Texas State Soil and Water Conservation Board
Clean Water Act §319(h) Nonpoint Source Grant Program
FY 2009 Workplan 09-03

NONPOINT SOURCE SUMMARY PAGE for the CWA §319(h) Agricultural/Silvicultural Nonpoint Source Grant Program						
Title of Project:	Groundwater Nitrogen Source Identification and Remediation in the Texas High Plains and Rolling Plains Regions					
Project Goals:	(1) Identify the source of nitrate nitrogen in groundwater in the Texas High Plains and Rolling Plains (2) Evaluate and demonstrate strategies and practices for reducing nitrate levels in groundwater in the Texas High Plains and Rolling Plains (3) Transfer results and recommendations to farmers directly and through project partners					
Project Tasks:	(1) Project Administration; (2) Quality Assurance; (3) Groundwater Nitrogen Source Identification (4) Evaluation and demonstration of Nitrogen Remediation Strategies					
Measures of Success:	(1) Quantification of nitrogen inventories under irrigated and dryland agriculture (2) Generation of new knowledge on the relative importance of natural and anthropogenic sources of nitrate to groundwater (3) Demonstrate management of fertilizer application practices with and without use of soil testing and irrigation water N crediting (4) Delivery of results and recommendations through (a) fact sheet development and distribution; and (b) presentation at a minimum of 1 field day, 2 national meetings, 2 regional meetings, and 3 workshops/stakeholder meetings					
Project Type:	Implementation ( ); Education ( ); Planning ( ); Assessment (x); Groundwater (X)					
Status of Water Body: 2008 Texas Water Quality Inventory and 303(d) List	Segment ID: Rolling Plains Seymour Aquifer High Plains Ogallala Aquifer		Parameter: Nitrate Nitrate		Category:	
Project Location (Statewide or Watershed and County)	Rolling Plains and High Plains regions of Texas					
Key Project Activities:	Hire Staff (X); Surface Water Quality Monitoring (); Technical Assistance (); Education ( ); Implementation (); BMP Effectiveness Monitoring (X); Demonstration (X); Planning (); Modeling (); Bacterial Source Tracking (); Other ()					
Texas NPS Management Program Elements:	LTG Objectives 2, 4, and 6 STG 2 Objective C STG 3 Objectives A, B, and E					
Project Costs:	Federal:	$450,010	Non-Federal:	$300,732	Total:	$750,742
Project Management:	Texas Water Resources Institute Texas AgriLife Research University of Texas Bureau of Economic Geology					
Project Period:	November 1, 2009 – October 31, 2012					

Part I – Applicant Information

Applicant							
Project Lead	Dr. B. L. Harris						
Title	Acting Director						
Organization	Texas Water Resources Institute						
E-mail Address	bl-harris@tamu.edu						
Street Address	2118 TAMU						
City	College Station	County	Brazos	State	TX	Zip Code	77843-2118
Telephone #	979.845.1851			Fax #	979.845.8554		

Project Co-Lead	Dr. Paul DeLaune						
Title	Asst. Professor & Environmental Soil Scientist						
Organization	Texas AgriLife Research - Vernon						
E-mail Address	PBDeLaune@ag.tamu.edu						
Street Address	11708 Hwy 70 South						
City	Vernon	County	Wilbarger	State	TX	Zip Code	76385
Telephone #	940.552.9941 ext 207			Fax #	940.552.2317		

Project Co-Lead	Dr. Bridget Scanlon						
Title	Senior Research Scientist						
Organization	Bureau of Economic Geology, Jackson School of Geosciences, Univ. of Texas at Austin						
E-mail Address	Bridget.scanlon@beg.utexas.edu						
Street Address	10100 Burnet Rd., Pickle Research Campus, Bldg. 130						
City	Austin	County	Travis	State	TX	Zip Code	78758
Telephone #	512.471.8241			Fax #	512.471.0140		

Project Partners	
Names	Roles & Responsibilities
Texas State Soil and Water Conservation Board (TSSWCB)	Provide state oversight and management of all project activities and ensure coordination of activities with related projects and TCEQ.
Texas A&M AgriLife, Texas Water Resources Institute (TWRI)	Project coordination, reporting, website development and maintenance, and QA (Tasks 1-2)
Texas AgriLife Research - Vernon (Dr. DeLaune and Dr. Sij)	Demonstrate N crediting (Task 4)
University of Texas Bureau of Economic Geology (UT-BEG) (Dr. Scanlon)	Identify relationships between land use and N loading in the Texas Rolling Plains Seymour aquifer and assess relative importance of natural and anthropogenic N inputs in the Texas High Plains Ogallala aquifer (Task 3)
Texas AgriLife Research - ESSM (Dr. Boutton)	Measure isotopes related to soil nitrate and carbon and analyze results (Task 3)
USDA-ARS (Dr. Schwartz, Bushland: Dr. Haney, Temple)	Measure nutrient parameters (Task 3)
Texas AgriLife Extension Service, Soil and Water Conservation Districts, Underground Water Conservation Districts, Natural Resources Conservation Service, Certified Crop Advisors, Texas Water Development Board	Assist with delivery of results and recommendations to farmers (Subtasks 4.4-4.5)

