

**NONPOINT SOURCE SUMMARY PAGE**  
**for the FY07 CWA, Section 319(h) Agricultural/Silvicultural Nonpoint Source**  
**Program**  
**Project 07-3**

- 1. Title of Project:** Adaptation of AVGWLF watershed model for use in Texas: Phase I
- 2. Project Goals/Objectives:** The purpose of this project is to test and modify the AVGWLF watershed model for use in selected areas of Texas and surrounding states.
- 3. Project Tasks:** The primary tasks of this project are to: (1) Prepare a QAPP; (2) Identify and select test watersheds for model calibration and verification; (3) Develop required regional GIS and weather data sets; (4) Compile relevant stream flow and water quality data for testing purposes; (5) Complete calibration and verification of AVGWLF model in selected test areas; and (6) Prepare final report outlining work tasks and results.
- 4. Measures of Success:** Development of a “regionalized” version of AVGWLF that can be used to support TMDL and watershed restoration activities in Texas and other states in EPA Region 6.
- 5. Project Type:** Statewide (x); Watershed Implementation/Education ( ); Watershed Planning/Assessment ( ); Watershed Protection ( )
- 6. Status of Water Body:** Project will cover selected ecoregions of Texas and surrounding states.
- 7. Project Location:** Outcomes of this project will impact many stream segments and watersheds in Texas and surrounding states.
- 8. NPS Management Program Reference:** State of Texas Agricultural/Silvicultural Nonpoint Source Management Program
- 9. NPS Assessment Report Status:** Impaired ( ); Impacted ( ); Threatened ( ); TMDL ( ); Other (X).
- 10. Key Project Activities:** Hire Staff ( ); Monitoring ( ); Regulatory Assistance ( ); Technical Assistance (X); Education ( ); Implementation ( ); Demonstration ( ); Other (X)
- 11. NPS Management Program Elements:**
- 12. Project Costs:** Federal (\$122,623); Non-Federal Match (\$0); Total Project (\$122,623)
- 13. Project Management:** Texas State Soil and Water Conservation Board (TSSWCB). Cooperating Entities: Penn State Institutes of Energy and the Environment (PSIEE)
- 14. Project Period:** Two years (ending June 30, 2009) from the receipt of funding.

## Adaptation of AVGWLF Watershed Model for use in Texas and Surrounding States: Phase I

### WORKPLAN

**Problem/Need Statement:** Given the number and complexity of water quality problems facing the State of Texas and other states in EPA Region 6, a need exists for expanding the suite of tools currently available for evaluating water quality problems at the watershed level; particularly those associated with nonpoint sources of sediment and nutrients. Under this current effort, the Texas State Soil and Water Conservation Board (TSSWCB), in collaboration with the Penn State Institutes of Energy and the Environment (PSIEE), proposes to develop a regional version of AVGWLF for the states covered by EPA Region 6 (i.e., New Mexico, Texas, Oklahoma, Arkansas and Louisiana). The overall goal of this project is to provide states within this region with a technical tool that can be used to develop non-point source pollutant load reduction estimates and TMDLs at the watershed and regional scale.

AVGWLF is a GIS-based watershed modeling system that was initially developed to facilitate the estimation of nutrient and sediment loads in watersheds in Pennsylvania. It has also been adapted for use elsewhere, including most recently New York and New England. The core watershed simulation model for this GIS-based application is the GWLF (Generalized Watershed Loading Function) model developed by Haith and Shoemaker (1987). The GWLF model provides the ability to simulate runoff, sediment, and nutrient (N and P) loadings from a watershed given variable-size source areas (e.g., agricultural, forested, and developed land). It also has algorithms for calculating septic system loads, and allows for the inclusion of point source discharge data. It is a continuous simulation model which uses daily time steps for weather data and water balance calculations. Monthly estimates are made for sediment and nutrient loads, based on the daily water balance accumulated to monthly values. The original GWLF model (called GWLF-E within AVGWLF) has been significantly enhanced to address better water-balancing as well as the estimation of such things as streambank erosion and pathogen loading from various sources.

AVGWLF is essentially a customized interface developed by Penn State for the ArcView GIS package that is used to parameterize input data for the GWLF model (see Evans et al., 2002). In utilizing this interface, the user is prompted to identify required GIS files and to provide other information related to “non-spatial” model parameters (e.g., beginning and end of the growing season; the months during which manure is spread on agricultural land, etc.). This information is subsequently used to automatically derive values for required model input parameters which are then written to the *transport.dat* and *nutrient.dat* input files needed to execute the GWLF model. Also accessed through the interface are Excel files that contain temperature and precipitation information used to create the necessary *weather.dat* input file for a given watershed simulation. A Users Guide has previously been developed (and updated) that provides background information on the modeling approach and information on how to use AVGWLF (Evans et al., 2006).

