USDA NRCS CIG
NRCS 68-3A75-6-142
Final Progress Report
December 16, 2010

USDA NRCS
CONSERVATION INNOVATION GRANTS
NRCS 68-3A75-6-142
Final Progress Report
December 16, 2010

Grantee Name: Arkansas Natural Resources Conservation Commission

Project Title: Quantification of impacts of on-farm water capture, storage, and re-use of surface water on water quantity and water quality

Dennis Carman, P.E., is the technical advisor for this project and as such has done most of the technical work associated with administering this project. He assumed most of the daily responsibilities for implementing this grant as a part of his duties and responsibilities as the Chief Engineer and Director for the White River Irrigation District which included representing ANRC and Mr. Young in implementing this project.

Project Director: Tom Fortner, Deputy Director for Technology
White River Irrigation District, 157 E. Front Street; P.O. Box 348, Hazen, AR 72064

Contact Information:
Randy Young, Arkansas Natural Resources Conservation Commission
Phone: 501-682-3986
Email: randy.young@arkansas.gov (Project Manager, Financial)
Email: tjsfortner@centurytel.net (Project Director)
Email: dcarmanpllc@comcast.net (Dennis Carman, P.E., technical advisor, primary source of information)

Period Covered by this report: October 1, 2006 thru August 30, 2010
Project End Date: September 30, 2009 (We request, and received a 1 year time only extension) See Attachment

Introduction

Difficulty in Report Preparation: It is very difficult to prepare this report as a final report for many reasons. One of them IS NOT for lack of progress or in completing the actual goaled tasks or items identified in the original grant application and agreement. We have exceeded the critical goals. What is difficult to convey is: 1) the importance of this initial CIG grant to the total accomplishments within the technology area; 2) the growth of technology from this "start" provided by this grant to where we are today through other programs and local efforts including additional funding; 3) the difficulty in presenting or summarizing a 4 year dedicated effort in a written document; and 4) the fact that we will never be finished with this effort. It is a continuing effort. It is extremely difficult to draw the line as to where this specific Conservation Innovative Grant stops and other efforts start. We are 100% complete with this grant and have met or exceeded

the goaled items in almost every instance. However, we have continued the data collection efforts and will continue to do so with local resources into the future.

Broad Overview: Has this CIG grant been successful? Absolutely! We have completed most of the goaled items with many of the major items exceeded including growing this technology into other important areas and accomplishments.

- We have clearly met the goals and overall intent of this grant as shown in the detailed documentation below.
- As a direct result of the initial CIG grant approval (this grant) in 2006, we have grown and expanded the technology enormously. We have technology that will not only measure the water depths and flow rates but we can now measure power use, do continuous pumping plant evaluations, measure depths of reservoirs and tailwater capture systems, report soil moisture, and control pumps and motors remotely. Although these accomplishments were not accomplished through the 2006 CIG grant, without this 2006 grant we could not have ever reached our current technology stage.
- We have also exposed the technology to other government agencies and local businesses. The Arkansas Game and Fish Commission has installed 5 monitoring systems to report water levels for wildlife management areas as an example.
- We have implemented an AWEP project based on much of the initial work and technology "learning curve" obtained from this initial grant that includes about 40 monitoring sites in place, another 40 monitoring sites scheduled for installation by March 2011, and another 150 approved applications for implementation before June of 2011.
- The basic technology is being integrated into the "normal" or "regular" USDA NRCS Conservation Delivery system.
- In addition, two companies have significantly improved their ability to deliver similar technology to others.

In summary, this 2006 CIG approval has been utilized as the **BASE** for developing and implementing technology on a statewide and region wide basis that is far in excess of the initial grant. We have taken the initial grant, learned the limitations, identified new needs, developed or modified the technology, implemented this technology through a second Conservation Innovation Grant to expand the technology, competed for and won approval for a 3 year AWEP project that we are currently implementing in specific watersheds, and are now moving the proven, developed technology into the regular NRCS Conservation Programs. None of this would have been possible without the initial BASE that was provided with this 2006 Grant.

We requested a 1 year time extension to complete some of the data collection and prepare final reports. We have also installed more data collection units within the specific project area than originally scheduled and contracted to accomplish. In addition, because of the success of this effort we now have an additional 7 installations in a broader region to measure rainfall and water status that have been funded by others.