Part II – Project Information

Project Type							
Surface Water		Groundwater	X				
Does the project implement recommendations made in a completed Watershed Protection Plan or an adopted TMDL or Implementation Plan?				Yes		No	X
If yes, identify the document.							
If yes, identify the agency/group that developed and/or approved the document.				Year Developed			

Watershed Information				
Watershed Name(s)	Hydrologic Unit Code (8 Digit)	Segment ID	305 (b) Category	Size (Acres)
High Plains Ogallala Aquifer	N/A	N/A	N/A	111,360,000
Rolling Plains Seymour Aquifer	N/A	N/A	N/A	300,000

Water Quality Impairment

Describe all known causes (pollutants of concern) of water quality impairments from any of the following sources: 2008 Texas Water Quality Inventory and 303(d) List, Clean Rivers Program Basin Summary, Basin Highlights Reports or Other Documented Sources.

Ambient Monitoring of Groundwater Quality Data from the Rolling Plains Seymour Aquifer from 1999-2006 showed that 83 of the 91 wells sampled (91%) exceeded the maximum contaminant limit (MCL) for nitrate nitrogen of 10 mg/l.

Ambient Monitoring of Groundwater Quality Data from the Texas High Plains Ogallala Aquifer from 1999-2006 showed that 701 of the 1465 wells sampled (48%) exceeded the maximum contaminant limit (MCL) for nitrate nitrogen of 10 mg/l.

Source: 2008 State of Texas Water Quality Inventory Groundwater Assessment (March 19, 2008) http://www.tceq.state.tx.us/assets/public/compliance/monops/water/08twqi/08twqi_groundwater.pdf.

Project Narrative

Problem/Need Statement

The Seymour Aquifer is a shallow aquifer underlying over 300,000 acres in 20 counties in northwest central Texas. According to Table D.1 of the Texas NPS Management Program, the Seymour Aquifer has the highest aquifer vulnerability rating of all the major aquifers in Texas. This indicates the aquifer's high susceptibility to impacts from surface activities. High nitrate concentrations are widespread in the Seymour Aquifer. Ambient Monitoring Groundwater

Quality Data from the Seymour Aquifer from 1999-2006 shows that of the 91 wells sampled, 83 exceeded the maximum contaminant limit of 10 mg/l. All 91 wells had detectable levels of nitrate. Median nitrate levels in Knox, Haskell, Baylor, Hall, Wichita, Wilbarger, and Fisher counties exceeded the federal safe drinking water standard (10 mg/L NO_3-N), with some exceeding 40 mg/L. The Groundwater Contamination Summary for the Seymour Aquifer Outcrop (2006) indicates that 15 sites had confirmed groundwater contamination with atrazine, dicamba, prometon, and propazine due to nonpoint sources. A study by the University of Texas Bureau of Economic Geology found that nitrate accumulations beneath irrigated agriculture are generally high.

High levels of nitrate in groundwater prior to fertilization and irrigation in the Seymour aquifer, low to moderate fertilizer application rates, and low to moderate unsaturated zone nitrate accumulations indicate that high groundwater contamination may be related to natural nitrate sources prior to irrigation and to irrigation recycling. These high concentrations are a concern because although 90% of the water from the aquifer is used for irrigation, it is used as a municipal water source for Vernon, Burkburnett, and Electra and rural families in the region.

In addition to the use of groundwater from the Seymour Aquifer for irrigation and municipal purposes, the aquifer also naturally discharges through seeps and springs. This natural discharge contributes to the baseflow of many streams throughout the region. Groundwater flows toward the east-southeast, heading to the perimeter of the Seymour deposits. Stream flow increases towards the perimeter because stream stage is at a lower elevation than groundwater in the Seymour aquifer. Nitrate is a concern in a number of waterbodies in the region including South Groesbeck Creek, Wichita River Below Diversion Lake Dam, and Paradise Creek. Activities designed to reduce nitrate levels in the aquifer may also benefit area streams receiving baseflow from the Seymour Aquifer.

Currently, producers do not account for the high nitrate levels in the irrigation water they apply from the Seymour Aquifer. Underutilization of water testing, historical low cost of fertilizer, and speculation regarding the amounts of nitrate in the irrigation water that is actually available to crops prevent widespread accounting of this nitrate source. As a result, this lack of crediting has in many cases led to over-application and build-up of soil nitrate which increases the potential for N transport to surface and groundwater water supplies. With the recent increases in fuel and fertilizer costs, farmers are searching for ways to better manage their nutrients and make their operations more efficient and profitable. Thus, the stage is set for positive changes in nutrient management. This project will work to build on this momentum and encourage nutrient management through demonstration of N remediation strategies. In the *Seymour Aquifer Water Quality Improvement Project Final Report* (TWRI Technical Report – 332), it was recommended that educational programs on irrigation management and nutrient management be provided to encourage regular soil testing, better manage irrigation systems, and account for nitrate levels in irrigation water when determining N fertilization needs. The report suggested that if nitrate in the aquifer could be “mined” using irrigation, then substantial cost savings could be realized by producers as a result of reduced nitrogen fertilization. It is estimated that irrigation water from some wells could supply the entire N requirement of a cotton crop (TWRI Technical Report – 332). This in turn could potentially improve the quality of the water in the aquifer. The goal of this project is to begin implementing these recommendations.

