Quality Assurance Project Plan
for the
Environmental Measurement Activities Relating to the

Reducing Atrazine Loss in Central Texas
Project 03 – 15

United States Environmental Protection Agency (USEPA), Region 6

Name: Donna Miller

Title: Chief; State/Tribal Programs Section

Signature:______________________________________Date:________________

Name: Ellen Caldwell

Title: Texas Nonpoint Source Project Manager

Signature:______________________________________Date:________________

Texas State Soil and Water Conservation Board (TSSWCB)

Name: Laurie Fleet

Title: Project Manager

Signature:______________________________________Date:________________

Name: Donna Long

Title: Quality Assurance Officer

Signature:______________________________________Date:________________

Name: Scott Senseman

Title: Pesticide Fate Laboratory Director and Sample Analysis QAPP Officer

Signature:______________________________________Date:________________

Name: Wyatt Harman

Title: Professor and Modeling Project Director and Modeling QAPP Officer

Signature:______________________________________Date:________________

Texas Cooperative Extension, Dept. of Soil and Crop Sciences

Name: Travis Miller

Title: Professor and Associate Department Head

Signature:______________________________________Date:________________

Name: Monty Dozier

Title: Extension Specialist – Water Resources and Project Manager

Signature:______________________________________Date:________________

Table of Contents

This is a USE CATEGORY III QAPP, as specified in EPA QA/R-5, Region 6, Dallas, TX. It is applicable to Region 6, Quality Management Plan entitled "Quality Assurance Management Plan, Texas State Soil and Water Conservation Board", approved Month, 2004. (04 QTRAK #Q-04-

Section A3: Distribution List

Organizations, and individuals within, which will receive copies of the approved Quality Assurance Project Plan (QAPP) and any subsequent revisions include:

- **United States Environmental Protection Agency**

  Name: Ellen Caldwell
  Title: Region 6, Texas Nonpoint Source Project Manager

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

  Name: Laurie Fleet
  Title: Project Manager

  Name: Donna Long
  Title: Quality Assurance Officer

- **Texas Agricultural Experiment Station (TAES)**

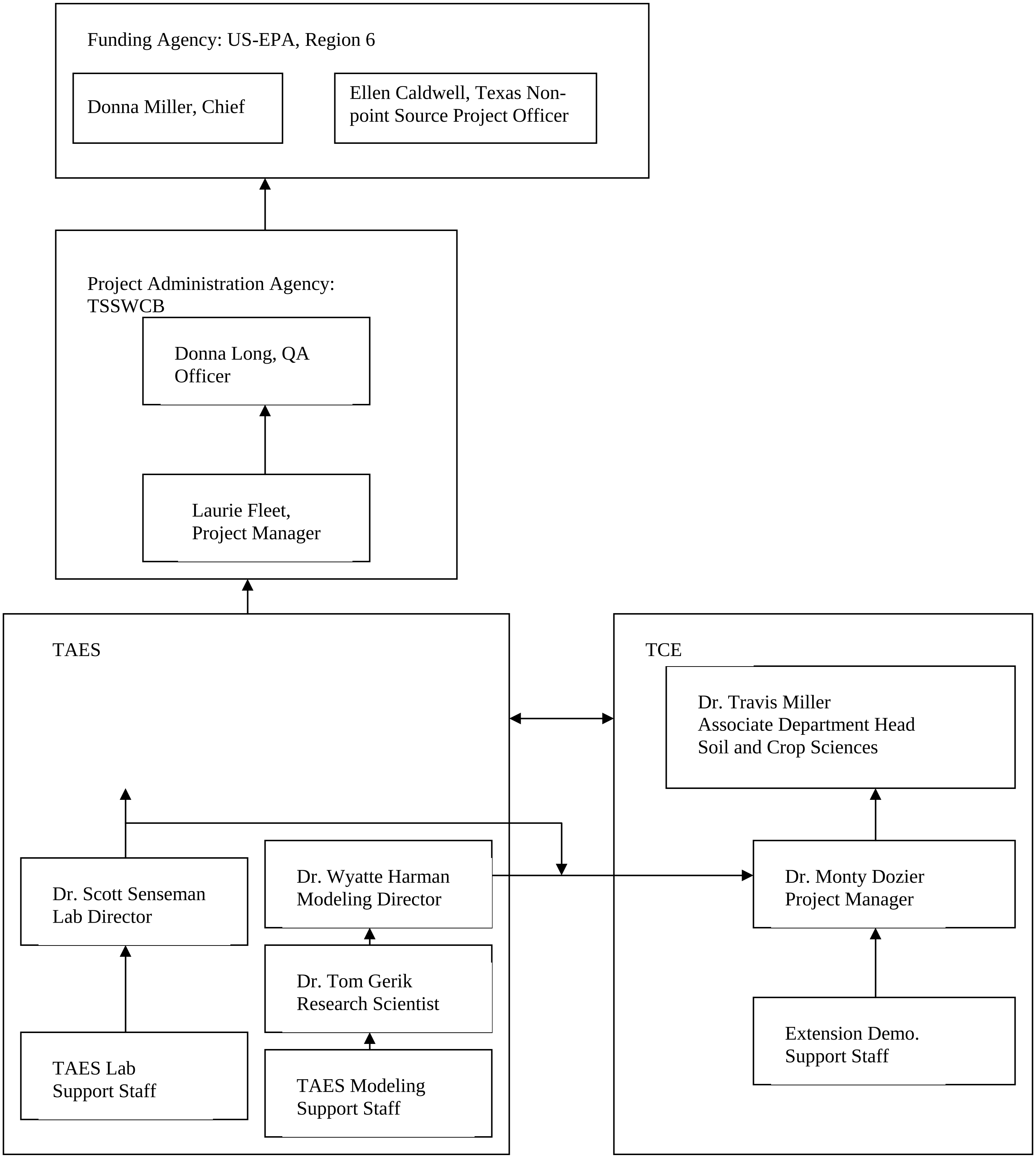
  Name: Scott Senseman
  Title: Pesticide Fate Research Laboratory (PFRL-TAES) Director And Lab Quality Assurance Officer

  Name: Wyatte Harman
  Title: Modeling Director and Modeling Quality Assurance Officer

- **Texas Cooperative Extension**

  Name: Monty Dozier
  Title: Project Manager

Section A4: Project Organization Chart:



Section A4: Project / Task Organization and Responsibilities

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

Ellen Caldwell, Texas Nonpoint Source Project Manager

United States Environmental Protection Agency, Region 6
Responsible for overseeing funding of project and insuring all federal
Project mandates and deadlines are met.

Laurie Fleet, Project Manager

Texas State Soil and Water Conservation Board (TSSWCB)
Responsible for overseeing the implementation of the proposed
demonstration project within federal guidelines.

Donna Long, Quality Assurance Officer

Texas State Soil and Water Conservation Board (TSSWCB)
Responsible for overseeing project QA.

Travis Miller, Professor and Associate Dept. Head

Department of Soil and Crop Sciences, College Station, TX
Texas Cooperative Extension (TCE)
Responsible for overall operation, integrity and success of the TAES/TCE project responsibilities and deliverables.

Monty Dozier, Associate Professor, Extension Specialist – Water Resources, and Project Manager

Texas Cooperative Extension (TCE)
Responsible for coordinating cooperation between TSSWCB, TCE, and TAES for all reporting requirements and deliverables.
Responsible for the design and placement of BMP demonstrations, all field sampling, and public information related to this project.

