Gain-Loss Streamflow Assessment in the Lower Guadalupe River Basin

Project Proposal

INTRODUCTION

Streamflow conditions in the lower Guadalupe River Basin (GRB) are affected by rainfall-runoff processes, point-source discharges, withdrawals for water supply, reservoir operations, springflow, and loss to aquifer recharge. During normal conditions, releases from Canyon reservoir and discharges from major springs (Comal, San Marcos, and Hueco springs) account for most of the streamflow in the lower Guadalupe River. A better understanding of how gains, losses, inflows, and withdrawals affect downstream flows can help resource managers design watershed management and operation strategies to improve utilization of available water resources.

OBJECTIVE

The objective of the study is to perform streamflow discharge measurements at selected sites on the Guadalupe River and Guadalupe River tributaries to help understand locations and quantities of possible gains and losses of streamflow.

SCOPE

The proposed study area includes the Guadalupe River from Canyon Dam and reservoir to the Guadalupe River near Tivoli, Texas, near state Highway 35. Measurements also will be made on selected tributaries, including Comal River, San Marcos River, Blanco River, Plum Creek, Sandies Creek Peach Creek, Coleto Creek, and the San Antonio River. Compilation and analysis of withdrawal and discharge data, and streamflow from available continuous gaging stations in the study area will be used with synoptic discharge

measurements to determine possible gains and losses for various reaches of the Guadalupe River and major tributaries.

APPROACH

In 2008, The USGS published a study of the analysis of gains and losses in the Guadalupe River, *Streamflow Conditions in the Guadalupe River Basin, South Central Texas, Water Years 1987–2006—An Assessment of Streamflow Gainsa and Losses and Relative Contribution of Major Springs to Streamflow (Ockerman and Slattery, 2008).* This study was based largely on available data from USGS gaging stations in the study area. In this new study, the USGS proposes to supplement data from gaging stations with synoptic streamflow measurements at selected sites.

The USGS, in cooperation with other agencies, maintains a network of about 28 continuous streamflow gages in the lower Guadalupe River basin (figure 1 and table 1). Besides the existing network of streamflow gaging stations, approximately 10 to 15 additional miscellaneous measurement sites will be identified to be added to the measurement network. Most of the additional sites will be located on tributaries to the main stem of the Guadalupe River. Other criteria for establishing additional measurement sites include: boundaries of aquifer outcrops, locations of known permitted discharges and withdrawals, reaches with reservoirs or other regulation, and site accessibility. After establishment of potential sites from a review of maps, a field reconnaissance of the potential measurement sites will be made to identify suitable measurement locations.

Two sets of streamflow synoptic measurement are planned. During each synoptic study, streamflow will be measured at all of the approximately 40 stations during a period of about 5 days. The synoptic study will be scheduled during periods of relatively stable baseflow, when significant rainfall and storm runoff are not occurring and have not occurred for at least two weeks. In this way, effects of runoff and unsteady flow conditions can be minimized in the estimation of gains or losses within the various stream reaches. If there is

not a significant change in stream flow conditions after the first set of synoptic measurements, USGS will meet with EAA personnel to decide if/when a second set of synoptic measurements will be warranted.

All streamflow measurements are expected to be made using acoustic Doppler technology. For sites that can measured by wading, Acoustic Doppler velocimeters will be employed to measure streamflow by the velocity-area method (Rantz and others, 1982). For sites where the measurement cross section is deeper, Acoustic Doppler current profilers will be used to measure discharge by the moving boat method (Mueller and Wagner, 2009). The estimated error of an individual discharge measurement is typically about five to ten percent. During each synoptic study, duplicate measurements will be made at selected sites. For quality assurance purposes, about three or four sites will be selected for duplicate measurements during each synoptic survey.

USGS gaging station locations will be used to define a set of stream reaches, or segments. For these stream reaches, streamflow gains and losses will be calculated for each selected synoptic period. During each synoptic period, streamflow will be determined at upper and lower boundaries of each reach. Gain or loss in each reach will be calculated as:

$$\Delta S = \text{Outflow} - \text{Inflow} - \text{Discharges} + \text{Withdrawals}$$

Where ΔS = gain or loss of streamflow within a stream reach, Outflow is streamflow at downstream boundary of reach. Inflow is streamflow at upstream boundary of reach. Discharges are reported flows into stream reach (such as wastewater discharges) and withdrawals are reported quantities taken from the reach. Evaporation, aquifer recharge, ground-water inflow, or other unreported or unmeasured water-budget components are not explicitly measured but are assumed to be included in the overall gain or loss within the reach. Estimated possible errors will be calculated for every streamflow measurement. Possible errors will be included in the gain/loss calculation so that estimated gains (losses) are reported as a possible range.

