# Texas Nonpoint Source Grant Program

## *Improving runoff water quality from small pork production facilities using vegetative treatment areas*

***TSSWCB Project Number 16-50***

***Revision #0***

## Quality Assurance Project Plan

## Texas State Soil and Water Conservation Board

Prepared by:

Texas A&M AgriLife Research
Texas Water Resources Institute

Effective Period: Upon TSSWCB Approval through September 2016

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

Lucas Gregory
Quality Assurance Officer
Texas A&M AgriLife Research
Texas Water Resources Institute
2118 TAMU
College Station, Texas 77843-2118
lfgregory@ag.tamu.edu
(979) 845-7869

## A1 APPROVAL PAGE

Quality Assurance Project Plan for *Improving runoff water quality from small pork production facilities using vegetative treatment areas*.

**Texas State Soil and Water Conservation Board (TSSWCB)**

Name: Ashley Wendt
Title: TSSWCB Project Manager (PM)

Signature:___________________________________Date:_____________

Name: Mitch Conine
Title: TSSWCB Quality Assurance Officer (QAO)

Signature:___________________________________Date:_____________

**Texas A&M AgriLife Research, Texas Water Resources Institute (TWRI)**

Name: Kevin Wagner, PhD
Title: TWRI Associate Director; Project Lead

Signature:___________________________________Date:_____________

Name: Lucas Gregory
Title: TWRI QAO

Signature:___________________________________Date:_____________

**USDA-Agricultural Research Service (ARS)**

Name: Daren Harmel, PhD
Title: ARS Agricultural Engineer; Project Co-Lead

Signature:___________________________________Date:_____________

**Texas A&M AgriLife Research Soil and Aquatic Microbiology Lab (SAML)**

Name: Terry Gentry, PhD
Title: Associate Professor of Soil & Aquatic Microbiology; SAML Director

Signature:___________________________________Date:_____________

## A2 TABLE OF CONTENTS

## A3 DISTRIBUTION LIST

Organizations, and individuals within, which will receive copies of the approved QAPP and any subsequent revisions include:

**Texas State Soil and Water Conservation Board (TSSWCB)**
**P.O. Box 658; Temple, Texas 76503**

Name: Ashley Wendt
Title: TSSWCB PM

Name: Mitch Conine
Title: TSSWCB QAO

**Texas A&M AgriLife Research, Texas Water Resources Institute (TWRI)**
**2118 TAMU; College Station, TX 77843-2118**

Name: Kevin Wagner, PhD
Title: TWRI Associate Director; Project Lead

Name: Lucas Gregory
Title: TWRI QAO

**USDA-Agricultural Research Service (ARS)**
**808 E. Blackland Rd.; Temple, TX 76502**

Name: Daren Harmel, PhD
Title: ARS Agricultural Engineer; Project Co-Lead

**Texas A&M AgriLife Research Soil and Aquatic Microbiology Lab (SAML)**
**2474 TAMU; College Station, TX 77843-2474**

Name: Terry Gentry, PhD
Title: SAML Director

## List of Acronyms

| | |
|---|---|
| AFOs | Animal feeding operations |
| ARS | USDA-Agricultural Research Service |
| BMP | Best Management Practice |
| CAFOs | Concentrated animal feeding operations |
| CAR | Corrective Action Report |
| CFU | Colony-Forming Unit |
| CNMPs | Comprehensive nutrient management plans |
| COC | Chain of Custody |
| DQO | Data Quality Objective |
| EMC | Event Mean Concentration |
| EPA | Environmental Protection Agency |
| FOTG | Field Office Technical Guide |
| LCS | Laboratory Control Sample |
| LCSD | Laboratory Control Sample Duplicate |
| LOQ | Limit of Quantitation |
| NELAC | National Environmental Laboratory Accreditation Conference |
| NELAP | National Environmental Laboratory Accreditation Program |
| NMPs | Nutrient management plans |
| NPDES | National Pollutant Discharge Elimination System |
| NPS | Nonpoint source pollution |
| NRCS | USDA-Natural Resource Conservation Service |
| PBS | Phosphate Buffer Solution |
| PM | Project Manager |
| QA | Quality Assurance |
| QC | Quality Control |
| QAM | Quality Assurance Manual |
| QAO | Quality Assurance Officer |
| QAPP | Quality Assurance Project Plan |
| Research | Texas A&M AgriLife Research |
| RPD | Relative Percent Difference |
| SAML | Soil and Aquatic Microbiology Laboratory |
| SOP | Standard Operating Procedure |
| TCEQ | Texas Commission on Environmental Quality |
| TPDES | Texas Pollutant Discharge Elimination System |
| TSSWCB | Texas State Soil and Water Conservation Board |
| TWRI | Texas Water Resources Institute |
| USDA | United States Department of Agriculture |
| VTA | Vegetative Treatment Area |
| WQMP | Water Quality Management Plan |

## A4 PROJECT/TASK ORGANIZATION

The following is a list of individuals and organizations participating in the project with their specific roles and responsibilities:

### Texas State Soil and Water Conservation Board (TSSWCB)

Ashley Wendt, TSSWCB PM

Responsible for ensuring that the project delivers data of known quality, quantity, and type on schedule to achieve project objectives. Provides the primary point of contact between TWRI and TSSWCB. Tracks and reviews deliverables to ensure that tasks in the workplan are completed as specified in the contract. Notifies the TSSWCB QAO of significant project nonconformances and corrective actions taken as documented in quarterly progress reports from TWRI Project Lead.

Mitch Conine, TSSWCB QAO

Reviews and approves QAPP and any amendments or revisions and ensures distribution of approved/revised QAPPs to TSSWCB participants. Responsible for verifying that the QAPP is followed by TWRI, ARS, and SAML. Assists the TSSWCB PM on QA-related issues. Coordinates, reviews and approves QAPPs and amendments or revisions. Conveys QA issues to appropriate TSSWCB management. Monitors implementation of corrective actions. Coordinates and conducts audits. Determines that the project meets the requirements for planning, quality assurance (QA) quality control (QC), and reporting under the TSSWCB Texas Nonpoint Source Grant Program.

### Texas A&M AgriLife Research, Texas Water Resources Institute (TWRI)

Kevin Wagner, TWRI Project Lead

Responsible for ensuring that tasks and other requirements in the contract are executed on time and with the QA/QC requirements in the system as defined by the contract and in the project QAPP. Assesses the quality of subcontractor/participant work. Submits accurate and timely deliverables to the TSSWCB PM. Responsible for coordinating attendance at conference calls, trainings, meetings, and related project activities with the TSSWCB. Responsible for verifying that the QAPP is distributed and followed by ARS, TWRI, and SAML. Responsible for the facilitation of audits and the implementation, documentation, verification and reporting of corrective actions. Reports status, issues, and progress of the overall project to TSSWCB PM.

Lucas Gregory, TWRI QAO

Responsible for coordinating development and implementation of TWRI's QA program including writing, maintaining and distributing QAPP and any appendices and amendments and monitoring its implementation. Ensures data collected for the project is of known and acceptable quality and adheres to the specifications of the QAPP. Responsible for identifying, receiving, and maintaining project quality assurance records. Responsible for coordinating with the TSSWCB to resolve QA-related issues.

Notifies the TWRI Project Lead, ARS Project Co-Lead, and TSSWCB PM of particular circumstances which may adversely affect the quality of data. Coordinates the research and review of technical QA material and data related to water quality monitoring system design and analytical techniques. Implements or ensures implementation of corrective actions needed to resolve nonconformance noted during assessments. Provides copies of QAPP and any amendments or revisions to each project participant.