Scott Senseman, Professor and Pesticide Fate Research Laboratory Director, and Lab Quality Assurance Officer

Department of Soil and Crop Sciences, College Station, TX
Texas Agricultural Experiment Station (TAES)
Pesticide Fate Research Laboratory (PFRL)
Responsible for coordinating laboratory procedures, data review, data management, equipment management and sample analysis.

Wyatte Harman, Professor and Director of Project Modeling

Texas Agricultural Experiment Station
Blackland Research Center, Temple, TX
Responsible for management of data, model calibration, running models, and making model analysis and interpretations.

Section A5: Problem Definition / Background

Atrazine is the most widely used herbicide in Texas corn and grain sorghum production. With its widespread use, atrazine has been detected in Texas groundwater and surface water. The detections of atrazine in surface water have been concentrated, mainly, in the Central Texas Blacklands including the counties of Milam, Falls, Ellis, Hill and Delta. Reports presented by the Texas Commission on Environmental Quality (TCEQ) (2000) indicate the presence of atrazine in eight public water supply lakes and one public water supply drawn from a river in Texas. These reports suggest atrazine is entering the public water supplies through surface runoff from corn and grain sorghum cropland and urban landscapes. Banning atrazine does not appear to be the answer because of the adverse economic impact on agricultural producers. It is estimated that Texas corn producers, as a whole, would face a total increase in the cost of production (based on increase in cost of production of using an alternative herbicide and decrease in income caused by yield reductions associated with increased weed populations and crop injury) of over $45,000,000 (USDA 1995). Given the reality that producers economically need to have continued access to atrazine coupled with the need to reduce off-target losses of atrazine in surface runoff, a concerted effort must be taken to study the benefits of reducing tillage, maintaining residues on the soil surface, and using alternative atrazine application practices on the target area to maintain weed control, reduce off-target losses, and maintain/increase yields.

Two BMPs, incorporation of atrazine at application time and banding at a reduced rate at planting, were recommendations of agricultural producers in Hill County which contains the majority of the watershed of Lake Aquilla. Lake Aquilla is the only public water supply reservoir indicated on the 2000 303(d) list as impaired for atrazine (Texas Commission on Environmental Quality 2000). In the TMDL Implementation Plan (Texas Commission on Environmental Quality 2001), TCEQ and Texas State Soil and Water Conservation Board (TSSWCB) included incorporation and banding as prescribed methods of atrazine application in the Aquilla watershed. Water quality data from central Texas corn and sorghum production areas need to be collected and evaluated to show that these two BMPs can reduce off-target losses of atrazine in surface runoff without sacrificing weed control and reducing crop yield. According to the Lake Aquilla TMDL Implementation Plan, failure to do so could lead to outright banning of the use of atrazine in the Aquilla watershed by Texas Department of Agriculture.

Section A6: Project Description

The primary objective of this project is to demonstrate alternative means of protecting water quality from atrazine contamination and assess their impacts by simulating field conditions over a long period of time, a shortcoming of year-to-year field demonstrations. Specific objectives include the following:

1. Demonstrate the effects of alternative tillage practices and atrazine application practices on protecting water quality by reducing atrazine losses;

2. Develop educational materials and present the demonstration results at agricultural meetings, field days, and conferences;

3. Validate the ***CroPMan*** simulation model with measured atrazine losses to facilitate simulating long-term losses of atrazine and the probabilities of meeting EPA standard for safe drinking water; and

4. Analyze the economic costs, profits, and the cost effectiveness (amount of reduction in atrazine loss per dollar cost) of alternative tillage methods.

The methodological approach will consist of a two-year timeframe in which the first year will focus on establishing four alternative tillage and atrazine application practices in corn production at the Stiles Farm Foundation. These plots will be used to measure atrazine runoff losses. They will also be used to educate and demonstrate environment-friendly alternatives at the 2004 and 2005 Stiles Farm Foundation Field Day.

The second year of the project will continue measurements of atrazine losses from the second crop of corn, repeat demonstrations at the 2005 Field Day, and extend project activities to develop educational information for central Texas producers. An educational packet entitled "*Enviro-friendly Use of Atrazine: A Guide to Central Texas*" will include information concerning: (a) the impacts of each of the four tillage practices on measured atrazine losses, both concentrations and loads, and will include supplemental demonstration/research results from past activities; (b) the use of a unique, new computerized crop and pesticide simulation program, ***CroPMan***, which can assess the potential long-term average atrazine loss and the probability of attaining the EPA safe drinking water standard of 3 ppb with improved farming practices; and (c) the economic cost, profitability, and cost effectiveness of each of the four tillage alternatives.

Section A6: Tasks, Objectives, Schedules, and Estimated Costs

Task #1- *Establish 2004 Corn Plots and Measure Atrazine Losses.* **Cost: $35,000**

During the period March-September, 2004, corn plots will be established and maintained at the Stiles Farm Foundation including four tillage and atrazine application practices described above. Runoff sampling devices will be installed and runoff samples collected and analyzed for each runoff event. Percent weed control and corn yields in bushels per acre will also be summarized by November, 2004.

Task #2- *Validate **EPIC**, the Crop and Pesticide Simulation Model.* **Cost: $ 6,352**

From January-May, 2005, ***EPIC*** will be validated using the ***CroPMan*** interface. Validation will use actual weather from the Stiles Farm Foundation for 2004, soil characteristics of the demonstration plots, crop production practices, and atrazine application dates and rates.

Task #3- *Present Results at Stiles Farm Foundation Field Day and Develop Educational Materials for Producers.* **Cost: $ 1,000**

Upon completion of the atrazine analyses, educational materials will be prepared to give producers attending the 2004 (year one of project) and 2005 (year two of project) Stiles Farm Foundation Field Day. The materials will include descriptions of the four tillage demonstrations and atrazine losses per event and total-to-date atrazine. Additionally, other atrazine losses will be included from previous demonstrations/research. Estimates of typical economic costs and profitability will also be determined for each of the four alternatives. Finally, in year two, a description of the user-friendly, computerized crop and pesticide simulation model ***CroPMan*** will be included.

Task #4- *Establish 2005 Corn Plots and Measure Atrazine Losses.* **Cost: $ 32,664**

During February-August, 2005, the corn plots will be established and maintained for year two of the project, soil samples analyzed, and atrazine losses for each runoff event measured and analyzed. % weed control and corn yields in bushels per acre will also be summarized by November, 2005.

Task #5- *Simulate Long-term Atrazine Losses*. **Cost: $ 10,000**

During the period June-October, 2005, the twelve simulations using 100-scenarios of weather will be analyzed and summarized for each soil/tillage/atrazine application practice. This analysis will include the estimated yearly average atrazine losses and the probability of exceeding the EPA standard of 3 ppb. Two soil types will be simulated with each of the six alternative tillage/atrazine application alternatives.

Task #6- *Estimate Economic and Environmental Trade-offs*. **Cost: $ 2,545**

Utilizing the long-term atrazine loss of each of the six tillage and atrazine application practices on each soil, a comparative analysis of their cost effectiveness will be made. In this analysis, the amount of atrazine lost using the common practice of non-incorporation versus the amount of atrazine lost and the cost of attaining the reduced loss from each alternative will be conducted in November-December, 2005.

