



DATA COORDINATION AND QUALITY CONTROL SERVICES

REVISED FINAL REPORT (October 23, 2006)

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1.0 INTRODUCTION

This final project report summarizes the data coordination and quality control (QC) activities Tetra Tech EM Inc. (Tetra Tech) completed as part of the Lake St. Clair Regional Water Quality Monitoring Project. This unique project was conducted during 2004 and 2005 under the direction of the Macomb County Health Department (MCHD) in response to citizens' concerns about public health issues such as beach closings, threats to drinking water, and fish consumption advisories.

Lake St. Clair is a vital link in the Great Lakes system and provides drinking water to 4.5 million people. In spite of environmental gains in recent years, the lake continues to experience water quality problems caused by faulty sewerage and septic systems, combined sewer overflows, toxic contamination, and storm water runoff with its associated pollutants. In 1997, the Macomb County Board of Commissioners formed a Blue Ribbon Commission to respond to some of the lake's water quality problems. The Blue Ribbon Commission's report identified four key elements required to solve the current problems and to prevent future problems. These key elements included monitoring, education, voluntary action, and regulation and enforcement. With regard to monitoring, the Blue Ribbon Commission called for "a substantial commitment to monitoring and study so we know where we are in regard to protecting drinking water, safety, swimming, recreating and protecting wildlife habitat." The Blue Ribbon Commission further recommended that monitoring data "be managed in ways that allow the technical community to access and evaluate them . . . and distilled into a format that is easily grasped by the general public" (Macomb County Blue Ribbon Commission 1997).

The Lake St. Clair Regional Water Quality Monitoring Project was designed to address public concerns by providing a comprehensive assessment of water quality within Lake St. Clair as well as the surrounding Lake St. Clair, Clinton River, and St. Clair River watersheds. The project was conducted by the Macomb County Health Department and was funded by a \$2.5 million grant from the Michigan Department of Environmental Quality (MDEQ) as the direct result of actions by a voluntary advocacy group, the Macomb County Water Quality Board. The project was implemented through contractual arrangements with private-sector firms, MCHD, and the U.S. Geological Survey (USGS).

Sampling and monitoring activities for the project were conducted from spring 2004 through fall 2005. These activities included continuous water quality monitoring at 13 fixed stations; automatic sampling during 14 wet weather events; and manual grab sampling during both wet weather events and dry periods. In addition, the project involved field measurements of water quality parameters, sediment sampling in depositional zones in Lake St. Clair and selected inland lakes, continuous and manual stream flow measurements at 23 locations, and rainfall monitoring at five locations. Samples were collected by MCHD and Environmental Consulting & Technology, Inc. [ECT]), and analyzed by several laboratories for a variety of physical, chemical, and biological parameters. In addition, USGS performed stream flow gauging and continuous water quality monitoring at 14 locations. Tetra Tech completed quality reviews of field measurements and laboratory results, and more than 28,000 quality-assured test results from the project have been uploaded to a dedicated web site in an interactive, publicly accessible database developed by Altarum (www.lakestclairdata.net). Table 1 lists key project participants and their roles and responsibilities.

The project database will provide researchers and other interested parties with data that can be used in statistical analyses and mathematical models. Analysis of the data will lead to scientifically sound findings about overall water quality conditions and pollutant loadings in Lake St. Clair and the surrounding watersheds.

MCHD selected Tetra Tech to provide data coordination and QC support for the Lake St. Clair Regional Water Quality Monitoring Project. Tetra Tech's primary responsibilities were to independently evaluate field measurement and laboratory results collected and reported by other organizations and to assess whether these measurements and results met MCHD's data quality requirements for the project. The remainder of this report summarizes the activities Tetra Tech conducted during the project. Section 2.0 summarizes efforts to identify historical data from other water quality studies conducted in the study area that could be combined with project data to form a more comprehensive historical database. Section 3.0 discusses four audits conducted to verify that organizations collecting data were completing activities in accordance with approved plans. Section 4.0 describes the data review and data validation activities completed to verify that field measurements and laboratory results met project quality requirements before they were added to the project database. Section 5.0 includes recommendations on whether the types and intensity of QC checks and reviews used on this project would be appropriate for future projects that are similar in scope. References cited in the final report are listed in Section 6.0. Tables cited in the text are included at the end of each section.

The final report also includes four appendices, which are provided on compact disk inside the back cover of the report. Appendix A includes Tetra Tech's review of historical water quality data sources, and Appendix B includes field audit reports and the report summarizing the review of USGS data collection, reduction, and reporting procedures. Tetra Tech previously submitted these reports to MCHD. Appendix C includes data validation reports documenting the more extensive review of selected laboratory data sets. Finally, Appendix D contains the data review checklists completed during reviews of the majority of field measurements and laboratory data collected during the study.