Groundwater nitrate contamination is also very important in the Texas High Plains Ogallala Aquifer. Groundwater contamination is most widespread in the southern half of the Southern High Plains where 25% of all wells exceed the Maximum Contaminant Level of 10 mg/L nitrate-N (Scanlon BR, Reedy RC, Bronson KF (2008) Impacts of land use change on nitrogen cycling archived in semiarid unsaturated zone nitrate profiles, southern High Plains, Texas. Env Sci & Tech 42: 7566-7572 DOI 10.1021/es800792w).

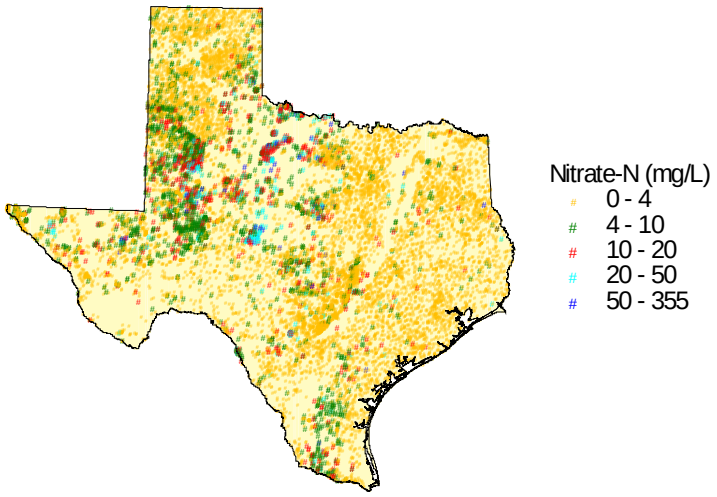

Figure 1. Distribution of NO_3-N in groundwater in Texas (TWDB Data).

Understanding the source of nitrate in the aquifers is essential for mitigating the problem. There are a variety of potential sources of high groundwater nitrate concentrations in the Texas High Plains Ogallala and Rolling Plains Seymour Aquifers. High nitrate concentrations are generally attributed to a surface source because of high correlations with water table depth and negative correlation with aquifer saturated thickness as a result of reduced assimilative capacity. Potential sources of nitrate in groundwater include atmospheric deposition, natural sources, inorganic fertilizer, organic fertilizer (manure), concentrated animal feeding operations (CAFOs), barnyards, septic tanks, and leaking sewer systems.

In the High Plains and Rolling Plains, the most widespread source of nitrate is from fertilizer application. However, preliminary results from a recent study suggest that much of the nitrate in the southern High Plains could be natural, originating from mineralization of soil organic matter (SOM) associated with initial soil cultivation (Scanlon et al., 2008). These data include high nitrate concentrations that extend into zones of high chloride concentrations in the unsaturated zone, indicating old soil water that pre-dated cultivation. The mechanism for release of nitrate from SOM is attributed to increased aeration and increased moisture content associated with cultivation and is shown by soil moisture data. Nitrogen isotope data from soil water could not be used to distinguish natural sources from fertilizer sources because fertilizer nitrogen is derived primarily from ammonium-based fertilizers that undergo similar processes to natural mineralization of SOM. If the nitrate pulse is related primarily to natural sources, then this source should eventually move through the system as a pulse and groundwater quality should improve with time.

Reservoirs of Nitrate in the Soil

It is difficult for farmers to determine if they are over applying nitrogen to their fields. However, drilling and sampling soil profiles provides excellent information on long-term nitrogen transport in the subsurface. Preliminary results from drilling in areas of different land management indicate that the largest nitrate-N reservoirs are restricted to irrigated agriculture with maximum concentrations ranging from 93 to 430 mg/L (Figure 2). Large bulges of nitrate are accumulating under irrigated settings because of over application and inappropriate timing of application (50% applied pre-plant). Educational materials need to be developed for agricultural and water resource managers to show that nitrate is currently being over-applied and is being leached below the root zone, particularly in irrigated areas. With increasing costs of fertilizers, such information would be extremely valuable to producers and should result in large scale reductions of nitrogen fertilizer applications.

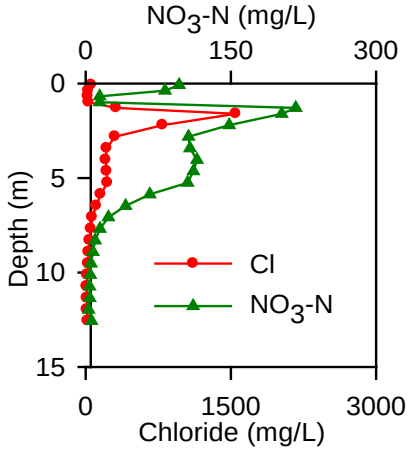

Figure 2. Concentration of nitrate and chloride in soil water in a 6-m soil profile in the southern High Plains (Terry County) related to evapoconcentration.

Project Narrative

General Project Description (Include Project Location Map)

In order to implement the recommendations described above, this project will (1) evaluate relative inputs of natural and fertilizer N in the Texas High Plains and Rolling Plains, (2) quantify nitrogen inventories under different agricultural land use management schemes, (3) identify and demonstrate strategies for reducing groundwater nitrogen levels (e.g. N crediting), and (4) transfer the results to farmers and others throughout the region through field days, workshops, and other venues.