Task #7- *Prepare Final Report of Methods and Results of Reducing Atrazine Losses for Texas State Soil and Water Conservation Board.* **Cost: $ 500**

The two-year results of the demonstrations will be summarized in a final report to the TSSWCB. Additionally, 100-year simulation results of expected long-term atrazine losses and the probabilities of attaining the EPA safe dinking water standard of 3 ppb will be summarized. An economic analysis will also be included for the six alternatives simulated. These modeling efforts will be completed by end of December 2005.

DELIVERABLES

December 15, 2004- Progress Report for 2004 Corn Season

This report will describe the project activities of 2004 and summarize corn yields and weed control during the crop season. Analyses of atrazine contents in runoff will also be reported if completed at this time.

May, 2005- Packet of Educational Materials: "Enviro-friendly Use of Atrazine:A Guide for Central Texas"

The Stiles Farm Foundation Field Day is held each year to inform producers of the latest technologies and farming practices in central Texas. The educational materials will include the 2004 atrazine demonstration results, information on ***CroPMan***, a user-friendly crop and pesticide simulation model, and the economics of each of the four tillage practices.

December 15, 2005- Final Report of Project

The final report of the project will include several items including the 2003-04 corn yields, weed control, atrazine runoff results, a summary of the long-term simulations of the twelve alternative soil/tillage/atrazine practices, and the economics along with the analysis of their relative cost effectiveness.

See Appendix D for map of Stiles Farm and Location of Demonstration Plots

Table A6.1 Project Plan Milestones

December 2003 Proposal and Contract Approved

January	**2004**	**Contact agency personnel to initiate project; Prepare Quarterly Report**
February	**2004**	**Demonstration Planning Meeting; Prepare draft QAPP; Secure Global Water pressure transducers/data loggers and h-flumes; Submit draft QAPP to TSWCB and US-EPA for approval**
March	**2004**	**Install h-flumes and data loggers; Install passive water samplers; Plant atrazine bmp demonstration sites; Spray atrazine treatments on demo sites; Incorporate atrazine on appropriate demonstration sites; Collect any demo plot runoff samples**
April	**2004**	**Collect any demo plot runoff samples; Prepare Quarterly Report**
May	**2004**	**Collect any demo plot runoff samples; Cultivate the banded demo plots**
June	**2004**	**Rate % weed control for demo plots**
July	**2004**	**Prepare Quarterly Report ; Conduct Field Day Tour of Demo Sites**
September	**2004**	**Harvest demo plots and determine yield; Ensure no-till beds not plowed to remove trash**
October	**2004**	**Prepare Quarterly Report**
January	**2005**	**Prepare Quarterly Report; Begin EPIC and CropMan modeling efforts**
March	**2005**	**Install h-flumes and data loggers; Install passive water samplers; Plant atrazine bmp demonstration sites; Spray atrazine treatments on demo sites; Incorporate atrazine on appropriate demonstration sites; Collect any demo plot runoff samples**
April	**2005**	**Collect any demo plot runoff samples; Prepare Quarterly Report**
May	**2005**	**Collect any demo plot runoff samples; Cultivate the banded demo plots; Conclude EPIC and CropMan modeling efforts**
June	**2005**	**Rate % weed control for demo plots; Begin 100 year modeling scenario efforts**
July	**2005**	**Prepare Quarterly Report; Conduct Field Day Tour of Demo Sites**
September	**2005**	**Harvest demo plots and determine yield**
October	**2005**	**Prepare Quarterly Report; Begin economic and environmental analysis**
December	**2006**	**Complete economic and environmental analysis**
July	**2007**	**Prepare Quarterly Report**
June	**2007**	**Remove all automatic sampling equipment; Prepare Draft Final Report**
August	**2007**	**Submit Final Report**

******These dates are estimates of activity scheduling. Therefore the timeline may change to accommodate local coordinating committees, project administration, and weather conditions .***

Section A7: Data Quality Objectives for Measurement Data

The data quality objectives for this project are to collect water quality runoff data, provide education, demonstration and training programs, assist in the implementation of BMP's, and monitor for results. TAES and TCE will provide education, demonstration and training programs utilizing latest technologies in the area of water quality to assist area residents interested in implementing environmental stewardship. Delivering BMP technology and monitoring water quality in this environmentally sensitive region requires a well-established, reliable communication between farmers and technology providers.

Overall project management will be conducted by TSSWCB and overseen by EPA. Demonstration runoff collection site selection and water sampling and BMP evaluation will be conducted by TCE. Analysis of all water runoff samples for atrazine will be conducted by TAES PFRL. Analysis of soil samples for nutrient, moisture, and sand, silt, and sand content will be done by the TCE Soil, Water, and Forage Laboratory. Education, and all modeling efforts will be carried out by TAES and TCE as outlined in the work plan.

TCE will monitor runoff collected from the individual demonstration site plots. TAES Blackland Research Center and TCE Weed Science technicians will assist Dozier in this sampling effort. Education and technology transfer will take place at the Stiles Farm field day conducted by TCE and TAES each July.

The major analytical parameter of concern will be atrazine. EPA approved laboratory procedures will be used for all sample analysis. Data collection and analyses will meet the study limits established for accuracy and precision listed in Table A7.1. The analysis of field and lab blanks should yield values less than the Minimum Quantification Limit. When target analyte concentrations are high, blank values should be less than 5% of the lowest value of the batch.

Although 100 percent of collected data should be available, accidents, insufficient sample volume, or other problems must be expected. A goal of 80 percent data completeness will be required for data usage. Should less than 80 percent data completeness occur, the Laboratory Director will initiate corrective action. Data completeness will be calculated as a percent value and evaluated with the following formula:

$$\text{Completeness (\%)} = \frac{SV}{ST} \times 100$$

Where: SV = number of samples with a valid analytical report,
ST = total number of samples collected

The TAES Pesticide Fate Research Laboratory (TAES_PFRL) at College Station will determine the precision of their analyses. This will be accomplished by repeating the entire analysis of a sample once per batch or once per 10 samples which ever is of a greater frequency. Relative percent deviation (RPD) of duplicate analyses (X_1 and X_2) will be calculated using the formula:

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

The accuracy of the analytical process will be monitored by determining the percent recovery of a spiked quantity of the parameter in question. The following formula will be utilized to determine percent recovery:

$$\text{Recovery (\%)} = \frac{SSR-SR}{SA} \times 100$$

Where: SSR = spiked sample result,
SR = un-spiked sample result,
SA = spike added.

Table A7.1a Accuracy and Precision Limits of Measured Parameters TAES-PFRL

Herbicide	Matrix	Processing Agency	Precision Limits High-level duplicates[1] (PD) %	Precision Limits Low-level duplicates[1] (PD) %	Recovery of Known Additions %
Atrazine	Water	TAES	20	40	70-130 [2]

[1]Standard Methods 18th Ed.; pg. 1.4, Table 1020:I
[2]EPA Method 525.2 and HPLC-PDA (TAES-PFRL)

Table A7-1b. Accuracy and Precision Limits of Measured Parameters TCE Soil , Water, Forage Lab

Parameter	Precision Limits (RPD[a])	Bias & % Recovery Limits	MDL[b]	Reporting Limits
Soil				
pH	NA[c]	±0.2	NA	0.2 pH units
Nitrate-Nitrogen	20%	80-120%	0.1 mg/kg	1.0 mg/kg[e]
Extractable Phosphorus[g]	20%	80-120%	0.01 mg/kg	1.0 mg/kg
Water Soluble P (CaCl)[h]	20%	80-120%	0.01 mg/kg	1.0 mg/kg
Potassium	20%	80-120%	0.01 mg/kg	5.0 mg/kg
Moisture	NA	±2%	NA	1%
Organic Matter	1%	±1%	NA	0.5%

[a] RPD = relative percent deviation [b] MDL = method detection limit [c] NA = Not applicable
[d] dS/m = decisiemens per meter [e] mg/kg = milligrams per kilogram [f] mg/L = milligrams per liter
[g] TCE Soil, Water and Forage Testing Laboratory determines extractable P with an aggressive acidified (pH=4.2) ammonium acetate EDTA extracting solution, yielding a value comparable to total P in the soil.
[h] TCE Soil, Water and Forage Testing Laboratory determines water soluble P with a 10 mmol $CaCl_2$ solution. High smectite content in soils precludes the use of a basic water extraction solution.

