Orange County TMDL Project
Quality Assurance Project Plan
DRAFT for Revision

PARSONS
8000 Centre Park Drive, Suite 200
Austin, TX 78754

and

Sabine River Authority of Texas
12777 Hwy 87 N
Orange, Texas 77631-0579

Total Maximum Daily Load Program
Strategic Assessment Division
Texas Commission on Environmental Quality
P.O. Box 13087, MC - 150
Austin, Texas 78711-3087

Effective Period: July 2003 through August 2004

Questions concerning this quality assurance project plan should be directed to:

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A1 Approval Page
Orange County TMDL Project

Texas Commission on Environmental Quality
Office of Environmental Policy, Analysis, and Assessment
Strategic Assessment Division

Candy Garrett, Director Date
Strategic Assessment Division

Faith Hambleton, Program/Grant Manager Date
Total Maximum Daily Load Program

Ward Ling, Project Manager Date
Total Maximum Daily Load Program

Office of Compliance and Enforcement
Compliance Support Division

Jose A. Franco, Director Date
Compliance Support Division

Stephen Stubbs, Manager Date
Quality Assurance Program

Sharon Coleman, QA Specialist Date
Quality Assurance Program

Monitoring Operations Division

Dr. David W. Sullivan, Manager Date
Monitoring Data Management and Analysis Section

PARSONS

Dr. Kirk E. Dean Date Project Manager	Sandra de las Fuentes Date Quality Assurance Manager

Note: The Parsons Quality Assurance Officer will secure written documentation (such as the letter in Appendix G) from each sub-tier project participant (e.g., subcontractors, other units of government, laboratories) stating the organization's awareness of and commitment to requirements contained in this quality assurance project plan and any amendments or revisions of this plan. The Parsons Quality Assurance manager will maintain the documentation as part of the project's quality assurance records, and will ensure that the document is available for review. **Copies will also be submitted as deliverables to the TCEQ Project Manager within 60 days of QAPP approval.**

Sabine River Authority of Texas

Miles Hall Date Project Manager	Mary Vann, Manager Date Environmental Services Division
Debra Malus Date Laboratory Manager	Leigh-ann Arena Date Laboratory Quality Assurance Officer

U.S. Environmental Protection Agency, Region 6

Joan Brown, Chief Date Assistance Programs Branch	Sylvia Ritzky, Project Officer Date State and Tribal Programs Section

A2 Table of Contents

A3 Distribution List

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Austin, Texas 78711-3087

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Office of Compliance and Enforcement

Compliance Support Division

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List of Acronyms and Abbreviations

AWRL	Ambient Water Reporting Limit
ADCP	Acoustic Doppler Current Profiler
ASAP	As Soon As Possible
°C	Degrees Celsius
$cBOD_5$	Carbonaceous Biochemical Oxygen Demand
CD-ROM	Compact Disc – Read Only Memory
CFR	Code of Federal Regulations
CFS	Cubic Feet Per Second
CFU	Colony-Forming Unit
CM	Centimeters
COC	Chain of Custody
DO	Dissolved Oxygen
EPA	United States Environmental Protection Agency
FOD	TCEQ Field Operations Division
H_2SO_4	Sulfuric Acid
HR	Hours
ID	Identification
LCS	Laboratory Control Standard
LCSD	Laboratory Control Standard Duplicate
MG/L	Milligrams per liter
MGD	Million Gallons per Day
ML	Milliliters
MM	Millimeters
MPN	Most Probable Number
MS	Matrix Spike
NA	Not Applicable
PES	Performance Evaluation Samples
PPT	Parts per thousand
QA	Quality Assurance
QAM	Quality Assurance Manual
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QAS	Quality Assurance Specialist
QC	Quality Control
QMP	Quality Management Plan
%R	Percent Recovery
RFP	Request for Proposals
RPD	Relative Percent Deviation

SM	Standard Methods for the Examination of Water and Wastewater
SOD	Sediment Oxygen Demand
SOP	Standard Operating Procedure
SRA	Sabine River Authority (of Texas)
SWQM	Surface Water Quality Monitoring
TMDL	Total Maximum Daily Load
TCEQ	Texas Commission on Environmental Quality
TPWD	Texas Parks and Wildlife Department
TRACS	Texas Regulatory and Compliance System
TSS	Total Suspended Solids
TSWQS	Texas Surface Water Quality Standards
$uBOD_{20}$	Ultimate Biochemical Oxygen Demand – 20 day
µG/L	Micrograms per liter
USGS	United States Geological Survey
VS	Volatile Solids
VSS	Volatile Suspended Solids

A4 Project/Task Organization

U.S. EPA Region 6

Sylvia Ritzky
EPA Project Officer
Responsible for managing the project for EPA. Reviews project progress and reviews and approves QAPP.

TCEQ Strategic Assessment Division

Faith Hambleton
TCEQ TMDL Program Manager
Responsible for managing the TCEQ TMDL Program. Oversees the development of QA guidance for the TMDL Team to be sure it is within pertinent frameworks of the TCEQ. Reviews and approves all TMDL Projects, QA audits, QAPPs, agency QMP, corrective actions, reports, work plans, and contracts. Enforces corrective action, as required, where QA protocols are not met. Ensures that all TCEQ TMDL personnel are fully trained, and TMDL projects are adequately staffed.

Ward Ling
TCEQ TMDL Project Manager
Responsible for ensuring that the project delivers data of known quality, quantity, and type on schedule to achieve project objectives. Provides the primary point of contact between Parsons, the Sabine River Authority (SRA), and the TCEQ. Tracks and reviews deliverables to ensure that tasks in the work plan are completed as specified in the contract. Reviews and approves QAPP and any amendments or revisions and ensures distribution of approved/revised QAPPs to TCEQ participants. Responsible for verifying that the QAPP is followed by Parsons and the SRA. Notifies the TCEQ QAS and TMDL Program Manager of significant project nonconformances and corrective actions taken as documented in quarterly progress reports from the Parsons and SRA Project Managers.

Kerry Niemann
TMDL Data Manager
Tracks and verifies data generated by TMDL projects. Responsible for receiving data (Event/Results Files) from TMDL Project Managers, converting the electronic files into Paradox tables, fixing storets, dates, and times and running a Paradox Tools Program that identifies invalid stations, invalid storets, outliers, and orphans. Corresponds deficiencies in data summary form to the TMDL Project Manager to ensure that data deficiencies are addressed by Parsons and the SRA. Provides quality assured data sets to TCEQ Information Resources in compatible formats to be uploaded into the SWQM portion of TRACS. Coordinates correction of data errors with TMDL Project Manager and TCEQ Information Resources Staff.

TCEQ Compliance Support Division

Sharon Coleman
TMDL Quality Assurance Specialist
Assists the TCEQ TMDL Project Manager on QA-related issues. Reviews and approves the QAPP and any amendments or revisions. Conveys QA problems to appropriate TCEQ management. Monitors implementation of corrective actions. May coordinate or conduct audits.

TCEQ Monitoring Operations Division

Monitoring Data Management and Analysis Data Manager
Reviews QAPP for valid stream monitoring stations, checks validity of parameter, program and source codes, and ensures that data will be reported following the *Surface Water Quality Monitoring Data Management Reference Guide, 2003* procedures or most current version. Surveys the TRACS database to monitor submittal of scheduled sampling data and provides data completeness reports to Project Managers on a quarterly basis. Analyzes TRACS database to identify level 1 data validation inconsistencies and report to appropriate Project Managers. Serves as Monitoring Operations data management customer service representative for TMDL Project Manager. Provides training to the TMDL Project Manager to ensure proper data submittal. Reviews and approves QAPPs.

TCEQ Field Operations Division

Name
TCEQ Regional Office TMDL Liaison
Assists in the development of the project's water quality monitoring plan as appropriate. Ensures that the water quality monitoring plan in Appendix B adequately represents the local water quality conditions that may account for the observed impairment by corresponding with respective FOD Regional Field Staff. Works with the TMDL Project Manager to resolve problems with water quality monitoring. Maintains contact with TCEQ Project Manager to ensure coordination of issues.

Sabine River Authority

Miles Hall
SRA Project Manager
The SRA Project Manager is responsible for ensuring that tasks and other requirements in the contract are executed on time and with the quality assurance/ quality control requirements in the system as defined by the contract and in the project QAPP; assessing the quality of subcontractor/participant work; submitting accurate and timely deliverables to the TCEQ TMDL Project Manager; and coordinating attendance at conference calls, training, meetings, and related project activities with the TCEQ. Responsible for verifying that the QAPP is distributed and followed by the SRA (including all subcontractors) and that the project is producing data of known and acceptable quality. Responsible for ensuring adequate training and supervision of all activities involved in generating analytical and field data, including the facilitation of audits and the implementation, documentation, verification and reporting of corrective actions.

Debra Malus
SRA Laboratory Manager
Responsible for supervision of laboratory personnel involved in generating analytical data for the project. Responsible for ensuring that laboratory personnel involved in generating analytical data have adequate training and a thorough knowledge of the QAPP and all SOPs specific to the analyses or task performed and/or supervised. Responsible for oversight of all laboratory operations ensuring that all QA/QC requirements are met, documentation related to the analysis is complete and adequately maintained, and that results are reported accurately. Responsible for ensuring that corrective actions are implemented, documented, reported and verified.

Leigh Ann Arena
SRA Laboratory Quality Assurance Officer
Monitors the implementation of the QAM/QAPP within the laboratory to ensure complete compliance with QA data quality objectives as defined by the contract and in the QAPP. Conducts in-house audits to ensure compliance with written SOPs and to identify potential problems. Responsible for supervising and verifying all aspects of the QA/QC in the laboratory. Performs validation and verification of data before the report is sent to the primary contractor. Ensures that all QA reviews are conducted in a timely manner from real-time review at the bench during analysis to final pass-off of data to the Parsons QA Manager.

PARSONS

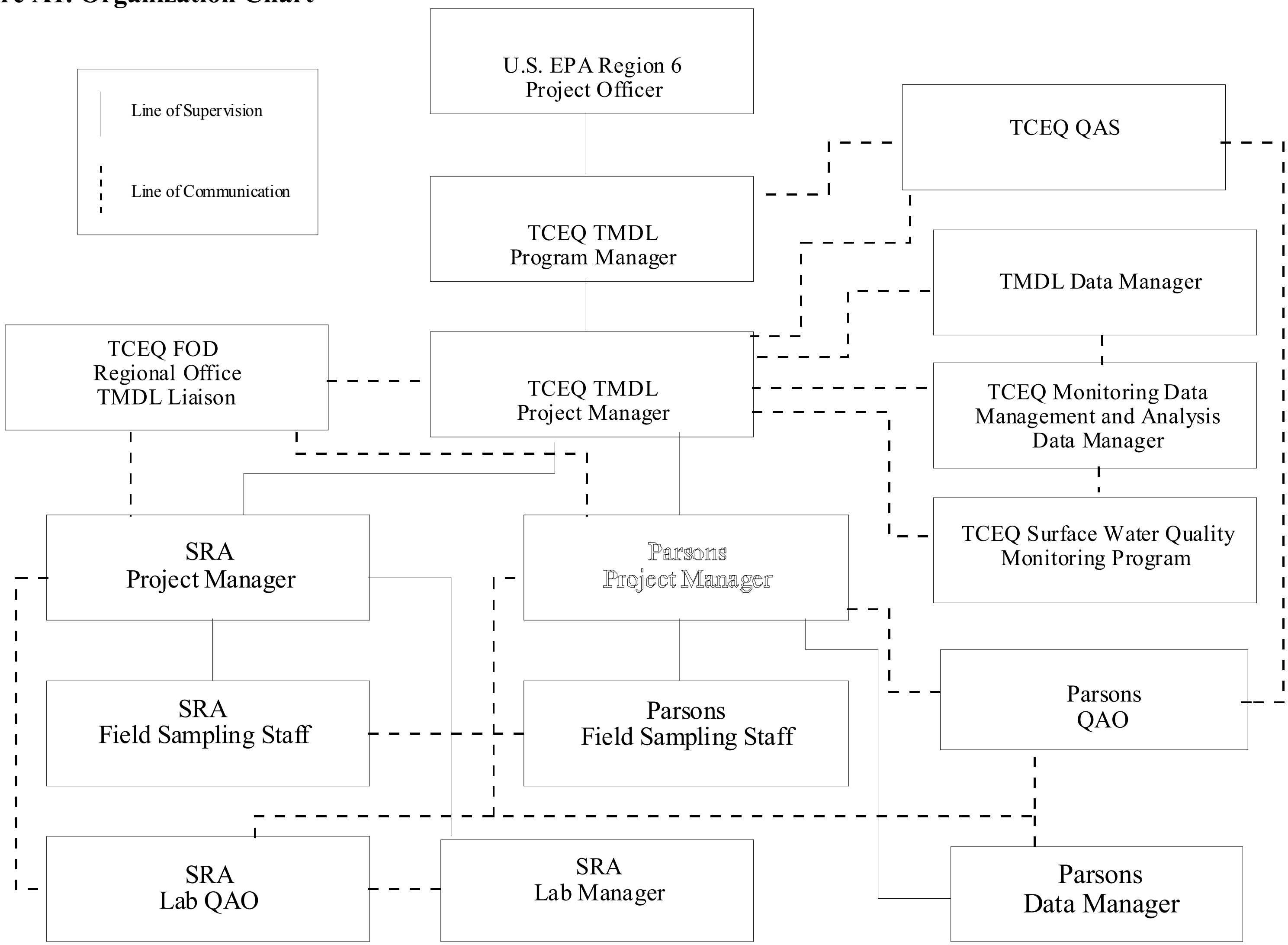
Kirk Dean
Project Manager
The Parsons Project Manager is responsible for ensuring that tasks and other requirements in the contract are executed on time and with the quality assurance/ quality control requirements in the system as defined by the contract and in the project QAPP; assessing the quality of subcontractor/participant work; submitting accurate and timely deliverables to the TCEQ TMDL Project Manager; and coordinating attendance at conference calls, training, meetings, and related project activities with the TCEQ. Responsible for verifying that the QAPP is distributed and followed by Parsons (including all subcontractors) and that the project is producing data of known and acceptable quality. Responsible for ensuring adequate training and supervision of all activities involved in generating analytical and field data, including the facilitation of audits and the implementation, documentation, verification and reporting of corrective actions.

Sandra de las Fuentes
Quality Assurance Officer
Responsible for coordinating development and implementation of the Parsons QA program. Responsible for writing and maintaining QAPPs and monitoring its implementation. Responsible for maintaining records of QAPP distribution, including appendices and amendments. Ensures the data collected for the project is of known and acceptable quality and adheres to the specifications of the QAPP. Responsible for maintaining written records of sub-tier commitment to requirements specified in this QAPP. Responsible for identifying, receiving, and maintaining project quality assurance records. Responsible for compiling and submitting the QA report. Responsible for coordinating with the TCEQ QAS to resolve QA-related issues.

Notifies the Parsons Project Manager and TCEQ Project Manager of particular circumstances which may adversely affect the quality of data. Coordinates the research and review of technical QA material and data related to water quality monitoring system design and analytical techniques. Conducts assessments of participating organizations during the life of the project as noted in Section C1. Implements or ensures implementation of corrective actions needed to resolve nonconformances noted during assessments.

Andrew Hands
Data Manager
Responsible for the acquisition, verification, and transfer of data to the TCEQ TMDL Project Manager. Oversees data management for the project. Performs data quality assurances prior to transfer of data to TCEQ in the acceptable format. Ensures that the data review checklist is completed and data is submitted with appropriate codes. Provides the point of contact for the TCEQ TMDL Project Manager to resolve issues related to the data and assumes responsibility for the correction of any data errors.

Figure A1. Organization Chart



A5 PROBLEM DEFINITION/BACKGROUND

The purpose of this QAPP is to clearly delineate QA policies, management structure, and procedures which will be used to implement the QA requirements necessary to document the reliability and validity of environmental data.

The particular problem to be addressed under this QAPP is described in the project description section of the Parsons work plan in Appendix A.

A6 PROJECT/TASK DESCRIPTION

The work for this project will be shared by Parsons and the SRA, under separate contracts with the TCEQ. The work to be performed and products to be produced by each entity, and the schedule for these activities, are described in the work plans of Parsons and the SRA in of Appendix A. Maps of the monitoring sites and a monitoring table listing sites, parameters, and monitoring dates are provided in Appendix B.

Revisions to the QAPP

Until the work described is completed, this QAPP shall be revised as necessary and reissued annually on the anniversary date, or revised and reissued within 120 days of significant changes, whichever is sooner. The last approved versions of QAPPs shall remain in effect until revised versions have been fully approved; the revision must be submitted to the TCEQ for approval before the last approved version has expired. If the entire QAPP is current, valid, and accurately reflects the project goals and the organization's policy, the annual re-issuance may be done by a certification that the plan is current. This can be accomplished by submitting a cover letter stating the status of the QAPP and a copy of new, signed approval pages for the QAPP.

Expedited Changes

Expedited changes to the QAPP may be necessary to reflect changes in project organization, tasks, schedules, objectives and methods; address deficiencies and nonconformances; improve operational efficiency; and/or accommodate unique or unanticipated circumstances. Requests for expedited changes are directed from the Parsons or SRA Project Manager to the TCEQ Project Manager in writing. The changes are effective immediately upon approval by the TCEQ Project Manager and Quality Assurance Specialist, or their designees. Expedited changes to the QAPP and the reasons for the changes will be documented, and revised pages will be forwarded to all persons on the QAPP distribution list by the Parsons QAO.

Expedited changes shall be reviewed, approved, and incorporated into a revised QAPP during the annual revision process or within 120 days of the initial approval in cases of significant changes.

A7 QUALITY OBJECTIVES AND CRITERIA

The project objective is to collect data that complies with TCEQ rules for surface water quality monitoring programs, which may be used to support decisions related to TMDL development, stream standards modifications, permit decisions, and water quality assessments. In particular, the goal of this effort is to provide sufficient data for the calibration and verification of a water quality model to support development of total maximum daily loads (TMDLs) for *E. coli* bacteria and dissolved oxygen in Adams Bayou and its tributaries Gum Gully and Hudson Gully, and for a second water quality model to support development of TMDLs for *E. coli* bacteria, dissolved oxygen, and pH in Cow Bayou and its tributaries, Coon Bayou, Cole Creek, and Terry Gully.

The measurement performance specifications to support the project objective are specified in Table A.1.

The QAPP is reviewed by the TCEQ to help ensure that data generated for the purposes described herein are scientifically valid and legally defensible. This review process will also help ensure that data submitted to the SWQM portion of the TRACS database have been collected and analyzed in a way that guarantees its reliability and can be used for such activities as TMDL development, stream standards modifications, permit decisions, pollutant source identification, water quality assessments, etc.