**USDA-Agricultural Research Service (ARS)**

Daren Harmel, Project Co-Lead

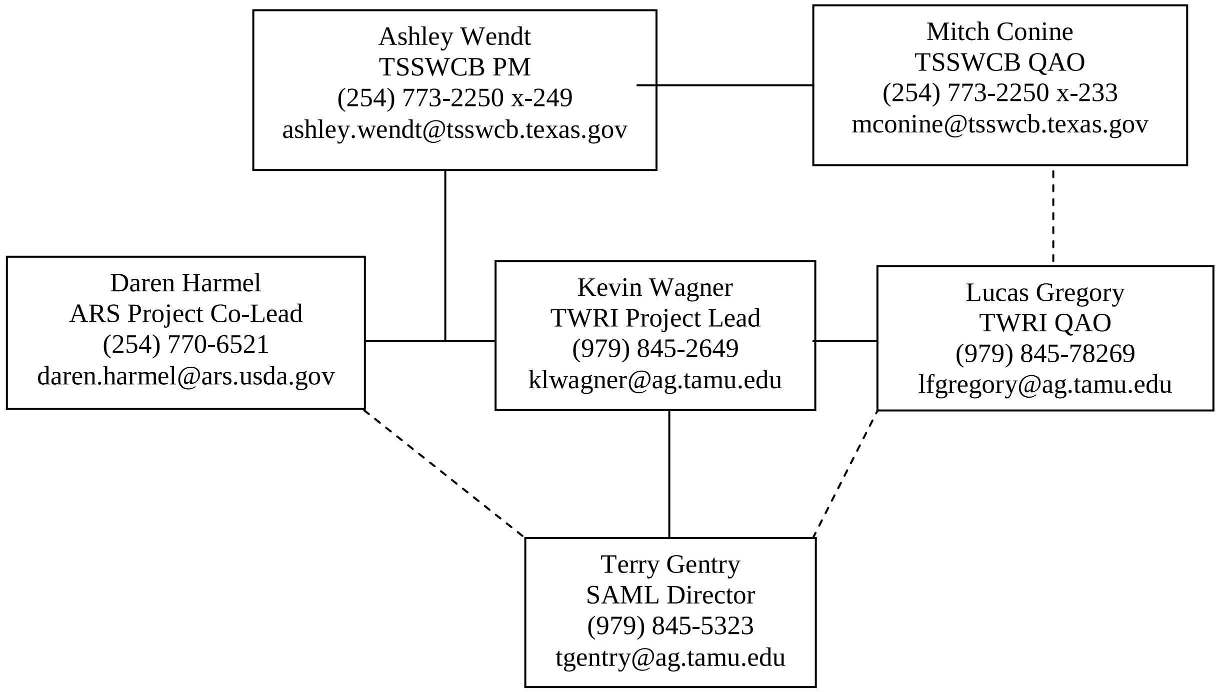
Responsible for supervising all aspects of the field sampling. Responsible for the collection of water samples and field data measurements at Bell, Brazos, and Robertson County sites. Responsible for laboratory analysis of water samples for nitrogen and phosphorus. Responsible for ensuring that field staff are appropriately trained for the collection of water samples and maintenance of field equipment. Responsible for supervision of ARS lab personnel involved in generating analytical data for the project. Responsible for ensuring that laboratory personnel involved in generating analytical data have adequate training and thorough knowledge of the QAPP and all SOPs specific to the analyses or task performed. Responsible for oversight of all ARS lab operations ensuring that all QA/QC requirements are met, documentation related to the analysis is complete and adequately maintained, and that results are reported accurately. Responsible for ensuring that corrective actions are implemented, documented, reported and verified. Monitors implementation of the measures within ARS lab to ensure complete compliance with project data quality objectives (DQOs) in the QAPP. Conducts in-house audits to ensure compliance with written SOPs and to identify potential problems. Responsible for verifying that the project is producing data of known and acceptable quality. Responsible for the acquisition, verification, and transfer of data to the TSSWCB PM. Oversees data management for the project. Performs data quality assurances prior to transfer of data to TSSWCB. Provides the point of contact for the TSSWCB PM to resolve issues related to the data and assumes responsibility for the correction of any data errors.

**Texas A&M AgriLife Research Soil and Aquatic Microbiology Lab (SAML)**

Terry Gentry, SAML Director

Responsible for the laboratory analysis for *E. coli* for Bell, Brazos, and Robertson County sites. Responsible for supervision of SAML personnel involved in generating analytical data for the project. Responsible for ensuring that laboratory personnel involved in generating analytical data have adequate training and thorough knowledge of the QAPP and all SOPs specific to the analyses or task performed. Responsible for oversight of all SAML operations ensuring that all QA/QC requirements are met, documentation related to the analysis is complete and adequately maintained and that results are reported accurately. Responsible for ensuring that corrective actions are implemented, documented, reported and verified. Monitors implementation of the measures within SAML to ensure complete compliance with project DQOs in the QAPP. Conducts in-house audits to ensure compliance with written SOPs and to identify potential problems.

**Figure A4.1 Organization Chart**



## A5 PROBLEM DEFINITION/BACKGROUND

On December 15, 2002, the Administrator of the United States Environmental Protection Agency (EPA) signed the final rule regulating concentrated animal feeding operations (CAFOs). In this rule, it reinforced the need for all animal feeding operations (AFOs), regardless of whether they are defined as CAFOs and required to operate under the coverage of a National Pollutant Discharge Elimination System (NPDES) permit to manage manures and wastewater by-products in a manner protective of U.S. waters. The nutrient management plan (NMP) requirement and recommendation that all AFOs obtain comprehensive nutrient management plans (CNMPs) was a key strategy for achieving maximum protection. As EPA has delegated the NPDES program to the State of Texas, the Texas Commission on Environmental Quality (TCEQ) has adopted the Texas Pollutant Discharge Elimination System (TPDES) under administrative rule, and certain management practices and technical requirements specific to unpermitted AFOs in Texas Administrative Code §321.47. In Texas, the TSSWCB, the agency responsible for management, prevention, and abatement of nonpoint source (NPS) pollution from agricultural and silvicultural activities, administers a certified Water Quality Management Plan (WQMP) Program. The term NPS, as it relates to AFOs, is loosely used to differentiate between AFOs, which do not require written authorization from TCEQ, from point source CAFOs, which do require written authorization under a permit. Because of this understanding, the TSSWCB's WQMP Program is applicable for any AFO not defined as a CAFO. There are approximately 3,000 such AFOs currently operating under the authority of a WQMP certified in accordance with Texas Agriculture Code §201.026. The technical elements of a WQMP are based entirely on the United States Department of Agriculture - Natural Resource Conservation Service's (NRCS) Field Office Technical Guide (FOTG), which is the best available technology and basis for many of the management practices and agricultural engineering standards incorporated into the permitting program. A certified WQMP developed for an AFO that meets the technical requirements of the FOTG is equivalent to a CNMP. A WQMP is effectively a conservation plan that includes a functionally equivalent level of environmental protection from a voluntary perspective. As a result, the TSSWCB encourages as many AFOs as possible to voluntarily participate in the WQMP Program, even if they are not explicitly required to obtain permit coverage.

Historically, dairy and poultry industries have showed significant interest in WQMPs and make up the bulk of the AFOs participating. In contrast, limited participation of the pork industry has occurred largely due to logistical and operational issues on smaller operations. Smaller pork facilities generally operate on smaller tracts of land that do not support traditional animal waste management systems such as waste storage ponds, treatment lagoons, and sufficient acreage for land application. Manure and wastewater is generally contained in "waste pits" and other structures that may or may not be adequate. As a result, this project will evaluate an alternative wastewater treatment system including manure scraping and offsite hauling and a vegetated treatment area (VTA) designed by NRCS to treat runoff and wash water. This system is compatible with small operations and was designed to function well with minimal management. This project will demonstrate the potential effectiveness of the alternative system to the regulatory community and unpermitted pork producers, thus encouraging increased participation in the WQMP program. Finally, the project will provide initial scientific evaluation of the system for possible inclusion in the WQMP Program and assistance from the EQIP Program.

## A6 PROJECT/TASK DESCRIPTION

This project will evaluate the alternative wastewater treatment system of using VTAs designed for small pork production facilities in Texas. The implementation and demonstration of the system was initiated through several previous TSSWCB projects. These include:

- *Demonstration of Alternative Best Management Practices for Small Pork Production Facilities (09-56, 11-53)*
- *Continued Demonstration of Alternative Best Management Practices for Small Pork Production Facilities (12-50)*
- *Preliminary Evaluation of VTA Effectiveness to Protect Runoff Water Quality on Small Pork Production Facilities in Texas (12-53)*
- *Evaluation and demonstration of VTA effectiveness to protect runoff water quality on small pork production facilities in Texas (14-50)*

In the current project (TSSWCB project #16-50), evaluation of the VTA system will be conducted on three small pork production facilities in Bell, Brazos, and Robertson Counties. At each of these facilities, water quality monitoring stations have been established: 1) on a control site to represent typical rural/agricultural land use, 2) below the pens and barns to quantify water quality leaving the facility prior to treatment in the VTA, and 3) at the VTA outlet to quantify effectiveness of the VTA in treating runoff. Rainfall depth, rainfall intensity, and flow will be measured for each runoff event (dependent on rainfall at each facility site). Event mean concentrations for *E. coli*, nitrogen and phosphorus will be determined for each runoff event where sufficient sample volume is available. The project will allow scientific evaluation of the quality of water entering the VTAs from runoff and washing and the water quality exiting the VTAs. Soil sampling will also be conducted to assess the spatial distribution and transport of nutrients within the VTAs.

A total of 9 water quality monitoring stations have been established across the three VTA sites. Eight of the water quality monitoring stations use an H-flume, which provide a stage discharge relationship for accurate flow rate measurement. One of the stations use an area-velocity sensor installed in a culvert to directly measure flow rate. Each station uses a Teledyne ISCO® Avalanche refrigerated sampler to automatically collect water quality samples and to measure and store flow rate. A rain gauge was also installed at each facility to measure precipitation.

For runoff events, water quality samples will be stored at $4^{o}$C in the refrigerated samplers immediately following collection. Samples will be retrieved from the field and analyzed within 24 hours of the first sample and will be transported to the lab on ice. Grab samples will be collected at all 9 sites once per week when flowing water that has been influenced by storm water runoff or a cleaning event is present.

All water samples will be analyzed by ARS for dissolved Nitrate+Nitrite ($NO_3$+$NO_2$-N), Ammonium ($NH_4$-N), and Ortho-Phosphate ($PO_4$-P), total N and total P. Further, samples will be analyzed by SAML for *E. coli*.

In order to assess nutrient accumulation and movement within the VTAs, soil samples will also be collected throughout each VTA using a sampling grid. Soil samples will be analyzed by ARS for plant available phosphate, mineralizable nitrogen, and total inorganic nitrogen.

