

TEXAS WATER RESOURCES INSTITUTE  
AND  
TEXAS TECH UNIVERSITY

Development of the Upper Llano River Watershed Protection Plan  
FY 2011 Work Plan 11-04

Quarter no. 13 from 10/01/14 Through 12/31/14

**I. Abstract**

This quarter, activities focused on the EDYS model, outreach, and preparing for the upcoming Coordination Committee meeting. Next quarter, the project team will focus on completing the final sampling event, modeling, and drafting the WPP in conjunction with the Coordination Committee.

**II. Overall Progress and Results by Task**

**Task 1 Project Administration**

*Subtask 1.1 TWRI 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.*

The following actions have been completed during this reporting period:

- a. The thirteenth quarterly report was prepared and submitted on January 15, 2015.

**84% Complete**

*Subtask 1.2 TWRI will perform accounting functions for project funds and will submit appropriate Reimbursement Forms to TSSWCB at least quarterly.*

The following actions have been completed during this reporting period:

- a. As of the November 30, 2014 invoice, \$437,509.57 (66%) of federal project funds had been expended as follows:
  - TWRI has expended 69% of their funds.
  - ESSM has expended <1% of their funds
  - SSL has expended 100% of their funds.
  - TTU has expended 62% of their funds.

**66% Complete**

*Subtask 1.3 TWRI will host coordination meetings or conference calls, at least quarterly, with project partners to discuss project activities, project schedule, communication needs, deliverables, and other requirements. TWRI will develop lists of action items needed following each project coordination meeting and distribute to project personnel.*

The following actions have been completed during this reporting period:

- a. TWRI hosted coordination meetings with project partners on October 21, 2014 and December 9, 2014.
- b. The next coordination meeting will be held on February 5, 2015 in Junction.

**84% Complete**

*Subtask 1.4 TWRI will work with project personnel from ESSM, TTU-WRC, TTU-LRFS, and SLWA to prepare the WPP incorporating input from stakeholders and findings of monitoring, modeling, and data analysis tasks.*

The following actions have been completed during this reporting period:

- a. No activity to report this quarter.

**0% Complete**

*Subtask 1.5 SLWA will continue to host and maintain a website (<http://southllano.org/>) to serve as a public clearinghouse for all project- and watershed-related information. All presentations, documents and results will be posted to this website. The website will serve as a means to disseminate information to stakeholders and the general public. TWRI and TTU-LRFS shall contribute content matter for the website as appropriate.*

The following actions have been completed during this reporting period:

- a. The SLWA website, listserv, and Facebook page continue to be a resource for stakeholders in the watershed on land and water stewardship, hydrologic and weather conditions, latest news, upcoming events, community participation, and related topics.
- b. For the quarter October-December 2014, there were 614 sessions and 425 users of the website, with daily visits at 7/day. The 4<sup>th</sup> quarter is generally slower than other quarters.
- c. The Facebook page for the Alliance currently has 184 "Likes" and reached a total of 1,239 Facebook users during the fourth quarter of 2014. The majority of this activity was related to the Guadalupe Bass Restoration Initiative workshop.

**84% Complete**

*Subtask 1.6 The Director of TTU-LRFS will serve as the Upper Llano River Watershed Coordinator and be responsible for the general oversight and coordination of all project activities, reporting requirements, and educational activities, and serve as the primary conduit for interaction with landowners, citizens, and entities to facilitate the development of the WPP. The Watershed Coordinator shall successfully complete (or have already completed) the Texas Watershed Planning Short Course and participate in Texas Watershed Coordinator Roundtables.*

The following actions have been completed during this reporting period:

- a. Dr. Tom Arsuffi, Director of the TTU-LRFS and Upper Llano River Watershed Coordinator, completed the Texas Watershed Planning Short Course on November 14-18, 2011.
- b. Project partner Tyson Broad of the South Llano Watershed Alliance completed the Texas Watershed Planning Short Course on September 24-28, 2012.

**100% Complete**

## **Task 2 Quality Assurance**

*Subtask 2.1 TWRI will develop a QAPP for water quality monitoring activities in Tasks 4 and 5 and a QAPP for watershed modeling activities in Task 6 consistent with the most recent versions of EPA Requirements for Quality Assurance project Plans (QA/R-5) and the TSSWCB Environmental Data Quality Management Plan.*

The following actions have been completed during this reporting period:

- a. QAPP for Tasks 4 and 6 – GIS & Modeling
  - Revision 0 (covering only GIS inventory & LULC) approved on July 27, 2012
  - Revision 1 (adding modeling) was approved on August 1, 2013.
- b. QAPP for Task 5, Water Quality Monitoring, was approved on September 6, 2012.

