OF EXPERIENCE

- Pollutant source assessment
- Watershed hydrology and stormwater
- Watershed runoff quality
- TMDL development and implementation
- Watershed management plan development
- BMP evaluation and implementation planning
- Tool development
- Information management system development
- Receiving water modeling
- Watershed modeling

Mr. Parker is an environmental engineer with more than 15 years experience providing technical and management support to federal, state, regional, municipal, and private clients in the areas of watershed and receiving water modeling, watershed and water quality assessment, water resource planning, and Total Maximum Daily Load (TMDL) development. He is Director of the Water Resources Modeling and Assessment Group and supervises 25 engineers and scientists focusing on watershed and receiving water modeling, advanced model development, and stormwater management. Mr. Parker has conducted watershed assessments and TMDL/modeling efforts for metals, bacteria, nutrients, dissolved oxygen, sediment, temperature, and PCBs in West Virginia and throughout the country (DE, VA, NJ, PA, MD, KY, ME, VT, MA, DC, GA, AL, MS, TN, NC, SC, LA, FL, USVI, CA, OR, NV, AZ, HI, TX, NE, MN, NM, CO, and WA). His TMDL development and modeling support efforts over the past 9 years for USEPA, states, and territories have led directly to the completion of more than 2,000 defensible TMDLs. Mr. Parker has extensive experience implementing hydrologic and water quality models, including BASINS, MDAS, LSPC, HSPF, SWMM, WASP, QUAL2E, EFDC, CE-QUAL-W2, and PHOSMOD. He has been part of the team developing and maintaining BASINS for USEPA's Office of Science and Technology, and he currently provides management and technical support for development of the next generation modeling system, the Modeling Toolbox. Mr. Parker also has extensive experience training individuals in the use of watershed and water quality models. He has additional experience assessing BMPs, monitoring streams, and performing laboratory analyses on aquatic samples.

Selected Project Experience

TMDL and Modeling Support for West Virginia DEP. Played a lead role in development of the Mining Data Analysis System (MDAS) and its application to metals and pH modeling and TMDL development for more than 100 streams, lakes, and rivers impacted by mining in the Tygart, Cheat, Monongahela, Elk, and Stony River Basins, WV. Managed development of PCB TMDLs for the Flat Fork, WV and the Shenandoah River, WV using a spreadsheet model developed in-house. Developed fecal coliform bacteria TMDLs for six rivers in the WV portion of the Potomac River Basin using BASINS-NPSM/HSPF. Developed siltation TMDLs for Mountwood Park Lake, Burches Run Lake, and Tomlinson Run Lake in WV using BASINS-NPSM/HSPF and EFDC.

Monitoring and Modeling for Klamath and Lost River TMDL Development, OR and CA. Managing monitoring and hydrodynamic and water quality modeling efforts to support TMDL development. Developed a comprehensive database of water quality data in the basin and summarized conditions in a detailed report. Developed a CE-QUAL-W2 model of the Lost River and CE-QUAL-W2, and EFDC models for the Klamath River. The models will be used to evaluate a series of management scenarios for this highly contentious area.

TMDL, Monitoring, and Modeling Support for USEPA Region 3.

- Managed DO and bacteria model and TMDL development for Mispillion River and Cedar Creek, DE. Models were developed using EFDC (three-dimensional hydrodynamic and water quality model) and LSPC.
- Managed a DO modeling and TMDL development effort for the Appoquinimink River, DE.

- Developed a TSS TMDL for the Anacostia River in D.C. through application of an existing WASP model.
- Provided technical oversight for nutrient, DO, and siltation modeling and TMDL development using GWLF, BATHTUB, and LAKE2K for Lake Nockamixon, Green Lane Reservoir, Lake Ontelaunee, and Lake Wallenpaupack in PA.
- Managed a PCB monitoring effort on the Shenandoah River to identify key sources, including point and nonpoint sources and background conditions.
- Provided technical support for development of VA's first fecal coliform bacteria TMDL (Muddy Creek) and first biological TMDLs (Cooks Creek and Blacks Run).
- Providing technical oversight for PCB TMDL development, monitoring, and modeling in the Roanoke Basin, VA.
- Peer reviewed HSPF modeling application for TMDL development on Black Creek, VA and a multiple regression (statistical) model used to develop biological TMDLs for a mining-impacted stream in southwestern VA.
- Managed a temperature TMDL development project for the Indian River and Island Creek, DE. Conducted modeling scenarios using the GEMSS model and evaluated the extent and temporal variability of the thermal plume from a power generation facility.
- Managed DO and sediment TMDL development on Wissahickon Creek, PA. The project involved a focused, low-flow water quality monitoring effort and evaluation of a multitude of point source discharge scenarios for contributing WWTPs.
- Conducted training courses to support USEPA and the states in modeling and TMDL development for bacteria, sediment, and nutrient impairments.

TMDL and Modeling Support for USEPA Region 4. Managed development of DO TMDLs for nearly 100 rivers in southern GA. Applied dynamic watershed (HSPF) and receiving water models (EFDC) to simulate nutrient and carbon inputs, in-stream fate, and sediment diagenesis processes. Created technical procedures for GA to develop fecal coliform bacteria TMDLs. Developed fecal coliform bacteria TMDLs in the Choctawhatchee and Blackwater watersheds in the FL panhandle. Provided technical oversight for development of nearly 100 fecal coliform bacteria TMDLs through SC. Provided 5 training courses in GA, AL, SC, and TN focusing on modeling and TMDL development using BASINS, and HSPF. Developing a comprehensive modeling toolbox to provide user-friendly interfaces and linkages between watershed and receiving water models, including HSPF, EFDC, WASP, and RIV-1.

Modeling and TMDL Support for USEPA Region 1. Provided management and technical oversight for development of a hydrodynamic and water quality model of the Lower Charles River, MA, to address eutrophication. The project involved monitoring recommendations provision, EFDC development and calibration, and participation in technical advisory committee meetings. Supported ME in selecting monitoring stations and monitoring parameters for 6 waterbodies in both urban and rural settings, assessing flow and water quality monitoring data, selecting appropriate models, setting-up and applying those models, and developing TMDLs. Provided oversight for stormwater modeling (using the P8 model) and detailed flow evaluation for VT, with a focus on stormwater regulation development.

Modeling and TMDL Support for USEPA Region 2, North Atlantic States, and U.S. Territories. Providing management and technical oversight for TMDL development efforts for NJ shellfish waters, NJ lakes, watersheds in Puerto Rico, and coastal waters in the USVI. Worked with NJ to develop a TMDL assessment report for the North and South Branch Rancocas Rivers. Managed development of a database of watershed export coefficients to support NJ in performing cursory assessments of watershed pollutant loadings using PLOAD. Managed a watershed assessment effort for multiple streams and a reservoir impaired by nutrients, bacteria, and sediment in Puerto Rico (Loiza watershed). Managed a DO TMDL development project for the Salt River Estuary, St. Croix, USVI. The project involved water quality monitoring recommendations and development and application of a customized BASINS system and a high-resolution EFDC estuary model. Conducted a week-long BASINS training course in Puerto Rico.

Modeling and TMDL Support for USEPA Region 9 and Western States. Provided technical oversight, QA/QC, and coordination for multiple TMDL projects throughout California. Supported USEPA in developing temperature TMDLs for the North Fork Eel River in California. Developed a GIS-based shade model that simulates solar radiation reaching the stream surface and linked it to a modified version of QUAL2E to route temperature through the stream network. Developed a spreadsheet model to support bacteria TMDL determination for the Palo Verde Storm Drain. Developed sediment TMDLs for the Pajaro watershed using the SWAT model. Developed a TMDL for Clear Lake with Regional Board 5 to address eutrophication. A dynamic watershed model, LSPC, was linked to a hydrodynamic and water quality model of the lake using EFDC. Providing technical oversight for bacteria, sediment, and nutrient TMDL development for the Hanalei River and Bay, Kauai, HI. Conducted a 1-day TMDL Training for the City of LA.

TETRA TECH, INC.

Teresa Rafi

Technical Writer

EDUCATION

M.A., Marine Affairs, University of Virginia, 1996

B.A., Environmental Science, University of Virginia, 1993

YEARS OF EXPERIENCE

Total: 17

With Tetra Tech: 13

KEY AREAS OF EXPERIENCE

- Water quality monitoring program design and implementation
- Watershed modeling
- Watershed characterization
- Watershed management
- Model development
- TMDL development
- Clean Water Act Program Support
- Technical Writing
- Project management

Ms. Rafi has over 15 years of professional experience in public sector environmental science and policy. She has been a member of the Water Resources Group at Tetra Tech, since October 2000, where her activities include curriculum development for watershed modeling courses, database development in support of numerous EPA programmatic initiatives as well as development of technical guidance and documentation for various EPA program initiatives. She has participated in and managed development of a variety of TMDLs for fecal coliform, nutrients, sediment, and metals-impaired waterbodies, using a range of models from simple to complex. Her technical and communications skills include watershed assessment and modeling using GIS-based tools and spatial data analysis techniques. She is experienced in development of outreach materials and presentation of technical information at public forums.

Selected Project Experience

Technical Documentation and Writing Support for the Chesapeake Bay TMDL (USEPA Region 3). For USEPA Region 3 and the Chesapeake Bay Program Office, coordinating development of the Chesapeake Bay Nutrients and Sediment TMDL Report, due for completion in December 2010. In charge of ensuring that the report clearly communicates the many technical concepts related to the TMDL, including the complex modeling framework and the unique allocation procedures developed for the TMDL. Responsible for developing original text as well as coordinating and compiling submissions by multiple contributors; organizing, prioritizing and incorporating comments from multiple reviewers within EPA and the state partners; and ensuring that all the required TMDL elements are included and adequately and clearly described.

Metals and Bacteria TMDLs for Dunloup Creek, West Virginia (USEPA Region 3). Reviewed available data for the Dunloup Creek watershed in southern West Virginia and prepared a metals, fecal coliform bacteria, and biological impairment TMDL. Watershed loading was modeled with the Mining Data and Analysis System and a reference watershed approach was used for calibrating hydrology. Prior to modeling, activities included acquiring and analyzing available datasets; identifying missing information areas; and recommending additional data collection. TMDL development required representation of permitted point sources and nonpoint sources, as well as continuously flowing mine seeps and discharges.

Sediment TMDL Development in West Virginia (West Virginia DEP). For the West Virginia Department of Environmental Protection, supported development of sediment TMDLs in the Upper Kanawha, Lower Kanawha, Upper Ohio, North Branch Potomac, and Coal River Basins. Project activities involved working with a team developing a large number of TMDLs for metals, fecal coliform bacteria, and sediment. Her duties required the coordination of two modeling efforts using GWLF and LSPC to generate allocations on the same spatial scale.

Mining TMDL Development for the Kiskiminetas-Conemaugh River Watershed (USEPA Region 3). Managed development of mining TMDLs in the Kiskiminetas-Conemaugh River watershed in southwestern Pennsylvania. Coordinated efforts of Tt team to compile information necessary for completing mining related TMDLs to satisfy Consent Decree deadlines for two eight digit HUC watersheds. Project involved extensive efforts to gather NPDES permit information for hundreds of municipal and industrial wastewater treatment facilities and mining facilities. GIS data related to abandoned mine lands were

compiled and incorporated into a custom landuse coverage for use in setting up a Mining Data Analysis System model of the watershed. TMDLs for iron, aluminum, manganese, sediment and pH were developed for the impaired waterbody segments.

Bacteria TMDL Development using LSPC (USEPA Region 4). Provided support to U.S. Environmental Protection Agency, Region 4 and the State of South Carolina to develop a fecal coliform TMDL for the Rocky River watershed in the upstate region of South Carolina. Analyzed available data and developed a watershed loading model using the Loading Simulation Program (C++). The model simulated point and nonpoint sources of fecal coliform bacteria, including permitted sources, septic systems, and agricultural runoff.

Mining TMDL Development (USEPA Region 3). For EPA Region 3, supported the development of mining TMDLs for the Cheat River and Tygart Valley River watersheds in West Virginia. Provided technical writing, editorial, and mapping support for the draft and final documents. Assisted project team in preparing materials for public meetings. Performed a data review and analysis for the Tug Fork River watershed in preparation of a metals and pH TMDL. Activities included acquiring and analyzing available datasets; identifying missing information areas; and recommending additional data collection.

Development of Nutrient and Sediment TMDLs for Lakes Ontelaunee and Wallenpaupack in Eastern Pennsylvania (USEPA Region 3). Managed development of nutrient and sediment TMDLs for Lakes Ontelaunee and Wallenpaupack in eastern Pennsylvania. The Lake Wallenpaupack effort also involved development of a TMDL for Mercury. Activities included data compilation and analysis, identification of endpoints, as well as development of linked watershed loading/receiving water quality models to identify load allocations. The efforts utilized the Generalized Watershed Loading Functions model (GWLF) to simulate watershed loading. The BATHTUB model was used to simulate the impact of nutrient loading to Lake Ontelaunee. The LAKE2K model was used to simulate the effects of nutrient loading to Lake Wallenpaupack.

Metals and Nutrient TMDL Development for the Shenango River Watershed in Northwestern Pennsylvania (USEPA Region 3). Managed development of metals TMDLs (aluminum, iron and lead) for the Shenango River watershed in northwestern Pennsylvania. The project involved compilation of existing point and nonpoint source data to determine the extent of impairments as well as development of a sampling plan to support evaluation of existing impairments. Nutrient and metals data were evaluated. The watershed includes two large reservoirs, Pymatuning Reservoir and Shenango River Lake, several MS4 areas, and covers parts of Pennsylvania and Ohio. The modeling effort utilized the Loading Simulation Program C++ to simulate point and non-point sources and hydrology. Data for 69 facilities with more than 100 discharge points in Pennsylvania and Ohio were compiled for the model simulation. TMDL allocations were developed for aluminum, iron and lead for 39 subbasins. The model is currently being updated to incorporate GIS data characterizing abandoned mine lands in the watershed as well as additional NPDES permitted mining activities.

Guidance Development for Developing Watershed TMDLs (USEPA Headquarters). Provided critical support in developing the draft guidance document for EPA headquarters, *Handbook for Developing Watershed TMDLs.* The document provides information to state TMDL programs and developers in the development of watershed-based TMDLs that address multiple segments and/or multiple pollutants. This guidance is designed to compliment other recent guidance documents recently produced by EPA, including watershed planning and watershed permitting.

Pittsburgh Bacteriological Monitoring Protocol (USEPA Region 3, 1996 to present). Managed a pilot project in a Pittsburgh area watershed designed to establish a volunteer-based bacteriological monitoring protocol to be used by the PA DEP in determining recreational use attainment status. The initial project involved three major efforts: gather and review existing watershed data related to bacteria, sources, and modeling; review model applications potentially appropriate for simulating bacteria and recommend an application suitable for the pilot watershed; develop a sampling and analysis plan and accompanying quality assurance project plan to guide citizen volunteers in the collection of high quality bacteria data. These efforts required coordination of multiple stakeholders in the project including representatives from multiple EPA offices, state and regional DEP personnel, county and municipal employees, and citizen groups. Subsequent phases of the project have involved refinement of data used to characterize septic inputs and development and calibration of an LSPC watershed model.

VA TMDL Support (USEPA Region 3). Provided support to U.S. Environmental Protection Agency, Region 3 and Virginia Department of Environmental Quality for development of protocols for addressing TMDL development in shellfish waters. The project involved a consent decree signed by U.S. EPA to establish TMDLs for over 260 shellfish waters. Activities include assisting the working group to conduct interagency meetings; reviewing monitoring data; and acquiring and assessing available watershed, pollutant, and land use information.

TETRA TECH, INC.

Mindy Ramsey

Project Manager

EDUCATION

M.S., Biological Sciences, Marshall University, 2002

B.S., Biology, University of Rio Grande 1996

YEARS OF EXPERIENCE

Total: 13

With Tetra Tech: 4

KEY AREAS OF EXPERIENCE

- TMDL development in WV including project management and stressor identification for biologically impaired streams.
- Source Water Assessment and Protection for public drinking water systems in WV and VA
- Conducting NEPA Studies for Threatened and Endangered Species, Wetlands, and Streams.
- NEPA Report writing to document resources and assessed impacts for drinking water system improvement and highway projects.
- Public meeting presentations and facilitation.

Ms. Ramsey is a biologist whose training and experience have prepared her to perform data collection and analysis, write technical and planning documents, coordinate with stakeholders, and communicate environmental topics to the public. She has extensive experience in developing Source Water Protection Plans for public drinking water systems throughout West Virginia and Virginia. More recently she has taken on the role of Director for the Tetra Tech Charleston office and led the TMDL development in D2, E2, and A3 watershed groups.

Selected Project Experience

TMDL Development, Group A3 Upper Ohio North, Upper Kanawha, South Branch Potomac, and Shenandoah Watersheds, WV. As project manager, oversees all aspects of TMDL development, communicates with technical leads and the WVDEP program manager and staff daily to insure progress and address any concerns that arise immediately. Coordinates with contract administrator to track progress and prepare financial reports to WVDEP. Participated in biological stressor identification.