USDA NRCS CIG
NRCS 68-3A75-6-142
Final Progress Report
December 16, 2010

Additional outcomes from this grant include the experience and technical expertise that has permitted us to expand water conservation and energy conservation efforts to continually monitor water quantity and energy use, including automated pumping plant performance evaluations. This a major improvement to the technology tool box available to irrigators. This was not a direct goal of this grant but the outcome is clearly one of the major success stories. Simply put, we have completed the major components and intent of this specific 2006 Grant and have dramatically expanded the utilization of this type of technology.

Our original items and goals as well as specific accomplishments are shown on the detailed report with accomplishments below.

Prepared and submitted by Dennis K. Carman. P.E.
Chief Engineer and Director, White River Irrigation District, 501-416-0859

USDA NRCS CIG
NRCS 68-3A75-6-142
Final Progress Report
December 16, 2010

The Arkansas Natural Resources Commission and the White River Irrigation District received a Conservation Innovation Grant from USDA NRCS. NRCS 68-3A75-6-142

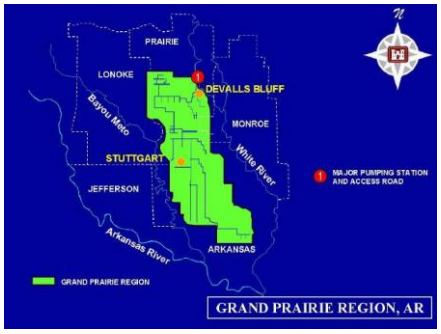
This is the final report however, if USDA NRCS or the reviewers require or request additional information, it is available. We have a large amount of support data including specific expenditures for components, personnel, or other expenses which is not included in this report because of the volume. We have detailed reports of data collected including rainfall, water levels, pumping volumes, water samples, and similar data available.

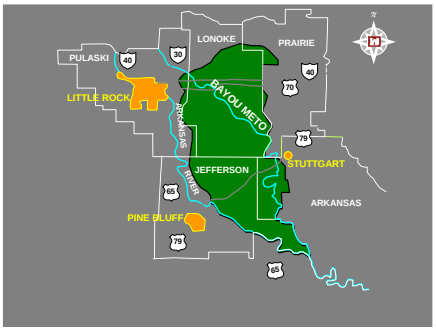
Date: December 16, 2010

The Grant was initiated in September of 2006 with dedicated work starting in January of 2007 and continuing through August 2010. We have completed the work for this grant but will continue to collect data over the next few years as well as expanding this into additional water quality collection in cooperation with the U.S. Army Corps of Engineers as we implement the Grand Prairie Irrigation Project.

Project Title: Quantification of impacts of on-farm water capture, storage, and re-use of surface water on water quantity and water quality

Where? Grand Prairie and Bayou Meto Areas of Eastern Arkansas. We expanded this activity into other locations with additional installations but the primary focus remains in the critical groundwater declines areas of Arkansas, Prairie, and Lonoke counties, Arkansas.





What we committed to do with this grant?

1) Specifically address the impacts of on-farm conservation irrigation practices and their impacts on sediment transport to surface water; irrigation management for water conservation; and maintenance of groundwater supplies through increased surface water utilization, off-stream storage and tailwater capture and reuse strategies.

2) Complete a benchmark inventory of the individual farmer's irrigation water and energy uses and determine the potential for increased on-farm irrigation storage, tailwater capture and re-use and the resulting energy savings on approximately 500 farms within the watersheds.

3) The unique focus of this activity was to develop a watershed evaluation tool that would be applicable in the humid, rain-fed portion of the U.S. to evaluate irrigation water needs, runoff, off stream storage of off season rainfall, and tailwater capture to meet irrigation needs and assess energy savings potential on a watershed basis.

What were the deliverables?
(1) Benchmark inventory of specific water use, source of water, pumping depths, type and amount of energy used for 500 farms within the geographic area in a GIS database format..

(**How many were completed**? 467 plans have been totally completed. We continue to prepare additional plans as farmers make requests)

2) 10 specific farms (locations) instrumented to continually measure the watershed inflow, watershed outflow, pumping into irrigation storage, pumping out of irrigation storage for irrigation purposes, and irrigation tailwater capture and re-use.

(**How many were completed**? 12 units installed plus a communication network which has grown to 40 locations currently through other programs and improved technology)

3) Methodology developed to assess the potential for increasing the watershed yield (and improved water quality) through increased winter water capture with controlled release

(**completed?** Yes. However the technology needs to be further refined which can only be accomplished through collection of additional data over time which we continue to do as a part of our irrigation district program)

4) Quantify the sediment reduction obtained through capture of off-season runoff, deposition within the tailwater system features, and direct capture and re-use of tailwater.