**100% Complete**

*Subtask 2.2 TWRI will implement the approved QAPPs. TWRI will submit revisions and necessary amendments to the QAPPs as needed.*

The following actions have been completed during this reporting period:

- a. QAPP for Tasks 4 and 6 – GIS & Modeling
  - Revision 2 was approved on October 28, 2014.
- b. QAPP for Task 5 - Water Quality Monitoring
  - Revision 1 approved on March 5, 2013.
  - Revision 2 was approved on April 29, 2014.

**100% Complete**

## **Task 3 Public Participation and Stakeholder Coordination**

*Subtask 3.1 TTU-LRFS, with input from TWRI, SWLA, and Texas AgriLife Extension Service, will compile (Months 1-3) and maintain (Months 4-36) a database of watershed stakeholders and affected parties for use in engaging the public in the watershed planning process. The stakeholder group will be added to based upon previous efforts of SLWA. The database and stakeholder group will represent a diverse cross section of Upper Llano River landowners, citizens, local businesses, local and regional governmental entities and elected officials, state and federal agencies, and environmental and special interest groups.*

The following actions have been completed during this reporting period:

- a. The Upper Llano Watershed Protection Plan stakeholder database remains at 444 landowners, citizens, local businesses, local and regional governmental entities and elected officials, state and federal agencies, and environmental and special interest groups.

**84% Complete**

*Subtask 3.2 TTU-LRFS will facilitate public participation and stakeholder involvement in the watershed planning process, specifically project meetings and activities. TTU-LRFS will coordinate meetings, secure meeting locations, prepare and disseminate meeting notices and agendas. Meeting summaries will be prepared and posted to the project website. It is anticipated that at a minimum,*

*quarterly public meetings will be sufficient; however, if more meetings are deemed necessary, they will be scheduled accordingly. Meeting frequency may be adjusted throughout the course of the project to accomplish project goals. TSSWCB will review and approve all meeting notices, agendas, and meeting summaries prior to public dissemination.*

The following actions have been completed during this reporting period:

- a. No meetings were held this quarter.
- b. The next Coordination Committee Meeting is planned for February 5, 2015 to review and discuss monitoring and modeling results, committee makeup, and initiate review of introductory sections of the WPP.

### **84% Complete**

*Subtask 3.3 TTU-LRFS will attend and participate in other public meetings as appropriate in order to communicate project goals, activities and accomplishments to affected parties. Such meetings may include, but are not limited to, city councils, county commissioners' courts, Clean Rivers Program Basin Steering Committee and Coordinated Monitoring, local soil and water conservation districts (SWCDs), groundwater conservation districts and other appropriate meetings of critical watershed stakeholder groups.*

The following actions have been completed during this reporting period:

- a. This quarter, TTU-LRFS met with/participated in the following meetings:
  - Arsuffi, T.L., R. Stubblefield, K. Lopez, and M. Newkirk. 2014. Multiple Pathways and Approaches to Natural Resource and Water Research, Engagement and Education at the Texas Tech Llano River Field Station. Engagement Scholarship Consortium Conference. Edmonton, Alberta, Canada. October 5-8.
  - Guadalupe Bass Symposium. Llano River Field Station. Economic Impacts. October 15, 2014
  - South Llano Watershed Alliance annual membership meeting. Llano River Field Station. October 15, 2014.
  - Thesis Defense and completed. M.Sc. Zack Thomas. 2014. Fishing Warmwater Streams with Limited Public Access: Angling Behavior, Economic Impact, and the Role of Guadalupe Bass in a 24-County Region of Texas. Completed: December 2, 2014.
  - Meadows Center for Environment Stream Team – Texas State University and South Llano River Watershed Alliance. Discuss plans for joint research project on Llano River. November 6, 2014. Junction, TX.
  - Texas Tech University Water Summit 2. Organizer, Presenter, Breakout facilitator. **Watersheds, Stewardship and Agricultural Sustainability** “Insidious and Stealthy Water Thieves of Texas: Factors Affecting Water Supply, Environmental Flows and Ecosystem Services” - Tom Arsuffi. November 6, 2014. Lubbock, TX.
  - Living Waters Conference 2015. Planning Team. December 17, 2014. Junction, TX.
  - Big 12 Universities Water Workshop. Track 2. Ecohydrology and Environmental Flows – Arsuffi co-lead. November 17-18, 2014. Lawrence, KS.
  - South Central Climate Science Center's 2014 Research Workshop. November 20-21, 2014. Grapevine, TX.
  - Hill Country Water Summit. December 6, 2014. Smithville, Texas.
  - Upper Llano Watershed Protection Plan Coordination Meeting. December 9, 2014. Junction, TX.