Table A.1 - Data Quality Objectives for Measurement Data

PARAMETER	UNITS	METHOD	METHOD DESCRIPTION	STORET CODE	AWRL	PRECISION of laboratory duplicates (RPD)	ACCURACY of matrix spikes % Recovery	AWRL Calibrating Standard % Recovery	Performing Laboratory
Field Parameters									
DO 24 hr. # measurements	# meas.	TCEQ SOP	Multiprobe	89858	NA	NA	NA	NA	Field
DO 24 hr avg.	mg/l	TCEQ SOP	Multiprobe	89857	NA	NA	NA	NA	Field
DO 24 hr max.	mg/l	TCEQ SOP	Multiprobe	89856	NA	NA	NA	NA	Field
DO 24 hr min.	mg/l	TCEQ SOP	Multiprobe	89855	NA	NA	NA	NA	Field
pH daily max.	pH units	TCEQ SOP	Multiprobe	00215	NA	NA	NA	NA	Field
pH daily min.	pH units	TCEQ SOP	Multiprobe	00216	NA	NA	NA	NA	Field
pH 24 hr # measurements	# meas.	TCEQ SOP	Multiprobe	00223	NA	NA	NA	NA	Field
Salinity 24 hr avg.	ppt	TCEQ SOP	Multiprobe	00218	NA	NA	NA	NA	Field
Salinity 24 hr min.	ppt	TCEQ SOP	Multiprobe	00219	NA	NA	NA	NA	Field
Salinity 24 hr max.	ppt	TCEQ SOP	Multiprobe	00217	NA	NA	NA	NA	Field
Salinity 24 hr # measurements	# meas.	TCEQ SOP	Multiprobe	00220	NA	NA	NA	NA	Field
Spec. Cond. 24 hr avg.	umhos/cm	TCEQ SOP	Multiprobe	00212	NA	NA	NA	NA	Field
Spec. Cond. 24 hr max.	umhos/cm	TCEQ SOP	Multiprobe	00213	NA	NA	NA	NA	Field
Spec. Cond. 24 hr min.	umhos/cm	TCEQ SOP	Multiprobe	00214	NA	NA	NA	NA	Field
Spec. Cond. 24 hr # measurements	# meas.	TCEQ SOP	Multiprobe	00222	NA	NA	NA	NA	Field
Water Temp. 24 hr avg.	°C	TCEQ SOP	Multiprobe	00209	NA	NA	NA	NA	Field
Water Temp. 24 hr min	°C	TCEQ SOP	Multiprobe	00211	NA	NA	NA	NA	Field
Water Temp. 24 hr max.	°C	TCEQ SOP	Multiprobe	00210	NA	NA	NA	NA	Field
Water Temp. 24 hr # measurements	# meas.	TCEQ SOP	Multiprobe	00221	NA	NA	NA	NA	Field
pH	pH units	EPA 150.1and TCEQ SOP	Multiprobe	00400	NA	NA	NA	NA	Field
DO	mg/L	EPA 360.1and TCEQ SOP	Multiprobe	00300	NA	NA	NA	NA	Field
Conductivity	umhos/cm	EPA 120.1and TCEQ SOP	Multiprobe	00094	NA	NA	NA	NA	Field
Salinity	ppt	SM2520B and TCEQ SOP	Multiprobe	00480	NA	NA	NA	NA	Field

PARAMETER	UNITS	METHOD	METHOD DESCRIPTION	STORET CODE	AWRL	PRECISION of laboratory duplicates (RPD)	ACCURACY of matrix spikes % Recovery	AWRL Calibrating Standard % Recovery	Performing Laboratory
Temperature, water	°C	EPA 170.1and TCEQ SOP	Multiprobe	00010	NA	NA	NA	NA	Field
Secchi Depth	meters	TCEQ SOP		00078	NA	NA	NA	NA	Field
Weather	1-clear, 2-pt cloudy, 3-cloudy, 4-rain	Field Observation		89966	NA	NA	NA	NA	Field
Days since last significant rainfall	days	TCEQ SOP		72053	NA	NA	NA	NA	Field
Wind Intensity	1-calm, 2-slight 3-moderate, 4-strong	Field Observation		89965	NA	NA	NA	NA	Field
Wind Direction	1-north, 2-south 3-east, 4-west 5-northeast 6-southeast 7-northwest 8-southwest	Field Observation		89010	NA	NA	NA	NA	Field
Total water depth, at sampling site	meters	TCEQ SOP		82903	NA	NA	NA	NA	Field
Stream Depth, average	feet	TCEQ SOP		00064	NA	NA	NA	NA	Field
Stream Width	feet	TCEQ SOP		00004	NA	NA	NA	NA	Field
Sediment oxygen demand, in situ, total	grams O_2/m^2-day	See Appendix H	See Appendix H	00390	NA	NA	NA	NA	Field
Flow	cfs	Acoustic Doppler or TCEQ SOP	Sontek XR and ADCP or equivalent	00061	NA	NA	NA	NA	Field
Flow, effluent	mgd	TCEQ SOP		50051	NA	NA	NA	NA	Field
Flow estimate	cfs	TCEQ SOP		74069	NA	NA	NA	NA	Field
Flow measurement method	1-gage 2-electric 3-mechanical 4-weir/flume			89835	NA	NA	NA	NA	Field
Flow Severity	1-no flow, 2-low, 3-normal, 4-flood, 5-high, 6-dry	TCEQ SOP		01351	NA	NA	NA	NA	Field
Conventional Parameters									
Alkalinity, total	mg/l as CaCO3	EPA 310.1	titrimetric	00410	10.0	20	80-120	NA	SRA Lab

PARAMETER	UNITS	METHOD	METHOD DESCRIPTION	STORET CODE	AWRL	PRECISION of laboratory duplicates (RPD)	ACCURACY of matrix spikes % Recovery	AWRL Calibrating Standard % Recovery	Performing Laboratory
Total suspended solids	mg/L	EPA 160.2	gravimetric	00530	4.0	0-10 mg/L: 30 10-100 mg/L: 20 >100 mg/L: 10	NA	NA	SRA Lab
Volatile suspended solids	mg/L	EPA 160.4	gravimetric	00535	4.0	0-10 mg/L: 50 10-100 mg/L: 25 >100 mg/L: 10	NA	NA	SRA Lab
E. coli	MPN/100 ml	SM 9223 B	IDEXX Colilert	31699	1	1**	NA	NA	SRA Lab
Ammonia nitrogen	mg/L	EPA 350.1	colorimetric	00610	0.02	20	80-120	75-125	SRA Lab or subcontract lab
Ortho-phosphorus	mg/L	EPA 300.1	ion chromato-graphry	00671	0.04	20	80-120	75-125	SRA Lab
Nitrate+nitrite nitrogen	mg/L	EPA 300.1	ion chromato-graphry	00630	0.04	20	80-120	75-125	SRA Lab
Total Kjeldahl nitrogen	mg/L	EPA 351.3	colorimetric, automated phenate	00625	0.2	20	80-120	75-125	SRA Lab or subcontract lab
Chlorophyll A	ug/L	SM 10200-H	colorimetric	32211	10.0	0-10 mg/L: 30 10-100 mg/L: 20 >100 mg/L: 10	NA	75-125	SRA Lab
Carbonaceous BOD	mg/L	SM 5210 B	potentiometric	00307	2.0	20	NA	NA	SRA Lab
Ultimate BOD, 20-day	mg/L	SM 5210 C	potentiometric	00324	2.0	20	NA	NA	SRA Lab
Sediment Conventional Parameters									
Percent solids in sediment	% by weight, wet	SM 2540 G	gravimetric	81373	5%	20	NA	NA	SRA Lab or subcontract lab
Volatile solids in sediment	% by weight, dry	SM 2540 G	gravimetric	85207	0.5%	20	NA	NA	SRA Lab or subcontract lab
Clay, sediment particle size, <0.0039 mm	% by weight, dry	*3.4	gravimetric	82009	NA	NA	NA	NA	SRA Lab or subcontract lab
Silt, sediment particle size, .0039-.0625 mm	% by weight, dry	*3.4	gravimetric	82008	NA	NA	NA	NA	SRA Lab or subcontract lab
Sand, sediment particle size, .0625-2 mm	% by weight, dry	*3.4	gravimetric	89991	NA	NA	NA	NA	SRA Lab or subcontract lab
Gravel, sediment particle size, >2 mm	% by weight, dry	*3.4	gravimetric	80256	NA	NA	NA	NA	SRA Lab or subcontract lab

* USEPA. *Field and Laboratory Methods Applicable to Overburden and Minesoils*. February 1978. EPA/600/2-78-054.

** based on range statistic as described in Standard Methods, 21st Edition, Section 9020B, “QA/QC – Intralaboratory QC Guidelines.” This criterion applies to bacteriological duplicates with concentrations greater than 10 MPN/100 ml

Ambient Water Reporting Limits

Ambient water reporting limits, or AWRLs, are the specifications at or below which data will be reported to the TCEQ. The reporting limit is the lowest concentration at which the laboratory will report quantitative data within a specified recovery range. Ongoing ability to recover an analyte at the AWRL is demonstrated through analysis of a calibration or check standard at the AWRL. The AWRL for target analytes and performance limits at AWRL for this project are set forth in Table A.1. The laboratory is required to meet the following:

- The laboratory's reporting limit for each analyte will be at or below the AWRL.
- The laboratory will demonstrate and document on an ongoing basis the laboratory's ability to quantitate at its reporting limits.

Acceptance criteria are defined in Section B5.

Precision

The precision of laboratory data is a measure of the reproducibility of a result when an analysis is repeated. It is strictly defined as a measure of the closeness with which multiple analyses of a given sample agree with each other. Precision is assessed by replicate analysis of laboratory control standards or sample/duplicate pairs in the case of bacterial analysis. Control limits for laboratory control standard/laboratory control standard duplicates are specified in Table A.1

Field splits are used to assess the variability of sample handling, preservation, and storage, as well as the analytical process, and are prepared by splitting samples in the field. Control limits for field splits are defined in Section B5.

Accuracy

Accuracy is a statistical measurement of correctness and includes components of systemic error. A measurement is considered accurate when the value reported does not differ from the true value. Accuracy is verified through the analysis of laboratory matrix spikes, laboratory control standards, and blank samples. Performance limits for laboratory spikes and calibration control standards for AWRL are specified in Table A.1. Performance limits for blank analyses are discussed in Section B5.

Representativeness

Most data collected under the TMDL Program will be considered representative of ambient water quality conditions. This data will be coded with Program Code TI or TQ in Appendix B, Table 1. TI reflects data collected over a 24-hour period under a TMDL QAPP that may be used to conduct an assessment on a body of water. TQ reflects grab data collected under a TMDL QAPP that may also be used to conduct an assessment on a body of water. Data not considered representative of ambient water quality conditions and collected under a TMDL QAPP will be coded TN (i.e. data collected to aid with source identification). Representativeness is a measure of how accurately a monitoring program reflects the actual water quality conditions. The representativeness of the data is dependent on 1) the sampling locations, 2) the number of samples collected, 3) the number of years and seasons when sampling is performed, 4) the number of depths sampled, and 5) the sampling procedures. Site selection and sampling of all pertinent media (water, sediment, and biota) and use of only approved analytical methods will assure that the measurement data represents the conditions at the site. The goal for meeting total representation of the water body is tempered by the availability of time and funding. Representativeness will be measured with the completion of samples collected in accordance with the approved QAPP.

Comparability

Confidence in the comparability of data sets from this project to those for similar uses is based on the commitment of project staff to use only approved sampling and analysis methods and QA/QC protocols in accordance with quality system requirements and as described in this QAPP and project SOPs. Comparability is also guaranteed by reporting data in standard units, by using accepted rules for rounding figures, and by reporting data in a standard format as specified in the *Data Management Plan* (Appendix E).

Completeness

The completeness of the data is basically a relationship of how much of the data is available for use compared to the total potential data. Ideally, 100% of the data should be available. However, the possibility of unavailable data due to accidents, insufficient sample volume, broken or lost samples, etc. is to be expected. Therefore, it will be a general goal of the project(s) that 90% data completion is achieved.

A8 SPECIAL TRAINING/CERTIFICATION

Field personnel will receive training in proper sampling and field analysis. Before actual sampling or field analysis occurs, they will demonstrate to the QA Officer (or designee) their ability to properly calibrate field equipment and perform field sampling and analysis procedures. Training will be documented and retained in the personnel file and be available during a monitoring systems audit.

Laboratory analysts have a combination of experience, education, and training to demonstrate a knowledge of their function. To perform analyses for the TCEQ, laboratory analysts will have a demonstration of capability on record for each test that the analyst performs. The initial demonstration of capability should be performed prior to analyzing samples and annually thereafter. In cases whereby analysts have been analyzing samples prior to an official certification of capability has been generated, a certification statement is made part of the training record to document the analyst's initial on the job training. Annual demonstrations of capability are a part of analyst training thereafter.

Global Positioning System (GPS) training and certification are required in accordance with TCEQ Operating Policies and Procedures 8.12: Global Positioning System. A person collecting GPS data for TCEQ is required to obtain certification. Certification can be obtained by: 1) completing an agency training class, 2) completing a suitable training class offered by an outside vendor, or 3) by providing documentation of sufficient GPS expertise and experience.

Field supervisors and other staff received or will receive TCEQ GPS certification. At least one crew member on every sampling trip will be certified if GPS data are being collected on that trip.

A9 DOCUMENTS AND RECORDS

The document and records that describe, specify, report, or certify activities, requirements, procedures, or results for this project and the items and materials that furnish objective evidence of the quality of items or activities are listed.

Table A.2 Project Documents and Records

Document/Record	Location	Retention	Form
QAPP, amendments, and appendices	Parsons	5 years	Paper
QAPP distribution documentation	Parsons	5 years	Paper
Field notebooks or field data sheets	Parsons/SRA*	5 years	Paper
Field equipment calibration/ maintenance logs	Parsons/SRA*	5 years	Paper
Chain of custody records	SRA	5 years	Paper
Field SOPs	Parsons	5 years	Paper
Field corrective action documentation	Parsons	5 years	Paper
Media/incubation logs	SRA	5 years	Paper
Laboratory sample reception logs	SRA	5 years	Paper
Laboratory QA manuals	SRA	5 years	Paper
Laboratory SOPs	SRA	5 years	Paper
Laboratory internal/external standards	SRA	5 years	Paper
Laboratory demonstration of capability	SRA	5 years	Paper
Instrument raw data files	SRA	5 years	Electronic
Instrument readings/printouts	SRA	5 years	Electronic
Laboratory data reports	SRA	5 years	Electronic
Laboratory data verification for integrity, precision, accuracy and validation	SRA	5 years	Paper
Laboratory equipment maintenance logs	SRA	5 years	Paper
Laboratory calibration records	SRA	5 years	Electronic
Laboratory corrective action documentation	SRA	5 years	Paper
Data verification/validation documentation	Parsons	5 years	Paper
TMDL data files	Parsons	5 years	Electronic
Progress report/final report/data	Parsons.	5 years	Electronic

*Parsons and SRA will each maintain the field notebooks and field equipment maintenance & calibration logs of their staff and equipment

The TCEQ may elect to take possession of records at the conclusion of the specified retention period.

Special Reporting Formats

Parsons and the SRA will use the reporting formats from the most recent version of the TCEQ Surface Water Quality Monitoring *Data Management Reference Guide*.

References

TCEQ. 2003. *Surface Water Quality Monitoring Data Management Reference Guide*.

TCEQ. 1999. *Surface Water Quality Monitoring Procedures Manual*.

USEPA, 2001. EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5, EPA/240/B-01/003, Office of Environmental Information, Washington, DC 20460.

B1 SAMPLING PROCESS DESIGN

See Appendix B for sampling process design information and monitoring tables associated with data collected under this QAPP.

B2 SAMPLING METHODS

Field Sampling Procedures

Parsons will follow the field sampling procedures for field and conventional chemical parameters documented in the TCEQ Surface Water Quality Monitoring Procedures Manual (1999a) and the TCEQ Receiving Water Assessment Procedures Manual (1999b) unless otherwise noted in the QAPP. Additional procedures for field sampling outlined in this section reflect specific requirements for sampling under this TMDL Project and/or provide additional clarification.

Ambient Water Samples

Water samples are to be collected from a site first, before field data, flow, or other samples may mix up the water. Ambient water samples are collected from the mixed surface layer, in most cases, directly by immersing the sample container to a depth of approximately one foot below the surface. In cases where the water depth is less than one foot, samples are collected directly from just below the surface, taking care to avoid disturbing the sediments. At some locations, it may be necessary to collect the sample from a bridge. In these cases, a plastic bucket or bailer attached to a rope will be used to collect the sample. In these cases, extreme caution must be exercised to avoid contaminating the sample with debris from the rope or bridge. Buckets or bailers will be pre-rinsed with site water before sample collection, and rinsed between samples with 1) a 10% bleach in deionized water solution, followed by 2) a 1% sodium thiosulfate in distilled water solution.

In cases where the water column is stratified with respect to conductivity and/or temperature, and the Sampling Plan (Appendix B) indicates an ambient water sample is to be collected from a depth below the mixed surface layer, water samples will be collected using a peristaltic pump and tubing attached to a metal rod with depth markings, from a depth midway between the halocline and the bottom, taking care to avoid disturbing the sediments. Prior to filling the sample container, at least 3 liters of water will be pumped through the tubing.

- Two 1-liter cubitainers for nitrogen analyses will be filled with water from the appropriate depth, then each preserved with two milliliters of concentrated analytical-grade sulfuric acid before capping, inverting about 20 times, and placing on cubed ice in a closed ice chest at 4°C.
- A third cubitainer will be filled for alkalinity, ortho-phosphorus, and TSS/VSS analysis before capping and placing in the ice chest.
- A fourth cubitainer for $cBOD_5$ analysis will be filled and placed in the ice chest.

- If a $uBOD_{20}$ analysis is to be performed, a fifth cubitainer will be filled and placed in the ice chest.
- An opaque plastic bottle for chlorophyll A analysis will be filled and placed in the ice chest

Field blank samples using laboratory deionized water are collected at a rate specified in Section B5.

Effluent Water Samples
Effluent water samples are collected from the waste stream following the final treatment unit, as close to the point of discharge as possible. Different site characteristics may allow direct collection into sample containers, or require use of buckets, bailers, or a peristaltic pump. The procedures described above for ambient water samples will be followed.

- Two 1-liter cubitainers for nitrogen analyses will be filled with water from the appropriate depth, then each preserved with two milliliters of concentrated analytical-grade sulfuric acid before capping, inverting about 20 times, and placing on cubed ice in a closed ice chest at 4°C.
- A third cubitainer will be filled for alkalinity, ortho-phosphorus, and TSS/VSS analysis before capping and placing in the ice chest.
- A fourth cubitainer for $cBOD_5$ analysis will be filled and placed in the ice chest.

Sediment Samples
Sediment samples are collected along with each SOD measurement. Sample collection procedures described in the TCEQ SWQM Procedures Manual (1999, or most recent edition) will be followed. One 1-quart glass jar should provide sufficient sample for all analyses. SOD measurement procedures are described in Appendix H.

Stormwater Samples
Stormwater samples will be collected via autosamplers set to collect a water sample from the stream periodically over the course of a runoff event. Substantial effort will be exerted to capture the “first flush” of runoff, which is expected to account for a large portion of the total load of many pollutants in a runoff event. Sample collection may be initiated manually by SRA personnel or automatically triggered by the sampler due to rising water depth. The period between sample collection may vary from one-quarter to four hours, based on the site-specific conditions and the experience and best professional judgment of SRA personnel regarding the expected duration of runoff at each site. Samples may also be collected continuously, with flow-weighted volumetric collection rate. Samples collected by the autosampler may be supplemented by manual grab samples collected in accordance with requirements described above for ambient water samples.

A recording multiprobe sonde will be deployed with each autosampler to record field parameters as well as water depth over the course of the runoff event.

Autosamplers will be cleaned between runoff events with procedures described above for peristaltic pumps.

Samples will be retrieved from autosamplers, processed according to ambient water sample handling requirements (described elsewhere in this section), and delivered to the laboratory within twelve hours of their collection.

Stormwater sample data will not be reported to TRACS, but will be used to assist in calibration of the nonpoint-source watershed model.

Sample Volume, Container Types, Minimum Sample Volume, Preservation Requirements, and Holding Time Requirements.

Table B.1 Field Sampling and Handling Procedures

Parameter	Matrix	Container*	Preservation	Sample Volume	Holding Time
Alkalinity	water	Pre-cleaned polyethylene cubitainer	4º C, dark	200 mL	14 days
TSS/VSS	water	Pre-cleaned polyethylene cubitainer	4º C, dark	400 mL	7 days
Total Kjeldahl Nitrogen	water	Pre-cleaned polyethylene cubitainer	4º C, dark, pH<2 with H_2SO_4	200 mL	28 days
Nitrite+Nitrate Nitrogen	water	Pre-cleaned polyethylene cubitainer	4º C, dark	100 mL	48 hours
Ammonia-Nitrogen	water	Pre-cleaned polyethylene cubitainer	4º C, dark, pH<2 with H_2SO_4	400 mL	28 days
ortho-Phosphorus	water	Pre-cleaned polyethylene cubitainer	4º C, dark	100 mL	filter upon collection; 48 hours until analysis
Chlorophyll A	water	Plastic opaque bottle	4º C, dark	500 mL	48 hours
$CBOD_5$	water	Pre-cleaned polyethylene cubitainer	4º C, dark	1000 ml	48 hours
$uBOD_{20}$	water	Pre-cleaned polyethylene cubitainer	4º C, dark	1000 ml	48 hours
E. coli	water	Sterile plastic bottle	1% sodium thiosulfate	100 ml	6 hours 12 hours for stormwater
Grain Size	sediment	1 quart glass jar with Teflon-lined lid	4º C	500 grams	14 days

Parameter	Matrix	Container*	Preservation	Sample Volume	Holding Time
Volatile solids	sediment	1 quart glass jar with Teflon-lined lid	4º C	500 grams	14 days
Percent Solids	sediment	1 quart glass jar with Teflon-lined lid	4º C	500 grams	14 days

*stormwater samples collected by autosampler are held for a brief time in the dark in polyethylene bottles prior to transfer to the sample container and preservation.

Sample Containers

Polyethylene sample containers (cubitainers) are purchased pre-cleaned for conventional parameters and are disposable. Pre-sterilized plastic bottles containing 1% sodium thiosulfate tablets are used for bacteriological samples. Certificates for pre-cleaned and pre-sterilized bottles are maintained in a notebook by the SRA laboratory. Opaque plastic bottles are used for chlorophyll A samples. One-quart glass jars with a Teflon-lined screw cap are used for sediment samples. These bottles are cleaned in an automatic steam washer with Dry-Contrad. One piece of glassware from each batch is checked with a 0.04% Bromothymol Blue solution to ensure proper rinsing. An equipment blank is run for each batch of amber glass bottles to ensure there is no contamination resulting from the washing procedure.