Evans, B.M., D.W. Lehning, K.J. Corradini, G.W. Petersen, E. Nizeyimana, J.M. Hamlett, P.D. Robillard, and R.L. Day, 2002. A Comprehensive GIS-Based Modeling Approach for Predicting Nutrient Loads in Watersheds. *J. Spatial Hydrology*, Vol. 2, No. 2., ([www.spatialhydrology.com](http://www.spatialhydrology.com)).

Evans, B.M., S.A. Sheeder, and K.J. Corradini, 2006. AVGWLF, Version 6.3: Users Guide. Penn State Institutes of Energy and the Environ., Penn State University, 82 pp.

Haith, D.A. and L.L. Shoemaker, 1987. Generalized Watershed Loading Functions for Stream Flow Nutrients. Water Resources Bulletin, 23(3), pp. 471-478.

**General Project Description:** As part of the proposed effort, PSIEE will develop the required data sets to support the use of AVGWLF for the area covered by EPA Region 6. Data development for the model will primarily be undertaken by PSIEE staff with limited input from GIS staff at TSSWCB, EPA and other cooperating state agencies. Within AVGWLF, both ArcView-compatible shape files and grids are manipulated for the purpose of estimating numerous model parameters. Up to 13 shape files and 4 grid files can be used by AVGWLF for the purpose of deriving required GWLF model input data. Table 1 provides a listing and brief description of all of the required and optional GIS layers used that will be compiled for the proposed project. To facilitate their use within this “regionalized” version of AVGWLF, the GIS data sets compiled for each state will be re-projected into a common geographic coordinate system; preferably one that is currently used by EPA Region 6.

Subsequent to data compilation, PSIEE will conduct model calibration and validation for Region 6. Due to limited funding, this work will only be conducted in selected areas of the region. To maximize the extent to which AVGWLF can be used, PSIEE proposes to test AVGWLF in three specific ecoregions that traverse EPA Region 6 (see Figure 1). These ecoregions include the Southwest Tablelands, Central Great Plains, and South Central Plains. Within each of these ecoregions, PSIEE proposes to test AVGWLF at 8 different sites (4 calibration and 4 validation) for a total of 24 test sites across all 5 states. During this phase, model algorithms will be tested and modified as needed to better represent conditions in each ecoregion.

Subsequent to model development and testing, a report will be prepared that summarizes work performed under the agreement. This report will include descriptions of the database development effort and model testing, statistical analyses, and an overview of any model limitations encountered and improvements that might be needed in the future.

### **Tasks, Objectives and Schedules:**

*Task 1: Develop a Quality Assurance Project Plan (QAPP).*

**Costs:** \$ 6,131 (Federal), \$ 0 (Non-Federal Match), \$ 6,131 (Total)

**Objective/Summary:** As required by EPA, a QAPP will be developed prior to beginning work on other technical activities related to the project. This document will be modeled on a similar QAPP developed as part of an earlier effort undertaken by PSIEE to adapt AVGWLF for use in New York and New England for the New England.

### **Deliverable**

- Submit QAPP.

**Delivery Date:** Within 2 months after start date.

Table 1. AVGWLF Data requirements.

File Names	Short Description	Required
<i>Shape Files</i>		
Weather stations	Weather station locations (points)	Y
Point Sources	Point source discharge locations (points)	N
Water Extraction	Water withdrawal locations (points)	N
Tile Drain	Locations of tile-drained areas (polygons)	N
Basins	Basin boundary used for modeling (polygons)	Y
Streams	Map of stream network (lines)	Y
Unpaved Roads	Map of unpaved roads (lines)	N
Roads	Road map (lines)	N
Counties	County boundaries - for USLE data (polygons)	N
Septic Systems	Septic system numbers and types (polygons)	N
Animal Density	Animal density (in AEU's per acre) (polygons)	N
Soils	Contains various soil-related data (polygons)	Y
Physiographic Provinces	Contains hydrologic parameter data (polygons)	N
<i>Grid Files</i>		
Land Use/Cover	Map of land use/cover (16 classes)	Y
Elevation	Elevation grid	Y
Groundwater-N	Background estimate of N in mg/l	N
Soil-P	Estimate of soil P in mg/kg (total or soil test P)	N