TABLE 1: ROLES OF PARTICIPATING ORGANIZATIONS

Organization	Primary Project Roles	Organization	Primary Project Roles
Macomb County Health Department (MCHD)	<ul style="list-style-type: none"> Manages and administers project Works with and coordinates activities of other participating organizations to achieve project goals Reviews project plans Collects samples required under the "Lake St. Clair Water and Sediment Analyses Services" statement of work Analyzes water and sediment samples for <i>E. coli</i> through the Martha T. Berry Laboratory Provides quarterly progress reports to MDEQ as the primary funding agency 	Tetra Tech EM Inc. (Tetra Tech)	<ul style="list-style-type: none"> Reviews surface water and sediment results to ensure that data collected meet project data quality requirements Notifies MCHD of data quality concerns and works with MCHD and other organizations to resolve concerns Conducts field audits of sampling and monitoring activities to ensure compliance with approved procedures Conducts literature search to identify historical water quality data that could be added to Lake St. Clair database Reviews USGS field measurements, documents data deletions, and recommends whether MCHD should concur with the deletions
Michigan Department of Environmental Quality (MDEQ)	<ul style="list-style-type: none"> Provides funding for the Lake St. Clair Regional Water Quality Monitoring Project through a grant agreement with MCHD Reviews and approves project plans, including quality assurance project plans (QAPP) Reviews quarterly progress reports submitted by MCHD Provides oversight and guidance to other participating organizations 	Environmental Consulting & Technology, Inc. (ECT)	<ul style="list-style-type: none"> Collects wet weather and dry weather grab samples required under "Water Sampling and Laboratory Analyses Services" SOW Records flow and in situ water quality measurements associated with dry weather sampling Works with Applied Science, Inc. (subcontractor) to collect automatic samples during wet weather events Receives QC-reviewed data from Tetra Tech for entry in project database, assisted by Altarum (subcontractor)
U.S. Geological Survey (USGS)	<ul style="list-style-type: none"> Conducts continuous in situ water quality measurements, flow monitoring, and current measurements in study area Works with Tetra Tech to identify historical data sources for comprehensive database 	Altarum	<ul style="list-style-type: none"> Develops interactive, publicly accessible project database, housed on dedicated web site Uploads preliminary data from laboratories to project database Incorporates QC review information provided by Tetra Tech before data is made available to public
RTI Laboratories, Inc. (RTI)	<ul style="list-style-type: none"> Analyzes surface water and sediment samples collected by MCHD and ECT during 2004 Follows project-required data reporting formats 	Paragon Laboratories, Inc. (Paragon)	<ul style="list-style-type: none"> Analyzes surface water samples collected by ECT during 2005 Follows project-required data reporting formats
Trace Analytical Laboratories, Inc. (Trace)	<ul style="list-style-type: none"> Analyzes surface water and sediment samples collected by MCHD during 2005 Follows project-required data reporting formats 	MCHD Martha T. Berry Laboratory	<ul style="list-style-type: none"> Analyzes water samples collected by MCHD for <i>E. coli</i> Follows project-required data reporting formats

2.0 HISTORICAL DATA REVIEW

Tetra Tech performed a search for historical water quality studies conducted in the Lake St. Clair watershed. Tetra Tech was aware of ongoing efforts by the Great Lakes Commission to develop a monitoring database for Lake St. Clair. The commission maintains an “Environmental Monitoring Inventory for the Lake St. Clair Basin,” which is described “as a compendium of current Lake St. Clair monitoring programs housed in a web-based, searchable database for use throughout the basin” (<http://www.glc.org/monitoring/stclair/>). The commission has also compiled a “Lake St. Clair Stakeholder Inventory” that lists major studies and reports related to Lake St. Clair and identifies federal, state, and local government; business and industry; academic; and non-government organization stakeholders in both the United States and Canada. However, the commission does not collect, store, or maintain water quality data from any of these organizations.

Based on this information, the Great Lakes Commission was identified as a resource for contact information on organizations and individuals that had conducted water quality studies in the Lake St. Clair watershed. The commission, MDEQ, and USGS provided extensive lists of organizations and key individuals that had reportedly collected water quality samples in the Lake St. Clair Watershed. Tetra Tech first reviewed the lists to remove duplicate contact organizations and individuals. Tetra Tech and USGS then contacted a total of 143 organizations and individuals by telephone. Many contacts stated that their organizations had not in fact conducted water sampling in the Lake St. Clair watershed. Other organizations stated that they did not have data beyond any Tetra Tech, USGS, or MCHD had already obtained.