Processes to Prevent Cross Contamination

Procedures outlined in the TCEQ SWQM Procedures Manual outline the necessary steps to prevent cross-contamination of samples. These include such things as direct collection into sample containers, when possible. When used, buckets, bailers, or peristaltic pumps and tubing are used to collect the sample, they will be pre-rinsed with site water before sample collection, and rinsed between samples with 1) a 10% bleach in deionized water solution, followed by 2) a 1% sodium thiosulfate in distilled water solution. Field blanks, as discussed in Section B5, are collected to verify that cross-contamination has not occurred.

Documentation of Field Sampling Activities

Field sampling activities are documented on field data sheets as presented in Appendix C. Flow work sheets, and multi-probe calibration records are part of the field data record. For all visits, station ID, location, sampling time, date, depth, and sample collector's name/signature are recorded. Values for all measured field parameters are recorded. Detailed observational data are recorded including water appearance, weather, biological activity, stream uses, unusual odors, specific sample information, missing parameters (items that were to have been sampled that day, but weren't), days since last significant rainfall, and flow severity.

Recording Data

For the purposes of this section and subsequent sections, all field and laboratory personnel follow the basic rules for recording information as documented below:

1. Legible writing in indelible, waterproof ink or pencil on waterproof paper with no modifications, write-overs or cross-outs;
2. Correction of errors with a single line followed by an initial and date;
3. Close-outs on incomplete pages with an initialed and dated diagonal line.

Deviations from Sampling Method Requirements or Sample Design, and Corrective Action

Examples of deviations from sampling method requirements or sample design include but are not limited to such things as inadequate sample volume due to spillage or container leaks, failure to preserve samples appropriately, contamination of a sample bottle during collection, storage temperature and holding time exceedance, sampling at the wrong site, etc. Any deviations will invalidate resulting data and may require corrective action. Corrective action may include for samples to be discarded and re-collected. It is the responsibility of the Parsons and SRA Project Managers, in consultation with the Parsons QAO, to ensure that the actions and resolutions to the problems are documented and that records are maintained in accordance with this QAPP. In addition, these actions and resolutions will be conveyed to the TCEQ Project Manager both verbally and in writing in the project progress reports.

B3 SAMPLE HANDLING AND CUSTODY PROCEDURES

Chain-of-Custody

Proper sample handling and custody procedures ensure the custody and integrity of samples beginning at the time of sampling and continuing through transport, sample receipt, preparation, and analysis.

A sample is in custody if it is in actual physical possession or in a secured area that is restricted to authorized personnel. The COC form is used to document sample handling during transfer from the field to the laboratory and among contractors. The following information concerning the sample is recorded on the COC form (See Appendix D).

1. Date and time of collection
2. Site identification
3. Sample matrix
4. Number of containers
5. Preservative used or if the sample was filtered
6. Analyses required
7. Name of collector
8. Custody transfer signatures and dates and time of transfer
9. Name of laboratory admitting the sample
10. Bill of lading (*if applicable*)

Sample Labeling

Cubitainers are labeled directly on the container with an indelible marker. Pre-glued computer-generated labels, filled out with a permanent, indelible marker, are affixed to each glass bottle or jar immediately following sample collection, and covered with transparent cellophane tape to prevent damage and improve readability. Label information includes:

1. Site identification
2. Date and time of sampling
3. Preservative added, if applicable
4. Sample type (e.g., analysis required, as defined in the monitoring schedule in Appendix B*)*

Sample Handling

COC forms are completed for each water or sediment sample upon collection. Ice chests containing samples will be collected from field personnel at least twice per day during intensive surveys, or at least once per day for stormwater or sediment sampling, and delivered to the SRA Laboratory.

All samples submitted to the laboratory for analysis must have proper documentation on the COC form as to their source, method of collection, and maintenance of integrity during transport and delivery.

The samples are received in the laboratory by the sample custodian or assigned alternate. After checking the COC form for completeness, the sample custodian records the date, time, and signs the form. The sample custodian maintains copies of the signed forms. The field personnel maintain the original signed field sheets in bound notebooks. Laboratory analyses conducted on the samples are referenced to the field sheets by the station name and date.

The sample custodian then affixes a computer-generated label to the sample. The label indicates the sample ID number, the place of storage, date received, date collected, tentative date of disposal, and the tests to be performed. The sample is then checked for proper preservation by the sample custodian and preserved as necessary. The sample custodian then performs any pretreatment procedures at this time when necessary.

The sample is stored in the appropriate refrigeration unit or issued to an analyst if immediate analysis is required. Only authorized laboratory personnel will handle samples received by the laboratory. Samples remain stored in the appropriate refrigeration unit until removed for analysis by an analyst. The Laboratory Supervisor or designate will assign testing to laboratory analysts within the specified holding times.

The analyst assigned to perform the test generates a work list of samples from the computer. The analyst removes the samples from storage and records the sample ID numbers in the appropriate bound benchsheet notebook. All other appropriate information is recorded in the book at this time. The information includes the date and time the analysis began, the analyst's initials, and any other information pertinent to the specific test such as standards, dilution volumes, all required quality assurance samples, etc.

The analyst is responsible for the integrity of the sample from the time it is removed from storage, during the time of the analysis, and until it is returned to storage. The analyst must be prepared to testify in a court of law that the integrity of the sample was maintained throughout the analysis.

Each sample is returned to its appropriate storage upon completion of the analysis. If the entire sample is used, the empty container will be stored in the designated storage place until the appointed disposal time. At the beginning of each month, samples are removed from refrigeration and stored on the storage shelf in the laboratory after all tests have been completed. The samples are properly disposed of 60 days after testing.

Failures in Chain-of-Custody and Corrective Action

All failures associated with chain-of-custody procedures as described in this QAPP are immediately reported to the SRA Project Manager. These include such items as delays in transfer, resulting in holding time violations; violations of sample preservation requirements; incomplete documentation, including signatures; possible tampering of samples; broken or spilled samples, etc. The SRA Project Manager, in consultation with the Parsons QAO will determine if the procedural violation may have compromised the validity of the resulting data. Any failures that have reasonable potential to compromise data validity will invalidate data, and the sampling event should be repeated if possible. The resolution of the situation will be reported to the TCEQ TMDL Project Manager in the project progress report. Corrective action reports will be maintained by the Parsons QAO.

B4 ANALYTICAL METHODS

The analytical methods are listed in Table A.1 of Section A7. Procedures for laboratory analysis will be in accordance with the most recently published edition of Standard Methods for the Examination of Water and Wastewater, the latest version of the TCEQ Surface Water Quality Monitoring Procedures Manual, 40 CFR 136, or other reliable procedures acceptable to TCEQ. Copies of laboratory SOPs are retained by the SRA and are available for review by the TCEQ. Laboratory SOPs are consistent with EPA requirements as specified in the method.

Standards Traceability

All standards used in the field and laboratory are traceable to certified reference materials. Standards preparation is fully documented and maintained in a standards log book. Each documentation includes information concerning the standard identification, starting materials, including concentration, amount used and lot number; date prepared, expiration date and preparer’s initials/signature. The reagent bottle is labeled in a way that will trace the reagent back to preparation.

Analytical Method Modification

Only data generated using TCEQ-approved analytical methodologies as specified in this QAPP will be submitted to the TCEQ. Requests for method modifications will be documented on form

TCEQ-10364, the TCEQ Application for Analytical Method Modification, and submitted for approval to the TCEQ Quality Assurance Section. Approval by the TCEQ will be granted or denied based on review of the application, specifically the section documenting an initial demonstration of method equivalency conducted by the laboratory. Work will only begin after the modified procedures have been approved.

Failures or Deviations in Analytical Method Requirements and Corrective Actions

Failures in field and laboratory measurement systems involve, but are not limited to, instrument malfunctions, failures in calibration, blank contamination, QC sample problems (i.e., poor spike recoveries), etc. In many cases, the field technician or lab analyst will be able to correct the problem (i.e., via re-calibration or re-analysis). If the problem is resolvable by the field technician or lab analyst, then they will document the problem on the field data sheet or laboratory record and complete the analysis. If the problem is not resolvable, then it is conveyed to the respective supervisor, who will make the determination. If the analytical system failure compromises the sample results, the data will not be reported to the TCEQ as part of this study. The nature and disposition of the problem is documented on the data report which is sent to the Parsons Project Manager. The Parsons Project Manager will include this information on the Quarterly Report which is sent to the TCEQ.

Corrective action documentation is maintained by the Parsons QAO.

B5 QUALITY CONTROL

Sampling Quality Control Requirements and Acceptability Criteria

The minimum field QC requirements are outlined in the *TCEQ Surface Water Quality Monitoring Procedures Manual.* Specific requirements are outlined below. Field QC sample results are submitted with the data report (see Section C2).

Field Equipment Blank - Field equipment blanks are required for samples when collected using sampling equipment such as peristaltic pumps, buckets, bailers, or autosamplers. An equipment blank is a sample of reagent water poured into a sample bottle, or poured over or pumped through a sampling or analysis device. It is collected in the same type of container as the environmental sample, preserved in the same manner and analyzed for the same parameter. The analysis of equipment blanks should yield values less than the AWRL. When target analyte concentrations are very high, blank values must be less then 5% of the lowest value of the batch. Field equipment blanks will be analyzed at a rate of one per 10 samples (10%) collected with each type of equipment.

Field splits - A field split is single sample subdivided by field staff immediately following collection and submitted to the laboratory as two separate, identified samples according to procedures specified in the SWQM Procedures Manual. Split samples are preserved, handled, shipped, and analyzed identically and are used to assess variability in all of these processes. Field splits apply to conventional samples only and are collected on a 10% basis or one per batch. The precision of field split results is calculated by relative percent difference (RPD) using the following equation:

$$\mathbf{RPD = \{ (X_1 - X_2) / \langle (X_1+X_2)/2 \rangle \} * 100}$$

A 30% RPD criteria will be used to screen field split results as a possible indicator of excessive variability in the collection and analytical system. If it is determined that meaningful quantities of constituent (i.e., > AWRL) were measured and analytical variability can be eliminated as a factor, then variability in filed split results will primarily be used as a trigger for discussion with field staff to ensure samples are being handled in the field correctly. Some sample results or batches of samples may be invalidated based on the examination of all extenuating information. Professional judgment during data validation will be relied upon to interpret the results and take appropriate action. The qualification (i.e., invalidation) of data will be documented on the Data Summary. Deficiencies will be addressed as specified in this section under Failures in Quality Control and Corrective Action.

Performance limits and control charts are used to determine the acceptability of field duplicate analyses.

At least one field duplicate shall be collected on each sampling trip. If more than ten samples are collected at a stream on a sampling trip, additional field duplicates shall be collected so that there is at least one field duplicate sample for every ten samples collected.

Laboratory Measurement Quality Control Requirements and Acceptability Criteria

Detailed laboratory QC requirements and corrective action procedures are contained within the individual laboratory quality assurance manuals (QAMs). The minimum requirements that all participants abide by are stated below. Lab QC sample results are maintained in the lab for review (see Section C2).

Laboratory duplicate - A laboratory duplicate is prepared by splitting aliquots of a single sample (or a matrix spike or a laboratory control standard) in the laboratory. Both samples are carried through the entire preparation and analytical process. Laboratory duplicates are used to assess precision and are performed on 10% of samples analyzed. Acceptability criteria are outlined in Table A.1 of Section A7.

For most parameters, precision is calculated by the relative percent deviation (RPD) of duplicate results as defined by 100 times the difference (range) of each duplicate set, divided by the average value (mean) of the set. For duplicate results, X_1 and X_2, the RPD is calculated from the following equation:

$$RPD = (X_1 - X_2)/\{(X_1+X_2)/2\} * 100$$

A bacteriological duplicate is considered to be a special type of laboratory duplicate and applies when bacteriological samples are run in the field as well as in the laboratory. Bacteriological duplicate analyses are performed on samples from the sample bottle on a 10% basis. Results of bacteriological duplicates are evaluated by calculating the logarithm of each result and determining the range of each pair. Precision limits for bacteriological analyses are defined in Table A.1.

Performance limits and control charts are used to determine the acceptability of duplicate analyses.

Laboratory Control Standard (LCS) and Laboratory Control Standard Duplicates (LCSDs)- A laboratory control sample is analyte-free water spiked with the analyte of interest prepared from standardized reference material. The LCS is generally spiked into laboratory pure water at a level less than or equal to the mid-point of the calibration curve for each analyte. The LCS is carried through the complete preparation and analytical process. The LCS is used to document the accuracy of the method due to the analytical process. LCSD are generally run at a rate of one each per batch. Acceptability criteria are laboratory specific and usually based on results of past laboratory data (i.e., control charts). LCSD are routinely incorporated into the analysis program. *Note: The analysis frequency of LCSD is not specified in this document and may be method dependent.* The analysis of LCSD is a measure of precision.

Percent recovery for the LCS is calculated using the following equation in which %R is percent recovery, SR is the observed spiked sample concentration, and SA is the spike added:

%R = SR/SA * 100

AWRL Calibration Standard or Check Standard - The laboratory's reporting limit will be at or below the AWRL. To demonstrate ongoing ability to recover at the reporting limit, the laboratory will analyze a calibration standard (if applicable) at or below the reporting limit on each day samples are analyzed. Two acceptance criteria will be met or corrective action will be implemented. First, calibrations including the standard at the reporting limit will meet the calibration requirements of the analytical method. Second, the instrument response (e.g., absorbency, peak area, etc.) for the standard at the reporting limit will be treated as a response for a sample by use of the calibration equation (e.g, regression curve, etc.) in calculating an apparent concentration of the standard. The calculated and reference concentrations for the standard will then be used to calculate percent recovery (%R) at the reporting limit using the equation:

%R = CR/SA * 100

where CR is the calculated result and SA is the actual or reference concentration for the standard. Recoveries must be within 75-125% of the reference concentration.

When daily calibration is not required (e.g., EPA Method 624), or a method does not use a calibration curve to calculate results, the laboratory will analyze a check standard at the reporting limit on each day samples are analyzed. The check standard does not have to be taken through sample preparation, but must be recovered within 75-125% of the reference concentration for the standard. The percent recovery of the check standard is calculated using the following equation in which %R is percent recovery, SR is the sample result, and SA is the reference concentration for the check standard:

$$\%R = SR/SA * 100$$

If the calibration (when applicable) or the recovery of the calibration or control standard is not acceptable, corrective actions (e.g., re-calibration) will be taken to meet the specifications before proceeding with analyses of samples.

Matrix spike (MS) - A matrix spike is an aliquot of sample spiked with a known concentration of the analyte of interest. Percent recovery of the known concentration of added analyte is used to assess accuracy of the analytical process. The spiking occurs prior to sample preparation and analysis. Spiked samples are routinely prepared and analyzed at a rate of 10% of samples processed. The MS is spiked at a level less than or equal to the midpoint of the calibration or analysis range for each analyte. The MS is used to document the accuracy of a method due to sample matrix and not to control the analytical process. Acceptability criteria are outlined in Table A.1 and are calculated by percent recovery. Percent recovery (%R) is defined as 100 times the observed concentration, minus the sample concentration, divided by the true concentration of the spike.

The percent recovery of the matrix spike is calculated using the following equation in which %R is percent recovery, SSR is the observed spiked sample concentration, SR is the sample result, and SA is the reference concentration of the spike added:

$$\%R = (SSR - SR)/SA * 100$$

Method blank - A method blank is an analyte-free matrix to which all reagents are added in the same volumes or proportions as used in the sample processing and analyzed with each batch. The method blank is carried through the complete sample preparation and analytical procedure. The method blank is used to document contamination from the analytical process. The analysis of method blanks should yield values less than the AWRL. For very high level analyses, blank value should be less then 5% of the lowest value of the batch, or corrective action will be implemented.

Additional method-specific QC requirements - Additional QC samples are run (e.g., surrogates, internal standards, continuing calibration samples, interference check samples) as specified in the methods. The requirements for these samples, their acceptance criteria, and corrective actions are method-specific.

Failures in Field and Laboratory Quality Control and Corrective Action

Sampling QC excursions are evaluated by the SRA and Parsons Project Managers, in consultation with the Parsons QAO. In that differences in field duplicate sample results are used to assess the entire sampling process, including environmental variability, the automatic rejection of results based on control chart limits is not practical. Therefore, some professional judgment will be relied upon in evaluating results. Rejecting sample results based on wide variability is a possibility. Blank data are scrutinized very closely. Blank values exceeding the acceptability criteria may automatically invalidate the sample, especially in cases where high blank values may be indicative of contamination which may be causal in putting a value above the standard. Incidences of field duplicate excursions and blank contamination are noted in the quarterly report.

Laboratory measurement quality control failures are evaluated by the laboratory staff. The disposition of such failures and conveyance to the TCEQ are discussed in Section B4 under "Failures or Deviations in Analytical Methods and Corrective Actions." Corrective action documentation is maintained by Parsons.

B6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

All sampling equipment testing and maintenance requirements are detailed in the *TCEQ Surface Water Quality Monitoring Procedures Manual*. Sampling equipment is inspected and tested upon receipt and is assured appropriate for use. Equipment records are kept on all field equipment and a supply of critical spare parts is maintained.

All laboratory tools, gauges, instrument, and equipment testing and maintenance requirements are contained within laboratory QAM(s). Testing and maintenance records are maintained and are available for inspection by the TCEQ. Instruments requiring daily or in-use testing include, but are not limited to, water baths, ovens, autoclaves, incubators, refrigerators, and laboratory pure water. Critical spare parts for essential equipment are maintained to prevent downtime. Maintenance records are available for inspection by the TCEQ.

B7 INSTRUMENT CALIBRATION AND FREQUENCY

Field equipment will be calibrated according to manufacturers' instructions. Post-calibration error limits as described on page 9-11 of the *TCEQ Surface Water Quality Monitoring Procedures* will be adhered to. Data not meeting post-error limit requirements invalidate associated data collected subsequent to the pre-calibration and are not submitted to the TCEQ.

Detailed laboratory calibrations are contained within the QAM(s). The laboratory QAM identifies all tools, gauges, instruments, and other sampling, measuring, and test equipment used for data collection activities affecting quality that must be controlled and, at specified periods, calibrated to maintain bias within specified limits. Calibration records are maintained, are traceable to the instrument, and are available for inspection by the TCEQ. Equipment requiring periodic calibrations include, but are not limited to, thermometers, pH meters, balances, incubators, turbidity meters, and analytical instruments. Calibration records are available to the TCEQ for review.

B8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

Each new batch of field and laboratory supplies are inspected and tested before use to ensure that they are adequate and not contaminated. The SRA QAM provides additional details on acceptance requirements for laboratory supplies and consumables.

B9 DATA ACQUISITION REQUIREMENTS (Non-direct Measurements)

Only data collected directly under this QAPP will be submitted to the SWQM portion of the TRACS database. Sampling or measurements conducted by the USGS, by the SRA under their routine Texas Clean Rivers Program monitoring, and the TPWD for their Tidal Streams UAA project, is not covered under this QAPP and will not be reported to the SWQM portion of the TRACS database by Parsons. However, data collected by the above organizations that meet the data quality objectives of this project and comply with all requirements/guidance of this project and the SWQM QAPP may be useful in satisfying the data and informational needs of this study. The collection and qualification of data by the SRA under the Texas Clean Rivers Program is covered by their most current QAPP for the Texas Clean Rivers Program. The collection and qualification of data by the TPWD is covered by their most current QAPP for the Tidal Streams UAA project. The collection and qualification of flow data by the USGS are addressed in the TCEQ SWQM QAPP. All acquired or non-direct measurement data will not be submitted under this QAPP.

Daily USGS streamflow data will be acquired for gage 08031000 on Cow Bayou at State Highway 12 "Cow Bayou nr Mauriceville, TX" via an online query at http://waterdata.usgs.gov/tx/nwis/sw.

SRA and TPWD data will be retrieved from TRACS via a data request to the TCEQ Information Resources Division, and transferred on CD-ROM to Parsons computers.

B10 DATA MANAGEMENT

Data Management Protocols are addressed in the Data Management Plan which is in Appendix E of this document and the Data Review Checklist in Appendix F.

References

TCEQ, 2003. *Surface Water Quality Monitoring Data Management Reference Guide*.

TCEQ, 1999a or most recent version. *Surface Water Quality Monitoring Procedures Manual.*

TCEQ, 1999b or most recent version. *Receiving Water Assessment Procedures Manual, GI-253*, June 1999

C1 ASSESSMENTS AND RESPONSE ACTIONS

The following table presents the types of assessments and response action for data collection activities applicable to the QAPP.

