FY2002 Proposal

for the

CWA, Section 319(h)

Agricultural/Silvicultural Nonpoint Source Program

02-11

TEXAS STATE SOIL AND WATER CONSERVATION BOARD
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Nonpoint Source Summary Page
CWA, Section 319(h) Agricultural/Silvicultural Nonpoint Source Program
02-11

1. **Title of Project:** Field Validation of the Texas Phosphorus Index

2. **Project Goals/Objectives:** 1) Determine the effects of selected soil properties in the Bosque and Leon River watersheds to measure and predict P runoff; 2) To compare and correlate different soil test and soil solution soluble P extracts to runoff P; 3) To validate and/or modify Texas Phosphorus Index as a predictive tool for classification of field sites relative to P loss potential.

3. **Project Tasks:** 1) Select sites for rainfall simulations and result demonstrations; 2) Establish result demonstrations and conduct rainfall simulations; 3) Measure and evaluate soil test extractable P and dilute salt soil extractable P; 4) Compare PI risk assessment to runoff P concentrations; 5) Validate and/or modify PI and provide educational programs regarding PI use and P runoff management.

4. **Measures of Success:** The information attained from the field studies will help validate and improve the Texas PI. With this information and additional studies similar to this across the state, quantitative assessments to predict the amount of P in runoff utilizing the Texas PI can be estimated. The runoff analyses will help determine the form of P, and whether it is mainly solution soluble or suspended. This will enable identification of appropriate BMPs to reduce the amount of P leaving fields, thus decreasing the amount of P reaching the surface water resources. Evaluations of various P extractants at different soil depths will demonstrate differences among the extracts and help identify the most effective soil depth and extractant to predict runoff P.

5. **Project Type:** Statewide ( ) Watershed (X) Demonstration ( )

6. **Waterbody Type:** River (X) Groundwater ( ) Other ( )

7. **Project Location:** Segments 1221 of the Leon River and 1226 and 1255 of the Bosque River

8. **NPS Management Program Reference:** USA Agricultural/Silvicultural Nonpoint Source Management Program, approved February 15, 2000.

9. **NPS Assessment Report Status:** Impaired (X) Impacted ( ) Threatened ( )

10. **Key Project Activities:** Hire Staff (X) Monitoring ( ) Regulatory Assistance ( ) Technical Assistance (X) Education (X) BMP Implementation (X) Demonstration Project (X) Other (X)

11. **NPS Management Program Elements:** Milestones No.

12. **Project Costs:** Federal ($203,178), Match ($116,713)

13. **Project Management:** Texas State Soil and Water Conservation Board

Cooperating Entities: Texas Cooperative Extension, Texas Water Resource Institute, USDA Natural Resources Conservation Service

14. **Project Period:** June 1, 2002 – June 30, 2004.

FIELD VALIDATION OF THE TEXAS PHOSPHORUS INDEX
TEXAS COOPERATIVE EXTENSION
FY02 CWA Section 319(h)

Problem/Need Statement:
Phosphorus (P) is an essential element in plant and animal nutrition. However, it also has been identified as an element that may serve a controlling function in the occurrence of eutrophication in surface waters. Eutrophication has been identified as one of the major causes of impaired water quality in the United States (USEPA, 1996). It restricts water use for fisheries, recreation, industry, and drinking due to the increased growth of undesirable algae, aquatic weeds and resulting oxygen shortages caused by their death and decomposition (Sharpley et al., 2000).

Although watershed-scale studies are important to evaluate gross potential nutrient losses, research has clearly shown that field-scale evaluations will be most critical for effective targeting of limited resources. Significant effort has been directed toward development of predictive tools which can be used to estimate potential nonpoint source losses of P. One example is a simple P index developed by the U.S. Department of Agriculture, Agricultural Research Service, as a field-level screening tool to rank the vulnerability of fields as sources of P loss in runoff water (Lemunyon and Gilber, 1993).