Quantify Relative Inputs of Natural and Fertilizer Nitrogen in the Texas High Plains

Preliminary work in the Texas High Plains indicated that 74% (median) of total nitrate inventories in soil profiles is from mineralization of natural SOM in the soil profile that developed during initial cultivation. Support for the attribution of nitrate to mineralization of SOM during initial cultivation was provided by bulges of nitrate levels in the deeper part of the profiles that extended into old soil water (pre-cultivation) and were dated using chloride concentration analyses. These results were preliminary and need more support and justification. UT-BEG was not able to compare native rangeland sites with nearby cultivated sites to quantify changes in organic carbon and nitrogen to support these results because suitable native rangeland sites were not available in the southern High Plains.

The proposed work is designed to quantify the changes between native rangeland sites and cultivated sites that are in close proximity to each other. UT-BEG will use data from the USDA Bushland site near Amarillo where an area of the research station has been maintained under rangeland management and is adjacent to cropland. Previous drilling has shown that there is very low nitrate under native rangeland at this site and there are high nitrate bulges that extend into old soil water under cropland, similar to results from the southern High Plains.

UT-BEG will measure organic carbon and total nitrogen in the native and cropland profiles to quantify the reduction in organic carbon from the native to the cropland site. These data will be used to determine if changes in organic carbon and nitrogen can account for the increased nitrate found in profiles under cropland. This is an ideal system to conduct this comparison because of the close proximity of the native and cropland systems and the similarity in soil types between the two settings. UT-BEG will also examine carbon-13 isotopes on the organic carbon which may provide insights on the impact of the shift from native vegetation to cropland on the relative proportions of soil organic carbon derived from the native system versus the cultivated system. Soil and plant N will also be determined from long-term Conservation Reserve Program (CRP) fields to provide proof of concept that SOM may be a potential source of nitrate. Mass balance studies will also be conducted to evaluate the relative inputs of nitrogen from different sources.

These results should be applicable to the entire Texas High Plains and much of the Rolling Plains Seymour aquifer regions where up to 70% of wells exceed the 10 mg/L NO_3-N maximum contaminant level. Unfortunately there are no appropriate rangeland sites in the Seymour aquifer region to apply this approach, but perhaps long-term CRP fields could serve as a substitute. Nitrate derived from mineralization of native SOM does not constitute a continuous input to the system and should move through the groundwater system as a pulse. UT-BEG will evaluate this process through mass balance analyses.

Quantify Nitrogen Inventories under Different Agricultural Land Use Management Schemes

Previous drilling and analyses have shown different nitrate inventories under various agricultural management scenarios. This drilling has been conducted at many sites in the Texas High Plains and Rolling Plains, including research farms associated with Texas Tech, such as La Mesa Research Farm in Dawson county, AgCares Farm, and Halfway Farm. Historical data of water and nutrient applications have been recorded at these sites. The drilling and sampling at these sites will be used to connect agricultural management practices and accumulation and/or leaching of nitrates in the subsurface. Historical records of agricultural practices will be examined for dryland and irrigated sites. The above farms offer ideal locations for conducting this work because of the detailed records on water and nutrient applications. The quality of the irrigation water has also been analyzed. Highest nitrate-N inventories were found under irrigated agriculture, moderate levels of nitrate were found under dryland agriculture, and very low levels of nitrate were found under rangeland settings.

UT-BEG will examine these data to determine relationships between nitrogen application rates and subsurface inventories. Based on these data and findings from UT-BEG, Texas AgriLife Research will develop recommendations on nitrogen application rates for farmers. In addition to the amount of nitrogen applied, the timing of the application process is also critical. Previous studies indicate that ~50% of the nitrogen is applied pre-plant (Bronson et al., 2006) and this nitrate may be much more vulnerable to leaching because the crop has not developed to utilize the applied N. These data are very important to minimize future groundwater nitrate contamination. Texas AgriLife Research will work with UT-BEG to determine best management practices (BMPs) related to nitrogen fertilizer applications for producers. UT-BEG will also evaluate nitrate input from mineralization of SOM. This mechanism may contribute substantial amounts of nitrate to the system. UT-BEG will supplement existing data by drilling additional boreholes in Lynn county where extremely high groundwater nitrate contamination is found, provided site access can be obtained.

One promising BMP is nitrogen crediting. This practice will be demonstrated and verified by Texas AgriLife Research located at the Vernon Center. Side-by-side plots of N crediting and conventional fertilization practices will be demonstrated to farmers in the region and benefits of N crediting documented, both economically and environmentally. This is greatly needed to provide assurance to farmers in the region that the nitrogen in the irrigation water (which in some soils leaches quickly through the root zone) is truly available for crop uptake and that reductions in fertilizer applications will not adversely impact crop yields and their livelihoods.

