Water Monitoring Project

A Surface Water - Groundwater (SW-GW) Monitoring Project in the Colorado and Brazos River basins and the Carrizo-Wilcox, Queen City, Sparta, Colorado Alluvial, and Brazos Alluvial Aquifer Groups in Bastrop and Lee Counties, Texas

by

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Environmental Stewardship

BRINGING SCIENCE TO DECISION-MAKING

GUIDANCE DOCUMENT

Revision 1

DRAFT 1

June 2024

INTRODUCTION

Over the last two years Environmental Stewardship has engaged interns and personnel and outfitted and equipped a water monitoring trailer to serve as a local water monitoring team to investigate and document surface water-groundwater interactions in Bastrop and Lee Counties, Texas. The project serves to advance our founding mission to protect, conserve, restore, and enhance the earth's natural resources in order to meet current and future needs of the environment and humans by gathering and using scientific information to restore and sustain ecological services provided by environmental systems. The information derived from the project serves to bring science to decision-makers and environmental outreach and education to the public thereby encouraging good public stewardship. As such, the Water Monitoring Project per se, falls under Environmental Stewardship's Science and Ecology purpose and informs its Public Policy, Outreach, and Education purposes.

The territorial scope of the project serves to enhance the existing, but disconnected monitoring programs in Central Texas where separate programs are operated by the Texas Commission on Environmental Quality (TCEQ) for surface waters within defined river basins, and local groundwater conservation districts, such as the Lost Pines Groundwater Conservation District (LPGCD) for groundwater with county jurisdictions. Neither of these two programs coordinate nor share efforts and data in a way that is aimed at conjunctively protecting, conserving, understanding, and beneficially using the surface and groundwater under their overlapping jurisdictions. To that end, it is necessary that the territorial scope of this project be broad enough to include the groundwaters that are under the jurisdiction of the LPGCD and the portions of the river basins that interact with these groundwaters in the Lower Colorado River Basin (Basin 14) under the jurisdiction of the Lower Colorado River Authority, and the Brazos River Basin (Basin 12) under the jurisdiction of the Brazos River Authority. It is anticipated that interaction between these stakeholder entities will evolve more-or-less organically as this project unfolds.

The water monitoring program is based on measuring stream flow and water chemistry in rivers, streams and domestic wells in areas where groundwater discharge is thought to occur or is otherwise relevant to the conservation and protection of these precious resources. Data sets of well, spring, and stream water quality data are used to determine if it is likely that the stream water and well water come from the same aquifer source, and at what rate the groundwater is being discharged to the stream. These data sets will be used to inform the groundwater availability model (GAM) to populate specific cells with surface water-groundwater interaction data. The well depth data will be used to monitor the water level in the Colorado River Alluvium (Colorado Alluvial Aquifer) to determine whether the river is being managed in a way that will maintain a gaining relationship through a repeat of the Drought of Record (2010-2015).

The mobile laboratory is equipped with professional grade scientific instruments including a SonTech FlowTracker 2 Doppler stream flow instrument, a Yellow Springs Instruments (YSI) Pro DDS (Digital Data System) water quality instrument that provides data of suitable quality to meet or set the standards required to estimate the likelihood of the stream and well water being from the same water source (aquifer or stream), and an Eco Scientific Well Sounder capable of measuring depth from surface to water in domestic water wells, as well as other equipment needed to maintain an off-grid mobile laboratory.

A key to success will be to recruit and incentivize several water monitoring specialists (intern/trainee) that can be groomed to run an independent local program under the leadership of a state university such as the Texas Stream Team or a nonprofit organization such as Environmental Stewardship.

GOALS

Goal 1. To develop a capacity to use modern scientific tools and methods to collect, analyze and report field data and provide such scientific information to decision-makers so as to better inform the management and regulation of surface and groundwater resources in Bastrop and Lee Counties, and the State.

Goal 2. To acquire the instruments and equipment to enable a trained crew to conduct such field studies as are necessary to quantitatively and qualitatively describe the flow relationships between surface water and groundwater in order to inform decision-makers and the public of current conditions and what the predicted impacts of over-pumping the Carrizo-Wilcox Aquifer Group water resources are on in Bastrop and Lee Counties.

Goal 3. To re-purpose the Environmental Stewardship trailer to serve as a mobile laboratory for use off-grid in rural parts of Bastrop and Lee Counties.

Goal 4. To assemble and train a group of persons interested in the study and management of aquatic ecosystems to produce a sustainable water future for the biological and human communities in Bastrop and Lee Counties.

Goal 5. To identify field sites that appear to have surface water and groundwater interactions such that the development of field data to quantitatively describe these relationships is likely and can serve as education and demonstration sites for increasing public awareness and appreciation of the importance of good management to a sustainable water future for Bastrop and Lee Counties.

Goal 6. To conduct scientific studies on such field sites as described in Goal 5 that will be useful in educating and informing landowners, decision-makers, and resource managers on how best to realize a sustainable water future in Bastrop and Lee Counties.

OBJECTIVES

Wilbarger Bend Education/Demonstration and Study Project (SAP): Having accomplished all or part of several of the above goals, it is the immediate objective to design a project that has the potential to bring together the coalition of concerned individuals and organizations that have interests in the conservation and protection of the Colorado River basin between Austin and Bastrop with those entities that have an interest in the growth and development on the area to find solutions that balance these interests in a way that is both economically and environmentally sustainable.