To promote consistency, Tetra Tech — with the assistance of USGS, MCHD, and MDEQ — developed a standard questionnaire for organizations that had collected water quality data that might be relevant to the Lake St. Clair Regional Water Quality Monitoring Project. The questionnaire was based on data entry forms developed by the Great Lakes Commission for the Environmental Monitoring Inventory described above. In addition to basic information about the organizations that were collecting data and their points of contact, the questionnaire included information on three criteria that could be used to qualitatively evaluate the data collected by each organization. These criteria included (1) available metadata, (2) comparability of water quality parameters and measurement methods, and (3) quality assurance (QA) and QC information.

Available metadata included parameters such as the duration of sampling, the number of sampling locations, whether the coordinates of the sampling locations were documented, and the data storage formats. The comparability criteria evaluated whether the parameters analyzed and the media sampled were comparable to the parameters and media currently being investigated under the project. The QA/QC criteria included whether (1) individuals who collected samples were volunteers or professionals, (2) a quality assurance project plan or similar document had been prepared and was available for review, and (3) the data were reviewed before they were reported.

The questionnaires that were completed are summarized in Table 2, and complete results of the historical data review are presented in Appendix A. Tetra Tech used the questionnaires to prioritize the potential usefulness of the data to the project, classifying the data sets in three categories: high priority, medium priority, and low priority. Each data set was reviewed by technical staff and then assigned a priority based on available metadata, comparability, and QA/QC information. Two data sets were identified as high priority, seven were identified as medium priority, and five were identified as low priority.

Five organizations provided Tetra Tech with electronic or hard copies of the data sets, and Tetra Tech transmitted the data to MCHD. The five data sets include one high-priority data set and two medium-priority data sets. Additional follow-up for the remaining medium-priority studies may provide sufficient information to classify them as high-priority studies.

TABLE 2: HISTORICAL DATA REVIEW RESULTS

Organization	Sampling Period	Data Available	Sampling Locations	Parameters, Methods	QA/QC
High Priority Data Sets					
Ontario Ministry of the Environment Aaron Todd	1964 to present	Yes, electronic*	23 stream sampling locations in the Sydenham River Watershed. Coordinates of sampling locations available.	Water temperature, pH, conductivity, dissolved oxygen, chloride, dissolved nutrients, trace metals, turbidity, alkalinity, major ions, total nutrients, and suspended solids	Samples collected by trained field technicians and water quality specialists. A QAPP was not prepared, but samples are submitted to laboratory with QA/QC protocols and data are reviewed by laboratory.
U.S. EPA STORET	Legacy, 1965-1998 Modernized, 1998-current	Yes, electronic	186 stations in Macomb County, along with equal numbers in surrounding counties.	<i>E. coli</i>	Samples collected by MDEQ and cataloged in STORET. A QAPP was prepared, and QA/QC protocols were followed.
Medium Priority Data Sets					
Macomb Count Public Works Office Fred Roskopp	2003 to present	Yes, electronic	200 county drain and outfall locations sampled, 200 more to complete. Coordinates of locations are available.	<i>E. coli</i> , temperature, surfactants, ammonia, appearance, and odor	Samples collected by county inspectors, and a QAPP was prepared and reviewed. Data are reviewed in house.
U.S. Army Corps of Engineers Pam Horner/John Bochenek	Early 1970s to present	Yes, hard copy and electronic	Thousands of sampling locations; coordinates of sampling locations are available.	PCBs, PNAs, and heavy metals in sediment and water	Samples collected by professionals, a QAPP was prepared and is available for review, and data were reviewed.
Oakland County Health Division Mark Hansell	Early 1970s to present	Yes, hard copy and electronic copy of data collected within the past 5 years	Sampling at three to eight lakes within the Clinton River Watershed. Exact locations may be available.	Coliform bacteria in early years. <i>E. coli</i> from the 1990s to present	Samples collected by trained interns, a QAPP was prepared, and data were reviewed in house.
Clinton River Watershed Council (CRWC) Heather Van Den Berg	1992 to present and 2003 to present	Yes, electronic.* Data from early years are available in hard copy.	Approximately 40 stream and river monitoring locations in the Clinton River watershed.	Width, depth, velocity, flow, erosion, physical cover, pH, DO, BOD, nitrates, phosphates, turbidity, temperature, coliform bacteria, and invertebrate diversity and abundance	Samples collected by CRWC-trained volunteers. A QAPP was prepared and reviewed by Michigan Department of Natural Resources (MDNR). Data reviewed by MDNR fisheries biologist.