Primary focus

Demonstration runoff work will include a two year period (two growing seasons) to determine BMP effectiveness. When runoff occurs, water samples will be collected at all sampling treatments during the monitoring period. Water samples from individual treatment plots will be collected by employing the use of passive water sampling techniques. A schematic of the passive samplers to be used is located in Appendix F.

A goal of 75 percent mean extraction recovery atrazine will be required for data usage. Should less than 75 percent mean extraction recovery occur atrazine within a batch, the Laboratory Director will initiate corrective action.

The Project Managers will coordinate with the Laboratory Manager and Staff to ensure that proper protocols are utilized. Data will be reviewed for abnormalities or results not in agreement with the specifications in Table A7.1. The data will be assumed normal and appropriate for decision determinations in the event no error is found. Any unusual results will be traced for error sources. If an error is found and cannot be resolved, the data will be discarded.

Concurrent with the collection of samples and the implementation of BMPs, educational activities will be conducted at the demonstration field sites.

Quarterly progress reports will be submitted to TSSWCB throughout the project. These reports will summarize activities as well as data collected and analyzed to date. A final report will also be submitted to TSSWCB.

Section A9: Documentation and Records

Reporting will include quarterly progress reports, reimbursement requests, and a final report at the culmination of the study.

Quarterly progress reports will be submitted to TSSWCB and will note activities conducted throughout the quarter, items or areas identified as potential problems, and any variations or supplements to the QAPP. Problems encountered will be discussed by the project team and corrective actions implemented will also be included in the appropriate quarterly report. Any changes to the QAPP will be printed and copies distributed to all individuals as outlined in the distribution list by TAES QA officer.

Reimbursement requests for TAES/TCE will be handled by the Texas A&M University – TAES/TCE accounting office in College Station. A report summarizing the data collected during the project period will be included in the project's final report. Copies of all raw data, laboratory analyses, documentation records, calibration logs, and other pertinent information will be kept at the TAES-PFRL Laboratory in College Station and will be available for review for audits and other purposes. All original data, both hardcopy and electronic forms, will be archived by TAES-PFRL for at least five years after termination of the project.

Soil sample results will be stored on file in TCE Soil, Water, and Forage Laboratory. Additional hard copies of the soil sample results will be stored in Dozier's files.

Quarterly reports and the final report will be copied on two separate CDs within two weeks of completion to insure copies will be available if computers fail or are stolen. CDs will be stored in TCE Department of Soil and Crop Sciences information office.

Section B1: Sampling Process Design (Experimental Design)

This project is designed to determine off-target losses of atrazine from several plots treated with different BMPs. There will be four treatments with four replications each. This will yield 16 samples per runoff event. It is anticipated that four runoff events will be collected during each growing season. Therefore, a total of 64 runoff samples will be collected and analyzed each growing season.

Soil samples will be collected from three locations in four of the plots at depths of one, two, and three feet for a total of 36 samples per growing season. Soil analysis is not a critical measurement.

The waterborne constituents that will be measured to demonstrate BMP effectiveness are shown in Table B1.1.

Table B1.1 Waterborne Constituents

Parameter	Area of Interest	Status	Reporting Units
Atrazine	Stiles Foundation Farm	Critical	μg/L

Quality control (QC) samples will be included to insure sample integrity. Field QC samples will include 1) field blanks and 2) field duplicates. Lab QC samples will include 1) deionized water from the laboratory fortified with atrazine (standards), 2) deionized water blanks (blanks), and 3) fortified grab sample water (matrix spikes). The purpose of these samples will be 1) to determine sample procedure efficiency and 2) to determine quantities of contamination from sample transport.

Section B2: Sampling Methods

Atrazine demonstration plot runoff samples will be collected from storm events for each demonstration plot using passive samplers. Field duplicates may not be taken if not enough runoff is generated for duplicating field samples. In preparation for transport to the lab, runoff samples will be emptied from the passive samples and into one-liter amber glass bottles. Passive samplers will be cleaned of sediment and triple-rinsed with water before replaced in the ground. Once collected, samples will be transported on ice, at a temperature of approximately 4^{o} C, to the TAES-PFRL at College Station for analysis. Samples will be stored in a refrigerator at 4^{o} C until extracted and prepared for analysis. Once samples are extracted, the one-liter amber bottles will be rinsed of sediment and cleaned using soap and water.

Prior to preplant fertilization each year, 6 to 12 inch soil cores will be collected at a depth of one, two, and three feet from four plots. The three cores from each individual plot will be mixed together separately (from the other three plots) in a plastic bucket and split into two subsamples. These samples will then be analyzed to: (1) determine preplant soil water and (2) to analyze for organic carbon, pH, and the nitrogen, phosphorus, sand, silt and clay contents. Samples will be collected with a steel hand soil probe. Soil probe will be cleaned by removing all excess soil and handwashed with water between samples. Each sample will be stored in Ziplock™ bags and transported to the TCE Soil Laboratory. Sample analysis procedures for the soil samples to be used by TCE Soil, Water, and Forage Laboratory are outlined in Appendix E.

All corrective action is the responsibility of the Project Leader. Corrective action will be documented in the appropriate quarterly report. Any problems that arise will be discussed and reviewed by all participants at the quarterly project team meetings.

Section B3: Sample Handling and Custody Requirements

This project involves the collection of water quality data from control/management of NPS pollution sources for demonstration purposes. Formal COC sheets will be completed for all water and soil samples collected. These sheets will record possession change and will require that the sample container have pertinent data (number, location, date, etc.) inked onto the sample container as written on the data sheet. The data sheets will be signed by the sample collector and will be transported with the water samples to the TAES-PFRL at College Station and soil samples to the TCE Soil, Water, and Forage Lab. All samples collected for lab analysis will be transported in coolers, on ice, to the laboratory. A copy of the COC is included in Appendix G.

Sample holding requirements will meet EPA accepted times and preservation procedures. Table B3.1 describes sample container, preservation and holding time information for the parameters of interest.

Table B3.1 Sampling Procedures and Handling Methods

Parameter	Matrix	Sample Size	Container	Preservation (^{o}C)	Holding Time (days)
Atrazine	Water	1 L	Glass/Teflon	4	14 pre-[1] / 30 post-[2]
Nutrients	Soil	1 G	Ziplock bag		14 pre-[3] / 30 post [4]

[1] refers to pre-extraction.
[2] refers to post-extraction.
[3] refers to # days from collection to initial lab preparation (oven drying of samples) for analysis
[4] refers to # days after samples are oven dried

Each water and soil sample will be identified by treatment number, plot (replication) number, and the date the sample was collected. This system will be used for field sample identification, COC sample identification, lab sample analysis identification, and sample results identification.