The Phosphorus Index (PI) is designed to provide a basic assessment of both source and transport factors (collectively referred to as site factors) controlling P loss in surface runoff. Source factors include soil test P level, and inorganic and organic fertilizer phosphorus application rates and methods of application. Transport factors include proximity of the nearest field edge to a named stream or lake, runoff class and erosion potential. In Texas, the P index is a simple 8 x 5 matrix that combines site factors with a series of condition classes which identify Very Low-Low, Medium, High and Very High levels of runoff potential. Site factors and condition classes are assigned weighted values based on relative importance. Utilizing field specific data, condition classes are assigned for each site factor and enable calculation of a numeric point value. Total index points for an individual site are then compared to a standard index to determine overall P runoff potential for the site.

Gburek et al. (1996) found that when the original PI was applied to a larger watershed in Pennsylvania, its field rankings did not accurately identify all areas with substantive impacts on stream water quality. Sharpley et al. (2000) reported that since the overall flow systems of upland watersheds are largely fixed in space, limited opportunity exists to control or manipulate the hydrology of these systems. Thus, the most realistic and likely most effective means for modification of potential P losses will be through management of the source terms of the PI.

One key area of concern deals with the soil test P level source factor and its relationship to potential P loss. Research in Texas has shown that soil test P level can be highly dependent on several site factors including soil type, field history, P source, and soil test extractant. A first step in refining effective site classification strategies such as the PI is to evaluate the efficiency of the key soil test parameter, and its relationship to other source and transport variables.

Rainfall simulation has been used as a tool for predicting the effects of site specific characteristics on potential P loss. It is much easier and cost effective than watershed scale studies. Most importantly, it offers an opportunity to verify the accuracy of less intensive methods, such as the PI, by examining the impacts of specific source and transport parameters on measured and predicted outcomes.

In theory, the PI provides a reasonably rapid approach for planners and land managers to identify sites with the greatest potential to contribute to nonpoint source pollution. In addition, it enables comparison of selected alternative management practices which can be used to reduce P losses. However, very limited research has been conducted to provide field validation of the effectiveness of the PI for predicting actual site vulnerability. Weighting factors for both source and transport factors, and vulnerability classifications largely have been intuitively defined. In addition, other soil and site factors may play important roles in controlling the potential for P loss under specific environmental conditions.

Field studies for this project will be conducted on sites within the Bosque and Leon Watersheds. Based on the results of this pilot project, additional studies likely will be recommended for the major soil series of Texas to enable establishment of scientifically based economic and environmental P thresholds.

General Project Description:
Study sites in the Bosque (waterbody segments 1226 and 1255) (Fig. 1) and Leon River (waterbody segment 1221) (Fig. 2) Watersheds will be selected based on predetermined characteristics designed to facilitate the evaluation of specific input or related variables of the PI. Emphasis will be placed on selection of soil series which represent the dominant series in the region and state. A total of 20 sites representing the dominant soil series used as manure application fields will be evaluated in year one and an additional 20 sites will be evaluated in year 2 as in year one.

Soil parameters to be used in site selection:

a) PI risk assessment: L, M, and VH.
b) Soil test P: L/M/H, >200 ppm.
c) pH: non-calcareous (pH < 7.5) soils and calcareous (pH = 7.5 or greater) soils within each of the PI/soil test P parameters.
d) Mineralogy, slope, leaching index, etc. will be documented for the PI.

For each field site, the PI will be determined based on a thorough site evaluation conducted by Texas Cooperative Extension (TCE) and USDA-Natural Resources Conservation Service (NRCS) personnel. Each site will be subjected to a complete soil characterization by USDA-NRCS and TCE staff. In addition, soil samples will be collected from each site at depth increments of 0 to 2, 2 to 6, and 0 to 6 inches for laboratory analysis of pH, EC, NO_3^--N, Ca, Mg, Na, K, P, S, and B. This evaluation will include the TAMU and Mehlich III methods for extractable P, soil pH, nitrate-N, 2:1/water:soil salinity, and soil solution soluble (SSSP). The SSSP will be based on a KCl and/or $CaCl_2$ soil extraction. This extraction will be selected based upon previous research comparing the reproducibility of the two dilute salts at various concentrations and shaking times.

