



THE MEADOWS CENTER
FOR WATER AND THE ENVIRONMENT

TEXAS STATE UNIVERSITY

TEXAS STREAM TEAM

TEXAS STREAM TEAM **CORE** WATER QUALITY COMMUNITY SCIENTIST MANUAL

Published and Distributed by:

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*Funded in part by the Texas Commission on Environmental Quality
and the U.S. Environmental Protection Agency*

Revised February 2025

ACKNOWLEDGMENTS

The Texas Stream Team encourages life-long learning about the environment and people's relationship to the environment through its multidisciplinary citizen science programs. We also provide hands-on opportunities for Texas State University students and inspire future careers and studies in natural resource related fields. Preparation of final reports serve as contract deliverables for granting entities, but they also serve as valuable educational experiences for the students and staff that prepare the reports. Texas Stream Team values the staff contributions and recognizes each individual for their role.

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1.0 INTRODUCTION

The Texas Stream Team Core Water Quality Citizen Scientist Core Manual presents methods and procedures to become a certified Texas Stream Team Standard and Probe Core Water Quality Citizen Scientist. Certification enables citizen scientists to collect water quality data that meet the requirements of the TCEQ-approved [Texas Stream Team Quality Assurance Project Plan \(QAPP\)](#).

Texas Stream Team has developed this citizen science program with input from the EPA and TCEQ to address the following goals and benefits:

- Standardized training and quality assurance procedures help citizen scientists collect accurate information and improves data quality and integrity which can be used in making environmentally sound decisions.
- As recognized by the EPA and TCEQ, citizen scientist collected, quality assured data can serve to enhance professionally collected data.
- Collection of quality assured data helps to improve understanding of environmental issues and promotes communication and positive cooperation between citizens, professional monitors, and the regulated community.

The Core manual was first developed to provide citizen scientists with clear instructions on how to collect Core water quality data, and to educate citizen scientists about the importance of water quality monitoring and why it is relevant to understanding water quality. This manual also features an educational section on NPS pollution. Texas Stream Team encourages new and veteran citizen scientists to develop a solid understanding of such key concepts as watersheds, stream order, and eutrophication. By raising awareness of NPS pollution, Texas Stream Team educates citizen scientists on more effective strategies for protecting water resources and for resolving water quality problems that originate at the community level.

Another important development in Texas Stream Team is its increasing emphasis on middle school and high school education. To support this emphasis, Texas Stream Team has developed a companion curriculum that adapts the information in this manual for the classroom. The Water Quality Monitoring Curriculum Companion and others can be found on the [Texas Stream Team website](#). These education tools provide teachers with the option of effectively conveying to students Texas Stream Team environmental concepts and skills, in the classroom and in the field.

1.1 WHAT IS TEXAS STREAM TEAM?

Texas Stream Team (formerly known as Texas Watch) is an environmental education and volunteer-based citizen scientist water quality monitoring program. Citizen scientists collect surface water quality data that may be used to promote and protect a healthy and safe environment for people and aquatic inhabitants. Texas Stream Team emphasizes communication about the environment, which is based on the premises that water issues are inextricably linked with air, biological, land, and human resource issues, and that the protection of the environment requires the active, positive, collaborative participation of all Texans.

Through Texas Stream Team, community members, students, educators, academic researchers, environmental professionals, and both public and private sector partners are brought together to conduct scientific research and to promote environmental stewardship.

Texas Stream Team encourages everyone to ask:

- What questions do we want to answer about the environment?
- What part of the environment are we most concerned with?
- What can I do to help preserve and protect the environment?

For those whose concerns are centered on water quality, Texas Stream Team helps them design water quality monitoring programs to address those concerns.

Recognizing the size and complexity of the water environment, the time and expense of monitoring water quality, and the significant role that each one of us has in protecting Texas waters, the Texas Commission on Environmental Quality (TCEQ), the U.S. Environmental Protection Agency (EPA), and Texas State University have formed a cooperative partnership to support Texas Stream Team. Texas Stream Team is funded through a EPA Nonpoint Source (NPS) Pollution grant under Section 319 of the Federal Clean Water Act.

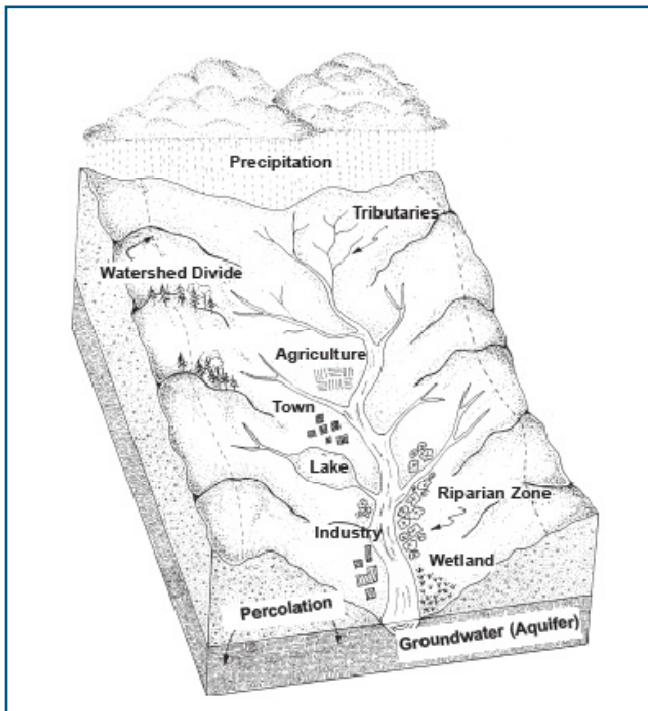


1.2 KEY CONCEPTS

What is a watershed?

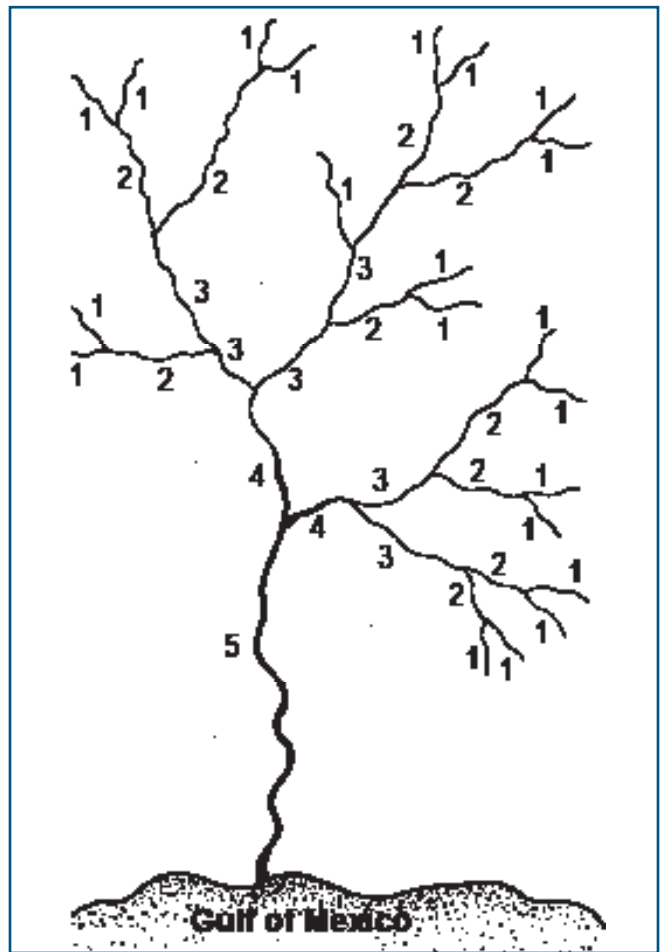
Everyone lives in a watershed, which is defined as a geographic area in which water, sediments, NPS pollutants, and dissolved materials drain into a common body of water. The body of water can be a stream, lake, playa, estuary, aquifer, or ocean. A watershed can be large or small. In a city, the gutters that run along the curb on your street are the drainage outlets for your city's watershed. In a neighborhood, water in your gutters flows into the storm drain system and empties into a nearby stream, which drain several neighborhoods in a larger watershed. That stream, in turn, flows into a larger stream or river.

Another example is the Colorado River watershed, which contains thousands of smaller watersheds and is one of the largest watersheds in Texas. All of the smaller watersheds and their corresponding streams flow downhill and converge, forming a tree-like network with the Colorado River as the main stem and its tributaries as the branches. All of the streams, from the smallest branch of Bee Creek to large tributaries such as the Llano River, comprise the river system of the Colorado River watershed.



Stream Order

Water quality professionals have developed a simple method to categorize the streams of a river system. Streams that have no tributaries flowing into them are called first order streams. Streams receiving flow from only first order streams are second order streams. When two second order streams combine, the result is a third order stream. This continues until all streams merge into the mainstem or the principal watercourse in a riverine drainage system, which ultimately drains into a lake or ocean. The order of the stream at the watershed outlet is the watershed order.



Texas River Basins

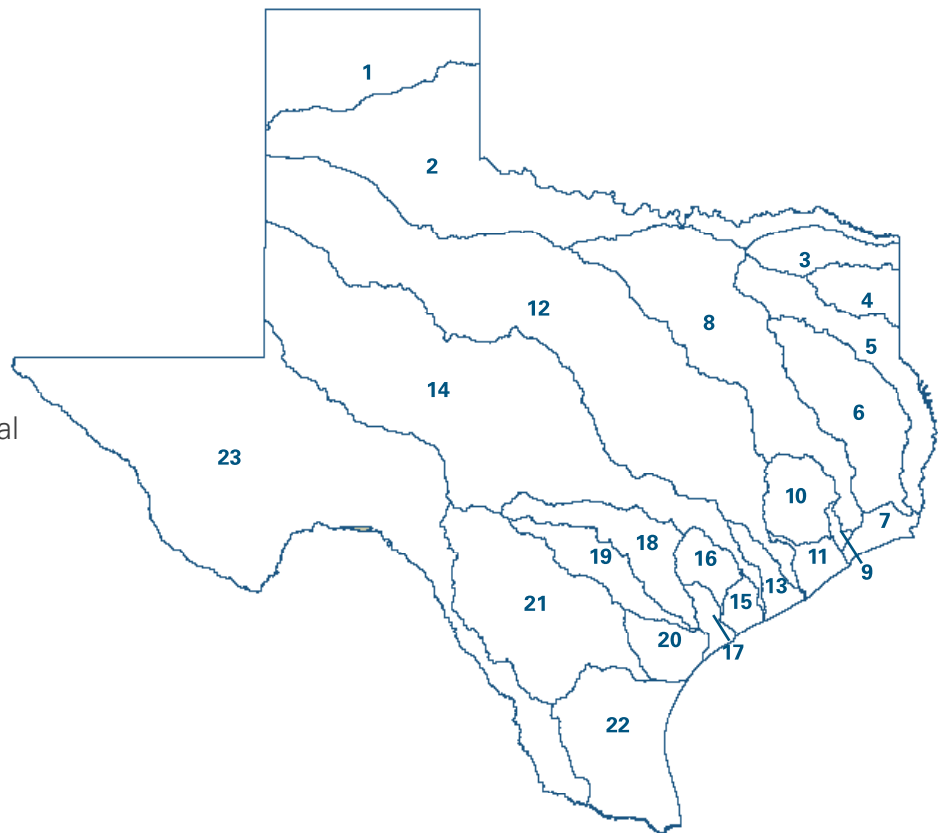
Water resource professionals categorize watersheds into hierarchical levels based on area and common outflow points. In Texas, catchment areas are often categorized into watersheds and river basins. Texas has 23 major river basins that can be subdivided into smaller watersheds. Oftentimes, these smaller watersheds will consist of only one major body of water and its smaller tributaries. For example, the Pedernales River makes up the largest catchment area within the Pedernales Watershed. The majority of this watershed is contained within two counties in central Texas, Gillespie County and Blanco County.

The Pedernales River is also contained within a higher order classification. The Colorado River Basin, which is one of the 23 major river basins in Texas, is a regional collection of multiple smaller watersheds. In contrast to the size of the Pedernales Watershed, the Colorado River Basin flows from Dawson County in northwest Texas all the way to the Gulf of Mexico. All streams, from the smallest branch of Bee Creek to large tributaries such as the Llano River, comprise the river system of the Colorado River watershed.

The interconnecting rivers, streams, creeks, and lakes that collectively define a Texas River Basin ultimately arrive at the same destination. All of the smaller watersheds and their corresponding streams flow from northwest to southeast Texas and drain into the Gulf of Mexico.

Texas River Basins

1. Canadian River Basin
2. Red River Basin
3. Sulphur River Basin
4. Cypress Creek Basin
5. Sabine River Basin
6. Neches River Basin
7. Neches-Trinity Coastal Basin
8. Trinity River Basin
9. Trinity-San Jacinto Coastal Basin
10. San Jacinto River Basin
11. San Jacinto-Brazos Coastal Basin
12. Brazos River Basin
13. Brazos-Colorado Coastal Basin
14. Colorado River Basin
15. Colorado-Lavaca Coastal Basin
16. Lavaca River Basin
17. Lavaca-Guadalupe Coastal Basin
18. Guadalupe River Basin
19. San Antonio River Basin
20. San Antonio-Nueces Coastal Basin
21. Nueces River Basin
22. Nueces-Rio Grande Coastal Basin
23. Rio Grande Basin



1.3 NONPOINT SOURCE (NPS) POLLUTION

Getting to the Point

To a large extent, water quality within a watershed is linked to the actions of the people who live, work, and play within its boundaries. Water quality issues caused by human activities can be a result of either point source or nonpoint source (NPS) pollution. A point source is a single, identifiable source of pollution such as discharges from wastewater treatment plants. Point sources are regulated under the Federal Clean Water Act and Texas state law and are subject to permit requirements. These permits specify effluent limits, monitoring requirements, and enforcement mechanisms. Even though effluent discharges are permitted and regulated, these point sources can contribute to water quality degradation.

NPS pollution is pollution from diffuse sources that does not have a single point of origin and is not introduced into a stream from a specific source. The pollutants are generally carried off the land by stormwater runoff. Nonpoint sources of pollution are largely unregulated and have not been evaluated in the same rigorous manner as point source pollution. NPS pollution originates from many different locations. We have all seen trash in our waterways following a rainfall event. Other contaminants, not so easily seen, enter our waters in much the same way. NPS pollution occurs when rainfall runoff transports contaminants on the surface of the land into

adjacent water bodies. Contaminated storm water can cause impairment to the beneficial uses of streams, reservoirs, estuaries, and oceans. Pollutants carried by water percolating through the soil and aquifer recharge features can contaminate groundwater. Land management activities associated with agriculture, forestry, and residential and urban development can increase NPS pollutants.

NPS Pollution's Effects on Aquatic Ecosystems

Dissolved oxygen (DO) is a basic requirement for a healthy aquatic ecosystem. Most fish and beneficial insects breathe oxygen dissolved in the water. Some fish and aquatic organisms, such as gar and sludge worms, are adapted to low DO concentrations. However, most desirable fish species, such as largemouth bass and darters, suffer if DO concentrations are below 4 milligrams per liter (mg/L). Insect larvae and juvenile fish are more sensitive and require even higher concentrations of DO to grow and reproduce.

Oxygen concentrations in the water column fluctuate under natural conditions, but severe depletion may be the result of human activities that introduce large quantities of biodegradable organic materials into surface waters.

Biodegradable organic materials which include lawn clippings, raw and treated sewage, food processing wastes, rice field drainage, and pulp paper wastes, are some examples of oxygen depleting organic materials that enter surface waters. As these wastes decompose and break down into essential nutrient enriched building blocks, many chemical and biological processes are directly affected. Nutrients are fundamental building blocks for healthy aquatic communities, but excess nutrients (especially nitrogen and phosphorus compounds) may over stimulate the growth of aquatic plants and algae. Excessive growth of these plants, in turn, can clog waterways and interfere with boating and swimming.



In addition, these plants will out-compete native submerged aquatic vegetation, and with excessive decomposition, lead to oxygen depletion or a condition called eutrophication. Oxygen concentrations often fluctuate widely, increasing during the day as aquatic plants conduct photosynthesis (produces oxygen) and falling at night as plants and animals continue to respire, consuming oxygen.

Fertilizers, malfunctioning septic systems, detergents and organic materials in treated sewage, and manure in agricultural runoff are examples of nutrient sources often responsible for water quality degradation. Rural areas are susceptible to groundwater contamination from nitrates found in fertilizer and manure. Nutrients are difficult to control because they typically recycle among the water column, algae, and bottom sediments. For example, algae may

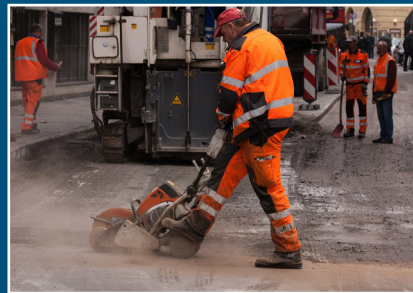
Common NPS Pollutants

Sediment from croplands, forestry activities, construction sites, and streambank erosion.

Nutrients from croplands, lawn and gardens, livestock operations, septic systems, and land waste application; nutrients bound to sediments from erosion can reduce clarity and sun penetration in bodies of water, harming aquatic plant life and fish. Nutrients can also be carried by runoff from over-fertilized areas or decaying leaves and lawn clippings. Excessive nutrients in waterways can cause excess plant and bacteria growth, resulting in eutrophication (oxygen depletion) and fish kills.

Bacteria from livestock, seepage from improperly maintained septic systems, leaking sewer lines, wildlife, and urban runoff.

Man-made chemicals, including pesticides from roadways, croplands, lawns, gardens, and forestry operations. Toxic materials, such as improperly applied pesticides or automotive products such as motor oil, engine degreasers and antifreeze. These toxins can wash from city streets and other areas or can result from illegal dumping. Surface trash, such as plastic containers or cigarette butts; this trash is not only aesthetically unappealing, but residue from discarded containers can be washed into water bodies.





temporarily but significantly reduce phosphorus from the water column, but the nutrients will return to the water column when the algae die and are decomposed by bacteria. Gradual inputs of nutrients tend to accumulate over time rather than leave the system.

Detecting and Tracking NPS Pollution

NPS pollution is episodic. This means it typically enters our rivers and lakes during episodes of rainfall, during isolated events such as incidences of illegal dumping, or in a random fashion, as when a sewer line overflows or breaks. It is difficult and expensive to monitor NPS pollution using a fixed monitoring schedule and employing tests for only a few chemical variables. Analyzing data for trends and correlations over space and time provides an effective strategy to investigate NPS pollution.

Conducting chemical tests on water quality is like taking a snapshot of the river or lake at that moment. Trend analysis on DO concentrations, Secchi depth measurements, and conductivity measurements provide additional clues in assessing NPS pollution. Looking at this information over an extended period of time provides a strong foundation to infer the corresponding DO values (oxygen concentrations will correspond to plant production and decomposition), rainfall contributions (conductivity values will change with runoff), and

nutrient fluctuations (Secchi measurements can be used to determine the productivity status of a system, which is influenced by nutrient loading).