Protection of Colorado River from degradation by disposal of treated wastewater, stormwater, and other TPDES permitted activities that impact the capacity of the ecological systems to fully support the Exceptional Aquatic-Life, Primary Drinking-Water, and Recreational Use Standards that have been designated to Segments 1428 and 1434 of the river by using such means as are available, prudent, and necessary.

Protect the Aquifers of the Area — the Carrizo-Wilcox, Queen City, Sparta, and the Colorado and Brazos Alluvial Aquifers — from being depleted by over-pumping thereby causing harm to surface water resources and landowner groundwater in Bastrop and Lee Counties by advocating for desired future conditions in Lost Pines Groundwater Conservation District and Groundwater Management Area 12 that are both attainable and sustainable.

Conjunctive management of surface and groundwater through holistic local and regional management practice.

THEORETICAL AND SCIENTIFIC BASIS FOR UNDERSTANDING THE PHYSICAL, ECONOMIC, AND SOCIAL IMPACTS OF WATER MANAGEMENT AT THE SURFACE WATER-GROUNDWATER INTERFACE

To better understand the value and inform the management practices that are influenced by water policy decisions and ultimately determine the future and sustainability of water supply and water quality we need to understand the science and models that are used to predict and measure future scenarios that can result from the policy decisions. To more accurately quantify those future scenarios, it is necessary that the models be refined to more accurately account for surface water and groundwater interactions on a quantitative basis.

The purpose of the proposed Water Monitoring Project is to provide qualitative and quantitative field data that will inform the Groundwater Models (GAMs) and Surface Water Models (WAMs) that are used by planners such as the groundwater districts (GCDs) that are a part of Groundwater Management Area 12 (GMA-12). GMA-12 is composed of the following groundwater districts:

Groundwater Conservation	Counties Included	River Basins/Authorities
Lost Pines GCD	Bastrop & Lee	Colorado (LCRA) and Brazos (BRA)
Post Oak Savannah GCD	Milam & Burleson	Brazos (BRA)
Fayette County	Fayette	Colorado (LCRA)
Brazos Valley	Brazos & Robertson	Brazos (BRA)
Mid-East Texas	Madison, Leon & Freestone	Brazos (BRA)

For the purposes of this study, we will focus on the interactions between Lost Pines GCD and the neighboring Post Oak Savannah and Fayette County GCDs. The GMA-12 Groundwater Availability Model (GAM) is the formally adopted model that is used by these districts to predict future scenarios in order to guide the development of desired future conditions (DFCs) for the aquifers associated with these counties and the surface waters that interact with these aquifers.

Figure 1 shows the extent of the Colorado River Alluvial Aquifer (Colorado Alluvial Aquifer – CAA). Wilbarger Bend (shown as the primary study site) is located in northwest Bastrop County extending from the Travis County line to the Hwy 969 bridge across the river near Utley and designated as Segment 1428, [subsegment designation]. The extended territorial study site easily could include Segment 1434 that extends through Bastrop County and to La Grange in

Fayette County. Both of these segments are designated for Exceptional Aquatic-Life, Primary Drinking Water, and Recreational Use by Texas. Many of the same concerns exist in the extended territory with the exception of the key intersection between the Simsboro and Hooper Aquifers. The extended territory would include areas of interaction with the Sparta, Queen City, and [name] Aquifers in south-east Bastrop County and north-east Fayette County.

Figure 2 shows the proposed Wilbarger Bend study site located in near proximity to recent industrial development where there have been recent requests for new or expanded wastewater treatment plants, and the location where the Simsboro and Hooper aquifers are predicted to exchange water with the Colorado River.

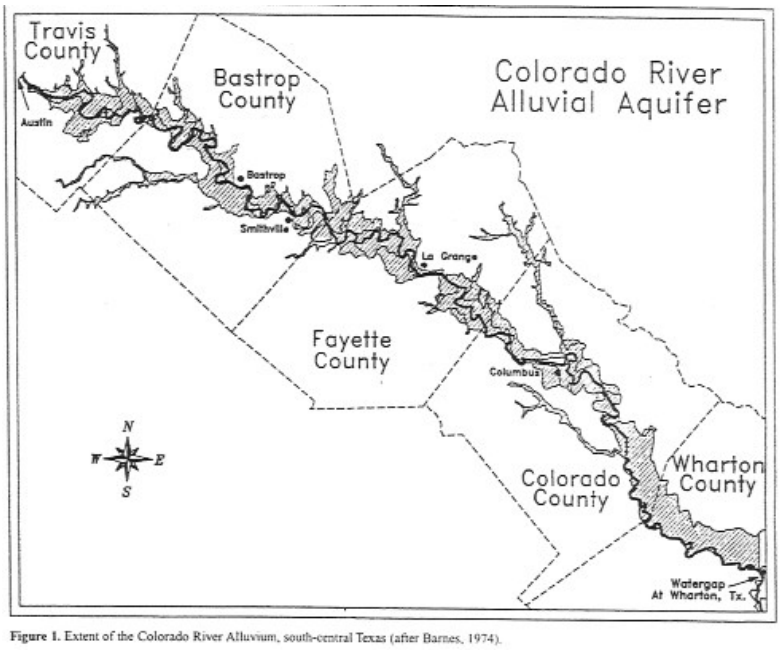

Figure 1. Extent of the Colorado River Alluvium, south-central Texas (after Barnes, 1974).