Rainfall simulations will be conducted to measure actual runoff P levels from field sites. Specific locations within each site will be selected to best represent the characteristics and properties upon which the PI characterization was based. These will include the soil series and related runoff and erosion potential classifications, slope, vegetative cover, proximity to nearest waterbody, organic and inorganic nutrient application rates and timing of application.

The rainfall simulations will be conducted using a Tlaloc 3000 rainfall simulator built by Joerns Inc. The simulator is based on the design of Miller (1987), and is an aluminum frame suspending a single low pressure, square pattern nozzle approximately 3 m above the soil surface. The simulator is capable of variable application rates up to 7.62 cm (3 in.) per hr. Based on this nozzle size and operating pressure, the actual application rate will be 7.5 cm per hr. This rate is being used across the nation for the P Benchmark Soils Project on which Sam Feagley is a cooperator. The rate is equivalent to the 24 hr/25 yr storm event for Stephenville, Texas. Simulations will be conducted on 1.5 m x 2 m plots. All rainfall simulation procedures will be conducted in accordance with the Sera-17 National P Project guidelines for rainfall simulations.

A total of 3 rainfall simulations will be conducted at each of the 40 locations, providing three replications for statistical comparison. Runoff samples (1000 mL) will be collected during each simulation at 2 intervals (15 and 30 minutes) after runoff is initiated. Total runoff volume will also be recorded. Water samples will be analyzed for pH, EC, NO_3^--N, Ca, Mg, Na, K, P, SO_4^{2-}, and B by the TCE Soil, Water and Forage Testing Laboratory. Selected samples will be analyzed for solution soluble P and suspended P.

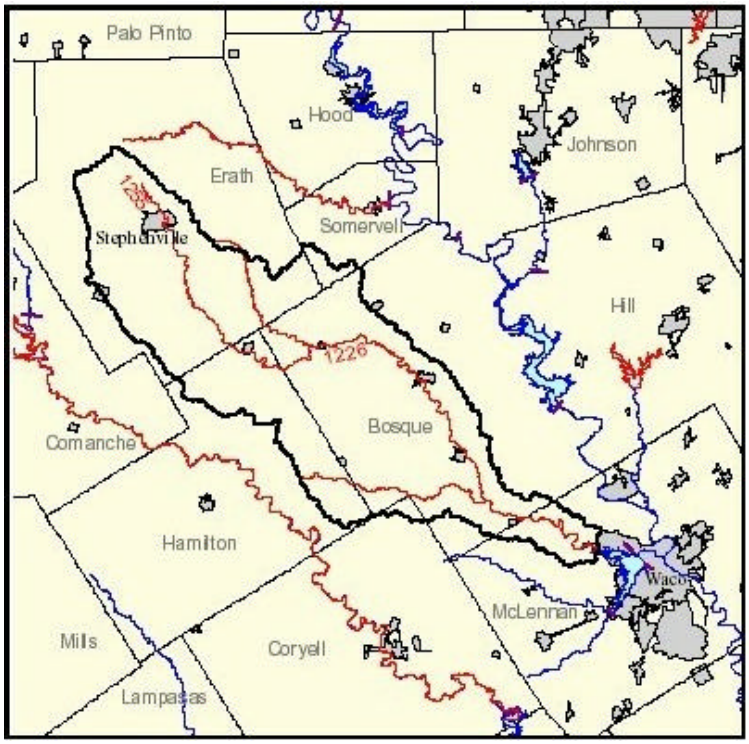

Figure 1. Study area in the Upper North Bosque River waterbody segment (1255, Stephenville and north) and North Bosque River waterbody segment (1226, Stephenville and south to Lake Waco).