Living organisms in a stream or lake can provide information about what has happened there over time as well. For example, monitoring a stream that has good habitat and good chemical water quality but no living organisms indicate something may have happened there prior to sampling to account for the lack of biodiversity. Perhaps a heavy rain storm scoured the site and displaced all the organisms. Perhaps some NPS pollution lowered the DO level, causing the organisms to die or move downstream. There are many possible explanations, but by investigating the biological community of the stream over time in conjunction with water chemistry, the citizen scientist becomes informed about the long-term conditions of the stream.

Water pollution from nonpoint sources are less obvious than those from point sources and are not as easy to control through traditional treatment strategies. The variability of rainfall events and the complexity of the landscape and geologic features lead to NPS pollution phenomena which are highly variable and intricate. The lack of a single identifiable source of pollution makes it difficult to establish specific cause-and-effect relationships but reinforces the importance of analyzing trends and correlations drawn from consistent, long-term monitoring efforts.



1.4 TEXAS STREAM TEAM CORE PARAMETERS

Texas Stream Team citizen scientists monitor various core environmental parameters including air and water temperature, transparency or water clarity, depth, dissolved oxygen, pH, and conductivity or salinity. Citizen scientists also document several field observations that help with the interpretation of the various monitored parameters. Collectively, these measurements are designed to track point and nonpoint sources of pollution and promote and protect a healthy and safe environment for people and the aquatic inhabitants.

1.5 GETTING STARTED WITH TEXAS STREAM TEAM

Please follow these steps to begin your monitoring project:

1. Schedule a training session(s) with a local [Texas Stream Team partner](#). Texas Stream Team partner contact information can be obtained by visiting the Texas Stream Team [website](#). All three training phases can be completed in one training session. If training phases are split up into multiple sessions, Training Phases I and II are generally scheduled with a group. After completing Phases I and II, Phase III is scheduled at a later time to complete the Core training. Phase III will typically take place at the citizen scientist's monitoring site.
2. Select a monitoring site and request a site location number based on the guidelines included in this manual under [Section 2.1 - Choosing a Monitoring Location](#).
3. If you are establishing a monitoring group, complete, a [Texas Stream Team Group Monitoring Plan](#). The monitoring plan identifies the objectives of monitoring and specifies the sites, parameters, and monitoring procedures. A copy of the Group Monitoring Plan and instructions can be obtained on the Texas Stream Team [website](#).
4. Acquire a [monitoring kit](#). Citizen scientists acquire kits in a variety of ways. They may pay for a kit with their own money or [raise the money from another source](#) such as a civic organization. Several Texas Stream Team partners provide kits, and the Texas Stream Team headquarters office in San Marcos periodically has kits to loan citizen scientists.
5. Begin monitoring, record data on [Monitoring Form](#), and send the data monthly to Texas

Stream Team on the approved monitoring forms, or enter the data directly into the [Waterways Dataviewer](#).

6. Contact Texas Stream Team for information on scheduling a training, completing a Group Monitoring Plan, acquiring equipment, or any other questions.

Phone: (512) 245 -1346

Email: TxStreamTeam@txstate.edu

Web: TexasStreamTeam.org

1.6 TRAININGS

Information describing the various levels of certifications and trainings offered by Texas Stream Team is provided [here](#). The longevity of the program is dependent upon the participation of our dedicated citizen scientists, and we encourage you to continue increasing your level of involvement each year by completing the required training to become a certified Texas Stream Team Advanced Water Quality Citizen Scientist, a Texas Stream Team Citizen Scientist Trainer, and/or Quality Assurance Officer.



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Texas Stream Team Citizen Scientist Trainings

Texas Stream Team offers a number of additional water quality and environmental monitoring trainings, including:

- [Standard Core Water Quality Citizen Scientist Training](#)
- [Probe Core Water Quality Citizen Scientist Training](#)
- [E. coli Water Quality Citizen Scientist Training](#)
- [Advanced Water Quality Citizen Scientist Training](#)
- [Macroinvertebrate Bioassessment Citizen Scientist Training](#)
- [Riparian Evaluation Citizen Scientist Training](#)

This manual covers information about the Standard Core and Probe Core Water Quality Citizen Scientist Trainings.

Visit Trainings.TexasStreamTeam.org to learn more about each training.

Standard Core and Probe Water Quality Citizen Scientist Training

To receive certification as a [Texas Stream Team Core Water Quality Citizen Scientist](#), all citizen scientists must complete the three-phase training program described on the following pages.

Each trainee is required to fill out the [Training Enrollment Form](#) to become an official Texas Stream Team Core Water Quality Citizen Scientist and begin monitoring activities.

PHASE I TRAINING

Phase I begins with an instructional classroom session covering an introduction to Texas Stream Team, watersheds, nonpoint source pollution, and approved methods for the core field observations and parameters. These methods are adapted from the most recent TCEQ Surface Water Quality Monitoring Procedures Manual. Safety in both the laboratory and field settings is also emphasized and discussed.



The Phase I training then transitions to an interactive demonstration of water quality monitoring procedures. A Texas Stream Team certified trainer begins by explaining how the monitoring equipment is used and describing the parameters that will be measured. The trainer then demonstrates water quality monitoring procedures, while trainees follow along with the demonstration using their provided kits. The trainees perform the core water quality tests simultaneously and under close supervision of the trainer. Trainees record their results in the training packet on the Phase I [Monitoring Form](#).

After all tests are completed and the trainees are comfortable with the Core procedures, the trainee and trainer review the Phase I [Monitoring Form](#). This form signifies the trainee's successful completion of Phase I training for the parameters specified and indicates their understanding of the monitoring procedures and commitment to following all safety procedures.

PHASE II TRAINING

During Phase II, trainees demonstrate the monitoring procedures they learned during Phase I in the field with the assistance of the trainer. Whenever possible the water body used for Phase II testing should be similar to the sites

the trainees will eventually monitor as a citizen scientist.

Trainees conduct water quality monitoring procedures on their own, with assistance from a trainer whenever necessary. The trainers carefully observe the trainees' procedures, answering any questions the trainees may have and assisting with data quality assurance.

After all questions have been answered and the trainee completes the Phase II [Monitoring Form](#), the trainee and the trainer discuss the trainee's strong points and weak points with respect to the monitoring procedures. The Phase II [Monitoring Form](#) is retained by the trainee for reference during Phase III.

PHASE III TRAINING

Phase III training can take place at the same location as Phases I and II, or it can take place at the trainee's approved monitoring site within 3 months of completing Phase II. The trainer observes the trainee as they conduct the water quality monitoring at the site. By this time, the trainee should be able to work through the monitoring procedures and complete the Monitoring Form without the assistance of the trainer.

After the trainee completes the training, the trainer then discusses next steps for how to set up a monitoring site. The trainee then signs and completes the online [Measures of Success Survey](#).

Once Phase III has been completed, citizen scientists are required to attend one quality control (QC) session every two years to comply with the [Texas Stream Team QAPP](#). During Phase III, the trainer will conduct the trainees' first QC session. The QC session will include a detailed observation of the trainees monitoring techniques to ensure monitoring is being conducted following the Texas Stream Team protocol as described in this manual without the assistance of the trainer. A QC session checklist will be used to document the session and to ensure monitoring protocols are adhered to by all trainees.



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Texas Stream Team Trainer

Core citizen scientists may receive additional certification as a Texas Stream Team Core Water Quality Citizen Scientist Trainer after completing the requirements described below.

- Trainer trainee must be a certified Texas Stream Team Riparian Evaluation citizen scientist who has been actively monitoring for at least two years.
- Trainee assists a certified trainer in planning, coordination, and presenting at one citizen scientist training session.
- Trainee plans, coordinates, and presents all phases of one citizen scientist training assisted by a certified Texas Stream Team trainer.

Texas Stream Team Quality Assurance Officer Training

TO PERFORM QC SESSIONS:

Certified trainers become certified QAOs upon completion of the trainer certification. Citizen scientists can be authorized to perform quality QC sessions upon approval as a Texas Stream Team QAO. Citizen scientists must first observe a field QC sessions preformed by a certified QAO, then lead a field QC session with a QAO present.

Certification

Upon completion of training phases I, II, and III, the trainee must submit the completed top sheet of the training packet to the Trainer before a certificate of completion can be issued. The Trainer will then submit completed forms to the Texas Stream Team to create and distribute the certificates. The certification process serves as the record to document completion of the training and the first QC session; therefore, it is critical that a legible form gets submitted. If the Trainer does not receive the completed form, a certificate of completion cannot be generated and sent to the trainee.

1.7 QUALITY ASSURANCE

Texas Stream Team data is collected under a [TCEQ-approved QAPP](#). Quality assurance (QA) consists of citizen scientist activities that involve planning, implementation, documentation, assessment, reporting, and quality improvement to ensure that Texas Stream Team water quality monitoring data are of the type and quality needed and expected by the agencies that provide financial support for the program, the TCEQ and ultimately the EPA.

The approved QAPP documents the procedures Texas Stream Team citizen scientists implement to ensure that the resulting data are of high quality and meet project data quality objectives (see below). The QAPP also ensures citizen

scientists state-wide use the same methods for measuring, collecting and analyzing field measurements and water samples to ensure comparable results. For these reasons, it is critical all citizen scientists are aware of the QAPP requirements and implement the procedures as stated in the approved document.

Data Quality Objectives

The Texas Stream Team data quality objectives (DQO) are provided below. The DQOs are used to verify the methods used for each parameter measured by citizen scientists and the corresponding reporting units, duplicate precision, accuracy, method sensitivity and completeness are comparable and of the highest quality.

Parameter	Method (Range)	Units	Duplicate Precision	Accuracy	Method Sensitivity	Completeness
Standard Core Citizen Scientist Water Quality Monitoring						
Air Temperature	Thermometer (-5 to 50)	Degrees Celsius (°C)	NA	±1°C	0.5 °C	90%
Water Temperature	Thermometer (-5 to 50)	Degrees Celsius (°C)	NA	±1°C	0.5 °C	90%
Transparency or Water Clarity	Secchi Disk	Meters (m)	NA	±0.1 m	0.5 m	90%
Dissolved Oxygen	Modified Winkler Titration	Milligrams per liter (mg/L)	±0.5 mg/L	±1.0	0.1 mg/L	90%
pH	Color comparator (3.0-6.5, 7.0-10.5)	Standardized units (s.u.)	NA	±1 s.u.	1 s.u.	90%
Conductivity	Digital Probe (0-1999)	µS/cm	NA	±2%	0.1µS/cm	90%
Salinity	Refractometer (0-100)	Parts per thousand (ppt or ‰)	NA	±1	1	90%
Probe Core Citizen Scientist Water Quality Monitoring						
Air Temperature	Thermometer (-5.0 to 50)	Degrees Celsius (°C)	NA	±1°C	0.5 °C	90%
Water Temperature	Digital Probe (0 to 50.0)	Degrees Celsius (°C)	NA	±1.0°C	0.1 °C	90%
Dissolved Oxygen	Digital Probe (0 – 20)	Milligrams per liter (mg/L)	NA	±2%	0.01 mg/L	90%
Transparency or Water Clarity	Secchi Disk	Meters (m)	NA	±0.1 m	0.5 m	90%
pH	Digital Probe (0.00 to 14.00)	Standardized units (s.u.)	NA	±0.01 s.u.	0.01 s.u.	90%
Conductivity	Digital Probe (0-1999)	µS/cm	NA	±2%	0.1µS/cm	90%
Salinity	Refractometer (0-100)	Parts per thousand (ppt or ‰)	NA	±1	1	90%

Quality Control

QC consists of the overall system of citizen scientist activities and compares the Texas Stream Team water quality monitoring data against defined standards to verify that they meet the stated requirements approved by the TCEQ.

There are currently five types of QC measures implemented by Texas Stream Team citizen scientists to achieve the data quality objectives.

- 1. Buddy system:** Try to always conduct water quality monitoring using the buddy system for safety purposes, but also to confirm measurements by conducting duplicate visual observations.
- 2. Duplicate samples (dissolved oxygen for Standard Core only):** A duplicate sample and analysis is conducted for dissolved oxygen. These measurements must meet the duplicate precision criterion listed in the Texas Stream Team data quality objectives stated above. The duplicate sample result is used to measure sample and analysis precision or a measure of mutual agreement among individual measurements.
- 3. Pre-/Post-test calibrations:** The dissolved oxygen, pH and conductivity probes, and the refractometer and thermometer must all undergo calibration procedures. For the probes and the refractometer, differences between the value the meter was calibrated to and the post-test calibration initial reading must meet calibration check error limits (see below). The thermometer used to measure air and water temperature is calibrated against the probe temperature measurement in water. Calibrations are used to test the accuracy of the method and/or equipment.
- 4. Quality Control Sessions:** Once trained, citizen scientists must attend one QC session every two years. A QC session includes observation of a citizen scientist conducting monitoring by either a Texas Stream Team Trainer, QAO, or Texas Stream Team staff member. Observations are documented on

a QC Session Checklist and results must be meet the data quality objectives and calibration check error limits listed below. Other online resources are being developed to assist with compliance of this requirement; please check the [Texas Stream Team website](#) for updates.

Calibration Check Error Limits for Thermometer, Digital Probe and Refractometer Measurements

Parameter	Error Limit
Dissolved Oxygen	±0.5 mg/L
Conductivity	±10% of calibration standard solution
pH	±0.5 s.u.
Salinity	±1 ppt

- 5. Data Management:** QA procedures and checklists are implemented before data is entered to the Dataviewer. See 3.0 Data Management for additional information.

If the calibration values associated with the probes/meters used to measure temperature, dissolved oxygen, conductivity, pH, and salinity fall outside the calibration check error limits listed above, then the data collected does not pass quality assurance and should be flagged in the [Waterways Dataviewer](#) when reported to Texas Stream Team, or in the Comments field of the [Monitoring Form](#) if copies are mailed to Texas Stream Team.

For duplicate water samples, the Texas Stream Team DQOs prescribe a precision limit of 0.5 mg/L when analyzing two dissolved oxygen samples for Standard Core water quality monitoring. This means that the sample values must be within 0.5 mg/L of each other to meet the Texas Stream DQOs. Please consult your trainer, QAO, or Texas Stream Team staff if you have questions about these values and how they are used.

2.0 SAFETY CONSIDERATIONS

General Precautions

1. Read all instructions to familiarize yourself with the test procedures before you begin. Note any precautions in the instructions.
2. Read the label on each reagent container before use. Some containers include precautionary notices or you may refer to material safety data sheets (MSDS), which provide important safety information. A link to the MSDS is located in 4.0 Appendix of this manual.
3. Keep all equipment and chemicals out of the reach of young children.
4. In the event of an accident or suspected poisoning, immediately call the Poison Control Center at (800) 222-1222. Be prepared to give the name of the reagent in question and its manufacturer's code number. LaMotte reagents are registered with POISINDEX, a computerized poison control information system available to all local poison centers.
5. Texas Stream Team recommends that you always implement a buddy system and sample with another person.
6. Thoroughly rinse sampling containers and vials twice before and after each test with deionized or distilled water (bottled drinking or tap water are acceptable if the other two are unavailable). Dry the outside of the containers.
7. After each use, tightly close all chemical containers. Do not switch caps.
8. Store the chemicals and equipment indoors at room temperature. Do not expose chemicals and equipment to direct sunlight for long periods of time and protect them from extremely high or low temperatures. Avoid storing your equipment in an automobile or truck.
9. Safely dispose of all out-of-date or waste chemicals by flushing them down a sanitary sewage system drain with plenty of water. Do not dispose of chemicals into a septic waste system, water body, or onto the ground.

Site Safety

Protecting Yourself and Your Equipment

1. Avoid contact between chemicals and skin, eyes, nose, mouth, and clothes.
2. Always wear safety goggles or glasses and rubber gloves when handling chemicals.
3. Use the test tube caps or stoppers, not your fingers, to cover test tubes during shaking and mixing.
4. When dispensing a chemical from a plastic squeeze bottle, hold the bottle upside-down in a vertical position (not at an angle) and squeeze it gently (if a gentle squeeze does not suffice, the dispensing cap or plug may be clogged).
5. Wipe up any chemical spills, liquid or powder, as soon as they occur. Rinse area with a wet sponge, then dry.
1. Park your vehicle safely away from off roads and out of the way of traffic. Be cautious of traffic when unloading or loading monitoring equipment and accessing your site.
2. Sample your site from bridges with pedestrian walkways, from docks, or from stream banks whenever possible. If you must enter the water, always have a partner on the shore nearby and always wear a life jacket if wading is necessary.
3. Approach your site carefully! Watch out for traffic on bridges and when crossing roads. Be on the lookout for snakes, fire ants, wasps, poison ivy, Africanized honey bees, wild animals, broken bottles, debris, or briars.
4. If using a boat or kayak to sample your site, learn and observe all U.S. Coast Guard and State of Texas regulations.

2.1 CHOOSING A MONITORING LOCATION

Historical water quality data is very useful in assessing impairments in water bodies, therefore it is preferable citizen scientists use existing monitoring sites with historical water quality data when possible. The [Datamap](#) can be used to assist in determining if an established site is available in the citizen scientist's area of concern.

View the Datamap at Datamap.TexasStreamTeam.org.

Creating a New Site

The location of a monitoring site should be based on the following [Texas Stream Team site selection guidelines](#).

First, ensure that the proposed site is safely accessible year round. If the site is on private property, obtain the landowner's written permission granting access prior to any monitoring activities taking place. A [Private Property Access form](#) must be filled out for this purpose and submitted before any Texas Stream Team monitoring can begin.

Texas Stream Team recommends selecting monitoring sites that best represent the overall water quality conditions of a water body. Sites should be free of backwater effects. Sites on streams with perennial (year round) flow are preferable to streams that flow intermittently. Lake and estuary sites should be in the major arms and/or near the dam (reservoirs). Coastal sites are best situated so that a representative sample can be collected, regardless of the tidal cycle.

Keep in mind that sites located at or immediately below major pollution sources may not accurately represent water quality conditions of that water body. Depending upon monitoring objectives, areas with significantly different contaminant sources or water quality problems may require additional sites to obtain a true representation of the water body.



2.2 REQUESTING A SITE IDENTIFICATION NUMBER

Activating an Inactive Site

Rather than establishing a new monitoring site, citizen scientists have the option of reactivating an inactive site. Inactive sites with historical data are useful for analyzing water quality trends. The more historical data that is available at a specific site, the better the trend analysis will be. This information can then be used by water and resource professionals to make informed decisions about the management of a water body.

Due to these advantages, Texas Stream Team encourages citizen scientists to reactivate historic sites, if possible, prior to the creation of a new site. Citizen scientists can view all current and historic sites by referencing the Texas Stream Team [Datamap](#), which can be used to identify an inactive site that appeals to you.