Table C.1 Assessments and Response Actions

Assessment Activity	Approximate Schedule	Responsible Party	Scope	Response Requirements
Status Monitoring Oversight, etc.	Continuous	SRA & Parsons Project Managers	Monitoring of the project status and records to ensure requirements are being fulfilled. Monitoring and review of contract laboratory performance and data quality	Report to TCEQ in Quarterly Report. Ensure project requirements are being fulfilled.
Laboratory Inspections	Dates to be determined by the TCEQ lab inspector	TCEQ Laboratory Inspector	Analytical and quality control procedures employed at the laboratory and the contract laboratory	30 days to respond in writing to the TCEQ to address corrective actions
	Annually	SRA QAO		Implements corrective action. Report sent to TCEQ Project Manager
Monitoring Systems Audit	Dates to be determined by TCEQ	TCEQ QAS	Field sampling, handling and measurement; facility review; and data management as they relate to the Project	30 days to respond in writing to the TCEQ to address corrective actions
	Annually	Parsons QAO		Report sent to TCEQ Project Manager. Resolves any deficiencies.
Performance Evaluation Samples	Annually	SRA QAO	Checks competency of the laboratory and the contract laboratory to perform analyses	Report sent to TCEQ Project Manager. Resolves any deficiencies. Verifies satisfactory performance with second set of PES

Corrective Action

The SRA Project Manager is responsible for implementing and tracking laboratory corrective action procedures as a result of audit findings, while the Parsons Project Manager is responsible for implementing and tracking corrective action procedures as a result of monitoring system audit findings,. Records of audit findings and corrective actions are maintained by both the

TMDL and TPWD Project Managers. Corrective action documentation will be submitted to the TCEQ with the Progress Report.

If audit findings and corrective actions cannot be resolved, then the authority and responsibility for terminating work is specified in the TMDL QMP and in agreements in contracts between participating organizations.

C2 REPORTS TO MANAGEMENT

Laboratory Data Reports

Laboratory data reports contain the results of all specified QC measures listed in section B5, including but not limited to field equipment blanks, trip blanks, field blanks, laboratory duplicates, laboratory control standards, matrix spikes, AWRL/reporting limit verification, Laboratory equipment blanks, and method blanks. This information is reviewed by the SRA Laboratory QAO and compared to the pre-specified acceptance criteria to determine acceptability of data before forwarding to the Parsons Project Manager. This information is available for inspection by the TCEQ.

Reports to TCEQ Project Management

All reports detailed in this section are contract deliverables and are transferred to the TCEQ in accordance with contract requirements.

Quarterly Progress Report - Summarizes the SRA's activities for each task; reports monitoring status, problems, delays, and corrective actions; and outlines the status of each task's deliverables.

Monthly Progress Report - Summarizes Parsons' activities for each task; reports monitoring status, problems, delays, and corrective actions; and outlines the status of each task's deliverables.

Monitoring Systems Audit Report and Response - Following any audit performed by Parsons, a report of findings, recommendations and response is sent to the TCEQ in the quarterly progress report.

Reports by TCEQ Project Management

Contractor Evaluation – Parsons and the SRA participate in a Contractor Evaluation by the TCEQ annually for compliance with administrative and programmatic standards. Results of the evaluation are submitted to the TCEQ Financial Administration Division, Procurements and Contracts Section.

D1 DATA REVIEW, VERIFICATION, AND VALIDATION

For the purposes of this document, verification means the processes taken to determine compliance of data with project requirements, including documentation and technical criteria. Validation means those processes taken independently of the data-generation processes to determine the usability of data for its intended use(s). Integrity means the processes taken to assure that no falsified data will be reported.

All data obtained from field and laboratory measurements will be reviewed and verified for conformance to project requirements, and then validated against the data quality objectives which are listed in Section A7. Only those data which are supported by appropriate quality control data and meet the data quality objectives defined for this project will be considered acceptable. This data will be submitted in the format specified in the Surface Water Quality Monitoring Data Management Reference Guide, 2003 or most recent copy to the TCEQ for entry into the SWQM portion of the TRACS database.

The procedures for verification and validation of data are described in Section D2, below. The Parsons Project Managers is responsible for ensuring that field data are properly reviewed and verified for integrity. The Laboratory Supervisor is responsible for ensuring that laboratory data are scientifically valid, defensible, of acceptable precision and accuracy, and reviewed for integrity. The Parsons Data Manager will be responsible for ensuring that all data are properly reviewed and verified, and submitted in the required format to the project database. The Parsons QAO is responsible for validating the data. Finally, the Parsons Project Manager, with the concurrence of the Parsons QAO, is responsible for validating that all data to be reported meet the objectives of the project and are suitable for reporting to TCEQ.

D2 VERIFICATION AND VALIDATION METHODS

All field and laboratory data will be reviewed, verified and validated to ensure they conform to project specifications and meet the conditions of end use as described in Section A7. The staff and management of the respective field, laboratory, and data management tasks are responsible for the integrity, validation and verification of the data each task generates or handles throughout each process. The field and laboratory tasks ensure the verification of raw data, electronically generated data, and data on chain-of-custody forms and hard copy output from instruments.

Verification, validation and integrity review of data will be performed using self-assessments and peer review, as appropriate to the project task, followed by technical review by the manager of the task. The data to be verified (listed by task in Table D.1) are evaluated against project specifications (Section A7) and are checked for errors, especially errors in transcription, calculations, and data input. Potential outliers are identified by examination for unreasonable data, or identified using computer-based statistical software. If a question arises or an error or potential outlier is identified, the manager of the task responsible for generating the data is contacted to resolve the issue. Issues which can be corrected are corrected and documented electronically or by initialing and dating the associated paperwork. If an issue cannot be corrected, the task manager consults with higher level project management to establish the appropriate course of action, or the data associated with the issue are rejected. The performance of these tasks is documented by completion of the data review checklist (Appendix F) by the Parsons Data Manager.

The Parsons Project Manager and QAM are each responsible for validating that the verified data are scientifically valid, defensible, of known precision, accuracy, integrity, meet the data quality objectives of the project, and are reportable to TCEQ. One element of the validation process involves evaluating the data again for anomalies. The Parsons QAO or Project Manager may designate other experienced water quality experts familiar with the water bodies under investigation to perform this evaluation. Any suspected errors or anomalous data must be addressed by the manager of the task associated with the data, before data validation can be completed.

A second element of the validation process is consideration of any findings identified during the monitoring systems audit conducted by the TCEQ QAS assigned to the project. Any issues requiring corrective action must be addressed, and the potential impact of these issues on previously collected data will be assessed. Finally, the Parsons Project Manager, with the concurrence of the QAO validates that the data meet the data quality objectives of the project and are suitable for reporting to TCEQ.

Table D.1 Data Review, Verification, and Validation Procedures

Data to be Verified	**Field Staff Task**	**Laboratory Task**	**Data Manager Task**	**QA Manager Task**
Sample documentation complete; samples labeled, sites identified	√	√		
Field QC samples collected for all analytes as prescribed in the TCEQ SWQM Procedures Manual	√			√
Standards and reagents traceable	√	√		
Chain of custody complete/acceptable	√	√		
Sample preservation and handling acceptable	√	√		
Holding times not exceeded	√	√		√
Collection, preparation and analysis techniques consistent with SOPs and QAPP	√	√		√
Field documentation (e.g. biological, stream habitat) complete	√			
Instrument calibration data complete	√	√		
QC samples analyzed at required frequencies	√	√		√
QC results meet performance and program specifications	√	√		√
Analytical sensitivity (AWRLs) consistent with QAPP		√		√
Results, calculations, transcriptions checked	√	√		√
Laboratory bench-level review performed		√		
All laboratory samples analyzed for all parameters		√		√
Corollary data agree	√	√		√
Nonconforming activities documented	√	√		√
Outliers confirmed and documented; reasonableness check performed				√

Data to be Verified	Field Staff Task	Laboratory Task	Data Manager Task	QA Manager Task
Dates formatted correctly			√	
Depth reported correctly			√	
TAG IDs correct			√	
TCEQ ID number assigned			√	
Valid STORET codes			√	
Source codes 1, 2, and program codes used correctly			√	
Time based on 24-hour clock			√	
Absence of transcription error confirmed	√	√	√	√
Absence of electronic submittal errors confirmed	√	√	√	
Sampling and analytical data gaps checked (e.g., all sites for which data are reported are on the monitoring schedule)	√	√		√
Field QC results attached to data review checklist			√	
Verified data log submitted			√	

D3 RECONCILIATION WITH USER REQUIREMENTS

No decisions will be made by the project team based on the data collected. Data that have been reviewed, verified, and validated will be summarized at each station individually, as well as all stations together, for their ability to meet the data quality objectives of the project and the informational needs of water quality agency decision-makers. The particular intended use of these data is to calibrate and verify models of pH, dissolved oxygen, and E. coli for Adams Bayou and its watershed, and Cow Bayou and its watershed. This model may subsequently be used by the TCEQ for TMDL development.

Data that have been reviewed, verified, and validated will be summarized at each station individually, as well as all stations together, for their ability to meet the data quality objectives of the project and the informational needs of water quality agency decision-makers. General questions that will be asked, and the metrics on which they will be evaluated, are listed in Table D.2.

Table D.2. Methods for Reconciling Results with Data Quality Objectives

Evaluation Issue	Specific Measures
How complete are the data relative to model needs?	% data completeness by station for each laboratory parameter
	% data completeness by station for each field parameter
How representative of ambient conditions are the measurements, relative to model needs?	were water flow, tide, season, and weather conditions representative of the ambient conditions under which impairment has been observed in the past?

	Did stormwater measurements adequately capture the overall runoff load by including the rise and tail of the hydrograph?
How precise and accurate are measured data, relative to model needs?	Did measurements meet data quality objectives for accuracy and precision?

Appendix A. Work Plans

Orange County Total Maximum Daily Load Project

Draft Work Plan for State Fiscal Year 2004
Contract 582-02-48662
submitted by
PARSONS
to
Texas Commission on Environmental Quality
June 1 2003

Introduction: The following document is a Work Plan for activities during State fiscal year 2004 for the Orange County Total Maximum Daily Loads Project (Umbrella Contract No. 582-2-48662, referred to as the Orange County TMDL project throughout the remainder of the Work Plan). The Work Plan describes the methods and technical approach that will be undertaken in completing the work for this project. The Work Plan also provides details on the specific tasks and subtasks, a time line for completion, a listing of personnel and their efforts, and a budget.

Project Description: The purpose of this project is to support the assessment of the presence and causes of depressed dissolved oxygen concentrations, elevated fecal coliform densities, and/or low pH in nine Texas water bodies (Stream Segments 0508, 0508A, 0508B, 0508C, 0511, 0511A, 0511B, 0511C, and 0511E) on the Texas 2000 Federal Clean Water Act §303(d) List.

The objective of this project is to: 1) Develop information necessary for the TCEQ to determine if the existing designated uses and criteria are appropriate and, if not, develop information necessary for the TCEQ to change the designated use and/or applicable criteria, 2) provide data necessary to determine if specific water quality standards and criteria are being met in each of the stream segments, 3) if necessary, develop information necessary to support modeling and assessment activities required to quantify pollutant sources and allocate pollutant loadings in each of the stream segments, 4) if necessary, perform the modeling and assessment activities necessary to allocate the loadings of the constituent of concern, 5) complete the TMDL document and Implementation Plan. This project will include the assessment of historical water quality data and, if necessary, the collection of additional data through a targeted monitoring effort. Parsons, under direction of the TCEQ, will have primary responsibility for: Project Administration, Sampling Plan Development, Quality Management Program Development, Model Development and Application, Reporting, and Support for Preparation of the Implementation Plan.

TASKS AND DELIVERABLES

Task 1 Project Administration

Parsons, under the direction of the TCEQ Project Manager, will provide administrative oversight of all in-house and consultant activities including preparing and submitting monthly progress reports, tracking and reporting expenses for reimbursement, maintaining backup documentation to support allowable costs, and providing oversight and monitoring of subcontracted activities (if any). This monitoring will include contract preparation and execution, troubleshooting any problems encountered, and insuring all work is completed in a timely manner. Other aspects of project management to be accomplished under this task will include, but are not limited to, participation in Contractor Evaluations; provision of updates reflecting any changes relating to personnel; participation in conference calls and project meetings in Austin; and other related activities.

Parsons will prepare and submit monthly progress reports to the TCEQ. These reports will detail all activities completed within the preceding time period, address any scheduling shortfalls, detail any significant problems, indicate equipment requirements, include the status of deliverables for each task as well as narrative descriptions of the progress and findings of each task. Accompanying the monthly progress report, Parsons will submit an invoice for a progress payment against the work order. Invoices will be prepared in accordance with section 3.3 found in the Agreement. The monthly progress report and invoice will be submitted within 21 days of the end of each month.

Parsons will also prepare a work plan for activities in the following fiscal year.

Specific Sub-Tasks and Deliverables:	***Due Date***
1.1 Progress Reports and Invoices	monthly
1.2 Work Plan for State fiscal year 2005	as requested

Task 2 Stakeholder Participation

Parsons' project manager and/or appropriate technical staff will attend up to three stakeholder meetings in Orange, Texas. At each meeting, Parsons staff will prepare and present a technical presentation regarding specific technical items of interest (to be determined) and/or a project status update. Parsons will assist the Sabine River Authority and their subcontractors in preparing for these meetings.

Specific Sub-Tasks and Deliverables:	***Due Date***
2.1 Copies of presentation materials	prior to each stakeholder meeting

Task 3 Quality Management Program

Parsons will have primary responsibility for quality assurance of field data collection efforts, as specified in the approved quality assurance project plan (QAPP). These activities will include required amendments to the QAPP, field audits, staff training, and data validation and management.

Specific Sub-Tasks and Deliverables:	***Due Date***
3.1 Amendments to the quality assurance project plan	as necessary
3.2 Audit reports and corrective action reports	as available
3.3 Station location request forms	as necessary
3.4 Data validation reports	August 31, 2004

Task 4 Data Collection and Analysis

Parsons will assist the Sabine River Authority in collecting the data required to calibrate and verify the instream water quality model. This data collection will include the following components:

1. Sediment Oxygen Demand Measurements: Parsons staff will measure sediment oxygen demand (SOD), with appropriate replication, at twelve or more sites in Adams and Cow Bayous and/or their tributaries, as specified in the final Sampling Plan and the approved QAPP.

2. Adams Bayou Intensive Surveys: Parsons will provide four staff and required supplies and equipment to assist in performing two 48-hour intensive surveys of Adams Bayou, as specified in the final Sampling Plan and the approved QAPP. These intensive surveys will include:

   a. field measurements collected periodically with vertical profiles of pH, temperature, dissolved oxygen, and conductivity,

   b. continuous field measurements of pH, temperature, dissolved oxygen, conductivity, and water depth with recording sondes,

   c. water quality grab sample collection from upper and lower depths for laboratory analysis,

   d. flow measurements using acoustic Doppler methods (as required or possible) to allow measurements at low flows with reversing and bi-directional flows,

   e. hydrologic measurements, including width, depth, elevation, etc.

3. Cow Bayou Intensive Surveys: Parsons will provide five staff and required supplies and equipment to assist in performing two 48-hour intensive surveys of Cow Bayou, as specified in the final Sampling Plan and the approved QAPP. These intensive surveys will include:

   a. field measurements collected periodically with vertical profiles of pH, temperature, dissolved oxygen, and conductivity,

b. continuous field measurements of pH, temperature, dissolved oxygen, conductivity, and water depth with recording sondes,

c. water quality grab sample collection from upper and lower depths for laboratory analysis,

d. flow measurements using acoustic Doppler methods (as required or possible) to allow measurements at low flows with reversing and bi-directional flows,

e. hydrologic measurements, including width, depth, elevation, etc.

Specific Sub-Tasks and Deliverables: ***Due Date***

4.1 verified and validated water quality data, in TCEQ format August 31, 2004

Time line:

Task	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1.1	X*	X*	X*	X*	X*	X*	X*	X*	X*	X*	X*	X*
1.2										X*		
2.1			X*				X*				X*	
3.1												
3.2										X		
3.3										X		
3.4									X	X	X	X*
4.1									X	X	X	X*
5.2											X	X*

* indicates a deliverable will be provided during this period

Project Staff: The table below provides a list of expected individuals to work on the project with an estimate of time to be spent by each person.

List of Personnel Expected to Work on Orange County TMDL Project

Name	Labor Classification	Expected Hours
Kirk Dean*	Project Manager	580
Randy Palachek*	Supervising Scientist	153
Jim Patek*	Supervising Engineer	220
Maria Gage	Senior Specialist	45
Chris Born-Long	Senior Specialist	40
Curt Burdorf*	Engineer	375
Chris Ryon	Engineer	266
Sandra de las Fuentes*	Scientist	160

TBD	Associate Scientist	200
TBD	Administrative Assistant	20

Other staff will be used as necessary. Brief resumes for these staff are available in Parsons proposal and incorporated by reference.
* indicates key personnel

The undersigned bind themselves to the faithful performance of this Work Plan:

TCEQ:	**PERFORMING PARTY:**
Texas Commission on Environmental Quality	Parsons Water and Infrastructure, Inc.
By:________________________________ Authorized Signature	By:________________________________ Authorized Signature
________________________________ Printed Name	S. Bijoy Ghosh, P.E. Printed Name
________________________________ Title	Vice President Title
________________________________ Date:	________________________________ Date:

Orange County Total Maximum Daily Load Project
Work Plan
in response to Work Order 582-0248633-02
Amendment #1
submitted by
Sabine River Authority
to
Texas Commission on Environmental Quality
June 1, 2003

Introduction: The following document is an amended Work Plan for the second Work Order (No. 582-0248663-02) issued by the Texas Commission on Environmental Quality (TCEQ) for the Orange County Total Maximum Daily Loads Project (Interlocal Agreement Contract No. 582-2-48663, referred to as the Orange County TMDL project throughout the remainder of the Work Plan). The Work Plan describes the methods and technical approach that will be undertaken in completing the Work Order for this project. The Work Plan also provides details on the specific tasks and subtasks, a time line for completion, a listing of personnel and their efforts, and a budget.

Project Description: The purpose of this project is to support the assessment of the presence and causes of depressed dissolved oxygen concentrations, elevated fecal coliform densities, and/or low pH in nine Texas water bodies (Stream Segments 0508, 0508A, 0508B, 0508C, 0511, 0511A, 0511B, 0511C, and 0511E) on the draft 2000 Federal Clean Water Act §303(d) List in an effort to comply with Texas law.

The objective of this project is to: 1) Develop information necessary for the TNRCC to determine if the existing designated uses and criteria are appropriate and, if not, develop information necessary for the TNRCC to change the designated use and/or applicable criteria, 2) provide data necessary to determine if appropriate water quality standards and criteria are being met in each of the stream segments, 3) if necessary, develop information necessary to support modeling and assessment activities required to allocate pollutant loadings in each of the stream segments, 4) if necessary, perform the modeling and assessment activities necessary to allocate the loadings of the constituent of concern, 5) complete the TMDL document and Implementation Plan. This project will include the assessment of historical water quality data and, if necessary, the collection of additional water quality data through a targeted monitoring effort. SRA will have primary responsibility for the public participation and data collection aspects of this project.

This Work Plan describes one (1) project to be undertaken by Sabine River Authority (SRA) as part of the referenced contract between TNRCC and SRA.

TASK AND DELIVERABLES

Task 1. Public Participation

SRA will work under the direction of the TCEQ to enhance and support public participation in the TMDL development and implementation process by developing and implementing outreach strategies, including public meetings, newsletters, news releases, public service announcements, and educational materials.

SRA will provide support for community outreach and environmental education programs (public schools, radio/television/newspaper advertisements, etc) that provide opportunities for direct public involvement.

SRA will utilize the Sabine Basin Steering Committee to further develop the existing stakeholder group in the project area in accordance with HB 2912 guidance.

SRA will conduct quarterly Stakeholder Advisory Committee meetings throughout the duration of the project utilizing materials produced by SRA and approved by TCEQ.

SRA will maintain a web page for the purpose of providing a project overview, history, and informational updates regarding the Orange County TMDL Project.

SRA will submit quarterly progress reports that will contain a summary of activities, copies of materials produced/distributed, and lists of attendees and/or copies of sign-in forms for activities conducted by SRA. Other information deemed necessary will be included.

SRA will coordinate our efforts with Parsons, the contractor chosen in the RFP process for the project.

Qualified Historically Underutilized Businesses (HUBs) will be afforded the maximum practical opportunity to participate in the performance of work for subcontracts under this work plan.

Task 2 Data Collection and Lab Analysis

SRA will assist Parsons with the data collection and lab analysis effort.

Data collection will be conducted in accordance with the final sampling plan and U.S. Environmental Protection Agency approved Quality Assurance Project Plan (QAPP) created by Parsons.