(**completed?** Partially. We collected the goaled samples and have met the initial conditions of this grant but we are not satisfied with the efforts/results. We have collected and analyzed the water samples however there is additional sampling required, specifically, the accumulated sediments within the tailwater capture system. We are finding the water quality samples alone do not adequately quantify the sediment trapping and accumulation on the bottom of the system. We can quantify the sediments within the water, how much water is stored in the reservoirs, but we are significantly underestimating the capture efficiency. Additional data collection and sediment accumulation measurements are needed (and were not a goaled item with this grant) and

will be collected during the next two years as we continue our project implementation efforts.
5) A watershed evaluation tool (model) that performs a water balance on a daily basis that balances irrigation needs, irrigation storage, pumping capacities, and tailwater capture methods on a watershed basis.

(**Completed?** Yes. The "model" utilizes SPAW, an approved USDA irrigation model, as the basic evaluation tool. We have made some basic modifications for data input, evaluations and outputs while keeping the SPAW model intact with no modifications. SPAW performs the water budget evaluation on a daily basis that includes the balance between rainfall, runoff, and irrigation needs on a daily basis. We have simply taken the output from SPAW runs for various crops of interest and performed additional daily balances for runoff, on-farm storage, irrigation needs/applications, runoff captured, runoff passing the system, and an overall farm water balance that includes off-season (winter) runoff capture, in-season (growing season) runoff capture, and irrigation needs. This answers basic questions such as 1) how much water can be reliably captured and stored from on-farm sources 2) what is the "better" balance of storage verses other sources of water 3) how much water passes by specific locations 4) what impacts changing crops has on the water balance and similar questions of interest by farmers in the lower Mississippi Valley that rely on rainfall runoff/capture/storage as a primary source of their irrigation water.

6) Establish the benchmark energy uses within the watershed and identify the potential energy savings through reduced pumping depths.

(**Completed?** Yes but not adequately to meet our needs. We have collected a significant amount of data and have developed an evaluation, inquiry and reporting process that reports pumping depths and pumping costs by geographic location over the watershed. We have the tool developed to analyze and display but not enough data for final acceptance/decisions. We have the basic information right now however it is not detailed enough to establish a reliable base for the entire watershed. We have captured data on about 30 systems but there is not enough season long reports to draw an acceptable conclusion. We will have 80 season long systems completed that will provide season long data during the 2011 irrigation season that will provide this information. The technology implemented with this specific 2006 CIG grant was simply not adequate to perform adequate detailed measurements. The improved technology that we implemented during the past year is accomplishing that task. We just need next year's irrigation season data. We performed every item originally scheduled for this 2006 grant but the technology and density of data collection was simply not adequate. We made the necessary adjustments in technology and have implemented that technology. We believe we have met the intent and conditions of this grant even though we do not have a specific, quantifiable, watershed wide energy benchmark value.

7) A watershed evaluation tool that evaluates the potential energy savings for off-season storage and tailwater capture on a watershed basis.

(**completed?** No. Not completely. We have done significant work on many of the details however we have not completed an evaluation tool. The models that will be utilized for a watershed analysis included annAGNPS as the basic tool that matches soils, topography, and landuse (crops) and performs the basic hydrology analysis. The basic technology utilized within annAGNPS is the same as what is utilized in SPAW. It is our belief and intent to utilize annAGNPS as the basic hydrology tool with modifications for tailwater systems and reservoir storage to perform the basic watershed analysis. We will utilize our collected water quality and runoff data for calibration. We have performed some basic analysis including populating annAGNPS for an initial evaluation but were unable to complete a final acceptable model. It was simply well beyond our capabilities. We continue to work on this item with ARS Oxford, MS. This is an item that we are proposing for the new ARS position at ASU Jonesboro that is in the process of being staffed by a research scientist. We believe we have made the honest effort to accomplish this goal but, at the end of the day, we have not completed this item. This was also our least important item.