TMDL Development, Group E2 West Fork River Watershed, WV. As project lead for Group E2, works closely with WVDEP Project Manager and technical staff to identify areas of concern and opportunities to improve upon existing methodologies and protocols. Coordinates tasks and staffing to maintain project schedule. Provides progress and financial reporting. Participated in the EPA stressor identification (SI) process for biologically impaired streams TMDL development for the WVDEP, which included preparing data analyses of water chemistry, benthic macroinvertebrates, and physical habitat parameters. Also contributed to the stressor determination for the biologically impaired streams.

TMDL Development, Group D2 Monongahela River Tributaries, WV. After taking on the role as office director, oversaw TMDL development, coordinated with technical leads and WVDEP staff to revise public and technical documents, performed QAQC on TMDL reports, allocations, supporting materials and comment responses. Participated in the EPA SI process for biologically impaired streams for Group D2 TMDL development for the WVDEP, included preparing data analyses of water chemistry, benthic macroinvertebrate, and physical habitat parameters. Also contributed to preliminary and final stressor determinations. Developed fecal coliform load allocations for select subwatersheds using MDAS model.

TMDL Development, Group C2 Middle Ohio Tributaries, WV. Lead the revision of the TMDL Technical Report, and participated in finalizing the drafts of the public report to include updates to the technical methodology for assessing sediment sources and assigning allocations. Participated in the EPA SI process for biologically impaired streams for Group C2 TMDL development for the WVDEP.

Ionic Stress TMDL Development, Upper Kanawha Pilot Study, WV. Participated in a pilot study in Upper Kanawha streams impaired by ionic loading in order to develop biological TMDLs. Was active in data management and analysis, taking part in workgroups assigned to provide information on ionic stress parameters and treatment technology for the planning and development of the TMDL.

WVDHHR DWSRF Program Support. Through a contract with the USEPA, supporting the WVDHHR Infrastructure and Capacity Development Program guide and monitor DWSRF funding recipients through state and federal regulations. Activities include contributing to the Asset Management guidance materials and webinars. Also, responsible for conducting NEPA environmental reviews and writing assessments seeking concurrence with the WVDHHR Finding of No Significant Impact for select projects.

Virginia Source Water Protection and Implementation. Managing a project with the Virginia Department of Health to develop Source Water Protection Plans for waterworks in the northern region of the state. Project will include providing implementation services. Responsible for identifying water works to participate, meeting with Local Advisory Committees, conducting surveys of protection areas, characterizing threats and proposing protective activities. Responsible also for project status and financial reporting, as well as overseeing activities of support staff.

Source Water Protection Technical Help Program. As a task manager of a contract with the WVDHHR, Source Water Assessment and Protection (WV SWAP) Program developed Source Water Protection Plans for public drinking water systems throughout West Virginia. Plans identify water protection areas and potential contaminant sources; prioritize threats; develop management strategies to address threats; contain an implementation plan to be carried out by the water system; and develop contingency plans for source water in case of a short or long term water loss. Tasks include conducting a series of meetings to gather information from local stakeholders, drafting and finalizing plans for state program approval and implementation by public water system, and presenting plans at meetings open and attended by the public. Was also responsible for tracking and reporting project progress, as well as coordinating invoicing with the WVDHHR and subcontractor.

WVSWAP Program Grant Administration. As an employee of the WVDHHR, SWAP Program worked with drinking water systems to finalize subrecipient grant awards of Safe Drinking Water Act funds through the Source Water Grant Program. To accomplish an award the following tasks were completed: preparing and distributing a solicitation and application; developing evaluation criteria and selecting recipients; gaining knowledge of and conveying to would be recipients federal and state grant award requirements; monitoring grant activities; authorizing payment of approved invoices; and reporting grant program status and progress for inclusion in semiannual reports to the EPA.

WVSWAP and Operator Certification/Training Program Support and Promotion. As an employee of the WVDHHR, performed a variety of tasks to support and promote the WV SWAP Program. Communicated Ground Water Under the Direct Influence (GWUDI) evaluation requirements to new and older non-compliant public water systems through formal written request, district personnel coordination, and/or verbal explanations to operators. She also created or modified and distributed GWUDI instructions/reporting forms explaining requirements and procedure for water systems to collect samples. Provided onsite assistance to collect raw water samples for water systems. Managed data provided for the evaluation and made GWUDI determinations. In addition to GWUDI, she completed tasks related to Groundwater Flow Model Loan Program to distribute model to area educators, included: conducting outreach, leading workshop to train on use of model, and monitoring model use. In support of the Operator Certification and Training Program, instructed the Groundwater/Wells and Basic Mathematics portions of the Class I Water Operators Training multiple years and the Microbiology portion for the Class II Water Operators.

National Environmental Policy Act (NEPA) Studies. During previous employment, managed tasks associated with NEPA studies to gain environmental clearance for several highway projects in West Virginia. As the task manager for the Endangered Species Act consultation with the USFWS, key tasks involved the Indiana bat, northern flying squirrel, running buffalo clover, and Cheat Mountain salamander and included: leading or participating in surveys; managing subcontractors; conducting habitat assessments; writing biological assessments and survey reports; writing letters and participating in meetings to gain USFWS concurrence. Other responsibilities related to NEPA studies included assessing streams utilizing EPA Rapid Bioassessment Protocol; and delineating wetlands.

TETRA TECH, INC.

John Riverson, Jr.

Model Development

EDUCATION

M.S., Civil/Environmental Engineering, University of Virginia, 1999

B.S., Civil Engineering, University of Virginia, 1997

YEARS OF EXPERIENCE

Total: 14

With Tetra Tech: 14

LICENSES & CERTIFICATIONS

Engineer in Training, Virginia, 1997

PROFESSIONAL AFFILIATIONS

American Society of Civil Engineers

KEY AREAS OF EXPERIENCE

- Pollutant source assessment
- Watershed modeling
- BMP Modeling
- Model and Tools Development
- Water quality modeling
- TMDL development
- Watershed management plan development
- Information management system development

Mr. Riverson is a water resources engineer with over 10 years of professional experience in the areas of watershed management, water quality modeling, point and nonpoint source pollution characterization and assessment, and TMDL development. He has two additional years of combined research and teaching experience in the fields of hydrodynamic modeling, surface water quality modeling, contaminant transport, data analysis and statistics, and environmental sustainability. Mr. Riverson has provided technical guidance and expertise for a variety of TMDL and other source water management related projects for U.S. federal, state, and local agencies such as USEPA (Regions 2, 3, 4, 5, 6, 8, and 9), several state and county water resource operatives, and the US Army Corps of Engineers. Mr. Riverson's experience also includes spreadsheet and database programming for managing, analyzing, performing statistics, and summarizing complex data sets. He has responded to numerous quick response requests for technical review and consultation, providing innovative and cost-effective solutions. He has an in-depth understanding of environmental data and their scientific use for screening level analysis, as well as for more rigorous analysis using various spatial and temporal modeling techniques and applications. He has practical experience in all parts of the environmental systems life cycle including the assessment of user requirements, system design, implementation, testing, quality assurance and product deployment and training. He has also hands-on experience in spreadsheet/ database programming (VBA), computer language programming (Visual Basic, FORTRAN, C++), and Geographic Information Systems (ArcView).

Selected Project Experience

Milwaukee Metropolitan Sewer District (MMSD) 2020 Planning study. HSPF/LSPC modeler for the development of watershed modeling, analysis, and management alternatives evaluation for the MMSD 2020 planning study. This landmark study takes a regional watershed perspective to evaluating water quality management. A comprehensive modeling system is being built including HSPF modeling of the watershed, linked with CSO and receiving water models in the estuary and near shore lake area. The modeling system will be used to evaluate alternatives under future land use conditions, which include various levels of sewer separation and watershed BMPs retrofits and new development practices. Alternatives will be evaluated based on multiple indicators including CSO overflows, sediment, nutrients, and pathogens. The project includes extensive multiple agency facilitation and public outreach support.

Best Management Practices Simulation Module (BMPDSS), Prince George's County, MD. Technical lead for the development and refinement of a BMP evaluation computer module. The system provides a variety of BMP options for storm water control that simulate Low-Impact Development (LID) practices at the site level, and evaluate the impact of their implementation on long-term water quality. This module, designed to operate in conjunction within a watershed model, is being used to demonstrate the benefits of LID practices at multiple control points in the drainage basin. Effectiveness is measured using a set of monitored urban indicator pollutants including flow, sediment, nitrogen, phosphorus, BOD-5, and metals. This module is a primary component of the ArcGIS-Based BMPDSS for selection, placement, and optimization of BMPs, and has also been used to

evaluate the effect of LID on reducing the frequency of CSO overflows in a Washinton D.C. Case study application.

Placement of BMPs in a Watershed to Manage Sediment and Protect Source Waters. Modeler and Systems Developer to identifying needs, available models and modeling systems, conceptual design, and system prototype for USEPA ORD NERL Edison Laboratory. This integrated decision-support system will provide the needed link between management action, source loading, stressors, and water quality endpoints. Ultimately this system will provide tools to optimize watershed management activities and trade resources to meet identified water quality goals. The resulting system will be tested using case studies with extensive monitoring records. The system will be available to support of comprehensive studies for TMDLs, trading, storm water/MS4 management and planning.

Lake Tahoe TMDL Watershed Model. For University of California, Davis, and the California Lahontan RWQCB, technical lead supporting the development of the Lake Tahoe Watershed Model, a core component of the 2007 Lake Tahoe TMDL Development Initiative. The snowfall/snowmelt process is among the cold-weather considerations successfully incorporated into the hydrologic modeling approach for the basin. The USEPA Loading Simulation Program in C++ (LSPC) Watershed Modeling System, customized for the Lake Tahoe study area, integrates research results from numerous studies being conducted in support of the Lake Tahoe TMDL (storm water monitoring, fine sediment monitoring and modeling studies, detailed meteorological data analysis and integration, air and groundwater quality, etc.), and the wealth of historical data currently available. The effort especially encourages the advancement and refinement of environmental assessment methodologies fueled by a diversity of data sources and research partners.

USEPA TMDL Modeling Toolbox, USEPA Region 4. Modeler and technical lead supporting the development of the TMDL Toolbox. The Toolbox is a modeling system that integrates watershed loading models, receiving water models, and database and visualization systems into a streamlined assessment package. Providing seamless exchange of information between all modeling components, the Toolbox allows for dynamic simulation of flow and pollutant fate and transport in all types of surface water environments. He lead the effort for refining and integrating Tetra Tech's Loading Simulation Program in C++ (LSPC) watershed model, and designing the key modeling linkages between LSPC and the multi-dimensional EFDC-Hydro and WASP water quality models.

Water Quality Assessment and Data/Information Management. Has developed numerous programs and tools for efficient data processing and statistical analysis. Some of these tools include: (1) METADAPT - Meteorological Data Preparation and Analysis Tool - is a time-saving, cost-effective process (and suite of tools) for compiling, estimating/repairing, analyzing, summarizing, and preparing potentially large meteorological datasets (sometimes several 100s of MB) for a wide range of existing modeling applications (LSPC, EFDC, WASP, CE-QUAL-W2, Riv1, WRDB, HSPF, and others). (2) Hydrology_Calibration (HydroCal) - dynamic VBA spreadsheet program for hydrologic calibration, providing both statistical and graphical assessment and presentation for single-year and multi-year modeled versus observed flow comparison. (3) PFACT - Pollutant-Flow Analysis and Characterization Technique - dynamic VBA spreadsheet program for identifying and characterizing observed trends between instream water quality observations and flow. (4) FECIA - Fecal Coliform Investigation and Analysis - dynamic VBA spreadsheet program for characterizing and performing simple statistics on the number and nature of instream standard-exceedence for Fecal Coliform and other pollutants. (5) LD_Analysis.xls - VBA spreadsheet for performing load-duration analysis and generating associated graphs and statistics tables to present results to provide guidance for developing the pollutant-specific TMDLs.

Modeling Training Course Instruction. Has served as an instructor for several USEPA, state, and local-county sponsored technical training courses for BASINS, TMDL Toolbox, and general Modeling/TMDL development. Training course locations include Phoenix, AZ; South Lake Tahoe, CA; Denver, CO; Atlanta, GA; Chicago, IL; Prince George's County, MD; Trenton, NJ; Albany, NY; Bismarck, ND; Cincinnati, OH; Clermont County, OH; Cleveland, OH; San Juan, PR; Fairfax, VA, Milwaukee, WI, Lexington, KY, and New York, NY.

TETRA TECH, INC.

Vladislav Royzman

Model Development

EDUCATION

B.S., Biology, George Mason University, 1999

YEARS OF EXPERIENCE

Total: 14

With Tetra Tech: 11

KEY AREAS OF EXPERIENCE

- Database development
- Web development
- Information system development
- Tool development
- Project management
- Aquatic Chemistry
- Drinking water regulations
- Water quality monitoring
- QA/QC review

Mr. Royzman specializes in database and web applications and is currently the IT Project Manager on USEPA's NPDES, eNOI, Septic, and Water Security (CFML/Oracle), Agricultural BMP Database, and Watershed Plan Development Tool, a lead developer on Designated Uses/Endangered Species Clearinghouses (CFML), Non-Point Source Toolbox (XML), and CADDIS and CADLit for USEPA. Mr. Royzman's previous experience was at SAIC working primarily as a GIS, database, Web developer, and environmental scientist specializing in toxicity, remediation, and environmental and industrial microbiology. Previous work includes: GIS work for the Savannah Army Depot, GIS and database support to USEPA's Chesapeake Bay Program Office, GIS, database, and environmental science support for USEPA's Office of Water Science, GIS, database, web, and modeling support for USEPA's Office of Research and Development, air quality modeling, database, and web support for the Joint Strike Force Air Emissions Program, PMA-290 program support, and permit writing for Louisiana's Department of Environmental Quality. Additional work experience includes working as a GIS and database specialist for Vistainfo.com, an online company providing Phase I Site Assessment. Mr. Royzman has experience working with national government databases, land-use and land-cover data, NHD and RCHF3 data, and NEPA databases.

Selected Project Experience

Causal Analysis/Diagnosis Decision Information System (CADDIS), USEPA Office of Research and Development NCEA Office. Serving as the lead developer and IT Project Manager for the development and enhancement of the CADDIS website, a web tool designed to help investigators identify the causes of impairments using the Stressor Identification process developed by USEPA in 2000. Developed and deployed the initial version of CADDIS onto USEPA servers and leading all new development of additional modules. Current development includes the Tolerance Value and CADLit a document storage and retrieval system associated with CADDIS models. The Tolerance Value module allows users to upload and download r-scripts to be run on statistical software. The Reference Modules includes data entry and search capabilities, which allow user to query through hundreds of reference that support the CADDIS process. Application was developed in Cold Fusion and Oracle.

Electronic Notice Of Intent (eNOI)/NPDES Website, USEPA Office of Wastewater Management. Serving as the IT Project Manager for the USEPA Office of Wastewater Management NPDES website and eNOI. Manages development of any database and application maintenance and enhancements to the USEPA NPDES website, a content management system that stores all website content within the database, and eNOI System, which allows applicants in USEPA regulated states to submit an industrial or construction NOI, NOT, NOE, or LOE for coverage under the general permit. The two systems contain over 500 dynamic pages and interact with thousands of users. ENOI is accessed through the USEPA Central Data Exchange (CDX) for submission of NOI, NOT, NOE, or LOE information and USEPA WebRIT for form validation. Current development includes eBenchmark, a tool that allows dischargers to submit electronic discharge information under the new MSGP. The application is developed in Cold Fusion Fusebox Technology and Oracle.

Website Development and Maintenance, USEPA Office of Ground Water and Drinking Water. Serving as the IT Project Manager for the USEPA Office Ground Water and Drinking Water online content management system. Developed the data model and application architecture for the content and knowledge management site that is shared by two programs within OGWDW, Water Security and Source Water. This Web site provides tools, training, publications and resources, case studies, information on programs, funding, and other assistance that states, water suppliers, stakeholder groups and the general public can use. The site is a Cold Fusion web site with an Oracle back-end. The sites is fully database driven in that no content is present in HTML format but is stored in the database and displayed using ColdFusion. The site is developed in the Fusebox Framework (web-based application frameworks supported by USEPA) to make the code easy to maintain and manage and to allow for maximum flexibility.

Agricultural Best Management Practices Effectiveness Databases, USEPA Headquarters, OWOW. Serving as the IT Project Manager for the USEPA Office of Wetland, Oceans, and Watersheds Non-Point Source Branch BMP Effectiveness Database. Led the development of the needs assessment, requirements document, and logical and physical database design and currently managing the development of the application in JAVA and Oracle. It will store effectiveness, cost, and site information on various BMPs gathered from studies, handbooks, and other related materials. Application allows TMDL Implementers, Watershed Planners, and modelers to select relevant BMPs by their specific site criteria. This application allows for BMP data to be loaded into the database through direct data entry or via an XML data dump.

Watershed Plan Development Tool Prototype and Watershed Portal Needs Assessment, USEPA. Wrote the needs assessment for the USEPA Watershed Portal, an application that will include the Watershed Plan Development Tool, collaboration tools, and data management, modeling and analysis tools. Developed and designed the prototype of the Watershed Plan Development Tool, a tool to help watershed planners design their plan using online tools. The tool's main function is to generate a site-specific outline that includes information on what to include in each section of the watershed plan and links to online tools, data, and contact information pertinent to each section. The application will be developed in JAVA and Oracle and linked to various USEPA and state applications and databases.