TABLE 2 (CONTINUED): HISTORICAL DATA REVIEW RESULTS

Organization	Sampling Period	Data Available	Sampling Locations	Parameters, Methods	QA/QC
MDNR – Fisheries Division Jim Francis	1980s to present for fish data and 2 years of water data	Yes, some hard copy and some electronic	About 20 sampling locations in the Clinton River Watershed. Township, Section, and Range for locations available.	Temperature and conductivity Two sets of data—one for fish, and one for water temperature and conductivity data	Samples collected by volunteers and environmental professionals. A QAPP was not prepared. Data is reviewed in house.
St. Clair County Drain Commissioner Fred Foller	February to April 2004	Yes, hard copy	One-time sediment sampling at 10 locations within Bunce Creek. Coordinates not available.	VOCs, SVOCs, PNAs, PCBs, metals, lead, glycols, herbicides, and pesticides	A QAPP was not prepared. Samples collected by environmental professionals. The laboratory followed QA procedures.
Mill Creek Volunteer Monitoring Project Terry Gill	1999 to present	Yes, hard copy*	10 sampling locations within Mill Creek. Sampling locations available with data set.	Width, depth, temperature, sediment load, and benthic macro invertebrates	Samples collected by Michigan Department of Environmental Quality (MDEQ)-trained volunteers. A QAPP was prepared and was reviewed by MDEQ. MDEQ also reviews the data.
Low Priority Data Sets					
MSU Extension – Sanilac County Office Jim Kneebone	1993 to present	Yes, hard copy	Sampling coordinates and number of water sampling locations not available.	Nutrients, macro invertebrates, <i>E. coli</i>	QA/QC data not available. Status may change on further review by USGS.
MSU Extension – St. Clair County Office Liane Allen	2001 to 2003	Yes, hard copy and electronic data	Three water sampling locations in Pine River and Belle River; coordinates are not available.	pH, conductivity, temperature, nutrients, phosphorus, macro-invertebrates, and bacteria	A QAPP was not prepared. Samples collected by volunteers. Results not reviewed.
Michigan Department of Agriculture Groundwater Monitoring Program Robert Pigg	1989 to present	Yes, hard copy and electronic data*	66 groundwater sampling locations within the St. Clair basin. Latitude and longitude of sampling locations are available.	Pesticides and VOCs	A QAPP was prepared, and sampling results are reviewed by laboratory staff and supervisors. Data entry reviewed by groundwater monitoring program manager.
St. Clair County Health Department Kristin O'Reilly	May 2002 to present	Yes, electronic database	No information was provided.	<i>E. coli</i>	No information was provided.

TABLE 2 (CONTINUED): HISTORICAL DATA REVIEW RESULTS

Organization	Sampling Period	Data Available	Sampling Locations	Parameters, Methods	QA/QC
St. Clair Region Conservation Authority Muriel Andreae	2003 to present	Yes, electronic database*	8 sites in the Sydenham River were sampled. Sampling locations available with dataset.	<i>E. coli</i>	Sampling conducted by environmental professionals. A QAPP was not prepared for the sampling project. Sampling protocol was provided.

Notes:

* Indicates data were provided to Tetra Tech and submitted to MCHD. Internet addresses for these organizations are listed below.

- QAPP Quality assurance project plan
- QA/QC Quality assurance and quality control
- PCB Polychlorinated biphenyl
- PNA Polynuclear aromatic hydrocarbon
- DO Dissolved oxygen
- BOD Biochemical oxygen demand
- VOC Volatile organic compound
- SVOC Semivolatile organic compound

Internet Addresses:

- Ontario Ministry of the Environment: <http://www.ene.gov.on.ca/water.htm>
- U.S. EPA STORET: <http://www.epa.gov/storet/dbtop.html>
- Clinton River Watershed Council: <http://www.crwcc.org/>
- Mill Creek Volunteer Monitoring Project: <http://www.millcreekmonitoring.org/>
- Michigan Department of Agriculture: <http://www.michigan.gov/mda>
- St. Clair Region Conservation Authority: <http://www.scrca.on.ca/>

3.0 AUDITS

Tetra Tech conducted three field audits during the Lake St. Clair Regional Water Quality Monitoring Project. The field audits covered the three types of sampling events that accounted for most of the data collected during the project: nearshore sampling conducted by MCHD, dry weather sampling conducted by ECT, and wet weather sampling conducted by ECT. Section 3.1 describes Tetra Tech’s overall approach to the field audits and summarizes the scope, activities, and findings for each audit.

At the request of MDEQ, Tetra Tech also audited USGS’s procedures for collecting, reducing, and reporting continuous water quality monitoring data. MDEQ recognized that USGS follows “rigorous in-house QA/QC procedures,” but required an independent evaluation to verify that these procedures were being applied to data that would be included in the project database. Section 3.2 summarizes Tetra Tech’s audit of USGS’s data collection.

3.1 FIELD AUDITS

Tetra Tech conducted field audits to verify that samples were being collected in accordance with quality assurance project plans (QAPP) and standard operating procedures (SOP) and that data collection activities were completely and properly documented. As a preliminary activity for each field audit, Tetra Tech reviewed the final approved QAPPs and SOPs to develop a checklist of audit requirements from the sampling, monitoring, sample handling, and reporting procedures included in these documents (MCHD 2004, ECT 2004). Tetra Tech then used the checklists and audit requirements as the basis for conducting each field audit.