Data produced in this project will be used by TWRI and USDA-ARS to evaluate VTAs as alternative wastewater treatment systems for small pork production facilities. At the conclusion of the project, TWRI and USDA-ARS will provide findings to TSSWCB, USDA-NRCS and others to show the effectiveness or lack thereof of VTAs to protect runoff water quality on small pork production facilities. Results of the VTA effectiveness will be distributed through outreach materials and producer meetings. If VTA effectiveness is confirmed, TWRI and USDA-ARS will develop a fact sheet summarizing the effectiveness of the VTA practice. This will be submitted to TSSWCB for review prior to publication. USDA-ARS and TWRI will present results to the Pork Producers Association and at State and National meetings. Finally, if VTA use is shown to be an effective practice, TWRI, TSSWCB, and USDA-ARS will work with USDA-NRCS and TCEQ to incorporate results into practice standards and achieve acceptance of this practice for meeting required environmental safeguards.

**Table A6.1. Project Plan Milestones**

| Task | Project Milestones | Agency | Start | End |
|---|---|---|---|---|
| 2.1/2.2 | Develop & implement QAPP & DQOs | TWRI/ARS | 10/15 | 09/16 |
| 1.4 | Develop & submit Final Report | TWRI/ARS | 10/15 | 09/16 |
| 3.1 | VTA-Evaluation: Land management | Cooperators/ARS | 10/15 | 09/16 |
| 3.2 | VTA-Evaluation: Soil sampling | ARS/TSSWCB/NRCS | 10/15 | 09/16 |
| 3.3 | VTA-Evaluation: Grab sampling | ARS | 10/15 | 09/16 |
| 3.4 | VTA-Evaluation: Stormwater sampling | ARS | 10/15 | 09/16 |
| 3.5 | Lab analysis of water quality samples | ARS/SAML | 10/15 | 09/16 |
| 4.4 | Draft journal article describing the evaluation and its results | TWRI/ARS/SAML | 10/15 | 09/16 |

# A7 QUALITY OBJECTIVES AND CRITERIA

The project objective is to demonstrate and evaluate the use of vegetative treatment areas to treat waste streams from small pork production facilities. To accomplish this, water quality (i.e. nutrient and bacteria levels) will be tested at the inlet and outlet of three pork production facilities to demonstrate the reductions resulting from the VTA. Further, the water quality of the water leaving the VTAs of these facilities will be compared to that of nearby control water catchments. A combination of grab and automated sampling will be used to capture both rainfall generated runoff events as well as those events resulting from discharge of process wastewater from the facilities. Replication is provided through the use of three facilities across the state. Results from the VTA effectiveness evaluation/demonstration will be transferred to landowners, natural resource agencies and others involved in animal waste management and as appropriate, incorporated into practice standards and program guidance of natural resource management agencies. Measurement performance specifications as specified in Table A7.1, will ensure data of known and acceptable quality is collected utilizing established methods.

## Ambient Water Reporting Limits And Laboratory Reporting Limits

It is not the objective of this project to evaluate ambient water quality conditions; thus, ambient water reporting limits are not applicable or needed to yield data acceptable to meet project objectives. The limit of quantitation (LOQ) [formerly known as the reporting limit] is the minimum concentration of a target variable that can be reported with a specified degree of confidence. The LOQ for target analytes are set forth in Table A7.1. For *E. coli* analysis in water, the LOQ is a result of the sample volume filtered. Sample volumes routinely filtered for indicator bacteria in runoff require that a wide dilution series be used to determine the volumes that achieve the appropriate colony count per analysis. Dilution series can include volumes as high as 10 ml and as small as 0.00001 ml. Thus, the LOQ for *E. coli* for runoff water quality samples analyzed for this project is 10 cfu/100 mL.

## Precision

Precision is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. It is a measure of agreement among replicate measurements of the same property, under prescribed similar conditions, and is an indication of random error. Laboratory precision is assessed by comparing replicate analyses of laboratory control samples in the sample matrix (e.g. deionized water) or sample/duplicate pairs in the case of bacteria analysis. Precision results are compared against measured performance specifications and used during evaluation of analytical performance. Program-defined measurement performance specifications for precision are defined in Table A7.1 Field splits are used to assess the variability of sample handling, preservation, and storage, as well as the analytical process, and are prepared by splitting samples in the field. Control limits for field splits are defined in Section B5.

## Table A7.1 - Measurement Performance Specifications

| PARAMETER | MATRIX | UNITS | METHOD | Limit of Quantitation (LOQ) | LOQ Check Standard %Rec | PRECISION (RPD of LCS/LCSD) | BIAS (% Rec. LCS/LCSD mean) | Laboratory Performing Analysis |
|---|---|---|---|---|---|---|---|---|
| *Discharge* | *Water* | *$m^3$* | *Bubble Flow Meter/ Area-velocity sensor* | *NA* | *NA* | *NA* | *NA* | *Field* |
| *Precipitation* | *Water* | *mm* | *Rain Gauge* | *NA* | *NA* | *NA* | *NA* | *Field* |
| *Plant available phosphate* | *Soil* | *lbs $P_2O_5$/ac* | *Haney et al. 2006*[1] | *NA* | *NA* | *10* | | *ARS* |
| *Mineralizable N* | *Soil* | *lbs N/ac* | *Haney et al. 2001*[2] | *NA* | *NA* | *10* | | *ARS* |
| *Total Inorganic N* | *Soil* | *lbs N/ac* | *Haney et al. 2006*[1] | *NA* | *NA* | *10* | | *ARS* |
| *Ortho-Phosphate Phosphorus* | *Water* | *mg/L* | *Flow IV Rapid Flow Analyzer (O.I. Analytical, College Station, TX)* | *0.1* | *70-130* | *20* | *80-120* | *ARS* |
| *Total Phosphorus* | *Water* | *µg/L* | *Varian MPX axial flow ICP-OES* | *10* | *70-130* | *20* | *80-120* | *ARS* |
| *Ammonium-Nitrogen* | *Water* | *mg/L* | *Flow IV Rapid Flow Analyzer (O.I. Analytical, College Station, TX)*[4] | *0.1* | *70-130* | *20* | *80-120* | *ARS* |
| *Nitrate/nitrite-Nitrogen* | *Water* | *mg/L* | *Flow IV Rapid Flow Analyzer (O.I. Analytical, College Station, TX)*[3] | *0.1* | *70-130* | *20* | *80-120* | *ARS* |
| *Total Nitrogen* | *Water* | *mg/L* | *Teledyne Tekmar, Mason, OH, Apollo 9000 C/N, combustion analyzer at 680$^o$C* | *1.0* | *70-130* | *20* | *80-120* | *ARS* |
| *E. coli*[5] | *Water* | *cfu/100 mL* | *EPA 1603*[6] | *1* | *NA* | *0.5*[7] | *NA* | *SAML* |

[1] Haney, R.L., E.B. Haney, L.R. Hossner, and J.G. Arnold. 2006. Development of a new soil extractant for simultaneous phosphorus, ammonium, and nitrate analysis. Communications in Soil Science and Plant Analysis, 37: 1511-1523, 2006.
[2] Haney R.L., F.M. Hons, M.A. Sanderson, and A.J. Franzluebbers. 2001. A rapid procedure for estimating nitrogen mineralization in manured soil. Biol. Fertil Soils (2001) 33:100-104.
[3] Technicon Industrial Systems. 1973a. Nitrate and nitrite in water and waste water. Industrial method no. 100-70w. Bran-Luebbe, Roselle, IL.
[4] Technicon Industrial Systems. 1973b. Ammonia in water and waste water. Industrial method no. 98-70w. Bran-Luebbe, Roselle, IL.
[5] E. coli samples should always be processed as soon as possible and within 8 hours. When transport conditions necessitate delays in delivery longer than 6 hours, the holding time may be extended and samples must be processed as soon as possible and within 24 hours.
[6] United States Environmental Protection Agency (EPA), "Methods for Chemical Analysis of Water and Wastes," Manual #EPA-600-4-79-020
[7] Based on range statistic as described in Standard Methods, 20th Edition, Section 9020-B, "QA/QC - Intralaboratory QC Guidelines." This criterion applies to bacteriological duplicates with concentrations >10 org/100 mL or 10 MPN/100 mL.

**Bias**

Bias is a measure of correctness and includes components of systemic error. Measurements are unbiased when values reported do not differ from the true values. Lab bias is verified using laboratory control samples and LOQ Check Standards prepared with known and verified concentrations of all target analytes in the sample matrix (e.g. deionized water) and by calculating percent recovery. For *E. coli* in water, SAML routinely process and analyze BioBall™ spiked PBS samples. Results are compared against measurement performance specifications (Table A7.1) and used to evaluate analytical performance. Another element of bias is the absence of contamination as determined through analysis of blank samples processed identically as the samples. Performance limits for blank analyses are discussed in Section B5.

**Representativeness**

Representativeness is a measure of how accurately a monitoring program reflects the actual water quality conditions. The representativeness of the data is dependent on 1) the sampling locations, 2) the number of samples collected, 3) the number of years and seasons when sampling is performed, 4) the number of depths sampled, and 5) the sampling procedures. Site selection and sampling of all pertinent media and use of only approved analytical methods will assure that the measurement data represents the conditions at the site. The goal for meeting total representation of the wastewater is tempered by the availability of time and funding. Representativeness will be measured with the completion of samples collected in accordance with the approved QAPP and sampling plan.

**Comparability**

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

**Completeness**

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

## A8 SPECIAL TRAINING/CERTIFICATION

No special certifications are required. However, new field and lab personnel will receive training in proper sampling techniques and sample analysis. Before actual sampling or analysis occurs, they will demonstrate their ability to properly perform field sampling or analysis procedures.