Specific goals and completions? August 30, 2010

Deliverables (1-7)			
(1) Benchmark inventory of specific water use, source of water, pumping depths, type and amount of energy used for **500 farms** within the geographic area in a GIS database format..			Completed **467**
Initial data collection methodology	No. Items Goaled	Items Completed	Percent completed
Establish Geo-referenced database parameters	1	1	100%
Groundwater depths - SPARTA - 1 SQ. MI. USGS	1	1	100%
Groundwater depths - ALUVIAL - 1 SQ. MI. USGS	1	1	100%
Specific Safe Yield - SPARTA - 1 SQ. MI. Base USGS	1	1	100%
Specific Safe Yield - ALUVIAL - 1 SQ. MI. Base USGS	1	1	100%
DEM data - 1 SQ. MI - USGS	1	1	100%
Landuse - aquisition/display in GIS layer	1	1	100%
Farm Specific Inventory (500 farms)	No. Items		
Crop rotations	500	467	**93.4%**
Irrigation methods - demand	500	467	**93.4%**
source of water (surface, groundwater)	500	467	**93.4%**
type and amount of energy used	500	467	**93.4%**
Pumping plant specifics (size, type,location)	500	467	**93.4%**
(note: Additional evaluations continue as clients make requests)			
Farm Specific Evaluation/Assessment	No. Items		

Complete site specific SPAW analysis	500	467	**93.4%**
Complete site specific water source option analysis	500	467	**93.4%**
Complete site specific on-farm tailwater, capture and storage evaluation	500	467	**93.4%**
Prepare on-farm energy evaluation with options/evaluations	500	467	**93.4%**
Prepare site specific on-farm water evaluation and energy report	500	467	**93.4%**
2) 10 specific farms (locations) instrumented to continually measure the watershed inflow, watershed outflow, pumping into irrigation storage, pumping out of irrigation storage for irrigation purposes, and irrigation tailwater capture and re-use.			
Equipment - Install Mini-sats with water sensors and communication	No. Items		
Mini-sat equipment and sensors	10	12	**120%**
Mini Sat installation support	10	12	**120%**
Provide utility cost - electricity provided	10	12	**120%**
Mini Sat weekly support and maintenance	150	300	**200%**
Satellite Fee	3	3	**120%**
Note: an additional 7 installations have been completed as a direct result of this grant and implementation of this technology. Other agency resources were utilized for the cost of installations and have not been reported here. These units record rainfall, water elevation, and temperature. They are for wetland management areas and decision making.			
3) Methodology developed to assess the potential for increasing the watershed yield (and improved water quality) through increased winter water capture with controlled release			
	No. Items		
Populate data base	1	100%	100%
Evaluate runoff, capture, storage, return flow data	1	100%	100%
Ground truthing	1	100%	100%
Model Programming	1	100%	100%
(**Note:** we still have some model programming "refinements" to perform but we are essentially complete until we get another full season of runoff data. Currently we are using a spreadsheet but intend to convert the basic program and data to a more efficient (quicker) software solution.			
4) Quantify the sediment reduction obtained through capture of off-season runoff, deposition within the tailwater system features, and direct capture and re-use of tailwater.			
Collect water Quality Samples - tailwater --100 samples	No.		

	Items		
Sampling	100	100	100%
Transport to lab	100	100	100%
Water Quality analysis	100	100	100%
5) A watershed evaluation tool (model) that performs a water balance on a daily basis that balances irrigation needs, irrigation storage, pumping capacities, and tailwater capture methods on a watershed basis.			100%
6) Establish the benchmark energy uses within the watershed and identify the potential energy savings through reduced pumping depths. **Note:** We have completed the basic data collection as originally goaled. The technology was inadequate to collect enough data. We do not have enough season long pumping data to make a definitive "stand-behind" decision. That will be accomplished during 2011 irrigation season with 80 season long evaluations.			100%
7) A watershed evaluation tool that evaluates the potential energy savings for off-season storage and tailwater capture on a watershed basis. Note: We have completed a large amount of this task but do not have a completed, successful model. It is not because of lack of trying and effort. It was simply beyond our capabilities. We were too optimistic. We will complete this task sometime in the future as we continue our technology development efforts. It is important to our overall irrigation district system operation. It is not a currently critical item.			60%

How much was the funding?
Total **initial** project cost: $590,300
Total Federal funds requested (and provided): $280,300

Final Project Cost: $610,553.92
Cash expenditures: $554,656.14
In Kind contribution by others: $55,897.79

Final Federal Share: 46%
Final Local Share: 54%
Note: No costs were included for the one year, no cost extension although significant investment was made by the local sponsors to continue the data collection effort.