Tetra Tech worked with MCHD and ECT to schedule the audits. During the audits, Tetra Tech evaluated whether each audit requirement was met, using the following designations:

- Y Yes (activity was observed and procedures outlined in project documents were followed)
- Y* Yes (activity was not directly observed, but compliance is based on other objective evidence reviewed during the audit)
- N No (activity was observed, and procedures outlined in project documents were not followed)
- NA Not applicable (activity did not occur or could not be observed during audit, or compliance determination was not necessary)

Tetra Tech identified all audit requirements with “N” designations as findings, and then further reviewed the findings to identify those that could significantly affect the quality of the data being collected. Tetra Tech recommended a corrective action for each significant finding.

Table 3 summarizes the results of Tetra Tech’s field audits, showing the audit dates, activities audited, and significant findings. Appendix B includes the audit reports and checklists completed during the three field audits (MCHD nearshore surface water sampling, Appendix B-1; ECT dry weather manual sampling, Appendix B-2; and ECT wet weather automatic and manual sampling, Appendix B-3).

3.2 USGS DATA AUDIT

USGS installed in situ water quality monitoring equipment at 14 locations in the Lake St. Clair watershed, and data collected at these locations were to be included in the project database. At the end of each season, USGS analyzes all data collected and compiles a record of stream flow gauging and water quality monitoring for each location. Based on its internal QC procedures, USGS may delete suspect data from the final records. As requested by MDEQ, Tetra Tech and MCHD met with USGS in April 2005 to begin an external review of the 2004 USGS data. The following USGS procedures were discussed in detail during the meeting: procedures for operating, maintaining, and calibrating water quality monitoring instruments; internal QC procedures and reviews to ensure data quality; and procedures for summarizing raw data, including the criteria used to delete any raw data from annual summaries.

It was clear from the discussions that USGS has well-defined and documented procedures for collecting, reviewing, summarizing, and reporting water quality monitoring data (USGS 2005). Based on the documents and records presented and reviewed, USGS was also able to provide objective evidence that it follows these procedures when it compiles water quality records for each monitoring location.

At the conclusion of the meeting, Tetra Tech, MCHD, and USGS agreed that an extensive review of USGS's 2004 monitoring data would not be an efficient use of project resources. However, the participants also agreed on an alternative approach that would satisfy the overall objective of providing an independent QC check of the USGS water quality monitoring data:

- Tetra Tech would randomly select one of the 14 water quality monitoring locations
- USGS would provide field data sheets, hourly results, and data summaries for that location
- Tetra Tech would independently review the information to verify that USGS had corrected, summarized, and deleted data in accordance with its written procedures

The location Tetra Tech selected for review is identified under the Lake St. Clair Regional Water Quality Monitoring Project as "BL03, Black-Jeddo." USGS identifies this location as "04159492, Black River near Jeddo, MI." Tetra Tech's review is summarized below and is completely documented in Appendix B-4.

After the requested information had been received from USGS, Tetra Tech first reviewed the field forms to verify that instrument fouling and calibration drift corrections were calculated correctly. Next, Tetra Tech reviewed the printouts for the hourly results and verified that USGS had properly applied the corrections to the in-stream monitoring data. No corrections were needed for temperature data, and pH data were corrected only for two inspection intervals. Most specific conductance data were corrected, and all dissolved oxygen data were corrected, except for the data deleted as described below.

USGS procedures require that the data not be published when the overall correction that must be applied exceeds a defined maximum allowable limit (MAL). None of the corrections for temperature, specific conductance, or pH exceeded the MAL, and USGS has published all data for these parameters. However, the overall corrections for dissolved oxygen exceeded the MAL during five inspection intervals, requiring USGS to delete data for some days during these intervals. Tetra Tech verified the overall corrections and independently identified the days when

data for dissolved oxygen should have been deleted. The results agreed with the USGS data deletions.

As a final check on the USGS results, Tetra Tech verified that daily minimum, maximum, and mean or median results presented in the "Water-Quality Record Summary" were consistent with the hourly data. USGS collected data over a 120-day period, from June 3 through September 30, 2004. Tetra Tech randomly selected 12 days (10 percent of the total) for each parameter (temperature, pH, dissolved oxygen, and specific conductance) and verified the daily values; no discrepancies were noted.

Based on the April 2005 meeting with USGS and an independent review of in-stream water quality monitoring data for the BL03 (Black-Jeddo) location, Tetra Tech concluded that (1) USGS has well-defined procedures for collecting, reviewing, summarizing, and reporting these data, and (2) USGS maintains sufficient documentation for an independent observer to verify that these procedures have been followed. Tetra Tech concurred with the data that USGS deleted from the record for this location and recommended that MCHD concur as well. Tetra Tech also recommended that the 2004 USGS data be entered into the project database without any further correction.