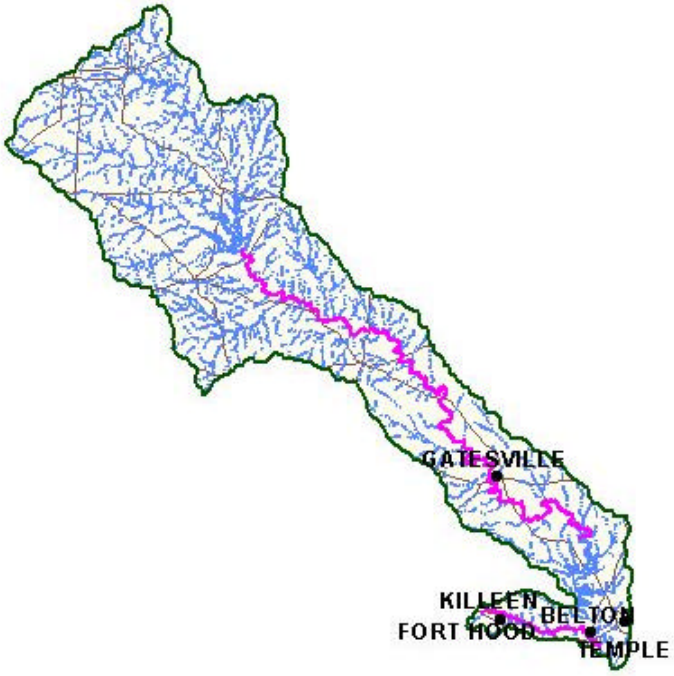

Figure 2. Study area in the Leon River waterbody segment (1221, south from Lake Proctor to Lake Belton)

A complementary component of the project will be to more intensively evaluate correlations between soil test P in the target region by analyzing selected incoming client soil samples and samples from the rainfall simulation sites at the TCE Soil, Water and Forage Testing Laboratory. Approximately 150 to 200 samples would be selected for analysis per year. These samples also will be analyzed using the TAMU and Mehlich III methods for extractable P, soil pH, nitrate-N, 2:1/water:soil salinity, and SSSP. The SSSP will be based on a dilute KCl and/or $CaCl_2$ soil extraction.

The Mehlich III, TAMU, and SSSP extracts will be analyzed by colorimetric and ICP methods. This will provide the needed insight into the influence of soluble organic P that will be required in order to establish rigid laboratory methodology and protocols. All other soil test parameters will be determined using the established standard operating procedures of the Soil, Water and Forage Testing Laboratory.

Data will be analyzed utilizing standard statistical methods including regression, analysis of variance, and mean separation.

This proposal addresses agricultural activities in the following stream segments:

Segment	Water Body
1221	Leon River Below Lake Proctor
1226	North Bosque River
1255	Upper North Bosque River

Waterbody segment 1221 is listed as pathogen and total dissolved solids impaired, 1226 is listed as pathogens and chlorophyll *a* impaired, and 1255 segment is listed as pathogens, chloride, sulfate, total dissolved solids, ammonia-N, nitrite+nitrate-N, chlorophyll *a*, ortho-P and total-P impaired from non-point sources. All of the above segments are listed in the Texas 2000 Clean Water Act Section 303(d) List as having potential sources of nutrients from agriculture.

The Objectives of This Project are as Follows:

1) Determine the effects of selected soil properties on measured and predicted P runoff.
2) Compare and correlate different soil test and soil solution extractable P levels to runoff P.
3) Validate and/or modify the Texas Phosphorus Index as a predictive tool for classification of field sites relative to P loss potential.

Literature Cited:

Gburek, W.J., A.N. Sharpley, L. Heathwaite, and G.J. Folmar. 2000. Phosphorus management at the watershed scale: A modification of the phosphorus index. J. Environ. Qual. 29:130-144.

Lemunyon, J.L. and R.G. Gilbert. 1993. Concept and need for a phosphorus assessment tool. J. Prod. Agric. 6:483-486.

Miller, W.P. 1987. A solenoid-operated, variable intensity rainfall simulator. Soil Sci. Soc. Am. J. 51:832-834.

Sharpley, A.N., B. Foy, and P. Withers. 2000. Practical and innovative measures for the control of agricultural phosphorus losses to water: An overview. J. Environ. Qual. 29:1-9.

USEPA. 1996. Environmental indicators of water quality in the United States. EPA 841-R-002. USEPA, Office of Water, U.S. Gov. Print. Office, Washington, D.C.

FIELD VALIDATION OF THE TEXAS PHOSPHORUS INDEX
Texas Cooperative Extension
FY02 CWA Section 319(h)

WORKPLAN
6/1/02 - 6/30/04

Tasks, Objectives, Schedules, and Estimated Costs:

TASK 1: Select sites for rainfall simulations and result demonstrations.
Costs: $20,318 (Federal), $11,671 (Match), $31,989 (Total)

Objective: 1. Determine the effects of selected soil properties on measured and predicted P runoff.