Creating a New Site

To create a new monitoring site, citizen scientists can submit an online [New Monitoring Site Request Form](#) to Texas Stream Team. Prior to filling out the form, citizen scientists are asked to review the [Texas Stream Team Site Selection Guide](#). The Site Selection Guide lists the necessary qualifications that a site must meet to be approved as a citizen scientist monitoring site. These qualifications must be met at every monitoring site in order to increase the accuracy of the data collected and ensure the safety of the monitors.

Once the [Texas Stream Team Site Selection Guide](#) has been reviewed and the new site has been confirmed to meet all necessary qualifications, the [New Monitoring Site Request Form](#) is submitted with the new site information. Please note that data cannot be entered in the Texas Stream Team Waterways Dataviewer without a site identification number that includes latitude and longitude coordinates and a short description. To determine the exact location of your site, use Google Maps, a U.S. Geological Survey topographic map (scale of

1:24000), a National Oceanic and Atmospheric Administration (NOAA) nautical chart, one of the several Street Atlas software systems that provide latitude/longitude coordinates or street address, or a calibrated global positioning system (GPS) unit.

Following submission of the [New Monitoring Site Request Form](#), a Texas Stream Team staff member will review the form to make sure all of the criteria are met and create a site. Once the site has been created, Texas Stream Team staff will send an email confirming the site has been created and include the unique site ID number for your use.

2.3 CHOOSING A SAMPLING TIME

Choose a convenient time and day to conduct monitoring. Samples should be collected once a month and at regular intervals. For example, if sampling is conducted monthly, try to sample every 30 days. If necessary, sampling can take place as early as 26 days after the last sampling event or as late as 34 days after the last sampling event.

Water quality and environmental conditions can change throughout the day, therefore monitoring at the same time and location helps to ensure the data collected on different sampling days using the same protocols are comparable. If you have questions about whether to cancel, postpone, sample early, or change your sampling location, call your local Training Coordinator or Texas Stream Team staff.

SAFETY CHECK: If conditions are not safe, do not sample.

2.4 EQUIPMENT AND SUPPLY LIST

Standard Core Water Quality Monitoring Equipment

Standard Core monitoring involves performing tests for parameters such as conductivity/salinity, dissolved oxygen, pH, total depth, water and air temperature, and water transparency using a chemical Standard Core kit. In addition to these parameters, Standard Core citizen scientists also conduct field observations.

STANDARD CORE MONITORING SUPPLIES

The supplies listed below are necessary for starting a standard core monitoring program.

- Standard Core Kit
- 60 or 120 cm Transparency Tube (optional for shallow water)
- Salinity refractometer (for tidally influenced or high salt content water bodies)
- Sample Bucket (white is preferred)
- D.I. water bottle filled with DI water
- Waste bottle/container
- Goggles
- Gloves – S, M, or L
- Conductivity Standard (84, 1413, or 12880 μ S)
- Salinity calibration solution of known concentration (optional)
- Meter stick

STANDARD CORE MONITORING REPLACEMENT REAGENTS

The Standard Core water quality monitoring kit will need to be restocked as reagents are depleted or expire. The list below includes the replacement reagents.

- Wide Range Indicator Solution
- Sodium Thiosulfate
- Alkaline Potassium Iodide Azide
- Sulfuric Acid
- Starch indicator Solution

- Manganous Sulfate Solution
- Conductivity Standard (600 or 1413 μ S, 1L)
- Salinity calibration solution of known concentration (optional)

STANDARD CORE MONITORING REPLACEMENT EQUIPMENT AND SUPPLIES

Equipment and supplies may become lost or broken. The list below includes items in the Standard Core monitoring kit that may need replacing.

- Secchi disk
- Armored, Centigrade Thermometer
- Salinity refractometer (for tidally influenced or high salt content water bodies)
- Titrators (0 to 10 Range)
- Titration tube, 20 ml w/ caps
- Glass bottles, 60 ml
- Salt, TDS, Temperature TRACER Pocket Tester (conductivity meter)
- 120 cm Transparency Tube
- Salinity refractometer
- Plastic square test tubes & caps, 2.5-10 mL
- Wide Range pH Octa-Slide 2 Bar (3-6.5)
- Wide Range pH Octa-Slide 2 Bar (7-10.5)
- Octa-Slide Viewer
- 150ml plastic beaker
- Batteries for conductivity meter

Probe Core Water Quality Monitoring Equipment

Probe Core monitoring involves performing tests to measure parameters such as conductivity/salinity, dissolved oxygen, pH, total depth, water and air temperature, and water transparency using a Probe Core kit. The parameters measured in the Probe Core training are the same parameters measured in the Standard Core training, however, Probe Core monitors use digital meters as opposed to chemical

tests. Probe Core citizen scientists also record the same field observations as those recorded by Standard Core citizen scientists.

PROBE CORE MONITORING EQUIPMENT AND SUPPLIES

The items listed below are necessary for starting a probe core monitoring program.

- Probe Kit (ExStik® II DO/pH/Conductivity)
- Secchi disk
- Armored, Centigrade Thermometer
- 120 cm Transparency Tube
- Salinity refractometer (for tidally influenced or high salt content water bodies)
- D.I. water bottle
- Waste bottles
- Gloves – S, M, or L
- Conductivity Standard (600 or 1413 μ S, 1L)
- pH Buffer 4.00, 7.0 or 10.0 s.u.
- Salinity calibration solution of known concentration (optional)
- Meter stick

PROBE CORE MONITORING REPLACEMENT REAGENTS

The Probe Core water quality monitoring kit will need to be restocked as solutions are depleted or expire. The list below includes the replacement solutions.

- Conductivity Standard (600 or 1413 μ S, 1L)
- pH Buffer 4.00, 7.0 or 10.0 su
- 15 mL EL8020 Filling Solution

PROBE CORE MONITORING REPLACEMENT EQUIPMENT AND SUPPLIES

Equipment and supplies may become lost or broken. The list below includes individual items in the Probe Core monitoring kit that may need replacing.

- Secchi disk
- 120 cm Transparency Tube
- Salinity refractometer (for tidally influenced

or high salt content water bodies)

- Armored, Centigrade Thermometer
- ExStik Replacement Dissolved Oxygen Meter
- ExStik Replacement pH/Conductivity Meter
- Membrane Kit for ExStik DO Meter (6pk w/ 1 Filling Solution)
- Sample Solution Cups
- 150ml plastic beaker
- Weighted Base
- Batteries

Vendor and pricing information for ordering supplies and equipment can be found on the [Texas Stream Team website](#).

All equipment must be inspected upon receipt from the manufacturer and prior to each sampling event. Equipment should be inspected for completeness, breakage, and to ensure it is operating properly.

Monitoring Reagents

Texas Stream Team requires all reagent expiration dates be inspected before each monitoring session. Reagent expiration information should be recorded in the appropriate check box on the [Core Environmental Monitoring Form](#) (Monitoring Form).



2.5 SAMPLING SEQUENCE

A typical sampling sequence for a certified citizen scientist would include the following steps:

1. Prior to arriving at a monitoring site, ensure you have the [Monitoring Form](#) ready to be filled out by either printing it out, or submitting your data directly into the [Waterways Dataviewer](#) using your account credentials.
2. Before sampling, review the field quality control checklist on the second page of the Core Environmental Monitoring Form. Use this list as a guideline throughout the sampling event to ensure all protocols are adhered to.
3. Conduct pre-test instrument calibrations and check reagent expiration dates. These procedures must be performed in a temperature-controlled environment before going into the field to conduct monitoring.
4. At the monitoring site, document field observations on the monitoring form about the condition of the water, weather and other pertinent facts.
5. Measure and record air temperature.
6. Measure water clarity with the Secchi disk or transparency tube, as applicable.
7. If possible, also measure total depth of the sample site with the Secchi disk.
8. Collect the water sample.
9. Measure and record water temperature (in a water body or bucket sample), conductivity, DO, and pH.
10. Conduct post-test instrument calibration procedures and ensure calibration check error limits are met.
11. Clean and store equipment.
12. Legibly record all applicable data on the Core Environmental Monitoring Form. Remember to double-check for accuracy and readability.
13. Review and check-off the field quality control checklist on the second page of the Core Environmental Monitoring Form.

14. Sign and date the [Monitoring Form](#).

15. Turn in the form to a local Texas Stream Team Data Coordinator, or to Texas Stream Team by emailing a pdf or high-quality picture to TxStreamTeam@txstate.edu.

QC CHECK: Pre- and post-test meter calibrations and reagent expiration checks should be performed within 24 hours of sampling and in a temperature-controlled environment.

2.6 MONITORING PROCEDURES

Sample Depth

Collect samples at a depth of 0.3 m (about 1 foot) below the surface. This is the depth at which most water quality measurements are made by the TCEQ's professional monitors.

Accepted Methods for Collecting Water Samples

Citizen scientists collect water samples using a bucket grab or sample container. For both methods, rinse your bucket or container with water from the same depth as the sampling depth twice. Lower your bucket or container (with the mouth facing down) vertically to a depth of 0.3 m as described above in Sample Depth and then turn the container upright. If there is a current, be sure you are standing downstream of your container. Do not drag the bucket or container on the bottom of the lake or stream, or disturb sediment to prevent it from contaminating your sample.

QC CHECK: Always throw the bucket or container rinse water downstream or on the bank so that the rinse water will not contaminate the sample.

Field Observations

When you arrive at the sampling site, some of the most important information you can collect is a record of your observations. Look at the water and other things related to the water quality. Record how humans and wildlife are using the water.



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When monitoring a site for the first time, some of the most important information to collect is a record of your observations. Look at the water and other things related to the water quality. Record how humans and wildlife are using the water.

When monitoring a site for the first time be very descriptive. Try to paint a word picture of your monitoring location. This close attention to detail will make you more familiar with the typical conditions of the site and allow you to better record changes that may occur. As you become accustomed to the site, describe any changes occurring at the site.

In the Field Observations Section of the [Monitoring Form](#) record the following:

Flow Severity

Dry (6): When the stream is dry, a flow severity value of “6” is recorded for the sampling visit. This will indicate the stream is dry with no visible pools.

No flow (1): Only write in a value of “1” when the water body is not flowing downstream. You should also write this value if there are pools of water in a river or stream bed that are not connected by flowing water (in other words the river or stream bed is dry between pools). There should be no obvious subsurface flow in sand or gravel beds between isolated pools.

Low (2): Write in a value of “2” when the river, creek, pond, or lake level is lower than normal. There are some visual clues to low flow: dry creek or lake bed between the water surface and the normal shore plants, or aquatic plants and algae that are now lying out of the water.

Normal (3): This is what, in your opinion, your monitoring site’s water level normally looks like. Write in the number “3.”

High (5): Record a value of “5” when the water body is higher than normal. One of the best clues of high water is partially submerged shoreline vegetation, which is normally out of the water.

Flood (4): We do not expect you to sample when it is flooding. Simply record a value of “4” in the box.



Algae Cover

This observation of surface and substrate algae is important because of the relationship algae has with the DO in water. When large amounts of algae are present and the sun is shining, providing the energy for photosynthesis, there will be a large amount of oxygen produced by the algae. The opposite is true at night. When the sun is not shining, excessive algae growth (along with other plant life) can cause DO levels to drop low enough to stress or even kill some fish and other aquatic life. When algae die, aerobic bacteria decompose this material and can deplete all available DO, thus contributing to anaerobic or low oxygen conditions.

1. **Absent:** No algae apparent (0%). Enter the appropriate value in the blank for algae.
2. **Rare:** Small patches, not readily apparent (1-25%).
3. **Common:** Substrate algae or surface mats noticeable (26-50%).
4. **Abundant:** Substrate and/or surface algae cover obvious and maybe thick in places (51-75%).
5. **Dominant:** The site is choked with algae. The entire substrate or surface is covered (76-100%).

QC CHECK: Do not mistake aquatic macrophytes, which are aquatic plants with vascular tissues (rigid, conductive tissues) for algae. These macrophytes will have roots, stems, and leaves. Any macrophytes present should be written in the comments section of the [Monitoring Form](#).

Water Color

Check water color when you collect your water sample for Core parameters. Look at the water in the sampling container against a white bucket or background and indicate the most appropriate color on your [Monitoring Form](#). If the water looks clear, write a value of “1” in the box. If it has a color not included in the given values, describe that color in the Comments section at the bottom of the [Monitoring Form](#). Do not use direct observation of the water body itself as the indication of color. What may appear to be the water’s color is often the color of the bottom, the reflection of trees or sky over the body of water, or a combination.

Water Clarity

Record the relative cloudiness of the water. This observation is especially important when you have noticed changes in clarity. Using the sampling container or Secchi disk/transparency tube may help determine this value. Record “1” if the water is clear, “2” if the water is cloudy, and “3” if the water is very turbid.

Water Surface

Record the appropriate value which describes the appearance of the water surface. For example if the surface is clear, record a value of "1". If scum is noticeable, record a value of "2" in the box. Record a value of "3" if there is foam on the water surface. If floating debris (organic or inorganic) is present on the water, record a value of "4" in the box and describe the type of debris in the Measurement Comments and Field Observations section. Record a value of "5" if you notice a sheen or oil on the water.

Water Conditions

Although this is intended primarily for lakes, ponds and bays, a value can be recorded for sampling a river or creek. For example, if you are sampling in rapids or riffles, record a value of "2" or "3" for ripples or waves. Increased aeration caused by ripples, rapids, and waves can increase DO levels in surrounding waters.

Water Odor

Check water odor when you collect your samples for Core parameters by holding your nose over the sample container (out of the breeze if possible) and waft the air toward your face.

SAFETY CHECK: If there seems to be a strong chemical odor or chemical appearance - do not perform the sniff test!

Present Weather

Record a value of "1" if the sky is completely clear. Record a value of "2" if there are clouds, even just one, but you can still see some blue sky. If there is full cloud cover with no visible sky, record a value of "3". If it is raining, record a value of "4".

Days Since Last Significant Precipitation

Significant precipitation refers to rainfall that visibly influences water quality. Record the number of days since the last rainfall that occurred in the watershed upstream or at your site. If it is raining when the sample is collected or has rained within the last 24 hours, record



a value < 1. If it has been a long time since a significant rainfall, record either the actual number of days, if known, or a greater than value - for example, > 30.

Rainfall Accumulation

Record the total rainfall (inches) that occurred in the last three days in the watershed and upstream of your monitoring location. There are several resources you can reference to obtain past rainfall information.

The following resources can be utilized to acquire rainfall information:

- Go online to www.Weather.com and enter the zip code of your monitoring location in the search bar at the top of the homepage. On the next page a bar will appear towards the top with various selection criteria. Select "Monthly"; and the next page will have weather and precipitation data for each day of the last month relevant to the zip code you inputted.

- Go online to www.CoCoRaHS.com, on the homepage, click on the state of Texas. On the next page, click “View Large Map” underneath the map of Texas counties. Select the county that your site is located in, and you will be able to view weather and precipitation data for that area.
- Go to <https://hydromet.lcra.org/>. Once on the homepage, a map of Texas river basins will appear. Within each basin is a blue line representing a body of water, as well as a gauge number. These gauges record flow, stage, temperature, relative humidity, and precipitation at the site. Hover your cursor over the gauge closest to your monitoring site, and precipitation data will appear.

QC CHECK: Rainfall runoff can affect water quality. By tracking rainfall information on a calendar at home, you can better understand how the level of rainfall runoff affects your particular monitoring site. Make sure the rainfall you track occurred in the watershed of the sampling location.

Additional Measurements and Observations

TIDE STAGE OBSERVATION

This section will remain blank unless the body of water you are sampled is on the Gulf Coast and influenced by the tides. Tidal conditions can greatly influence salinity levels. Record a value of “1” if the tide is low or a value of “2” if it is falling. Record a value of “3” if the tide is in a slack stage (neither rising nor falling). Record a value of “4” if the tide is rising or a value of “5” if it is high.

SALINITY MEASUREMENT

Salinity is a measure of the saltiness or the dissolved inorganic salt concentration in water. Salinity is often measured in ocean or estuarine waters, but in Texas there are some streams that have high salt content due to the local geology and require salinity measurements. Some common ions measured as salinity include sodium, chloride, magnesium, sulfate, calcium, and potassium. Seawater typically has a salt content of 35 parts per thousand (ppt or ‰).

Like other measured water quality parameters, salinity affects the homeostasis or the balance of water and solutes of both plants and animals. Too much or too little salt can affect plant and animal cell survival and growth, therefore salinity is an important measurement.

Refractometers measure the salinity content in water. Refractometers operate based on the principle of refraction. When light rays pass from one medium onto another, the rays are bent towards or away from a line between the two media. Refractometers measure salinity values based on the corresponding angle of refraction. Angle of refraction is converted to percent salinity which represents the salt concentration.

SALINITY REFRACTOMETER PRE-TEST CALIBRATION

Pre-test calibration should be completed before salinity testing is performed. Calibrate the refractometer using deionized (DI) water or a salinity calibration solution of known concentration.

STEP 1: Observe refractometer and ensure there is no damage to the instrument.

STEP 2: Rinse the prism and translucent cover flap with DI water to ensure there is no residual salt remaining on the refractometer from previous use.

STEP 3: To calibrate the refractometer, use a pipette to place some DI water or salinity calibration solution on the prism. Cover the prism with the flap and wait until the temperature equilibrates with the instrument and the measurement stabilizes.

STEP 4: Hold the instrument up to a light source and look through the eyepiece. Observe the scale inside the field of view to gather your initial reading. Record the value on the [Monitoring Form](#). The blue line on the scale should read zero, if using DI water, or the value (concentration) of the salinity calibration solution, if using a calibration solution. If it does, it is calibrated. If it does not, use the mini screwdriver located in the pouch provided with the instrument to

loosen the screw on the refractometer ring. Adjust the ring until the scale in the viewfinder reads the value of the solution used for calibration (i.e. zero for DI water or the value of the salinity calibration solution). Record the value the refractometer was adjusted to on the [Monitoring Form](#). The calibration is now complete.

MEASURING SALINITY

STEP 1: After calibration is complete, use pipette to cover the prism with sample water. Gently close the cover flap and make sure there are no air bubbles.

STEP 2: Wait until the temperature equilibrates and the measurement stabilizes.

STEP 3: Hold the instrument up to a light source, look through eye piece and record the salinity measurement on the [Monitoring Form](#).

SALINITY REFRACTOMETER POST-TEST CALIBRATION

These steps should be conducted after salinity testing has been completed. Conduct the post-test calibration of the refractometer using deionized (DI) water or a salinity calibration solution of known concentration.

STEP 1: Observe refractometer and ensure there is no damage to the instrument.

STEP 2: Rinse the prism and translucent cover flap with DI water to ensure there is no residual salt remaining on the refractometer from previous use.

STEP 3: To calibrate the refractometer, use a pipette to place some DI water or salinity calibration solution on the prism. Cover the prism with the flap and wait until the temperature equilibrates and the measurement stabilizes.

STEP 4: Hold the instrument up to a light source and look through the eyepiece. Observe the scale inside the field of view to gather your post-test reading. Record the post-test reading on the [Monitoring Form](#).