Designated Uses/Endangered Species Clearinghouse. Serving as the lead developers for the DCH/ESA Clearinghouse website (currently in development). Led the development of the data model to support entry of multiple types of documents and document supported data, data entry, and public interface of the DCH. Wrote the technical document for a comparison of the DCH database to an existing database called PRAWN, to determine if and how the DCH data can be migrated into PRAWN. Future work includes ESA document data entry/edit forms, ESA search engine, and preparing the site for deployment on the USEPA server.

CERI Contract Support Developing Nationwide Mercury and PCB Fish Advisory Website. Fish Quality Index website is a tool developed for USEPA Office of Research and Development to report Mercury content in river, lake, and fish species Mr. Royzman was tasked with modifying the database to except State inputs for calculating data, create the ColdFusion administrator pages and security features, incorporate client side JavaScript to manipulate data, and migrate new data into the database.

National Data Services for US Forest Service. Mr. Royzman currently is the Program Manager for providing GIS application development services to the Geospatial Services and Technology Center. In this capacity, he coordinated a recruitment, retention, and training program to successfully place several GIS application developers on site at the USFS GSTC facility in Salt Lake City, Utah.

Content Management and Maintenance System, USEPA Office of Ground Water and Drinking Water and Office of Wastewater Management. Mr. Royzman served as the Project Manager for the EPA OGWDW and OWM NPDES online content management system. Mr. Royzman lead a team of developer to develop the data model and application architecture for the content and knowledge management site that is shared by four programs within OGWDW, Water Security, Drinking Water and Source Water Protection, Arsenic, Lead and PWS Publications and two programs within the OWM, NPDES and Septic. The Web site provides tools, training, publications and resources, case studies, information on programs, funding, and other assistance that states, water suppliers, stakeholder groups and the general public can use. The sites are developed in the Fusebox Framework (web-based application frameworks supported by EPA) to make the code easy to maintain and manage and to allow for maximum flexibility and uses Oracle as the back-end database. The sites are fully database driven in that no content is present in HTML format but is stored in the database and utilizes customizable rendering to display the data. The system interacts with thousands of users. In addition, the OGWDW tool contains an administrative section that allows EPA employees to log-in and edit content, links, publication and post the information to management for review.

TETRA TECH, INC.

Leslie Shoemaker, Ph.D

Program Manager

EDUCATION

Ph.D., Agricultural Engineering, University of Maryland, 1990

M.Eng., Agricultural Engineering, Cornell University, 1984

B.A., Mathematics, Hamilton College, 1979

YEARS OF EXPERIENCE

Total: 28

With Tetra Tech: 22

PROFESSIONAL AFFILIATIONS

American Society of Civil Engineers

Reviewer, Journal of Environmental Engineering

American Society of Agricultural Engineers

American Water Resources Association

Soil and Water Conservation Society

Alpha Epsilon

USDA National Needs Fellow

Cornell Master of Engineering Fellowship

KEY AREAS OF EXPERIENCE

- Pollutant source assessment
- Watershed hydrology and stormwater
- Watershed runoff quality
- TMDL development and implementation
- Watershed management plan development
- BMP evaluation and implementation planning
- Tool development
- Information management system development
- Receiving water modeling
- Watershed modeling

Dr. Shoemaker has more than 25 years experience in the analysis of watersheds and ecosystems and development of management plans. She has provided project management and oversight for hundreds of work assignments under a variety of federal, state and local contracts. Dr. Shoemaker has been supporting TMDL and related program activities since 1991. She has provided technical and programmatic support to all phases of the TMDL program, from guidance development, technical reviews, TMDL development, to national training and facilitation. Her TMDL related activities have included review of more than 80 TMDLs, technical oversight for hundreds of TMDL development projects throughout the United States, development of new TMDL course materials and performance of highly acclaimed training courses, development of the first TMDL protocols and modeling compendium, recommendations on 303(d) listing, and technical support and facilitation for the development of sediment criteria. She has responded to numerous quick response requests for technical review and consultation. Dr. Shoemaker has also directed numerous large-scale, multi-disciplinary watershed management projects such as Lake Tahoe, Milwaukee, Clermont County, and Prince Georges County. She developed and has provided TMDL training at over 30 locations and is widely recognized as a national TMDL expert. She has applied both ground and surface water models including HSPF, BASINS, SWMM, GWLF, WASP, CREAMS, GLEAMS, PRZM, MODFLOW, and DRASTIC. Dr. Shoemaker supported the development and testing of the first version of GWLF, and the initial design and development of the BASINS modeling system. Dr. Shoemaker manages Tetra Tech's Water Resources Center, which includes over 60 specialists in modeling, water quality assessment, and systems development throughout the United States.

Selected Project Experience

Lake Tahoe TMDL Development. Principal Investigator for the development and execution of a comprehensive four year plan to develop a watershed/lake study and TMDL including design of a modeling system, stakeholder involvement planning, data needs, and TMDL components. Oversaw the development of a watershed model, model testing, and collaboration with the interagency TMDL development group. Tetra Tech has been providing support to the Lake Tahoe stakeholders for the past 3 years and were recently awarded (January 2006) a new 3-year contract worth $1.5M to refine the watershed model and develop a detailed BMP modeling tool that will be used to optimize BMP placement in the watershed. The Lake Tahoe effort is highly collaborative and involves representatives from numerous federal agencies, academic universities, California and Nevada state agencies, and a regional planning agency (TRPA) responsible for protecting the lake.

Region 3 TMDL Development and Modeling Support. Provided continuous support in developing TMDLs, training states, and providing technical review and analysis as needed. Under extremely short lawsuit-mandated time frames and limited budgets, directed the development of hundreds of TMDLs in WV, VA, and DE for metals, nutrients, and fecal coliforms. Each TMDL required close coordination with state, local, and regional representatives; development of innovative procedures; integration of point and nonpoint sources; and presentation of allocation alternatives for selection by the region. Provided technical presentations and facilitation among stakeholders to educate users on the methodology and implications of allocations.

USEPA Region 4 TMDL Support. Provided continuous support to USEPA Region 4 in developing TMDLs, training, developing guidance, and providing technical review and analysis as needed. Over the past ten years, developed training materials, wrote monitoring and listing guidance, and provided oversight for the development of technical tools and software systems including the TMDL Toolbox, now supported by USEPA's Office of Research and Development.

TMDL Guidance for California. Supported the development of A Process for Addressing Impaired Waters in California, a technical and programmatic guidance document developed for the California State Water Resources Control Board. The document provides information on the critical steps and processes available for identifying appropriate technical analyses and approaches and regulatory actions for addressing waters that do not meet water quality objectives or support designated uses. Also managed the development of two companion technical modules for the development of bacteria and urban pesticide TMDLs. The categorical technical modules provide detailed information and "how-to" guidance relevant to developing TMDLs for the specific pollutants.

Development of System for Urban Stormwater Treatment Analysis and Integration (SUSTAIN), USEPA ORD. Former project acronym: ISMDSF. Principal Investigator identifying needs, available models and modeling systems, conceptual design, and system prototype. This integrated decision-support system will provide the needed link between management action, source loading, stressors, and water quality endpoints. Ultimately this system will provide tools to optimize watershed management activities and trade resources to meet identified water quality goals. The resulting system will be tested using case studies with extensive monitoring records. The system will be available to support of comprehensive studies for TMDLs, trading, stormwater/MS4 management and planning.

USEPA ORD Model Review. For USEPA ORD, managed the development of *TMDL Model Evaluation and Research Needs* (EPA/600/R-05/149). Included review of more than 60 process-based modeling systems used for TMDL development, including allocation of loads and evaluate of management practices. Reviewed several models for model capabilities and features, input requirements, output formats, model strengths and limitations, hardware/software requirements, supporting linkages, calibration considerations and associated uncertainty, and pre- and post-processing capabilities. Wrote overall document and identified recommendations for future research and development efforts and evaluated current and emerging trends in modeling to support TMDLs.

USEPA Technical Guidance Development. For over 11 years, provided continuous support to USEPA in developing guidance for modeling, model selection, and watershed and TMDL assessment techniques. Key author for the ***USEPA Model Compendium for Watershed Assessment and TMDL Development (versions 1 and 2), TMDL Protocols for Pathogens, Nutrients, and Sediment, TMDL Guidance for the 2001 Rule, and the TMDL Case Study Series.*** Supported numerous other documents such as the ***BOD/DO Technical Support Document,*** and ***USEPA Region 4 Monitoring and Listing Guidance.*** Most recently supported the development of the USEPA's Watershed Handbook – a new guide for procedures and analysis for the development of watershed management plans.

Modeling and TMDL Training. Lead instructor for Watershed 103/TMDL Training. Developed training materials on programmatic, technical, modeling, and case studies. Identified case studies for a variety of pollutant and waterbody types representative of geographic araes throughout the U.S. In the last 3 years Dr. Shoemaker presented the course in over 20 locations to over 1000 practitioners throughout the U.S. with consistently excellent reviews. She is also a lead instructor for training courses in modeling including BASINS, SWMM, and HSPF.

Prince George's County NPDES Support and Related Professional Services, Prince George's County, MD. Supported Municipal Stormwater Management and NPDES Permit Application for Prince George's County, MD. Developed a SWMM-GIS modeling framework for stormwater pollutant load estimations. In one of the first applications of this kind, output from continuous simulations of the Storm Water Management Model were used to develop a daily, seasonal, and annual watershed loading for the county's 12 planning watersheds. Other recent task orders include green engineering and site design demonstration projects, BMP modeling system development, septic system databases, WPS update, and ongoing monitoring support.

Milwaukee Metropolitan Sewer District (MMSD) 2020 Planning study (Milwaukee, WI). Tetra Tech lead for the development of watershed modeling, analysis, and management alternatives evaluation for the MMSD 2020 planning study. This landmark study takes a regional watershed perspective to evaluating water quality management. Building a comprehensive modeling system including HSPF model of the watershed, linked with CSO and receiving water models in the estuary and near shore lake area. The modeling system will be used to evaluate alternatives under future land use conditions which include various levels of sewer separation and watershed BMPs retrofits and new development practices. Alternatives will be evaluated based on multiple indicators including CSO overflows, sediment, nutrients, and pathogens. The project includes extensive multiple agency facilitation and public outreach support.

TETRA TECH, INC.

Mark Sievers

Watershed Analyst

EDUCATION

M.S., Civil Engineering, University of Virginia, 1998

B.S., Environmental Geoscience, Indiana university of Pennsylvania, 1995

YEARS OF EXPERIENCE

Total: 14

With Tetra Tech: 12

KEY AREAS OF EXPERIENCE

- Watershed modeling
- TMDL development
- Information management system development
- Water quality monitoring program design and implementation
- Project Management

Mr. Sievers has 13 years of experience as an environmental scientist and engineer. This experience has covered a wide range of environmental areas, including data management, data analysis, geographic information systems (GIS), hydrologic modeling, TMDL development, environmental monitoring, and remedial investigations. Mr. Sievers has successfully managed the development of more than 200 TMDLs in 3 states and 2 EPA regions. Many of these TMDLs were performed under tight budget and time restriction. Mr. Sievers has experience performing data management and analysis on various data types for the TMDL development process including stream flow, stream channel characteristics, water quality, point source and nonpoint information, and weather information. He is conversant with ArcView GIS, ArcMap, Microsoft Office (Word, Excel, Access, and PowerPoint), and Adobe Acrobat Professional. His modeling experience includes MDAS, LSPC, LA-QUAL, and various MS Excel-based modeling approaches.

Selected Project Experience

West Virginia Upper Kanawha and Upper Ohio Watershed Pollutant Source Reports. Supported the development of pollutant source reports for metals, pH, and pathogen TMDLs. Performed data analysis with ArcView GIS and MS Excel and reviewed pollutant source data including logging activities, abandoned mines, roads, and sampling locations. Delineated the watersheds with ArcView GIS.

Metal TMDLs Upper North Branch of the Potomac River Watershed, Maryland. For the Maryland Department of the Environment, managed the model development and completion of the draft TMDL report for aluminum and iron in the Upper North Branch of the Potomac River watershed. Also aided in model calibration, load reductions, and the final TMDL report.

Kiskiminetas and Conemaugh Rivers TMDLs, Pennsylvania. Aided in the development of metal (aluminum, iron, and manganese) TMDLs for acid mine drainage impacted streams in the Kiskiminetas and Conemaugh River watersheds in Western PA. Attended and presented at two public meetings in Johnstown, PA as part of the public review of the TMDL. Researched and organized information on several hundred permits from various sources.

pH TMDLs for the Western Maryland. For the Maryland Department of the Environment, used an updated version of Mining Data Analysis System (MDAS) to model the hydrology and water quality of 5 watersheds. The updated MDAS includes the ability to simulate atmospheric deposition, soil moisture transportation, and advance chemical reactions to better simulate pH in stream segments. Performed data management, created of model weather files and, performed watershed delineation. Included various mining permits and mining seeps into the model and took local geology into account during the modeling process. TMDLs were developed for 52 impaired streams throughout the five watershed basins with allocations for iron, aluminum, sulfate, nitrate, and ammonium.

pH TMDL for the Youghiogheny River, Maryland. For EPA Region 3 and the Maryland Department of the Environment, managed the development of TMDLs for 25 impaired streams with allocations for iron, aluminum, sulfate, nitrate, and ammonium. Used an updated version of MDAS to model the hydrology and water quality of the watershed. Managed the updates the model. The updated MDAS

includes the ability to simulate atmospheric deposition, soil moisture transportation, and advance chemical reactions to better simulate pH in stream segments. Performed data management, created model weather files, performed watershed delineation, and prepared a data inventory of the environmental data available for TMDL area.

Wissahickon Creek Watershed, Pennsylvania TMDL Reports. Supported the development of nutrient and sediment TMDLs for the U.S. Environmental Protection Agency. Performing data management and analysis using ArcView GIS and Microsoft Excel. Conducted watershed delineation using ArcView GIS.

TMDL Support for EPA Region 6 – Louisiana TMDLs. For EPA Region 6, is the project manager for the development of TMDLs in Louisiana. Developed and is developing TMDLs for various basins in Louisiana. Developed TMDLs for impaired subsegments in six basins in Louisiana (Red River, Sabine River, Terrebonne, Pearl River, Atchafalaya River, and Mississippi River) for parameters including fecal coliform bacteria, sulfate, chlorides, total dissolved solids, mercury, dissolved oxygen, nutrients, turbidity, sediment, and total suspended solids (TSS). TMDLs were calculated using load duration curves, concentration-based reductions, and LA-QUAL. Helped prepare and present a 3-day modeling workshop for LA-QUAL and QUAL2K. Currently overseeing a stormwater monitoring project for a municipal separate storm sewer system (MS4) in Louisiana that consists of storm sample collection, flow measurements, and data management that will be used by Louisiana Department of Environmental Quality to characterize stormwater water quality and loading in urban areas.

TMDL Support for EPA Region 6 – Arkansas TMDLs. Managed the development of TMDLs for impaired reaches in the Bayou de L'Outre, Big Creek, Caddo River, and Saline River watersheds, for EPA Region 6. TMDL parameters included copper, lead, zinc, sulfate, chloride, total dissolved solids, and turbidity. TMDLs were calculated using load duration curves and QUAL2K.

Grand Lake o' the Cherokees Watershed, Oklahoma Dissolved Oxygen and Sediment TMDLs. Project manager for the development of dissolved oxygen and turbidity TMDLs for impaired portions of the Grand Lake o' the Cherokees watershed. The watershed encompasses four states in two EPA regions.

Louisiana TMDL Support. Project manager for the development of TMDLs for impaired subsegments throughout the state for fecal coliform bacteria and lead for the Louisiana Department of Environmental Quality. TMDLs for fecal coliform bacteria were calculated using load duration curves, while lead TMDLs were developed using a critical 7Q10 load determination method. Performed the calculations, created the report figures in ArcGIS, and performed quality assurance on the reports.

Sacramento River Watershed Hydrology Model. For the Central Valley Regional Water Quality Control Board (RWQCB) and EPA Region 9, acted as the watershed modeler using LSPC. The hydrology model was set up taking into account agricultural and irrigation practices in addition to flood control structures, such as bypasses and overflows. Involved in preparing the Data Inventory and Model Approach Report and the Data Analyses and Procedure Outline for Model Calibration Report. Created weather files for the model and was responsible for data management and the delineation of the model area, which was downstream of major reservoirs and upstream of the tidally influenced portion of the Sacramento River and considered flood control devices, such as levees, bypass, and weirs; weather patterns; topography; and previously delineated watersheds provided by the California Central Valley RWQCB.

Chollas Creek, CA Modeling. For the San Diego RWQCB and EPA Region 9, developed copper, lead, and zinc TMDLs for the small urban watershed in San Diego, California, using hydrology parameters from a previous calibrated wet-weather model for bacteria. For the TMDL, made minor adjustments to the hydrology parameters based on updated and more detailed land use information. Pollutant buildup and wash-off rates were based on literature values and calibrated to match local conditions. In addition, the model output was used along with storm event mean concentrations to calculate loadings for additional parameters, such as silver, polycyclic aromatic hydrocarbons, and pesticides. Determined the 95 percentile standard deviations.