Section B4: Analytical Methods Requirements

Water samples collected during this project will be analyzed by the TAES-PFRL at College Station. A listing of analytical methods requirements are listed in Table B4-1. Methodologies for atrazine are included in Appendix A.

Soil samples will be analyzed by the TCE Soil, Water, and Forage Lab. Methodologies for analysis of N,P, K, soil moisture, soil pH, soil carbon content, and soil texture in the soil are included in Appendix E.

In the event of a failure in the analytical system, the Project Leader will be notified. The Laboratory Director and the Project Leader will then determine if the existing sample integrity is intact, if re-sampling can and should be done, or if the data should be omitted.

Table B4.1 Analytical Methods Requirements

Parameter	*Procedure*	*Equipment Used*	*EPA or [1]SWFTL Method Number*	*Method Detection Limit (MDL)*	*Method Quantification Limit (MQL)*
Atrazine	[2]SPE	[3]GC-MS	525.2	0.076µg/L	0.1µg/L
Atrazine	SPE	[4]HPLC with PDA		0.2 µg/L	0.3 µg/L
Soil Nitrogen	Keeny/Nelson	[5]Latchet	00013	TCE Lab	TCE LAB
Soil Phosphorus	Mehlich	ICP	0006 & 0008	TCE Lab	TCE LAB
Soil Moisture-	Gravimetric	Drying oven	NA	NA	NA
Soil Texture (% sand, silt, and clay)	Hydrometer	Hydrometer	NA	NA	NA
% Clay Content	Hydrometer	Hydrometer	NA	NA	NA
pH	1:2 soil to DI H_20 Extract	[6] Labtronic	0015		

[1] Soil, Water, and Forage Testing Lab of TCE
[2] Solid phase extraction disks. (See Appendix A.1). Solid Phase Extraction (often referred to as SPE) refers to the extraction of a wide range of organic compounds that are efficiently partitioned from the water sample onto a C_{18} organic phase that is chemically bonded to a solid matrix in a disk or cartridge. Please refer to the first paragraph in section 1.1 of Method 525.2, which explains the use of this type of disk or cartridge.
[3] Gas chromatography-mass spectrometry.
[4] High Performance Liquid Chromotography – Photo Diode Array
[5] Latchet 8000 Flow Injection Analyzer
[6] Labtronic MagicChem 901 Robot

Section B5: Quality Control Requirements

The TAES-PFRL at College Station will determine the precision of their analyses. Quality assurance of field sampling methods will be done through review of TCE personnel by project leader. Quality control (QC) samples will be included to insure sample integrity. Field QC samples will include 1) field blanks and 2) field duplicates. Lab QC samples will include 1) deionized water from the laboratory fortified with all 4 compounds (standards), 2) deionized water blanks (blanks), and 3) fortified grab sample water (matrix spikes). The purpose of these samples will be 1) to determine sample procedure efficiency and 2) to determine quantities of contamination from sample transport.

All analyses will have the precision and accuracy of data determined on the particular day that the data was generated. This requires the analysis of a minimum of one duplicate and one spike each time a particular parameter is measured. Larger batches of samples require that additional precision and accuracy checks be made which will represent 10 % of the total batch. Depending on the analysis, certain methodologies require that water blanks, standards and reagent blanks be analyzed to verify that no instrument or chemical problem will affect data quality. Table B5.1 and Appendix A outline the required analytical quality control for the parameters of interest.

Table B5.1 Required Laboratory Quality Control Analyses

Parameter	*Blank*	*Standard*	*Duplicate*	*Spike*
Atrazine	**A**	**A**	**B**	**B**
Soil		**C**		

A: Where specified, blanks and standards shall be performed each day that samples are analyzed.
B: Where specified, duplicate and spike analyses shall be performed on a 10% basis each day that samples are analyzed. If one to 10 samples are analyzed on a particular day, then one duplicate and one spike analyses shall be performed.
C: Calibration and quality control of samples per method and instrument used as outlined in Appendix E

If control limits are exceeded, the Lab QC or the TCE Soil, Water, and Forage lab manager will inform the project manager. Lab QC will be responsible for determining and documenting what actions related to control limits are taken and reporting such information to the project manager. The project manager will then include this information in the next scheduled quarterly report and the final project report.

Section B7: Instrument Calibration and Frequency

All instruments or devices used in obtaining environmental measurement data will be calibrated prior to use. Each instrument has a specialized procedure for calibration and a specific type of standard used to verify calibration. For the GC-MS , all calibration procedures will meet the requirements specified in EPA Method 525.2 (Appendix A). The frequency of calibration recommended by the equipment manufacturer as well as any instructions specified by applicable analytical methods will be followed. The Varian GC-MS manual is kept on file in the PFRL, room 607 Herman Heep Center, College Station, Tx. This manual is available for viewing upon request at the lab. All records of calibration will be kept by the person performing the calibration and will be accessible for verification during either a laboratory or field audit.

All calibration procedures used in the field or laboratory will meet or exceed the calibration frequencies published in EPA Method 525.2 or in the owners' manuals.

Additional calibration procedures may be conducted if laboratory personnel determine additional calibration is warranted as beneficial to this project.

For the Waters HPLC-PDA unit, equipment manufacturer calibration and operation recommendations will be followed as outlined in the owner's manual. This manual is kept on file in the PFRL, room 607 Herman Heep Center, College Station, Tx. This manual is available for viewing upon request at the lab. This type of analysis is added to the QAPP to provide more flexibility to TAES-PFRL in sample analysis. This should provide a means to run samples in a timely and efficient manner. By adding this method, the lab staff will also have a mechanism for conducting routine instrument maintenance and required repairs without jeopardizing the integrity of the samples due to loss time associated with an instrument being down for maintenance or repairs.

For the TCE soil lab, all instruments or devices used in obtaining environmental measurement data will be used according to appropriate laboratory practices. All instruments or devices used in obtaining environmental measurement data will be calibrated prior to use. Laboratory equipment and devices needing calibration and recalibration are numerous and varied. Thus, each instrument has a specialized procedure for calibration and a specific type of standard used to verify calibration.
Standards used for instrument or method calibrations shall be of known purity and be National Institute for Standards and Testing (NIST) traceable whenever possible. When NIST traceability is not available, standards shall be manufactured by a company that has verified standard results against NIST standards. All certified standards will be maintained traceable with certificates on file in the laboratory. Dilutions from all standards will be recorded in the standards log book and given unique identification numbers.
Generally, calibrations are performed with a minimum of four standards of increasing concentrations and a calibration blank. Instrument calibration for each analyte will achieve an r^2 value of 0.990 or higher. The frequency of calibration recommended by the equipment manufacturer or as stated in the SOPs, as well as any instructions specified by

applicable analytical methods, will be followed. Calibration shall be verified immediately after a set of standards is analyzed and continuously throughout an analytical run, after every sample batch, and at the end of an analysis to verify that the instrument or method has not drifted or changed since calibration. The initial calibration verification and continuing calibration verification will be matched to the generated standard curve and screened for acceptability. Laboratory standards will be checked to verify that the concentrations are those which are prescribed for the analytical method. All information concerning calibration will be recorded by the person performing the calibration and will be accessible for verification during either a laboratory or field audit.