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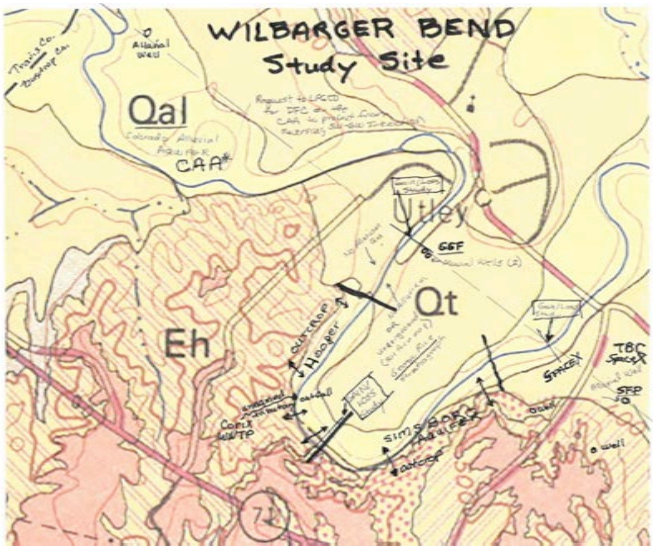

Figure 2. Wilbarger Bend Study Site in Segment 1428 of the Colorado River below Lady Bird Lake.

HYPOTHESIS AND PREDICTED OUTCOMES OF OVER-PUMPING OF THE SIMSBORO AQUIFER

Environmental Stewardship's water monitoring efforts[1] have resulted in the hypothesis that the primary interaction between the Colorado River, the Colorado Alluvial Aquifer (CAA) and the Simsboro and Hooper aquifer formations of the Wilcox Group occur in the Wilbarger Bend reach of the river (Figure 2). The purpose of the study is to test this hypothesis by conducting gain/loss studies in the segment to determine if there is a quantifiable gain in water flow from the upper portion of the bend to the river bridge. If there is a significant gaining relationship, and the chemistry of the water is comparable to the chemistry of Simsboro and Hooper groundwater formations, then it would be reasonable to conclude that the flow is being contributed by these aquifers.

The primary concern from this conclusion would be that a potential scenario[2] of the groundwater availability model (GMA-12 GAM) predicts that over-pumping of groundwater from these formations will cause a reverse in the flow of water that currently comes from the aquifers into the river causing it to be a "gaining" stream. Should such a reversal occur it would allow water to flow from the river to the aquifers causing it to become a "losing" stream. Such a reversal would cause the flow of surface water into the Simsboro aquifer formation that is becoming the primary source of drinking water for the City of Bastrop, and the Aqua Water Supply service area.

A reversal in flow condition could result in the Simsboro aquifer becoming contaminated with the soup of chemical substances[3] that are in the river due to disposal of stormwater, treated wastewater, and other TPES permitted outflows into the river (such as the Bastrop Energy Sources power plant in Cedar Creek that has recently applied for a renewal of their permit to dispose of 2 million gallons of treated cooling water into the river near Pope Bend above the Wilbarger study site. The proposed 10x expansion of the Corix McKinney Roughs Wastewater Treatment Plant (WWTP) would dispose of 510,000 gallons per day of treated wastewater just above the sensitive study site. As such, the question becomes whether it is prudent to expand the WWTP in this location, relocate the project to another site, or tie the project into the City of Bastrop Wastewater Treatment Plant No. 3, and whether the quality of the cooling water continues to be acceptable to be disposed of into the river.

POTENTIAL FUTURE SW-GW INTERACTION MONITORING SITE

The Wilbarger Bend Study Site (Figure 2) could prove to be an excellent location for an automated SW-GW monitoring station to collect data and monitor trends necessary to protect this segment of the Colorado River and the Colorado Alluvial Aquifer from experiencing the unreasonable impacts that are predicted to result from over-pumping of the Simsboro and connected aquifers. The site is situated between key river gauges (see APPENDIX 1) that could be used as part of a well monitoring network to inform desired future conditions on the Colorado Alluvial Aquifer.

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[1] December 11, 2023, Float Trip where the YSI Pro DDS was used to take 160 chemistry readings that show statistically significant changes between the upper bend (first half of the samples) and the lower bend from McKinney Roughs to the bridge.

[2] Cite GAM run #

[3] PFAS, water treatment chemicals, pharmaceuticals and other industrial chemical compounds that are not removed by the water treatment technologies employed by wastewater treatment plants below Austin in Travis County and further down-river.

During the period from 2019-2021 the Texas Water Development Board (TWDB), through Contract No.1900012305 with LCRA and performed by R.W. Harden and INTERA, a Pilot SW-GW monitoring project was conducted at the request of the Colorado and Lavaca Basin and Bay Area Stakeholder Committee (CL-BBASC) to evaluate the methodology to do such studies in this segment of the river. Field data from such a monitoring site would be and is suitable to inform the GMA-12 Groundwater Availability Model (GAM2020). As such the Lost Pines GCD and the LCRA will be invited to participate in the Wilbarger Bend Study in an advisory and funding capacity.