SAML is NELAP™-accredited for enumerating *E. coli* in both non-potable and drinking water using EPA Method 1603. Lab *Personnel, Training, and Data Integrity* requirements are provided in Section 17 of the Lab Quality Manual and *Demonstration of Capability* and *On-Going Proficiency* requirements are provided in Sections 19.1 and 19.2, respectively. These documents are kept in the lab.

## A9 DOCUMENTS AND RECORDS

The documents and records that describe, specify, report, or certify activities, requirements, procedures, or results for this project and the items and materials that furnish objective evidence of the quality of items or activities are listed in Table A9.1.

**Table A9.1 Project Documents and Records**

| Document/Record | Location | Retention | Form |
|---|---|---|---|
| QAPP, amendments, and appendices | TWRI | 5 years | Paper/Electronic |
| Chain of custody records | SAML/ ARS | 2 years | Paper |
| Corrective action reports | TWRI | 2 years | Paper/Electronic |
| Laboratory QA manuals and/or SOPs | SAML/ ARS | 5 years | Paper/Electronic |
| Lab equipment calibration records & maintenance logs | SAML/ ARS | 2 years | Paper |
| Lab data reports/results | SAML/ ARS | 5 years | Paper/Electronic |
| Quarterly progress reports/final report/data | TWRI | 5 years | Paper/Electronic |

Quarterly progress reports will note activities conducted in connection with the water quality monitoring program, items or areas identified as potential problems, and any variations or supplements to the QAPP. Corrective Action Reports (CARs) will be utilized when necessary. CARs that result in any changes or variations from the QAPP will be made known to pertinent project personnel and documented in an update or amendment to the QAPP. All quarterly progress reports and QAPP revisions will be distributed to personnel listed in Section A3. A blank CAR form is presented in Appendix A, a blank chain-of-custody (COC) form is presented in Appendix B, blank bacteriological data log sheet is presented in Appendix C and an ISCO® sampler maintenance log is presented in Appendix D. The TSSWCB may elect to take possession of records at the conclusion of the specified retention period.

### Laboratory Test Reports

Test/data reports from the laboratory must document the test results clearly and accurately. Routine data reports should include the information necessary for the interpretation and validation of data. At a minimum, test reports (regardless of whether they are hard copy or electronic) should include the following:

- Sample results
- Units of measurement
- Sample matrix
- Dry weight or wet weight (as applicable)
- Station information
- Date and time of collection
- Sample depth (as applicable)
- Holding time for EPA 1603
- LOQ and qualification of results outside the working range (if applicable)

## QAPP Revision and Amendments

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

QAPP amendments may be necessary to reflect changes in project organization, tasks, schedules, objectives and methods; address deficiencies and nonconformances; improve operational efficiency; and/or accommodate unique or unanticipated circumstances. Written requests for amendments are directed from the TWRI Project Lead to the TSSWCB PM and are effective immediately upon approval by the TSSWCB PM and QAO. Amendments to the QAPP and the reasons for the changes will be documented and distributed to all individuals on the QAPP distribution list by the TWRI Project Lead or designee. Amendments shall be reviewed, approved, and incorporated into the next revision of the QAPP.

## B1 SAMPLING PROCESS DESIGN

### Sample Design Rationale

The goal of the monitoring is to evaluate VTAs as BMPs for reducing bacteria and nutrient runoff from small pork production facilities. To achieve this goal, data collection efforts will involve monitoring edge of field bacteria and nutrient runoff above and below VTA's established on three pork production facilities in Bell, Brazos, and Robertson Counties and comparing runoff water quality from this BMP to that of control sites established at each facility. Information gained from this project will be used to educate pork producers and provide critical information to natural resource management agencies regarding the effectiveness of this BMP in reducing bacteria and nutrient runoff. Constituents to be analyzed are listed in Table B1.1.

**Table B1.1. Sampling Constituents**

| Parameter | Matrix | Status | Reporting Units |
|---|---|---|---|
| Discharge* | Water | Critical | $m^3$ |
| Precipitation | Water | Non-critical | mm |
| Plant available phosphate | Soil | Non-critical | lbs $P_2O_5$/ac |
| Mineralizable N | Soil | Non-critical | lbs N/ac |
| Total Inorganic N | Soil | Non-critical | lbs N/ac |
| Ortho-Phosphate Phosphorus | Water | Critical | mg/L |
| Total Phosphorus | Water | Critical | mg/L |
| Ammonium-Nitrogen | Water | Critical | mg/L |
| Nitrate/nitrite-Nitrogen | Water | Critical | mg/L |
| Total Nitrogen | Water | Critical | mg/L |
| *E. coli* | Water | Critical | cfu/100 mL |

* Discharge only measured for runoff events

### Monitoring Sites

To achieve the identified goals of the project, 9 monitoring sites in Table B1.2 and Figure B1.1 were identified. VTAs were established on three small pork production facilities in Texas during September through December 2012. At each of these facilities in Bell, Brazos, and Robertson Counties, three water quality monitoring stations were established: on a control site to represent typical rural/agricultural land use (referred to as "Control"); below the pens and barns to quantify water quality leaving the facility prior to treatment in the VTA (referred to as "VTA in"); and at the VTA outlet to quantify effectiveness of the VTA in treating runoff (referred to as "VTA out").

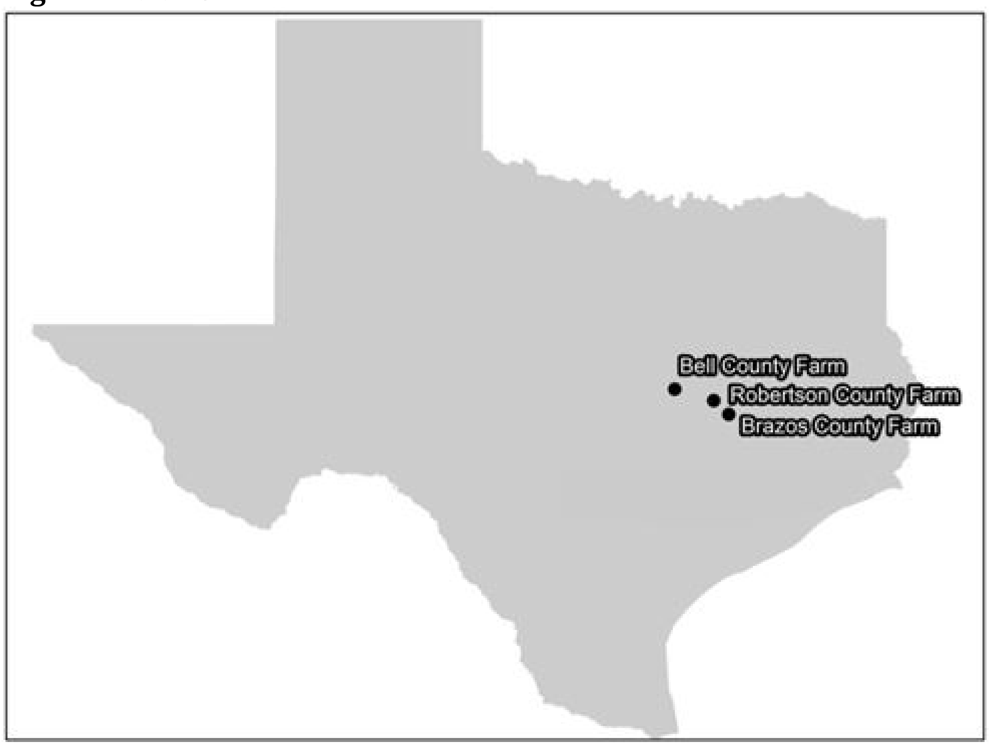
Eight water quality monitoring stations use H-flumes, which provide stage-discharge relationships for flow rate measurement. One station uses an area-velocity sensor installed in a culvert to directly measure flow rate. Each station uses a Teledyne ISCO® Avalanche refrigerated sampler to automatically collect water quality samples and to measure and store flow rate. A rain gauge was installed at each facility to measure precipitation.

**Table B1.2. VTA Sample Sites and Monitoring Frequencies**

| Station ID | Station Type | Nutrients & Bacteria | Sampling Entity | County |
|---|---|---|---|---|
| Bell In | VTA In | Weekly + storm events* | ARS | Bell |
| Bell Out | VTA Out | Weekly + storm events* | ARS | Bell |
| Bell Control | Control | Weekly + storm events* | ARS | Bell |
| Brazos In | VTA In | Weekly + storm events* | ARS | Brazos |
| Brazos Out | VTA Out | Weekly + storm events* | ARS | Brazos |
| Brazos Control | Control | Weekly + storm events* | ARS | Brazos |
| Rob In | VTA In | Weekly + storm events* | ARS | Robertson |
| Rob Out | VTA Out | Weekly + storm events* | ARS | Robertson |
| Rob Control | Control | Weekly + storm events* | ARS | Robertson |

*Weekly grab samples will only be collected when visible flow observed as a result of storm water runoff or pen cleaning events. In addition, following storm events, grab samples will be collected at all sites when retrieving runoff samples from automated samplers.

**Figure B1.1. VTA Sites**




## Sampling Regime

Each site will be monitored from October 2015 through September 2016. For runoff events, flow data and flow-weighted water quality samples will be collected as generated by natural storm events with ISCO® Avalanche refrigerated samplers. Grab samples will be collected at all flowing sites that have been influenced by storm events or pen cleaning events once per week. No more than 94 samples will be collected over the project timeframe. ARS staff will collect samples from the Bell, Brazos, and Robertson County sites.