All calibration procedures used in the laboratory will meet or exceed the calibration frequencies published in the test methods used for this project. Additional calibration procedures will be conducted if laboratory personnel determine additional calibration is warranted as beneficial to this project.

Section B9: Data Acquisition Requirements (Non-Direct Measurements)

Evaluations of the BMPs used in these demonstrations will be based on data collected from the demonstration sites within the duration of this project. This information will then be used in the modeling portion of this project.

The CropMan (**Cro**p **P**roduction and **Man**agement) model will be used to address the long-term fate and transport of atrazine in commercial production agriculture across diverse weather conditions. The CropMan model simulates atrazine soil adsorption, water solubility, volatility, and half-life based on generic coefficients provided by industry. CropMan is a Windows® interface for the EPIC (**E**nvironmental **P**olicy/**I**ntegrated **C**limate) model. One component of EPIC simulates pesticide transport by water and sediment as a function of soil organic carbon and a linear adsorption isotherm by employing the GLEAMS (**G**roundwater **L**oading **E**ffects of **A**gricultural **M**anagement **S**ystems). The CropMan model is a state-of-the art computerized simulation model *CroPMan* (Gerik et al. 2004) which is driven by the *EPIC* (Environmental Policy Integrated Climate) model (Williams et al., 1989)

Limits to validity and operating conditions- Part of this investigation of soluble and adsorbed atrazine losses in the Blackland Prairie is being undertaken to determine limits to the model validity in predicting runoff losses from high clay soils. In central Texas, vertisol soils are present on 6-7 million acres of which about half is cropland. They are conducive to "shrink and swell" characteristics as soil moisture varies from dry to wet, making cracks in the soil a common occurrence. Cracks impact the partitioning of rainfall between runoff and percolation. Adequate wetting from rainfall or irrigation will eventually close or "swell" soil cracks shut to the point of slowing further infiltration significantly (Harris and Gerik, 1990). While intensive tillage impacts cracking through soil moisture depletion, Harman et al. (2004) simulated tillage practices including conservation tillage and no-tillage and found that they were only marginally effective in reducing atrazine losses in the Aquilla Lake watershed where vertisol soils are common.
Tillage treatments that maintain residue levels and conserve soil water will be investigated in this study. Treatments will range from conventional tillage where residue is not maintained on the soil surface to conservation tillage and to no-till where surface residues vary both in quantity and in surface to soil contact. Measured losses will be compared and utilized to validate the simulation model, *CroPMan*.

Wyatte Harman will serve as modeling director and modeling QA officer. Tom Gerik will work with Wyatte in making CropMan model runs. All modeling work will be completed at the TAES Blacklands Research Center in Temple, Texas.

Harman, W.L., E. Wang, J.R. Williams. 2004. Reducing atrazine losses: Water quality implications of alternative runoff control practices. J. Environ. Qual. 33:7-12.
Harris, B.L. and T.J. Gerik. 1990. Management of cropland Vertisols in Texas. Proc. Vertisol Management Worshop: Int. Collaboration in Research, Training and Extension (ed. C.A. Jones and T.J. Gerik), pp1-12, College Station, Texas, June 25-29, 1990.

Gerik, T.J., W.L. Harman, J.R. Williams, L. Francis, J. Greiner, M. Magre, A. Meinardus, and E. Steglich. 2004. User's guide: *CroPMan* (Crop Production and Management) model, version 3.2. Blackland Research and Extension Center, Temple, Texas, pp.150

Williams, J.R., C.A. Jones, J.R. Kiniry, and D.A. Spanel. 1989. The *EPIC* crop growth model. Trans ASAE 32(2): 497-511.

Section C1: Assessments and Response Actions

The proper use of approved equipment and standard methods when obtaining environmental samples and producing field or laboratory measurements must involve periodic verification. Project Leader will verify that proper equipment is available and that all personnel involved in the field activities have received sufficient training to properly take samples. The application of procedures will be verified annually and documented in the appropriate quarterly report. This verification constitutes the annual field performance audit. Staff in the field will be observed during actual field operations to verify that procedures are properly applied. A member of the TSSWCB will perform this audit. The project leader will be responsible for contacting the TSSWCB QAO to schedule the annual audits.

All laboratory samples will have the precision and accuracy of data determined on the particular day that the data were generated. Depending on the analysis, certain methodologies require that water blanks, standards, and reagent blanks be analyzed to verify that no instrument or chemical problem will affect data quality.

To minimize downtime of all measurement systems, all field measurement and sampling equipment, in addition to all laboratory equipment, must be maintained in a working condition. Also, backup equipment or common spare parts will be made available if any piece of equipment fails during use so that repairs or replacement can be made quickly, allowing measurement tasks to be resumed. Site specific check lists and maintenance records will be used to assist with proper equipment upkeep.

Data collection and analytical results will be reviewed semi-annually by the Project Leader and Laboratory Manager to ensure that the data collection program is obtaining the desired results. During this semi-annual review, any necessary modification to the data collection efforts will be implemented to improve the integrity, validity and usefulness of the data.

Regarding model corrective action, model validation and any necessary calibrations will be made by Drs. J.R. Williams and W.L. Harman. Accuracy of daily weather and rainfall runoff data as well as soluble and adsorbed atrazine data measurements will be monitored and verified by Drs. M. Dozier and T.J. Gerik.

Project manager will attach to appropriate quarterly reports any corrective action reports from the lab or modeling efforts.

Section C2: Reports to Management

The field measurement and sampling for the project will be done according to the approved workplan. The Project Leader will be required to report on the proper implementation of the procedures outlined in this QAPP and thereby the status of the data quality. The QAO, at the TSSWCB, will be informed of any quality assurance problems encountered, and solutions adopted, during quarterly reports submitted to TSSWCB.

Upon completion of the project, the final report will contain a detailed quality assurance section to address the accuracy, precision and completeness of the measurement data used in the project's conclusions. It will also discuss any problems encountered and solutions made. This final project QA report is therefore the responsibility of the Project Leader with any assistance required from the Laboratory Manager, and laboratory and field technical assistance personnel. All reports detailed in this section are contract deliverables and will be provided to TSSWCB.

Section D1: Review Verification and Validation Requirements

The Laboratory Director and TCE monitoring personnel will be responsible for reviewing, validating and verifying the measurement and sample data and the routine assessment of measurement procedures for precision and accuracy. It will be the responsibility of the Laboratory Director to verify that the data is representative. The laboratory data's precision, accuracy, and comparability will also be the responsibility of the Laboratory Director. The Laboratory Director will, likewise, have the responsibility of determining that the percent mean recovery criteria is met, or will justify acceptance of a lesser percentage.

Whenever the procedures and guidelines established in this QAPP fail to meet the specified levels of data quality, corrective action will be required. Corrective action may be initiated by the QAOs if variances from proper protocol are noted. The responsibility

to see that corrective actions are made will be the responsibility of the Laboratory Director and administrated by the Project Leader. Lab Director and Project Leader may also initiate corrective action on his own initiative, if situations arise that require immediate attention. Documentation of any corrective action procedures will be provided by the Lab Director/Project Leader as appropriate, along with the results of the implemented changes through the use of quarterly reports.

Section D3: Reconciliation with User Requirements

By following the guidelines described in this QAPP, and through careful sampling design, the data collected in this project will be representative of the actual conditions and will be comparable to similar applications. The comparability of the data produced is predetermined by the commitment of the TSSWCB staff and the contracted laboratory staff to use only EPA approved analytical methods. Table A7.1 in Section A7 "Data

Quality Objectives" lists the required accuracy limits for the parameters of interest. The completeness of the data will be affected by the reliability of the equipment, frequency of field and laboratory errors or accidents, and unexpected events. It will be the general goal that 75 percent mean recovery will be required.