- Arsuffi, T.L. and others. 2014. Transdisciplinary bridges to watershed science and human systems in Texas, USA. Accepted. International Water Resources Association World Water Congress XV.

#### **84% Complete**

*Subtask 3.4 TTU-LRFS will facilitate communication with stakeholders in order to engage the public and affected entities in the watershed planning process. TTU-LRFS will utilize all appropriate communication mechanisms including direct mail, e-mail, the project website, and mass media (print, radio, television). TTU-LRFS will utilize the existing SLWA Google Group to facilitate direct discussion between stakeholders. TTU-LRFS will develop, publish, and distribute 5 semi-annual newsletters (1 in year 1 and 2 in years 2 and 3) that highlight Upper Llano River watershed activities; the newsletter shall be distributed as most appropriate to individual landowners and entities in the watershed. TSSWCB must approve all project-related content in any educational materials and publications prior to distribution.*

The following actions have been completed during this reporting period:

- a. The 4<sup>th</sup> newsletter is under final review and will be disseminated early the next quarter.
- b. The SLWA Google Groups "South Llano River Project" group continues to be an effective tool for communicating with stakeholders. Those interested can sign-up for the group at the SLWA website (<http://southllano.org/>).
- c. Meadows Center for Environment Stream Team – Texas State University, South Llano River Watershed Alliance, Hill Country Alliance and TTU-LRFS met to discuss plans for joint research project on Llano River to evaluate potential impacts of truck stop on Llano River.

#### **84% Complete**

*Subtask 3.5 TTU-LRFS will coordinate with SCSC to host a Texas Watershed Steward Program workshop focused on the Upper Llano River through TSSWCB project 11-05, Continued Statewide Delivery of the Texas Watershed Steward Program.*

The following actions have been completed during this reporting period:

- a. A Texas Watershed Steward Program was held on August 30, 2012. Thirty-five local stakeholders participated in this exceptional training program.

#### **100% Complete**

### **Task 4 GIS Inventory and Land Use/Land Cover Analysis**

*Subtask 4.1 TAMU-SSL will collaborate with project partners, local agencies and stakeholders to develop a comprehensive GIS inventory of the Upper Llano River watershed. This GIS inventory will include the most recent information available on land use, elevation, soils, stream networks, reservoirs, roads, public park lands, municipalities and satellite imagery or aerial photography. Locations of SWQM stations, USGS gages, public access points to the waterbodies, floodwater-retarding structures, wetlands, known OSSFs, TPDES permittees (including WWTFs, CAFOs and MS4s), and subdivisions will also be included. Sites permitted for land application of sewage sludge and septage should be included. Information from subtasks 5.4 and 5.5 should be included. The cumulative impact of TSSWCB-certified WQMPs on the management of agricultural and silvicultural lands should be documented. TAMU-SSL will provide watershed maps for stakeholder meetings as needed.*

The following actions have been completed during this reporting period:

- a. The compilation of GIS data for the watershed is complete.

**100% Complete**

*Subtask 4.2 TAMU-SSL will perform a combination of satellite based image (2006-2010) classification schemes and where needed “heads-up digitizing” of the 2006-2010 NAIP aerial photos of the watershed using ESRI’s ArcGIS 9.x software. TAMU-SSL will identify individual LULC classes and delineate them in shapefile or ArcGIS grid format with a minimum mapping unit of 2 ac on screen. LULC classes will be comparable to NLCD. TAMU-SSL will verify LULC classification through field sampling and ground truthing information to an accuracy of 80% or greater. Ground control points used in the field sampling will be collected for at least ten locations per land use type using GPS units with an accuracy of 1-10 m.*

The following actions have been completed during this reporting period:

- a. TAMU-SSL has classified the LULC in the watershed, ground truthed the data using ground control points, and provided it to the project team.

**100% Complete**

*Subtask 4.3 TAMU-SSL will provide the GIS inventory and LULC update to the TTU-WRC for utilization in the watershed model. TAMU-SSL will also provide TTU-LRFS needed maps for the WPP.*

The following actions have been completed during this reporting period:

- a. On October 10, SSL provided the GIS inventory and LULC update to the project team.