Once samples are collected (or removed from the ISCO® automatic stormwater samplers), they are split and stored under refrigeration until they are transported to (1) the SAML in College Station to be analyzed for *E. coli* using EPA Method 1603 [Bell, Brazos, Robertson Co. samples] and (2) ARS lab in Temple to be analyzed for nutrients [all samples]. All sites are accessible to ARS staff. For each sampling event, *E. coli*, mineralizable N, plant available phosphate, total inorganic N, nitrate/nitrite-N, ammonium-N, total nitrogen, total phosphorus, orthophosphate-P, precipitation and flow will be measured (Table A7.1) at each site. Additionally, grid soil sampling will be conducted throughout each VTA annually and analyzed for nutrient concentrations by ARS.

## B2 SAMPLING METHODS

Specific requirements for sampling are outlined in the following sections. Sample volume, container types, minimum sample volume, preservation requirements, and holding time requirements are listed in Table B2.1.

**Table B2.1. Sample Storage, Preservation and Handling Requirements**

| Parameter | Matrix | Container | Preservation | Sample Volume | Holding Time |
|---|---|---|---|---|---|
| Ortho-Phosphate Phosphorus | Water | Pre-cleaned LDPE bottle or Cubitainer | $4^oC$, dark | 75 mL | 28 days |
| Total Phosphorus | | | | | |
| Ammonium-Nitrogen | | | | | |
| Nitrate/nitrite-Nitrogen | | | | | |
| Total Nitrogen | | | | | |
| *E. coli** | Water | Sterile bottles | $4^oC$, dark | 100 mL | 8 hr / 24 hr* |
| Plant available phosphate | Soil | Sealable plastic bags | None | 1 pint | 6 months |
| Mineralizable N | | | | | |
| Total Inorganic N | | | | | |

**E. coli* samples should always be processed as soon as possible and within 8 hours. When transport conditions necessitate delays in delivery longer than 6 hours, the holding time may be extended and samples must be processed as soon as possible and within 24 hours.

### Collection of Soil Samples

Soil samples will be collected annually at each VTA to evaluate nutrient accumulation and movement within the VTAs. Sampling will be conducted along a grid. Approximately 1 pint of soil sample is required for routine analyses. Sampling of areas such as small gullies, slight field depressions, terrace waterways, or unusual areas will be avoided.

On an annual basis, ARS will collect 12 from the Bell County facility, 10 from the Robertson County facility, and 10 from the Brazos County facility using a spade, soil auger or soil sampling tube. Litter will be cleared from the surface making sure to not remove decomposed black material. When using a soil auger or probe, ARS will make the core or boring 6 inches deep. When soil conditions are too wet, making sampling with an auger or probe very difficult, ARS will (1) dig a V-shaped hole with a spade and take a 1-inch slice from the smooth side of the hole, then (2) take a 1 x 1 inch core from the center of the shovel slice. Each sample collected will be put in a clean plastic bucket or other non-metallic container and thoroughly mixed before being transferred to a one pint bag for transport to the ARS lab. All samples will be tested separately in order to assess spatial variation over time.

### Grab Sample Collection

Grab samples will be collected at all 9 sites once per week when visible flow from storm water events or pen cleaning events is present. This will allow the capture of those events resulting from discharge of processed wastewater from the facilities. In addition, following storm events, grab samples will be collected at all sites when retrieving runoff samples from automated samplers. No more than 730 samples are to be collected over the project timeframe. ARS staff will collect samples from the Bell, Brazos, and Robertson County sites. Grab samples will be collected directly into the containers they will be transported to the lab in. Once samples are collected, they are split and stored on ice or under refrigeration until they are transported to (1) the SAML in College Station to be analyzed for *E. coli* using EPA Method 1603 [Bell, Brazos, Robertson Co. samples] and (2) ARS lab in Temple to be analyzed for nutrients [all samples].

**Grab Sample Holding Time**

Grab samples will be thoroughly mixed and sub-samples transferred to appropriate containers as outlined in Table B2.1, and transported on ice to (1) the ARS lab for analysis of nutrients and (2) the SAML lab for analysis of *E. coli*. For *E. coli* sub-samples, a minimum volume of 25 ml (and preferably 100 ml or more as available) will be poured into sterile plastic bottles and stored in refrigeration at 4°C. *E. coli* samples should always be processed as soon as possible and within 8 hours. When transport conditions necessitate delays in delivery longer than 6 hours, the holding time may be extended and samples must be processed as soon as possible and within 24 hours and noted as such.

All samples will be transported by ARS at 4°C to the lab(s) for analysis. All filtration and incubation will be performed in the laboratory. Samples must be stored at 4°C until processed in each lab. In the event that *E. coli* samples cannot be collected, transported, processed and incubated within 24 hours, samples will still be analyzed, but it will be noted that the target holding time was not met.

**Collection of Runoff**

Flow-weighted composite stormwater samples from edge-of-field watershed sites will be collected using refrigerated ISCO® Avalanche full-size portable samplers with single bottle configuration into clean polyethylene 5-gallon square bottles for runoff events with more than 1.32 mm of runoff volume. Following each event, each 5 gallon bottle will be washed with dilute soapy (P-free) water, rinsed three times with tap water and three times with DI water, air dried upside down and on side to allow complete drying and finally, capped when completely dry.

Collection of flow-weighted composite samples will allow calculation of event mean concentrations of *E. coli* and nutrients for each rainfall runoff event and determination of total annual loadings. A minimum of 200 ml will be collected by automatic samplers. After the first sample is collected until sample retrieval the Avalanche cools the refrigerated compartment to $1^{o}$C +/- 1. One hour after the last sample of the program is taken, the Avalanche adjusts its control to maintain the samples at $3^{o}$C +/- 1. Flow from each watershed site will be measured with either bubble flow or area-velocity meters. This, in combination with the EMCs, will allow calculation of bacteria and nutrient loading for each runoff event. Flow and precipitation data is downloaded at least monthly using an ISCO® 581 Rapid Transfer Device.

**Runoff Event Holding Time**

The runoff samples in the 5-gallon bottles will be retrieved from the refrigerated ISCOs, thoroughly mixed, and sub-samples transferred to appropriate containers as outlined in Table

B2.1, and transported on ice to (1) the ARS lab for analysis of nutrients and (2) the SAML lab for analysis of *E. coli*. The beginning of a storm event is defined as the point in time that flow exceeds the enable levels and the end of the storm is when flow is below the enable level and when more rain (flow increases) is not expected within 2 hours. At the end of the storm the storm sample should be collected, data downloaded, and ISCO® reset for the next event.

For *E. coli* sub-samples, a minimum volume of 25 ml (and preferably 100 ml or more as available) collected by automatic samplers will be poured into sterile plastic bottles and stored in refrigeration at 4°C. Edge-of-field *E. coli* samples must be removed from automatic samplers, transported to the SAML laboratory, filtered, and placed in the incubator within 24 hours of the start of the stormwater runoff event, that is, from the first automatically collected stormwater sample. This applies even when storm events exceed 24 hours (although not expected due to the small size of the drainage areas involved).

All samples will be transported by ARS at 4°C to the lab(s) for analysis. All filtration and incubation will be performed in the laboratory. Samples must be stored at 4°C until processed in each lab. In the event that *E. coli* samples cannot be collected, transported, processed and incubated within 24 hours, samples will still be analyzed but it will be noted that the target holding time was not met.

**Processes to Prevent Cross Contamination**

To prevent cross-contamination, stormwater subsamples will be transferred directly from the 5-gallon sampler bottle into the containers they will be transported to the appropriate lab in while grab samples will be collected directly into containers they will be transported to the lab in. Soil samples will be collected with cleaned probes/shovels into clean 5 gallon buckets for mixing. Probes and buckets are wiped with a cloth then "washed" with ambient soil from the next site to ensure that all soil residue from the previous site has been removed. Soil subsamples will be placed into new plastic bags for transport to labs. Field QC samples as discussed in Section B5 are collected to verify that cross-contamination has not occurred.

**Documentation of Field Sampling Activities**

Field activities are documented as needed in field notes. For all water samples collected, station ID, sampling date and time, sample type, and sample collector’s name/signature are recorded on the sample container and COC.

**Recording Data**

All field and laboratory personnel follow the basic rules for recording information as follows:

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

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

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

CARs document: root cause(s); programmatic impact(s); specific corrective action(s) to address any deviations; action(s) to prevent recurrence; individual(s) responsible for each action; the timetable for completion of each action; and the means by which completion of each corrective action will be documented. CARs will be included with quarterly progress reports. In addition, significant conditions (i.e., situations which, if uncorrected, could have a serious effect on safety or on the validity or integrity of data) will be reported to the TSSWCB immediately both verbally and in writing.

## B3 SAMPLE HANDLING AND CUSTODY

### Chain-of-Custody

Proper sample handling and custody procedures ensure the custody and integrity of samples beginning at the time of sampling and continuing through transport, sample receipt, preparation, and analysis. The COC form is used to document sample handling during transfer from the field to the laboratory. The sample number, location, date, changes in possession and other pertinent data will be recorded in indelible ink on the COC. The sample collector will sign the COC and transport it with the sample to the laboratory. At the laboratory, samples are inventoried against the accompanying COC. Any discrepancies will be noted at that time and the COC will be signed for acceptance of custody. In the instance that the field sample collector and laboratory sample processor are one in the same, a field-to-lab COC will be unnecessary. A copy of a blank COC form used on this project is included as Appendix B.