Subtask 1.1 Work with TSSWCB personnel to develop a QAPP and submit to TSSWCB and EPA for approval before data collection begins. (Start Date: Month 1; Completion Date: Month 2.)

Subtask 1.2 Work with County Extension Agents (CEAs), TSSWCB personnel, and NRCS agronomists and soil scientists in Erath, Bosque, McLennan, Comanche, Hamilton, and Coryell counties to identify areas with PI risk ratings of low, medium, and very high, non-calcareous vs calcareous, and soil test P low to high and >200 ppm. A range in mineralogical characteristics and dominant soil series where manure is applied will also be part of the selection criteria. (Start Date: Month 1; Completion Date: Month 8.)

Subtask 1.3 Collect and analyze soil samples from selected areas. (Start Date: Month 2; Completion Date: Month 8.)

Subtask 1.4 Select field sites for rainfall simulation. (Start Date: Month 3; Completion Date: Month 9.)

Deliverables:
? Soil test results for dilute salt, Mehlich III, and TAMU extracts.
? Site selection map.
? QAPP.

TASK 2: Establish result demonstrations and conduct rainfall simulations.
Costs: $71,112 (Federal), $40,849 (Match), $111,962 (Total)

Objective 1: Determine the effects of selected soil properties on measured and predicted P runoff.

Subtask 2.1 Establish rainfall simulation sites. (Start Date: Month 3; Completion Date: Month 10.)

Subtask 2.2 Conduct rainfall simulations and collect soil and water samples from simulation sites only and analyze water samples. (Start Date: Month 4; Completion Date: Month 20.)

Subtask 2.3 Analyze water and selected suspended samples for pH, EC, NO_3^--N, Ca, Mg, Na, K, P, and SO_4^{2-}-S.

Deliverables:
? Runoff P concentrations in the solution soluble and suspended material.
? Chemical analyses of simulated rainfall runoff.

TASK 3: Measure and evaluate soil test extractable P and dilute salt soil extractable P.
Costs: $71,113 (Federal), $40,849 (Match), $111,962 (Total)

Objective 2: Compare and correlate different soil test and soil solution extractable P levels to runoff P.

Subtask 3.1 Analyze soils samples for Mehlich III and TAMU extractable P. (Start Date: Month 2; Completion Date: Month 23.)

Subtask 3.2 Analyze soil samples for soil solution soluble P and selected samples for solution suspended P. (Start Date: Month 2; Completion Date: Month 23.)

Subtask 3.3 Analyze all soil samples for pH, EC, NO_3^--N, Ca, Mg, Na, K, P, S, and B through TAMU Soil, Water and Forage Testing Laboratory (Routine + B). (Start Date: Month 2; Completion Date: Month 23.)

Subtask 3.4 Analyze extracted soil P using ICP and colorimetric techniques. (Start Date: Month 2; Completion Date: Month 23.)

Deliverables:
? Comparison of solution soluble and solution suspended P in the runoff.
? Comparison of ICP vs colorimetric P from soil samples.
? Comparison of dilute salt P, and Mehlich III and TAMU extractable P concentrations from soil samples.
? Comparison of different extractable P concentrations to soluble and suspended runoff P.

TASK 4: Compare PI risk assessment to runoff P concentrations.
Costs: $20,317 (Federal), $11,671(Match), $31,989 (Total)

Objective 3: Validate and/or modify the Texas Phosphorus Index as a predictive tool for classification of field sites relative to P loss potential.

Subtask 4.1 Compare initial PI risk assessment to runoff P. (Start Date: Month 3; Completion Date: Month 23)

Subtask 4.2 Compare initial PI risk assessment to different extractable P concentrations. (Start Date: Month 2; Completion Date: Month 23)

Deliverables:
? Case studies evaluating the success of the PI for predicting low, medium, or very high potential for P runoff.
? Information dissemination through CEAs with multi-county meetings and field days.