Bacteria TMDLs for San Diego, California. For the San Diego Regional Water Quality Control Board (RWQCB) and EPA Region 9, he developed dry-weather bacteria TMDLs for multiple beaches, creeks, and coastal lagoons of San Diego County and Orange County. This TMDL involved a mass balance approach, using a model created in MS Excel to calculate required reductions to pathogen loadings. The model included options for tidal lagoons with additional pollutant loadings contributed by waterfowl. Other tasks include map preparation and geographic analyses, such as watershed delineation and land use analyses, with ArcView GIS. In addition, analyzed relationships between land use and pathogen levels or stream flow, helped develop the pathogen wet-weather TMDLs, and provided support in preparing final TMDL report for both the wet-weather and dry-weather TMDLs.

TETRA TECH, INC.

Jonathan Smith, PE

Deputy Project Manager

EDUCATION

B.S., Biological & Agricultural Engineering, North Carolina State University, 1995

Graduate Course Work: 21 units focused on hydrology and stormwater management, NCSU, 1998 - 2006

YEARS OF EXPERIENCE

Total: 18

With Tetra Tech: 6

LICENSES & CERTIFICATIONS

Professional Engineer

WV license #19285
VA license # 44925
NC license # 026523
SC license # 26822

Certified Professional in Erosion and Sedimentation Control (CPESC), registrant #4111

Certified Professional in Storm Water Quality (CPSWQ), registrant #0048

PROFESSIONAL AFFILIATIONS

CPSWQ Inc. Chair (2008 – present); CPSWQ Approved Instructor

NC-APWA Water Resources Committee Director (2008 – present)

CPESC Regional Representative (2005 – 2009)

EnviroCert International Inc., Technical Vice-Chair (2008 – 2010)

Envirocert International Inc., Chair (2010-present)

KEY AREAS OF EXPERIENCE

- Hydrologic and Hydraulic Studies
- Site Scale Water Quality Modeling
- Stormwater Master Planning
- Stormwater Program Development and Implementation
- Stormwater and Watershed Restoration BMP Design

Jonathan Smith has 17 years of experience in water resources engineering, specializing in stormwater management. He is the Engineering Manager for Stormwater Services in the Research Triangle Park, NC office of Tetra Tech. Mr. Smith is a professional engineer, a Certified Professional in Stormwater Quality, a Certified Professional in Erosion and Sedimentation Control, and is a LEED-Accredited Professional. He is an expert in stormwater management and as a consultant focuses on planning, implementing and managing stormwater-related projects for municipal, industrial and development clients. Mr. Smith is an approved instructor for CPSWQ, and is currently the CPSWQ Inc. Chair and EnviroCert International Inc. Chair. As a project manager, Mr. Smith has extensive experience in supplying clients with project deliverables through technical reports, construction documents and construction management, supervising technical, production and administrative staff throughout. He has completed design and construction oversight of more than 20 stormwater BMPs including stormwater wetlands, bioretention areas, green roofs, pervious pavement practices, innovative wet ponds, level spreaders, media filters, and a number of water quality retrofits of existing BMPs.

Before becoming a consultant, Mr. Smith was an Extension Engineer at North Carolina State University, where he supervised the daily activities for numerous projects within a stormwater focused research Group. He led development of several research studies including the effects of BMPs on thermal impacts to stormwater runoff, retrofitting abandoned septic tanks into stormwater infiltration facilities, the effects of media selection on green roof pollutant removal performance, and development of a municipal BMP monitoring pilot program. He co authored a number of guidance documents on BMPs for wastewater irrigation and stormwater management as well as several journal articles. He also supervised Extension Associates, graduate students and undergraduate students in the development of research projects, providing instruction on budgeting, site design, permitting, competitive bid processes, construction, instrumentation, data collection and data analysis.

Selected Project Experience

Concord Ecosystem Restoration. Concord, NC. Managing project for United States Army Corps of Engineers involving design of four retrofit stormwater management practices as well as restoration of 750 linear feet of perennial stream in an urbanized watershed. Project deliverables include basis of design reports, various preliminary and final construction plans and specifications, cost estimates and Sediment and Erosion Control Plan applications for each site. Stormwater Practices include stormwater wetlands, wetponds, and temporary detention.

Pulaski County Stormwater Design Manual and Site Evaluation Tool Development, Pulaski Co., AR. Managed project for Pulaski County Arkansas to develop stormwater drainage design manual and Site Evaluation Tool (SET). Coordinating the planning for and facilitation of a workgroup meeting comprised of local public agency and stakeholder engineering staff to identify and develop manual components and SET user interface functions. Providing oversight for technical staff in development of design manual incorporating functionality specific to Pulaski County development conditions. Supervised development of the SET incorporating lower limit effluent limitations on BMP performance for local conditions including low density development and steep slope topography.

Third Fork Creek Watershed Planning and Design, Durham, NC. Task manager for a $1M+ planning and design project in Durham, NC. Relevant tasks included stormwater retrofit planning and design, LID and Better Site Design, and BMP maintenance program review for Third Fork Creek.

NCEEP Alternative Wetland Mitigation Stormwater BMP Pilot Project. For the North Carolina Ecosystem Enhance Program, supervised application of a proposed method for determining mitigation credits associated with two constructed stormwater wetland BMPs in the Catawba River basin. The project represents a potential pilot for urban watersheds where available land for traditional wetland mitigation does not meet overall mitigation needs.

San Diego LID Manual, San Diego CA. Supported preparation of a Low Impact Development manual for the City of San Diego's stormwater program. Provided review of performance criteria for stormwater best management practices required by San Diego County. Review included research of criteria for volume and flow based control practices and associated publications detailing development of these performance criteria. Results were utilized to recommend criteria which were most appropriate to the city's objectives and incorporation into the manual. Authored design guidance on vegetated swales and vegetated filter strips. Provided quality assurance technical review of other design sections of manual.

McAlpine Creek Stream Restoration and Stormwater Improvements, Mecklenburg Co, NC. Design engineer responsible for preparation of design documents related to the retrofit of an existing urban pond to a stormwater treatment facility consistent with the Center for Watershed Protection's "New Emergent Wetland" design guidance. The existing pond exhibited poor conditions including undersized outlet, failing banks, excessive waterfowl use and lack of vegetation. The modified design incorporated a forebay to pre-treat flows entering the facility, an extended detention settling zone, a bypass structure for larger flows, and a low flow wetland to provide polishing treatment of baseflow and smaller runoff events.

Central Yard Municipal Facility Stormwater Retrofit Design, Charlotte, NC. Project Manager for the identification of methods to reduce impacts of a municipal vehicle maintenance and washing facility on adjacent surface waters through source reduction and modifications to an existing non-functioning filter system. Conducted a feasibility analysis of various source reduction techniques and BMP modifications incorporating site operational restrictions, municipal NPDES phase II compliance requirements, and existing infrastructure conditions. Provided design and preparation of construction documents for specific improvements including diversion of rooftop runoff directly to stream, construction of rooftop over vehicle washpad, and conversion of filter system to a staged detention, vertical filter, finishing wetland system.

Partners Equity Stormwater Improvement, Partners Equity Group, Smithfield, NC. Managed the development of design and permitting for the conversion of an existing wetpond serving a 51 acre commercial subdivision to an enhanced wetpond facility to achieve nitrogen reduction goals. The conversion was conducted in order to obtain a 401 water quality certification from the NC-DWQ wetlands unit for impacts to jurisdictional wetlands within the development. Specific improvements included the enlargement and deepening of the pond and enhancement through the incorporation of a vegetated littoral shelf.

Trash Guard Hydraulic Analysis, Trash Guard, Inc., Raleigh, NC. Managed the development of a hydraulic analysis of the trash guard system, a patented screening insert developed to capture and retain large stormwater solids. The client requested hydraulic analysis spreadsheet preparation to determine steady flow hydraulic characteristics.

St. James Hydraulics Study and Analysis, Reserve Development Co. LLC, Southport, NC. Managed a hydraulics study to assess the causes of flooding in a large residential development related to two flooding events in Brunswick County. Work included simulation of the storms of interest using a HEC-HMS model and incorporation of as-built survey data as required supporting a HEC-RAS hydraulics model of the existing creeks, ponds, and roadways. Sensitivity analysis was conducted on these two models to determine potential improvements to the drainage system for mitigation of future flooding. A written report was developed from the results of the project to and provided to the client with recommendations of upgrades or replacements of road crossings and diversions.

UNC Bell Tower Stormwater Management Services, Skidmore, Owings & Merrill LLP, Chapel Hill, NC. Provided initial feasibility analysis for the design and of a 50,000 cubic feet stormwater harvest system on the existing campus of University of North Carolina at Chapel Hill. The system captures stormwater from a proposed Genome Sciences building with a rooftop of approximately 1 acre and stores it in an underground cistern. The cistern system is connected to a nearby reclaimed water line to provide reliable water supply to irrigate adjacent landscape areas, a nearby stadium athletic field and provide indoor toilet flushing water for the Genome Sciences building.

TETRA TECH, INC.

April Storm

Watershed Analyst

EDUCATION

B.S. Environmental Resource Management with a concentration in Water and Soil Conservation, Pennsylvania State University, 1997

YEARS OF EXPERIENCE

Total: 8

With Tetra Tech: 4

TRAINING

Pennsylvania stream surveying and sampling Training, PADEP, 2000-2002

Project WET, PADEP, 2002

Requirements for Hazardous Waste Operations & Emergency Response Personnel (OSHA 1910.120), including yearly re-certification; Hazardous Materials Site Worker Annual Recertification, 1997-2000

Project Management Training, ADVENT Environmental, Inc., 1998

Risk Management Training, ADVENT Environmental, Inc., 1998

KEY AREAS OF EXPERIENCE

- TMDL implementation
- Community outreach
- GIS and data management
- Water and air quality monitoring
- Abandoned Mine Lands
- Environmental education

Mrs. Storm has over 7 years of experience in the environmental field performing stream monitoring, watershed management, Abandoned Mine Lands assessments, natural resource conservation, UST groundwater assessments, and hazardous materials programs. She is currently working to develop the Piney Creek Watershed Based Plan to implement existing metals and fecal TMDLs. Mrs. Storm has also provided GIS and data management support for West Virginia Department of Health and Human Resources (WVDHHR) Source Water Protection Plans. She has also performed administrative oversight for the WVDHHR's American Recovery and Reinvestment Act (ARRA) projects. Before joining Tetra Tech, Mrs. Storm's fieldwork experience included soil and water assessments, maintaining water and biological monitoring sites, environmental education instruction, and environmental outreach. She has experience gathering field samples including soil, surface water, groundwater, macroinvertebrate, and sediment. She has also monitored air at hazardous sites. Sites have included chemical manufacturing plants, general businesses, municipal landfills, abandoned mine land, and whole watershed areas. Mrs. Storm also has familiarity working with Microsoft Office Suite, Global Positioning Systems, Visual Groundwater, and GIS software.

Selected Project Experience

Piney Creek TMDL Implementation Watershed Based Plan, WV. Mrs. Storm provides community and stakeholder outreach for the project. She also organizes and coordinates stakeholder and organizational meetings for the project. She has conducted watershed assessments with WVDEP staff to find appropriate project locations, and has reached out to larger landowners to discuss the possibilities of using private land for implementation projects. Mrs. Storm is also documenting data gathering efforts and stakeholder comments, creating project maps, and compiling the watershed based plan.

American Recovery and Reinvestment Act (ARRA), WV. Mrs. Storm provided support to Department of Health and Human Resources Infrastructure and Capacity Development Department to oversee ARRA construction projects by tracking all ARRA documentation submitted by the project's personnel. To track appropriate documentation, she helped to develop tracking tools for ARRA and bond documents. Information gathering included contacting project personnel such as engineers, mayors, administrators, and contractors. Project management duties also included conducting project site inspections in which Mrs. Storm would travel to the project site and check over all Davis Bacon prevailing wage rate, and Buy American documentation to make sure the projects were in full compliance with ARRA rules.

Source Water Protection Field Surveys, WV. For the West Virginia Department of Health and Human Resources, Source Water Assessment and Protection Program, Mrs. Storm used GIS to prepare project maps of potential contaminant sources. Maps were used in outreach presentations and were incorporated into source water protection plans for over 50 drinking water systems. She also performed data entry tasks in support of potential contaminant source field surveys.

Kiski-Conemaugh Stream Team, Ligonier, PA. Mrs. Storm worked as the Water Monitoring/Site Coordinator of the KC Stream Team. Her work there included

managing the abandoned mine drainage monitoring sites throughout the Kiski-Counemaugh River Basin. She evaluated, marked, wrote directions, recalculated GPS units, and took quarterly samples for the monitoring sites. The data from the monitoring sites she choose was also used by the Pennsylvania Department of Environmental Protection. Her responsibilities also included recruiting, managing and training the volunteer core. Mrs. Storm has gained experience with creating and maintaining an Excel database, incorporating and organizing old databases from various groups, helping to get the data put into GIS, and teaching others how to use the database. She also spent time coordinating with other entities about issues in the watershed and worked on an Abandoned Mine Drainage curriculum that is now being used in many Pennsylvania schools.

Dark Shade Brownfields Project (DSBP)/ Shade Creek Watershed Association (SCWA), PA. As the Watershed Coordinator for the DSBP and the Executive Director of SCWA, Mrs. Storm had many responsibilities. For one, she has involved with the first ever full watershed to earn a Brownfield designation. While there, she worked on a Brownfield job training certificate program that the DSPB was doing in conjunction with Carnegie Mellon University. The program took underprivileged from the Pittsburgh area and the Appalachian Mountain area and taught them skills for becoming Environmental Technicians. Mrs. Storm was responsible for writing the entrance and exit exam, and designing the curriculum and teaching a few of the classes. She was in charge of the risk, soil and water assessment classes; this included teaching the students about toxicology, chemistry, risk reporting, soil and water VOC, and petroleum testing, soil vapor analysis, water bacteria and AMD sampling, macroinvertebrate studies and water flow measurements. She was also in charge of the DSBP/SCWA monitoring programs. She held public meetings recruiting volunteers, trained people in coordination with the PADEP, managed the volunteer core, and transported the samples to the PADEP. Mrs. Storm also managed the excel database while there and shared her results with many other environmental entities such as the State DEP, consultants, and other non-profits.

Mrs. Storm worked as the Executive Director of the SCWA where she conducted monthly meetings, recruited volunteers for helping with projects, and wrote grant applications. She also taught about environmental and historical aspects of the Kiski-Conemaugh River Basin inside and outside the classroom environment.

ADVENT Environmental, Inc., Charleston, SC. Mrs. Storm worked as a Staff Scientist at ADVENT where her responsibilities included providing environmental services on groundwater and soil assessments. She was involved in many aspects of the assessments including data management, aquifer testing, sampling, remediation construction/design, soil vapor monitoring, soil disposal, reporting to governmental agencies, and site closure reports. Many of the assessments that she took part of involved various hazardous chemicals. Mrs. Storm worked on all facets of various projects reports from composing and mapping to peer review. She also gained some training in the bid process. Mrs. Storm performed database management tasks in Excel and created macros in Visual Basic for commercial site assessments. She also took the lead in transferring historical data into Access for a commercial client. A large amount of Mrs. Storm's job included creating 3D models for commercial groundwater assessments. Additionally, she carried out consulting services for assessment involving underground storage tanks. Her responsibilities included, but weren't limited to, overseeing construction, soil and groundwater sampling, overseeing line upgrades, and site closures.

TETRA TECH, INC.

James Stribling, Ph.D

Biological Analyst

EDUCATION

Ph. D., Entomology, The Ohio State University, 1986

M.S., Entomology, The Ohio State University, 1982

B.S., The University of Mississippi, 1980, Zoology

YEARS OF EXPERIENCE

Total: 28

With Tetra Tech: 22

TRAINING

Fluvial Geomorphology 1993, Pagosa Springs, Colorado

KEY AREAS OF EXPERIENCE

- Ecological Monitoring and Assessment
- Identification and Prioritization of Retrofit and Restoration Opportunities
- Evaluation of BMP Effectiveness
- BMP Planning and Design
- Watershed management plan development
- Quality Assurance and Quality Control (QA/QC)
- Development of Ecological Indicators Management
- Quantifying Error Rates in Biological Taxonomy
- Statistical Design for Monitoring at Multiple Spatial Scales

Dr. Stribling is an environmental scientist with over 25 years of experience in applying ecological principles to natural resource management decisionmaking. He has been instrumental in developing methods for the U. S. Environmental Protection Agency for the assessment of biological condition, physical habitat quality, and landscape integrity and the use of QA/QC for ensuring improved data quality. Dr. Stribling has been a national lead for developing techniques for biological method performance characteristics and comparability analyses, led analyses of taxonomic data quality for the USEPA National Wadeable Streams Assessment, is a co-author of USEPA Rapid Bioassessment Protocols (RBP), and provided primary technical support to the USEPA Office of Research and Development for development of Large River Bioassessment Protocols. He is involved in development of biological and nutrient loadings indicators and monitoring design for evaluating conditions in the Gulf of Mexico for the Gulf of Mexico Alliance (GOMA). In addition, he has extensive experience in applying these tools to County- and State-scale environmental management needs including monitoring designs, ecological assessments of streams and watersheds, NPDES permit requirements, stressor identification/restoration designs, stormwater management, and public outreach.