### Sample Labeling

Samples will be labeled on the container with an indelible, waterproof marker. Label information will include site identification, date, sampler's initials, and time of sampling. The COC form will accompany all sets of sample containers.

### Sample Handling

Following collection, water samples will be placed on ice in an insulated cooler for transport to the appropriate laboratory. At the laboratory, samples will be placed in a refrigerated cooler dedicated to sample storage. The Laboratory Director has the responsibility to ensure that holding times are met with water samples. The holding time is documented on the COC. Any problem will be documented with a CAR.

Soil samples will be collected as outlined in Section B2 and placed in new sealable plastic bags for transport. The 1 pint soil samples will be delivered to the ARS Laboratory in Temple, TX for nutrient analysis. No preservation is required for the soil samples submitted to ARS.

### Failures in Chain-of-Custody and Corrective Action

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

## B4 ANALYTICAL METHODS

The analytical methods are listed in Table A7.1. In summary, samples will be analyzed by ARS for dissolved $NO_3$+$NO_2$-N, $NH_4$-N, and $PO_4$-P concentrations using colorimetric methods (Technicon 1973a; 1973b) with a Technicon Autoanalyzer IIC (Bran-Luebbe, Roselle, IL) or a Flow IV Rapid Flow Analyzer (O.I. Analytical, College Station, TX). Water samples will be analyzed by ARS using a Teledyne Tekmar, Mason, OH, Apollo 9000 C/N, combustion analyzer at 680$^{o}$C for total N. Water samples will be analyzed for Total P by ARS with a Varian MPX axial flow ICP-OES. Samples will be analyzed for *E. coli* by SAML using EPA Method 1603. Finally, within 2 weeks of arrival at the lab (and typically less than 1 week), each soil sample is dried at 40$^{o}$C for 24-48 hours (depending on moisture level), ground to pass through a 5-mm sieve, and analyzed for nitrogen and phosphorus concentrations using methods developed at the ARS lab and described in Haney et al. (2001, 2006).

### Standards Traceability

All standards used in the laboratory are traceable to certified reference materials. Standards preparation is fully documented in lab manuals. The reagent bottle will be labeled in a way that will trace the reagent back to preparation.

### Analytical Method Modification

Only data generated using approved analytical methodologies as specified in this QAPP will be submitted to the TSSWCB. Requests for method modifications will be documented and submitted for approval to the TSSWCB QAO. Work will only begin after the modified procedures have been approved.

### Failures in Measurement Systems and Corrective Actions

Failures in field and laboratory measurement systems involve, but are not limited to, such things as instrument malfunctions, failures in calibration, blank contamination, quality control samples outside QAPP defined limits, etc. In many cases, the field technician or lab analyst will be able to correct the problem. If the problem is resolvable by the field technician or lab analyst, then they will document the problem and complete the analysis. If the problem is not resolvable, then it is conveyed to the appropriate lab director, who will make the determination in coordination with the TWRI QAO. If the analytical system failure may compromise the sample results, the resulting data will not be reported to the TSSWCB as part of this project. The nature and disposition of the problem is reported on the CAR and submitted with the quarterly progress report to the TSSWCB PM.

CARs document: root cause(s); programmatic impact(s); specific corrective action(s) to address any deviations; action(s) to prevent recurrence; individual(s) responsible for each action; the timetable for completion of each action; and the means by which completion of each corrective action will be documented. In addition, significant conditions will be reported to the TSSWCB immediately both verbally and in writing.

## B5 QUALITY CONTROL

Table A7.1 lists the required accuracy, precision, and completeness limits for the parameters of interest. Specific requirements are summarized in Table B5.1 and described below.

**Table B5.1. Required Quality Control Analyses**

| Parameter | Matrix | LOQ | LOQ Check Std | LCS | Lab Dup | Field Blank | Method Blank |
|---|---|---|---|---|---|---|---|
| *Plant available phosphate* | *Soil* | *NA* | *NA* | *NA* | *NA* | *NA* | *NA* |
| *Mineralizable N* | *Soil* | *NA* | *NA* | *NA* | *NA* | *NA* | *NA* |
| *Total Inorganic N* | *Soil* | *NA* | *NA* | *NA* | *NA* | *NA* | *NA* |
| *Ortho-Phosphate Phosphorus* | *Water* | √ | √ | √ | √ | √ | √ |
| *Total Phosphorus* | *Water* | √ | √ | √ | √ | √ | √ |
| *Ammonium-Nitrogen* | *Water* | √ | √ | √ | √ | √ | √ |
| *Nitrate/nitrite-Nitrogen* | *Water* | √ | √ | √ | √ | √ | √ |
| *Total Nitrogen* | *Water* | √ | √ | √ | √ | √ | √ |
| *E. coli* | *Water* | *NA* | *NA* | *NA* | √ | √ | √ |

### Limit of Quantitation (LOQ)

The laboratories will analyze a calibration standard (if applicable) at the LOQ on each day samples are analyzed. Calibrations including the standard at the LOQ will meet the calibration requirements of the analytical method or corrective action will be implemented.

### LOQ Check Standard

An LOQ check standard consists of a sample matrix (e.g., deionized water, sand, commercially available tissue) free from the analytes of interest spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It is used to establish intra-laboratory bias to assess the performance of the measurement system at the lower limits of analysis. The LOQ check standard is spiked into the sample matrix at a level less than or near the LOQ for each analyte for each batch of samples are run.

LOQ check standards are carried throughout the preparation and analytical process and are run at a rate of one per analytical batch. A batch is defined as samples that are analyzed together with the same method and personnel, using the same lots of reagents. The percent recovery of the LOQ check standard is calculated using the following equation in which %R is percent recovery, SR is the sample result, and SA is the reference concentration for the check standard:

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

Measurement performance specifications are used to determine the acceptability of LOQ Check Standard analyses as specified in Table A7.1.

**Laboratory Control Sample (LCS)**

An LCS consists of a sample matrix (e.g., deionized water, sand) free from the analytes of interest spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It is used to establish intra-laboratory bias to assess the performance of the measurement system. The LCS is spiked into the sample matrix at a level less than or near the midpoint of the calibration for each analyte. The LCS is carried through the complete preparation and analytical process. LCSs are run at a rate of one per analytical batch. In this case, BioBalls™ are utilized for the laboratory control sample. Results of LCSs are calculated by percent recovery, which is defined as 100 times the measured concentration, divided by the true concentration of the spiked sample. The following formula is used to calculate percent recovery, where %R is percent recovery; Ns is the measured result of the spiked sample, Nu is the measured result in the unspiked sample and T is the true measure of *E. coli* in the spiked sample based on the lot mean value provided by the manufacturer:

$$\%R = 100 * (Ns-Nu)/T$$

Measurement performance specifications are used to determine the acceptability of LCS analyses as specified in Table A7.1.

**Laboratory Duplicates**

A laboratory duplicate is prepared by taking aliquots of a sample from the same container under laboratory conditions and processed and analyzed independently. A laboratory control sample duplicate (LCSD) is prepared in the laboratory by splitting aliquots of an LCS. Both samples are carried through the entire preparation and analytical process. LCSDs are used to assess precision and are performed at a rate of one per batch. A batch is defined as samples that are analyzed together with the same method and personnel, using the same lots of reagents. For most parameters, precision is calculated by the relative percent difference (RPD) of LCS duplicate results as defined by 100 times the difference (range) of each duplicate set, divided by the average value (mean) of the set. For duplicate results, $X_1$ and $X_2$, the RPD is calculated from the following equation:

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

Bacteriological duplicates are a special type of laboratory duplicate. Bacteriological duplicate analyses are performed on samples from the sample bottle on a 10% basis. Results of bacteriological duplicates are evaluated by calculating the logarithm of each result and determining the range of each pair. Measurement performance specifications are used to determine the acceptability of duplicate analyses. The specifications for bacteriological duplicates in Table A7.1 apply to samples with concentrations >10 cfu/100 mL.

**Method blank**

A method blank is a sample of matrix similar to the batch of associated samples that is free from analytes of interest and is processed simultaneously with and under the same conditions as the samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses. The method blank is carried through the complete sample preparation and analytical procedure. The method blank is used to document contamination from the analytical process. The analysis of method blanks should yield values less than the LOQ. For very high-level analyses, the blank value should be less than 5% of the lowest value of the batch, or corrective action will be implemented.

**Field blank**

For each storm event, deionized water will be placed in a clean 5-gallon ISCO® bottle and then processed as a field blank. A field blank is a sample of analyte-free media which has been used to rinse common sampling equipment to check the effectiveness of decontamination procedures. It is collected in the same type of container as the environmental sample, preserved in the same manner and analyzed for the same parameter. The analysis of field blanks should yield values lower than the LOQ. When target analyte concentrations are very high, blank values must be less than 5% of the lowest value of the batch or corrective action will be implemented.

**Failures in Quality Control and Corrective Action**

Sampling QC excursions are evaluated by the TWRI Project Lead, in consultation with the TWRI QAO. In that differences in sample results are used to assess the entire sampling process, including environmental variability, the arbitrary rejection of results based on pre-determined limits is not practical. Therefore, the professional judgment of the TWRI Project Lead and QAO will be relied upon in evaluating results. Rejecting sample results based on wide variability is a possibility. Notations of field split excursions and blank contamination are noted in the quarterly progress report and the final QC Report.