Field samples will be analyzed according to guidelines specified in the final TCEQ and EPA approved QAPP.
Describe in each quarterly Progress Report the number of sampling events and the types of monitoring conducted.

Data will be submitted to the TCEQ in the form of quarterly reports in the format specified in the TCEQ Surface Water Quality Monitoring Data Management Reference Guide.

SRA shall thoroughly quality assure/quality control electronic data.

Review of the data for compliance with the TCEQ and EPA approved QAPP should take place prior to initiation of the subsequent sampling events (when possible), in order to allow time to make any necessary changes to the sampling and/or analysis protocol.

Task 3 Project Administration

SRA will develop the Work Plan for the upcoming fiscal year in order to ease the transition, in order for actual work and invoicing to continue with minimal interruption across the fiscal year boundaries.

Tasks	Deliverables:	Due Date
1.0	Quarterly Progress Reports	September 15, 2003; December 15, 2003; March 15, 2004; June 15, 2004
	Maintain Web Page for Orange County TMDL	Updates as needed
	Hold Quarterly Stakeholder Group Meetings	November 30, 2003; February 28,2004; May 30, 2004; August 31, 2004
	Notice of Stakeholder Group Meetings Mailed and e-mailed notices Notice placed on appropriate web page Notices in local news media	With Quarterly Reports
	Meeting Materials Meeting Summary List of Attendees Informational Packets	With Quarterly Reports
	Public Participation & Outreach Activities Summary of activities Copies of materials produced/distributed	With Quarterly Reports
2.0	Data Collection and Laboratory Analysis Sampling event details Quality assured data	With Quarterly Reports
3.0	Project Administration Draft Workplan for FY 2005 Final Workplan for FY 2005	June 15, 2004 July 31, 2004

<u>Time line:</u>

FY	2003											
Task	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1.0			X			X			X			X
2.0												X
3.0										X	X	

<u>Project Staff</u>: The table below provides a list of expected individuals to work on the project with an estimate of time to be spent by each person.

List of Personnel Expected to Work on Orange County TMDL Project

Name	Labor Classification	Estimated Hours
Jack W. Tatum	Water Resources Manager	56
Gerard M. Sala	Water Resources Coordinator	76
Mary S. Vann	Environmental Services Manager	32
Miles A. Hall	Resource Management/Project Development Manager	196
James E. Brown	Website Administrator	144
Mark S. Howard	**GIS Analyst**	152
Bambi Granger	Secretary	44
Ann Galassi	Public Relations / Economic Development Manager	114
John Payne	Special Projects Administrator	72

Intensive Survey Sampling

Labor/Equipment	Number	Events	Units Per Event	Total	Unit Cost	Total Cost
Field Biologists	4	2	40	320	$75.00	$24,000.00
Equipment (boats)	2	2	1	4	$100.00	$400.00
Equipment (Hydrolab)	2	2	1	4	$100.00	$400.00
Vehicle (Mileage)	2	2	50	200	$0.36	$72.00
Total Labor/Equipment						$24,872.00
Laboratory Analysis						$93,585.00
Total for Intensive Survey Sampling						$118,457.00

Budget:

Budget Category	FY 2004
Personnel/Salary	$24,157.99
Fringe Benefits	$6,039.50
Travel	$1,200.00
Supplies	$3,000.00
Equipment	$-
Contractual	$13,500.00
Construction	$-
Other	$121,457.00
Total Direct Costs	$169,354.49
Indirect Costs	
Total Cost	$169,354.49

Appendix B - Sampling Process Design and Monitoring Schedule (Plan)

Sampling Plan for Modeling to Support TMDL Development in Adams Bayou Tidal (Segment 0508), Cow Bayou Tidal (Segment 0511) and Their Tributaries

Introduction

The goal of this effort is to provide sufficient data for the calibration and verification of a water quality model to support development of total maximum daily loads (TMDLs) for *E. coli* bacteria and dissolved oxygen in Adams Bayou and its tributaries Gum Gully and Hudson Gully, and for a second water quality model to support development of TMDLs for *E. coli* bacteria, dissolved oxygen, and pH in Cow Bayou and its tributaries, Coon Bayou, Cole Creek, and Terry Gully.

The historical and current water quality data for the water bodies under investigation were assessed in detail in a companion report entitled *Assessment of Water Quality Impairments in Adams Bayou Tidal (Segment 0508), Cow Bayou Tidal (Segment 0511) and Their Tributaries (Parsons 2002)*. The report concluded that a review of ambient water quality data collected in the latest 5-year period indicated a high degree of confidence (>99%) that dissolved oxygen criteria are not met in portions of Segments 0508, 0508A, 0508C, 0511, 0511A, and 0511B. Similarly, data indicated with a high degree of confidence that fecal coliform criteria are not met in portions of Segments 0508, 0508A, 0508B, 0508C, 0511B, and 0511E. There is a small chance (about 5%) that the decision that the minimum pH criterion was not met in Cow Bayou Tidal was incorrect.

The selection of appropriate water quality models for development of these TMDLs was addressed in a technical memorandum entitled *Model Evaluation and Selection for TMDL Development in Adams Bayou Tidal (Segment 0508), Cow Bayou Tidal (Segment 0511) and their Tributaries.* This memorandum concluded that both a watershed and a receiving water model would be required for TMDL development. The dissolved oxygen depletion in these bayous appears to be largely controlled by sediment oxygen demand (SOD) and its concomitant depositional patterns throughout the bayous. An increased SOD zone midway through each bayou generally corresponds to the areas of maximum freshwater/saltwater mixing at the head of the oscillating tidal wedge. This is an area of rapidly changing electrochemical potential due to steep salinity gradients that often produces chemical and physical flocculation and coagulation. This can, in turn, effectively sweep suspended, and in some cases dissolved, oxygen-demanding materials out of the water column, deposit them into the sediments, and produce augmented SOD. The exacerbated bacterial respiration associated with this SOD is likely also responsible for the accompanying pH depression. The sources of both bacteria and the oxygen-demanding materials in the water column that eventually settle to produce the SOD are both point and nonpoint, but episodic nonpoint loading is believed to dominate the loads in most areas.

On the basis of several criteria, HSPF was determined to be the most appropriate watershed model, and WASP (using DYNHYD or EFDC as the hydrologic component) was determined to be the most appropriate receiving water model. The important processes that require modeling are discussed below.

Model Processes

The important processes controlling dissolved oxygen, pH, and *E. coli* concentrations that are considered in the selected models include:

- re-aeration of the water column with atmospheric oxygen
- carbonaceous BOD - bacterial respiration of dissolved and particulate organic matter in the water column
- nitrification - bacterial-mediated oxidation of ammonia to nitrate (nitrogenous BOD)
- denitrification – conversion of nitrate to nitrogen gas (more important in sediments)
- settling of particulate CBOD to sediments
- re-suspension of particulate CBOD from sediments
- algal photosynthesis
- algal respiration
- algal death and decomposition
- sediment oxygen demand - bacterial respiration of organic matter in the sediments
- E. coli die-off
- E. coli settling
- E. coli re-suspension

Some processes not explicitly considered in the model include groundwater exchange, atmospheric deposition, photosynthesis and respiration by aquatic macrophytes, *E. coli* regrowth, sediment diagensesis, and chemical oxidation of iron, manganese, sulfide, and other redox-sensitive substances. Not all of these processes may be critically important in Adams Bayou and Cow Bayou. It is considered best to develop the simplest model that includes all the important processes affecting the observed water quality problems (USEPA, 1991). Thus, some less important processes, such as algal photosynthesis and respiration, may be de-emphasized in the models developed for Adams Bayou and Cow Bayou. Also, processes such as *E. coli* die-off, settling, and re-suspension may be combined to an overall net *E. coli* decay rate.

The rates and parameters required by these models are listed in Table 1. The values of these rates and parameters required by the model can be derived from several sources. They can be:

1. measured in the system being modeled,
2. calculated based on other more easily measurable parameters using established empirical or theoretical relationships, or
3. estimated based on measured values from other systems found in the scientific literature, or adjusted to achieve the best fit to observed response variables during calibration.

While models can be developed and run with few measurements in the system being modeled, their predictions are subject to large uncertainty (USEPA, 1990). To achieve the most accurate model and reduce uncertainty, it is best to measure as many of the key rates and parameters as possible in the system being modeled. Table 1 presents a recommended sampling plan to support the modeling effort, reflecting the modeler's subjective opinion of the most cost-effective approach to achieving a defensible model.

Table 1. Key Model Parameters and their Sources

Process	Parameter	Source of Parameter Estimate			Calculation Basis and Other Notes
		Measured	Literature values or model calibration	Calculated from other parameters	
re-aeration	re-aeration rate			√	water velocity, depth, wind speed, air & water temperature, salinity
carbonaceous BOD oxidation	CBOD conc.	√			
	CBOD oxidation rate constant and temp. coefficient		√		
	CBOD half-saturation constant		√		
nitrification	ammonia nitrogen conc.	√			
	nitrification rate constant and temp. coefficient		√		
	nitrification half saturation constant		√		
denitrification	nitrate nitrogen conc.	√			
	denitrification rate constant and temp. coefficient		√		
	denitrification half saturation constant		√		
organic carbon (as CBOD) settling	CBOD particulate fraction	√			
	particulate CBOD settling velocity			√	particle size and density, water velocity
re-suspension	upward re-suspension velocity		√		
algal photosynthesis, respiration, death, and decomposition	algal carbon			√	measured chlorophyll A with literature OC:ChlA ratios
	algal growth rate constant and temperature coefficient		√		

Process	Parameter	Source of Parameter Estimate			Calculation Basis and Other Notes
		Measured	Literature values or model calibration	Calculated from other parameters	
	algal respiration rate constant and temp. coefficient		√		
	algal death rate constant and temp. coefficient		√		
sediment oxygen demand	sediment oxygen demand	√			
	CBOD oxidation rate constant and temp. coefficient		√		
	Sediment denitrification rate constant and temp. coefficient		√		
	Sediment algal decomposition rate constant and temp. coefficient		√		
	diffusive exchange coefficient		√		
	active surface sediment layer thickness	√			
	sediment porosity, density, and grain size (% sand, silt, clay)	√			
	sediment-water interfacial area			√	channel width, average depth
E. coli settling	E. coli settling rate		√		
E. coli re-suspension	E. coli resuspension rate		√		
E. coli die-off	E. coli die-off rate		√		
Wasteloads	DO, EC, pH, Cl-, TSS, VSS, temp., salinity, alkalinity, $CBOD_5$, NO_3-N, NH_3-N, TKN, TP, OP, discharge	√			

Process	Parameter	Source of Parameter Estimate			Calculation Basis and Other Notes
		Measured	Literature values or model calibration	Calculated from other parameters	
NPS Loads	DO, EC, pH, Cl^-, TSS, VSS, temp, salinity, alkalinity, $CBOD_5$, NO_3-N, NH_3-N, TKN, TP, OP, discharge	√	√	√	utilization of literature values, long-term gage and precipitation data together with a limited amount of runoff monitoring to assist in calibrating the model for NPS loading
Boundary concentrations	DO, EC, pH, Cl^-, TSS, VSS, temp, salinity, alkalinity, discharge, $CBOD_5$, NO_3-N, NH_3-N, TKN, TP, OP, ChlA	√			
in-stream conditions	DO, EC, pH, Cl^-, TSS, VSS, temp, salinity, alkalinity, $CBOD_5$, NO_3-N, NH_3-N, TKN, TP, OP, ChlA, flow	√			Measured in the epilimnion and hypolimnion in areas with vertical stratification
hydrography	surface elevation	√			
	bottom elevation			√	surface elevation - depth
	surface area	√			
	volume			√	surface area x mean depth
	channel length, depth, width, and cross-sectional area	√			
	Manning's roughness coefficient		√		
	channel orientation	√			
	wind speed and direction	√			acquired data
	channel hydraulic radius			√	~ depth for wide channels

Process	Parameter	Source of Parameter Estimate			Calculation Basis and Other Notes
		Measured	Literature values or model calibration	Calculated from other parameters	
	mean channel velocity	√			
	tidal height versus time at downstream boundary	√			
	Cl^-, salinity, or conductivity	√			
meteorology	hourly precipitation	√			acquired data
	daily pan evaporation	√			acquired data
	daily min and max temperature	√			acquired data
	daily wind movement (speed and direction)	√			acquired data
	daily solar radiation	√			acquired data
	dew point temperature	√			acquired data
	average daily cloud cover	√			acquired data
watershed properties	digital elevation model	√			acquired data
	land use delineation	√			acquired data
	soils delineation, characteristics	√			acquired data
hydrography	channel length, width, and cross-sectional area	√			
	surface elevation	√			
	bottom elevation			√	surface - mean depth
	sediment particle size distribution	√			
	water diversions and point source discharges	√			acquired data
	contributing drainage area for each reach	√			

Table 2. Summary of Laboratory-Measured Parameters

Parameter	Sample Type	Total Sample Count#			
		Ambient†	**Effluent †**	**Storm ‡**	**Sediment**
carbonaceous biochemical oxygen demand ($CBOD_5$)	water	374	26	84	0
ultimate biochemical oxygen demand (UBOD)	water	12	26	0	0
ammonia nitrogen (NH_3-N)	water	374	26	84	0
nitrate+nitrite nitrogen (NO_3+NO_2-N)	water	374	26	84	0
total Kjeldahl nitrogen (TKN)	water	374	26	84	0
ortho-phosphorus (OP)	water	374	26	84	0
chlorophyll A (ChlA)	water	134	0	0	0
total suspended solids (TSS)	water	374	26	84	0
volatile suspended solids (VSS)	water	374	26	84	0
E. coli (EC)	water	374	26	84	0
alkalinity, total and phenolphthalein	water	374	26	84	0
grain size (% sand, silt, & clay)	sediment	0	0	0	24
total percent solids (%solids)	sediment	0	0	0	24
volatile solids (VS)	sediment	0	0	0	24

includes quality control samples
† total includes four intensive surveys, two for each bayou system, with each lasting 48 hours.
‡ total includes two storm events at six or seven sites, which would be sampled in groups of two or three. Approximately ten to eighteen samples would be generated on a sampled day.

Data Collection Considerations
1. Model Duration and Temporal Resolution

Due to the nature of the impairment, a dynamic water quality simulation was recommended in the model selection technical memorandum. Because of the impact of the tidal cycle and the necessity to simulate storm runoff, the model timestep should be from one to three hours, and sampling should occur at least every 3 hours at most sites. Whenever possible, all locations should be sampled synoptically (USEPA, 1990).

The period being modeled has a strong influence on the sampling plan. There are several considerations in determining the length of this period. Of course, the shortest sufficient duration is preferable to the extent that it reduces the level of effort in collecting the data required by the model. The important considerations include the size of the domain being modeled versus the hydrologic time of travel, the time scale of hydrologic and reaction kinetics being simulated, and the time scale of the regulatory limits used as the water quality target. The model simulation duration should also be long enough to eliminate the effects of the initial conditions on important water quality constituents at critical locations (USEPA, 1990). In a tidally-influenced system, the model duration should include at least two full tidal cycles (Brown and Ecker 1978).

Water time of travel was measured to be 0.272 feet per second in above tidal reaches of Cow Bayou in a 1986 intensive survey (Kirkpatrick 1988). At this rate, water would move approximately four and a half miles per day. Given that the total length of Cow Bayou is over 30 miles in length, approximately seven days would be required for water to flow from the headwaters to the Sabine River at this rate. The reversing tidal flows would tend to lengthen this period, while higher runoff flows would shorten it. Time of travel has not been measured in Adams Bayou, but Adams Bayou is substantially shorter.

The key reaction kinetics to be simulated are believed to include the re-aeration of the water column with atmospheric oxygen, die-off and settling of E. coli bacteria, bacterial respiration of organic matter in the water column, particulate BOD settling, nitrification, and bacterial respiration of organic matter in the sediments. BOD settling was found to be among the slowest kinetic factors in the 1986 waste load allocation for Adams and Cow Bayous, with rates of 0.05-0.15 day^{-1}. At a rate of 0.1 day^{-1}, 23 days would be required for 90% of the particulate BOD to settle. Thus, the hydraulic residence time limits the BOD settling. Ammonia nitrification and bacterial BOD respiration in the water column and sediments can also be limiting kinetic factors.

For practical reasons, the intensive data collection effort must be limited to approximately 48 hours, a sufficient period to allow for two complete tidal cycles. A maximum four-hour time period between measurements at each site is recommended, with suspended sampling in the dark. However, some sites should be monitored with 24-hour recording sondes to achieve continuous water level and water quality data. Other sites, such as some boundary or oxbow stations, may have reduced sampling.

2. Watershed Model and Nonpoint Source Loading

Due to the important impacts of nonpoint sources of fecal coliform and oxygen demanding substances, monitoring of runoff events for quantification of pollutant loads is recommended to assist in calibration of the HSPF watershed model. Ideally, the monitoring should include the in-stream response to the runoff loads and return to base flow conditions, when dissolved oxygen levels tend to be lowest. This is considered the situation most reflective of the impairments observed here, and would likely provide the most accurate model predictions. The probability of rainfall events of various magnitudes is given in Table 3. On average, a one-half inch rainstorm occurs approximately weekly in July. A one-half inch rainstorm is likely to produce measurable runoff. Review of precipitation and stream flow data for Cow Bayou indicates that three to five days are typically required following a significant runoff event to return to low flow conditions. Thus, an intensive survey covering a rainfall event and recovery to base flow conditions would likely require a full week of data collection. This type of sampling effort is precluded by the length of the sampling period, the uncertainty of rainfall, and the intensity of effort required to simultaneously measure runoff loads and the in-stream response. Instead, we plan to calibrate the in-stream model under low-flow conditions, and develop the watershed model separately. This will simplify scheduling, reduce the amount of personnel and equipment required, and reduce the expense.

In order to assist in quantifying runoff flows and nonpoint-source pollutant loads for the watershed model, runoff loads will be measured on six Adams and Cow Bayou tributaries that drain sub-watersheds with a variety of different land uses. Each site will be monitored twice, and antecedent dry periods will vary to estimate pollutant buildup and washoff parameters. In addition to this data, long-term records of rainfall and flow in Cow Bayou will be used to calibrate flow in the watershed model.

Table 3. Precipitation Frequency in the Orange County TMDL Project Area (from Miller and Frederick, 1966)

Month	**Normal Number of 24-hour Periods with Specified Rainfall**		
	0.5”	**1”**	**2”**
June	2.5 − 3	1.25 − 1.5	0.5 − 0.6
July	4 − 4.5	~ 2.5	0.8 − 1
August	3 − 3.5	1.5 − 1.75	~ 0.6
September	~ 3	1.5 − 1.75	~ 0.6

3. One-, Two-, or Three-Dimensional Model

The most basic in-stream WASP model would treat the stream as a horizontally and vertically well-mixed system, with a single upstream-downstream dimension. However, Adams and Cow Bayous are tidal systems with salinity-based density stratification. In other similar systems, a saltier wedge of water has been found to move up and down the bayou during a tidal cycle, with less dense freshwater flowing above it. In some cases, these two water layers flow in opposite directions. Because mixing between the surface and deeper waters may be very limited, the assumptions of a one-dimensional model are likely violated. Thus, a two-dimensional model including surface and deeper water masses will likely be required. This will not entail a great deal of additional modeling effort, but will require ambient water sampling of the surface and deeper waters, and vertical profiles of field parameters and flow, at stations where vertical stratification is present.

The oxbows comprising the historical river channel prior to its dredging create another potential difficulty for modeling. The oxbows are an additional reservoir of water. With the tidal cycle, water will move from these oxbows into the main channel and back. A portion of the flow down the stream may also travel through the oxbows rather than the main channel. From a modeling standpoint, the oxbows are expected to cause a time lag in changes of the concentrations of water quality constituents. This may hinder calibration of the model. The model can be modified to account for the oxbows, but additional hydrologic and water quality data must be collected in the oxbows to calibrate this three-dimensional model. Because we do not know the impact of the oxbows on flow and water quality, it is recommended that a limited amount of sampling on oxbows be performed to allow calibration of the three-dimensional model.

4. Model Calibration, Validation, and Analysis

Model calibration alone is not sufficient to determine the predictive capability of a model. Model confirmation testing, or validation, should be performed, using an ambient water quality data set independent from that used for calibration (USEPA, 1990). Thus, water quality monitoring should ideally include two separate and independent events, with one used to calibrate the model and the second to verify that the model adequately predicts water quality conditions. However, the cost of a second intensive survey on each bayou will be substantial. The availability of funding will dictate whether this independent model validation is performed.

5. Use of Existing Data

Some of the values required by the models have been measured in previous surveys of Adams and Cow Bayous. These values include:

- water quality constituent measurements in point source effluents, rainfall runoff, and in-stream locations;
- flow, cross-section, velocity, and time-of-travel measurements at in-stream locations;
- meteorology;
- primary productivity measurements in Cow Bayou;
- sediment oxygen demand measurements in Cow Bayou; and
- tidal measurements in Cow Bayou.