STEP 5: Ensure the difference between the

meter adjusted to pre-test and post-test value meets the post-test calibration error limit of ± 1 ppt. If the post-test calibration value falls outside the error limit (± 1 ppt), then the data collected does not pass QC. If the values fall within the error limit ($< \pm 1$ ppt), then the data collected passes QC and should be reported on your Monitoring Form. If the data does not pass QC the citizen scientist can either start over to submit accurate data, or submit their monitoring form as is where the data will then be flagged in the dataviewer.

MAINTENANCE

After each use, rinse the refractometer with DI water and wipe off any residual water with a clean, dry cloth before storing in protective pouch.

Comments Measurement

Record any explanatory information about the measurements or observations in the Comments field. For example, if you were not able to record temperature because your thermometer broke, you can document it here. This is also the section of the form where you can describe the physical appearance of the water and surrounding area, the presence of any obvious pollutants, muddiness, or any other factors, which could also impact water quality. This is also the best place to describe:

- The biological conditions such as a plankton bloom, fish kill, presence and abundance of fish, aquatic insects, aquatic plants, and wildlife.
- The lake and stream uses like swimming, wading, boating, fishing, irrigation pumps, and navigation.
- In stream or drainage basin activities and events that are impacting water quality – bridge construction, soil washouts, herbicide or pesticide use, livestock watering, dredging, or changes in stream bottom.
- Type of floating debris found at your site.

Temperature

OVERVIEW

Although temperature may be one of the easiest measurements to perform, it is one of the most important parameters to measure. It dramatically affects the rates of chemical and biochemical reactions within the water. For example, temperature affects feeding, reproduction, and the metabolism of aquatic animals. Temperature preferences among species vary widely, but all species can tolerate slow, seasonal changes better than rapid changes. Thermal stress and shock can occur when temperatures change more than 1 to 2 degrees Celsius in 24 hours.

Temperature also affects the solubility of compounds in water, such as DO. Colder water holds more DO than warm water. Temperature can also influence the distribution and abundance of organisms living in the water, rates of chemical reactions, density inversions and mixing, and movement of currents.

STRATIFICATION

Water temperature fluctuates considerably from one season to another. Shallow streams and rivers are susceptible to temperature changes because their capacity to store heat is relatively small. Lakes, however, are more resistant to temperature change because the volume of water is relatively large. In larger bodies of water, the temperature of the surface and subsurface waters often differs, with water generally becoming colder as depth increases. This results in thermal stratification of deeper water and can lead to density differences. Cold water is heavier than warm water, and, in some lakes, it is as if there are two separate lakes – one lake with warm water that receives sunlight on top, and underneath it, another lake with cold water and little light. The shallow water near the surface usually has an adequate amount of oxygen for fish because it is in contact with the air and it also receives sunlight for photosynthesis. The deeper water near the bottom typically contains less oxygen since there is less sunlight to support the plants that produce oxygen and since it is not in direct contact with the air.

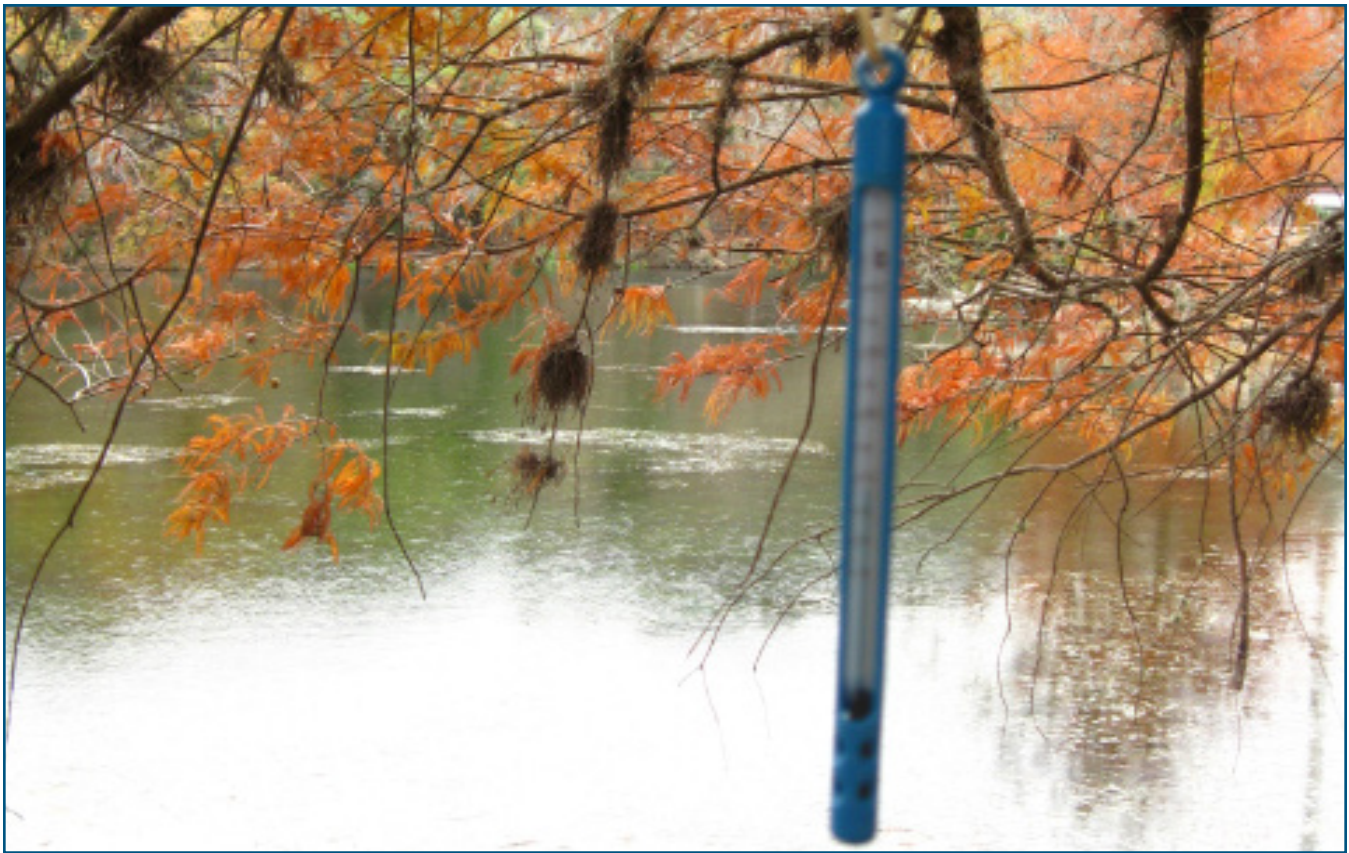
In the fall, as the warming radiation from the sun begins to diminish, the surface water cools, increases in density, and becomes heavier. Once the shallow surface water becomes heavier, it begins to sink. This is when the process of vertical mixing, or destratification, occurs. Wind may speed up the process as the mixing action brings nutrients from the bottom up into the surface water. These nutrients can sometimes cause an algae bloom, indicative of darker greenish or brownish colored water. These bottom waters sometimes produce a rotten egg odor, due to the depletion of oxygen and presence of hydrogen sulfide.

THERMOMETER-PROBE TEMPERATURE CHECK

Before monitoring a site, the temperature reading of the thermometer will need to be checked against the temperature of the conductivity probe. Thermometers and temperature sensors on probes are factory calibrated and cannot be adjusted by the user. However, it is good practice to compare temperature readings from different devices to ensure accuracy. Be sure to conduct the temperature check in a temperature-controlled environment and allow adequate time for the water and instruments to acclimate.

TEMPERATURE TEST PROCEDURE

1. Fill the beaker with tap or DI water and allow it to acclimate to room temperature.
2. Place the thermometer and the conductivity meter in the beaker.
3. Allow the temperature reading to stabilize and record both measurements on the monitoring form.
4. The difference between the two measurements must be within $\pm 1^{\circ}\text{C}$.
5. If the difference is greater than $\pm 1^{\circ}\text{C}$, then perform routine maintenance on both instruments.
 - a. Check that the thermometer is not broken or that the alcohol column is not separated. If it is broken, purchase a new one. If the column is separated, see the section



below titled Troubleshooting a separated alcohol column in a thermometer.

- b. Check the batteries in the meter to ensure they are charged and working properly. See section 3.2 Clean-up and Storage of Equipment and/or the manufacturers manual for guidance on improving the accuracy of the measurement.
6. Repeat steps 1-4 above until the measurements are within the specified limit ($\pm 1^{\circ}\text{C}$).

MEASURING TEMPERATURE

Texas Stream Team Citizen Scientists collect the air and water temperature once they arrive at their site. The temperature is recorded in degrees Celsius ($^{\circ}\text{C}$), usually using an armored, centigrade thermometer. Although it is recommended that a thermometer calibrated to read in degrees Celsius be used for determining air and water temperatures, the following table provides Fahrenheit conversions to degrees Celsius.

AIR TEMPERATURE

$^{\circ}\text{C}$ $^{\circ}\text{F}$	$^{\circ}\text{C}$ $^{\circ}\text{F}$	$^{\circ}\text{C}$ $^{\circ}\text{F}$
0 ...32.0	13 ...55.4	26 ...78.8
1 ...33.8	14 ...57.2	27 ...80.6
2 ...35.6	15 ...59.0	28 ...82.4
3 ...37.4	16 ...60.8	29 ...84.3
4 ...39.2	17 ...62.6	30 ...86.0
5 ...41.0	18 ...64.4	31 ...87.8
6 ...42.8	19 ...66.2	32 ...89.6
7 ...44.6	20 ...68.0	33 ...91.4
8 ...46.4	21 ...69.8	34 ...93.2
9 ...48.2	22 ...71.6	35 ...95.0
10 ...50.0	23 ...73.4	36 ...96.8
11 ...51.8	24 ...75.2	37 ...98.6
12 ...53.6	25 ...77.0	38 ...100.4

The thermometer-probe temperature check is only conducted before the monitoring event takes place. There is no need to conduct this check after the event has been completed. Unlike calibrations of other instruments, thermometers cannot be manually calibrated, they are calibrated by the manufacturer prior to shipment.

Locate a place at your monitoring site to test the air temperature. Do not use your phone to measure the air temperature unless you are certain the measurement was collected at the same time sampling occurred and the same location as the monitoring site. Hang the thermometer on a dock, pier, or a tree out of direct sun and wind.

Wait 2-3 minutes to allow the thermometer to equilibrate. You may conduct field observations while waiting.

Record the value to the nearest 0.5 °C on your [Monitoring Form](#). When reading the thermometer, always hold the thermometer on the end that is opposite the thermometer bulb to prevent interference with temperature reading.

WATER TEMPERATURE

QC CHECK: Remember to measure air temperature before you measure water temperature. A wet thermometer will not accurately measure air temperature.

When you have collected the water sample in the bucket, remove the sample from direct sunlight and wind. Do not hold the bucket in your hands because your hands might begin to warm the water. As soon as possible, put the thermometer in the bucket for one and a half minutes and record the value to the nearest 0.5 °C. Read the thermometer while the bulb and lower part of the thermometer are underwater. Never take the thermometer out of the water to read the temperature. If your site is appropriate, you may place the thermometer directly in the stream or lake.

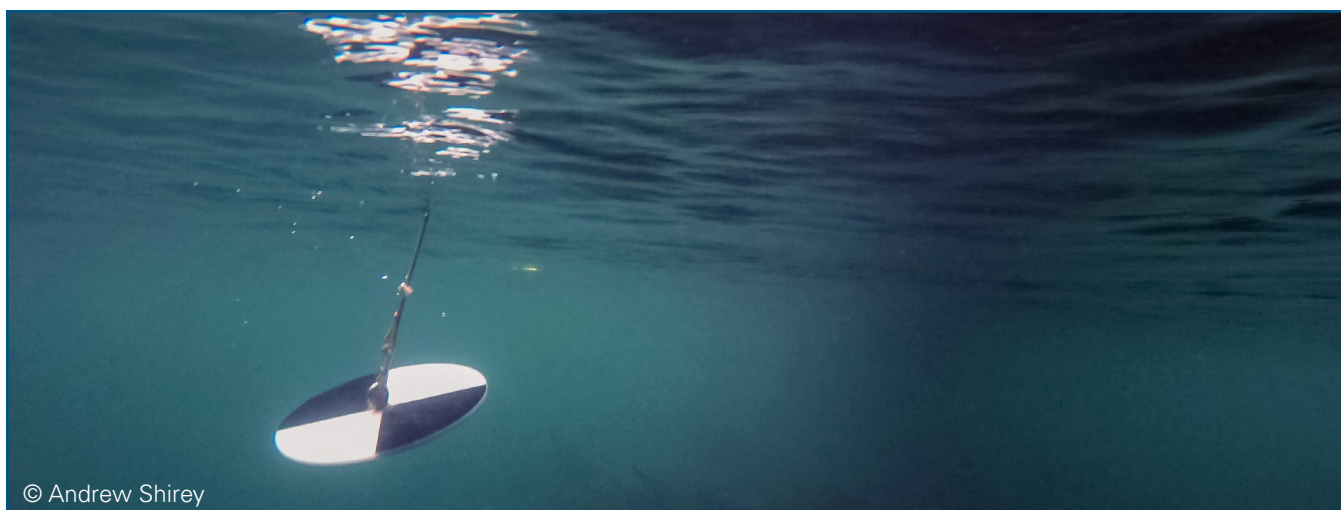
TROUBLESHOOTING A SEPARATED ALCOHOL COLUMN IN A THERMOMETER

COOLING METHOD TO FIX A SEPARATED THERMOMETER

With the thermometer in an upright position, cool the bulb only in a solution of shaved ice and salt so the alcohol column retreats slowly into the bulb. Remove and swing thermometer in a short arc forcing the entrapped gas to the top of the alcohol. Allow the bulb to warm slowly in the air.

HEATING METHOD TO FIX A SEPARATED THERMOMETER

Heat the thermometer bulb in warm water sufficient to allow the alcohol to rise slowly, until the separation and a portion of the main column enter the chamber. Tap the thermometer in palm of hand or on a padded surface reuniting the column. Allow to cool slowly.



Water Transparency

OVERVIEW

Materials that become mixed and suspended in water will reduce its transparency and make the water turbid. Turbidity is a measure of water transparency, specifically, of how much the solid matter suspended in water decreases the passage of light through the water column. In deeper waters, the Secchi disk is often used to measure water transparency, while in shallower waters, the transparency tube is used to measure water transparency.

High turbidity is typically an indicator of either runoff from disturbed or eroded soil, or blooms of microscopic organisms (usually due to high nutrient inputs). A primary source of turbidity is sediment from disturbed or eroded soil; however, many different materials can contribute to turbidity. In the summer, plankton plays an important role. These microscopic organisms grow and multiply at a rapid pace in warm, sunlit, nutrient-rich water. During periods of heavy runoff, silt-laden surface runoff can be seen flowing into rivers, lakes, streams, bays, and bayous. In shallow areas or near the shore, wind-generated waves and boat wakes interact with the bottom to stir up sediments. In some cases, fish and other aquatic life, like turtles and carp that feed on the bottom, can stir up sediments.

Water transparency is also influenced by water color. In much of East Texas decaying plants, including dissolved organic acids like tannins and

lignins, give the water a brown, tea-like color. These tannins and lignins can also affect water transparency, especially in deeper waters.

HOW TURBIDITY AFFECTS A HABITAT

Moderately low levels of turbidity may indicate a healthy, well-functioning ecosystem in which plankton flourish at a sustainable level and form the foundation of the food web. Harmful amounts of turbidity, however, can have significant, detrimental effects on aquatic life. As described above, high turbidity interferes with the penetration of sunlight needed for the growth of algae and sea grasses. Suspended particles can also transport heavy metals and other toxic substances into the habitat, which can cause damage to aquatic organisms. Turbidity can also disrupt the feeding and predation habits of aquatic organisms by limiting their visibility.

THE SECCHI DISK

The Secchi disk provides an easy method for measuring how far light penetrates below the water's surface. Secchi disk transparency is the average of the deepest point you can still see the Secchi disk and the point at which it disappears from view.

If monitoring is taking place from a bridge or pier, use a fixed point on the bridge structure as a height reference point. Lower the Secchi disk until the surface of the disk is exactly even with the water's surface. Record the distance from the bridge (or pier) height to use as a reference

point to the water's surface using the Secchi disk line. This measurement will be used when measuring water transparency or total depth with the Secchi disk.

PREPARING THE SECCHI DISK

The Secchi disk should be cleaned, weighted, and suspended on a metric-calibrated chain, wire, or Dacron line. Do NOT use nylon or cotton because stretching may cause erroneous readings. Tie a wrist loop in the end of the disk line to prevent loss of the Secchi disk.

MARKING THE SECCHI DISK LINE

Secchi disks are usually a 20-centimeter diameter disk, with black and white quadrants. Before starting your Secchi disk measurements, make sure that your Secchi disk line is marked every 1/2-meter, meter and 5 meters. You can mark your line using waterproof markers and a meter stick. Holding the line attached to the middle of the disk straight, hold the meter stick against the line and place a black mark on the line 1/2 meter from the top of the disk. Continue placing a black mark at every 1/2 meter, a red mark at every meter, and a yellow mark at every 5 meters. Draw the marks all the way around the line and wide enough to be clearly visible from a distance of 3 meters (9.84 feet).

QC CHECK: Check line measurements yearly for inaccuracy due to stretching. If possible, use a chain, wire, or Dacron line to prevent stretching and use a meter stick to improve the accuracy of the measurements to nearest 0.10 m.

SECCHI DISK PROCEDURES

Upon arrival at monitoring site, follow these steps:

STEP 1: Take the reading without sunglasses in the shade or while standing with the sun to your back. If on a boat take the reading on the shaded side if possible. The viewer should maintain an eye level of less than two meters above the water surface if possible.

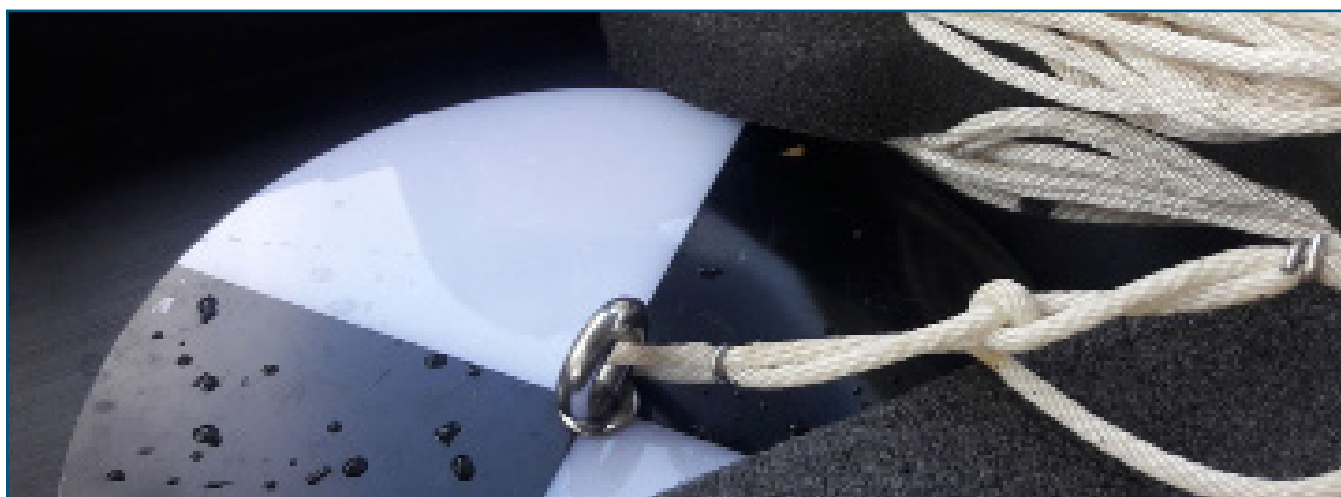
STEP 2: Lower the disk into the water until the disk disappears from sight and note the depth at which it disappears.