Selected Project Experience

Comprehensive Stream Assessment for High Gradient, Perennial Streams in West Virginia. Directed staffing, field sheet and database development, and final product delivery. Project is focused on characterization of reference streams throughout West Virginia, with field crews gathering data on physical habitat, hydrology, field water chemistry, benthic macroinvertebrates, amphibians, riparian vegetation (density, stand health, and diversity). Habitat data gathered are being input to RiverMorph software for intermediate post-processing, and are sufficient for geomorphic characterization equivalent to Rosgen level 2. The totality of the dataset will be used as input to the hydrogeomorphic (HGM) approach.

Watershed-based, County-wide Biological Monitoring using Fish and Benthic Macroinvertebrates. Project manager and technical lead for a watershed-based biological monitoring and assessment program in Prince George's County, Maryland, that will sample approximately 250 stream sites over a three year period for benthic macroinvertebrates, fish, physical habitat quality, and field water chemistry. Results will be presented, with known confidence, as the proportion of stream miles that are biologically degraded, and will be used to help prioritize County efforts to reduce and eliminate stressor sources in its streams and rivers.

Technical Support for Biological Indicators Research and Development Activity, including Review of a Fish Index of Biotic Integrity for the Yazoo River Delta (Mississippi). Technical lead in providing support to USACE-ERDC to evaluate the foundation of their efforts in developing a fish indicator of biological integrity of waterbodies in Mississippi, in particular, the Yazoo River watershed, which occupies the Mississippi Delta. For this project, he is evaluating field fish sampling methods, data quality associated with the results coming from those efforts, including precision, accuracy, bias, representativeness, and completeness, in short, the capacity of the methods for accomplishing stated objectives.

Ecological Assessment Input to an Ecosystem Response Model (ERM) for the Indian-Sugar-Intrenchment-Snapfinger Watershed (Georgia). Lead aquatic ecologist in this multidisciplinary study of which the goal is conceptual design for watershed restoration alternatives. He designed the ecological assessment, which used fish and benthic macroinvertebrates as indicators of stream and watershed conditions, and led to defensible statements of problem areas and identification of the sources of pollutants. He managed the fieldwork and laboratory and data analysis, and coauthored the technical report. As part of the team, Dr. Stribling provided technical input and critique of the Ecosystem Response Model (ERM) output and the design alternatives.

Conduct Statistical Analysis and Quality Control Services the Wisconsin Macroinvertebrate Biotic Index. Is the project manager and technical lead in this project to work with Wisconsin DNR scientists to characterize stressor vs. non-stressor conditions (stream sites), quantify performance of field and laboratory methods, document stressor-response relationships to the extent possible, and develop a benthic index of biological integrity for the streams of Wisconsin. The dataset he is working with represents 678 samples (including macroinvertebrates, physical habitat, and field chemistry) from streams throughout the state.

Mississippi-Benthic Index of Stream Quality (Phases 1-10). Program and project manager for MDEQ in maintenance of their statewide biological monitoring and assessment program, including comprehensive quality assurance/quality control (QA/QC) oversight, data management, and statistical analysis of their indicators of stream quality. He led initial calibration of the Mississippi-Benthic Index of Stream Quality (M-BISQ) in 2001, and has directed its refinement and recalibration with additional sets of data collected from approximately 100 new streams each of 9 years. Assessment results are used for setting TMDL targets, listing-delisting stream impairment for CWA §303(d), and for the Mississippi 305(b) report on "state of the streams".

An Assessment of Storm Water Management Retrofit and Stream Restoration Opportunities in Bennett Creek Watershed. Project manager and technical lead supporting the Frederick County (MD) Department of Public Works in evaluating ecological data to identify and prioritize stressor sources for correction and elimination (retrofit assessment). He directed water resources engineers on the project team in developing 10% conceptual designs for five separate best management practice (BMP) projects in the watershed, including engineering designs and CADD drawings.

Taxonomic Data Quality Control Analysis for the National Aquatic Resource Surveys. Dr. Stribling developed a detailed approach for characterizing the quality of data associated with taxonomic identifications used in biological assessments as part of the USEPA National Wadeable Streams Assessment (WSA). He used the same approach for documenting taxonomic precision for the National Lakes Assessment (NLA), and evaluated 200 randomly – selected samples as approximately 10% of the project total sample lot, was able to show a 5% reduction in error rate to about 10% nationally. As a result of this work, Dr. Stribling is the national lead for QC oversight, in general, and taxonomic data quality, in particular, for all of the USEPA National Aquatic Resource Surveys (NARS), including streams, rivers, and lakes.

Watershed Assessment of the Lake Allatoona/Upper Etowah River Basin. Project manager and lead aquatic ecologist, and used statistical power analysis to develop a long-term, watershed-scale monitoring program with the capacity of detecting a 20% change in biological condition for a 1,120 mi^2 watershed in northern Georgia. He organized field teams and managed sampling of 50-60 stream sites per year over a six-year period resulting in a rigorous and defensible estimate of the percentage of stream miles that are biologically impaired. Those values are being used to establish ecological restoration goals for the watershed.

Evaluation of Effluent Toxicity as an Indicator of Aquatic Life Condition in Effluent-Dominated Streams: A Pilot Study. Co-project manager, Dr. Stribling led the analytical design for evaluating the comparability of biological assessments using instream collections of fish, benthic macroinvertebrate, and diatoms with those from whole effluent toxicity (WET) tests from wastewater treatment plants. He used a quantitative Data Quality Objective (DQO) process to develop very specific statement of the quantity and quality of data needed to address this question for WERF. Subsequent to standardized field data collection and acquisition of WET testing data from WWTPs, Dr. Stribling performed statistical analysis determined that there is a low rate of synchrony between failing WET tests and instream biological impairment.

TETRA TECH, INC.

Barry Tonning

Outreach Specialist

EDUCATION

M.A., Risk Communication, Morehead State University, 1994

B.A., Journalism, University of Georgia, 1977

YEARS OF EXPERIENCE

Total: 31

With Tetra Tech: 14

LICENSES & CERTIFICATIONS

Kentucky Division of Water Class I Wastewater Treatment Plant Operator

Erosion and Sediment Control (GA Soil & Water Conservation Commission, Louisville MSD)

PROFESSIONAL AFFILIATIONS

International Erosion Control Association

American Society of Agricultural Engineers

National Onsite Wastewater Recycling Association

Water Environment Federation

KEY AREAS OF EXPERIENCE

- Stakeholder facilitation
- Watershed management
- Stormwater assessment and control
- Erosion and sediment control
- Training
- Antidegradation
- Public outreach
- Onsite wastewater treatment systems

Mr. Tonning is a senior level water resource management consultant specializing in stormwater management, erosion and sediment control, risk assessment and communication, public health, and technology transfer with extensive experience in training, policy development, and program design. Over the past 30 years he has directed and managed stormwater and erosion/sediment control training and compliance programs, environmental and natural resource policy research initiatives, solid waste planning and management programs, decentralized wastewater and nonpoint source pollution assessment and control projects, watershed planning and management activities, the publication of environmental management guidance documents, and the development, coordination, and facilitation of public meetings, conferences, and workshops on a wide variety of environmental, public health, and natural resource topics.

Selected Project Experience

US EPA Stormwater and TMDLS Workshops. Currently developing training materials and schedules for a series of workshops for MS4s in US EPA Region 4 on the connection between stormwater programs and TMDLs. Workshop topics include review of water quality standards, assessment methodologies, how impairment decisions are made, BMP selection and siting, quantifying BMP load reductions, monitoring program development, and related topics. Workshops are set for Kentucky (January) and Florida (February); others TBD.

US EPA Low-Impact Development Training Modules. Developed training and other materials for US EPA training program on low-impact development during 2005 – 2006. Researched LID principles, field applications, performance data, and demonstration projects. Created slides and text for workshop presenters, and used the materials personally in presentations related to stormwater management, smart growth, and integrated water resource management.

USEPA Stormwater Phase II - National Training Program. Project leader and trainer for a series of US EPA workshops on the Stormwater Phase II program, delivered in Charleston (WV), Philadelphia, Atlanta, Kansas City, Boise, Lexington (KY), and other US EPA Regional Office locations and Phase I and II cities during 2004 – 2009. Developed and delivered training materials on construction site runoff controls, inspector training, education/ outreach, and public participation; led sessions at workshops; assisted in training program review.

Indiana Low-Impact Development and Watershed Management Workshops. Created training materials and conducted workshops in northern Indiana on "improving development by design" and watershed assessment, planning, and management during 2006 – 2007. Presented information on design principles and field application of LID practices, developed and delivered watershed assessment/planning/management workshop, sponsored by regional conservation foundation and local government.

Construction Site Stormwater Training, West Virginia. Conducted training workshops on construction site erosion, sediment, and stormwater permit compliance in Hurricane (2008), Beckley (2007), and Charleston (2007, as part of the US EPA stormwater workshop). Conducted all presentations and provided analysis for field trip site reviews, in cooperation with local workshop hosts.

Chesapeake Bay Executive Order Guidance for Federal Facilities, USEPA. Served as task order manager and conducted focused research on methods for addressing nutrient inputs into the Chesapeake Bay from individual and clustered wastewater treatment systems; developed guidance for treatment system effluent quality for various spatial risk zones, based on current treatment technological capabilities and pollutant time/travel/removal research. Co-authored relevant chapter of USEPA guidance document in 2010.

Construction Site Stormwater Field Guide and Technical Manual, Kentucky. Conducted research on construction site erosion, sediment, and stormwater management approaches in various states and localities during 2004-2006; wrote and produced new statewide Field Guide on construction site stormwater runoff control in 2005, co-developed (with Richard Walker of Tetra Tech – Lexington KY) and produced the new Technical Specifications Manual for the Kentucky construction site stormwater management program in 2006.

Lake Maumelle Watershed Management Plan. Provided support for construction site erosion and sediment control ordinance development and wastewater treatment options for Central Arkansas Water, which manages Lake Maumelle near Little Rock AR as a major drinking water supply lake. Researched approaches for minimizing area of exposed soil and minimizing the time of exposure, developed language for incorporation into Stormwater Pollution Prevention Plan requirements, developed wastewater options for analytical studies.

Watershed Management Planning – Arkansas. Provided research, program development, and other support for the development of watershed management plans in the Fayetteville-Springdale-Rogers-Bentonville metro area of Northwest Arkansas. Conducted focused research on wastewater treatment facility performance, decentralized wastewater management, stormwater program development, and stakeholder interests.

Antidegradation Implementation - Arizona and West Virginia. Co-leader of work assignments to develop an antidegradation implementation guidance document for the West Virginia Department of Environmental Protection and Arizona Department of Environmental Quality. Conducted research on state and national Clean Water Act antidegradation issues and approaches, prepared issue summaries for state water agency staff, led consensus meetings with stakeholders, and co-wrote guidance document.

TMDL National Training Project. Work assignment leader for Total Maximum Daily Load (TMDL) overview workshop developed by USEPA and Tetra Tech. Assisted in curriculum development, produced and edited slide presentations, conducted presentations, led group exercise, and facilitated case study discussion.

Onsite Wastewater Treatment Systems - National Guidance. Work assignment leader for 2002revision of the USEPA Onsite Wastewater Treatment and Disposal System Design Manual, which was first issued in 1980. Wrote two chapters of the five-chapter document, conducted research on management approaches, implementation strategies, technological applications, and integration of onsite system management with broader watershed planning programs.

Decentralized Wastewater Management - National Guidance. Work assignment leader for the USEPA Office of Wastewater Management's program to improve the management of onsite wastewater systems. Assisted in development of the onsite systems management guidance manual, co-wrote management handbook, led USEPA OWM outreach efforts to promote voluntary management guidelines, facilitated meetings among stakeholders and interested parties in management guidelines development, and provided support for agency staff conducting workshops or briefings on septic system management topics.

Clean Water Act - National Training Program. Work assignment leader for Clean Water Act training programs sponsored by the USEPA Office of Water. Assisted in program development, conducted presentations on various sections of the Clean Water Act, facilitated group exercises, led discussion groups for workshops at USEPA Regional Offices in Denver, Chicago, Atlanta, Boston, New York, and other state/federal training sites.

Acid Mine Drainage Guide - USEPA. Co-wrote *A Citizen's Guide to Address Contaminated Coal Mine Drainage* for USEPA Region 3. The guide addresses identification of CMD problems, organization of watershed partnerships, watershed assessment, contaminated mine drainage treatment technologies and options, and fundraising.

USEPA Watershed Management and Stream Restoration Training. Project manager for developing and conducting *Working at a Watershed Level* and *Stream Corridor Restoration* training courses for USEPA, The Nature Conservancy, California State University, The Council of State Governments, University of New Hampshire, and other clients in MI, WV, GA, FL, and OH. Responsible for developing course content and materials, recruiting instructors, planning field trips, facilitating interactive group exercises, and conducting sessions on watershed planning, management, threat abatement strategies, monitoring, and outreach. Course attendees included representatives from federal, state, local, and nongovernmental organizations at each location.

TETRA TECH, INC.

Peter von Loewe

Senior Water Resource Engineer

EDUCATION

M.S., Environmental Studies, University of Charleston/Medical University of South Carolina, 2001

B.S., Anthropology, College of Charleston, 1992

YEARS OF EXPERIENCE

Total: 15

With Tetra Tech: 11

KEY AREAS OF EXPERIENCE

- Pollutant source assessment
- Watershed hydrology
- Watershed runoff quality
- TMDL development and implementation
- Tool and model interface development

Mr. von Loewe is a water resources engineer providing technical and project management support to federal, state, and municipal clients in the areas of watershed management, hydrologic and water quality studies, point and nonpoint source pollution characterization and assessment, TMDL development and implementation, and model interface development. Mr. von Loewe currently provides technical and management support and guidance for strategic TMDL planning efforts in Pennsylvania, California, Puerto Rico, and the U.S. Virgin Islands. Specifically, he serves as both the technical and project management lead for the development of watershed models to support multiple TMDLs in waterbodies impaired by metals, pH, bacteria, nutrients, turbidity, oil and grease, and low dissolved oxygen. Mr. von Loewe has also managed model interface design and development to assist with model management and implementation. He has designed several interfaces to the Environmental Fluid Dynamics Code (EFDC) hydrodynamic model, which provide a user-friendly GIS-based interface for model development. He has also designed a similar interface to allow permit writers access to modeled point source input data, allowing for permits to be modified and for new scenario results to be analyzed. He has practical experience in many facets of water resources engineering, with and in-depth understanding of the relationship between hydrology, water quality, watershed management, and regulations.

Selected Project Experience

Data Compilation for the Tug Fork River, WV. Assisted in centralization of water quality data collected in the Tug River basin, West Virginia. Manipulated raw NPDES monitoring station data into a workable database referenced by MDAS for calibration purposes. All available water quality data, including metals, pH, specific conductivity, solids, and other parameters were included in the database, which assists in modeling the attenuation of pollutants present in acid mine discharges to the basin.

Development of Bacteria TMDLs for Virginia Streams. Supported USEPA Region 3 with TMDL development for Cooks Creek, Virginia. This project included development of TMDL for fecal coliform impairments due to nonpoint source runoff. The project assimilated a modeling effort performed by the USGS for Blacks Run, a stream contributing fecal coliform loads to Cooks Creek. The USGS results were used as input to the dynamic water quality model HSPF, to assist in the representation of fecal coliform contributions.

Metals TMDLs for the Shenango River, PA. For PA DEP and USEPA Region 3, co-managing the development of metals TMDLs for the Shenango River and surrounding watershed in western Pennsylvania. Compiled monitoring and spatial data from a variety of sources in preparation for developing a linked Loading Simulation Program C++ (LSPC) watershed modeling system. Sources such as point source discharges, nonpoint source loading of local metals-rich soils, and internal loading of lakebed sediment-associated metals will be addressed in the TMDL. Additionally, a site-specific model postprocessor will be developed for the Shenango River LSPC model to allow DEP or municipal staff to investigate alternative scenarios.

Bacteria TMDLs for San Diego Beaches, Creeks, Coastal Lagoons, and San Diego Bay Shorelines, CA. For the San Diego Regional Water Quality Control Board and USEPA Region 9, provided technical support for bacteria TMDL

development for multiple beaches, creeks, and coastal lagoons of San Diego County and Orange County, as well as impaired shorelines of San Diego Bay. For wet weather conditions, a watershed model using the LSPC provided source assessment and linkage analysis to the impaired waterbodies. For dry conditions, a low-flow, steady-state modeling approach was used with loads estimated using statistical analysis of observed conditions in the region. To simulate receiving waters of coastal lagoons and San Diego Bay shorelines, the EFDC was used to model the assimilative capacity of the waterbodies and provide an analytical framework for assessment of impairment conditions. Results of modeling analyses were used for determination of TMDLs and required load reductions for nonpoint sources and MS4 stormwater permits.

Hydrologic Model of the Sacramento River Watershed, CA. For the Central Valley Regional Water Quality Control Board and USEPA Region 9, providing technical support for development of a hydrologic watershed model of the Sacramento River basin. A linked modeled system is under development with LSPC serving as a watershed model, and the EFDC used for simulation of the hydrodynamics of the lower portion of the Sacramento River. The modeling system will be used for prediction of streamflows in ungaged locations in the watershed and assist Regional Board and USEPA staff in assessment of critical hydrologic conditions resulting in water quality impairments.