There are several problems with using the existing data to develop a water quality model. Most of the data was not collected on a synoptic basis, or at sufficient temporal resolution to allow calibration of a dynamic water quality model. Very little of the existing data includes coverage of upstream reaches and all the tributaries to be addressed for these TMDLs. The available data from intensive surveys that was collected on a synoptic basis is, for the most part, fifteen to twenty years old. Numerous changes have occurred since that time in wastewater discharges, nonpoint pollutant sources, and possibly flow and hydraulic properties of the bayous. The existing data from intensive surveys was collected in support of a steady-state model, which has different data requirements than a dynamic model. However, the existing data will be useful to guide selection of appropriate estimates for model parameters.

6. Coordination and Collaboration with Other Data Collection Efforts

Table 4 describes the data that will be collected independent of this TMDL project starting in 2003. These efforts could provide a significant portion of the data required for the Cow Bayou model, if the two data collection efforts can be scheduled to coincide with each other and share data. All efforts should be made to achieve this co-scheduling for Cow Bayou.

Suggested Data Collection

Stormwater Measurements to Assist in Calibration of a Watershed Loading Model

Table 5 lists seven stormwater monitoring sites (displayed in Figure 1), from which six will be selected for monitoring based on site accessability and security considerations. The selected sites to be monitored are on non-tidal tributaries of Adams and Cow Bayou that have minimal or no point source wastewater inputs. The sites monitored include both rural and urban watersheds.

It is considered optimal, in calibrating a runoff model, if one of the two events sampled at each site has a short antecedent dry period before runoff sampling, while the other event sampled has a longer antecedent dry period. In practice, it may be difficult to achieve these conditions, and given that autosamplers are rented by the week and their installation at a site can be time-consuming, it is expected that all satisfactory rainfall samples will be acceptable. Over the course of the sampling, a sufficiently varied mix of short and long antecedent period rainfall events will likely be sampled to allow model calibration.

Sediment Oxygen Demand Measurements to Assist Calibration of the Instream Water Quality Models

Because SOD appears to be the proximate factor responsible for oxygen depletion, it will strongly influence the model. While SOD is difficult to accurately measure, a measured but approximate estimate is preferable to a baseless guess to bracket the range of potential SODs for the model. SOD will be measured at a number of stations, listed in Table 6 and displayed in Figure 2, in each of the designated portions of Adams and Cow Bayou. Because spatial heterogeneity in sediments can be much more substantial than temporal variation in sediments, SOD will be measured at a given station on only a single occasion, but at two or three adjacent locations at each station (e.g., 10-50 feet apart on a stream transect). In addition to SOD, sediment samples will be collected for laboratory analysis of volatile solids (primarily organic matter), total solids content, and grain size. Additionally, the active benthic layer thickness will be visually estimated from sediment cores.

Instream and Effluent Measurements as part of Intensive Surveys

Instream flow and ambient water quality measurements suggested as part of an intensive survey of Adams Bayou are listed in Table 7, displayed in Figure 3, and synoptic Adams Bayou effluent measurements are listed in Table 8. Instream flow and ambient water quality measurements suggested as part of an intensive survey of Cow Bayou are listed in Table 9, displayed in Figure 4, and synoptic Cow Bayou effluent measurements are listed in Table 10. For these ambient water quality measurements, vertical profiles of field parameters should be collected. In the case that the water column is stratified, water quality samples should be collected from both the epilimnion and hypolimnion (i.e., one foot below the surface and one foot above the bottom).

Budget

Because this sampling effort will be carried out by two entities, the Sabine River Authority and Parsons, it is difficult to determine an overall budget for this work. Parsons and the Sabine River Authority will separately provide their budgets for the portion of the work they will perform. However, it is believed that the data collection effort outlined in this plan can be completed for between $300,000 and $400,000.

References

Kirkpatrick, J. 1988. Intensive Survey of Cow Bayou Tidal, Segment 0511, September 9-11, 1986. IS 88-02. Texas Water Commission, Austin, TX

Miller, J.F., and R. H. Frederick. 1966. Normal Monthly Number of Days with Precipitation of 0.5, 1.0, 2.0, and 4.0 Inches or More in the Conterminous United States. Tech. Paper No. 57. U.S. Dept. of Commerce, Washington, DC.

U.S. Environmental Protection Agency (USEPA). 1990. Technical Guidance Manual for Performing Waste Load Allocation. Book III. Estuaries. Office Of Water, Washington, DC.

Parsons 2002. Assessment of water quality impairments in Adams Bayou Tidal (segment 0508), Cow Bayou Tidal (segment 0511) and their tributaries.

Parsons 2003. Technical Memorandum, model evaluation and selection for TMDL development in Adams Bayou Tidal (segment 0508), Cow Bayou Tidal (segment 0511) and their tributaries.

Table 4. Planned Water Quality Monitoring in Adams and Cow Bayous, 2003, External to this Project

Station ID	Site Description	Start Date	End Date	SC1/ SC2	Prog Code	Monitoring Frequency (Per Year)							
						24hr Field[1]	Flow[2]	Aquatic Habitat	Benthic Infauna	Routine Nekton	Bact.	Conv[3]	Field[4]
17877	Cow Bayou tidal approx 2.2 km upstream of SH 87 in original stream channel	Spring 2003	Fall 2004	PW/PW	TI TO	6	6	1 during study	3	6		6	6
10451	Cow Bayou at SH 87	Spring 2003	Fall 2004	PW/PW	TI TQ	6	6	1 during study	3	6		6	6
10454	Cow Bayou 50 yds downstream of Cole Creek	Spring 2003	Fall 2004	PW/PW	TI TQ	6	6	1 during study	3	6		6	6
10446	Cow Bayou approximately 2400 feet above confluence with the Sabine River	Spring 2003	Fall 2004	PW/PW	TI TQ	6	6	1 during study	3	6		6	6
10441	Adams Bayou at FM 1006 in Orange, TX, Subwatershed 1.03 (AB2)	September 2002	August 2003	SR/SR	IS						12	12	12
15107	Adams Bayou at FM 3247 NW of Orange, TX Subwatershed 1.03 (AB7)	September 2002	August 2003	SR/SR	DI IS	2					12	12	12
10449	Cow Bayou At FM 1442 (downstream crossing, Round Bunch Rd) east of Bridge City, TX , SW 1.02 (CB1)	September 2002	August 2003	SR/SR	IS						12	12	12
13781	Cow Bayou At FM 1442 (North Crossing) Between FM 105 And IH10, Subwatershed 1.02 (CB4)	September 2002	August 2003	SR/SR	DI IS	2					12	12	12

124hr. Field Measurements: temperature, dissolved oxygen, specific conductance, salinity, depth, and pH, recorded every half hour with a logging sonde at two depths: 0.3 meter, and 1 meter above the bottom.

2Flow: recording Acoustic Doppler flow meter installed for at least 24 hours at Station 10446, with instantaneous flows at other stations

3Conv.:may include total dissolved solids, chloride, sulfate, total suspended solids, volatile suspended solids, 5-day carbonaceous biochemical oxygen demand, total organic carbon, chlorophyll A, pheophytin A, total Kjehdahl nitrogen, ammonia nitrogen, nitrate+nitrite nitrogen, total phosphorus, and orthophosphate.

4Field: temperature, dissolved oxygen, pH, specific conductance, salinity, depth, days since last significant rainfall, flow, flow severity, and Secchi depth.

Table 5. Stormwater Measurement Stations

Station ID	Site Description	Number of Events	Area (km^2)	Land Use
16058	Cow Bayou at Jasper CR 826	2	120	70% forest, 12% pasture, 9% wetlands, 6% transitional, 3% developed
TBD	Dognash Gully at County Road 826	2	51	67% forest, 25% wetlands, 5% pasture, 1% developed, 1% transitional
16060	Cole Creek at IH-10	2	32	64% forest, 21% pasture, 7% developed, 6% wetlands, 1% open water
16040	Terry Gully at IH-10	2	10	65% forest, 19% developed, 15% pasture, 1% wetlands, 1% open water
16049	Gum Gully at Halliburton Rd. (GG)	2	9	47% pasture, 38% forest, 12% wetland, 2% developed, 1% open water
16041	Hudson Gully at Lexington (HG)	2	7	37% developed, 36% pasture, 23% forest, 2% wetland
16053	Adams Bayou Lateral #8 at Bancroft Road (AL8)	2	6	58% pasture, 22% forest, 9% open water, 8% developed, 3% wetland

Note: six of these seven sites wil be selected for stormwater measurements based on site access and safety considerations. Station 16053 is included as an alterante site.

Table 6. Sediment Oxygen Demand Measurements to Calibrate the Instream Water Quality Model

Station ID	Site Description
15107	Adams Bayou at FM 3247 (AB7)
10443	Adams Bayou at IH 10 (AB6)
14990	Adams Bayou at Park Ave. (AB5)
16059	Adams Bayou at Green Ave. (AB4)
10442	Adams Bayou at Western Ave. (AB3)
10441	Adams Bayou at FM 1006 (AB2)
10337	Cow Bayou at SH12 (CB6)
10457	Cow Bayou at IH 10 (CB5)
13781	Cow Bayou at FM 1442 North Crossing (CB4)
10453	Cow Bayou at FM 105 (CB3)
10451	Cow Bayou at SH 87 (CB2)
10449	Cow Bayou At FM 1442 (CB1)

Table 7. Ambient Water Quality Stations to be Monitored as part of an Intensive Survey of Adams Bayou to Calibrate the Instream Water Quality Model

Station ID	Site Description	24 hr Field	Instantaneous Field	Flow/ Hydrography	Conv. + Bact. Grab
14964	Adams Bayou at FM 1078 (AB8)	√		√	√
15107	Adams Bayou at FM 3247 (AB7)		√	√	√
10443	Adams Bayou at IH 10 (AB6)	√		√	√
14990	Adams Bayou at Park Ave (AB5)		√	√	√
16059	Adams Bayou at Green Ave (AB4)	√		√	√
10442	Adams Bayou at Western Ave (AB3)		√	√	√
10441	Adams Bayou at FM 1006 (AB2)	√		√	√
TBD	Sabine River at confluence with Adams Bayou		√		√
16049	Gum Gully at Halliburton Rd (GG)	√		√	√
16041	Hudson Gully at Lexington (HG)		√	√	√
16056	Adams Bayou Lateral #8 at Bancroft Rd. (AL8)*		√	√	√
16057	Adams Bayou Lateral #1 at FM 2177 (AL1)*		√	√	√
16053	Adams Bayou Lateral #2 at Flint Rd. (AL2)*		√	√	√
TBD	Adams Bayou oxbow #11*		√	√	√
TBD	Adams Bayou oxbow #12*		√	√	√

*conventional parameters and flow will be measured at a reduced frequency on some oxbow and tributary stations

Table 8. Effluents to be Monitored as part of an Intensive Survey of Adams Bayou to Calibrate the Instream Water Quality Model

Effluent samples would be collected twice per intensive survey, once per day. Measurements at each site would include field parameters, as well as samples for conventional and bacteria analysis. Wastewater flow measurements of each facility would be measured or acquired from each facility, if available.

Station ID	Site Description
16044	Orange County WCID #2 WWTP (AW2) - Permit WQ0010240.001
16043	City of Pinehurst WWTP 001 (AW3) - Permit WQ0010597.001

Table 9. Ambient Water Quality Stations to be Monitored as part of an Intensive Survey of Cow Bayou to Calibrate the Instream Water Quality Model

Station ID	Site Description	24 hr Field	Instantaneous Field	Flow/ Hydrography	Conv + Bact Grab
16058	Cow Bayou at Jasper CR 826 (CB7)		√	√	√
10337	Cow Bayou at SH12 (CB6)	√		√	√
10457	Cow Bayou at IH 10 (CB5)		√	√	√
16060	Cole Creek at IH 10 (CC)		√	√	√
13781	Cow Bayou at FM 1442 North Crossing (CB4)	√		√	√
10454	Cow Bayou 50 yds downstream of Cole Creek		√	√	√
10453	Cow Bayou at FM 105 (CB3)	√		√	√
10452	Cow Bayou halfway between FM 105 and SH 87		√	√	√
10451	Cow Bayou at SH 87 (CB2)	√		√	√
10449	Cow Bayou At FM 1442 (CB1)		√	√	√
TBD	Cow Bayou approx. 8500 ft upstream from Sabine River	√		√	√
10392	Sabine River at confluence with Cow Bayou		√		√
16052	Coon Bayou at SH 87 (CNB)		√	√	√
TBD	Terry Gully at FM 1442		√	√	√
TBD	Cow Bayou Oxbow 2*		√	√	√
TBD	Cow Bayou Oxbow 3*		√	√	√
17877	Cow Bayou tidal approx 2.2 km upstream of SH 87 in original stream channel (Oxbow 4*)	collected by TPWD staff			

**conventional parameters and flow will be measured at a reduced frequency on some oxbow and tributary stations*

Table 10. Effluents to be Monitored as part of an Intensive Survey of Cow Bayou to Calibrate the Instream Water Quality Model

Effluent samples would be collected twice per intensive survey, once per day. Measurements at each site would include field parameters, as well as samples for conventional and bacteria analysis. Wastewater flow measurements of each facility would be measured or acquired from each facility, if available.

Station ID	Site Description
16068	City of Bridge City WWTP 001 (CW1) - Permit WQ0010051.001
16063	Orangefield ISD WWTP (CW5) - Permit WQ0011607.001
16064	PCS Development Co (CW8) – Permit WQ0011916.001
16062	Oak Terrace WWTP 001 (CW10) - Permit WQ0011357.001
16045	Jasper WCID #1 WWTP 001 (CW13) - Permit WQ0010808.001
16047	Bayer Corp. COBR Outfall 001 (CI1) - Permit WQ0001167.001
16070	Bayou Pines Park (Edward N. Smith, Jr.) – Permit WQ0011315.001
16066	TXDOT Orange Co. Comfort Station – Permit WQ0011457.001
16073	Firestone Polymers Inc. Outfall 001 (CI4) - Permit WQ0000454.001
16074	Chevron Phillips Chemical Co. (CI3) - Permit WQ0000359.001
TBD	Honeywell International Outfall 001 - Permit WQ0000670.001