Representativeness and comparability of data, while unique to each individual collection site, is the responsibility of the Laboratory Director and the Modeling Director. Representativeness and comparability of laboratory analyses will be the responsibility of the Laboratory Director. The modeling project director will be responsible for representativeness and comparability of modeling data and results. The Project Leader will review the final data to ensure that it meets the requirements as described in this QAPP. Analysis of data using the methods and procedures described in Section A7 (lab) and B9 (modeling) will be the final indicator of data validity. Project leader will review all quarterly and final reports before submission to TSSWCB.

Limitations of the modeling data will be dependent on the data collected in the field runoff study portion of this project.

Appendix A: Laboratory and Field Sampling Methods for Atrazine

Appendix B: EPA List of Approved Test Procedures for Pesticides

Appendix C: List of Acronyms

Ag/NR – Agriculture and Natural Resources

BRC – Blackland Research Center

COC – Chain of Custody

DQO – Data Quality Objectives

EPA – Environmental Protection Agency

GC-MS – Gas Chromatography – Mass Spectrometry

HPLC-PDA – High Performance Liquid Chromatography – Photo Diode Array

MDL – Method Detection Limit

NPS – Non-Point Source pollution

NRCS – Natural Resources Conservation Commission

PD – Percent Deviation

PFRL – Pesticide Fate Research Laboratory

QA – Quality Assurance

QAO- Quality Assurance Officer

RPD – Relative Percent Deviation

SA – Spike Added

SPE – Solid Phase Extraction

SR – unSpiked sample result

SSR – Spiked Sample Result

ST – total number of samples collected

SV – number of samples with a valid analytical report

SWCD – Soil and Water Conservation District

TAES – Texas Agricultural Experiment Station

TCE – Texas Cooperative Extension

TSSWCB – Texas State Soil and Water Conservation Board

USDA – United States Department of Agriculture

USEPA – United States Environmental Protection Agency

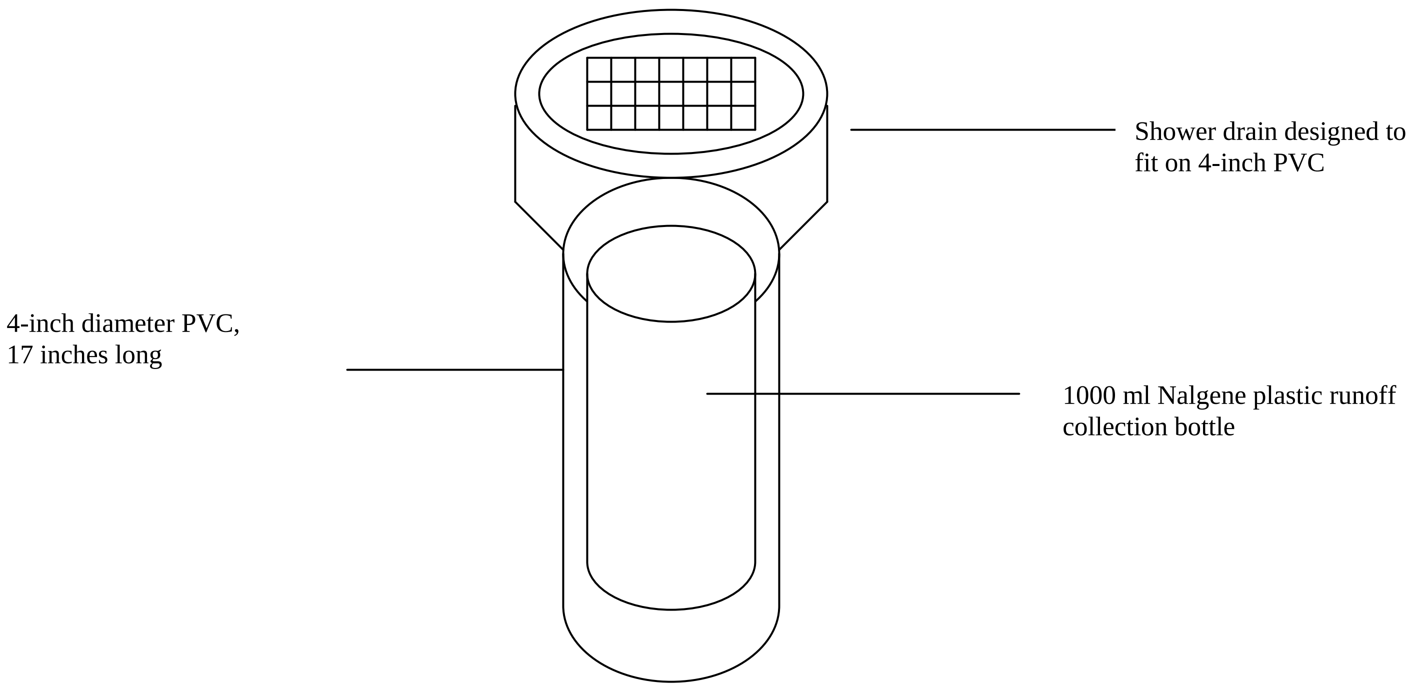
X_1 – sample with reporting value

X_2 – duplicate of sample with reporting value

Appendix D: Stiles Farm Map and Demonstration Site Location

Appendix E: TCE Soil, Water, and Forage Testing Laboratory Soil Anaylsis Procedures

Appendix F: Schematic of Passive Sampler



Appendix G: Chain of Custody Form

Appendix H: *CroPMan* and EPIC Model Manuals

The most current versions of the CroPMan and WinEPIC manuals are quite voluminous and would add hundreds of pages to the QAPP. All CroPMan and WinEPIC manuals, in addition to other beneficial, model-related information may be found at the CroPMan website: http://cropman.brc.tamus.edu/manuals.htm

TheCroPMan manual provides detailed information about CroPMan as well as How-to information for setting up the program, making various types of runs, analyzing and deleting previous runs, and viewing the output. Maps illustrating databases available for Texas, Missouri, and Alabama can be viewed by clicking the appropriate state link on the website.

The WinEPIC manual provides detailed information about WinEPIC as well as How-to information for setting up the program, creating runs, setting up batch runs and viewing and analyzing output.

The Crop Weather Analyzer manual provides detailed information about Crop Weather Analyzer and How-to information about downloading weather data from the web, editing weather data, formatting weather data for use by Crop Weather Analyzer and CroPMan, and analyzing weather data.

And finally, **the CroPMan flowchart** provides a quick reference to setting up the program, making various types of runs, analyzing and deleting previous runs, and viewing the output.

Appendix I: Work Plan

Measuring the Effects of Tillage on Atrazine Losses in Field Demonstrations.

Four tillage treatments will be demonstrated:

1. The common practice of applying atrazine pre-emerge without incorporation;
2. Pre-emerge application of atrazine with immediate incorporation;
3. Banding of atrazine at 33% rate supplanted with seasonal row cultivation; and
4. No-till corn production with spring applied atrazine.

The above descriptions of each tillage practice are self-explanatory. Records of each practice including tillage type and date, fertilizer rate and date, corn planting and harvesting date, atrazine application rate and date, and initial soil characteristics will be used in validating the simulation model and for simulating long-term atrazine losses over time. This complimentary use of a computerized simulation tool is a good example of estimating long-run impacts from short-term field research results.