In addition, the Wilbarger Bend Study Site might offer opportunities as a Custom Supplemental Environmental Project (SEP) under Section 7.067 of the Texas Water Code that local stakeholders would designs, proposes, and implements after approval from the TCEQ. A custom SEP[4] must have a significant, enduring, and quantifiable environmental benefit. A custom SEP cannot be used to address the respondent's violations. Creating a custom SEP can be time consuming, but it allows the respondent to plan a project around the specific environmental needs in the respondent's community. As such, regulated entities surrounding the study site would be able to direct financial support to the custom SEP in order to satisfy its obligations under enforcement actions related to violations of TCEQ jurisdiction permits in the region.

GENERAL PROJECT DESCRIPTION

The project will entail measuring stream and spring flow, well water levels and chemical characterization in relation the Colorado River Alluvium (Colorado Alluvial Aquifer - CAA) and comparing those levels to historical low-flow of the river during the 2010-15 drought. Such an evaluation will inform the depth that needs to be maintained in the CAA in order to avoid a reversal during a repeat of the most recent drought of record. See APPENDIX 2 for more detailed information.

The data collected will consist of the same key parameters used in the pilot program mentioned earlier to identify sources of water (aquifers or surface waters) thereby linking qualitatively and quantitatively well waters/aquifer sources with surface water flows using manual instrumentation of similar quality. The resulting data should be suitable as input data to the GMA-12 updated GAM to further calibrate and confirm the SW-GW interaction capabilities of the model alongside similar data collected at fixed stations. The data collected will cover a larger and more diverse geographic area than is possible with stationary stations and will link specific stream and spring flows on public and private properties with communicating groundwater formations. Overall, the project will advance the reliability of the GAM predictions regarding the current and future impacts of groundwater pumping on the surface waters, and to establish criteria and practices such as adopting desired future conditions to protect surface waters in Bastrop and Lee Counties, Texas.

Environmental Stewardship's interest is to have an ongoing monitoring program to ensure that the surface water and groundwater interests of the communities and environment of Bastrop and Lee Counties are protected.

[4] TCEQ Supplemental Environmental Projects (SEPs), Putting fines to work closer to home. GI-352, Rev. 10/15.

MANAGING A REGIONAL WATER SYSTEM

The State of Texas has historically managed water in a segmented manner with surface water and groundwater being managed by separate laws and regulatory agencies. These practices are not likely going to change in the near future. However, to holistically manage water in a region of the state would benefit from considering the components of the water resource system, the sources of water, how the sources interact, how they are used, how they are processed through the system (treated), how they are returned to the system, where the water is needed, and what are the implications of management decisions on the sustainability of the system. Some of these topics have been addressed in this paper.

What I want to address now are two important topics in the management of the lower Colorado River basin system from Austin to La Grange (Segments 1428 and 1434). Let's call it the Bastrop-La Grange System or "our" regional system that also corresponds to Environmental Stewardship's Waterkeeper Alliance designated exclusive territorial jurisdiction (APPENDIX 3).

First, I will address the hydraulics of the system, and then the water quality of the system. From a hydrological viewpoint a river basin system has two primary sources of water; surface water and groundwater (both of which are derived from atmospheric rainwater). We have discussed the importance of the interaction between these two component sources. What we want to address next are the hydraulics and then the water quality of the system.

Hydrology of the water system – There is a need to manage the hydrological dynamics of the system in a way that maintains the ecological functions that are performed in relationship to rainfall; wet, dry, and drought conditions. Groundwater is an important source of drinking water in our regional system. Unlike the City of Austin, most of the drinking-water in the lower basin is derived from groundwater. Hydrologically there are inflows, outflows, and exchanges within our system.

Inflows

Inflows to our regional system come from water released to the lower basin from the Highland Lake system managed by LCRA under strict regulatory guidance through the Highland Lakes Water Management Plan administered by LCRA and regulated by TCEQ as directed by the Legislature based on the Conservation Amendments to the Texas Constitution. We will call these "regulated inflows" or "Highland Lake outflows".

Other inflows to the system are horizontal movements of water between aquifers as regulated by groundwater conservation districts and GMA-12. Vertical flows of groundwater from deep aquifers to shallower aquifers and finally to the surface water component are captured sources of water that are brought to the surface by the artesian pressure of the aquifers, or by pumps in groundwater wells. The vertical source of groundwater is considered stored water in groundwater management terminology.

Rainwater is the other primary source of water into both the surface and groundwater systems. Stormwater runoff into stormwater sewer systems and directly into rivers, streams, and karst aquifers (like in the Hill Country) is rather immediate. Rainwater that infiltrates into sand aquifers like we have in our water system is extremely slow (days, year, decades, millenniums).

The result is that rainwater that infiltrates into our system may be thousands of years old by the time it reaches the surface through artesian pressure or is pumped.