**100% Complete**

## **Task 5 Water Quality Monitoring**

*Subtask 5.1 TTU-LRFS will conduct routine ambient monitoring at 14 mainstem sites and tributaries quarterly, collecting field parameters, conventional parameters, and flow. The QAPP, as detailed in Task 2, will precisely identify sites. The sampling period extends over 30 months. The number of samples planned for collection through this subtask is 140. Currently, routine ambient monitoring is conducted quarterly at 2 stations by LCRA and TCEQ (16701 and 17425) through the Clean Rivers Program. Sampling will be coordinated with these entities to prevent duplication of efforts and ensure comparability. Flow data will be collected by gage, electric, mechanical or Doppler, and flow severity will be noted. Field parameters measured will include pH, temperature, conductivity, and dissolved oxygen. Conventional parameters measured will include total suspended solids, turbidity, sulfate, chloride, nitrate nitrogen, ammonia nitrogen, total kjeldahl nitrogen, chlorophyll a, pheophytin, total hardness, total phosphorus and E. coli (enumerated using USEPA Method 1603). The Edwards Aquifer Research & Data Center at Texas State University, a NELAC accredited laboratory, will conduct sample analysis, provide all containers and chain of custody.*

The following actions have been completed during this reporting period:

- a. The 10<sup>th</sup> and final quarterly stream sampling will be conducted in January 2015.

**90% Complete**

*Subtask 5.2 TTU-LRFS will conduct biological monitoring (fish, macroinvertebrate, and habitat assessment) at 14 locations twice a year for 2 years to assess the cumulative impact of pollutant loading on stream health and biological communities of stream health. Biotic conditions and assessments for main stem and lower portions of the watersheds are just beginning as part of the Guadalupe Bass Restoration Project for the South Llano River with TPWD in conjunction with TTU-LRFS and Texas State University.*

The following actions have been completed during this reporting period:

- a. The first semi-annual biological sampling was conducted in September 2012.
- b. The second semi-annual biological sampling was conducted February 18-28, 2013
- c. The third semi-annual biological sampling was conducted September 16-26, 2013.
- d. The fourth and final semi-annual biological sampling was conducted on March 3-14, 2014.

**100% Complete**

*Subtask 5.3 TTU-LRFS will conduct spring sampling at 6 sites including 700 Springs, Big Paint and Tanner Springs. TTU-LRFS will work with Kimble County Groundwater Conservation District to identify other priority springs. Quarterly field, conventional, and flow parameters will be collected. Water quality parameters to be measured are defined in Subtask 5.1. The QAPP, as detailed in Task 2, will precisely identify sites. The sampling period extends over 30 months. The number of samples planned for collection through this subtask is 60. The Edwards Aquifer Research & Data Center, a NELAC Accredited Laboratory, will conduct sample analysis and provide all containers and chain of custody.*

The following actions have been completed during this reporting period:

- a. The 10<sup>th</sup> and final quarterly spring sampling will be conducted in January 2015.

**90% Complete**

*Subtask 5.4 TTU-LRFS will conduct surveys and map distribution and abundance of invasive emergent and aquatic plants from the headwaters (Llano Springs, 700 Springs, South Llano River and North Llano River) to Junction. TTU-LRFS and ESSM will work with the TPWD Aquatic Habitat Enhancement Program Director to determine BMPs for controlling or eradicating invasive species and develop an invasive species management plan for incorporation into the WPP.*

The following actions have been completed during this reporting period:

- a. Evaluation of BMPs for invasive emergent and aquatic plant species are almost completed in consultation with Earl Chilton - Aquatic Habitat Enhancement Program Director at Texas Parks and Wildlife Department.

**90% Complete**

*Subtask 5.5 TTU-LRFS will conduct surveys and map the distribution, abundance, and severity of cut and eroding banks on the South and North Llano Rivers.*

The following actions have been completed during this reporting period:

- a. Surveys of the distribution, abundance, and severity of cut and eroding banks on the North and South Llano rivers were completed in June 2013.

**100% Complete**

*Subtask 5.6 TTU-LRFS will conduct a historical data review for the waterbody, to be included in the WPP, in order to assess and characterize trends and variability in water quality. Historical data collection activities will concentrate on 1) ambient water quality data (including groundwater); 2) stream flow and water level data; 3) precipitation records; and 4) biological data. U.S. Geological Survey, National Weather Service, TPWD, Texas Water Development Board, GCDs, LCRA, TCEQ, EPA and others will be queried for data related to the study area.*

The following actions have been completed during this reporting period:

- a. TTU-LRFS presented the draft historical data review for the upper Llano River to TSSWCB in May 2013. A final draft of the report was approved by TSSWCB in July 2013. The final report was presented to the Coordination Committee at the August 1, 2013 meeting and posted on the SLWA website.