Due to the quick leaching alone, it is likely that a one to one accounting of the nitrogen in the irrigation water is not possible. This will also vary depending on the irrigation method used. These impacts must be quantified and demonstrated to area farmers to obtain widespread adoption. Primary crops in the region include cotton, bermudagrass hay, wheat, and peanuts. Demonstrations at the Chillicothe Experiment Station will target three different irrigation systems cropped to cotton: subsurface drip, furrow, and overhead irrigation. Nutrient management strategies will be based on the crop's agronomic: 1) N requirements; 2) N and phosphorous (P) requirements; 3) N requirements minus irrigation N credit; 4) N and P requirements minus irrigation N credit and 5) the control (N supplied through irrigation water only). Soil samples will be taken to a depth of 36 inches following each growing season. Samples will be segmented (0-6, 6-12, 12-18, 18-24, and 24-36 inches) and analyzed for nitrate, ammonium and phosphorus. Irrigation water samples will also be taken weekly throughout the irrigation season and analyzed for nitrate. One irrigation treatment based on a pre-selected evapotranspiration replacement level will be used among the three irrigation systems. Lastly, plant samples from each of the demonstration plots will be collected and analyzed for Total N levels to demonstrate the N uptake of each plant species.

To transfer the results and recommendations of the project to farmers directly and via project partners, AgriLife Research will work with TWRI and UT-BEG to develop and distribute a fact sheet, technical report, handouts, presentations, and refereed journal publications and posters (as appropriate). This information will be presented at a minimum of 1 field day at the demonstration site, 2 national meetings, 2 regional meetings, and 3 workshops/stakeholder meetings held to discuss nitrate and irrigation strategies. These educational materials will primarily target the Texas High Plains and Rolling Plains regions but will have applicability to similar systems both regionally and nationally. To ensure the long-term delivery of these materials, findings, and recommendations, the educational materials will subsequently be made available to AgriLife Extension and other project partners for use at other venues in the region.

Tasks, Objectives and Schedules

Task 1:	Project Administration					
Costs:	Federal:	$64,784	Non-Federal:	$35,432	Total:	$100,216
Objective:	To effectively administer, coordinate and monitor all work performed under this project including technical and financial supervision and preparation of status reports.					
Subtask 1.1:	TWRI, with input from Texas AgriLife Research and UT-BEG, will prepare electronic quarterly progress reports (QPRs) for submission to the TSSWCB. QPRs shall document all activities performed within a quarter and shall be submitted by the 15th of January, April, July and October. QPRs shall be distributed to all project partners and posted on the project website developed and hosted by TWRI.					
	Start Date:	Month 1	Completion Date:	Month 36		
Subtask 1.2:	TWRI will perform accounting functions for project funds and will submit appropriate Reimbursement Forms to TSSWCB at least quarterly.					
	Start Date:	Month 1	Completion Date:	Month 36		
Subtask 1.3:	TWRI will participate in meetings as appropriate in order to efficiently and effectively achieve project goals, coordinate monitoring efforts and summarize activities and achievements made throughout the course of this project.					
	Start Date:	Month 1	Completion Date:	Month 36		
Subtask 1.4:	TWRI will work with AgriLife Research and UT-BEG to develop a project final report summarizing the results of the groundwater nitrogen source identification and demonstration of nitrogen remediation strategies for submittal to the TSSWCB and EPA.					
	Start Date:	Month 30	Completion Date:	Month 36		
Deliverables	• Quarterly progress reports in electronic format • Project website • Reimbursement Forms and necessary documentation in hard copy format • Project final report (Electronic copy and 3 hard copies)					

Tasks, Objectives and Schedules						
Task 2:	Quality Assurance					
Costs:	Federal:	$5,000	Non-Federal:	$3,333	Total:	$8,333
Objective:	To develop data quality objectives (DQOs) and quality assurance/control (QA/QC) activities to ensure data of known and acceptable quality are generated through this project.					
Subtask 2.1:	TWRI will develop a QAPP for activities in Tasks 3-4 consistent with *EPA Requirements for Quality Assurance Project Plans (QA/R-5)* and the *TSSWCB Environmental Data Quality Management Plan*. All monitoring procedures and methods prescribed in the QAPP shall be consistent with the guidelines detailed in the *TCEQ Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue (RG-415)* and *Volume 2: Methods for Collecting and Analyzing Biological Community and Habitat Data (RG-416)*.					
	Start Date:	Month 1	Completion Date:	Month 6		
Subtask 2.2:	TWRI will submit revisions and necessary amendments to the QAPP as needed.					
	Start Date:	Month 6	Completion Date:	Month 36		
Deliverables	• QAPP approved by TSSWCB and EPA Region 6 in both electronic and hard copy formats • Approved revisions and amendments to QAPP, as needed. • Data of known and acceptable quality as reported through Tasks 3-4.					