Nutrient TMDL for Clear Lake, Lake County, CA. For the Central Valley Regional Water Quality Control Board and USEPA Region 9, managed the nutrient TMDL development for California's Clear Lake watershed in USEPA Region 9. Assessed and compiled monitoring and spatial data from a variety of sources in preparation for developing a linked LSPC watershed and EFDC receiving water modeling system. He developed hypothetical condition scenarios for the Clear Lake system to represent a range of loading rates specific to Clear Lake, to insure that appropriate TMDL targets are set considering its unique nutrient budget. The linkage of LSPC results with the EFDC model will allow for the assessment of sources and processes that have led to the impairment of Clear lake, and identify a solution to attain water quality standards in this naturally-productive system.

Dissolved Oxygen TMDL for Salt River Bay, St. Croix, U.S. Virgin Islands. For USVI DEP and USEPA Region 2, managed the development of a dissolved oxygen TMDL for Salt River Bay and surrounding watershed in St. Croix, USVI. Compiled monitoring and spatial data from a variety of sources in preparation for developing a linked LSPC watershed and EFDC receiving water modeling system, similar to the design of the Clear Lake modeling system developed for California. Similarly, the linkage of the two modeling techniques allowed for the assessment of sources and processes that have led to the impairment of Salt River Bay. The reduction of Biochemical Oxygen Demanding substances (BOD) was used as the vehicle to attain water quality standards in this productive system, in lieu of limited nutrient monitoring data, illustrating the flexibility of the linked LSPC-EFDC modeling system.

EFDCView Software Development for USEPA Region 4. Manages the design, development, and maintainance of EFDCView; a graphical user interface to EFDC. The user interface enables the user to develop a complex series of input files required by EFDC within a familiar shapefile-oriented environment, and provides seamless access to extensive post-processing capabilities. Ongoing development will ultimately provide a linkage to other stand-alone watershed and water quality models. This streamlined interface represents an integral component of the USEPA Region 4 TMDL Toolbox; a compendium of tools designed to assist in TMDL development.

TETRA TECH, INC.

Julie Wandling

Watershed Analyst

EDUCATION

B.S., Biology, West Virginia State College, Institute, 1998

YEARS OF EXPERIENCE

Total: 14

With Tetra Tech: 4

TRAINING

ArcView Introduction to ArcGIS, 2001

ArcGIS Introduction to GIS /Advanced GIS Topics, WVU/NRAC 2006

Dale Carnegie, WVDEP, 2005

EPA NPDES Permits Writers Course, VA 11/2001

Managing Wet Weather with Green Infrastructure, WVDEP/EPA 7/2009

Microsoft Excel and Access, 2009

Phase II Stormwater Management, WVDEP/EPA, 5/2007

QUAL2E Enhanced Stream Water Quality Model Training Seminar, PA 3/2002

W.V. Biological Stream Monitor, WVDEP, 2001

KEY AREAS OF EXPERIENCE

- TMDL Development
- Watershed assessment
- Watershed data management
- ArcGIS analysis
- Data manipulation in GIS, MS Excel and MS Access
- Water quality modeling
- Wasteload Allocations
- NPDES permitting
- Low flow estimating statistics of unregulated streams
- Metals Analyst
- Inorganic Data Package Analyst

Mrs. Wandling is an environmental scientist specializing in water resource management and TMDL development. She currently provides technical support in the development of Total Maximum Daily Loads (TMDL) to the West Virginia Department of Environmental Protection, Division of Water and Waste Management. Her duties include data management, GIS analysis, and water quality modeling. Mrs. Wandling works with West Virginia DEP staff as well as other state and federal agencies to develop the most recent and accurate watershed data necessary to build TMDL models for metals, sediment, acid deposition, and fecal coliform. She also has over 8 years of experience in implementing and managing the Wasteload Allocation program for the West Virginia Department of Environmental Protection, Division of Water and Waste Management. She has a breadth of knowledge and experience in NPDES permitting, antidegradation implementation, and low flow estimating statistics.

Selected Project Experience

TMDLs for Selected Tributaries of Upper Kanawha River, Upper Ohio North River, and South Branch Potomac River Watersheds, WV. For the WVDEP, served as TMDL development team member. Organized chemical, biological and physical data for statistical analysis. Aided in the development of the OWR NPDES Permits Database which generated the NPDES permits data. Collaborated with staff at the Division of Water and Waste Management to determine point and non-point source permits within the TMDL watersheds. Provided technical review and comments on the OWR NPDES and Mining NPDES Permits to WVDEP staff. Developed the Permits Summary and Pollutant Source Reports.

TMDLs for West Fork River Watershed, WV. For the WVDEP, served as TMDL development team member. Organized chemical, biological and physical data for statistical analysis. Aided in the development of the OWR NPDES Permits Database which generated the NPDES permits data. Worked in unison with staff at the Division of Water and Waste Management to determine point and non-point source permits within the TMDL watersheds. Provided technical review and comments on the OWR NPDES and Mining NPDES Permits to WVDEP staff. Developed the Permits Summary and Pollutant Source Reports. Contributed to the model setup and development. Developed the Technical Report Appendices, report figures, and ArcGIS viewer project and shapefiles.

TMDLs for Tributaries of the Monongahela River Watershed, WV. For the WVDEP, served as TMDL development team member. Organized chemical, biological and physical data for statistical analysis. Aided in the development of the OWR NPDES Permits Database which generated the NPDES permits data. Worked in unison with staff at the Division of Water and Waste Management to determine point and non-point source permits within the TMDL watersheds. Provided technical review and comments on the OWR NPDES and Mining NPDES Permits to WVDEP staff. Developed the Permits Summary and Pollutant Source Reports. Contributed to the model setup and development. Developed the Technical Report Appendices, report figures, and ArcGIS viewer project and shapefiles.

TMDLs for Middle Ohio South and Middle Ohio North Watersheds, WV. For the WVDEP, served as TMDL development team member. Organized chemical, biological and physical data for statistical analysis. Aided in the development of

the OWR NPDES Permits Database which generated the NPDES permits data. Worked in unison with staff at the Division of Water and Waste Management to determine point and non-point source permits within the TMDL watersheds. Provided technical review and comments on the OWR NPDES and Mining NPDES Permits to WVDEP staff. Developed the Permits Summary and Pollutant Source Reports. Contributed to the model setup and development. Aided in the development of the S values for the streambank erosion analysis. Developed the Technical Report Appendices, report figures, and ArcGIS viewer project and shapefiles.

TMDLs for Elk, Lower Kanawha, and North Branch Patterson Creek Watersheds, WV. For the WVDEP, served as TMDL development team member. Prepared reduction alternative allocations for the Lower Kanawha and the North Branch Patterson Creek using LSPC model. Developed the Technical Report Appendices, report figures, and ArcGIS viewer project and shapefiles.

TMDLs for Cheat Watershed, WV. For the WVDEP, served as TMDL development team member. Developed the Technical Report Appendices, report figures, and ArcGIS viewer project and shapefiles.

West Virginia, Department of Health and Human Resources, Infrastructure and Capacity Development Section, DWTRF-ARRA. For the EPA Region III, served as the lead contractor in supporting role to the WVDHHR-DWSRF. Provided technical, programmatic support, and asset management support to applicants whose project are being considered for WVDHHR-DWSRF funding. This includes evaluating systems for compliance with State and Federal requirements, bond conditions, DBE, ARRA, Davis Bacon, Buy American, and Asset Management. Designed the WVDWTRF Projects Tracking Database which aids in tracking utility and prime contractors compliance with program requirements. Worked closely with program staff to effectively manage the workload and upcoming inspections. Key role in the development of the WVDWSRF Asset Management Guidance Tool which was spotlighted at USEPA collaboration meetings, WV Public Service Commission, and Rural Water Association Conferences.

District of Columbia Toxins TMDL, EPA Region 3. Assisted in consolidating, reviewing, and analyzing water quality, sediment, and fish tissue data to determine any data gaps, inadequacies, or limitations of using the data for assessing TMDL impairments and to ultimately develop a sampling assessment plan.

Ohio River Bacteria TMDL, OH. Worked in coordination with the Cleveland office and WVDEP on gathering the NDPES outfalls contributing fecal coliform to the Ohio River from 2005-2008. Reviewed and analyzed the data to select only the relevant outfalls. Assisted WVDEP to gather the DMR data for the appropriate outfalls. Supported the Cleveland office in model setup tasks for representation of the WV Combined Sewer Overflows discharges.

Louisiana Nutrients TMDL, LA. Provided support to evaluate the Louisiana's NPDES data to identify potential stakeholders that may be affected from the development of the numeric criteria for nutrients. Development of the potential stakeholders were derived from the TEMPO and USEPA ICIS database systems.

Agriculture Non Cost Share BMP Database, for Chesapeake Bay TMDL. Supported the WV Department of Agriculture in developing a Non Cost Share BMP Database which will aid them in implementing the Chesapeake Bay requirements in the Eastern Panhandle. Worked closely with the WV Department of Agriculture in gathering the necessary data for development. Created and finalized the database tables and established the field relationships for incorporation into a oracle database application.

Online TMDL Viewer Tool. Created the GIS Viewer Tool for UOS, A2 TMDL, B2 TMDL, and C2 TMDL. Worked closely with Tetra Tech IT section to develop the projects, shapefiles, geodatabases, and provided testing of the tool and reports.

USEPA Region 3 Ionic Stress Fish Study. Provided GIS and data analysis to create maps and figures showing the progression of mining over the last twenty years. Delineated the DNR Fish sampling sites in the Twelvepole Creek and Sprucefork/Pond Fork watersheds. Created the connectivity and calculated drainage areas. Tabulated the area of each NLCD land cover class. Used Microsoft Access to create a table listing each DNR fish sampling site and its corresponding total drainage area in acres, the total accumulative area in acres of forest, urban, and barren. Determined the percent of Forest, Urban, and Barren at each Fish sampling site record. Analyzed various streams and dams data to determine the number of dams on first, second, and third order streams. Created summaries showing the sum total dams per stream order per ecoregion. Also, calculated the number of HUCs with dams to determine the dams intensity per HUC. Summarized this data with the number of Sample sites per HUC.

TETRA TECH, INC.

Samuel Wilkes, PWS

Biological Analyst

EDUCATION

M.S. Environmental Science & Policy, Johns Hopkins University, Baltimore, MD; 2003

B.S. Earth & Environmental Science, Wilkes University, Wilkes-Barre, PA; 1996

YEARS OF EXPERIENCE

Total: 17

With Tetra Tech: 10

LICENSES & CERTIFICATIONS

Professional Wetland Scientist (#00001395), July 2003; Recertified December 2008

OSHA 40 Hour HAZWOPER Certified 2013

Certified Forest Stand Delineator and Conservation Planner in Maryland, September 2003

PROFESSIONAL AFFILIATIONS

Society of Wetland Scientists

Trout Unlimited

KEY AREAS OF EXPERIENCE

- Biological TMDL development
- Watershed assessment and planning
- Surface water quality assessment
- Watershed data management
- Data manipulation in GIS, MS Excel and MS Access
- Statistical data analysis
- Water quality modeling
- Public meeting facilitation
- Report documentation
- Riparian habitat ecology
- Aquatic ecology
- Wetland scientist
- Project management

Mr. Wilkes is an environmental scientist providing technical support for the development of Total Maximum Daily Loads (TMDL) to the West Virginia Department of Environmental Protection, Division of Water and Waste Management. His responsibilities include watershed data management, organization of the stressor identification process, modeling and assisting with the development of various TMDLs (iron, aluminum, manganese, selenium, pH, fecal coliform, acid deposition, and sediment) for the state of West Virginia. He communicates and coordinates with clients throughout the TMDL development process. Mr. Wilkes has assisted in the statistical analysis of biological, chemical and physical data in the development of the Stressor Identification Report for biologically assessed streams in the Cheat River, Coal River, Elk River, Gauley River, James River, Lower Kanawha River, Little Kanawha River, Monongahela River, North Branch Potomac River, Ohio River Watersheds, Upper and Lower New River, Greenbrier, Potomac Direct Drains,South Branch River and West Fork watersheds in West Virginia.

He has assisted in the development of numerous TMDL documents and provided technical support to the client in training sessions and various public meetings. Mr. Wilkes has accompanied WVDEP staff to locate and assess pollutant sources in various watersheds, assisted in the sediment storm sampling in Coalburg Hollow and Shrewsbury Hollow, and assisted in the trout iron and sediment modeling project.

In addition to TMDL development, Mr. Wilkes has assisted EPA by conducting landuse and data analysis during their development of *A Field-based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams* document. He has lead the project for developing a TMDL implementation plan for the Piney Creek Watershed, which encompasses the city of Beckley, WV.

Selected Project Experience

Biological TMDL Development, WV. Mr. Wilkes has prepared data, presentation material, organized and facilitated meetings and participated in the stressor identification (SI) process for biologically impaired streams for TMDL Groups B, C, D, E, A2, B2, C2 D2, E2 and A3 with the WVDEP staff. The USEPA stressor identification methodology was used to identify pollutant stressors to the biological community to ensure that all significant pollutant sources (sediment, AMD, ionic strength, nutrients, habitat alteration, temperature, metals toxicity, organic enrichment, etc.) would be captured in the TMDL process. To further define biological impairments, macroinvertebrate tolerance values and a new modeling approach ("dirty reference modeling") were developed. Tolerance values were determined for macroinvertebrates at the genus taxonomic level and were based on observed data collected throughout the state by WVDEP's Watershed Assessment Branch (WAB) biologists. The macroinvertebrate observances were correlated with chemical and physical parameters also collected throughout the state. Statistical analysis was conducted and the final tolerance values were mathematically calculated according to the statistical relevance, chemical concentration and physical parameter. The "dirty reference modeling" is an approach that uses a known impaired site as a "reference" for each type of impairment to which all other sites are compared. A similarity matrix is calculated for each impairment and sites that group together may be impaired for that particular parameter. The "dirty reference modeling" demonstrates promising

results and coupled with tolerance values and the USEPA SI approach; demonstrate a tremendous strength of evidence for determining biological stressors in biological impaired streams. The dirty reference model has been developed to be incorporated into the WAB's Oracle database.

Biological Assessment and Stressor Identification West Fork, Monongahela, Upper Kanawha, South Branch and Upper Ohio North Watersheds, WV. Mr. Wilkes revised the SI database and built the summary tables used to evaluate potential biological stressor conditions. This information was used by WVDEP and Tetra Tech biologists to reach consensus in determining the causative stressors to the biological communities in streams.

TMDLs for Middle Ohio North and Middle Ohio South Watersheds, WV. Mr. Wilkes provided oversight and QA/QC of the SI database and participated in the preliminary and final SI calls for 77 biological impaired streams which consisted of 829 sampling stations and 4,576 individual samples. The 77 biologically impaired streams data was reviewed and evaluated with WVDEP biologists to arrive at a consensus using best professional judgment on the aquatic stressors and TMDLs to be developed.

TMDLs for Elk, Lower Kanawha, and North Branch Potomac Rivers, WV. Mr. Wilkes provided input and oversight for the conversion from Microsoft Excel based worksheets to the development of the SI database in Microsoft Access. The SI database is designed to accept base data tables (chemistry, macroinvertebrate, rapid bioassessment parameters and qualitative sampler comments) directly from WVDEP's WAB database. Once imported, the base data is normalized and analyzed by both biologically impaired stream and individual sampling stations on biologically impaired streams. This tool was used to assess the biologically impairments for 101 streams, which consisted of 1,299 sampling stations and 8,054 individual samples. The design of this database also allowed for full integration into WVDEP's Oracle data structure.

Piney Creek Watershed Implementation Plan, WV. For the West Virginia, Department of Environmental Protection, Division of Water and Waste Management Non Point Source Program, Mr. Wilkes conducted coordination between the WVDEP and various stakeholders, including the Piney Creek Watershed Association, numerous Publicly Owned Treatment Works, National Park Service, various non-profit organizations, private landowners and concerned citizens. The implementation plan integrates pollutant reduction strategies required by the TMDLs for both point and nonpoint sources, such as abandoned mine lands, runoff from urban and non vegetated areas, and stream bank erosion throughout the watershed.

USEPA Office of Research and Development, Cincinnati, OH. Mr. Wilkes has supported the USEPA's Office of Research and Development in conducting data and GIS analysis for the macroinvertebrate and fish species response to elevated conductivity concentrations throughout West Virginia. Various GIS analysis of chemistry and landuse data were completed to provide documentation of potential impacts to macroinvertebrate and fish communities due to elevated conductivity. Results from the data analysis were used, in part by EPA to develop the document *A Field-based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams.*

TMDLs for Cheat River, Camp Creek of Twelvepole and Dunkard Creek, Greenbrier, James, Little Kanawha, Youghiogheny and New Rivers, WV. Mr. Wilkes coordinated and oversaw all aspects of the watershed delineations and biological Stressor Identification process. He communicated regularly with the clients to incorporate new data such as the sediment layer profile and to incorporate a data averaging calculation into the SI summary sheet. He continues to work with the TMDL team to improve the quality of the TMDL modeling approaches and efficiency. Mr. Wilkes has been responsible for incorporating the final public and EPA comments into the TMDL documents and producing the final versions for publication.

TMDLs for Gauley River and Potomac Direct Drains Watersheds, WV. Mr. Wilkes performed the watershed delineation for the Potomac Direct Drains watershed, which was used in the LSPC model. He also provided oversight and guidance throughout the SI development process including meeting the deliverable schedule for submitting the watershed delineations, SI deliverable and pollutant source report. Mr. Wilkes calibrated the hydrology and water quality parameters for the LSPC fecal coliform model. He performed all the modeling scenarios and completed allocations during the fecal coliform modeling. The fecal coliform allocation database was updated to generate the final publishable fecal coliform TMDL tables for the report. Mr. Wilkes corresponds regularly with the client to obtain comments on deliverables, such as the pollutant source report, SI, preliminary draft report documents, and allocations.