Both MCHD and MDEQ accepted Tetra Tech's recommendations. In addition, MDEQ determined that a similar review of the 2005 USGS data would not be required because Tetra Tech's review of the 2004 USGS data identified no minor or significant concerns.

TABLE 3: FIELD AUDIT SUMMARY

Type of Sampling Event	Organization Audited (Representative)	Audit Date	Activities Observed	Key Findings and Recommendations
Near-shore surface water sampling	MCHD (Cole Shoemaker)	September 23, 2004	<ul style="list-style-type: none"> • Collection of surface water samples for analysis of <i>E. coli</i> • Field measurement of water quality parameters • Sample handling and chain of custody • Recordkeeping procedures 	<ul style="list-style-type: none"> • MCHD personnel were labeling only the caps of the sample containers with the sample number. This deviation from the QAPP could affect overall quality of the data collected. Samples could be incorrectly identified if the caps (which contain the sample number) become separated from the containers that hold the samples (which are not numbered). Tetra Tech recommended that MCHD follow the sample identification procedures in the QAPP and label sample containers, rather than container caps. • Tetra Tech did not observe any instrument calibrations, and MCHD confirmed that field measurement equipment is calibrated quarterly. If there is a significant drift in the instrument reading from one calibration to the next, the accuracy of field measurements taken between the two calibrations could be questionable. Tetra Tech recommended that MCHD increase the calibration frequency, and MCHD implemented this recommendation during the 2005 sampling season.
Dry weather manual sampling	ECT (Annette DeMaria)	October 13, 2004	<ul style="list-style-type: none"> • Collection of surface water samples for analysis of <i>E. coli</i> and various chemical parameters • Decontamination of sampling equipment • Field measurement of water quality parameters and calibration of associated instruments • Measurement of stream velocity • Sample handling and chain of custody • Recordkeeping procedures 	<ul style="list-style-type: none"> • Dechlorination tablets were added to samples collected for analysis of <i>E. coli</i>. Tablets may be appropriate for treated potable water samples that contain residual chlorine, but it is unlikely that residual chlorine is present in natural surface water samples in significant concentrations. As a result of this finding, ECT modified <i>E. coli</i> sampling procedures to eliminate the use of dechlorination tablets. • The sample numbering system observed during the audit was different from the system described in the QAPP, and it was not clear that the system could uniquely identify the date and time of each sample. Tetra Tech subsequently verified that ECT was correctly and completely identifying all samples. • ECT calibrated field instruments before measurements were taken, but did not recalibrate the instruments after measurements were completed, as required by the dry weather sampling SOP. As a result of the audit, ECT conducted post-measurement calibrations during subsequent sampling events.
Wet weather automatic and manual sampling	ECT (Annette DeMaria and April Olssztyl)	July 26, 2005	<ul style="list-style-type: none"> • Pre-event activities, such as instrument maintenance • Collection of manual grab samples of surface water • Calibration and operation of autosamplers • Sample handling and chain of custody • Recordkeeping procedures 	<ul style="list-style-type: none"> • During the churn splitting operation, ECT deviated from some of the procedures outlined in the Sample Compositing and Splitting SOP. Specifically, ECT (1) did not shake the autosampler composite bottle before pouring the sample into the churn splitter; (2) did not churn the sample at a uniform rate of about 9 inches per second; (3) allowed the churn splitter to break the surface of the water; and (4) did not reestablish the churning rate with 10 strokes between samples.

4.0 DATA VALIDATION AND DATA REVIEW

Tetra Tech completed data validation or data reviews of all monitoring data and sampling results collected by MCHD and ECT during the Lake St. Clair Regional Water Quality Monitoring Study. The purpose of these QC activities was to verify that data have been collected in accordance with approved QAPPs and SOPs, required field QC checks have been completed, QC samples have been collected and analyzed, and results meet project acceptance criteria for sample reporting limits, precision, and accuracy. Tetra Tech conducted data validation — a more extensive QC check — on a subset of the project data that represented the full range of sample types (surface water and sediment) and analytical parameters. Tetra Tech conducted a complete, but less intensive, data review for most project data. Sections 4.1 and 4.2 describe the data validation and data review.