TASK 5: Validate and/or modify PI and provide educational programs regarding PI use and P runoff management.
Costs: $20,318 (Federal), $11,671 (Match), $31,989 (Total)

Objective 3: Validate and/or modify the Texas Phosphorus Index as a predictive tool for classification of field sites relative to P loss potential.

Subtask 5.1 Conduct initial attempt to modify the PI to predict actual P in runoff based upon phosphorus index points. (Start Date: Month 4; Completion Date: Month 23.)

Subtask 5.2 Conduct educational outreach through CEAs and using multi-county meetings to educate landowners and managers about runoff P and use of the PI as a management tool. (Start Date: Month 6; Completion Date: Month 24.)

Subtask 5.3 Recommend potential changes to PI with NRCS and incorporate into Nutrient Management Certification Short Course. (Start Date: Month 13; Completion Date: Month 23.)

Subtask 5.4 Provide updates and training for TNRCC, TSSWCB, and NRCS personnel and other groups and organizations on PI use and proposed modifications. (Start Date: Month 7; Completion Date: Month 24.)

Subtask 5.5 Submit Final Report (Start Date: Month 1; Completion Date: Month 27.)

Deliverables:

? Provide recommended modifications for PI to improve accuracy.
? Educational outreach for landowners and managers in the target regions.
? Final Report

Coordination, Roles and Responsibilities:

Participating organizations and agencies along with their roles in this project include:

? TWRI will administer the project and assist in data interpretation and information distribution.
? TCE will be responsible for data collection and interpretation and quarterly, yearly, and final report preparation and educational materials development and programming.
? Texas State Soil And Water Conservation Board - State Lead Agency for Agricultural and Silvicultural Non-Point Source Pollution Program.
? NRCS and CEAs will assist in site selection and educational outreach through multi-county meetings and field days.

Public Participation:
The primary goals of this project are to evaluate the Texas PI as an estimator of P runoff potential and to determine which soil test is best correlated with solution and suspended P in the runoff. The following subtasks will address the public participation component of this project:

? Conduct educational outreach through CEAs and using multi-county meetings to educate landowners and managers about runoff P and use of the PI as a management tool
? Distribute educational materials to landowners, and state and local agencies
? Disseminate informational fact sheets to landowners and county/city governing agencies in the watersheds
? Conduct field tours and multi-county educational programs
? Provide updates and training for TNRCC, TSSWCB, and NRCS personnel and other groups and organizations on PI use and proposed modifications
? One on one technical assistance and educational efforts (at least 25) with landowners in watersheds
? Oral and poster presentations at American Society of Agronomy, Soil Survey and Land Resource Workshop, and Surface Mine Reclamation Workshop annual meetings and other events
? News articles, fact sheets, information on http://nutrientmanagement.tamu.edu web site, and CEU development for Certified Nutrient Management Specialists
? Include result demonstration findings and recommendations on appropriate Web sites.

Measures of Success:
The information attained from the field studies will help validate and improve the Texas PI. With this information and additional studies similar to this across the state, quantitative assessments to predict the amount of P in runoff utilizing the Texas PI can be estimated. The runoff analyses will help determine the form of P, and whether it is mainly solution soluble or suspended. This will enable identification of appropriate BMPs to reduce the amount of P leaving fields, thus decreasing the amount of P reaching the surface water resources. Evaluations of various P extractants at different soil depths will demonstrate differences among the extracts and help identify the most effective soil depth and extractant to predict runoff P.

Reference To Project In The NPS Management Program:
Category: Agriculture
Milestones:

Project Lead:

Name:	Sam Feagley
Address:	Soil and Crop Sciences Texas Cooperative Extension 2474 TAMU College Station, TX 77843-2474
Phone #	(979)845-1460
Affiliation:	Professor, State Soil Environmental Specialist

TSSWCB Project Manager:

Name:	Jay Bragg
Address:	Texas State Soil and Water Conservation Board 311 North 5th Street P.O. Box 658 Temple, TX 76503
Phone:	(254)773-2250
Affiliation:	Natural Resource Specialist IV

FIELD VALIDATION OF THE TEXAS PHOSPHORUS INDEX

Texas Cooperative Extension

FY02 CWA Section 319(h)