Return flows

Water that is derived from surface water or groundwater, used, sometimes treated, and returned to the system is often referenced as “return flows” or “wastewater”. From an ecological and economic systems perspective, we need to stop considering used water as wastewater so that we manage the treatment of such water in a way that serves the limitations and needs of the receiving water system, whether it be a return flow to a surface, ground, municipal, industrial or other use status. For example, the return flows to the river from what are currently termed wastewater treatment plants (WWTP) need to be treated to a level that helps improve or maintain (fully support) the regulatory designated uses of the receiving system, in our case: exceptional aquatic-life, primary drinking water, and recreational uses. To a limited extent, the current methodology used by TCEQ for permitting such return flows takes into consideration these regulated uses by requiring that the WWTP outflow into the system at the outfall meets criteria designed not to degrade the water quality and designated uses of the receiving water. This is an area where Environmental Stewardship, our Coalition, TCEQ, treatment plant operations (such as Corix and the City of Bastrop) and our local elected officials need to give greater consideration to the level of treatment that is required — and not just economically feasible — to maintain Sections 1428 and 1434 (our water system) at a level that fully supports the designated uses based on data that has been timely collected and evaluated in relation to the current water quality status of the river and its tributaries. The 2022 adopted revisions to the TCEQ guidelines seems to take a step in this direction.

Outflows

Outflows from our water system include surface water that runs down the river to Matagorda Bay and the Gulf of Mexico. Though LCRA likes to claim all the water goes to the Gulf, there are actually two routes; a channel dug many years ago to route river flow directly to the Gulf (LCRA has a Nature Park in the vicinity of the confluence with the gulf). The other is a structure that re-routes much of the flow back to Matagorda Bay as was the original case. This is important because it provides badly needed freshwater inflows to the bay that help maintain the salinity at a lever that is conducive to shrimp and oyster growth, and especially survival during drought conditions.

Surface water that runs down the river is known as “run-of-river” water. The other major outflow is evaporation from surface waters (especially lakes and large rivers), and transfer of permitted groundwater and surface water (through surface water rights) to users outside our system. For example, LCRA manages water rights in the lower basin and passes water through our system to be delivered to users in the basin below our system such as for irrigation in Colorado, Wharton, and Matagorda Counties. Another out-of-system diversion is to Corpus Christi, and the other major diversion permit is for the South Texas Nuclear Project. Most of this downriver water demand is met by releases from the Highland Lakes and run-of-river flow except for during high water rain events. This flow through our system provides hydrological and ecological benefits to our system.

Other outflows are from groundwater permits to Recharge Water (formerly End Op) and GateHouse (formerly Forestar). Both of these permits provide for the conveyance of the water by pipeline out of the Lost Pines GCD jurisdictional territory.

Exchanges

The main exchange of water in our system is from groundwater to municipal drinking water and industrial as cooling water. This exchanged water is typically considered "wastewater" when it is returned to the Colorado River by way of tributaries from wastewater treatment plant outfalls. As mentioned earlier, this is water that we need to start thinking of as "return flows" that are treated to match the needs of the receiving water. Rather than thinking of this water as "waste", we need to start thinking more seriously about higher value re-use of the water. An example of an alternative use that is gaining acceptance is to use the water as "gray water" for irrigation. Of course, like with the soup of chemicals that pass through the treatment plants, this water likely contains the same soup of chemical so the location of use — like golf courses and public spaces — is likely more acceptable and beneficial than to use the water for irrigation of food crops.

Water Quality of the System – The water quality of water that is exchanged within our regional water system, imported into our system, and exported out of our system needs to be commensurate with the water quality needed to maintain or restore the designated uses of the Colorado River with Segments 1428 and 1434; Exceptional Aquatic-Life, Primary Water-Supply, and Recreational uses. Environmental Stewardship and our Coalition of concerned individuals and organizations will need to be vigilant about stipulating and enforcing water quality standards in the region.

STATUS AND IMPACT OF LEGAL INITIATIVES INVOLVING WATER MONITORING

Environmental Stewardship has had some significant wins in its legal initiatives in the administrate and judicial systems over the past several years. In 2013 ES and three landowners attempted to become parties to a contested case hearing regarding a groundwater permit application at Lost Pines Groundwater Conservation District (LPGCD). A ruling by Judge Carson Campbell in Bastrop District court, concluded that these landowners were wrongfully denied party status in the hearing. The decision by Judge Campbell remanded the case back to the groundwater district. Upon appeal by End Op, the permit applicant, the ruling was reversed on a technicality. However, some five years later, when LCRA filed an application for groundwater pumping permits on the Boy Scout Griffith League Ranch property, neither LCRA nor Lost Pines GCD objected to Environmental Stewardship's request, and that of about 45 other landowners (The Grissom Landowners), and they were granted status as affected persons allowing them to participate in the hearing. The significance of the case was that the Judge's decision acknowledged that since the landowners own the water under their land by statute, they have the right to participate in court proceedings whether or not they have a groundwater well on the property.

For Environmental Stewardship it was an opportunity to bring surface water-groundwater arguments before the administrative law judges. Consistently throughout our legal initiatives our arguments have prevailed on the merits and have only been derailed on technical matters. Our arguments, based on good science, have prevailed in every matter ES has challenged.