Prior to preplant fertilization each year, 1-ft soil cores will be mixed from each of four plots to 3 ft depth and split into two samples to: (1) determine preplant soil water in a drying oven, and (2) to analyze for organic carbon, pH, and the nitrogen, phosphorus, sand, silt and clay contents. To avoid discrepancies in atrazine losses caused by unexpected rainstorm events, atrazine will be applied on the same day except for the banding demonstration, which will be applied at planting.

Plots will be evaluated for effective weed control, grain yield, and for each runoff event for which runoff volume and atrazine losses will be analyzed. Runoff collection devices will be placed in four replicated plots to collect water samples. All samples will be analyzed for atrazine concentration using gas chromatography-mass spectrometry techniques. To determine the amount (load) of atrazine lost with each event, the volume of water lost in runoff will also be measured in two plots. Determination of the load of lost atrazine is preferred to the sample concentration since runoff volume is expected to be variable with each storm. Atrazine concentrations will vary widely depending on volume of runoff. For this purpose, six data loggers will be purchased by the project to supplement the two currently needing repairs. This will provide two for each treatment, providing a backup in case one does not work correctly.

Validation of *EPIC*, A Crop and Pesticide Simulation Model.

Successful simulations of various production practices depend on complete and accurate characterization of land and water resources, production inputs, and field operations. This necessitates accurate characterization of soils, slopes, historical weather, cultural practices, crops and rotations, and management options. These data will be developed from several sources including National Weather Service climatic data; Natural Resource Conservation Service soils and land slope data, and Stiles Farm Foundation demonstration field records.

The accuracy of simulating long-term impacts on atrazine runoff losses of alternative BMPs depends on validating the ***EPIC*** (***E***nvironmental ***P***olicy/***I***ntegrated ***C***limate) model (Williams et al. 1989), a crop and environmental simulation model, with measured data. Runoff data will be utilized along with measured rainfall and typical soil characteristics of the field site. When simulation deviations depart from measurements, improvements will be made by calibrating soil and crop parameters using the ***CroPMan*** (***Cro***p ***P***roduction and ***Man***agement) model (Gerik and Harman 2001), a Windows® interface for ***EPIC*** to facilitate user-friendly applications.

A basic familiarity with ***EPIC*** is necessary to understand how crops and pesticides are simulated over time. ***EPIC*** was developed for a USDA national study in the mid-1980's to assess the effect of soil erosion on crop productivity. Since the time of the 1985 USDA National Resource Conservation Assessment, ***EPIC*** has been expanded and refined to facilitate simulation of many more processes important in agricultural management including nitrogen and phosphorus uptake, runoff and sediment losses, soil adsorption, volatility, and mineralization. Presently, many pesticides are included in fate and transport functions also.

CroPMan can be used to simulate year-to-year, long-term effects of crop and pesticide management strategies. Major components include weather, hydrology, erosion-sedimentation, nutrient cycling, pesticide fate, plant growth, soil temperature, tillage, and plant environment control. Though weed, insect, and disease control per se are not simulated, a nutrient/pesticide fate model, ***G***roundwater ***L***oading ***E***ffects of ***A***gricultural *M*anagement ***S***ystems (***GLEAMS***) is contained in ***EPIC*** to simulate pesticide transport by water and sediment as a function of soil organic carbon content and a linear adsorption isotherm (Leonard et al. 1987). Additionally, both long-term mineralization and short-term plant uptake are simulated as a part of the nutrient cycling process.

Long-term Simulations of Corn Production Practices.

A major limitation to demonstrating practices in field plots is the common limitation of the short number of seasons that are usually included in the demonstration. In the case of environmental impacts such as atrazine losses, this is a severe limitation unless by chance wide extremes in rainstorm intensities and amounts occur during the demonstrations. After validation of a crop and pesticide simulator such as ***CroPMan***, a major advantage is that many climatic scenarios can be assessed in a short time and probabilities of losses can be estimated. In this project, validation will be based on the first year of measured runoff losses, sediment losses, soluble and particulate atrazine concentrations/loads, and rainstorm amounts recorded at the Stiles Farm Foundation site.

Another advantage of using a simulation tool is that other practices including alternative atrazine application rates and timings of application, tillage intensities, and soil types can be rapidly simulated. The long-term simulation analysis in this project includes twelve simulated situations including two soils typical of central Texas soils—a clay and a loam—each using six tillage/atrazine application practices of which the first four are those being demonstrated and the last two are additional options:

#1-The common practice of no incorporation of a pre-emerge spring application of atrazine preceded by normal preplant tillage operations;

#2-Immediate incorporation of the pre-emerge application of atrazine preceded by normal preplant tillage operations;

#3-Banded application at a reduced rate (33%) at planting time preceded by normal preplant tillage operations;

#4-No-till corn production with a broadcast spring application of atrazine plus fall and spring applications of Roundup® + 2,4D (Landmaster®) at rates adequate for weed control;

#5-Split broadcast applications of atrazine incorporated immediately—one-half rate in the fall and one-half in the spring; and

#6-Banding at the 33% reduced rate at planting preceded by no-till in the fall with fall applications of one-half rate broadcast atrazine followed by an application of Landmaster® at a rate dequate for weed control.

CroPMan will be used to simulate 100 years of randomly generated weather (based on long-term weather records at nearby Thrall, Texas). These 100 simulations will be used to estimate long-term average atrazine losses and probabilities of attaining the EPA safe drinking water standard of 3 ppb with each tillage and atrazine application practice. Each practice will be based on records of field operations in 2003 and simulated for the same dates of tillage, atrazine application dates and rates, seeding rates, and planting and harvest dates. Yearly crop yields as well as monthly and yearly atrazine losses will be simulated for each tillage/atrazine application practice on a soil with characteristics typical of the field soil samples.

<u>Economics of Tillage Practices to Reduce Atrazine Losses.</u>

Farm economic impacts, both short-run and long-term, of atrazine remediation require predicting long-term crop yields and income associated with alternative BMPs and estimating the economic costs of each. Yields, gross income, operating costs, machinery depreciation costs, and profits will be estimated with the economic component of ***CroPMan***. Each of the six tillage/atrazine application practices above utilize different machinery items which affect fuel, labor, and repair costs. Long-run machinery depreciation costs also vary by practice.

In addition to the economic analysis, an enviro-economic tradeoff analysis will be made to evaluate and rank each BMP by the relative cost effectiveness in reducing atrazine losses. The reduction in atrazine load of each BMP from the base alternative (#1 above) will be used to calculate the reduction per dollar of additional cost (or loss of profitability) in comparing cost effectiveness. Ranking of the BMPs by this method provides farmers with decision criteria with which to make their choice of tillage/atrazine application practice. The ranking also provides policymakers, water district managers, environmentalists, and others having an interest in water quality protection an objective means of forming water quality policies and/or developing economic incentives to attain the desired water quality objectives.

The TCE and PFRL will be responsible for composing the Quality Assurance Project Plan (QAPP), analyzing samples in accordance with the QAPP and composition of the final water quality data for this project. The TCE will be responsible for planting and managing the corn crop, installing and maintaining sampling equipment, collecting runoff samples, developing educational materials, preparing and submitting quarterly reports, and preparing and submitting the final report. BRC will be responsible for conducting and analyzing all CropMan and EPIC model runs.