**100% Complete**

*Subtask 5.7 Through TSSWCB project 05-02 FY05 Statewide NPS Pollution Management Project, USGS will install and operate one new real-time streamflow gage at an appropriate location on the South Llano River as near the outlet of the assessment unit as is practical. Through this project, and contingent upon TSSWCB project 05-02, TTU-LRFS will work with USGS to provide operation and maintenance for this new real-time streamflow gage. Continuous sampling extends over 36 months. This gaging station will complement the existing gages maintained by the USGS. The USGS maintains real-time gages at 08150000 Llano River near Junction and 08148500 North Llano River near Junction and collects periodic data at gages 08149500 Seven Hundred Springs near Telegraph and 08149400 South Llano River near Telegraph. TTU-LRFS will work with USGS to ensure continued operation of these other USGS gages throughout the duration of the project.*

The following actions have been completed during this reporting period:

- a. The USGS stream gage was activated on May 16, 2012 on the South Llano River at Flatrock Crossing near the Texas Tech Campus. The SLWA website includes a link to this gage: [http://waterdata.usgs.gov/tx/nwis/uv/?site\\_no=08149900&PARAMeter\\_cd=00065,00060](http://waterdata.usgs.gov/tx/nwis/uv/?site_no=08149900&PARAMeter_cd=00065,00060)

**84% Complete**

*Subtask 5.8 TTU-LRFS will transfer monitoring data from activities in Subtask 5.1-5.3, and 5.7 to TSSWCB for inclusion in SWQMIS at least quarterly. Data will be transferred in the correct format using the TCEQ file structure, along with a completed Data Summary, as described in the most recent version of TCEQ Surface Water Quality Monitoring Data Management Reference Guide. TWRI will submit Station Location Requests to TCEQ, as needed, to obtain TCEQ station numbers for new monitoring sites. TWRI will input monitoring regime, as detailed in the QAPP, into the TCEQ CMS. Data Correction Request Forms will be submitted to TSSWCB whenever errors are discovered in data already reported. All monitoring data files, Data Summary, and Data Correction Request Forms will also be provided to LCRA. TTU-LRFS will post monitoring data from activities in Task 5 to the project website in a timely manner.*

The following actions have been completed during this reporting period:

- a. New staff technician is being hired and will be trained to upload remaining data sets to TCEQ SWQMIS.

**40% Complete**



*Subtask 5.9 TTU-LRFS, with assistance by TWRI, will incorporate the watershed assessment findings in the WPP developed through Task 8.*

The following actions have been completed during this reporting period:

- a. No activity to report this quarter.

**0% Complete**

## **Task 6 Modeling and Data Analysis**

*Subtask 6.1 TTU-WRC, with cooperation from project partners, will evaluate models, such as SWAT and EDYS, to simulate flow and water quality at appropriate subwatershed scales and identify BMPs and targeted locations to enhance the quality of runoff and recharge. TTU-WRC will recommend the use of a suitable candidate model. Once the most suitable model is selected by TTU-WRC, TWRI, and TSSWCB, TTU-WRC will assist TWRI in developing a modeling QAPP (Task 2). TTU-WRC will collect and evaluate relevant hydrologic data for the Upper Llano River watershed, including rainfall, stream flow, and groundwater conditions, and recent land use and vegetation distributions generated through Tasks 4-5.*

The following actions have been completed during this reporting period:

- a. The EDYS (Ecological Dynamics Simulation) model, which was selected for use in the project, continues to be prepared for use in the watershed to simulate flow and water quality and identify BMPs and targeted locations to enhance the quality of runoff and recharge. A detailed report on the status of the modeling is attached and a summary of progress this quarter is summarized below.
  - Review of spring flow data continued.
  - Comparison of ground-truth reconnaissance of vegetation data and aerial photo vegetation mapping data continued.
  - Additional vegetation types were added for the Edwards and Real portions of the spatial footprint to increase ecological resolution.
  - Work continued on including giant cane, aoudad sheep, and feral hogs into the models.
  - Work continued on detailing water quality endpoint variables.
  - Each of the three primary models are being sub-divided into three models (upland, riparian, channel) to provide increased spatial precision in modeling ecological responses along the waterways. This is a major effort and these models are currently undergoing QA/QC. Particular emphasis is being placed on verifying that boundaries between cells of different sizes match.
  - Review of all plant parameter values is underway prior to inclusion prior to final simulation runs. This process is scheduled for completion in early 1Q 2015.