Streamflow conditions in the main stem of the Guadalupe River are at times unsteady because of hydropower operations. Selected instantaneous streamflow measurements will not necessarily provide sufficient data to determine gains or losses in the reach. Rather, gain/loss

determinations will be calculated (from the equation above) using average discharge data from the continuous gaging stations that define endpoints of the stream reaches. Streamflow data from the continuous streamflow gaging stations will be averaged over the entire synoptic period (approximately 5 days) to provide a more reliable average of flow conditions and gain/loss determinations. Also, streamflow travel times will be considered in the gain-loss determinations. Within-reach travel times can be estimated by observance of the occurrence and timing of the effects of hydropower operations (for example, opening and closing of gated structures) on streamflow hydrographs at each gaging station. Besides measurements at the continuous gaging stations, synoptic measurements also will be made at other locations, primarily focusing on tributaries, where streamflow is relatively steady.

Locations of major wastewater discharges will be identified and TCEQ and selected individual dischargers will be contacted to determine discharge quantities during the measurement synoptic. A similar accounting for permitted withdrawals also will be made. In the previous USGS study of Guadalupe River gains and losses, monthly discharge and withdrawal data were used for gain/loss calculations. In this study, the TCEQ South Texas water master will be contacted for daily data on withdrawals during the measurement synoptic.

At present (September 2009), most streamflows in the lower Guadalupe watershed are below median flow conditions. Streamflow at station 08173900 Guadalupe River at Gonzales was about 380 cubic feet per second on September 21 which represents approximately the 15th percentile streamflow. These current conditions would provide a good opportunity to observe gains and losses during low-flow conditions. So, the first measurement synoptic, depending on changes in streamflow conditions, is planned for Oct-Nov 2009. A second measurement synoptic is planned for around January 2010, depending on flow conditions. The purpose of the second synoptic is to observe gain/loss conditions during different streamflow, climatic and water-use conditions.

DELIVERABLES

Measurement data will be reviewed and entered into the USGS database according to established quality-control procedures. Streamflow measurement data will be published in the 2010 USGS annual data report.

A USGS report will be published that will document the measurements and gain/loss calculations. The target date for completion of the draft report is Sept 30, 2010. The report will be reviewed and published in Q2 of FY11.

TIMELINE

A project timeline is shown below. The timeline is based on the project beginning in Oct 2009.

Description	Oct 09	Nov 09	Dec 09	Jan-Mar 10	Apr-Sept 10	Oct 2010-Mar 2011
Site Reconnaissance and establish network of sites						
Measurement Synoptic 1						
Measurement Synoptic 2, timing dependent on conditions						
Data compilation, review, and analysis						
Complete draft report					•	
Review and publish USGS report						•

BUDGET

Category	FY10	FY11
Site reconnaissance	$ 8,000	
Synoptic 1	$ 25,500	
Synoptic 2 (optional)	$ 25,500	
Draft report preparation	$ 46,000	
Final report preparation		$ 37,000
Total	$ 105,000	$ 37,000

AGENCY CONTRIBUTIONS

Agency	FY10	FY11
Edwards Aquifer Authority	$80,000	$27,000
U.S. Geological Survey	$25,000	$10,000
Total	$105,000	$37,000

REFERENCES

Mueller, D. S., and Wagner, C. R., 2009, Measuring discharge with acoustic Doppler current profilers from a moving boat: U.S. Geological Survey Techniques and Methods 3A-22, 72 P.

Ockerman, D. J, 2008, Streamflow conditions in the Guadalupe River Basin, South-Central Texas, Water Years 1987 – 2006—An assessment of streamflow gains and losses and relative contribution of major springs to streamflow: U.S. Geological Scientific Investigations Report 2008–5165, 22 p.

Rantz, S. E., and others, 1982 Measurement and computation of streamflow, Volume 1, Measurement of stage and discharge: U.S. Geological Survey Water Supply Paper 2175, 284 p.