LCRA Griffith League Ranch Groundwater Permit Application – is on appeal. Environmental Stewardship joined several water supply companies in contesting this application because of the quantity of water being requested from the Boy Scout Ranch property that had been evaluated earlier and been determined only to be capable of sustainably producing about 1/3 of

the amount of water being requested. ES argued that the groundwater availability models predicted that the volume of water to be pumped from these Simsboro wells would cause the Colorado River to become a “losing” stream which is an unacceptable impact due to the ecological impacts on the river and its aquatic fish and invertebrate communities, and because the reversal in flow would reduce or eliminate inflows to the river during drought conditions. These findings were sustained by the administrative court and included in the permit conditions.

In addition, recently we have collected data to that leads to the hypothesis that such a reversal in the vicinity of Wilbarger Bend would cause the soup of chemicals in the river to flow into the alluvial aquifer and thence into the Simsboro and risk contaminating the drinking water supply for most of west-central Bastrop County (City of Bastrop and Aqua Water Supply Corporation Simsboro wells in the area).

Based on the science, which was also agreed to by the groundwater district, Environmental Stewardship required that a special condition be included in the permits, that would require LCRA to install a surface water-groundwater monitoring network to gather field data to inform the GMA-12 GAM that predicted the unreasonable impacts and to inform decisions on how to manage the situation. The Administrative Law Judges (two ALJs) and Lost Pines GCD agreed, and the special condition was included in the permit that was granted.

LCRA has appealed these decisions in an attempt to both increase the quantity of pumping permitted and to rid the permit of this monitoring requirement. LCRA lost its first appeal and now have appealed for a second time. The irony is this second appeal tries to reverse a ruling by the Bastrop District Court in the earlier case involving ES and three landowners that granted ES and the landowners the right as affected persons to be included as parties to the End Op Contested Case Hearing.

Corix McKinney Roughs WWTP permit application – is pending a Contested Case Hearing granted to Environmental Stewardship and long-term recreational fisherman Richard Martin.

ES argues that the TCEQ has failed to collect and assess the scientific data and information needed to determine whether the river system is healthy enough to be supportive of the uses delegated to the river system (See Findings of Fact in APPENDIX 4). The result is that TCEQ is unable to say that the river is healthy, and only claims that it is not on the state’s impaired water list. In response ES argues that the scientific evidence must be collected and assessed to determine the ability of the river to assimilate the amount of wastewater proposed for disposal into it before a permit can be issued. The bottom-line questions are: 1) is this segment of the Colorado River impaired, 2) is it capable of assimilating the wastewater without being further degraded, and 3) is the level of treatment of the wastewater commensurate with maintaining or, if necessary, improving the water quality of this segment of river to a point where it is fully supportive of the designated uses.

APPENDIX 1. RIVER GAUGING STATIONS with Primary and Extended Territory of the Wilbarger Bend Study Site

Gauging Station Location in Bastrop and Lee Counties that can serve as site for river/stream stage data.

COLORADO RIVER WATERSHED

1. **Colorado River @ Webberville - Site 5423**
    a. Location: unknown location down-river from Webberville.
    b. Description: Gauge located in river alluvium surrounded by fluviatile terrace deposits with Midway Group deposits down river. This site is above the intersection of the Carrizo-Wilcox Group intersection with the river.

2. **Colorado River @ Utley - Site 5450**
    a. Location: Hwy 969 bridge south of Utley, TX
    b. Description: Gauge located at river bridge in Colorado River alluvium with fluviatile QT terrace deposits associated with the Hooper and Simsboro outcrops on the North and the Hooper, Simsboro and Calvert Bluff to the South. This location is above the confluence of both Wilbarger and Sandy Creeks with the Colorado River.

3. Wilbarger Creek @ Elgin - Site 5464
    a. Location: 2810-2814 FM 1704
    b. Description: Gauge located on Wilbarger Creek in fluviatile terrace deposits with Hooper outcrop on both banks. Simsboro outcrop just down-stream on north bank at confluence with Colorado River. Calvert Bluff outcrop below confluence.

4. Big Sandy Creek near Elgin - Site 5473
    a. Location: 2333-2361 N Hwy 95, Elgin, TX
    b. Description: Gauge located on Big Sandy Creek with Calvert Bluff outcrop on both banks and Camp Swift Military Reservation immediately East. Simsboro outcrop located on North and South sides of Calvert Bluff outcrop.

5. Colorado River @ Bastrop - Site 5499
    a. Location: Hwy 21/71 bridge in Bastrop
    b. Description: Gauge located on bridge with alluvium and fluviatile QT terrace deposits associated with the Carrizo outcrop on the East bank. Calvert Bluff outcrop just up-river associated with the Piney Creek watershed, Bastrop Lake, and LCRA Power Plant.

6. Cedar Creek near Bastrop - Site 5521
    a. Location: 581-599 FM 20, Bastrop, TX
    b. Description: Gauge located on bridge with alluvium and flluviatile QT terrace deposits associated with the Calvert Bluff and Simsboro aquifers on the north banks and the Wilcox Group (Ewi) sands on the south bank.