Corrective action will involve identification of the cause of the failure where possible. Response actions will typically include re-analysis of questionable samples. In some cases, a site may have to be re-sampled to achieve project goals.

Laboratory measurement quality control failures are evaluated by the laboratory staff. The disposition of such failures and the nature and disposition of the problem is reported to the Laboratory QAO. The Laboratory QAO will discuss with the TWRI Project Lead. If applicable, the TWRI Project Lead will include this information in the CAR and submit with the quarterly progress report which is sent to the TSSWCB PM.

CARs document: root cause(s); programmatic impact(s); specific corrective action(s) to address any deviations; action(s) to prevent recurrence; individual(s) responsible for each action; the timetable for completion of each action; and the means by which completion of each corrective action will be documented. In addition, significant conditions (i.e., situations which, if uncorrected, could have a serious effect on safety or on the validity or integrity of data) will be reported to the TSSWCB immediately both verbally and in writing.

## B6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION AND MAINTENANCE

To minimize downtime of all measurement systems, spare parts for field and laboratory equipment will be kept in the laboratory, and all field measurement and sampling equipment, in addition to all laboratory equipment, must be maintained in a working condition. All field and laboratory equipment will be tested, maintained, and inspected in accordance with manufacturer's instructions. Records of all tests, inspections, and maintenance will be maintained in lab and field notebooks. These records will be available for inspection by the TSSWCB. Maintenance of the ISCO® automated samplers will be conducted at least monthly and documented on an ISCO® Sampler Maintenance form (Appendix D). In summary, field staff will check ISCO® samplers for the following:

i. Sampler tube (not clogged or holding water)
ii. Water level (stage) (ft)
iii. Stage Adjustment (+/- ft)
iv. Dessicant strength (OK)
v. Battery (v)

Additionally, on a monthly basis, field staff will check/perform the following:

i. Solar panel output (v)
ii. Battery under load (v)
iii. Pump test
iv. Mow/weed eat (as needed)
v. Download data

Finally, twice annually the velocity meter will be tested.

Failures in any testing, inspections, or calibration of equipment will result in a CAR and resolution of the situation will be reported to the TSSWCB PM in the quarterly progress report. The CARs will be maintained by the TWRI Project Lead and the TSSWCB PM.

## B7 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

All instruments or devices used in obtaining environmental data for this project will be calibrated according to and at the frequency recommended by the equipment manufacturer's instructions as each instrument have a specialized procedure for calibration and a specific type of standard used to verify calibration. Failures in any testing, inspections, or calibration of equipment will result in a CAR and resolution of the situation will be reported to the TSSWCB PM in the quarterly progress report. The CARs will be maintained by the TWRI Project Lead and the TSSWCB PM.

## B8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

All standards, reagents, media, plates, filters, and other consumable supplies are purchased from manufacturers with performance guarantees, and are inspected upon receipt for damage, missing parts, expiration date, and storage and handling requirements. Labels on reagents, chemicals, and standards are examined to ensure they are of appropriate quality, initialed by staff member and marked with receipt date. Volumetric glassware is inspected to ensure class "A" classification, where required. Media will be checked as described in quality control procedures. All supplies will be stored as per manufacturer labeling and discarded past expiration date. In general, supplies for microbiological analysis are received pre-sterilized, used as received, and not re-used.

## B9 NON-DIRECT MEASUREMENTS

Only data collected directly under this QAPP will be submitted to the TSSWCB.

## B10 DATA MANAGEMENT

### Field Collection and Management of Samples

All field collection will be completed as described in Section B2 of the QAPP. A COC is filled out in the field for each sampling event noting the site name, time and date of collection, sample type, comments, sample collector's name, and other pertinent data. Samples collected will be labeled with site identification, date, sampler's initials, and time of sampling and transported to the laboratory as outlined in B3. The COC and associated sample bags/bottles are submitted to laboratory analyst, with relinquishing and receiving personnel both signing and dating the COC.

### Laboratory Data

Once the samples are received at the respective laboratories, samples are logged and stored as described in Table B2.1 until processed. The COC will be checked for number of samples, proper and exact I.D. number, signatures, dates, and type of analysis specified. If any discrepancy is found, proper corrections will be made. All COC and analytical data will be manually entered into electronic spreadsheets. The electronic spreadsheets will be created in Microsoft Excel software, maintained on the computer's hard drive, and simultaneously saved in a network folder. Data manually entered in the spreadsheets will be reviewed for accuracy as follows to ensure that there are no transcription errors. The SAML Director will monitor and evaluate data for all *E. coli* analyses and the ARS Project Co-Lead will monitor and evaluate data for all nutrient analyses (both soil and water). Paper and electronic copies of data will be housed in the individual laboratories for a period of five years following the conclusion of the project. Any COC's and analysis records related to QA/QC of lab procedures will be housed at the respective lab. All pertinent electronic data files will be backed up monthly on an external hard drive and stored in separate area away from the computer. All electronic files will be archived to CD upon completion of the project and stored with the final report for 5 years.

### Data Validation

Following review of laboratory data, any data entry that is not representative of environmental conditions, because it was generated through poor field or laboratory practices, will not be submitted to the TSSWCB PM. This determination will be made by the Project Co-Leads, TWRI QAO, TSSWCB QAO, and other personnel having direct experience with the data collection effort. This coordination is essential for the identification of valid data and the proper evaluation of that data. The validation will include the checks specified in Section D2.

### Data Dissemination

At the conclusion of the project, Project Co-Leads will provide the project electronic spreadsheet via recordable CD to the TSSWCB PM, along with the final report. The TSSWCB PM may elect to take possession of all project records. However, summaries of the data will be presented in the final report. TWRI, ARS, and SAML will deliver presentations to Pork Producers Association, State, and National meetings along with other venues to disseminate project findings.

## C1 ASSESSMENTS AND RESPONSE ACTIONS

Table C1.1 presents types of assessments and response actions for data collection activities applicable to the QAPP.

**Table C1.1. Assessments and Response Actions**

| Assessment Activity | Approximate Schedule | Responsible Party | Scope | Response Requirements |
|---|---|---|---|---|
| Status Monitoring Oversight | Continuous | TWRI | Monitoring of project status and records to ensure requirements are being fulfilled. | Report to TSSWCB in Quarterly Progress Report. |
| Internal Monitoring Systems Audit of Program Subparticipants | Dates to be determined by the TWRI | TWRI | Field sampling, handling and measurement; facility review; and data management as they relate to the project | 45 days to respond in writing to the TWRI. TWRI will report problems to TSSWCB in Quarterly Progress Report. |
| TSSWCB Monitoring Systems Audit | Dates to be determined by TSSWCB | TSSWCB | Field sampling, handling and measurement; facility review; and data management as they relate to the project | 45 days to respond in writing to TSSWCB to address corrective actions |
| Laboratory Inspections | Dates to be determined by TSSWCB | TSSWCB | Analytical and quality control procedures employed at project laboratories | 45 days to respond in writing to TSSWCB to address corrective actions |

Internal audits of data quality and staff performance to assure that work is being performed according to standards will be conducted by all entities. Audits will be documented and initialed by the pertinent Project Co-Lead, PM, or Director. If audits show that the work is not being performed according to standards, immediate corrective action will be implemented and documented.

The TSSWCB QAO (or designee) may conduct an audit of the field or technical systems activities for this project as needed. Each entity will have the responsibility for initiating and implementing response actions associated with findings identified during the on-site audit. Once response actions have been implemented, the TSSWCB QAO (or designee) may perform a follow-up audit to verify and document that response actions were implemented effectively. Records of audit findings and corrective actions are maintained by the TSSWCB PM and TWRI QAO. Corrective action documentation will be submitted to the TSSWCB PM with the quarterly progress report. If audit findings and corrective actions cannot be resolved, then the authority and responsibility for terminating work is specified in agreements or contracts between participating organizations.

**Corrective Action Process for Deficiencies**

Deficiencies are any deviation from the QAPP. Deficiencies may invalidate resulting data and may require corrective action. Corrective action may include for samples to be discarded and re-collected. Deficiencies are documented in logbooks, field data sheets, etc. by field or laboratory staff. It is the responsibility of each respective entity's Project Co-Lead or PM, in consultation with the TWRI QAO, to ensure that the actions and resolutions to the problems are documented and that records are maintained in accordance with this QAPP. In addition, these actions and resolutions will be conveyed to the TSSWCB PM both verbally and in writing in the quarterly progress reports and by completion of a CAR. All deficiencies identified by each entity will trigger a corrective action plan.

**Corrective Action Report**

CARs should:

- Identify the problem, nonconformity, or undesirable situation
- Identify immediate remedial actions if possible
- Identify the underlying cause(s) of the problem
- Identify whether the problem is likely to recur, or occur in other areas
- Evaluate the need for Corrective Action
- Use problem-solving techniques to verify causes, determine solution, and develop an action plan
- Identify personnel responsible for action
- Establish timelines and provide a schedule
- Document the corrective action

The status of CARs will be included with quarterly progress reports. In addition, significant conditions (i.e., situations which, if uncorrected, could have a serious effect on safety or on the validity or integrity of data) will be reported to the TSSWCB immediately.