Why was this grant important?
This grant was critical to our short and long term **water solutions for eastern Arkansas. It got us started and we have taken clear advantage of the opportunity provided by**

NRCS through this program. We believe we have been extremely successful. It is critical to our activities in the Grand Prairie and Bayou Meto project areas as we work cooperatively with the Corps of Engineers and NRCS.

It will provide critically needed information to identify solutions to Northeast Arkansas's ground water problems as well as other locations in the lower Mississippi Delta and the Southeastern portion of the U.S. The map to the left shows new wells that have been installed in 2003 and illustrates the urgent need for solutions to our critical groundwater situation. We simply **must have more and better evaluation tools** to make informed decisions and identify better solutions.

It is a regional issue that affects much of eastern Arkansas directly but has widespread impacts and implications for the entire lower Mississippi Delta Region of Missouri, Tennessee, Mississippi and Louisiana.

Other Highlights or Accomplishments

Cooperation with the University of Arkansas at Pine Bluff: UAPB is our 1890 institution that we work closely with on implementing and promoting technology. The UAPB farm is located in the Bayou Meto Watershed and serves as a model farm where technology is implemented and shared with farmers during annual tours. We have implemented:

- two monitoring systems, instrumented one reservoir, tailwater system, and one pump for a reservoir water balance
- We have made available and installed 3 water control structures to control and measure water runoff from 3 separate evaluation fields
- Installed 3 flow measurement devices to automatically quantify the runoff including temperature and rainfall measurements.

Cooperation with USGS: We continue to work directly with USGS on sharing collected ground water and pumping data. We are using some of our detailed collected ground water and pumping results to truth current ground water evaluation models. Without this data we would have less confidence in the model outputs. We are currently focusing on monitoring actual pumping volumes as another key component to verify models, regional pumping scenarios, and truthing of models.

Cooperation with ARS: We continue to work with ARS on several water issues associated with water quality and water quantity. We are currently focusing on developing an ARS program and presence at Arkansas State University at Jonesboro, Arkansas. ARS is in the process of locating a scientist with some support staff at ASU.

USDA NRCS CIG
NRCS 68-3A75-6-142
Final Progress Report
December 16, 2010

Growth, the future: The 2006 CIG grant (this grant) was our **base**. It provided us with a place to start. 1) We have completed that grant; 2) developed new and more robust technologies utilizing a second CIG grant; 3) competed for and won approval for one of the AWEP projects that provided implementation funds for accelerated implementation 4) recruited 3 primary landowners in NE Arkansas to implement this technology on a whole farm basis.

Why is this whole farm work important? We will have one **3500 acre farm**, with a farmer as the conservation leader. The farm will have 49 pumps, motors, and wells instrumented where we can measure rainfall, temperature, water pumped, energy used, soil moisture and pumping depth for each field. The farmer competed like every other eligible farmer through the AWEP program, was ranked and approved. The farmer will pay his 35% of the cost like every other farmer. This 3500 acre farm will be instrumented for pumping, runoff and water uses and will be utilized for various water studies, nutrient studies, yield studies, and economic studies over the next few years by ARS and ASU. We are utilizing the programs to meet on farm needs as well as expand the technology development efforts and opportunities. We think that deserves special attention and recognition.

My highlighted item: From our perspective we have completed this grant to a high degree of success. We were overly optimistic about accomplishments compared to cost and time. We are proud of the technology development effort and take added pride in moving this technology into the mainstream NRCS programs. We believe that is how technology development needs to occur and **how the programs should be utilized**. We used CIG to develop the technology, AWEP to focus the implementation initially, and the EQIP regular program for other long term statewide implementation…and during the process ended up with a 3500 acre farm that will be well instrumented and will be utilized by the university and ARS researchers into the future.

Other Items accomplished but not specifically goaled:

- Hosted a delegation from Serbia
- Hosted a delegation of rice growers from Brazil
- Technology tour – Arkansas state legislature
- Article published in the SWCS magazine
- Hosted and toured the S1018 committee/group of SE Water scientists
- Made presentations and shared information with other states in the lower Mississippi River Valley.
- Developed and improved the expertise and available technology within 2 privately owned companies (Iowa and Arkansas) that can now implement technology to aide in measuring and reporting conservation parameters.

Exhibits

A. Time extension
B. Typical Water Balance Plan
C. Basic water balance model

D. Installation site locations
E. Photos
F. SWCS Journal

For additional information contact:
Dennis K. Carman, Chief Engineer/Director, WRID 501-416-0859
Randy Young, Director, Arkansas Natural Resources Commission 501-682-3986