BRAZOS RIVER WATERSHED (Lee County)

7. Middle Yegua Creek near Dime Box, TX - USGS Station 08109700
    a. Location: East Hwy 21, E TX 21.
        i. Lee County, Texas, Hydrologic Unit Code 12070102
        ii. Latitude 30°20'21", Longitude 96°54'16" NAD27
        iii. Drainage area 236 square miles

iv. Contributing drainage area 236 square miles
v. Gauge datum 295.40 feet above NGVD29

b. Description: Gauge in alluvium on the borders of the Sparta Sands and the Cook Mountain Formation. Likely is hydrologically separated by geographic features from the Carrizo-Wilcox Group. For our purposes might provide some useful information to confirm/refute communication with C-W Group.

8. East Yegua Creek near Dime Box, TX - USGS Station 08109800
   a. Location: East Hwy 21, E TX 21
   b. Description: Gauge in alluvium on the borders of the Sparta Sands and the Cook Mountain Formation. Likely is hydrologically separated by geographic features from the Carrizo-Wilcox Group. For our purposes might provide some useful information to confirm/refute communication with C-W Group. Also located on Lee and Burleson County lines.

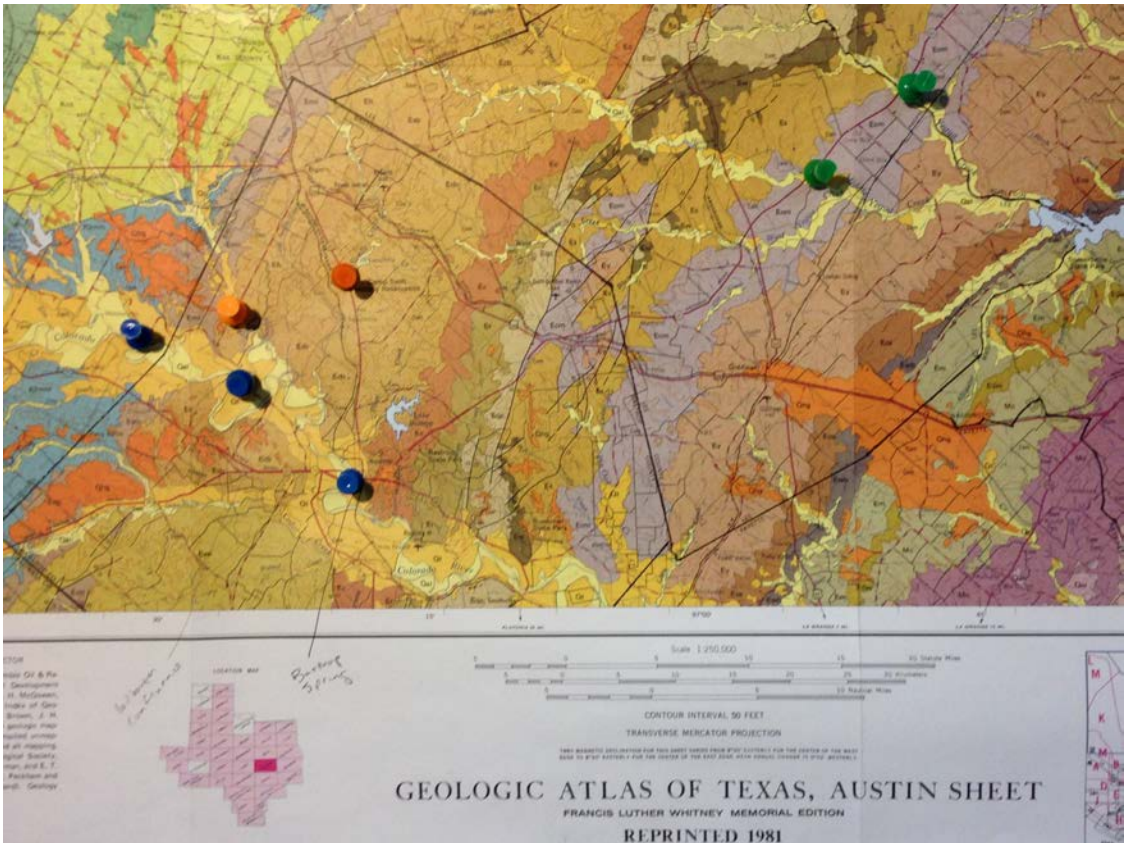

Figure 1. SW-GW Monitoring Gauge Locations. Colorado River Main (3 blue pins), Wilbarger, Big Sandy Creek (2 orange pins) and Cedar Creek (not pinned) tributaries to the Colorado River, Middle and East Yegua Creek tributaries to the Brazos River

(2 Green pins)

APPENDIX 2. WILBARGER BEND STUDY PLAN

NOTICE: This section is in process of a full revision.

INTRODUCTION

Field studies conducted by Environmental Stewardship on December 11, 2023, indicate that there is a potential that the Simsboro and Hooper aquifers contribute groundwater to the Colorado River along the contours of the lower end of the peninsula. Chemical and physical data collected showed that three parameters changed statistically between the first half and the last half of the of the river bend. A gain-loss study, along with chemical comparisons between the river and aquifers, are needed to conclude that these aquifers communicate with the river and river alluvial aquifer in this reach of the river.