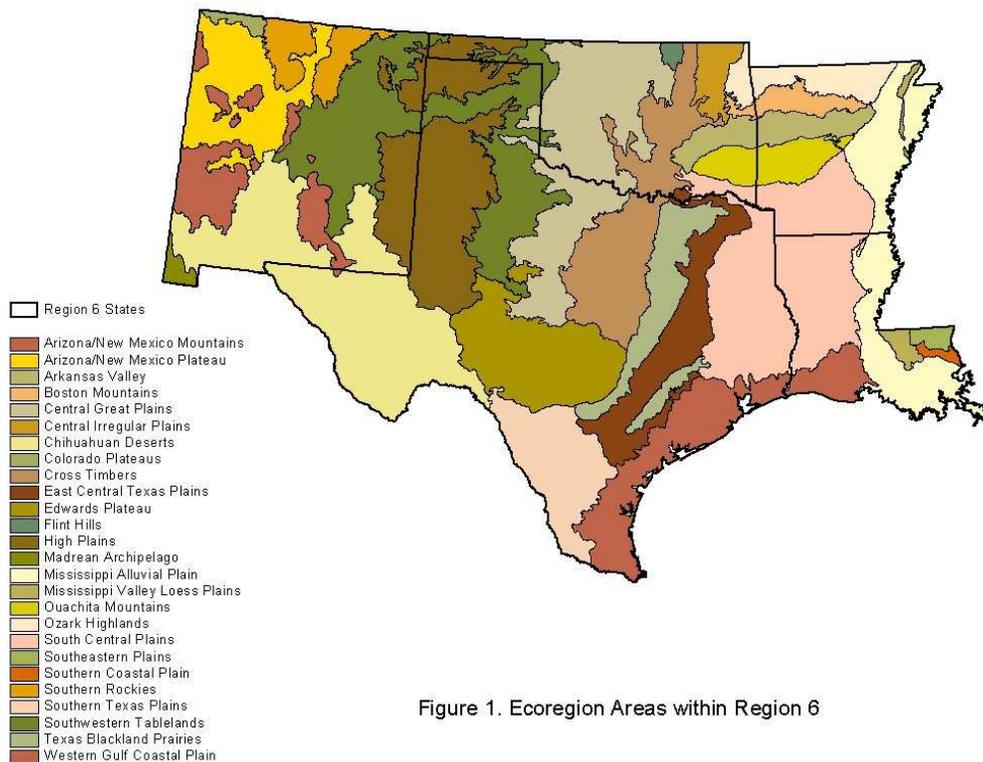


Figure 1. Ecoregion Areas within Region 6

*Task 2: Identify and select test watersheds for model calibration and verification.*

**Costs:** \$ 14,662 (Federal), \$ 0 (Non-Federal Match), \$ 14,662 (Total)

**Objective/Summary:** A number of watersheds within three ecoregions spanning Texas and other surrounding states in EPA Region 6 will be evaluated for use as test sites for AVGWLF modeling. Within each of these ecoregions, PSIEE proposes to test AVGWLF at 8 different sites (4 calibration and 4 validation) for a total of 24 test sites across all 5 states. The final selection will be based on various watershed characteristics such as type of land use, degree of impact from point sources versus nonpoint sources, extent of stream impairment, availability of historical stream flow and water quality data, and other important factors.

**Deliverable**

- List of project test sites.

**Delivery Date:** Within 4 months after project start.

*Task 3: Develop required regional GIS and weather data sets.*

**Costs:** \$ 18,393 (Federal), \$ 0 (Non-Federal Match), \$ 18,393 (Total)

**Objective/Summary:** The purpose of this task will be to compile the data sets necessary to drive the AVGWLF model. These data sets include both GIS data layers and historical weather data as described earlier in this document. With respect to compiling GIS data, emphasis will be placed on using existing data sets (e.g., land use/cover, soils, elevation) rather than creating new layers. Other new data sets (e.g., the background nitrogen in groundwater map and the soil phosphorus map) will be developed; however, these will primarily be developed using information contained in other previously-compiled data sets. Additionally, historical weather data for perhaps 20 to 30 weather stations distributed throughout the ecoregions evaluated will be compiled to provide the necessary precipitation and weather data to drive the watershed model. It is anticipated that approximately 10-15 years of weather data will be assembled for each station selected.

**Deliverables**

- GIS data sets as listed in Table 1 above.
- A weather database for approximately 20-30 weather stations.

**Delivery Date:** Within 8 months after project start.

*Task 4: Compile relevant stream flow and water quality data for testing purposes.*

**Costs:** \$ 24,525 (Federal), \$ 0 (Non-Federal Match), \$ 24,525 (Total)

**Objective/Summary:** The purpose of this task will be to compile “observed” data sets that can be compared against simulated results produced by AVGWLF in each of the test watersheds. For each test watershed, data on both stream flow and water quality will be compiled. In the latter case, an attempt will be made to develop observed data

sets for sediment, nitrogen and phosphorus loads. In some cases, depending on the availability of monitoring data, it may be possible to develop historic load information for only one or two of these pollutants.

**Deliverables**

- Data set of observed flows for each test watershed.
- Data sets of observed sediment and/or nutrient loads for each test watershed.