Tasks, Objectives and Schedules

Task 3:	Groundwater Nitrogen Source Identification					
Costs:	Federal:	$199,961	Non-Federal:	$132,951	Total:	$332,912
Objective:	To evaluate (1) the relationship between land use and nitrogen loading to the aquifer and (2) natural versus fertilizer sources of nitrate.					
Subtask 3.1:	To quantify the changes between native rangeland sites and cultivated sites that are in close proximity to each other, UT-BEG will use data from the USDA Bushland site near Amarillo where an area of the research station has been maintained under rangeland management and is adjacent to cropland.					
	Start Date:	Month 6	Completion Date:	Month 24		
Subtask 3.2:	UT-BEG will quantify organic carbon and total nitrogen in the native and cropland profiles to quantify the reduction in organic carbon from the native to the cropland site. These data will be used to determine if changes in organic carbon and nitrogen can account for the increased nitrate found in profiles under cropland.					
	Start Date:	Month 6	Completion Date:	Month 30		
Subtask 3.3:	UT-BEG will also examine carbon-13 isotopes on the organic carbon which may provide insights on the impact of the shift from native vegetation to cropland on the relative proportions of soil organic carbon derived the native system versus the cultivated system. Utilization of long-term CRP land may also be employed.					
	Start Date:	Month 12	Completion Date:	Month 30		
Subtask 3.4:	Mass balance analyses will also be conducted by UT-BEG, in collaboration with USDA-ARS, to evaluate the relative inputs of nitrogen from different sources. These results should be applicable to the entire Texas High Plains Ogallala and the Rolling Plains Seymour Aquifers.					
	Start Date:	Month 1	Completion Date:	Month 24		
Subtask 3.5:	Nitrate derived from mineralization of native soil organic matter does not constitute a continuous input to the system and should move through the groundwater system as a pulse. UT-BEG will evaluate this process through mass balance analyses.					
	Start Date:	Month 6	Completion Date:	Month 30		
Subtask 3.6:	Historical records of agricultural practices will be examined for dryland and irrigated sites by UT-BEG to determine relationships between nitrogen application rates and subsurface inventories. Based on these data and findings from UT-BEG, Texas AgriLife Research will develop recommendations on nitrogen application rates for farmers (Subtask 4.6).					
	Start Date:	Month 1	Completion Date:	Month 24		
Subtask 3.7:	UT-BEG will assist Texas AgriLife Research with determining BMPs related to nitrogen fertilizer applications for producers.					
	Start Date:	Month 1	Completion Date:	Month 18		
Subtask 3.8:	UT-BEG will evaluate nitrate input from mineralization of SOM. This mineralization mechanism with subsequent release of nutrients forms the basis of the crop's nutrient requirements in the northern portion of the Texas High Plains and may contribute substantive amounts of nitrate to the system. UT-BEG will supplement existing data by drilling additional boreholes in Lynn county where extremely high groundwater nitrate contamination is found.					
	Start Date:	Month 12	Completion Date:	Month 24		
Deliverables	• Technical report describing assessment results for inclusion in fact sheet, handouts, presentations, posters, refereed journal publications, and final report					

Tasks, Objectives and Schedules	
Task 4:	Evaluation and demonstration of Nitrogen Remediation Strategies

Costs:	Federal:	$180,265	Non-Federal:	$129,016	Total:	$309,281
Objective:	To identify and evaluate strategies and practices for reducing nitrate levels in groundwater in the Texas High Plains and Rolling Plains. The benefits and effectiveness of select practices, such as nitrogen crediting, will be demonstrated by Texas AgriLife Research - Vernon to farmers throughout the region.					
Subtask 4.1:	AgriLife Research will utilize a 2.5 acre block of land under subsurface drip, pivot and furrow irrigation cropped to cotton/sorghum rotation as prescribed by staff at the Chillicothe Research Station to demonstrate and document benefits of irrigation water N crediting to area farmers.					
	Start Date:	Month 6	Completion Date:	Month 30		
Subtask 4.2:	At Chillicothe, AgriLife Research will demonstrate nutrient management strategies based on the crop's agronomic (1) N requirements, (2) N and P requirements, (3) N requirement minus irrigation N credit, (4) N and P requirement minus irrigation N credit, and (5) control (N from irrigation water only) on plots cropped to cotton under subsurface drip, furrow, and overhead irrigation.					
	Start Date:	Month 6	Completion Date:	Month 30		
Subtask 4.3:	AgriLife Research will collect and analyze soil samples from a depth of 36 inches following each growing season. Soil samples will be analyzed by AgriLife Research at Vernon for nitrate, ammonium, and P. Irrigation water samples will also be collected weekly throughout the irrigation season at demonstration sites and analyzed for nitrate. AgriLife Research will also conduct an economic analysis of different nutrient management practices (Subtask 4.2), demonstrating the most cost-effective BMP. Plant samples from each test plot will be analyzed for Total N to illustrate plant N utilization.					
	Start Date:	Month 6	Completion Date:	Month 30		
Subtask 4.4:	Based on findings from UT-BEG (Subtask 3.6), Texas AgriLife Research will develop recommendations on nitrogen application rates for farmers. Texas AgriLife Research will also work with UT-BEG to determine BMPs related to nitrogen fertilizer applications for producers. Texas AgriLife Research will provide these recommendations on application rates and BMPs via development of a technical report and fact sheet (see Subtasks 4.5 and 4.6 below) to Texas AgriLife Extension Service personnel, local soil and water conservation districts, NRCS personnel, TSSWCB personnel, Texas Water Development Board staff, underground water conservation districts, certified crop advisors, and directly to farmers to ensure delivery of these recommendations.					
	Start Date:	Month 24	Completion Date:	Month 36		
Subtask 4.5:	AgriLife Research will host a minimum of 1 field day at the demonstration site. Additionally, project results will be presented at the Beltwide Cotton Conference and American Society of Agronomy meetings. The Beltwide Cotton Conferences speed the transfer of new technology to U.S. cotton producers and other industry members. Coordinated by the National Cotton Council (NCC) and its cooperating partners, this annual forum is recognized as the global champion for cotton technology transfer. Regionally, project results will be presented at the annual meetings of the Texas State Support Committee of Cotton Inc. in Lubbock and the Texoma Farm and Ranch Show in Wichita Falls. These regional meetings are well attended by producers, industry, and commodity board members. Finally, at least 3 workshop/stakeholder meetings will be held to discuss nitrate and irrigation strategies. AgriLife Research will work with UT-BEG to develop handouts, presentations, and posters (as appropriate) describing results along with other educational materials for the Texas High Plains and Rolling Plains regions for use at the field day, regional and national meetings, and workshop/stakeholder meetings. Specifically, at least one fact sheet is planned for development on recommendations on nitrogen application rates and BMPs. These materials will subsequently be made available to AgriLife Extension and others as listed in Subtask 4.4 above for use at other venues in the region and distributed to farmers.					
	Start Date:	Month 6	Completion Date:	Month 30		
Subtask 4.6:	AgriLife Research will work with TWRI and UT-BEG to develop a technical report and refereed journal publication summarizing results of the demonstration and groundwater nitrogen source evaluation for further technical transfer and incorporation into the final report submitted to the TSSWCB and EPA.					
	Start Date:	Month 6	Completion Date:	Month 30		