Trout Water Iron Modeling Project, WV. For the West Virginia Department of Environmental Protection, Division of Water and Waste Management, Mr. Wilkes has been part of the field team collecting physical data for the model parameterization during the trout iron/sediment study. Watershed delineation, landuse assessment and landuse modification based on aerial photography were conducted for the sites being studied.

TETRA TECH, INC.

John Zastrow, PMP

Model Development

EDUCATION

P.M.P, Project Management Professional, George Mason University, Fairfax, VA, Project Management Institute, 2006

Certificate, Urban GIS, University of Wisconsin, Milwaukee, WI, 2001

M.S., Biology, University of Wisconsin, Milwaukee, WI, 2001

B.A., Biology, University of Colorado, Boulder, CO, 1995

YEARS OF EXPERIENCE

Total: 16

With Tetra Tech: 11

LICENSES & CERTIFICATIONS

Project Management Professional

KEY AREAS OF EXPERIENCE

- Water quality assessment
- Aquatic ecology
- Environmental data management and analysis
- Geospatial data management and analysis
- Technical project management

Mr. Zastrow has more than 15 years of experience in the use and application of GIS and information technology for environmental resource management. His experience includes the management and technical oversight of projects involving the delivery of GIS products and services for federal, state, local, and tribal, government clients. As a PMP certified professional, he has served projects in various capacities including project manager, data manager, GIS technical lead/architect, GIS/systems analyst, and subject matter expert. He is currently acting as technical project manager and data manager for many aspects of the global Navy Marine Resources Assessment support contract. He is leading the development of Navy Laserfiche dynamic document system and coordinates data management for all of the task orders in the program. He is also involved in the development of the Navy marine resource assessment science process and is developing information tools that support it. Mr. Zastrow also has many years of supporting data management and analysis projects involving EPA STORET/WQX, USGS NWIS and other water quality data management systems. For the Geospatial Services and Technology Center of the US Forest Service, he has led GIS technical projects that involved geodatabase design and the development of desktop and web-based tools to support habitat assessment and reporting, travel mapping and routing, metadata management, and mapping. For EPA, he served as the GIS data lead and coordinator to promote data sharing between EPA and various tribal governments in support of EPA's Tribal Information System.

Selected Project Experience

Fairfax County Virginia Comprehensive Watershed Planning and Stormwater Support. Stormwater Division, Fairfax, VA. (Project Manager and Technical Leader; February 2007 – Present). Mr. Zastrow served as a task order manager for data management and the development an information system to support watershed management in Fairfax County, VA. The system is used to develop and maintain watershed plans, analyze future stormwater management options, evaluate indicators of water quality, provide for long-term data management, and visualization of modeling results and countywide GIS data. He led the planning and requirements gathering and analysis phase of the project and continues to provide technical guidance and vision to the project.

Arizona Assessment Calculator (AZAC), Phases 1 and 2, Arizona Department of Environmental Quality (Project Manager and Technical Leader; 2005 – 2007). Mr. Zastrow served as a project manager for the development of thw Web-based Arizona Assessment Calculator (AZAC). AZAC is a Java-based model that integrates with ADEQ's comprehensive water quality database and assesses the records against the complex Arizona Impaired Waters Rule to automatically determine exceedances and other guidance for impairments for the entire state. He worked closely with ADEQ to accurately interpret the Rule into the application and to design a system that provides a robust assessment platform for the determination of impaired waters based on a high-quality, centralized database.

Southwest Florida Feasibility Study (SWFFS), Army Corps of Engineers, Jacksonville District and South Florida Water Management District. West Palm Beach, FL. (Technical Leader; February 2002 – January 2004). Mr. Zastrow managed the data assimilation and modeling effort that developed a preferred water quality database for Everglades restoration containing approximately 9,000 stations and more than 2,800,000 records from 89 unique studies or programs. This project was conducted for the Army Corps of Engineers,

Jacksonville District and South Florida Water Management District. The project also developed a Java-based water quality assessment model and an automated report building tool that automatically summarized the 89 migrated datasets into a highly formatted report including map figures. He also contributed technical sections to the final written report.

Second Generation Environmental Data Analysis System (EDAS2), Fairfax, VA. (Project Manager and Technical Leader; November 2006 – Present). Mr. Zastrow is the project manager and one of the chief designers of EDAS2, a free and open source enterprise system for the storage and analysis of biological data. Mr. Zastrow oversees that the technical implementation of the system, conducts outreach and marketing, and controls the direction and scope of this innovative system.

California State Water Resources Control Board (SWRCB), Sacramento, CA. (Project Manager and Technical Leader; March 2003 – Present). Mr. Zastrow was project lead and water quality subject matter expert for multiple projects with SWRCB. Since 2004 he has led the development of the water quality assessment database (CALWQA), an online tool that manages the evidence used to assess the conditions of California surface waters. He was also a task leader and expert on the California Integrated Water Quality System (CIWQS) project, an enterprise information management system, supported with extensions to desktop tools such as ArcGIS. CIWQS provides automated tools and standardized business processes to improve the State's and Regional Boards' ability to enhance and preserve the quality of California's waters. Mr. Zastrow focused on the Geo Water Body System (GeoWBS), comprised of desktop GIS and Web applications to describe and report on all of California's monitored waters and important attributes (beneficial uses, water quality objectives, status relevant to the 305(b)/303(d) integrated approach, and all evidence used to arrive at that status) in a central enterprise database.

National Data Services for the US Forest Service. Geospatial Services and Technology Center, Salt Lake City, UT. (Project Manager and Technical Leader; November 2005 - present). Mr. Zastrow is the GIS technical lead for several task orders/projects under this contract. In this capacity, he led a team of GIS analysts and developers in providing GIS services and products to the Geospatial Services and Technology Center of the USFS. Some of the projects include geodatabase design to support travel mapping and routing, and development of desktop and web-based tools to support habitat assessment and reporting, travel mapping and routing, metadata management, and mapping. He has also facilitated the business modeling meeting among several USFS representatives from various forests and regions across the county to support the development of the Standard Data Management System of the USFS, which is an enterprise system for the central management of USFS inventory and monitoring standardized data assets.

Surface Water Quality Management Information System (SWQMIS), Texas Commission on Environment Quality (TCEQ), Austin, TX. (Analyst and Technical Leader; February 2005 – September 2007). Mr. Zastrow managed the collection and organization of system requirements, conducted geodatabase design, and coordinated closely state users as an integral member of the requirements and design team. SWQMIS is an enterprise, statewide system for planning and managing water quality data collection activities, streamlined receipt of data from agency staff, laboratory information management systems, real-time field sampling devices, and partner agencies. SWQMIS supports an integrated GIS, water standards management, rigorous traceability and quality controls, and provides a foundation for integration with a planned automated assessment tool and network transmittal of data to EPA STORET.

EPA Environmental Data Adapter. EPA Office of Science and Technology, Washington, DC. (Project Manager and Technical Leader; December 2007 – June 2008). Mr. Zastrow conceptualized and led the effort to develop a novel software utility to support two related functions. The first is the transformation of Superfund Staged Electronic Data Deliverable (SEDD) analytical result files and FORMS II Lite field sampling files to produce valid electronic data deliverables for direct submission into EPA's Central Data Exchange (CDX) following the Water Quality Exchange (WQX) schema. The second function allows users to extract environmental data from the EPA STORET Web Services via an open standards-based interactive map and immediately produce native files for sediment and tissue analysis by NOAA's Office of Response and Restoration's Query Manager and MARPLOT desktop tools. The utility is capable of operating both a desktop and a web-based utility and provides an extendable framework for a variety of other functions.

EPA Region 4 Environmental Data Management (Project Manager and Technical Leader; 2003 – 2004). Mr. Zastrow managed a multifaceted effort to assist the Region with impacted water evaluations in the state of Florida. The first aspect of the project involved implementing an Oracle database to receive ambient water quality data from numerous agencies from throughout Florida, including Florida Department of Environmental Protection. As the contacts with the key organizations were made, the various data sets were brought into the system in preparation for the second phase. Mr. Zastrow also managed the effort to develop the online GIS Florida Environmental Data Extraction Tool (F-EDET) to extract the data and provide it to remote desktop users as files used in the Water Resources Database (WRDB) product.

TETRA TECH, INC.

Hua Zhang, Ph.D

Soils Specialist

EDUCATION

Ph.D., Soil Science, Louisiana State University, 2006

M.S., Soil Science, Chinese Academy of Sciences,2002

B.S., Environmental Management, HuaZhong Agricultural University, 1999

YEARS OF EXPERIENCE

Total: 12

With Tetra Tech: 7

PROFESSIONAL AFFILIATIONS

Soil Science Society of America

American Geophysics Union

KEY AREAS OF EXPERIENCE

- Water Quality Modeling
- TMDL Development
- Reactive Transport Modeling
- Heavy Metal Biogeochemistry
- Agricultural and storm water BMPs
- Acid Mine Drainage

Dr. Zhang is an environmental engineer with extensive engineering and scientific experience specializing in hydrologic and water quality modeling, watershed management, point and nonpoint source pollution assessment, soil and groundwater remediation, agricultural system management, heavy metal contamination analysis, TMDL development and implementation. He has extensive scientific knowledge in soil and water sampling, characterization, and assessment. Dr. Zhang possesses extensive programming experience concentrated in the surface and groundwater quality modeling. He currently develops and applies reactive transport model for TMDL development and remedial investigation. Dr. Zhang published more than 10 peer reviewed articles on major journals in the area of environmental science. He has also served as peer reviewer for several international journals on environmental management.

Selected Project Experience

West Virginia Metals TMDLs Development for Hydrologic Groups B2. For the West Virginia Department of Environmental Protection (WVDEP), gathered, compiled, and prepared relevant water quality data for characterization and modeling of the Elk and Lower Kanawha watersheds. Developed and calibrated models for total iron, pH, and dissolved aluminum impaired streams. Conducted stream bank erosion and sediment transport modeling. Prepared mining and non-mining NPDES permit relational databases. Prepared comprehensive TMDL scenario databases where all of the project information can be accessed and queried.

Support Activities for the Re-evaluation of the Cheat River Watershed TMDL in West Virginia. In support of EPA Region III, developed and calibrated mining data analysis system (MDAS) water quality models for pH, total iron, dissolved aluminum, and manganese. The model dynamically simulate stream acidity results from multiple sources including acid precipitation caused by sulfur and nitrogen emissions, as well as acid mine drainage (AMD) with very high concentrations of sulfate and dissolved metals (Fe and Al) from abandoned coal mining sites in the region.

West Virginia Troutwater Iron Modeling. In support of WVDEP, developed and calibrated hydrologic, sediment and water quality models for two trout streams (Elklick Run and Holcomb Run). Created dynamic landuse to simulate impacts of forest harvest on soil erosion and sediment generation in streams.

West Virginia Metals TMDLs Development for Hydrologic Groups C, D, and E. For West Virginia Department of Environmental Protection (WVDEP), gathered, compiled, and prepared relevant water quality data for characterization and modeling of the Gauley, Little Kanawha, New River, Youghiogheny, and Dunkard watersheds. Developed and calibrated models for total iron, total manganese, pH, dissolved aluminum, and chloride impaired streams. Prepared mining and non-mining NPDES permit relational databases. Prepared comprehensive TMDL scenario databases where all of the project information can be accessed and queried.

Piney Creek Watershed Management Plan. In support of WVDEP, developed a MS Excel based BMP decision support tool to help plan and prioritize potential projects based on available funding sources, project cost, and measureable water quality benefits in Piney Creek watershed.

Dissolved Metals Transport Modeling for Left Hand Creek, James Creek, and Little James Creek, CO. In support of EPA region VIII, developed dissolved copper, zinc, lead, and cadmium TMDL in the Left Hand watershed using an in-stream chemical transport model developed by Tetra Tech. Analyzed hydrologic and water quality data collected under the critical high flow and low flow conditions. Evaluated remedial effectiveness scenarios of various mining reclamation activities in the Left Hand watershed.

Acid Mine Drainage TMDLs for the Kiskiminetas-Conemaugh River Watershed, Pennsylvania. In support of EPA Region III, analyzed water quality data and pollutant discharge permits of streams impacted by abandoned mine land (AML) in Kiskiminetas River watershed. Developed and calibrated water quality models for total iron, aluminum, and manganese using MDAS model.

Dissolved Cadmium and Zinc Transport Modeling for Silver Creek, Utah. In support of EPA Region VIII, had a lead technical role in the development of models for simulating dissolved Cd and Zn transport for Silver Creek near Park City, Utah. Evaluated water quality data and pollutant sources to determine the relationships between in-stream metal concentrations and discharge from mine tailing. Used steady state solute transport model equipped with sediment transport routines coupled with a dynamic chemical speciation model to simultaneously simulate multiple dissolved metals.

Non-Point Source Monitoring and BMP Development for TMDL Implementation in Bayou Wikoff Sub-Watershed. In support of Louisiana Department of Environmental Quality (LADEQ), technical lead for monitoring nonpoint pollutant source and developing BMPs for TMDL implementation in Bayou Wikoff watershed in southern Louisiana. Evaluated multiple BMPs for reducing sediment and nutrient (N and P) load from sugarcane and pasture field.

TETRA TECH, INC.

Jenny Zhen, Ph.D

Senior Water Resource Engineer

EDUCATION

Ph.D., Environmental and Civil Engineering, University of Virginia, 2002

M.S., Environmental Engineering, Tsinghua University, China, 1998

B.S., Environmental Engineering, Tsinghua University, China, 1996

YEARS OF EXPERIENCE

Total: 12

With Tetra Tech: 11

PROFESSIONAL AFFILIATIONS

American Society of Civil Engineers

KEY AREAS OF EXPERIENCE

- Watershed modeling
- BMP Evaluation
- Model/Tool/Decision Support System development
- TMDL development
- Watershed management plan development
- Information management system development

Dr. Zhen has over 10 years of experience in nonpoint source pollution control and stormwater management, including watershed modeling, evaluation and design of best management practices (BMPs), water quality modeling analysis, as well as applying optimization techniques for BMP implementation and watershed management. She has conducted a dissertation research in applying simulation and optimization approach to develop cost effective best management practices (BMPs) placement strategies at the watershed scale. Dr. Zhen has intensive experience in assessing BMP and BMP evaluation computer model development and application. Dr. Zhen has also been supporting TMDL development studies for USEPA Region 3 and Region 10.

Selected Project Experience

Development of System for Urban Stormwater Treatment Analysis and Integration (SUSTAIN) for USEPA ORD. Technical Lead for the development of System for Urban Storwater Treatment Analysis and Integration (SUSTAIN). The system is to be based on integrated GIS watershed/BMP database, cost, and hydrologic, hydraulic, and water quality modeling to cost-effectively achieve desired watershed-based water quality objectives. The system will be used to facilitate optimal placement of BMPs options at strategic locations in mixed land use urban watersheds.

Benthic TMDL Development for Streams in Virginia,. Supported the development of TMDLs for several biologically impaired watersheds for USEPA Region 3 and the Commonwealth of Virginia. The methodology used in this project incorporates a reference watershed approach for the identification of benthic community stressors and appropriate TMDL endpoints. The reference watershed selection process was based upon a comparative analysis of key watershed attributes and the results of a Multimetric Bioassessment Index that was developed specifically for this project using metric discrimination analyses. The stressor identification process involved the review of water and sediment quality data, toxicity test results, and physical processes (i.e. hydromodification, riparian buffer disturbance, etc.) to determine the primary causes of impairment. Impaired and reference watersheds are currently being modeled to determine the conditions necessary to support a healthy benthic community.

Development of Stomrwater BMP Decision Support System for Vermont. For Vermont Department of Environmental Conservation, developing a decision support system to disaggregate TMDL watershed targets to sub-watershed/parcel based targets and identify cost effective and suitable BMPs to meet the target. The system will be built on the ArcGIS platform, and use P8 model with enhanced groundwater component for hydrology simulation. The Prince George's County, MD, BMP Module will be employed for BMP simulation and evaluation.

Development of a Best Management Practices (BMP) and Low Impact Development (LID) Decision Support System. For Department of Environmental Resources, Prince George's County, MD, technical lead in the development of the system. The system provides a variety of BMP options for storm water control that simulate LID practices at the site level, evaluates the impact of their implementation on runoff hydrology and water quality. Effectiveness is measured using a set of monitored urban indicator pollutants including flow, sediment, nitrogen, phosphorus, BOD-5, and metals. The system provides interfaces for BMP placement, BMP attribute data input, and decision optimization management.

The system includes a stand-alone BMP simulation and evaluation module, which complements both research and regulatory nonpoint source control assessment efforts, and allows flexibility in the examining various BMP design alternatives. Process based simulation of BMPs provides a technique that is sensitive to local climate and rainfall patterns. The system incorporates a meta-heuristic optimization technique to find the most cost-effective BMP placement and implementation plan given a control target, or a fixed cost. The system was used to evaluate the performance and cost of proposed LID practices for Anacostia Sewershed 006, and perform an optimization search to identify the most cost-effective combinations of management practices for reducing combined sewer overflow frequency and flow volume to the Anacostia River.