**Delivery Date:** Within 10 months after project start.

*Task 5: Complete calibration and verification of AVGWLF model in selected test areas.*

**Costs:** \$ 49,049 (Federal), \$ 0 (Non-Federal Match), \$ 49,049 (Total)

**Objective/Summary:** This task comprises the bulk of the work to be accomplished in the proposed project. As described in previous sections, the initial focus of this project will be to develop the various input data sets used by AVGWLF to derive model input files. Subsequent to this activity, watershed simulations will be performed for each of the test watersheds located in the three ecoregions. Initial model calibrations will be performed on half of these watersheds for a 5-10 year period depending on the availability and period of record of historic stream data. During this step, adjustments will be iteratively made in various model parameters until a “best fit” is achieved between simulated and observed stream flow, and sediment and nutrient loads. Based on the calibration results, revisions will be made to various AVGWLF routines to alter the manner in which model input parameters are estimated. To check the reliability of these revised routines, follow-up verification runs will be made on the remaining watersheds for the same time period. Finally, statistical evaluations of the accuracy of flow and load predictions will be made.

**Deliverables**

- Data set of simulated flows for each test watershed.
- Data sets of simulated sediment and/or nutrient loads for each test watershed.

**Delivery Date:** Within 18 months after project start.

*Task 6: Prepare final report outlining work tasks and results.*

**Costs:** \$ 9,863 (Federal), \$ 0 (Non-Federal Match), \$ 9,863 (Total)

**Objective/Summary:** The purpose of this task will be to prepare a final report that describes the activities and results associated with each work task completed as part of the proposed project.

**Deliverable**

- AVGWLF Model
- AVGWLF Model Training
- Final report.

**Delivery Date:** Within 24 months after project start.

**Project Leader:** Dr. Barry M. Evans, PSIEE  
**Co-project Leader:** Dr. Brian A. Dempsey, PSIEE  
**Project Members:** Mr. Kenneth J. Corradini, PSIEE  
Mr. David W. Lehning, PSIEE  
Mr. Scott A. Sheeder, PSIEE

**Coordination, Roles, and Responsibilities:** The Project Leaders and Members will be responsible for coordinating the project staff and for communication between the project, TSSWCB, Project Stakeholders and other appropriate individuals and agencies. Program development, modifications and delivery will be coordinated through TSSWCB and the Project Stakeholders.

**Project Stakeholders:**  
Texas State Soil and Water Conservation Board  
EPA Region 6

**Public Outreach:** N/A

**Measures of Success and Performance:** Success of this project will be measured by the ability of the adapted version of AVGWLF to simulate sediment and nutrient loads within the test watersheds that are similar to the observed loads for the same time periods, as well as by the ease of its' use by agency personnel in the region.

**Project Lead**  
Name: Dr. Barry M. Evans PSIEE  
Telephone: 814-865-3357  
Organization: Pennsylvania State University

**Project Costs:** Federal (\$122,623), Non-Federal Match (\$0), Total Project (\$122,623)

**Project Period:** Two years (ending June 30, 2009) from the receipt of funding.

**OBJECT CLASS BUDGET**  
**for the**  
**Adaptation of AVGWLF Watershed Model for use in Texas and**  
**Surrounding States: Phase I**

<u>Object Class Category</u>	<u>Federal Funds</u>	<u>Non-Federal Match</u>	<u>Total Costs</u>
Personnel	\$86,103	\$0	\$86,103
Fringe Benefits	\$22,214	\$0	\$22,214
Barry M. Evans			
Brian A. Dempsey			
Kenneth J. Corradini			
David W. Lehning			
Scott A. Sheeder			
Subtotal Personnel & Fringe	\$108,317	\$0	\$108,317
Travel	\$0	\$0	\$0
Equipment	\$0	\$0	\$0
Supplies	\$0	\$0	\$0
Contractual			
Construction			
Other	\$3,158	\$0	\$3,158
Subtotal	\$3,158	\$0	\$3,158
Total Direct Costs	\$111,475	\$0	\$111,475
Indirect (15% Rate)	\$11,148	\$0	\$11,148
Unrecovered IDC	<u>\$0</u>	<u>\$0</u>	<u>\$0</u>
<b>Total Project Costs</b>	<b>\$122,623</b>	<b>\$0</b>	<b>\$122,623</b>

**BUDGET Justification  
for the  
Adaptation of AVGWLF Watershed Model for use in Texas and  
Surrounding States: Phase I**

**Personnel:** (1) Associate and (3) Research Assistants

**Fringe:** Research Associate and Research Assistants are calculated at 26.6% of salary

**Travel:** Support for 2 multi-day trips by B. Evans (PSIEE) to Texas to meet with TSSWCB, EPA Region 6, and/or other project participants.

**Equipment:** N/A

**Supplies:** N/A

**Other Direct:** N/A

**Indirect Costs:** Per TSSWCB RFP for CWA, Section 319(h) Agricultural/Silvicultural Nonpoint Source Program, a maximum of 15% indirect costs will be reimbursed.