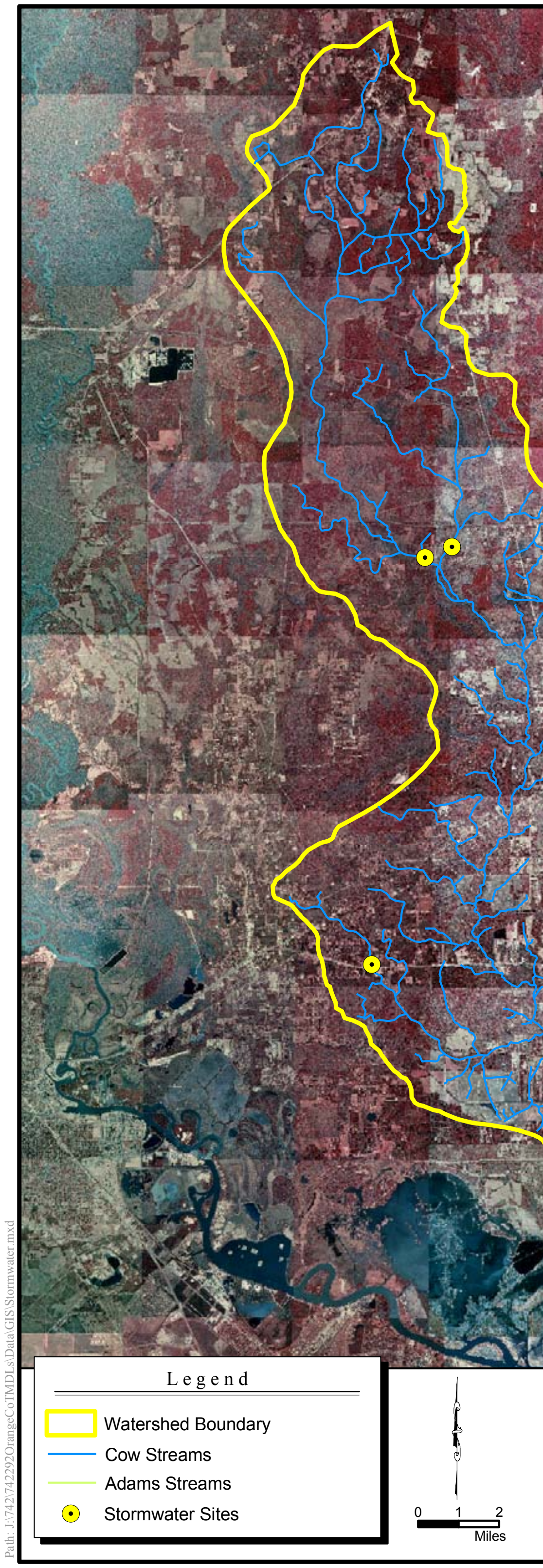


Figure 1

Stormwater Monitoring Sites

Orange County

PARSONS

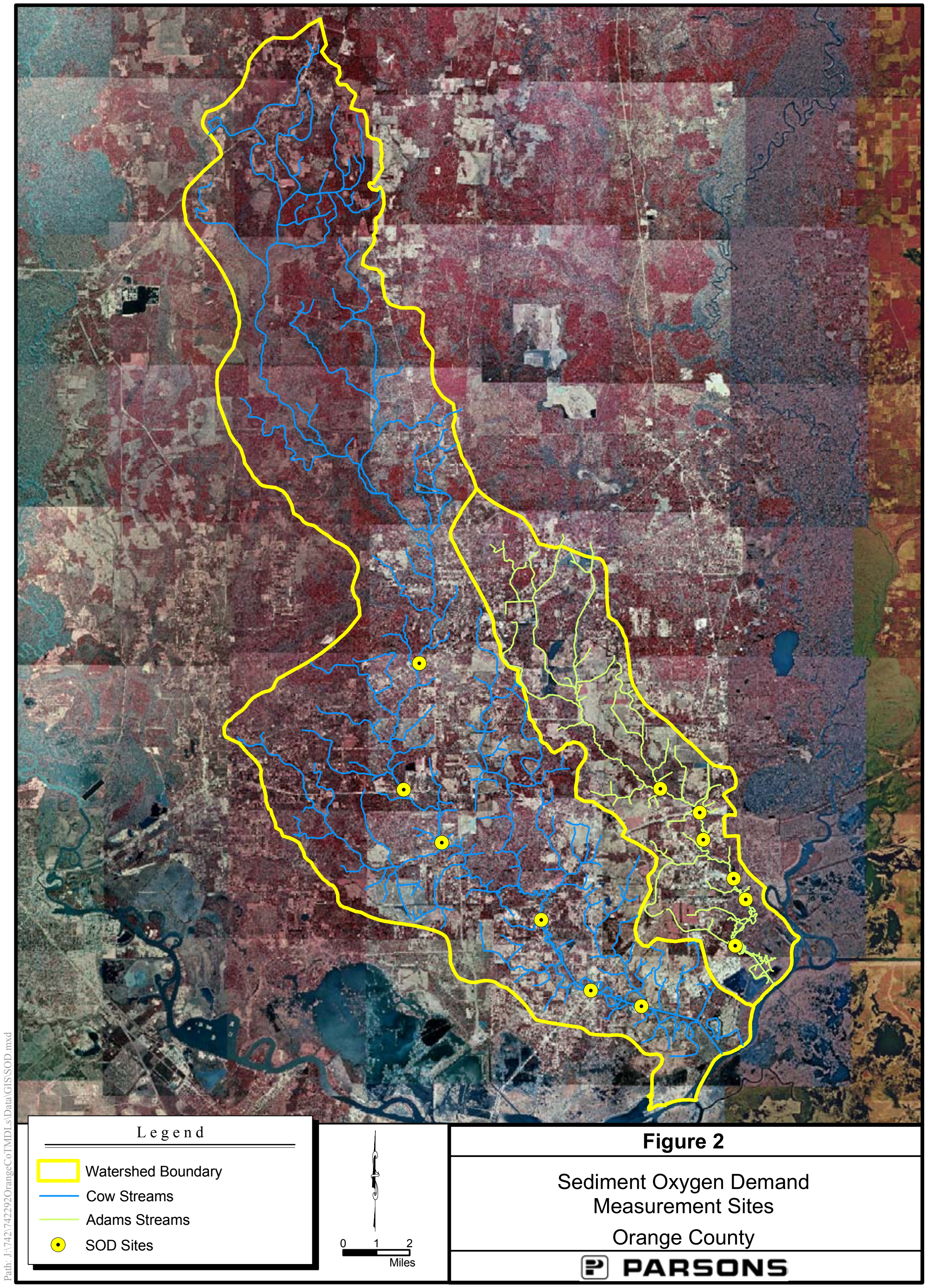


Figure 2

Sediment Oxygen Demand Measurement Sites

Orange County

PARSONS

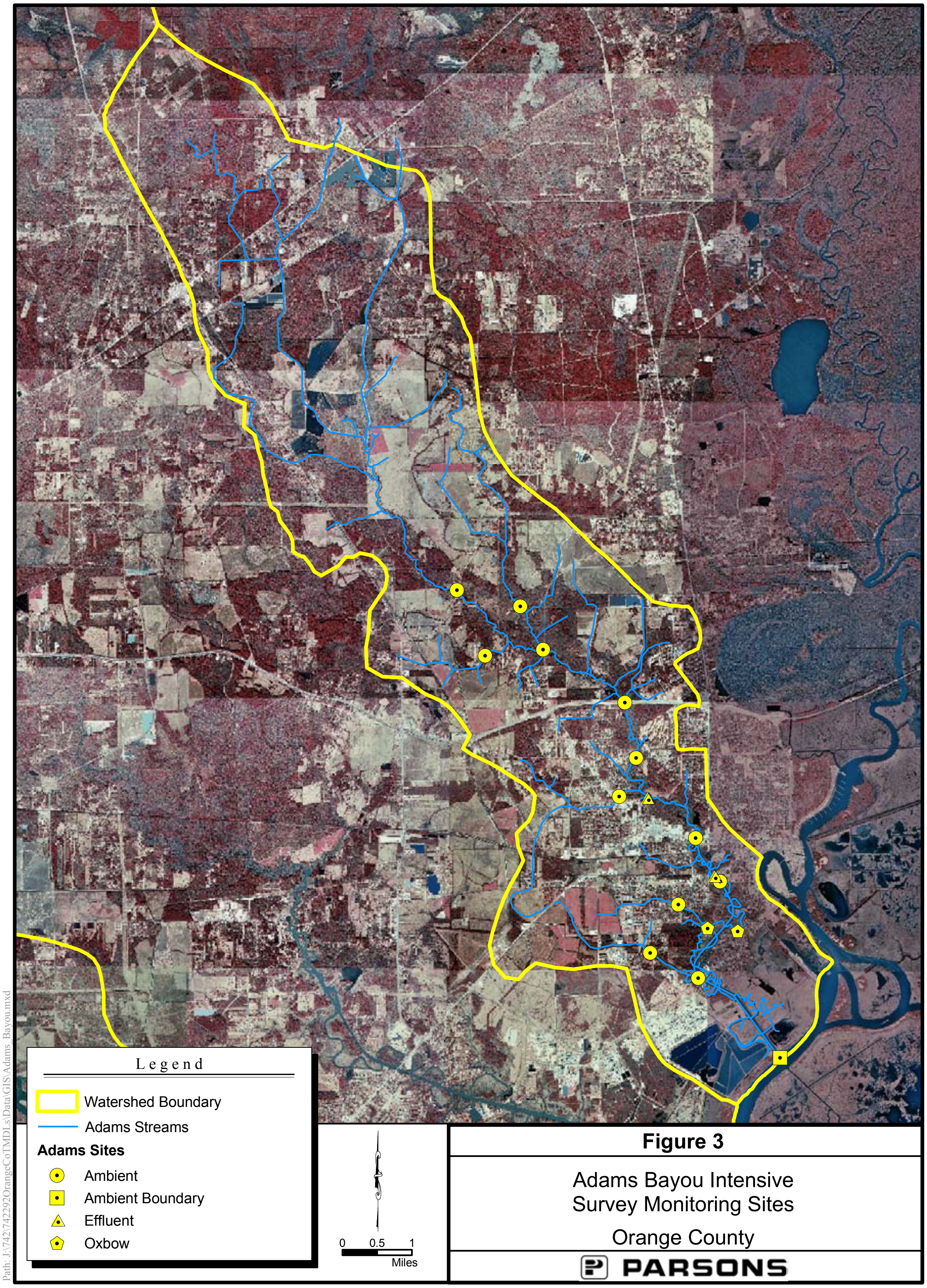


Figure 3

Adams Bayou Intensive Survey Monitoring Sites

Orange County

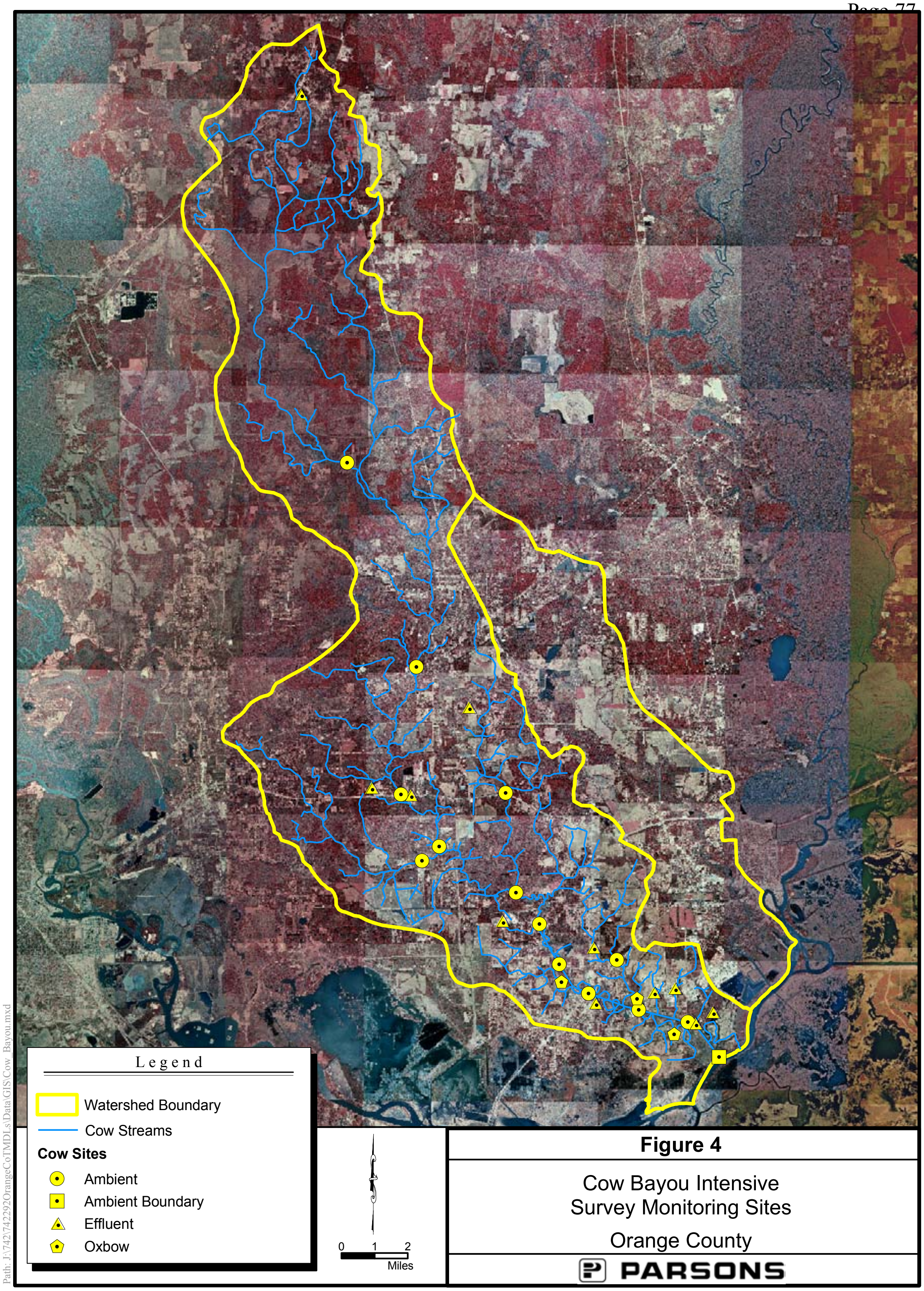


Figure 4

Cow Bayou Intensive
Survey Monitoring Sites

Orange County

Appendix C. Field Data Recording Forms

Multiprobe Sensor Calibration and Maintenance Log

Multiprobe Sensor Calibration Information

Multiprobe Sensor Calibration and Maintenance Log

	Calibration ____	Post Calibration ____	Initials:
Date:	Time:	Instrument:	Battery Voltage:
	If this is a post calibration, give date of original calibration ______		

Function	Temp. of Standard	Value of Standard	Initial Reading	Calibrated To	Comments
Dissolved Oxygen					
Specific Conductance (high)					
Specific Conductance (low)					
pH calibrated (~7)					
pH slope (~ 4/10)					
Table D.O. ________	Alt. (ft) ________	ALTCORR ________	Bar. Pres (mm)________ Bar. Pres (in)__________		BAROCORR________

Dissolved Oxygen Standard = Table D.O. Value x ALTCORR x BAROCORR

	Calibration ____	Post Calibration ____	Initials:
Date:	Time:	Instrument:	Battery Voltage:
	If this is a post calibration, give date of original calibration ______		

Function	Temp. of Standard	Value of Standard	Initial Reading	Calibrated To	Comments
Dissolved Oxygen					
Specific Conductance (high)					
Specific Conductance (low)					
pH calibrated (~7)					
pH slope (~ 4/10)					
Table D.O. ________	Alt. (ft) ________	ALTCORR ________	Bar. Pres (mm)________ Bar. Pres (in)__________		BAROCORR________

Check previous maintenance and use; do the following before calibration:

Polish conductivity electrodes. Must be polished within the last two months or once every 15 field trips	Date:	Name/Comments:
Change pH reference probe solution. Must be renewed within last two months or once every 15 field trips.	Date:	Name/Comments:
Inspect D.O. membrane for nicks or bubbles. Must be changed within last six months or once every 15 field trips.	Date:	Name/Comments:
Change battery in 400 series sonde. Change once a year. Change internal batteries for newer generation products according to guidelines in product manual.	Date:	Name/Comments:

YSI Instrument Calibration and Deployment Record

YSI Instrument Calibration and Deployment Record

DEPLOYMENT RECORD	
File Name:	Site:
Date Deployed:	Date Recovered:
Sonde I.D.:	DO probe S/N:
NOTES:	

CALIBRATION INFORMATION					
Date of Calibration:			Technician:		
DO Membrane Changed ?	Y	N	Note: Should wait 6 to 8 hours before final calibration		
Turbidity Wiper Changed?	Y	N	Wiper Parks ≈180° from Optics?	Y	N
Record Battery Volatage:					

Record the following diagnostic numbers after calibration:			**RECORD CALIBRATION VALUES**		
Conductivity Cell Constant		Range 4.5 to 5.5		Actual	Sonde
DO Charge		Range 25 to 75	Conductivity		
DO Gain		Range 0.7 to 1.7	DO		
pH MV Buffer 7		Range 0 ±40 MV	pH		
pH MV Buffer 10		Range -180 ±40MV	pH		
pH MV Buffer 4		Range +180 ±40MV	Turbidity		
Note: Span between pH 7 and 10, milli-volt numbers should be ≈170 to 180 MV			Turbidity		
NOTES:			Depth		
			ORP		

DEPLOYMENT					
In situe Date:		Time			
Field Readings:					
DO mg/L		Temperature °C		Salinity	
Air Temperature (°C or °F)		Wind Speed MPH		Wind Direction	
Tide (Nearest tide and stage (ebb, slack, flood):					
Secchi Depth		Total Depth		Sonde Depth	
Wave Height	C=calm, SM=smooth wavelets, M=moderate (come whitecaps), R=rough (numerous whitecaps), VR=very rough				
Cloud Cover	S=sunny, PC=partly cloudy, LR=light rain, HR=Heavy rain, TS=thunder storms				
DEPLOYMENT NOTES:					

YSI Instrument Calibration and Deployment Record

RECOVERY INFORMATION					
In situe Date:			Time		
Field Readings:					
DO mg/L		Temperature °C		Salinity	
Air Temperature (°C or °F)		Wind Speed MPH		Wind Direction	
Tide (Nearest tide and stage (ebb, slack, flood):					
Secchi Depth		Total Depth		Sonde Depth	
Wave Height	C=calm, SM=smooth wavelets, M=moderate (come whitecaps), R=rough (numerous whitecaps, VR=very rough				
Cloud Cover		S=sunny, PC=partly cloudy, LR=light rain, HR=Heavy rain, TS=thunder storms			
Probe/Sensor Fouling		1=none, 2=light, 3=moderate, 4=heavy			
RECOVERY NOTES:					

POST CALIBRATION AND CHECKOUT		
Battery Voltage at Recovery:		
Data Upload Successful: Y or N		
	As Recovered	After Cleaning
DO % in Calibration Cup		
Warning: DO reading for the post calibration must be recorded in either unattended mode or in discrete mode with a 120 second sampling interval. Discrete samples taken at the 4 second rate will display a DO value that is lower than actual with the standard DO warm-up interval.		
pH 4		
pH 7		
pH 10		
Conductivity		
Turbidity 0 NTU		
Turbidity 100 NTU		
DO Charge (Range 25-75)		
Turbidity Wiper Parks 180° from Optics	Y or N	
NOTES:		

Field Data Reporting Form

Sample ID	Station ID	Collector	Source1	Source2	Program
0001					

Station Description

Start Date	End Date:	Start Time	End Time:	Start Depth	End Depth:
				m	m

	Flow Severity	Flow (CFS)	Flow Method	Gage Height	Secchi Depth

Stream Avg. Depth	Stream Width	Total depth at sampling site	Wind Direction	Wind Intensity	Weather
m	m	m			

24-Hour Measurements

	MIN	MAX	AVG	N
Temp °C				
pH				
D.O (mg/l)				
Cond. (μmho/cm)				
Salinity (ppt)				

Vertical Profile or Single Grab Measurements

Depth (m):	Temp °C	pH	D.O. (mg/l)	Cond. (μmho/cm)	Salinity (ppt)
0.3					
0.6					
1					
1.5					
2					
2.5					
3					
4					
5					
6					
7					
8					

Appendix D. Chain-Of-Custody Form

CHAIN OF CUSTODY RECORD (Do Not Write In Shaded Areas)

ENVIRONMENTAL SERVICES DIVISION
(409) 746-3284
(409) 746-2249 FAX

SABINE RIVER AUTHORITY of TEXAS
1895 Owens-Illinois Rd.
Orange, Texas 77632

Request of Analysis (See left margin to select by number)

Company: Address: Tele No.: Fax No.:

Report(s) Sent To: Client Project No.:

Project Name: Purchase Order #:

Sampler(s) Name / Company Name (print):

Courier:

Parameter List Requisition

CHEMISTRY
1 Alkalinity-Total
2 BOD-5
3 Bromide
4 COD
5 Chloride
6 Chlorine-Free
7 Chlorine-Total
8 Chlorophyll (a)
9 Coliform, Fecal
10 Coliform, Total
11 Color, True
12 Conductivity
13 Dissolved O2
14 Fluoride
15 Hardness-Calcium
16 Hardness-Total
17 Ammonia as N
18 Nitrate as N
19 Nitrite as N
20 Nitrate / Nitrite
21 Oil & Grease
22 pH
23 Phosphorus-Ortho
24 Residue, TDS
25 Residue, TR
26 Residue, TSS
27 Residue, VR
28 Residue, VSS
29 Solids, Settleable
30 Strep-Fecal
31 Sulfate
32 TOC
33 Turbidity

METALS
34 Aluminum
35 Arsenic
36 Barium
37 Cadmium
38 Calcium
39 Chromium
40 Chromium, Hex
41 Copper
42 Iron
43 Lead
44 Magnesium
45 Manganese
46 Mercury
47 Nickel
48 Potassium
49 Selenium
50 Zinc
51 Silver
52 Sodium

BIOMONITORING
53 24-Hr Screening Daphnia pulex
54 24-Hr Screening Pimephales promelas
55 24-Hr Screening Mysidopsis bahia
56 24-Hr Screening Menidia beryllina
57 24-Hr Definitive Daphnia pulex
58 24-Hr Definitive Pimephales promelas
59 24-Hr Definitive Mysidopsis bahia
60 24-Hr Definitive Menidia beryllina
61 48-Hr Definitive Daphnia pulex
62 48-Hr Definitive Pimephales promelas
63 48-Hr Definitive Mysidopsis bahia
64 48-Hr Definitive Menidia beryllina
65 7-day Chronic Ceriodaphnia dubia
66 7-day Chronic Pimephales promelas
67 7-day Chronic Mysidopsis bahia
68 7-day Chronic Menidia beryllina
69 7-day Ambient Toxicity Ceriodaphnia dubia
70 7-day Ambient Toxicity Pimephales promelas
71 7-day Ambient Toxicity Mysidopsis bahia
72 7-day Ambient Toxicity Menidia beryllina
73 TIE Initial Toxicity
74 TIE Baseline Toxicity
75 TIE pH Adjustment
76 TIE Aeration
77 TIE Filtration
78 TIE C18 Extraction
79 TIE Oxidant Reduction
80 TIE EDTA Chelation
81 TIE Graduated pH
82 TIE Special 72-Hr Screening

83 OTHER

Lab Seq No.	Field Sample ID	Date	Time	Sample Type: OTHER	SEDIMENT/SOLIDS	DRINKING WATER	WASTE WATER	CONTAINER TYPE	PRESERVATION	NO. OF CONTAINERS
1.										
2.										
3.										
4.										
5.										
6.										
7.										
8.										
9.										
10.										

Client Specific Notes:

83 Other Test(s):

RELINQUISHED BY SAMPLER (Signature) 1 ____ PRINT LAST NAME ( ) DATE: / / TIME:
RECEIVED BY (Signature) 2 ____ PRINT LAST NAME ( ) DATE: / / TIME:
LABORATORY NO:

RELINQUISHED BY SAMPLER (Signature) 3 ____ PRINT LAST NAME ( ) DATE: / / TIME:
RECEIVED BY (Signature) 4 ____ PRINT LAST NAME ( ) DATE: / / TIME:
REQUESTED RESULTS TURNAROUND (Date): ____ / ____ / ____

RELINQUISHED BY SAMPLER (Signature) 5 ____ PRINT LAST NAME ( ) DATE: / / TIME:
RECEIVED BY LABORATORY (Signature) 6 ____ PRINT LAST NAME ( ) DATE: / / TIME:
SAMPLE CONTAINER(S) CONDITION: ☐ ACCEPTABLE ☐ CALL CLIENT

SAMPLE DISPOSAL
☐ Return
☐ Dispose
☐ Client Pickup
☐ Hold
☐ Sub Lab
☐ N/A-Field

WHITE COPY – To Accompany Samples to Lab YELLOW COPY – Retained by Laboratory PINK COPY – Retained by Client

SABINE RIVER AUTHORITY
Chain of Custody Record

Appendix E. Data Management Plan

1. Personnel -

The Data Manager is responsible for ensuring that the data management objectives of the current active work plan are achieved. These objectives include:

- ensuring that water quality data are managed in an efficient manner
- ensuring that such data is transferred to the TCEQ
- ensuring that data submitted to TNRCC for inclusion in the SWQM database has been verified by a quality assurance procedure as outlined in the Data Management Plan.
- ensuring the data system is documented and that the DMP is updated accordingly

Field sampling personnel are responsible for ensuring that field data are recorded completely and accurately, and transferred to the Parsons project manager.

Laboratory analysts are responsible for ensuring that laboratory data are recorded completely and accurately, and transferred to the laboratory manager.

The laboratory manager is responsible for ensuring that lab data are complete and accurate, and for transferring the lab data to the Parsons project manager.

The Parsons project manager is responsible for reviewing the data for completeness and accuracy before transferring them to the Parsons data manager.

The Parsons QAM is responsible for verifying and validating the data versus the project-specific QC requirements.

2. Hardware and Software Requirements -

SRA Laboratory

The Sabine River Authority Environmental Service Division Laboratory computer system consists of a NetWare 5.1 server and a NetWare 4.2 server providing storage, database access, and file and print services to its 100 MBps switched Ethernet network. The minimum configuration for SRA computers is currently a Dell Precision workstation with 2.66 GHz Intel Xeon/533 Processor, 500 MB RAM, and 60 GB IDE hard drive. Software includes Microsoft Access (database), Microsoft Excel (spreadsheet), Microsoft Word (word processing), and Adobe Acrobat. GIS software includes Environmental Systems Research Institute (ESRI) ArcInfo 8x, Arcview 8x, Spatial Analyst 8x, 3d Analyst 8x, ArcIMS 4.0.1 and ERDAS Imagine 8.6. The current LIMS software is “Sample Master” by Accelerated Technology Laboratories, Inc

Parsons

The Parsons Austin LAN consists of a Dell Poweredge server, running Microsoft Windows 2000 Server software, providing storage, database access, as well as file and print services to a 100 MBps switched Ethernet network. Storage devices include six hard disks (330 gigabytes) with a RAID controller, and a 7-tape Dell tape backup unit.