4.1 DATA VALIDATION

MCHD's original scope of work for data coordination and QC services did not require inspections of chromatograms, mass spectra, and other raw data that would normally be reviewed as part of laboratory data validation. However, Tetra Tech proposed in its work plan that full data validation be conducted on some laboratory data packages early in the project to help identify any significant laboratory quality issues that, if not discovered, could compromise the project's overall data quality objectives. Consequently, Tetra Tech conducted a more thorough data validation of the following laboratory data packages:

- A laboratory data package prepared by RTI for 16 sediment samples collected by MCHD on July 27, 2004. The samples were analyzed for polynuclear aromatic hydrocarbons (PAH), diesel range organics (DRO), polychlorinated biphenyls (PCB), chlorinated pesticides, metals, total petroleum hydrocarbons (TPH), total organic carbon (TOC), ammonia, total Kjeldahl nitrogen (TKN), total phosphorus, and chemical oxygen demand (COD)
- A laboratory data package prepared by RTI for 13 water samples collected by ECT during dry weather event #1 on September 16 and 17, 2004. The samples were analyzed for *E. coli*, total suspended solids (TSS), total dissolved solids (TDS), chloride, nitrate, biochemical oxygen demand (BOD), ammonia, TKN, TOC, total phosphorus, COD, aluminum, hardness, oil and grease, and ortho-phosphate
- A laboratory data package prepared by Paragon for six water samples collected by ECT during dry weather event #18 on October 13 and 14, 2005. The samples were analyzed for *E. coli*, TSS, TDS, chloride, nitrate, BOD, ammonia, TKN, TOC, total phosphorus, COD, aluminum, hardness, oil and grease, and ortho-phosphate

Tetra Tech was unable to complete data validation of analyses conducted by Trace during the 2005 sampling season. Although Tetra Tech requested a complete laboratory data package from Trace, Trace did not provide this information. However, as described in Section 4.2, all laboratory data produced by Trace went through a complete, but less intensive, data review.

Tetra Tech followed standard data validation procedures developed by the U.S. Environmental Protection Agency's (EPA) Contract Laboratory Program (CLP) (EPA 1999, 2004). Data validation for organic parameters included a review of the following QC parameters: holding times, instrument performance checks, initial and continuing calibrations, blank results, surrogate recovery results, matrix spike and matrix spike duplicate (MS/MSD) results, laboratory

control sample (LCS) results, internal standard response, and target compound identification and quantitation. Data validation for inorganic parameters includes a review of the following QC parameters: holding times, initial and continuing calibrations, blank results, results for inductively coupled plasma interference check samples, LCS results, duplicate sample results, MS/MSD results, and sample result quantitation. Tetra Tech documented data validation results using a standard reporting format that addressed these items; completed data validation reports are included in Appendix C.

Key findings of the data validation conducted by Tetra Tech include the following:

- Several analytical methods used by RTI and Paragon differed from the methods listed in the MCHD and ECT QAPPs (MCHD 2004, ECT 2004). For example, RTI used U.S. EPA Water Method 350.2 for analysis of ammonia, while the QAPPs specified Method 350.1. Tetra Tech reviewed all such deviations and concluded that the alternative methods used by both laboratories are appropriate and likely to produce acceptable results.
- The raw data reflect good laboratory practices, including use of checklists and forms to minimize errors and omissions and occasional re-analysis when problems occurred.
- Observed problems were minor irregularities that are common in laboratory analysis of environmental samples (for example, a matrix spike recovery that exceeded laboratory control limits). Tetra Tech qualified such results as “estimated” when required by the CLP data validation guidelines.
- The types of problems observed during data validation of the full laboratory data packages would have been apparent during the more limited data reviews that were conducted for most analytical results.
- Overall, the analytical data generated by laboratories that participated in the project were acceptable for use either as reported or with the data qualifiers Tetra Tech added.

4.2 DATA REVIEWS

Tetra Tech conducted more limited data reviews for most surface water and sediment sampling and monitoring data collected during the Lake St. Clair Regional Water Quality Monitoring Project. Tetra Tech first developed data review checklists for each analytical parameter and sample matrix (surface water and sediment) included in the project to complete these reviews. The checklists were based on the following:

- Requirements for method detection limits, precision, and accuracy of laboratory analytical data listed in the MCHD and ECT QAPPs (MCHD 2004, ECT 2004)
- QA/QC requirements and procedures included in the analytical methods specified for the project

The checklists allowed Tetra Tech’s data reviewers to verify that the laboratories used appropriate analytical methods, analyzed samples within holding times, met detection limits, calibrated analytical instruments correctly, ran appropriate blank samples that were free of contamination, and analyzed laboratory QC samples (such as surrogate spikes, MS/MSD samples, and laboratory control samples), with QC sample results within control limits.

Next, Tetra Tech worked with the analytical laboratories (through MCHD and ECT) that analyzed project samples to ensure that the summary data packages developed by each laboratory included sufficient QC data for Tetra Tech to complete all items on each checklist. This step involved review of electronic data deliverables (EDD) prepared by the laboratories and identification of missing information, such as calibration results or duplicate sample results.