**90% Complete**

*Subtask 6.2 TTU-LRFS will employ EPA's Causal Analysis/Diagnosis Decision Information System (CADDIS) to conduct a causal evaluation of the benthic macroinvertebrate data. CADDIS, an online application, provides a pragmatic guide for determining the causes of detrimental changes and undesirable biological conditions observed in aquatic systems. CADDIS supports defensible causal*

*analyses of the mechanisms, symptoms, and stressor-response relationships for various stressors in order to draw appropriate conclusions.*

The following actions have been completed during this reporting period:

- a. New staff, a benthic ecologist, is being hired and trained to conduct CADDIS analysis of benthic macroinvertebrate data.

**0% Complete**

*Subtask 6.3 TTU-WRC, with cooperation from project partners, will summarize modeling findings to inform the stakeholders about the physical behavior of their watershed resulting from various implementation scenarios and work with project partners to incorporate this into the WPP.*

The following actions have been completed during this reporting period:

- a. No activity to report this quarter.

**0% Complete**

## **Task 7 Public Outreach and Education**

*Subtask 7.1 ESSM, in conjunction with the TTU-LRFS, TTU-WRC, and SLWA will provide watershed training workshops for landowners on riparian protection, land stewardship, grazing management, invasive species, brush control, conservation, wildlife and habitat plans and water resource issues. Two workshops per year are planned to provide adequate coverage of the broad range of elements associated with water and watersheds and to allow a broad coverage of stakeholder groups. Pre- and post-participant surveys will be administered at selected events to evaluate (1) changes in producer knowledge and awareness and (2) expected adoption of BMPs.*

The following actions have been completed during this reporting period:

- a. A Guadalupe Bass workshop was held on October 15, 2014.

**90% Complete**

*Subtask 7.2 TTU-LRFS will develop and offer a K-12 TEKS based water and watershed curriculum unit.*

The following actions have been completed during this reporting period:

- a. TTU-LRFS rewrote the established curriculums: Aquatic Biology Units, The Understanding Watersheds, and the Soils/Pedology.
- b. The updated curriculum was unveiled summer 2013 and received positive feedback from a group of teachers attending a Professional Development event at TTU-LRFS.

**100% Complete**

*Subtask 7.3 TTU-LRFS will organize a Texas Water Symposium in partnership with Texas Public Radio, Schreiner University, Hill Country Alliance, SLWA, and TWRI on EPA's Healthy Watersheds Initiative with this project as a case study for Texas.*

The following actions have been completed during this reporting period:

- a. TTU-LRFS hosted a Texas Water Symposium on Healthy Watersheds and Upper Llano WPP efforts on March 22, 2011. The Symposium was held at TTU- LRFS in front of a live audience and taped for broadcast during Texas Public Radio's Newsmaker Hour. The TWS included panelists from TPWD, TSSWCB, Hill Country Alliance, TTU-LRFS, and TWRI.
- b. A second Texas Water Symposium on Texas Springs: Making Connections between Groundwater, Surface Water, Science, and Stewardship was held on March 8, 2013. The TWS discussed the connection between groundwater and surface water and included a panel of local ranchers, TTU-LRFS, and Texas Water Development Board.
- c. A third Texas Water Symposium on Private Property Rights was held on October 24, 2013 in Kerrville, TX. The TWS included panelists from the San Antonio Area Foundation, Texas Parks and Wildlife Commission, a national non-profit Sustainable Water Infrastructure Program, and the Real County Judge.

**100% Complete**

### **Task 8 Watershed Protection Plan Development**

*Subtask 8.1 TTU-LRFS, in collaboration with project partners, will develop a WPP for the Upper Llano River watershed that is consistent with and satisfies the expectations of the nine elements fundamental to watershed-based plans as described in EPA's 2004 Nonpoint Source Program and Grants Guidelines for States and Territories [68 Fed. Reg. 60653-60674 (October 23, 2003)] and incorporates the elements of EPA's Healthy Watersheds Framework as described in the technical guidance document Identifying and Protecting Healthy Watersheds (EPA 2011). The WPP shall be founded on decisions made by stakeholders through the watershed planning process (Task 3) and incorporate findings from project Tasks 4-7. TTU-LRFS will facilitate public review and stakeholder approval of the WPP.*

The following actions have been completed during this reporting period:

- a. Introductory chapters of the WPP have been drafted and will be discussed at the February Coordination Committee Meeting.