The Project Lead, Co-Lead, or PM of each respective entity is responsible for implementing and tracking corrective actions. Records of audit findings and corrective actions are maintained by the Project Lead, Co-Lead, or PM of each respective entity. Audit reports and corrective action documentation will be submitted to the TSSWCB with the quarterly progress report.

# C2 REPORTS TO MANAGEMENT

## Laboratory Data Reports

Laboratory data reports contain the results of all specified QC measures listed in section B5. This information is reviewed by the TWRI QAO and compared to the pre-specified acceptance criteria to determine acceptability of data before forwarding to the TWRI Project Lead. This information is available for inspection by the TSSWCB PM.

## Reports to TSSWCB Project Management

Quarterly Progress Report – Quarterly progress reports will be generated by the TWRI Project Lead and will note activities conducted in connection with the water quality monitoring program, items or areas identified as potential problems, and any variation or supplement to the QAPP.

Corrective Action Documentation – Records of all quality assurance audits and associated corrective actions will be submitted to the TSSWCB PM with the quarterly progress reports. CARs will be utilized when necessary (Appendix A) as described under Sections B3, B4, and B5 in the QAPP. Any situation which, if not corrected by the TWRI Project Lead, may have a serious effect on validity or integrity of the data, will be reported to the TSSWCB PM immediately verbally and followed up in writing. CARs that result in changes or variations from the QAPP will be made known to pertinent project personnel, documented in an update or amendment to the QAPP and distributed to personnel listed in Section A3. CARs will be maintained in an accessible location for reference at TWRI.

Monitoring Systems Review Audit Report – Following any audit performed by the TWRI Project Lead (or designee), a report of findings, recommendations, and responses are sent to the TSSWCB PM in the quarterly progress report.

## D1 DATA REVIEW, VERIFICATION AND VALIDATION

All data obtained from field and laboratory measurements will be reviewed and verified for conformance to project requirements, and then validated against the data quality objectives which are listed in Section A7. Only those data which are supported by appropriate quality control data and meet the data quality objectives defined for this project will be considered acceptable. This data will be submitted to the TSSWCB.

## D2 VERIFICATION AND VALIDATION METHODS

All field and laboratory data will be reviewed, verified and validated to ensure they conform to project specifications and meet the conditions of end use as described in Section A7 of this document. Data review, verification, and validation will be performed using self-assessments and peer and management review as appropriate. The data review tasks to be performed include evaluation of:

- Sample documentation complete; samples labeled
- Field QC samples collected as prescribed in QAPP
- COC complete
- NELAP Accreditation current
- Holding times not exceeded
- Collection, preparation, and analysis consistent with QAPP
- Bacteriological records complete
- QC samples analyzed at required frequency
- QC results meet performance and program specifications
- Results, calculations, transcriptions checked
- Laboratory bench-level review performed
- All laboratory samples analyzed for all parameters
- Nonconforming activities documented
- Outliers confirmed and documented; reasonableness check performed
- Absence of transcription error confirmed
- Sampling and analytical data gaps checked
- Verified data log submitted
- 10% of data manually reviewed

Potential errors are identified by examination of documentation and by manual or computer-assisted examination of corollary or unreasonable data. If a question arises or an error is identified, the Project Co-Lead or PM responsible for generating the data will work to resolve the issue. Issues which can be corrected are corrected and documented. If an issue cannot be corrected, the responsible Project Co-Lead or PM will consult with the TWRI Project Lead to establish the appropriate course of action, or the data associated with the issue are rejected and not reported to the TSSWCB PM. Field and laboratory reviews, verifications, and validations are documented.

After the field and laboratory data are reviewed, another level of review is performed once the data are combined into a dataset. This review step is performed by the Project Lead, Co-Lead, and PMs. Data review, verification, and validation tasks to be performed on the dataset include, but are not limited to, the confirmation of laboratory and field data review, evaluation of field QC results, additional evaluation of anomalies and outliers, analysis of sampling and analytical gaps, and confirmation that all parameters and sampling sites are included in the QAPP.

Another element of the data validation process is consideration of any findings identified during the monitoring systems audit conducted by the TSSWCB PM. Any issues requiring corrective action must be addressed, and the potential impact of these issues on previously collected data will be assessed. After the data are reviewed and documented, the Project Lead, Co-Lead, and PMs validate that the data meet the data quality objectives of the project and are suitable for reporting to TSSWCB PM.

If any requirements or specifications of the QAPP are not met, based on any part of the data review, it will be documented and submitted to the TSSWCB PM with the data. This information is communicated to TSSWCB PM by TWRI Project Lead in the Final Report.

## D3 RECONCILIATION WITH USER REQUIREMENTS

Data produced in this project will be analyzed and reconciled with project data quality requirements. Data meeting project requirements will be used by TWRI and ARS to evaluate vegetative treatment areas as alternative wastewater treatment systems for small pork producers. No other decisions will be made by the project team based on the data collected. Data which do not meet requirements will not be submitted to the TSSWCB nor will be considered appropriate for the use noted above.

# APPENDIX A. CORRECTIVE ACTION REPORT

# Corrective Action Report

**CAR #:______________**

Date:____________________ Area/Location:_____________________

Reported by:____________________ Activity:__________________________

State the nature of the problem, nonconformance, or out-of-control situation:

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

Possible causes:

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

Recommended corrective action:

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

CAR routed to:________________________________

Received by:__________________________________

Corrective Actions taken:

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

Has problem been corrected? YES NO

Immediate Supervisor:______________________________

Project Leader:_________________________________

Quality Assurance Officer:___________________________

# APPENDIX B. CHAIN-OF-CUSTODY FORM

# USDA - ARS
# GRASSLAND, SOIL AND WATER RESEARCH LABORATORY
# CHAIN OF CUSTODY RECORD

| Project Name: | | | | | # of containers | Analyses Required | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station ID | Date | Time (24hr) | Matrix | Description | | | | | | | | | | | | | Sample ID |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) | Date: | Time: | Laboratory remarks: |
| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) | Date: | Time: | Lab log # |
| Relinquished by: (Signature) | **Date:** | **Time:** | **Received for lab by: (Signature)** | **Date:** | **Time:** | **Laboratory Name:** USDA-ARS |

# TEXAS A&M UNIVERSITY
## SOIL AND AQUATIC MICROBIOLOGY LAB
## CHAIN OF CUSTODY RECORD

| Project Name: | | | | | # of containers | Analyses Required | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station ID | Date | Time (24hr) | Matrix | Description | | | | | | | | | | | | | Sample ID |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) | Date: | Time: | Laboratory remarks: |
| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) | Date: | Time: | Lab log # |
| Relinquished by: (Signature) | **Date:** | **Time:** | **Received for lab by: (Signature)** | **Date:** | **Time:** | **Laboratory Name:** SAML |

# APPENDIX C.
# BACTERIOLOGICAL DATA LOG SHEET

**Bacteriological Data Log Sheet-Membrane Filter**

| Sample Location | Sample Date | Sampler Initials | Time | | | | Volume Filtered | Colony Count | | | Temperature | | Analyst Initials | Turbidity | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Collected | Filtered Incubator #1 | Incubator #2 | Counted | | Colony Count X | 100 mL vol. filtered | #/100 mL | Initial © | Final © | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

**Flow depth** | |
**Estimated flow** | |

**20 NTU Turbidity Standard** | |

# APPENDIX D. ISCO® SAMPLER MAINTENANCE

| ISCO SAMPLER MAINTENANCE | | | | |
|---|---|---|---|---|
| | | | | |
| **Date:** | | | **Date:** | |
| | | | | |
| | | | | |
| **time** **site** | | | **time** **site** | |
| bubbler rate (not pinched or clogged) | s | | bubbler rate (not pinched or clogged) | s |
| dessicant (pink OK, blue change) | | | dessicant (pink OK, blue change) | |
| sampler tube (not clogged or holding water) | | | sampler tube (not clogged or holding water) | |
| water level (Bubbler) | ft | | water level (Bubbler) | ft |
| water level (actual) | ft | | water level (actual) | ft |
| battery | | | battery | |
| data downloaded | | | data downloaded | |
| strainor cleaned | | | strainor cleaned | |
| comments, problems: | | | comments, problems: | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| **time** **site** | | | **time** **site** | |
| bubbler rate (not pinched or clogged) | s | | bubbler rate (not pinched or clogged) | s |
| dessicant (pink OK, blue change) | | | dessicant (pink OK, blue change) | |
| sampler tube (not clogged or holding water) | | | sampler tube (not clogged or holding water) | |
| water level (Bubbler) | ft | | water level (Bubbler) | ft |
| water level (actual) | ft | | water level (actual) | ft |
| battery | | | battery | |
| data downloaded | | | data downloaded | |
| strainor cleaned | | | strainor cleaned | |
| comments, problems: | | | comments, problems: | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| **time** **site** | | | **time** **site** | |
| bubbler rate (not pinched or clogged) | s | | bubbler rate (not pinched or clogged) | s |
| dessicant (pink OK, blue change) | | | dessicant (pink OK, blue change) | |
| sampler tube (not clogged or holding water) | | | sampler tube (not clogged or holding water) | |
| water level (Bubbler) | ft | | water level (Bubbler) | ft |
| water level (actual) | ft | | water level (actual) | ft |
| battery | | | battery | |
| data downloaded | | | data downloaded | |
| strainor cleaned | | | strainor cleaned | |
| comments, problems: | | | comments, problems: | |