STEP 3: Slowly raise the disk and note the depth at which it reappears (barely visible).

STEP 4: Average the two depth readings obtained above in steps 2 and 3. The average of the two readings is your Secchi disk transparency value and is considered to be the limit of visibility, or index of transparency.

STEP 5: Record the average transparency measurements on the [Monitoring Form](#) to the nearest 0.10 meter (10.0 centimeters). Use a meter stick or ruler to improve the accuracy of the secchi disk transparency measurements on the Secchi disk line.

QC CHECK: If your Secchi disk reaches the bottom and you can still see it, record this depth measurement in the Secchi disk transparency box on the monitoring form, and place a greater than symbol (>) in front of the value. For example, if your Secchi disk is on the bottom of the creek and it is still visible, the water depth at that point is 1.56 meters and the value recorded in the Secchi Disk box on the [Monitoring Form](#) is >1.56.



THE TRANSPARENCY TUBE

Transparency Tubes consist of two main pieces: the tube with measurement markings in increments every two millimeters and the release spout with a valve at the base of the tube.

TRANSPARENCY TUBE PROCEDURES

STEP 1: COLLECTING SAMPLE

Samples for the Transparency Tube procedure should be collected after Core parameter sample collection is complete. This way, collecting the water sample for the Transparency Tube will not disturb water conditions for other tests. Water is collected at a depth of 0.30 meters below the surface in one of two ways.

The first is to wade downstream of the sampling location (if safe to do so), rinse the tube twice with water from the location you waded to, and then fill the tube with the open end facing upstream.

If not wadable due to swiftly moving water, flood conditions, water contamination, or other reasons, the second method is to pour water collected from a bucket grab into the tube. Stir or swish the water until it is homogeneous, taking care not to produce air bubbles (these will scatter light and affect the measurement). Rinse the tube twice with the sample water from this bucket grab before filling the tube for measurement and pour the water slowly in the tube. Note in the comments field if a bucket grab was used for sample collection.

STEP 2: MEASUREMENT

Take the water-filled tube into the shade so the sunlight does not directly penetrate the water. Direct sunlight can make turbid water seem more transparent. If no shade is available, the shadow cast by standing in between the sun and tube is adequate. Sunglasses should not be worn while measuring transparency with the tube.

If the black and white pattern can be seen without releasing any water, simply record "greater than (tube maximum measurement)." If the pattern is not visible, begin to release water from the tube using the valve at the bottom in increments of 1 centimeter until the black and white pattern

becomes just visible. Once the pattern can faintly be seen, record this depth in meters (ex: 0.22 m), indicating the level of transparency.

STEP 3: CLEAN UP

Fully open the valve to avoid crimping along the release line and pour the water from the tube back into the body of water downstream.

Rinse the tube thoroughly twice with tap water while allowing water to also run through the release valve to clean it as well.

To dry, lean the tube upside down to reduce water spots. Attempt to keep the plastic sleeve on the tube to protect it from scratches. Upon re-use, change the location of the release valve to avoid long term crimping and wear on the tube.

Depth

TOTAL DEPTH PROCEDURES

To use the Secchi disk to measure depth, lower the disk until you see or feel the line go slack. Pull up on the line gently to straighten it out. Read the measured line attached to the disk at the water level. Record the total depth of the water in meters.

In very shallow water bodies, a weighted metric tape measure or meter stick can be used to improve the accuracy of the total depth measurement. Remember to convert measurement to meters before recording the information on the [Monitoring Form](#).



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Total Dissolved Solids (TDS) & Conductivity

OVERVIEW

Total dissolved solids (TDS) is defined as the quantity of dissolved material in water. Background TDS levels for a specific area depend mainly on the solubility of rocks and soils the water contacts. For instance, water that flows through limestone and gypsum dissolves calcium, carbonate, and sulfate, resulting in high levels of TDS. Fluctuations in TDS could indicate human-caused pollution. Point and nonpoint discharges to water bodies can change the conductivity depending on the characteristics of the effluent and runoff, respectively. A failing sewage system could raise the conductance because of the presence of chloride, phosphate, and nitrate; an oil spill would lower the conductance because oil does not conduct electrical current very well.

There are a wide variety of inorganic substances or dissolved solids like sodium, chloride, sulfate, calcium, bicarbonate, nitrates, phosphates, iron, magnesium, etc. in water solutions. All of these substances at certain concentrations are essential for life and all have the ability to carry an electrical current. These substances affect the flow of materials in and out of the cells of organisms

living in the water and they may also be used as energy sources for certain organisms. They also serve as the parts of molecules necessary for building new cells.

There are several terms used for describing inorganic materials in water: conductivity, dissolved solids, total dissolved solids, salinity, salt concentration, conductivity, and resistivity. Although they are measured in different units, their values can be converted for comparative purposes. The term salinity is typically used as an indication of how salty the water is in bays, estuaries, and oceans. Strictly speaking, salinity describes the relative amounts of certain salts, especially chloride, that are in the same ratio to each other as they occur in seawater.

In general terms, water with high concentrations of dissolved solids (such as seawater) is considered salty and has a high level of conductance. Water with low concentrations of dissolved solids is considered fresh. Most fish, plants, and other organisms are adapted to living in waters with a particular salt concentration range. For this reason we would never expect to

catch a largemouth bass in the Gulf of Mexico, and, on the other hand, we would not expect to see a red snapper in the Brazos River. Inorganic materials in water are generally determined by the geology of the watershed. For example, if the soil and rock formations are composed of limestone, water draining this watershed will probably be high in calcium, magnesium and carbonate, the common constituents of limestone.

Fluctuating levels of dissolved solids and conductance can be indicators of pollution from various activities. Examples of these activities include wastewater discharges that may be high in salts; brine water from oil production activities; irrigation; removal of vegetation shading a stream and causing increased evaporation; overuse of fertilizers; or the spreading of road salt during icy conditions.

CONDUCTIVITY

A convenient way to measure TDS is to test the conductance of the water sample. Conductance is a measure of the ability of water to pass an electrical current and is affected by the presence of dissolved solids. Dissolved substances in water dissociate into ions with the ability to conduct electrical current. As the level of TDS rises, the conductivity will also increase.

Texas Stream Team measures conductance in microsiemens per centimeter ($\mu\text{S}/\text{cm}$), but it can also be measured in micromhos per centimeter ($\mu\text{mhos}/\text{cm}$). Distilled water has a conductance in the range of 0.5 to 3 $\mu\text{S}/\text{cm}$. The conductance of rivers generally ranges from 50 to 1500 $\mu\text{S}/\text{cm}$.

MEASURING CONDUCTIVITY

Conductance (or TDS) can be recorded using a conductivity meter.

CONDUCTIVITY METER PRE-TEST CALIBRATION

The following procedures are for the ECTester11 (tan-colored meter). If your kit has a different meter, follow the manufacturer's guidance for calibrating the equipment. Calibration is performed using a Conductivity Standard

consisting of potassium chloride or sodium chloride mixed with deionized water. It is not toxic or hazardous. The meter should be calibrated to the nearest 0.10. The temperature of the Conductivity Standard should be stable. For this reason, it is recommended that the pre-test calibration and post-test calibration be performed in your house or lab at room temperature. Storing the standard in the trunk of a car or in a garage can interfere with proper calibrations, thus resulting in unreliable measurements.

QC CHECK: Conductivity calibrations should be performed within 24 hours of the sampling event, but it is recommended that this procedure be performed immediately before and after completing your field sampling event.

STEP 1: Under the conductivity "Standard Value" box on your [Monitoring Form](#), record the value of the conductivity calibration standard. This value is found on the conductivity standard bottle.

STEP 2: Remove the protective cap from your conductivity meter. Rinse the beaker and meter's probe twice with a small (approximately 1.5 oz or 50 mL) volume of conductivity standard solution.

STEP 3: Pour about 20 mL of conductivity calibration standard into the beaker, depending on the size of the beaker in your kit. Submerge and hold the meter in the calibration standard.

STEP 4: Stir gently and check to make sure there are no air bubbles trapped on the bottom of the probe. If there are air bubbles, they can be removed by tapping the bottom of the probe against the side of the beaker while the bottom of the probe is in the calibration standard.

STEP 5: Turn the meter on while it is in the standard solution.

STEP 6: The readings might initially increase or decrease as the meter reacts to the temperature difference between the meter and the Conductivity Standard. Wait two minutes to allow the temperature sensor to fully compensate for this difference.

QC CHECK: Your meter reading will not be accurate if your meter is resting on the bottom or the sides of the beaker. Whenever calibrating or reading the meter, make sure that it is always at least one centimeter (½ inch) above the bottom of the beaker.

STEP 7: After two minutes, once the display has stabilized, read and record the meter reading (in °C) in the calibration box under “Initial Meter Reading.”

STEP 8: If the conductivity meter is not reading the same value as the Conductivity Standard (rounded to the nearest 10), remove the battery compartment lid. Next to the batteries are two white buttons. One button increases the value in the meter display, and the other decreases it. When adjusting, make sure that the meter is not resting on the bottom of the beaker and that there are no bubbles on the bottom of the meter probe. Press one or the other button to make the meter reading match the value of the Conductivity Standard (rounded to the nearest 10). The display will flash, and ENT will appear on the meter display. This means that the meter accepts the calibration and returns to measurement mode. Replace the battery compartment lid. The final meter reading should be recorded in the calibration box under the column titled “Meter Adjusted To.”



STEP 9: Turn the meter off while submerged and remove from the Conductivity Standard. Shake the excess Conductivity Standard from the meter, rinse with distilled or deionized water, and replace the cap. Periodically soak or swab probes with alcohol as part of the routine maintenance procedures.

STEP 10: Keep the calibration standard for use during the post-test calibration procedure after sampling. Ensure that the standard does not become contaminated between the readings.

CONDUCTIVITY TEST PROCEDURES

STEP 1: Remove the cap from the meter and rinse the sample beaker and the meter twice with the water from the same location and depth as the water to be sampled. Dispose of the rinse water downstream or up on the shore to avoid contamination of your sample.

STEP 2: Fill the beaker with 20 mL of sample water and place the meter in the beaker. Make sure the meter is not touching the bottom of the beaker and there are no air bubbles trapped underneath it.

STEP 3: Turn the meter on, wait 2 minutes, and read the meter display. Make sure the beaker with the sample water and meter are out of direct sunlight and protected from rapid temperature changes. Remember that the meter must be 1/2 inch above the bottom and not touching the sides of the beaker when the measurement is recorded. Turn meter off while submerged.

STEP 4: Record the meter reading in the “Conductivity” box on the [Monitoring Form](#). Rinse the meter and beaker twice with deionized water, wipe dry, and return to kit.



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CONDUCTIVITY METER POST-TEST CALIBRATION

The post-test calibration should be completed in a temperature-controlled environment after monitoring has been completed and within 24 hours of the pre-test calibration.

STEP 1: Complete a post-test calibration by first rinsing the probe with deionized water.

STEP 2: Next place the probe in the beaker with the same standard used for the conductivity pre-test calibration. Allow the reading to stabilize and then record it in the post-test initial value box on the [Monitoring Form](#). **DO NOT CALIBRATE THE METER AT THIS TIME.**

STEP 3: Determine if the meter met the calibration error limits and passed QA requirements. If the difference in readings between the “meter adjusted to” and the “post-test initial value” is within 10% of the conductivity standard value, the conductivity meter passed the QC and the data can be submitted Texas Stream Team, or entered directly into the to the [Waterways Dataviewer](#). If the difference between the two measurements did not fall within 10% of each other, the data did not pass QA and will have to be “flagged” in the [Dataviewer](#).

For example, if you are using a conductivity standard of 1413 $\mu\text{S}/\text{cm}$, the difference between the “meter adjusted to” and “post-test initial value” needs to be within $\pm 141.3 \mu\text{S}/\text{cm}$ to pass QA. If you adjusted the meter to 1410 $\mu\text{S}/\text{cm}$ and the post-test initial value was 1500 $\mu\text{S}/\text{cm}$, then the difference is 90 $\mu\text{S}/\text{cm}$. The difference (90 $\mu\text{S}/\text{cm}$) is within the 10% (141.3 $\mu\text{S}/\text{cm}$) criterion, therefore the meter passed QA requirements and the data can be submitted to the [Dataviewer](#) without a flag.

NOTE: After post-calibration, dispose of the conductivity standard by flushing it down the drain with plenty of water.

Dissolved Oxygen

OVERVIEW

DO is a measurement of the amount of oxygen freely available in water. DO is one of the most important indicators of water quality for aquatic life, and it is essential for all plants and animals inhabiting a body of water. The amount of oxygen required varies according to species and stage of life, however, usually DO levels of 5.0 to 6.0 milligrams per liter (mg/L) are required for growth and activity. When oxygen levels in the water fall to below about 3.0 mg/L, fish and other aquatic organisms may have difficulty successfully reproducing, feeding, or surviving. When DO levels fall below 2.0-1.0 mg/L, most aquatic life will not be able to survive.

SOURCES AND SINKS OF DO

Oxygen is transferred from the atmosphere into the surface waters by the aerating action of the wind through a process called physical aeration or diffusion. It is also added as a by-product of plant photosynthesis. As a result, floating and rooted aquatic plants increase DO levels through the process of photosynthesis. Since the survival of plants also depends on the availability of light, the oxygen producing processes primarily occur near the surface or in shallow waters. Once dissolved in water, oxygen diffuses very slowly and distribution depends on the movement of aerated water from turbulence and currents caused by wind, water flow, and thermal upwelling.

Oxygen levels may be reduced to harmfully low levels because high densities of bacterial or aquatic organisms use up the oxygen through the process of respiration. Respiration is a 24-hours-a-day process that nearly all aquatic plants and animals use to produce the energy they need. Through respiration, an overabundance of aquatic plants and animals can at times consume most of the oxygen in the water. Too much aquatic plant or algal growth may occur when there are elevated concentrations of nitrogen and phosphorus (two nutrients essential for plant growth) in the water. This process is called over-fertilization. Over-fertilization may be

caused by runoff from farmland, fertilized yards and golf courses, or partially treated wastewater effluent. Consumption of oxygen can be most damaging at night and on very cloudy days when the production of oxygen by photosynthesis does not occur or slows down. Respiration usually occurs at higher rates during the summer when higher temperatures increase plant and animal metabolism.

OXYGEN SATURATION

Oxygen is a particularly sensitive constituent because other chemicals present in the water, biological processes, and temperature influence its availability during the year.

Temperature plays a major role in influencing the amount of DO in water. Water at a temperature of 31°C (typical for Texas' summer days) will only hold about half as much DO as the same water on a cold winter day at 1°C. Due to the physical and chemical properties of water, cold water generally contains more oxygen than warm water.

The DO test measures how much oxygen is dissolved in the water, but it does not measure how much DO the water is capable of holding at the temperature, which can also be tested. When water holds all the DO it can at a given temperature, it is said to be 100 percent saturated with oxygen. The following table shows the relationship between various temperatures and the solubility of oxygen in mg/L.

The amount of oxygen that water can hold also decreases as the barometric pressure of the atmosphere decreases. Barometric pressure generally decreases as the altitude or elevation of the water body increases. For example, the barometric pressure in the mountains is less than the barometric pressure near the ocean at sea level.

The concentration of DO in water decreases as salt concentrations increase. For example, water from Corpus Christi Bay that is 100% saturated with oxygen at a temperature of 25 °C, and that has a salinity of 15 ppt (conductivity of 24,900 µS/cm), has a DO concentration equal to 7.6 mg/L. From the table above, you will see that

freshwater that is 100% saturated with oxygen at a temperature of 25 °C, has a DO concentration equal to 8.4 mg/L.

DO can also be measured in parts per million (ppm); 1 mg/L equals to 1 ppm.

Temp	Solubility	Temp	Solubility
°C.....	mg/L	°C	mg/L
0.....	14.6	16	10.0
1.....	14.2	17	9.8
2.....	13.8	18	9.6
3.....	13.5	19	9.4
4.....	13.1	20	9.2
5.....	12.8	21	9.0
6.....	12.5	22	8.9
7.....	12.2	23	8.7
8.....	11.9	24	8.6
9.....	11.6	25	8.4
10.....	11.3	26	8.2
11.....	11.1	27	8.1
12.....	10.9	28	7.9
13.....	10.6	29	7.8
14.....	10.4	30	7.7
15.....	10.2	31	7.4

MEASURING DO

There are two procedures for determining the value of DO. One is by using the modified Winkler method, which is used for the Standard Core procedure, and the other is by using a DO meter, which is used for the Probe Core procedure.

MODIFIED WINKLER METHOD

The DO test involves three stages: collecting the sample; fixing or stabilizing the sample; and titrating the sample to determine a DO value. Once the water sample is fixed, contact with the atmosphere will not affect the test result, so it is not necessary to perform the titration procedure immediately.

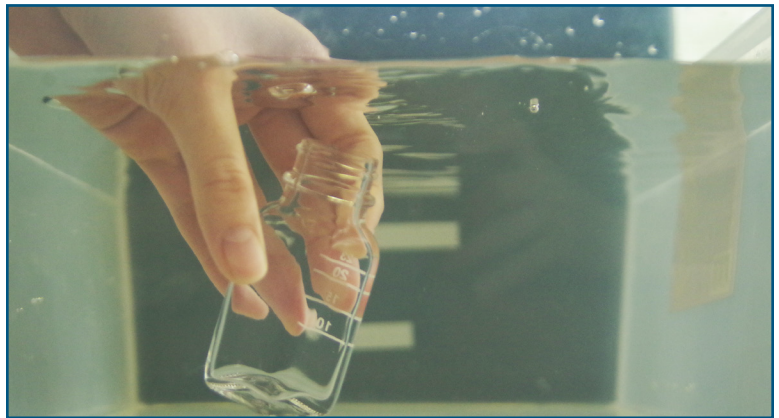
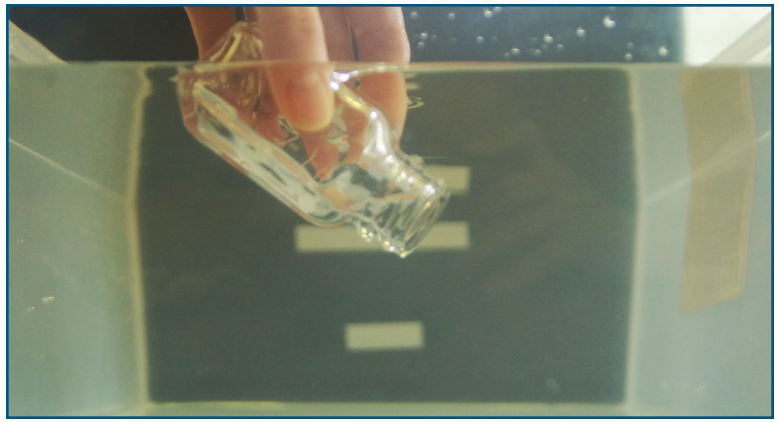
Titration of the sample involves the addition of several chemicals to the fixed sample resulting in a DO value. Using this method, several samples can be collected, fixed in the field, and then transported to a testing station or laboratory for titration. Fixed samples should be stored in the dark and away from hot or very cold temperatures. Titration should be completed no longer than 4 hours following fixation.