Deliverables	• Fact sheet, field day handouts, presentations, posters, journal publications and a technical report describing demonstration results for inclusion in final report • Deliver project results and recommendations to farmers directly and via project participants thru (at a minimum) 1 field day, 2 national meetings, 2 regional meetings, and 3 workshops/stakeholder meetings

Project Goals (Expand from NPS Summary Page)
The overarching goal of the project is to reduce groundwater nitrate levels in the Texas High Plains and Rolling Plains regions. The aquifers in these regions have some of the highest nitrate levels in the state. Area streams have concerns resulting from elevated nitrate levels, and these streams ultimately feed into the Red or Brazos Rivers. These nutrients ultimately discharge into the Gulf of Mexico where nitrogen has been identified as a possible cause of the hypoxia. To achieve this overarching goal, this project seeks to understand the relative inputs of natural and anthropogenic nitrate to the aquifer using the Texas High Plains as an example, quantify nitrate inventories beneath dryland and irrigated cropland in the Rolling Plains Seymour aquifer region, identify strategies for reducing groundwater nitrate, demonstrate selected practices such as nitrogen crediting, develop reports and publications summarizing the results, and deliver the project results and recommendations to farmers directly and via project partners. The time is right for such an effort. In the current economy, farmers are desperately searching for ways to make their operations more efficient and profitable. As a result, efforts to improve nutrient management are more likely to be well received while improving the quality of our surface and ground water resources.

Measures of Success (Expand from NPS Summary Page)
A primary indicator of the project's success will be the identification of groundwater N sources and the development of strategies to remediate areas with elevated nitrate levels. This project will quantify nitrogen inventories under irrigated and dryland agriculture and generate new knowledge on the relative importance of natural and anthropogenic sources of nitrate to groundwater. The project will also demonstrate management of fertilizer application practices with and without use of soil testing and irrigation water N crediting. A fact sheet, technical report, handouts, presentations, and posters (as appropriate) describing results and recommendations will be developed and delivered to project partners and producers in the Texas High Plains and Rolling Plains regions at the field day, regional and national meetings, and workshop/stakeholder meetings. Through these activities, producers and farm managers will have the information needed and be better positioned to modify their nutrient management strategies, adopt the practice of N crediting, and achieve water quality improvements.

2005 Texas Nonpoint Source Management Program Reference (Expand from NPS Summary Page)
Goals and/or Milestone(s)
This project supports three Long-Term Objectives listed in the 2005 Texas NPS Management Program. The project will support the implementation of regional and local programs to reduce NPS pollution to groundwater (Objective 2). The project supports the implementation of regional and local programs to prevent nonpoint source pollution through assessment, implementation, and education (Objective 4). The project will increase overall public awareness of NPS issues and prevention activities (Objective 6).
This project supports Short-Term Goal 2, Objective C by assisting in the development and implementation of BMPs to address NPS constituents of concern (nitrate) in surface and groundwater bodies.
This project will support Short-Term Goal 3, Objective A by enhancing existing outreach programs at the regional and local levels to maximize the effectiveness of NPS education.
This project will help achieve Short-Term Goal 3, Objective B by administering programs to educate citizens about water quality and their potential role in causing NPS pollution.
The project will help support Short-Term Goal 3, Objective E by implementing outreach activities identified in the Texas Groundwater Protection Strategy to prevent NPS impacts to groundwater.