Evaluation of Site-Scale Stormwater Management Options. For Department of Environmental Resources, Prince George's County, MD. She conducted a case study at a sub-urban residential site in Prince George's County. The study focuses on examining integrated storm water management at the site-scale. A detailed water balance analysis, including assessment of potable water, wastewater, and storm water were carried out, to identify opportunities for maximizing the reuse of storm water to effectively minimize the use of potable water. The Prince George's County BMP Tool was used to evaluate various storm water management options. A suite of final alternatives was identified, including LID practices -such as green landscaping, storm water recycling and innovative septic systems.

Development of a Stream Routing and Sediment Transport Simulation Module Accommodating the Generalized Watershed Loading Function (GWLF). For West Virginia Department of Environmental Protection, developed a stream routing and sediment transport simulation module that can be used in combination with Genelized Watershed Loading Function (GWLF). The module has been used to development of TMDLs for the watersheds in USEPA Region 3 (West Virginia and Pennsylvania), and Region 10 (Idaho).

Sediment TMDL Development for Fighting Creek, Idaho, Region 10. For USEPA Region 10, provided technical support in nutrients and sediment TMDL development for Fighting Creek, Idaho, using GWLF to simulate watershed loadings. Reference watershed approach was applied to identify the sediment and nutrients TMDL target.

TETRA TECH, INC.

Lei Zheng, Ph.D

Biological Analyst

EDUCATION

Ph.D., Ecology, Evolutionary Biology, and Behavior (EEBB) Program and Department of Zoology, dual degree, Michigan State University, 2003

M.A., Botany, Xiamen University, China, 1991

B.S., Botany, Xiamen University, Xiamen, China, 1988

YEARS OF EXPERIENCE

Total: 15

With Tetra Tech: 10

KEY AREAS OF EXPERIENCE

- Statistical analysis
- TMDL support
- Stressor identification
- Biological assessment
- Indices of biological integrity
- Nutrient and conductivity water quality criteria developement
- Water resources management

Dr. Zheng is a senior aquatic ecologist in Tetra Tech Inc., Center for Ecological Sciences, located in Owings Mills, Maryland. He is a research scientist with broad experiences in aquatic environmental sciences especially in biological assessment of aquatic ecosystems. He is an algae and nutrient expert, specialized in algal ecology, taxonomy, and physiology; and his particular interest is to use biological indicators (algae, macroinvertebrates, fish, and plants) to assess ecosystem health. During his professional career, he has been involved in a range of multidisciplinary research in streams, lakes, wetlands, as well as marine systems. His strong background in experimental design and statistical analysis has helped to integrate complicated information into simple models and indices for environmental management. Dr. Zheng has worked with EPA and other state agencies to identify environmental stressors and human disturbance that cause the degradation of aquatic system. By using statistical modeling approaches, he has been able to identify the relative risk of environmental stressors to aquatic systems, therefore to develop scientific defensible water quality standards/criteria. His other technical abilities include, but are not limited to, wetlands ecology, stream ecology, and algae-nutrient interactions.

Selected Project Experience

West Virginia Stressor Identification and TMDL Development. Dr. Zheng's research was part of a multiple-year project focused on identifying environmental stressors impairing biological condition (macroinvertebrates) in West Virgina streams to help the West Virginia Department of Environmental Protection (WVDEP) develop Total Maximum Daily Loads (TMDLs) for streams throughout the state. Research included: applied multivariate statistical approaches to develop empirical models; weighted averaging for tolerance development; and a dirty reference model (discriminant functional analysis) for stressor identification. Dr. Zheng developed nutrient targets for the Potomac Direct Drains Watershed based on responses of algae and macroinvertebrates. He developed pH, and Aluminum toxicity thresholds based on multiple approaches; and developed sulfate and chloride thresholds based on statistical approaches.

Development of Biological Indicators (IBI) Of Urban Disturbance In Wetlands. Principal investigator and data analyst for wetland IBI (indices of biological integrity) development in Ramsey-Washington Metro watershed district, MN. Dr. Zheng performed data analyses to identify an urban disturbance gradient using landscape disturbance intensity (LDI) index; He also applied multivariate statistical approaches to identify the main stressors that impact plant and macroinvertebrate communities in the urban wetlands. Based on the analyses, he developed both plant and macroinvertebrate IBIs to indicate the conditions of urban wetlands.

Using Field Data to Derive An Aquatic Life Benchmark For Conductivity. Contracted by National Center for Environmental Assessment (NCEA), USEPA to develop methodologies to derive conductivity criteria for mountain top mining (MTM) impacted regions in the U.S. Dr. Zheng explored numerous statistical methods, including weighted average, weighted/un-weighted cumulative distribution function(CDF), linear and quadratic logistic regression (Generalized Linear Models, GLM), and generalized addictive models, by using macroinvertebrate species compositional data and a number of environmental variables to derive numerous benchmark for conductivity. The final product is a report adapting the standard U.S. EPA methodology (species sensitive distribution)

for deriving ambient water quality criteria. The method is applied to derive effect benchmarks for dissolved salts as measured by conductivity in Central Appalachian streams using data from West Virginia and Kentucky. Upon request from USEPA region 3 and the states, Dr. Zheng has adapted this methodology to derive for water quality benchmarks for Tennessee and Ohio.

Florida Nutrient Criteria Development. As part of the EPA teams, Dr. Zheng is actively involved in an ongoing process of developing nutrient criteria for Florida's lakes and streams. Dr. Zheng reviewed and analyzed datasets for Florida's lakes and streams and provided valuable comments and suggestions to EPA for revising and finalizing Florida's criteria documents. He applied various statistical techniques (Regression analyses, change point analysis, hierarchical (mixed) models etc.) and scientific expertise to help EPA derive the final criteria.

Clermont County Watershed Management. Provided assistance on development of a community-led TMDL for Little Miami River watershed in Clermont County, Ohio. Dr. Zheng participated this multi-year project to develop and implement a comprehensive water resources management program for the county. He conducted statistical analysis to develop stressor end points (habitat, nutrients, and hydrological stressors) and provided recommendations for management.

Method Evaluation for Effluent Toxicity Test. A project sponsored by USEPA office of Wastewater Management to evaluate statistical methodologies of Effluent Toxicity Test using various techniques. Dr. Zheng evaluated statistical properties (Type I and Type II errors) of a number of testing methods (Ceriodaphnia, fish, sea urchin, etc reproduction and survival data) and determined a balance of different error rates based on risk assessment decisions. Numerous simulation models have been developed to test these methods using R.

N-STEP Support: Nutrient Endpoint Development for Various States. Dr. Zheng provided technique support through Tetra Tech's nutrient center (Office of Wastewater Management) to help states to develop scientificly defensible nutrient criteria for lakes and streams. Dr. Zheng has helped review nutrient criteria guidance for various states, including Maine, Ohio, and Minnesota. Dr. Zheng also applied statistical methodology to derive numeric nutrient endpoints for waterbodies in various regions of Kentucky, West Virginia, and Montana. In order to more effectively conduct statistical analysis for similar sets of data from different regions and states, Dr. Zheng developed a statistical package using R programming to perform the main approaches commonly used for nutrient criteria development: summary statistical analysis, scatter plots and LOWESS regression, conditional probability analysis, change point analysis, uncertainty analysis, propensity function for covariance, and hypothesis testing. Dr. Zheng has also directed usages of the application for develop nutrient endpoints for Illinois, Indiana, Delaware, and other states.

Nutrient Target for Northern Piedmont Ecoregion in PA. 2007. The goal of this project was to develop nutrient TMDL targets for six watersheds in Southeast Pennsylvania, a project sponsored by EPA region 3. Due to limited sample size and data availability, Dr. Zheng expanded his analysis to the Northern Piedmont Ecoregion by collecting data from PA, NJ and MD. Dr. Zheng and colleagues used a Weighted Evidence Approach from multiple sources to develop nutrient targets for this region, including reference approach, stressor-response approach, modeling approach, and literature reviews. He applied a number of statistical techniques, e.g., regression tree, linear regression. He used both algal and macroinvertebrate metrics to examine biological condition gradients for the analysis.

Nutrient Criteria Development for Wadeable and Non-Wadeable Streams In The State Of Mississippi. The goal of this project was to develop scientific defensible nutrient criteria for both wadeable and non-wadeable streams. Dr. Zheng took on the majority of the tasks of this project include: 1. Building a comprehensive database with existing nutrient and biological data (mostly macroinvertebrates); 2. Classifying streams and defining reference conditions for each class; he developed three stream classes (minimally disturbed, least disturbed, and biological attained reference conditions. 3. Using scientific approaches to analyze data to reach nutrient end points; He used a number of statistical approaches (change point analysis, LOWESS regression, and biological indicators to identify thresholds. 4. Making sure criteria are comparable across waterbodies.

Excel Statistical Tools for Wastewater Effluent Toxicity Test. A project sponsored by USEPA office of Wastewater Management to develop a statistical tool which performs various statistic tests for WET test. Dr. Zheng directed and implemented adapting these statistic techniques, including Shapiro-Wilkes normality test, Bartlett's Test of Homogeneity, Levy's multiple comparison of variance, Dunnett's multiple comparison and t-test with Bonferroni's adjustment, nonparametric Steel's many one multiple comparisons and Wilcoxon rank sum test, Fisher's exact test, and linear interpolation of IC25 into the spreadsheet tool. The tool would allow users select one WET test methods from a total of 20 WET test types, input WET test data, run through these statistical methods, and view statistical output and graphs automatically.

TETRA TECH, INC.

Rui Zou, Ph.D

Senior Water Resource Engineer

EDUCATION

Ph.D., Environmental Engineering, University of Virginia, 2002

M.S., Environmental Chemistry (Systems), Peking University, China, 1998

B.S., Ecology and Environmental Sciences, Yunnan University, China, 1990

YEARS OF EXPERIENCE

Total: 20

With Tetra Tech: 11

PROFESSIONAL AFFILIATIONS

American Society of Limnology and Oceanography

American Geophysical Union

American Society of Civil Engineers (ASCE)

KEY AREAS OF EXPERIENCE

- Hydrodynamic and Water Quality Modeling
- Environmental System Analysis
- Watershed Planning and Optimization
- Linear and Non-linear programming
- Uncertainty Based Decision-Making
- Numerical Model Development
- Modeling Algorithm Development

Dr. Zou is an environmental engineer with 20 years of experience specializing in hydrodynamic and water quality modeling, environmental system analysis, uncertainty analysis and risk assessment. He has developed and applied a wide variety of computational methodologies for water quality modeling and uncertainty based environmental system simulation and decision making. He has developed an enhanced EFDC modeling framework with high complexity level kinetics simulation modules, nitrogen fixing and luxury phosphorus uptake algorithms, and a general bacteria modeling system. He has developed an enhanced CE-QUAL-W2 modeling framework with piece-wise simulation and other advanced capability to accurately simulate the fate and transport of pollutant in waters. He has developed a linking interface between CE-QUAL-W2 and WASP models, an enhanced WASP/EUTRO model with zooplankton dynamics, periphyton dynamics, diurnal dissolved oxygen simulation module, sediment diagenesis simulation module, and real-time visualization function. He has also developed a comprehensive pH simulation module representing the interaction between pH and phytoplankton, periphyton, benthic activity, organic matter, and water-atmosphere exchange, and incorporated this module into the RMA-11 model. In addition, he has developed post-processing programs for modeling systems including CE-QUAL-W2, WASP/EUTRO, WASP/TOXI, EFDC, and RMA using Fortran, Matlab, and Techplot.

Dr. Zou's experience in environmental engineering includes serving as environmental engineer for a variety of projects, and working as a project manager for international cooperative environmental projects in China. Dr. Zou has involved in near 40 environmental engineering projects during the past decade, and has produced near 60 publications in peer-refereed professional journals and scientific conferences in his professional area. He also has served as a peer reviewer for a number of international journals on environmental engineering and management.

Selected Project Experience

Integrated Hydrodynamic and Water Quality Modeling for Supporting TMDL Development of Wissahickon Creek Basin, PA. Provided technical support to EPA Region 3 and the Pennsylvania Department of Environmental Protection (PADEP); developed a hydrodynamic model for Wissahickon Creek basin; developing an enhanced WASP/EUTRO water quality model with real-time visualization and a full periphyton-DO interaction module; developed a DO diurnal simulation module in the WASP/EUTRO system; enhanced the linking interface between EFDC and WASP to integrate the hydrodynamic model with the water quality model; developed a water quality modeling system for the entire basin based on the enhanced WASP/EUTRO modeling framework; developed an automatic TMDL tool for the linked hydrodynamic and water quality modeling system; implemented pollution control scenario analysis and TMDL development.

Linked Hydrodynamic and Water Quality Modeling for the Appoquinimink river, DE. Provided technical support to EPA Region 3 and DNREC for the TMDL development of Appoquinimink River; developed an enhanced WASP/EUTRO code with predictive sediment diagenesis modules; fixed errors in the model previously developed; updated the hydrodynamic model for Appoquinimink River based on the DYNHYD framework; developed a dynamic water quality model simulating mass transport, nutrient cycling, algae dynamics,

and sediment diagenesis for the river; implemented pollution control scenario analysis and TMDL development.

Integrated Hydrodynamic and Nutrient Transport Modeling for Canyon Lake, CA. Provided technical support to EPA Region 9 and the Santa Ana RWQCB of California; enhanced the EFDC modeling code with artificial decay kinetics for simplified nutrient fate and transport simulation; enhanced the dam formulation in the EFDC; developed a vertically integrated 2-dimensional hydrodynamic and nutrient transport model for Canyon Lake; implemented pollutant control scenario analysis and developed watershed pollutant control scheme for protecting the lake water quality.

Three Dimensional Hydrodynamic and Eutrophication Modeling for Lower Charles River Basin, MA. Provided technical support to EPA Region 1 for the Lower Charles modeling efforts; developed a 3-D hydrodynamic and water quality model for lower Charles River Basin, simulating the impact of lock operation, salt intrusion, and power plant water intake and discharge on the water circulation in the basin; enhanced the EPA-endorsed EFDC modeling framework with vertically spatial variable DO dependent phosphorus-sediment adsorption/desorption mechanism for simulating the key dynamic in the system.

Simulating Nutrient-Algae-DO Dynamics and Evaluating Watershed Development and Management alternatives for Lake Maumelle, AR. Provided technical support to Central Arkansas Waters (CAW) for the effort of lake water quality protection and watershed management; developed a luxury uptake module for phytoplankton and periphyton/macrophyte and incorporated it into the source code to simulate spatially temporal variable algal phosphorus composition in response to water column phosphate concentration; developed an integrated hydrodynamic and eutrophication simulation model based on the CE-QUAL-W2 modeling framework for the lake; conducted watershed pollutant impact analysis in support of the development of management schemes for protecting the water quality in this primary drinking water source.

Three Dimensional Hydrodynamic and Bacteria Fate and Transport Modeling for Canyon Lake, CA. Provided technical support to the Santa Ana RWQCB and U.S. EPA Region 9 to develop an integrated hydrodynamic and bacteria fate and transport model for Canyon Lake; enhanced the EFDC model code with a general bacteria modeling (GBM) system which allows simultaneously simulating any arbitrary number of bacteria species with advanced kinetic structure that is necessary for representing the complexity in many real-world systems; developed a three-dimensional hydrodynamic and water quality model based on the EFDC modeling framework, simulating water circulation, thermodynamics, complicated bacteria kinetics based on solar radiation and temperature distribution in the lake, and conducted source-response analysis using the developed model to support developing management schemes.

Nested Hydrodynamic and Bacteria Fate and Transport Modeling for San Diego Bay and Beaches, CA. Provided technical support to San Diego RWQCB and U.S. EPA Region 9 to develop an integrated hydrodynamic and bacteria fate and transport model for San Diego Bay based on the EFDC modeling framework; developed a series of nested hydrodynamic models to represent the water circulation patterns in San Diego Bay as well as five beach areas in the Bay; developed five beach area hydrodynamic and bacteria fate and transport models to implement bacteria source-response analysis.

Three-Dimensional Hydrodynamic and Power Plant Thermal Discharge Impact Modeling and TMDL Development for Indian River Bay, DE. Provided technical support to EPA Region 3 and the Delaware Department of Natural Resource and Environmental Control (DNREC) for the effort of developing thermal TMDL for the Indian River Bay; developed a three-dimensional modeling system for the Bay and calculated a TMDL to ensure environmental compliance in terms of excessive temperature, which can have severe impact on the aquatic ecological system.

Large Scale Watershed BMP optimization modeling for Los Angeles County watershed. Developed a Risk Explicit Interval Linear Programming (REILP) algorithm as a mathematical tool for an uncertainty based decision making framework; developed a Nonlinearity-Interval Mapping Scheme (NIMS) as a mathematical algorithm that allows solve large scale, nonlinear optimization problem which was previously computationally impossible; verify the performance of the developed algorithms using a waste-load allocation case and a pilot study area in the Los Angeles watershed by solving these cases with the developed algorithms and comparing the solutions with that of using a Genetic Algorithms (GA) ; formulating and solving the large scale watershed BMP simulation- optimization model with 2655 decision variables for minimum cost implementation plan to achieve water quality compliance at more than 100 compliance points.

TMDL Development Process