**25% Complete**

*Subtask 8.2 TTU-LRFS will develop an "executive summary" style document, based on the WPP, which will serve as a public outreach tool to garner support for the implementation of the WPP and achieve long term sustainability.*

The following actions have been completed during this reporting period:

- a. No activity to report this quarter.

**0% Complete**

*Subtask 8.3 After EPA has completed a satisfactory nine element consistency review of the WPP, TWRI will publish, print, and distribute the WPP and "executive summary" document to stakeholders.*

The following actions have been completed during this reporting period:

- a. No activity to report this quarter.

**0% Complete**

**III. Related Issues/Current Problems and Favorable of Unusual Developments**

- N/A

**IV. Projected Work for Next Quarter**

- Sampling data will be uploaded into TCEQ SWQMIS database.
- Conduct final EDYS simulation runs.
- The Newsletter will be distributed.
- TTU-LRFS will participate in SLWA Board Meetings.
- Continue writing of WPP
- Meet with Coordination Committee on February 5

## LLANO EDYS MODEL PROGRESS REPORT: OCT-DEC 2014

1. **Spatial footprint.** The spatial footprint covers approximately 2100 mi<sup>2</sup> (1,344,000 acres) in Edwards, Kimble, and Sutton Counties, with small portions of Kerr, Menard, Real, and Schleicher Counties also included. The footprint is gridded into 40 m x 40 m cells (0.4 acre), resulting in a total spatial footprint of about 3.4 million cells.

Because of the size of the footprint, the model domain is divided into three primary models, one primarily including the area in Kimble and Menard Counties, one including the area in Edwards, Kerr, and Real Counties, and the third including the area in Sutton and Schleicher Counties. A linkage module has been built that allows each model to be run separately, or in any combination of the three models simultaneously. This linked-three model approach allows for more rapid run times and less memory requirements than if the entire domain was included into a single model.

The spatial footprint includes elevations across the entire domain (40 m x 40 m resolution), along with slopes and aspect. The rivers and major and minor drainages are included, along with locations of roads, towns, and major structures. The capability for some areas to be modeled at a finer resolution (10 m x 10 m, or smaller) is included in the model. Those areas are yet to be defined. Once defined, the larger grid will be subdivided into the finer grid for the selected areas (e.g., river channels).

Each of the three primary models is further divided into three sub-models: upland, riparian, and channel. These divisions are implemented in order to provide finer-scale resolution for the riparian and channel footprints. The 40 m x 40 m resolution is adequate for most upland requirements but not for riparian and channel ecosystems because of the scales of their spatial heterogeneity and ecological responses. A 10 m x 10 m cell size is now implemented for these lowland systems. Even finer-scale resolution would be useful. However, 10-m resolution is the lower limit dictated by the elevation data currently available.

Data on location of important springs along the drainages, and some limited discharge data, are being reviewed. Following the review QA/QC, these data will be added to the spatial footprint of the models.

2. **Soils.** The soil layer has been completed. A total of 77 soil units are included. Each of the 3.4 million cells is assigned a particular soil type, based on the location of the cell in the soil map. EDYS soil profiles have been built for each of the 77 units, each profile containing 20 layers, the thickness and soil properties of each layer varying by soil type.
3. **Precipitation.** The spatial footprint has been divided into 7 precipitation zones, 3 corresponding to west-east segments of the North Llano, 3 corresponding to west-east segments of the South Llano, and one corresponding to the area around the confluence. Each segment is assigned a unique precipitation regime based on distances to primary precipitation stations. Precipitation data were collected and summarized from 16 primary (20 years or more data) and 28 secondary stations (less than 20 years data).

Long-term (1893-2012) constructed daily precipitation files were created for the 12 primary stations used to calculate precipitation events for the 7 zones. The constructed data files were built from existing data when available and from estimated data for other dates. The estimated data were

created from similarity relationships among recorded precipitation events and each two-station combination for the 16 primary stations.

4. **Vegetation.** A vegetation map has been constructed for the spatial footprint. Each cell is assigned a particular vegetation type. The vegetation types are developed from NRCS ecological site descriptions, which are then modified based on information from the published literature and from woody plant coverage estimated from NAIP aerial photographs. Woody plant coverage was visually estimated from the photographs in each of 16,838 vegetation polygons across the spatial footprint. An automated geospatial processing method was developed to increase the efficiency of the processing in future applications. A QA/QC process based on line transects drawn on aerial photographs was developed to estimate the accuracy of both the visual and the automated methods. Estimates of woody plant cover on the areas subjected to the QA/QC process averaged 50% by the transect method (assumed to be most accurate), 58% by the automated method, and 62% by visual estimation.