Once the project began, preliminary data from the analytical laboratories were submitted to Altarum, the database contractor, for entry into the project database. Altarum then provided Tetra Tech with spreadsheets for each EDD that contained the preliminary data and the laboratory provided separate spreadsheets with associated QC data. Tetra Tech assigned a primary chemist to review each EDD and complete the data review checklists. A second Tetra Tech chemist also reviewed the EDD and completed checklist as an internal QC measure. Once both reviewers concurred on the data review results, they signed the completed checklist. Tetra Tech then entered any QC flags onto the spreadsheet, along with comments that explained the flags. For example, sample results for a specific parameter may have been flagged as estimated based on low surrogate spike recovery. Finally, Tetra Tech returned the spreadsheet, now updated with QC information, to Altarum so that the data could be uploaded to the project database in final form.

Tetra Tech conducted data reviews for field measurements in a similar manner. However, associated QC data for field measurements were obtained from ECT and MCHD in the form of logbook pages or field data forms.

The checklists completed by Tetra Tech identify all results that were flagged during data review and describe the reasons for the QC flags that were attached. The data reviews did not reveal any systematic or significant problems with the data produced by any of the laboratories participating in the project, including Trace (as noted in Section 4.1, Trace did not provide a complete laboratory package for full data validation).

Over the duration of the project, Tetra Tech completed over 300 checklists to document these data reviews. Appendix D includes copies of each checklist. Checklists for data generated from samples collected by ECT are included in Appendices D-1 (dry weather sampling) and D-2 (wet weather sampling). Checklists for data generated from samples collected by MCHD are included in Appendices D-3 (2004 sampling events) and D-4 (2005 sampling events).

5.0 RECOMMENDATIONS

Tetra Tech believes that the QC approach used on the Lake St. Clair Regional Water Quality Monitoring Study was effective and conserved project resources. This approach would be recommended as appropriate for similar studies that MCHD or other organizations may conduct in the future. Field audits verified that data collecting organizations were following approved plans for nearly all activities, but also identified potential data collection problems. Identifying these problems early in the project improved the quality of subsequent data. For example, problems with the frequency of field instrument calibration that were noted during 2004 field audits were corrected and resulted in improved calibration procedures and better field measurement quality for 2005.

The approach to reviewing laboratory data was also effective. By conducting full data validation of sample data packages, Tetra Tech was able to determine that the laboratories were able to analyze sample matrices and parameters without any significant or systematic problems. In addition, the streamlined data review conducted for most data was able to identify the types of problems noted during full data validation. Although some sample results were qualified as estimated based on these reviews, almost no data were rejected as unusable.

The area that was most problematic for Tetra Tech was the overall data management during the project. The data validation and data review approach described above works effectively if full data validation is done on results for samples collected early in a sampling season. In that way, any systematic or significant problems that are identified can be corrected before most of the samples have been collected and analyzed. For the 2005 sampling season, Tetra Tech was unable to obtain data packages until after all samples had been collected. Fortunately, no significant laboratory problems were identified during data validation of Paragon's results or during data review of Trace's results.

In addition, data need to be reviewed in a timely manner as the project proceeds. Tetra Tech received more than 100 EDDs from the 2005 sampling season after December 20, and many of these EDDs were for samples that had been collected several months earlier. Furthermore, EDDs were often not accompanied by the associated QC data or the chain-of-custody forms for the samples. One possible contributing factor to this problem was the decision to enter preliminary data into the project database before the data reviews were conducted. Tetra Tech recommends either revising this procedure for future studies or modifying the procedure so that there is no more than a 1-month interval between data collection and data review.

6.0 REFERENCES

- Environmental Consulting & Technology, Inc. 2004. "Water Quality Sampling and Analysis Quality Assurance Project Plan, Lake St. Clair Regional Monitoring Project." Prepared for Macomb County Health Department. August.
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APPENDIX A
HISTORICAL WATER QUALITY DATA REPORT

Note: All appendices are included on a compact disk inside the back cover of this report.

APPENDIX B
AUDIT REPORTS

B-1: MCHD NEARSHORE SURFACE WATER SAMPLING AUDIT

B-2: ECT DRY WEATHER MANUAL SAMPLING AUDIT

B-3: ECT WET WEATHER AUTOMATIC AND MANUAL SAMPLING AUDIT

B-4: USGS DATA AUDIT

Note: All appendices are included on a compact disk inside the back cover of this report.

APPENDIX C
DATA VALIDATION REPORTS

Note: All appendices are included on a compact disk inside the back cover of this report.

APPENDIX D

DATA REVIEW CHECKLISTS

D-1: ECT DRY WEATHER SAMPLING CHECKLISTS

D-2: ECT WET WEATHER SAMPLING CHECKLISTS

D-3: MCHD 2004 SAMPLING CHECKLISTS

D-4: MCHD 2005 SAMPLING CHECKLISTS

Note: All appendices are included on a compact disk inside the back cover of this report.