COLLECTING THE SAMPLE

STEP 1: Rinse the sample bottles and caps twice from a depth of 0.3 meters (1.0 feet). If you are rinsing with water from a bucket, DO NOT throw the rinse water back into the bucket. If you are rinsing the bottles and caps directly from the water body, throw the rinse water downstream or up on the bank so the rinse water will not affect the water at your sample location.

STEP 2: Holding both bottles in one hand, vertically submerge them one foot with the mouth of the bottles facing down. Turn the bottles right side up and hold them at the sampling depth until they are filled (until they stop bubbling). Tap the sides of the submerged bottles to dislodge any air bubbles clinging to the insides. With both caps in one hand, invert and tap the caps to release bubbles. Cap the bottles under water. If the water is not deep enough, collect surface water by holding the bottles slightly submerged facing upstream. Fill the bottles to the brim and cap them while they are still submerged (see photo on right for reference).

STEP 3: Take the bottles out of the water. Turn the bottles upside down, tap them against the palm of your hand and examine them carefully to make sure that no air bubbles are trapped inside. If air bubbles are present in one or both bottles, pour the water samples downstream or on the bank and repeat step two until no air can be detected in either bottle.



The above is shown using only one bottle. When monitoring, the samples should be collected in both bottles simultaneously, unless using the bucket grab method (see Step 2).

FIXING THE SAMPLE

SAFETY CHECK: Put safety goggles and gloves on at this time and use until the end of the DO test!

STEP 4: Carefully uncap the sample bottles. Add 8 drops of Manganous Sulfate Solution and 8 drops of Alkaline Potassium Iodide with Azide to each sample. Hold the reagent bottles perfectly vertical above the sample bottle when adding the chemicals to the water. Do not let the reagent bottles touch the sample at any time. Cap the sample bottles. Mix by tightly holding the bottles and gently inverting them 25 times (do not shake). A precipitate will form. Allow the precipitate to settle below the shoulder of the bottles. Invert the bottles 10 more times and allow the precipitate to settle again below the shoulders. It may take up to 2 minutes for each settling (see photos on right).

NOTE: You may want to do other tests while the precipitate is settling.

STEP 5:

Add 8 drops of Sulfuric Acid to each sample bottle. Hold the reagent bottle perfectly vertical above the sample bottle when adding the chemical. Cap the bottles and mix the reagents by gently inverting the bottles until both the reagent and the precipitate have completely dissolved into a homogeneous solution. A clear-yellow to brown-orange color will develop, depending on the DO content of the sample. A dark yellow-brown color indicates high DO, while little or no color indicates low DO. Your sample is now fixed.

QC CHECK: After you are done fixing the sample at the end of step 5, contact between the water sample and air will not affect the test result. Fixed samples should be stored in the dark and away from hot or very cold temperatures if the titration will take place at a later time/place. Titration must be completed within 4 hours of fixing the sample.

TITRATING THE SAMPLE

STEP 6:

Rinse the glass titration vial and cap twice with a small amount of the fixed sample. Pour 20 mL of the fixed solution from the sample bottle into the glass titration vial, filling so the meniscus (dip in the water) rests on top of the 20 mL white line, and cap. Do this for each of the two sample bottles.

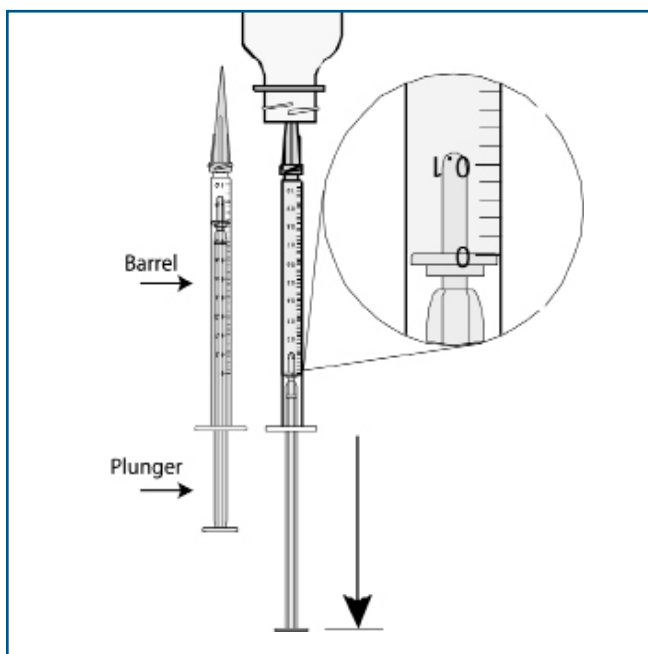


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QC CHECK: Use only a small amount of fixed solution in rinsing the titration vial. You want to leave enough fixed sample to perform the titration a second time if necessary. (See Calculating DO Value).



STEP 7: Fill the titrator with Sodium Thiosulfate. Do this by inserting the tip into the Sodium Thiosulfate bottle, inverting the bottle, and pulling back the plunger of the titrator. Be sure to expel any air bubbles from the titrator barrel by moving the plunger up and down repeatedly or by tapping the side of the titrator at the bubble with your finger. Fill the titrator until the top (not the bottom) of the ring of the green plunger tip lines up with the 0.0 mark. Check to ensure the plunger does not move. Remove the titrator from the reagent bottle and place it into the hole in the cap of the glass titration vial.

QC CHECK: Since the titrator never comes into contact with any other reagents, it should not be necessary to rinse the titrator EXCEPT when your Sodium Thiosulfate has become out of date OR if you think your titrator may have become contaminated. In these cases you should rinse the titrator twice with a small amount of Sodium Thiosulfate, disposing of the rinse directly into your waste container.

STEP 8: Add 1 drop of Sodium Thiosulfate from the titrator to the glass titration vial; swirl the glass titration vial gently but thoroughly

to mix. Add another drop of the Sodium Thiosulfate and swirl again. Continue this titration process one drop at a time until the yellow-brown solution in the glass titration vial turns to a pale-yellow or straw color. Uncap the glass titration vial with the Sodium Thiosulfate-filled titrator still inserted in the cap of the glass titration vial. Keep the tip of the titrator in the mouth of the titration vial.

STEP 9: Add 8 drops of Starch Indicator Solution to the glass titration vial while holding the reagent bottle vertically. Place the vial cap and titrator back onto the glass vial. Swirl the titration vial gently but thoroughly (do not shake) to mix. The solution should almost instantly turn from light yellow to dark blue.



QC CHECK: The final part of the titration is best conducted against a white background (such as a white sheet of paper) so that you can clearly see when all the blue color has disappeared.

STEP 10: Continue the titration process with the remaining Sodium Thiosulfate until the test solution turns from blue to clear. Be careful not to add any more Sodium Thiosulfate than is necessary to avoid turning the sample completely clear. Swirl the vial thoroughly after each drop. A half drop can be added by tapping the vial.



QC CHECK: If you use 9 units of Sodium Thiosulfate and the color is still blue STOP and completely refill your titrator with additional Sodium Thiosulfate. Remember to add the 9 units to the additional amount of Sodium Thiosulfate used to complete the DO test.

STEP 11: Using the scale on the side of the titrator, count the total number of units to the nearest 0.1 of Sodium Thiosulfate used in the titration. Each line on the titrator represents 0.2 mg/L of oxygen. That number equals the number of mg/L of oxygen dissolved in the water. Record this value in the blank on your [Monitoring Form](#) for the first titration.

QC CHECK: Any remaining Sodium Thiosulfate in your titrator after each titration should be disposed of by injecting it into the titration vial or your waste container. Do not put excess back into the Sodium Thiosulfate bottle. Store titrator with plunger pulled away from the tip, or it will stick eventually.

Repeat Steps 6-11 on the fixed sample in the second sample bottle. Record this value on your [Monitoring Form](#) for the second titration.

If the values for both titrations differ by more than 0.5 mg/L, repeat the titration on one of the sample bottles. If the range between two sample bottles is still more than 0.5 mg/L, repeat the titration on the second sample bottle.

QC CHECK: If the values are still more than 0.5 mg/L oxygen apart, perform the entire DO test a second time and record only the second test result on your [Monitoring Form](#). If this is not possible, please indicate all four initial DO values on your [Monitoring Form](#), but do not average the results.

STEP 12: CALCULATING DO VALUE

Calculate the average of the two titrations that are within 0.5 mg/L of each other and record the average (rounded off to the nearest 0.1 mg/L) in the Dissolved Oxygen field on the [Monitoring Form](#).

STEP 13: CLEAN UP

A sealable waste container should be used for collection of all sample waste. Safely dispose of all out-of-date or waste chemicals by flushing them down a sanitary sewage system drain with plenty of water. Do not dispose of chemicals in a septic waste system, water body, or onto the ground. Rinse sampling bottles, titration vials and caps, and titrators (including tips) twice with deionized water.

DO METER: PRE-TEST CALIBRATION

STEP 1: Both pre- and post- test calibrations must take place before and after field measurements have been collected in a temperature-controlled environment.

Remove the probe cap and moisten but don't soak the sponge contained inside the cap with distilled water.

STEP 2: Turn the probe on and press the MODE/HOLD button until the percent saturation mode (%) is displayed on the LCD.

STEP 3: Keep the probe on and allow it to fully polarize. If you haven't used the probe in more than 7 days, this could take 2-3 minutes. If the probe is fully polarized, a tiny asterisk will be visible from the bottom right portion of the screen. Once the meter stabilizes, record the value in the "Pre-test calibration initial meter" field on the [Monitoring Form](#).

STEP 4: Press and hold the CAL/RECALL button until CAL is shown in the lower display. The readings will blink "101.7" and "SA" will appear. When the calibration is complete, "END" will appear and then the probe will return to the normal measurement mode. Turn the probe off.

STEP 5: Record 101.7 in the "Meter adjusted to" field on the [Monitoring Form](#).

MEASUREMENT

STEP 1: Turn on the DO probe. Toggle the MODE/HOLD button until the units mg/L appear on the LCD.

STEP 2: Rinse both the sample beaker and the probe in the sample water twice. Dispose of the sample water downstream away from the sample location. Fill the sample beaker with 20 mL of sample water and stir the DO probe for two minutes to remove any air bubbles.

STEP 3: Allow the probe reading to stabilize, then record the value on the [Monitoring Form](#). When entering the DO value in the [Dataviewer](#), record the one probe value for both titrations.

STEP 4: Rinse probe and beaker with distilled water prior to storing.

POST-TEST CALIBRATION

STEP 1: Remove the probe cap and moisten but don't soak the sponge contained inside the cap with distilled water. This step may not need to take place depending on the moisture content of the sponge in the cap.

STEP 2: Turn the probe on and press the MODE/HOLD button until the percent saturation mode (%) is displayed on the LCD.

STEP 3: Keep the probe on and allow it to fully polarize. Once the meter stabilizes, record the value in the "Post-test calibration initial meter reading" field on the [Monitoring Form](#). DO NOT CALIBRATE.

STEP 4: Replace the probe cap and turn the probe off.

STEP 5: Check if the difference between the "Meter adjusted to" value of the pre-test calibration and the "Post-test calibration initial meter reading" value meets the calibration check error limit (0.5 mg/L). If it does, the measurement passed QA; if not, it did not pass QA and the measurement will be flagged in the [Dataviewer](#).

pH

OVERVIEW

The pH is a measure of how acidic or basic (alkaline) a solution is. In any given solution, some molecules of water break apart to form H⁺, hydrogen ions, and OH⁻, hydroxyl ions. The pH scale spans from 1.0 to 14.0 standard units, and indicates which ion has the greater concentration. At a pH of 7.0, the concentration of both ions is equal and the water is said to be neutral, neither acidic nor alkaline. Pure water has a pH of 7.0. When the pH is less than 7.0, there are more hydrogen ions than hydroxyl ions and the water is said to be acidic. When the pH is greater than 7.0, there are more hydroxyl ions than hydrogen ions and the water is said to be basic or alkaline. For most streams, ponds, lakes, and bays in Texas, the pH is usually slightly alkaline ranging from 7.0 to 9.0. Many streams and ponds in East Texas are acidic, with pH values as low as 5.5.

The pH is defined as the negative logarithm of the hydrogen ion concentration. This means that on the pH scale (0 - 14), the concentration of hydrogen ions does not increase or decrease in a linear fashion. Because the pH scale is logarithmic, increases are in powers of 10, and a change in pH value of 1 unit is equivalent to



a 10-times increase or decrease in the acidity or alkalinity of the water. This means pH of 3 is not twice as acidic as a pH of 6; it is 1000 times as acidic.

THE EFFECT OF PH ON AQUATIC LIFE

Generally, an aquatic organism's ability to complete a life cycle greatly diminishes as pH becomes greater than 9.0 or less than 5.0. A range of pH 6.5 to pH 8.2 is considered optimal for most organisms. Drastic changes in pH can affect aquatic life indirectly by changing other aspects of the water chemistry. For instance, toxic metals trapped in sediment are released into the water at lower pH levels, and the level of ammonia that fish can tolerate varies tremendously within a small range of pH values.

HOW IS PH INFLUENCED?

Water's ability to resist changes in pH is its buffering capacity or alkalinity. Buffering materials are added to the water from the soils, minerals, and rocks in the watershed. If a body of water has an abundance of buffering materials, it is more stable and resistant to changes in pH. The buffering capacity of a water body is critical to aquatic life.

Photosynthesis by aquatic plants also influences pH. It removes carbon dioxide from water, which increases the alkalinity. In especially low-velocity or still waters with lots of plant life (including planktonic algae), an increase in pH can be expected during growing seasons or even during warm, sunny afternoons.

Other events in the watershed that may affect pH include human activities such as accidental spills, agricultural runoff (pesticides, fertilizers, animal wastes), and sewer overflows.

MEASURING PH

There are two procedures for determining the value of pH. One is by using a Color Comparator Viewer, which is conducted with Standard Core procedures. The other is by using a pH meter, which is conducted with Probe Core procedures.

QC CHECK: Remember that the pH scale is logarithmic and a change in pH value of 1 unit is equivalent to a 10 times increase or decrease in the acidity or alkalinity of the water.

WIDE RANGE INDICATOR AND COLOR COMPARATOR VIEWER

Wide Range pH Indicator is a dye that changes color according to the pH of the water sample. The color is then matched to color standards representing known pH values using a Color Comparator.

There are three different model comparators that can be used to measure pH for the Texas Stream Team program:

- Octa Slide 2 Viewer and Slide Bars (1101, 2193-01, 2196-01)
- Wide Range pH Viewers (2193 and 2196)
- Liquid Wide Range pH Viewer (2192)

New kits are equipped with the Octa-Slide 2 Viewer and slide bars. However, other comparators are acceptable for pH monitoring.

It is essential the appropriate sample volume is used depending on the model used. Liquid Wide Range Indicator allows measurement of pH in a range of 3.0 to 10.5 su.

WIDE RANGE PH INDICATOR TEST PROCEDURES

STEP 1: Rinse 1 test tube and cap 2X with sample water.

STEP 2: Determine the type of pH viewer you are using:

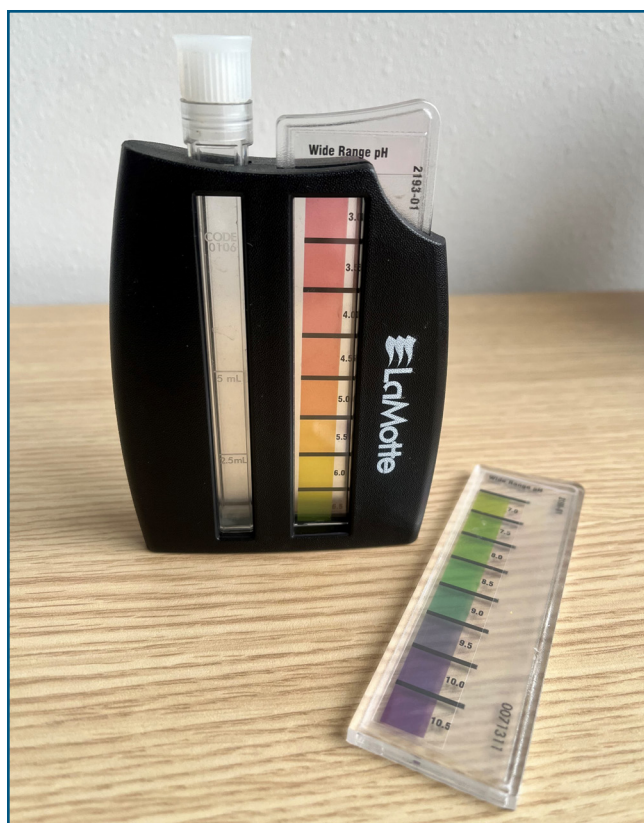
- If using the Wide Range pH Viewer (2193 and 2196) or the Liquid Wide Range pH Viewer (2192), fill round test tube with sample water to the 5 mL indicator line.
- If using the Octa-Slide 2 Viewer with slide bars (1101) with color bars (2196-01 and 2193-01) fill the square test tube with sample water to the 10 mL line.

STEP 3: Invert pH Wide Range Indicator reagent bottle a few times to mix, add 10 drops to water sample, cap tube, and invert 10 times.

SAFETY CHECK: Use your safety goggles and gloves while performing this test but remove goggles for color comparison (Step 5).

STEP 4: Insert the tube in the Color Comparator Viewer, remove cap, and hold up to a white background. Estimate to nearest 0.1 s.u. and record under pH.

STEP 5: Rinse tube and cap 2X with DI water.



Octa Slide 2 Viewer and Slide Bars



Wide Range pH Viewers



Liquid Wide Range pH viewer

QC CHECK: The key to this test is the color of the water sample, not how dark or light the sample is. The colors which influence the calibrated ampoules in the color comparator graduate from red (acidic) to yellow to blue (basic) with green (a more common color to observe due to its indication of midrange pH) being a combination of yellow and blue. If the sample looks green, compare the amount of yellow in the sample vial with the amount of yellow in the calibrated ampoules. The more yellow sample will have the lower pH. The sample with a darker green color will have more blue added to it. This color represents a higher pH value.