Ground truthing for a portion of the aerial photograph vegetation maps was conducted during 2Q 2014. Approximately one-third of the lower portions of the North and South Llano Rivers was mapped by ground reconnaissance. Comparison of the field data to the data from the aerial photographs continued in 4Q 2014. These comparisons are being used to make appropriate corrections to the EDYS spatial vegetation map.

Field validation plots were established this reporting period. Two 20 m x 20 m sites were established on Seismograph Hill in Kimble County. Detailed spatial data (% cover by plant species, litter, rock, and bare ground) were collected for each 1-m<sup>2</sup> quadrat (total of 400 quadrats) within one of these two sites. These data are being used to calibrate our aerial-photo spatial distribution map. The calibrated spatial footprint will be used to increase the precision of the surface runoff component of the model. Canopy cover of woody species and aboveground biomass of herbaceous species data were collected at the second site. These data are being used to verify the NRCS-based estimates of composition and production at this site, along with 1) the relationship between herbaceous production (by species) and canopy cover of woody species (primarily Ashe juniper) and 2) the response of herbaceous production and composition to reduction in Ashe juniper cover resulting from drought. These data will allow for improved estimates of the effect of woody plant cover on herbaceous production and the effect of the recent (current) drought on species dynamics across the landscape.

Each plant community (vegetation type) contains a specific combination of 47 plant species in the Upper Llano model, with the amounts of the woody species varying within a community based on percent woody plant coverage. Data from plant parameter matrices are used by EDYS to simulate changes in the vegetation over time. There are 33 matrices, each matrix containing data on 1-6 variables for each species. Preliminary data have been entered for all 47 species for all 33 matrices. These data continued to be reviewed and updated with additional information in 4Q 2014.

Work on inclusion of some additional vegetation types in the Edwards and Real areas was completed in 4Q 2014. The need for these additional types was identified in our QA/QC process during 3Q 2014. Some areas in the Edwards and Real footprints were under-represented by the existing vegetation types. These additional types are being added to improve the ecological realism of the spatial footprint.

Work continued in 4Q 2014 on including the non-native invasive plant species *Arundo donax* (giant cane) into the model. This is the species most likely to present the most serious threat to the Upper Llano River wetland ecosystems.

5. **Animals.** Work on the inclusion of animal dynamics into the models continued during this reporting period. These include livestock, wildlife, and aquatic species. Preliminary herbivory data have been included for cattle, deer, rabbits, and insects. These preliminary data will allow testing of the model to be conducted while additional animal data are collected and entered.

Two additional animal species are being added to the model, aoudad sheep and feral hogs. These two non-native species present a major potential threat to water quality and wetland vegetation in the Upper Llano River Watershed. In this reporting period, we continued collecting ecological data on these two species for inclusion into the model.

6. **Management.** Initial land management options (brush control, level of livestock grazing, reseeding, cultivation, surface disturbance) and stressor (fire, drought, flooding, nutrient and sediment loadings) have been included. Additional options may be added if needed.

Work continued in 4Q 2014 on including six water quality endpoint variables into the model: sediments, organic matter, nitrogen, phosphorus, *E. coli*, and algae. Sediments, organic matter, and nitrogen are standard endpoint variables in EDYS models. Phosphorus, bacteria (*E. coli*), and algae are components of the aquatic EDYS module. Work on these six endpoint variables is concentrating on reviewing 1) the transfer dynamics between terrestrial and aquatic modules (e.g., nitrogen, phosphorus, and sediment inputs from terrestrial areas to aquatic areas) and 2) effects of the sediments and nutrients on bacteria and algae populations. The third step (scheduled to be completed in 1Q 2015) will be to incorporate effects of animal populations (e.g., feral hogs and aoudad sheep) on water quality, primarily through physical impacts on wetlands and input of fecal material.

7. **Simulation Scenarios.** Initial simulation test runs began in 4Q 2014. These initial runs include some variations in precipitation and land management regimes, but are the purpose of testing the linkages and calibrating parameter values. Once the additional plant (Item 4) and animal (Item 5) species are included and the water quality linkages (Item 6) reviewed and testing, full simulation runs will begin. These full simulation runs will be used to evaluate the combined models. Once this level of testing is completed, the final simulation runs can be made.
8. **Report.** Preparation of the draft report continued during this reporting period. Portions of the text for the soils, precipitation, and vegetation sections have been written, along with appendix tables with supporting information. These will be expanded and completed, along with the other sections, as additional information and results become available.