Parsons uses Dell Optiplex computers with the Microsoft Windows 2000 Professional operating system. Parsons computers are equipped with the Microsoft Office Professional Suite.

3. Security

Virus protection:
Norton Antivirus Corporate Edition 7.5 is installed on SRA computers. Updated virus signatures are retrieved from the Internet by each LAN's file server. PCs on a LAN download the updates as available with each login.

Trend Micro's PC-cillin is installed on all Parsons computers, and PC-cillin Server Protect is installed on the Parsons server to prevent computer viruses. Full virus scans are automatically run each week.

LAN security:
The SRA local area network is protected from intrusion via the Internet by a SonicWALL XPRS2 firewall appliance. Only HTTP is allowed inside the firewall from the Internet. Dial-up access via modem to the SRA network is username and password protected and allows only Internet access by default. Access to servers or routers is governed by internal LAN username and password. Dial-up access to individual PC's using PC-Anywhere is governed by user level access rights, username and password, and PC-Anywhere level encryption. Each SRA LAN user is granted a password, which must be changed every 90 days. Users are advised to keep their passwords private and to log off the network when they are not present at their workstation. Logins to the NDS8 (eDirectory) is governed by Secure Sockets Layer at the NetWare client. SRA LAN users are allowed access only to those resources to which they are granted rights via assigned NetWare rights stored in the NDS tree. Administrative passwords are severely restricted. Each department container of the NetWare NDS tree has a container administrator with administrative rights to that container only. The NDS root administrator password is limited to key personnel, as are the administrator password of the Web Server, the admin password of the firewall, and the enable passwords for the Cisco routers.

The Parsons domain also includes a firewall to protect its networks from unauthorized access. Access to the Parsons network is username and password protected and allows only Internet access by default. Access to servers or routers is governed by internal LAN username and password.

Email security: SRA LAN Users are advised that email is not a secure means of communication. Users who wish to keep their email secure from internal viewing are advised to password protect their screen savers, to lock NT workstations, or to use a password protected Outlook Express identity.

Parsons operates its own Microsoft Exchange email server, which prohibits messages containing file types commonly associated with computer viruses. All email accounts are password protected. PC-cillin also checks email messages for viruses

4. Archives/Backup

<u>Backup</u>

The SRA_ESD1 and SRA_ESD2 servers are backed up using 4mm DAT tape using either Backup-Exec 8.5 or ArcServe 6.1 for Netware. The following tape rotation system is used:

Monday	Full backup on Monday tape
Tuesday	Full backup on Tuesday tape
Wednesday	Full backup on Wednesday tape
Thursday	Full backup on Thursday tape
Friday 1 (1st Friday of month)	Full backup on Friday 1 tape
Friday 2 (2nd Friday of month)	Full backup on Friday 2 tape
Friday 3 (3rd Friday of month)	Full backup on Friday 3 tape
Friday 4 (4th Friday of month)	Full backup on Friday 4 tape
<MonthYYYY> Last Friday of month	Full backup on <MonthYY> tape (month tapes are kept for six months)

The SRA_ESD1 and SRA_ESD2 tapes are stored in the Quality Assurance Officer's office with the most recent tape being carried "off-site" overnight or until a more recent tape is available. Users are advised not to store critical data on a local HD without a regular backup procedure in place.

The Parsons server is backed up using a seven-tape Dell Tape Backup Unit. The entire server is backed up each week, with incremental backups run each night. Each month, the most recent tape set is stored "off-site" until a more recent tape is available. Users are advised not to store critical data on a local HD.

<u>Archive</u>

SRA Laboratory archive data is stored in dated directories on the SRA_ESD1, and SRA_ESD2 servers and backed up as per the schedule above. Archive GIS data sets are written to CD-R.

Electronic data files on the Parsons network are archived to CD-ROM after approximately one year, then maintained in a locked, restricted-access, fire-resistant storage area in the Parsons' Austin office.

5. Disaster Recovery

Disaster recovery procedures consist of reinstalling the operating system and software from the original software media and restoring data from tape.

6. Migration/Transfer/Conversion

When the data verification and validation is complete, the Parsons Data Manager will convert the Microsoft Access database into the appropriate TCEQ-approved format (see Data Dictionary) The data files will be provided in ASCII text with each field delimited by the pipe character (|) in the field format detailed below. The Parsons Data Manager will transfer these electronic files to the TCEQ Project Manager by email, followed up by a backup hard copy on CD-ROM media through the U.S. Postal Service.

7. Data Dictionary

Terminology and field descriptions are included in the SWQM Data Management Reference Guide, 2003. For the purposes of verifying which source codes are included in this QAPP, a table outlining the codes that will be used when submitting data under this QAPP is included below.

Name of Monitoring Entity	Source Code 1	Source Code 2	Program Code
Parsons	PE	PE	TN
Sabine River Authority	PE	SR	TN

Note that the alphanumeric (A) field sizes indicate the <u>maximum</u> number of characters allowed and do not indicate nor imply a fixed size field in the delimited ASCII text file.

Events file:

Tag_id	A7	This field is the key between the event and results tables and is 7 characters long. The first character(s) is the prefix code for the submitting agency.
Station	A9	This is a combination of the segment_id and the sequence of a site within a segment
Stationid	A5	This is a unique id that identifies each sampling station. This number is generated by the TNRCC.
Enddate	A10	The date the sample was collected in the form of MM/DD/YYYY
Endtime	A5	The time the sample was collected in military format HH:MM)
Enddepth	A6	This is the depth in meters at which the sample was collected.
Startdate	A10	This field is only required for composite samples and is the beginning date in the form of MM/DD/YYYY
Starttime	A5	This field is only required for composite samples and is the beginning time (in military format) at which the sample was collected (HH:MM)
Startdepth	A6	This field is only required for composite samples and is the depth nearest surface (in meters) at which the sample was collected.
Category	A1	This field is only required for composite samples and should correspond to the following codes:

		T is for time composites S is for space composites (i.e.depth) B is for both space and time composites F is for flow weighted composites
Calculation	A1	This field is no longer used and should be left blank
Type	A2	This field is only required for composite samples and should correspond to the following codes: CN for continuous ## where ## is the number of grab in the composite GB where the number of grabs is unknown
Comment	A135	This is a text field where record of any observational data is included with the sample
Source1	A2	The TNRCC assigned code for the submitting agency.
Source2	A2	An optional field that may be used to further identify the sample
Program	A2	A field that further identifies the sample. This field may be used to tie targeted monitoring to specific permits.

Results File:

Tag_id	A7	This field is the key between the event and results tables and is 7 characters long. The first character(s) is the prefix code for the submitting agency.
Enddate	A10	The date the sample was collected in the form of MM/DD/YYYY
Storetcode	A5	This is a five digit code which identifies the substance or measurement.
Gtlt	A1	If the value is above the detection limit then this field should contain an >.
Value	A8	This is the test result and should be reported in units according to the storet description.

Associated files included with data upload will include:

1. Error log of data points which fell outside the minimum or maximum limits of the SW_PARM table or outside the limits of SRA's historical data set. The error log will indicate the verification status of outlier data points.
2. Readme file listing all files included in the upload and their contents.
3. Data Review Checklist

8. Data Management Plan Implementation –

Field Observations

Instantaneous field observations will be recorded on the appropriate field data reporting forms (Appendix C). These forms will be reviewed for accuracy and copied by the person(s) performing the water sampling, then provided to the Parsons project manager along with a copy of the sample COC form, who will review them for accuracy and completeness. Following his review, the Parsons Project Manager will provide the forms to the Parsons Data Manager, who will enter the data in an electronic database created in Microsoft Access 2000 software. The project database will be maintained on a Parsons network drive, which is backed up to tape media every night. The data manager will then store hard copies of data forms in the project files in Parsons' Austin, Texas office.

Field measurement data collected by recording sondes and flow measurement devices is stored in ASCII flatfile format in the instrument's internal memory until the intensive survey is complete. The data files will then be transferred from the sonde to a Parsons computer using the RS-232 serial data cable provided with the instrument (Parsons computer systems are described under hardware/software requirements). The data file will be reviewed for accuracy by the person(s) performing the water sampling, then provided to the Parsons project manager, who will review the data for accuracy and completeness. Following his review, the Parsons Project Manager will provide the data file to the Parsons Data Manager, who will import the data into the electronic Microsoft Access database.

Data will be verified via the procedures described in Section D2 (Verification And Validation Methods). The data to be verified (listed by task in Table D.1) are evaluated against project specifications (Section A7) and are checked for errors, especially errors in transcription, calculations, and data input. Potential outliers are identified by examination for unreasonable data, or identified using computer-based statistical software.

Original data recorded on paper files are stored for at least five years in a locked, restricted-access, fire-resistant storage area in the Parsons' Austin office.

Flow of data: Field Sampling Personnel → Parsons Project Manager → Parsons Data Manager → electronic database → Parsons QAM → Parsons Data Manager → TCEQ.

Laboratory Measurements

Sample analysis data are recorded by the laboratory analyst and maintained on the laboratory information management system (LIMS) on the SRA's ESD server. Sample results will be transferred to the Parsons Project Manager in Microsoft Excel spreadsheet format via e-mail. The Parsons Project Manager will check the data file for accuracy and completeness, then forward the data file to the Parsons data manager for import into the project Microsoft Access database. Data will be verified via the procedures described in Section D2 (Verification And Validation Methods).

Flow of data: Laboratory Analyst → LIMS → Laboratory Manager → Parsons Project Manager → Parsons Data Manager → Parsons QAM → Parsons Data Manager → TCEQ.

Data will be transferred electronically to TCEQ in pipe-delimited ASCII text through email as attachments.

Quality Assurance/Control - See Section D of this QAPP.

Information Dissemination – Information will be disseminated to the TCEQ or those individuals/entities who receive permission from the TCEQ Project Manager for receipt of the data.

Appendix F. Data Review Checklist

		√, X, or N/A
Data Format and Structure		
A.	Is the file in the correct format (e.g. ASCII pipe delimited)?	________
B.	Are there any duplicate *Tag Id* numbers?	________
C.	Are the *Tag* prefixes correct?	________
D.	Are all *Tag Id* numbers 7 characters?	________
E.	Are TCEQ station location (SLOC) numbers assigned?	________
F.	Are sampling *Dates* in the correct format, MM/DD/YYYY?	________
G.	Is the sampling *Time* based on the 24-hour clock (e.g. 13:04)?	________
H.	Is the *Comment* field filled in where appropriate (e.g. unusual occurrence, sampling problems, unrepresentative of ambient water quality)?	________
I.	*Source Code 1, 2* and *Program Code* used correctly?	________
J.	Is the sampling date in the *Results* file the same as the one in the *Events* file?	________
K.	Values represented by a valid parameter (*STORET*) code with the correct units?	________
L.	Are there any duplicate STORETs for the same *Tag Id*?	________
M.	Are there any invalid symbols in the Greater Than/Less Than (*GT/LT*) field?	________
N.	Are there any tag numbers in the *Results* file that are not in the *Events* file?	________
O.	Have confirmed outliers been identified? (preferably with a "1" in the remarks field)	________
Data Quality Review		
A.	Are all the values reported at or below the AWRL?	________
B.	Have the outliers been verified?	________
C.	Checks on correctness of analysis or data reasonableness performed? e.g.: Is ortho-phosphorus less than total phosphorus? Are dissolved metal concentrations less than or equal to total metals?	________
D.	Have at least 10% of the data in the data set been reviewed against the field and laboratory data sheets?	________
E.	Are all STORET codes in the data set listed in the QAPP?	________
F.	Are all stations in the data set listed in the QAPP?	________
Documentation Review		
A.	Are blank results acceptable as specified in the QAPP?	________
B.	Were control charts used to determine the acceptability of field duplicates?	________
C.	Was documentation of any unusual occurrences that may affect water quality included in the Event table's Comments field? ________	
D.	Were there any failures in sampling methods and/or deviations from sample design requirements that resulted in unreportable data? If yes, explain on next page.	________
E.	Were there any failures in field and laboratory measurement systems that were not resolvable and resulted in unreportable data? If yes, explain on next page.	________

EXHIBIT 4B - DATA REVIEW CHECKLIST (contd.)

Describe any data reporting inconsistencies with AWRL specifications. Explain failures in sampling methods and field and laboratory measurement systems that resulted in data that could not be reported to the TCEQ. (attach another page if necessary):

____‘
____‘
____‘
____‘
____‘
____‘
____‘
____‘

Date Submitted to TCEQ: ______________________________‘

TAG Series: ______________________________‘

Date Range: ______________________________‘

Data Source: ______________________________‘

Comments (attach README.TXT file if applicable): ______________________________‘
____‘
____‘

Parsons Data Manager Signature: ______________________________ ‘

Date: ______________________________‘

Appendix G. Example letter to document adherence to the QAPP

TO: (name)
(organization)

FROM: Sandra de las Fuentes
Parsons

Please sign and return this form by (date) to: Sandra de las Fuentes

Parsons
8000 Centre Park Dr., Suite 200
Austin, TX 78754

I acknowledge receipt of the referenced document(s). I understand the document(s) describe quality assurance, quality control, and other technical activities that must be implemented to ensure the results of work performed will satisfy stated performance criteria.

____

Signature Date

Appendix H. Standard Operating Procedure for Sediment Oxygen Demand Measurement

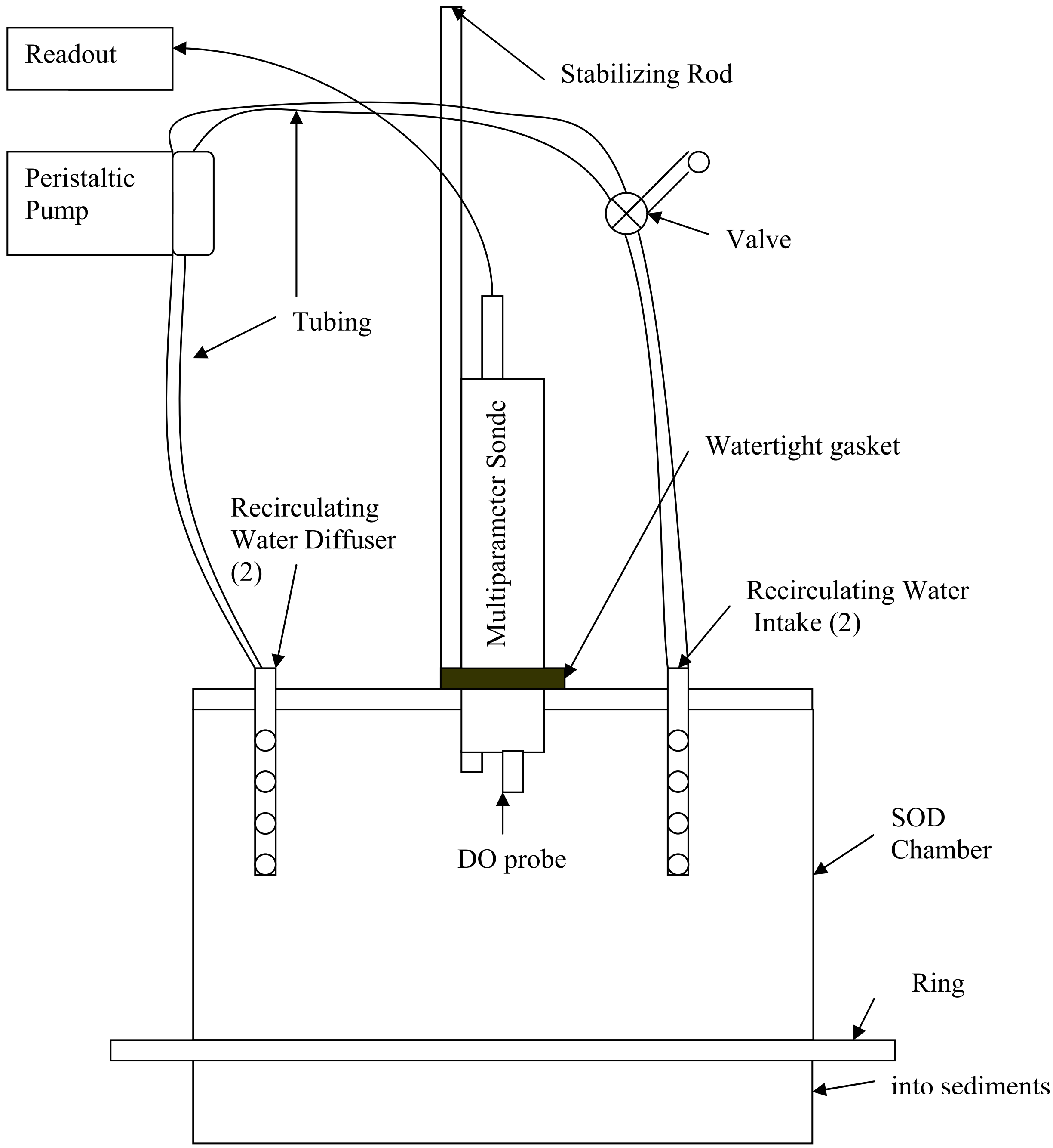
Sediment Oxygen Demand (SOD) is a measure of the rate at which sediments consume oxygen from the overlying water column. The major processes responsible for SOD include the degradation of organic matter, nitrification (microbial-mediated conversion of ammonia to nitrite and nitrate) and chemical oxidation of substances such as iron. The principle behind SOD measurements is to isolate a fixed and known volume of oxygenated water above a fixed area of sediments and monitor the change in its dissolved concentration with time. Because the volume of water and sediment interfacial area is known, the rate of oxygen consumption in grams of oxygen per square meter per day can be estimated by fitting a line to a plot of the change in dissolved oxygen with time.

SOD can be measured in the laboratory, but the disturbance of the sediments likely introduces substantial oxygen. Thus, most SOD measurements are made in the field. There is no "standard" or EPA-approved method for measuring SOD. In fact, SOD chambers have differed in every report we've reviewed that involved SOD measurement. The major differences are in the geometry of the chamber - rectangular or cylindrical - and the method of circulating water inside the chamber - via a pump or stirring paddle. The circulation should be adequate so that the DO concentration is somewhat uniform throughout the chamber, but the sediment surface is not suspended into the water. Features common to all SOD devices include a port for a dissolved oxygen probe, a ring to fix the bottom of the chamber at the sediment surface, and a collar to penetrate several inches into the surface sediments, to prevent their oxidation from adjacent water just outside the chamber, and to prevent oxygen from the chamber from escaping under the outer ring. We prefer the cylindrical design because 1) it is easier to design a sturdy device from available materials such as large-diameter pipe, and 2) there will be less unmixed "dead" areas in the corners. We also prefer the pumped design over the stirred design because 1) circulation rates can be more precisely and reproducibly regulated, and 2) nozzles and diffusers can be used to aim the direct circulation flows laterally and/or upward, away from the sediments, thus avoiding resuspending sediments. A pumped system also allows us to introduce oxygenated water from the upper water column to the SOD chamber at the beginning of the measurement, in case the DO level at the sediment surface is too low (e.g., <2 mg/l). A basic schematic of the SOD chamber is shown below.

Any site with soft sediments is satisfactory for the SOD chamber. However, care must be exercised to avoid disturbing the sediments. More than two feet of water is required to allow boat access without disturbing sediments. Very deep sites also limit the safe deployment of the chamber by divers. The chamber may be deployed from the boat in water depths of three to four feet. Depths greater than four feet, or in areas with sloping or thin sediments, will require deployment by a diver.

1. Calibrate the sonde
2. Using the sonde, measure the dissolved oxygen concentration in the water at 1 foot above the sediments.
3. Insert sonde in top of SOD chamber, sealing it with the rubber gasket, and tighten securely to the stabilizing rod with clamps.

4. Attach peristaltic pump tubing to intakes and diffusers
5. Lower chamber into water and pump site water through the peristaltic pump tubing for 2 minutes.
6. Insert chamber into sediments until the ring is at the sediment surface.
7. If the DO level above the sediments is less than 2 mg/l, turn the 3-way valve on the intake tubing to take in water form the oxygenated surface waters and pump until the dissolved oxygen reading from the sonde is greater than 2 mg/l, then turn valve so that intake pump tubing draws from the chamber.
8. Record initial DO reading, time, and temperature
9. Turn on recirculating pump
10. Record DO concentration every five minutes until the dissolved oxygen has declined by more than 2 mg/l, or for three hours, whichever is less.


Readout
Stabilizing Rod
Peristaltic Pump
Valve
Tubing
Multiparameter Sonde
Watertight gasket
Recirculating Water Diffuser (2)
Recirculating Water Intake (2)
DO probe
SOD Chamber
Ring
into sediments