SAFETY CHECK: A sealable waste container should be used for discarding all test samples upon completion. Safely dispose of all out of date or waste chemicals by flushing them down a sanitary sewage system drain with plenty of water. Do not dispose of chemicals into a septic waste system, water body, or onto the ground.



USING A PH METER

The following steps are recommended to get the best results from a pH meter. Please ensure both pre-test and post-test calibrations take place and they meet the calibration check error limit (± 0.5). Be sure to include the results of these procedures on the [Monitoring Form](#).

PRE-TEST CALIBRATION OF THE PH METER

These steps should be completed before pH testing is performed in a temperature-controlled environment. Calibrate the meter using the pH calibration standard solution.

STEP 1: Under the pH "Standard Value" box on the [Monitoring Form](#), record the value of the pH calibration standard (usually 7.0 su).

STEP 2: Remove the protective cap from the meter. Rinse the beaker and meter prongs twice with a small volume of pH 7.0 s.u. calibration standard.

STEP 3: Pour about 50 mL of pH calibration standard into the beaker. Submerge and

hold the meter in the pH calibration standard solution.

STEP 4: Turn the meter on by pressing the ON/OFF button. Hold the meter one-half inch from the bottom of the beaker and swirl gently for two minutes. Wait one minute for the display to stabilize, then check the meter reading. Record this value under the pH "Pre-Test Calibration Initial Reading" field on the [Monitoring Form](#). If the meter reads 7.0, you are done calibrating and you do not need to write anything in the "Meter Adjusted to" field on the [Monitoring Form](#). If the reading is not 7.0, proceed to step 5.

STEP 5: While the meter is still submerged in the pH standard solution, begin calibration by pressing the CAL button. The number displayed should begin flashing and will approach 7.0. It will rest on a number and stop changing. The number will continue flashing.



STEP 6: Calibrate the meter by pressing the HOLD button. The reading should immediately change to 7.0. Record the value in the “meter adjusted to” field on the [Monitoring Form](#).

STEP 7: Turn the meter off while submerged. Rinse the beaker and meter prongs twice with distilled water.

STEP 8: Save the calibration standard solution for use during the post-test calibration pH reading after sampling has taken place, but make sure the standard does not become contaminated during the time between the pre- and post-test calibrations.

PH METER WATER SAMPLE TEST PROCEDURES

STEP 1: Once you arrive at the monitoring site, the sample has been collected, and you are ready to measure pH, remove the meter’s protective cap.

STEP 2: Rinse the beaker and meter prongs twice with a small volume of sample water.

STEP 3: Fill the beaker halfway and then submerge and hold the meter in the sample water.

STEP 4: Turn the meter on by pressing the ON/ OFF button. Hold the meter one-half inch off the bottom of the beaker and swirl gently for two minutes, dislodging any air bubbles that might have formed. Wait one minute for the display to stabilize, and then check the reading. Record this number as your pH value under the “Core Tests and Measurements” section on your [Monitoring Form](#). Turn the meter OFF, and replace cap.

POST-TEST CALIBRATION OF THE PH METER

STEP 1: A post-calibration test should be completed after you have sampled your designated monitoring location. Complete a post-calibration test in a temperature-controlled environment by first rinsing the probe with distilled or deionized water.

STEP 2: Place the probe in the beaker with the same standard solution used for the pre-calibration test. Allow the reading to stabilize

and then record it in the Post-Test Calibration Initial Reading blank on the [Monitoring Form](#).

DO NOT CALIBRATE THE METER AT THIS TIME.

STEP 3: If the difference between the post-test calibration initial value is not within ± 0.5 s.u. of the standard value or “meter adjusted to” value, the pH reading did not pass QC and will be flagged in the [Dataviewer](#). Please note this as a Comment on the [Monitoring Form](#) and be sure to change the batteries and conduct routine maintenance before your next sampling.

Note: After post-test, dispose of standard solution in waste container or by rinsing it down the drain with plenty of water.

MAINTENANCE OF THE PH METER

After each use, rinse your pH meter with deionized water, distilled water, or tap water if the others are not available. When storing the pH meter, it is recommended that you maintain moisture on the sponge in the cap with tap or distilled water, and then replace the cap firmly. This prevents the electrode from drying out and prolongs the life of the pH meter.

Note: Large differences in readings of pH (± 0.5 su) could be due to a dry electrode or run-down batteries. To improve performance, leave pH meter up to 2 inches deep in tap water for a few minutes at least once a week. To change batteries, open the cover at the top of the meter and replace batteries.

3.0 FOLLOW-UP AND CLEAN-UP

Clean-Up

DISPOSING OF WASTE

Safely dispose of all waste chemicals by slowly pouring them down a sanitary sewage system drain with water. While pouring the waste into the drain, turn on the tap and keep it running throughout the process. This will dilute the waste chemicals.

Do not dispose of chemicals into a septic waste system, water body, or onto the ground.

STORING CHEMICALS AND KITS

Kits should be sealed and stored in a cool, dark place, and should not be stored in direct sunlight or high temperatures. Ensure that your kit is stored in a safe location, where it cannot be accessed by children or animals. The contents of the core monitoring kit contain potentially harmful chemicals that require special handling.

All chemicals should be stored inside the kit. Alternatively, ensure that any chemicals outside of the kit are stored in a cool, dark place that is safely away from children and pets.

Follow-Up

Once you have become a certified Texas Stream Team citizen scientist, you can begin your monitoring project. To get started with monitoring, certified citizen scientists need to obtain monitoring equipment, select a site, and create a monitoring schedule.

MONITORING EQUIPMENT

To obtain equipment, please reference the [Texas Stream Team Equipment Form](#). **Please note**, Texas Stream Team is a federally recognized state-wide monitoring program with an approved [QAPP](#), therefore all monitoring must be conducted with the equipment listed, unless prior approval has been granted by Texas Stream Team staff. Texas Stream Team is entirely grant funded, and, therefore, unable to provide extensive funding assistance to citizen scientists. For assistance with funding your monitoring project, Texas

Stream Team highly encourages our citizen scientists and partners to seek alternate funding sources. Please reference the [Texas Stream Team Funding Sources Document](#) for assistance with funding.

MONITORING SITE

To select a site, citizen scientists can begin by referencing the Texas Stream Team [Datamap](#). The Datamap includes all historic and current water quality sites. Citizen scientists can choose to reactivate an inactive site by referencing the Texas Stream Team Datamap, or they can create a new site using the [Texas Stream Team Site Selection Guide](#) and [New Monitoring Site Request Form](#). For more information on site selection, please reference Section 2.2- Site Identification.

MONITORING SCHEDULE

Citizen scientists must decide on a monitoring schedule that will allow them time to pick up supplies, travel to their monitoring site, conduct sampling, and return supplies (if necessary). In order to ensure data quality, Texas Stream Team asks that monitors sample at least once a month and at the same time of day. Try to schedule a consistent time and day to monitor your site. For more information on scheduling your sampling time, see Section 2.3- Choosing a Sampling Time.

SUBMITTING TRAINING PACKETS

Training packets must be signed before they are submitted to Texas Stream Team. Prior to submitting completed training packets to your Texas Stream Team trainer, please ensure the Citizen Scientist Participation Release has been signed. Please note that Texas Stream Team will be unable to certify citizen scientists who do not provide their signature.

Once signed, please submit the training packet to the Texas Stream Team trainer. The trainer will send training documentation including training packets to Texas Stream Team, for processing by a staff member. Certificates will then be emailed within the first week of the month following your training.

3.1 DATA MANAGEMENT

Citizen scientists are required to use the [Monitoring Form](#) to record measurements at their monitoring site(s). Test results are always recorded on the form as they are completed in the field. All applicable sections of the [Monitoring Form](#) should be completed. For example, if information is not collected for a parameter, such as salinity, the space on the form remains blank.

Recording Data

To ensure compliance with the approved [QAPP](#), citizen scientists should observe the following rules when completing the Monitoring Form:

1. Write legibly in ink or pencil.
2. Correct errors with a single line strike-through followed by initials of the individual making the correction and date the correction was made.
3. Complete the QC Checklist on the second page of the [Monitoring Form](#) to confirm protocol was followed.
4. Sign and date the form once complete for validation.
5. Before monitoring data can be entered into the [Dataviewer](#), it must undergo a QC check to ensure the data are of the highest quality and meet the following conditions:
6. It is collected by a certified citizen scientist that has met all training requirements as described in this manual.
7. It is collected using the protocols, equipment, and the QC Checklist provided on the form described in this manual.
8. All data entries are legible.
9. All [Monitoring Forms](#) are complete and include a signature by the citizen scientist that conducted the monitoring.
10. All equipment calibrations have been completed, recorded, and meet the calibration error limits described in this manual.
11. All QA and QC protocols described in this manual have been implemented and met to the best of the citizen scientist's ability. See 3.1 Data Entry Checklist.

Entering Data into Waterways Dataviewer

Once the [Monitoring Form](#) is complete and meets the QC checks, the next step is to enter the data into the Waterways Dataviewer. There are two ways to enter the data:

1. Data sheets get forwarded to the group Data Coordinator. The group Data Coordinator conducts a quality control check and enters the data into the [Dataviewer](#).
2. Data sheets get forwarded to Texas Stream Team by emailing scanned copies or high quality photos (TxStreamTeam@txstate.edu) for entry by Texas Stream Team staff. The Texas Stream Team staff conducts a QC check and enters the data into the [Dataviewer](#).

Before group Data Coordinators can access the [Dataviewer](#) to enter data, they must first request an account and receive assigned login credentials. A request for an account can be made online through the [Waterways Dataviewer Account Request Form](#).

Once the data from the Monitoring Forms are entered into the [Dataviewer](#), the group Data Coordinator, Texas Stream Team staff, and/or designee verifies the data entry and the data then becomes publicly available.

If the data do not meet the QC checks described above, the data are flagged upon entry to the [Dataviewer](#) for further review by the Texas Stream Team staff or designee. The purpose of flagged data is to note inconsistencies or identify data that may have excessive variability. The [Dataviewer](#) is designed to recognize and flag water quality data that do not meet requirements in the QA checklist. For example, data may be flagged if the reagents were expired or missing values are identified related to the data collection process. Therefore, it is critical for citizen scientists to comply with the protocols described in this manual to ensure data measurements are of the highest quality and can be used to track point and nonpoint sources of pollution and promote and protect a healthy and safe environment for people and the aquatic inhabitants.

3.2 DATA ENTRY CHECKLIST

The data entry checklist is used by the Texas Stream Team Citizen Scientist and Data Coordinator to verify that data are collected using approved protocols prior to entering data into the [Waterways Dataviewer](#).

General Procedures

- ☐ None of the reagents used for testing were expired.
- ☐ Sampling was conducted at approximately the same time/day as previous sampling events at this site, preferably before noon or after 4pm (16:00).
- ☐ All relevant measurements were recorded in appropriate fields on [Monitoring Form](#).
- ☐ The [Monitoring Form](#) was signed by the citizen scientists.

Instrument Calibrations

- ☐ Thermometer-probe temperature check was conducted and difference between measurements was within ± 1 °C.
- ☐ Pre- and post-test meter calibrations were conducted and the differences between the "Meter adjusted to" value of the pre-test calibration and the "Post-test calibration initial reading" fall within the error limits listed in the table below:

Parameter	Error Limit
Dissolved Oxygen	± 0.5 mg/L
Specific Conductivity	$\pm 10\%$ of calibration standard solution
pH	± 0.5 s.u.
Salinity	± 1 ppt

Core Tests and Measurements

- ☐ **Sample Depth:** The sample depth is either 0.3 m or half of the total depth.
- ☐ **Air Temperature:** Values reported in degrees Celsius.
- ☐ **Total Depth, Transparency Tube, and Secchi Disk Transparency:** Values reported in meters.

- ☐ **Secchi Disk Transparency:** Ensure the average of two measurements, the measurement the disk disappears and the measurement the disk reappears, is reported in meters to two significant figures (examples: 0.35 m or 1.3 m).
- ☐ **Water Temperature:** Reported to the nearest tenth in degrees Celsius (example: 25.94 to 25.9, or 26.97 to 27.0)
- ☐ **Dissolved Oxygen:**
 - Duplicate samples were conducted for standard core, and titration values are within 0.5 mg/L of each other.
 - Values reported to the nearest tenth in mg/L (example: 5.94 to 5.9, or 6.97 to 7.0).
- ☐ **pH:** Values reported to the nearest tenth in pH standard units (example: 7.94 to 7.9, or 7.97 to 8.0).
- ☐ **Conductivity:**
 - Values are recorded in microsiemens per centimeter ($\mu\text{S}/\text{cm}$).
 - Only 3 significant figures are used for values over 100 (example: 1532 to 1530).
 - For Values < 100 $\mu\text{S}/\text{cm}$, standard rounding rules should be followed and reported to the nearest whole number (example: 88.7 as 88 $\mu\text{S}/\text{cm}$).

Coastal Area Salinity Tests and Observations

- ☐ Salinity values above 2.0 ppt were reported to the nearest tenth.
- ☐ For Estuarine waters above 2.0 ppt, the actual value was reported. Values less than 2.0 were reported as < 2.0 (example: 0.85 to < 2.0 ; 1.5 to < 2.0).

Field Observations

Suggested rainfall resources: Community Rain, Hail & Snow Network (www.CoCoRaHS.org), Weather.com (www.Weather.com) and LCRA's Hydromet Page (<https://hydromet.lcra.org/>).

- ☐ Days since last significant precipitation: Report whole numbers. If it is raining when the sample is collected, or has rained within the past 24 hours, report a value of <1. Otherwise, report the actual number, if known, or a 'greater than' value.
- ☐ Rainfall accumulation: Report inches of rain within the last 3 days.

3.3 EQUIPMENT MAINTENANCE AND STORAGE

QC CHECK: Do not use soap when cleaning your equipment. This can leave a residue, which can alter your results.

The importance of proper maintenance and storage of all monitoring equipment cannot be overstated. The accuracy of the measurements depends on proper maintenance and storage. The time, effort, and expense that goes into conducting Texas Stream Team water quality monitoring is highly valued, therefore do not dismiss this very important step that will add value to the quality of data produced and increase the longevity of the equipment.

Standard Core Water Quality Monitoring Equipment

THERMOMETER

Rinse the thermometer in tap water after each use and place back in protective sheath. Store in kit in a temperature-controlled environment.

SECCHI DISK

Rinse the Secchi disk in tap water after each use and allow to air dry. Wind rope around disk and return to kit. Check line measurements annually for inaccuracy due to stretching.

DISSOLVED OXYGEN

Safely dispose of all expired reagents and used chemicals by flushing them down a sanitary sewage system drain with plenty of water. Do not dispose of chemicals into a septic waste system, water body, or onto the ground. Thoroughly rinse sampling containers and vials after each test preferably with deionized or distilled water

(tap water is acceptable if the other two are unavailable). Do not rinse the titrator used for titrations with Sodium Thiosulfate. Dry the outside of the containers and put all chemicals away in a cool, dark place away from children and pets until next use.

PH COLORIMETRIC COMPARISON VIEWER

Rinse all tubes and caps with distilled water. Dry and store in protective kit.

CONDUCTIVITY METER

To store and care for the conductivity meter, ensure the meter is off at all times except when in use to extend battery life. Dry the probes with a dry, clean paper or cloth towel after each use and replace the protective cap. Always store in a temperature-controlled environment. Refer to the manufacturer's manual for more information about how to maintain, store, and trouble-shoot problems with the meter.

Probe Core Water Quality Monitoring Equipment

CONDUCTIVITY/PH PROBE

GETTING STARTED

1. Before using the probe, the manufacturer recommends soaking the electrode in tap water or pH 4 Buffer solution for about 10 minutes to dissolve any build-up resulting from storage.
2. White Potassium Chloride crystals may be present in the cap or on the electrode due to storage, but they will dissolve after soaking the electrode and improve accuracy of measurement.

UPKEEP

1. After using the probe, keep the sponge in the protective cap soaked with tap water or pH 4 Buffer solution. This will help sustain the life of the electrode.
2. In most cases, use a 1413 $\mu\text{S}/\text{cm}$ Conductivity Standard for calibrating in the conductivity mode. If extremely low or high conductivity results are anticipated, calibrate using an 84 $\mu\text{S}/\text{cm}$ or 12880 $\mu\text{S}/\text{cm}$ standard, respectively.

3. Do not touch the inner surfaces of the conductivity electrodes with bare hands. Touching them can damage the electrode and reduce the life of the probe.
4. Always rinse the electrode with deionized water twice between measurements to avoid cross contamination of samples.
5. When using the 20mL sample cup in a conductivity reading, do not let the electrode sit in the sample for any longer than necessary. Electrolytes can leak into the sample, which raises the conductivity value.
6. To prevent corrosion of the meter, it is highly recommended that batteries be removed when meter is not in use. When the batteries become weak the “BAT” icon will appear in the display as a reminder to replace the batteries.

WHEN RENEW INDICATOR IS DISPLAYED

1. If when in pH mode a “RENEW” indicator flashes, this means the probe is not performing to expected specifications. This means the electrode’s “slope” has fallen below 70% of a nominal slope, which negatively affects the meter’s accuracy.
2. When “RENEW” is flashing, try cleaning the electrode with the pH/conductivity rinse solution provided in the kit. If this fails, proceed to the “Cleaning the electrode” section.

CLEANING THE ELECTRODE

1. If the electrode is contaminated by water soluble substances, clean it with deionized water. Soak or scrub the electrode with a soft brush, then recondition the electrode in 4 or 7 pH Buffer for one hour.
2. If the electrode is contaminated by grease and oil, rinse it with warm water and household detergent. Soak or scrub the electrode with a soft brush for a maximum of 10 minutes. Rinse thoroughly with deionized water, then recondition in 4 or 7 pH Buffer for one hour.
3. If the electrode is contaminated by heavy levels of grease and oil, rinse or soak with

rubbing alcohol for a maximum of five minutes, then scrub with a soft brush. Rinse thoroughly with deionized water, then recondition in 4 or 7 pH Buffer for one hour.

4. If the electrode is contaminated by lime or hydroxide coatings, clean with 10% acetic acid and soak until the contaminant’s coating is dissolved for a maximum of five minutes. Rinse thoroughly with deionized water, then recondition in 4 or 7 pH Buffer for one hour.
5. If after cleaning the “RENEW” indicator is still flashing, replace the electrode with a new one.

REPLACING AN ELECTRODE

1. Unscrew and completely remove the green electrode collar by turning it counterclockwise.
2. Gently rock the electrode from side to side, pulling it downwards, until it disconnects from the meter.
3. To attach a new electrode, carefully plug it into the probe socket, then tighten the electrode collar to make sure it’s sealed properly.

DISSOLVED OXYGEN (DO) PROBE

GETTING STARTED

1. The DO probe electrode is shipped “dry” and requires filling with the supplied DO-600 Electrolyte Solution before use. The electrode cap’s membrane should be in place and does not need replacement. To fill the bonded cap, proceed to the “Fill and replace bonded electrode cap” section.