PROJECT BUDGET

6/1/02 - 3/31/06

Revised 10-28-04

Category	Year 1		Year 2		Total	
	Federal	**Match**	**Federal**	**Match**	**Federal**	**Match**
I. Salaries and Wages						
A. Principle Investigators	0	$39,754	0	$40,735		$80,489
B. Extension Associate (0.5)	$26,000		$27,700		$53,700	
C. Student Labor (2)	11,000		13,000		24,000	
Sub-total	37,000	39,754	40,700	40,735	77,700	80,489
D. Fringe Benefits	7,168	8,395	7,809	8,395	14,977	16,790
D. Total Salaries	**$44,168**	**$48,149**	**$48,509**	**$49,130**	**$92,677**	**$97,279**
II. Materials and Supplies						
A. Rainfall simulation	15,000		14,500		29,500	
B. Soil Testing	8,000		8,000		16,000	
C. TWRI	2,000		2,000		4,000	
Sub-total	**$25,000**		**$24,500**		**$49,500**	
III. Travel						
A. TCE	15,000		15,500		30,500	
B. TWRI	2,000		2,000		4,000	
Sub-total	**$84,668**	**$48,149**	**$92,009**	**$49,130**	**$176,677**	**$97,279**
Indirect Costs (15%)	12,700	9,313	13,801	10,121	26,501	19,434
TOTALS	**$97,368**	**$57,462**	**$105,810**	**$59,251**	**$203,178**	**$116,713**
GRANT TOTAL						**$319,891**

FIELD VALIDATION OF THE TEXAS PHOSPHORUS INDEX

Texas Cooperative Extension
FY02 CWA Section 319(h)

PROJECT BUDGET

6/1/02 - 6/30/04

Itemized Budget Justification:

I. Salaries and Wages

The Extension Associate will be in charge of the rainfall simulator. He is the one that designed the trailer according to the specifications from the P Benchmark Soils Project. Half of his salary is requested. He will assist with the entire project.

The Student Labor is to hire 2 student workers. One will help in the Soil, Water and Forage Testing Laboratory with the non-routine sample analyses and the other will help with the project in the field. The students will work 20 hours or less during the Fall and Spring semesters and 40 hours during the summer.

II. Materials and Supplies

The operating of the rainfall simulator is estimated to cost about $2,000 per result demonstration site. This cost includes sample containers for soil and water samples, ice for storing water samples, analyses on all soil and water samples collected, miscellaneous field supplies, and costs associated with the trailer upkeep, and plumbing and water filtering columns. The columns cost about $1000 per replacement and columns will be replaced about every 9,000 gals of water. Each simulation is estimated to consume about 300 gals of water, thus, the columns will need to be replaced every 30 simulations. We have 60 simulations proposed each year. Therefore, the columns will be replaced 2 times each year.

The soil testing component will be the analyses of the initial 150 to 200 samples to aid in the selection of the sites. Each analysis is $40 to cover the costs of the TAMU routine+B, Mehlich III, and dilute salt. The TAMU and Mehlich III extracts will also be analyzed for colorimetric P.

TWRI will use the funds for office supplies.

III. Travel

The TCE travel funds will be used for the field result demonstrations and agencies and multi-county educational outreaches. Most of the travel associated with the result demonstrations will involve four to six individuals each trip. These funds will also be used Extension Associate to attend one national meeting to present the results each year. Rental of TCE vehicles to pull the trailer and transport personnel will be at a rate of $0.17 per mile. Per diem for personnel is $80 for lodging and $34 for meals.

The TWRI funds will be used for travel associated with this project.

IV. Fringe Benefits and Indirect Costs

The fringe benefits are calculated at 15.5% of the Extension Associates salary and 8.25% of the Student Labor wages. In addition, the Extension Associate receives insurance charged at a rate of $375 per month.

The indirect costs are calculated at 15% as specified by agreement between TSSWCB and TCE.

V. Matching Funds

The matching funds come from 10% salaries of Sam Feagley, Mark McFarland, Tony Provin, John Pitt, and Bill Harris and the 11% indirect cost savings.