Part III – Financial Information

Budget Summary			
Federal	$ 450,010	% of total project	60%
Non-Federal	$ 300,732	% of total project	40%
Total	$ 750,742	Total	100%

Category	Federal	Non-Federal	Total
Personnel	$ 89,072	$ 66,862	$ 155,934
Fringe Benefits	$ 37,730	$ 19,059	$ 56,789
Travel	$ 9,000	$ 0	$ 9,000
Equipment	$ 13,850	$ 0	$ 13,850
Supplies	$ 12,300	$ 0	$ 12,300
Contractual	$ 199,961	$ 132,951	$ 332,912
Construction	$ 0	$ 0	$ 0
Other	$ 29,400	$ 0	$ 29,400
Total Direct Costs	$ 391,313	$ 218,872	$ 610,185
Indirect Costs (≤15%)	$ 58,697	$ 39,953	$ 98,650
Unrecovered IDC	$ 0	$ 41,907	$ 41,907
Total Project Costs	$ 450,010	$ 300,732	$ 750,742

The TSSWCB CWA §319(h) NPS Grant Program has a 60/40% match requirement. The cooperating entity will be reimbursed 60% from federal funds and must contribute a minimum of 40% of the total costs to conduct the project. The 40% match must be from non-federal sources and should be described in the budget justification. Reimbursable indirect costs are limited to 15% of total federal direct costs. The project budget generally covers a three year period.

Budget Justification (Federal)		
Category	Total Amount	Justification
Personnel	$ 89,072	• TWRI Project Manager at 12% effort for project management and QA • AgriLife Research Tech I at 100% effort for N testing and demo for Year 1 & 2. In year 3, 25% effort • Graduate Research Assistant 100% effort in Year 3
Fringe Benefits	$ 37,730	• 17.6% of Personnel Cost plus percent effort times $5,652 •
Travel	$ 9,000	• TWRI Travel at $1000/year for travel to and from project meetings • AgriLife Research Travel at $2,000/year for travel to producer and project meetings and presentations at regional and/or national meetings
Equipment	$ 13,850	• AgriLife Research Giddings soil corer for deep profile soil sampling
Supplies	$ 12,300	• TWRI Supplies at $500/year • AgriLife Research Lab Supplies at $2,700/year • AgriLife Research Fuel Costs at $900/year
Contractual	$ 199,961	• UT-BEG Subcontract to TWRI for Groundwater Nitrogen Source ID
Construction	$ 0	N/A
Other	$ 29,400	• Chillicothe Research Station Land User (Rental) fee at $3,000/yr • AgriLife Research Equipment (i.e. farm equipment, irrigation systems, and vehicles) Maintenance at $1,000/yr. • Graduate Research Assistant- Tuition, Fees and Insurance (~$ 11,230/yr)
Indirect	$ 58,697	• 15% of Total Direct Federal

Budget Justification (Non-Federal)		
Category	Total Amount	Justification
Personnel	$ 66,862	• TWRI Project Manager at 2% effort for project management and QA • AgriLife Research Professor & Environmental Soil Scientist (Vernon) at 20% effort for oversight of nitrogen use efficiency verification • AgriLife Research Assistant (Vernon) at 21% effort for assistance with nitrogen use efficiency verification
Fringe Benefits	$ 19,059	• 17.6% of Personnel Cost plus percent effort times $5,652
Travel	$ 0	N/A
Equipment	$ 0	N/A
Supplies	$ 0	N/A
Contractual	$ 132,951	• Match provided by UT-BEG under TWRI Subcontract
Construction	$ 0	N/A
Other	$ 0	N/A
Indirect	$ 39,953	• 46.5% of Total Direct Non-Federal Match minus Contractual
Unrecovered IDC	$ 41,907	• 31.5% of Total Direct Federal minus Contractual >$25,000

Contractual Budget Justification (Federal) - UTBEG

Category	Total Amount	Justification
Personnel	$ 87,527	• UT-BEG Graduate Research Assistant at 0.1 months effort in year 1, and 0.5 months effort in years 2 and 3 • UT-BEG Post Doc at 0.1 months effort in year 1, 6 months effort in year 2, and 6.5 months effort in year 3 • B. Scanlon at 0.1 months effort in year 1 and 0.4 months effort in years 2 and 3 • R. Reedy at 0.5 months effort in year 1, and 1.1 months in year 2 and 1 month in year 3
Fringe Benefits	$ 25,383	• 29% of Personnel Cost
Travel	$ 10,995	• $1,000 in year 1, $8,000 in year 2, $1,995 in year 3 for travel from Austin to demonstration sites
Equipment	$ 0	N/A
Supplies	$ 5,490	• $1,990 in year 1, $1,600 in year 2, and $1900 in year 3 for misc supplies
Contractual	$ 0	N/A
Construction	$ 0	N/A
Other	$ 44,532	• $12,000 for drilling, $27,000 for analysis, $5,160 for computer usage, $372 for tuition
Indirect	$ 26,034	• 15% of Total Direct Federal minus tuition

Contractual Budget Justification (Non-Federal) - UTBEG		
Category	Total Amount	Justification
Personnel	$ 51,265	• UT-BEG Post Doc at 5.8413 months effort in year 2 and 5.5 month effort in year 3 • B. Scanlon at 0.1 months effort in year 1
Fringe Benefits	$ 14,867	• 29% of Personnel Cost
Travel	$ 0	N/A
Equipment	$ 0	N/A
Supplies	$ 0	N/A
Contractual	$ 0	N/A
Construction	$ 0	N/A
Other	$ 0	N/A
Indirect	$ 0	N/A
Unrecovered IDC	$ 66,819	• 38.5% of Total Direct Federal minus tuition