FILL AND REPLACE BONDED ELECTRODE CAP

Note: NEVER touch the membrane. Skin oils will interfere with the oxygen permeability rate of the membrane. Use caution when replacing the bonded cap.

1. If using for the first time, unscrew the membrane cap on the electrode. If replacing with a new one, unscrew the old cap and dispose in the trash.
2. Take the new cap and place it on a hard, flat surface. Rinse the anode and cathode with

deionized water to remove old electrolyte solution.

3. Fill the bonded cap with the DO-600 Electrolyte Solution up to the bottom of the threads on the inside of the cap.
4. Tap the side of the bonded cap to help free any trapped air bubbles from the electrolyte solution.
5. Keeping the cap in a fixed position on a flat surface, carefully insert the electrode into the new bonded cap by first dipping and removing the electrode several times from the cap. With each dip, push the electrode progressively deeper into the bonded cap.
6. Finally, screw the electrode slowly onto the bonded cap in a clockwise direction until fully tightened. Excess electrolyte solution may leak during the process—clean off the excess solution before use.
7. If the bonded cap appears to be properly prepared but errors are occurring, you will need to replace the electrode on the Dissolved Oxygen ExStik® II meter. To replace a full electrode, see the “Replacing an electrode” section under the Conductivity/pH probe section. To replace the batteries, see the “Replacing batteries” section under the Conductivity/pH probe section.
8. To prevent corrosion of the meter, it is highly recommended that batteries be removed when meter is not in use.

3.4 REPORTING UNUSUAL ACTIVITY AND UNLAWFUL EVENTS

Illicit discharge

An illicit discharge can have different meanings across different regulatory agencies. For the purpose of Texas Stream Team monitoring activities, an illicit discharge is defined as any event wherein a storm drain has a measurable flow during dry weather conditions (Brown, et. al, 2004). Illicit discharges are usually produced from a singular source or operation and can be further broken down into categories based on

their frequency, flow-type, and mode of entry.

Illicit discharges can be either direct or indirect. An illicit discharge has a direct mode of entry when the discharge is directly connected to a storm drain through a sewage pipe, shop drain, or other kind of pipe. An indirect discharge occurs when flows generated outside of the storm drain enter the system, either through inlets, or by infiltrating the joints of a pipe (Brown, et. al, 2004).

Illicit discharges include any instances wherein chemicals or waste are discarded into a sanitary sewer drain. Examples of illicit discharges include improperly discarded oil and grease, runoff from excessive fertilizers and pesticides, and illegal dumping of hazardous chemicals. Other examples include septic tank seepage, laundry wastewater, pool or spa wastewater, or illegal sanitary sewer connections.

For information about illicit discharge, and additional examples of illicit discharges that might be expected corresponding to land uses, please visit page 12, table 2 of the EPA's [Illicit Discharge Detection and Elimination Guidance Manual for Program Development and Technical Assessments](#).

HOWTO REPORT AN ILLICIT DISCHARGE

To report an illicit discharge, please contact your city office. Many cities allow citizens to anonymously report illicit discharges online. Check your city's Department of Water or Department of Public Works for an online form, or, alternatively, you can contact your city office at their main office phone line.

For assistance with reporting illicit discharges, you can also contact Texas Stream Team at TxStreamTeam@txstate.edu or by calling (512) 245-1346.

Wildlife Kills and Pollution Events

The [Texas Parks and Wildlife Department's Kills and Spills Team \(KAST\)](#) is comprised of a group of biologists who investigate fish and wildlife kills. KAST biologists evaluate both unnatural and natural events to assess the impacts to fish and

wildlife resources and to determine the causes of the events.

KAST biologists work to:

1. Determine the causes of wildlife kills and/or pollution events
2. Attempt to minimize environmental damage resulting from wildlife kills and/or pollution events
3. Obtain compensation for environmental damage and restore the affected environment

REPORTING A KILL OR SPILL

Prompt notification is essential to a successful investigation, and the sooner that KAST biologists are notified of a potential wildlife kill or pollution event, the better the chances are that useful evidence can be collected, and conclusive actions can be taken.

1. When reporting a Kill or Spill, make a note of the: Location, date, and time
2. Water color, clarity, and odor
3. Number, size, and species of affected organisms
4. Recent weather
5. Condition and behavior of animals or organisms
6. Condition of plants/other organisms

To contact the KAST Team, call (512) 389-4848 or contact your regional Kills and Spills Team biologist. You can find your regional KAST biologist at www.tpwd.gov/landcover/water/environconcerns/kills_and_spills/regions.

TCEQ Compliance and Enforcement

[The TCEQ Office of Compliance and Enforcement](#) is responsible for enforcing compliance with state environmental laws, responding to emergencies and natural disasters, overseeing dam safety, and monitoring air quality.

TCEQ divides the state of Texas into four areas, with further regional divisions. Within their defined administrative region, each regional office is responsible for:

- Investigating compliance at permitted air, water and waste facilities
- Investigating complaints at facilities and operations- permitted or not- from citizens, businesses, and other concerned parties
- Developing enforcement actions and referrals for violations
- Environmental education and technical assistance for communities
- Monitoring the quality of ambient air, surface water, and public drinking water

REPORTING AN ENVIRONMENTAL PROBLEM

Concerned citizens can file an Environmental Complaint with the TCEQ. In general, the TCEQ can assist with any complaint, provided that you have:

- Seen water that may be polluted
- Seen or smelled something unpleasant in the air
- Seen land that may be contaminated
- Are having problems with your drinking water
- Have information or evidence about an environmental problem
- Are having problems with an individual or company licensed or registered by the TCEQ
- Need assistance or information regarding environmental laws, possible pollution sources, or other questions relating to TCEQ Compliance and Enforcement

For more information on what TCEQ can and cannot help you with, please visit the [TCEQ website](#).

To report an Environmental Problem, please contact the TCEQ Office of Compliance and Enforcement at the 24-hour line 888-777-3186 or fill out their [online form](#). If you would prefer to contact your regional TCEQ Field Office, you can find applicable contact information on the TCEQ website.

4.0 APPENDIX

Online Resources

[Citizen Scientist Environmental Monitoring Form](#)

[Equipment Form](#)

[Funding Guidance](#)

[Group Citizen Scientist Monitoring Plan](#)

[New Monitoring Site Request Form](#)

[Private Property Access Form](#)

[Site Selection Guide](#)

[Standard Core Field Guide](#)

[Texas Stream Team Dataviewer Account Request Form](#)

[Texas Stream Team Dataviewer and Datamap](#)

[Texas Stream Team Quality Assurance Project Plan \(QAPP\)](#)

For additional forms and resources please visit the [Texas Stream Team Forms and Resources webpage](#).

Bibliography

Brown, E., Caraco, D., Pitt, R. (2004). Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments. Retrieved from <https://www3.epa.gov/npdes/pubs/iddmanualwithappendices.pdf>.

Kills and Spills Team. (n.d.). Retrieved from https://tpwd.texas.gov/landwater/water/envirionconcerns/kills_and_spills/

Office of Compliance and Enforcement. (2020). Retrieved from <https://www.tceq.texas.gov/agency/organization/oce.html#8>

Safety Data Sheets

Safety Data Sheets (SDS) for the reagents used to conduct Texas Stream Team Core Water Quality Monitoring can be located on the LaMotte webpage (<https://www.lamotte.com/en/support/sds-search>). Click on "Search SDS By Reagent Number Name or Kit" and search for the reagent using the product code provided below for each reagent type.

LaMotte Reagent	Product Code
Alkaline Potassium Iodide w/ Azide	7166
Manganous Sulfate Solution	4167
Sodium Thiosulfate	4169
Sulfuric Acid	6141
Wide Range Indicator	2218
Starch Indicator Solution	4170

4.1 GLOSSARY OF TERMS

Acute Toxicity: The ability of a substance to cause poisonous effects resulting in severe biological harm or death soon after a single exposure or dose. Also, any severe poisonous effect resulting from a single short-term exposure to a toxic substance.

Algae: Plants that lack true roots, stems, and leaves. For the physical assessment described herein, algae consist of non-vascular plants that attach to rocks and debris or are free floating in the water. Such plants may be green, blue-green, or olive in color, slimy to the touch, and usually have a coarse filamentous structure.

Alkalinity: A measure of the acid-neutralizing capacity of water. Bicarbonate, carbonate, and hydroxide are the primary cause of alkalinity in natural waters. Concentrations are expressed as mg/L of CaCO_3 .

Ammonia-Nitrogen ($\text{NH}_3\text{-N}$): Ammonia, naturally occurring in surface and wastewaters, is produced by the breakdown of compounds containing organic nitrogen.

Aquatic Macrophyte: Vascular plants that usually are arranged in zones corresponding closely to successively greater depths in shallow water. The characteristic plant forms that dominate these gradients (in order of decreasing depth) are: (1) submersed rooted aquatics, (2) floating-leaved rooted aquatics, (3) emergent rooted aquatics, and (4) marginal mats. Some vascular plants (like duckweed) may live unattached in the water and may occur anywhere on the water surface.

Bank: The portion of the channel that tends to restrict lateral movement of water. It often has a slope less than 90° and exhibits a distinct break in slope from the stream bottom. Also, a distinct change in the substrate materials or vegetation may delineate the bank.

Benthic Region: The bottom of all waters that supports the benthos.

Benthos: Aquatic bottom dwelling organisms that include: worms, leeches, snails, flatworms, burrowing mayflies, clams.

Bloom: The accelerated growth of algae and/or higher aquatic plants in a body of water. This is often related to pollutants that increase the rate of growth.

Channel: That portion of the landscape which contains the bank and the stream bottom. It is distinct from the surrounding area due to breaks in the general slope of the land, lack of terrestrial vegetation, and changes in the composition of substrate materials.

Channelization: Straightening and deepening streams so water will move faster, a method of flood control that disturbs fish and wildlife habitats and can interfere with a water body's ability to assimilate waste.

Chloride (Cl-1): One of the major inorganic ions in water and wastewater. Concentrations can be increased by industrial processes. High chloride concentrations can affect metallic objects and growing plants.

Chronic Toxicity: The capacity of a substance to cause long-term poisonous human health effects (See acute toxicity).

Conductivity: A measure of the electrical current carrying capacity, in $\mu\text{mhos/cm}$, of 1 cm of water at 25°C . Dissolved substances in water dissociate into ions with the ability to conduct electrical current. Conductivity is a measure of how salty the water is; salty water has high conductivity.

Contact Recreation: Recreational activities involving a significant risk of ingestion of contaminant water, including wading by children, swimming, water skiing, diving, and surfing.

Criteria: Water quality conditions which are to be met in order to support and protect designated use.

Cubic Foot Per Second (ft³/s)(cfs): A commonly used measure of the rate of flow where a 1 cubic foot volume of water travels one foot in 1 second.

Detritus: Decaying organic material.

Ecological Impact: The effect that a man-made or natural activity has on living organisms and their abiotic (non-living) environment.

Eddy Current: A circular water movement formed on the side of a main current. Eddies may be formed where the main stream passes obstructions (logs, rocks,).

Effluent: Wastewater (treated or untreated) that flows out of a treatment plant or industrial outfall (point source), prior to entering a water body.

Emergent Vegetation: Aquatic macrophytes (plants) that are rooted in the sediment, near shore, or in marshes, with nearly all of the leaves above the water surface (cattails are an example of this).

Estuary: Regions of interaction between rivers and near shore ocean waters, where tidal action and river flow create a mixing of fresh and salt water.

Euphotic Zone: The zone of water from the surface to depth of light penetration. Photosynthesis respiration occurs in this zone.

Eutrophic: Refers to shallow, murky bodies of water that have excessive concentrations of plant nutrients resulting in increased algal production.

Eutrophication: The slow, aging process during which a lake, estuary, or bay evolves into a bog or marsh and eventually disappears.

Family: A group of related plants or animals forming a category ranking above a genus and below an order and usually comprising several to many genera.

Fecal Coliform Bacteria: Bacteria found in the intestinal tracts of warm-blooded animals. Organisms used as an indicator of pollution and

possible presence of waterborne pathogens.

Floating Vegetation: Rooted plants (some free floating) with leaves floating on the surface (ex: water lily, water shield, duck weed, and invasive water hyacinths).

Flood Plain: The area adjacent to the channel which is occasionally submerged under water. Usually the flood plain is a low gradient area well covered by various types of riparian vegetation.

Food Chain: The dependence of organisms upon others in a series for food. The chain begins with producers (plants) and ends with the largest of the consumers (carnivores).

Food Web: An interlocking pattern of several to many food chains.

Genus: A category of biological classification ranking between the family and the species, comprising structurally or phylogenetically (evolutionary relationship) related species and being designated by a Latin or latinized capitalized singular noun.

Glide: Portion of the water column in which the flow is characterized by slow-moving laminar flow, similar to that which would be found in a shallow canal. Water surface gradient over a glide is nearly zero, so velocity is slow, but flow is shore to shore without eddy development. A glide is too shallow to be a pool, but the water velocity is too slow to be a run.

Habitat: The area in which an organism lives.

Indicator Organisms: An organism, species, or community that indicates the presence of a certain environmental condition or conditions.

Inorganic: Any compound lacking carbon.

Invertebrate: Animal lacking a backbone.

Macrophyte: Any large vascular plant that can be seen without the aid of a microscope or magnifying device (cattails, rushes, arrowhead, water lily, etc.).

Natural Vegetative Buffer: The natural vegetative buffer refers to an area of either natural or native vegetation which buffers the water body from terrestrial runoff and the activities of man. In natural areas, it may be much greater than the riparian zone width. In man-altered settings, the natural vegetative buffer limit would be at the point of man's influence in the riparian zone such as a road, parking lot, pasture, or crop field. It is the width of this buffer that we are most interested in measuring for purposes of quantifying potential stream impairments.

Nitrate-Nitrogen (NO₃-N): A compound containing nitrogen which can exist as a dissolved solid in water. Excessive amounts can have harmful effects on humans and animals >10 mg/L).

Nonpoint Source: Pollution sources which are diffuse and do not have a single point of origin or are not introduced into a receiving stream from a specific outfall. The pollutants are generally carried off the land by stormwater runoff. The commonly used categories for nonpoint sources are: agriculture, forestry, urban, mining, construction, dams and channels, land disposal, and saltwater intrusion.

Nutrient: Any substance used by living things to promote growth. The term is generally applied to nitrogen and phosphorus in water and wastewater, but is also applied to other essential and trace elements.

Orthophosphate (O-P): Nearly all phosphorus exists in water in the phosphate form. The most important form of inorganic phosphorous is orthophosphate, making up 90% of the total. Orthophosphate, the only form of soluble inorganic phosphorus that can be directly utilized, is the least abundant of any nutrient and is commonly the limiting factor.

Outfall: A designated point of effluent discharge.

pH: The hydrogen-ion activity of water caused by the breakdown of water molecules and presence of dissolved acids and bases.

Phosphorus: Essential nutrient to the growth of organisms and can be the nutrient that limits the primary productivity of water. In excessive amounts, from wastewater, agricultural drainage, and certain industrial wastes, it also contributes to the eutrophication of lakes and other water bodies.

Photosynthesis: The manufacture by plants of carbohydrates and oxygen from carbon dioxide and water in the presence of chlorophyll using sunlight as an energy source.

Plankton: Organisms (plants and animals) which live in open water, either suspended or floating.

Phytoplankton (plant): (1) Microscopic (2) movement dependent on currents (3) primary producers (solar radiation and nutrients used for growth) (4) have effect on water quality.

Zooplankton (animal): (1) Microscopic, but some can be seen by the naked eye (2) capable of movement (3) secondary producers (feed on phytoplankton, bacteria and detritus (dead organic matter)).

Point Source: A specific location from which pollutants are discharged. It can also be defined as a single identifiable source of pollution (e.g., pipe or ship).

Pollution: the man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water (EPA CWA definition).

Pool: A portion of a stream where water velocity is slow and the depth is greater than the riffle, run, or glide. Pools often contain large eddies with widely varying directions of flow compared to riffles and runs where flow is nearly exclusively downstream. The water surface gradient of pools is very close to zero and their channel profile is usually concave.

Reservoir: Any natural or artificial holding area used to store, regulate, or control water.

Riffle: A shallow portion of the stream extending across a stream bed characterized by relatively fast-moving turbulent water. The water column in a riffle is usually constricted and water velocity is fast due to a change in surface gradient. The channel profile in a riffle is usually straight to convex.

Riparian Zone: Generally includes the area of the stream bank and out onto the flood plain which is periodically inundated by the flood waters from the stream. The limit of the zone depends on many factors including native plant community make up, soil moisture levels, and distance from the stream (or the limit of interaction between land and stream processes). It is periodically inundated by the flood waters from the stream. Interaction between this terrestrial zone and the stream is vital for the health of the stream.

River Basin: The land area drained by a river and its tributaries.

Run: A relatively shallow portion of a stream characterized by relatively fast moving non-turbulent flow. A run is usually too deep to be considered a riffle and too shallow to be considered a pool. The channel profile under a run is usually a uniform flat plane.

Runoff: The part of precipitation or irrigation water that runs-off land into streams and other surface water.

Salinity: The amount of dissolved salts in water, generally expressed in parts per thousand (ppt).

Sediment: Particles and/or clumps of particle of sand, clay, silt, and plant or animal matter carried in water and are deposited in reservoirs and slow moving areas of streams and rivers.

Segment: Waters designated by the Texas Natural Resource Conservation Commission in the Texas Surface Water Quality Standards, which include most rivers and their major tributaries, major reservoirs and lakes, and marine waters. Segmented waters have designated physical boundaries, specific uses and numerical

physicochemical criteria (Ex: DO, temperature, fecal coliform, chloride, sulfate) in the state's water quality standards.

Species: A category of biological classification ranking immediately below the genus, comprising related organisms potentially capable of interbreeding. A species is identified by a two part name; the name of the genus followed by a Latin or latinized uncapitalized noun agreeing grammatically with the genus name.

Submerged Vegetation: Rooted plants with almost all leaves below the water surface (e.g. alligator weed, hydrilla, or elodea).

Sulfate (SO₄-2): Sulfate is derived from rocks and soils containing gypsum, iron sulfides, and other sulfur compounds. Sulfates are widely distributed in nature.

Surface Water Quality Standards: The designation of water bodies for desirable uses and the narrative and numerical criteria deemed necessary to protect those uses.

Tolerant Organism: Organisms that have the capacity to grow and thrive when subjected to unfavorable environmental factors.

Total Dissolved Solids (TDS): The amount of material (inorganic salts and small amounts of organic material) dissolved in water.

Water Quality Standards: Established limits of certain chemical, physical, and biological parameters in a water body; water quality standards are established for the different designated uses of a water body (e.g., aquatic life use, contact recreation, public water supply).

Watershed: The area of land from which precipitation drains to a single point. Watersheds are sometimes referred to as drainage basins or drainage areas.

NOTES AND OBSERVATIONS