If true that these Wilcox aquifer formations exchange water with the river at this location, it becomes incumbent on decision makers to follow the interest of recommendations of the Central Texas Greenprint for Growth to designate the Wilbarger Bend as a high priority sensitive ecological area, and a high priority water quality and quantity region. Under such a designation and considering the concerns regarding contamination of the aquifers that serve as drinking-water sources for the City of Bastrop and Aqua Water Supply Corporation service territory, monitoring of the surface water-groundwater interaction in the Bend will be a high priority.

To that end, Environmental Stewardship intends to declare the Wilbarger Bend as a high priority water monitoring study site and initiate field studies to confirm whether this reach of the river is a location for major surface water-groundwater interaction, and the current status of the Colorado Alluvial Aquifer.

MATERIALS AND METHODS

The water monitoring project is based on measuring stream flow in rivers, stream and springs; water chemistry in rivers, streams and domestic wells; and dept to water in domestic wells in areas where groundwater discharge is thought to contribute the flow of rivers and streams. In this project these measurements will be used to test the hypothesis that the primary interaction between the Colorado River, the Colorado Alluvial Aquifer (CAA) and the Simsboro and Hooper aquifer formations of the Wilcox Group occur in the Wilbarger Bend reach of the river. By conducting gain/loss studies in the segment using the FlowTracker we should be able to determine if there is a quantifiable gain in water flow from the upper portion of the bend to the river bridge. If there is a significant gaining relationship, and the chemistry of the water is comparable to the chemistry of Simsboro and Hooper groundwater formations, then it would be reasonable to conclude that the flow is being contributed by these aquifers.

Stream Flow: A SonTech FlowTracker2 Doppler stream flow instrument is used to quantify the rate of water flowing out of a spring or in a stream or river. A transect is established with a cloth tape measure across the stream and anchored on both sides. Based on the width and depth of the stream a number of Doppler readings are taken manually by the field crew using the FlowTracker. Based on the settings in the instrument, it is capable of calculating the rate of flow in cubic feet per seconds. The data are downloaded from the instrument into a computer where the software analyzes the readings and provides a report with validated data.

By comparing flow rates from two or more transects taken during the same time period (generally the same day) it is possible to determine if a stream reach is gaining or losing water as it flows from one transect to another. It is important to determine if there are potential sources of water flowing into, or being taken out of the stream between transects and quantify these flows in order to calculate the final value for the reach. This is called a gain/loss study.

Water Chemistry: The Yellow Springs Instruments (YSI) Pro DDS (Digital Data System) water quality instrument is used to take electronic measurements of various physical and chemical characteristics of a sample of water. Values such as temperature, pH, total dissolved solids, conductivity, can be taken simultaneously in one reading and are recorded in the instrument. These data can then be downloaded and compared to data sets from other water sources to see if they appear to be the same or similar. Such information is useful in determining with some level of precision whether the two sample — for example a well water sample and a spring discharge — are coming from the same groundwater formation. If a hydrogeologist is able to identify the aquifer formation into which the well has been completed, then the source of the aquifer contributing water to the stream can be identified. This information, along with the rate of flow can inform the groundwater availability model (GAM) regarding the source and rate that the groundwater is being contributed to the stream.

Depth to water in a well: An Eco Scientific Well Sounder is used to measure the distance from the land surface (top of the well) to the water in the well by measuring the time it takes for a sound to reflect back to the receiver in the instrument. This method avoids using any physical measuring tools like measuring tapes or rods to take a measurement. All that is needed is a port hole in the cap at the top of the well. Such a measurement, taken on a periodic basis can inform the well owner whether the aquifer source from which the well water is being derived is being depleted, is stable, or is increasing. Depending on climatic conditions, and on the rate of other groundwater pumping in the aquifer, the depth and rate of depletion can change over time.

Groundwater Conservation Districts (GCDs) use such depth to water measurements to determine whether the aquifers they are responsible to manage are being depleted at a rate faster than anticipated, or if the level of depletion is nearing the pre-established and agreed desired future condition (DFC) for the aquifer.

Environmental Stewardship is interest in measuring the depth to water in the Colorado River Alluvium (Colorado Alluvial Aquifer) to determine whether the river is being managed in a way that will maintain a gaining relationship through a repeat of the Drought of Record (2010-2015). As such we are interested in establishing a group of alluvial wells in the Wilbarger Bend reach of the river to get a baseline on the current condition (depth to water) and continue monitoring these wells on a periodic basis to determine if the level of the alluvium is changing. These aggregate data will be shared with the Lost Pines GCD until such time as they have a network of wells established in Bastrop County to monitor the surface water-groundwater relationship between the river and the alluvial aquifer.

The mobile laboratory is equipped with as well as other equipment needed to maintain an off-grid mobile laboratory. For more information visit our website at: https://www.environmental-stewardship.org/2022/05/14/mobile-water-monitoring-field-laboratory/ .

Monitoring Data:

A data set will include:

Site location information:

- Owner's name, phone number and email address
- Physical address and mailing address
- Well registration number with Lost Pines GCD.
- Coordinates on well (latitude and longitude)
- Surface elevation at well head
- Location where water quality sample is taken
- Any details on well depth, screen location, and presumed aquifer.
- Copy of driller's records and any historical well depth data available.
- Primary use of well (domestic, irrigation, etc.)
- Name of stream and watershed (if known)
- Description of stream, pond, and other surface water located on property
- Any know withdrawals from, or discharges to, the stream or associated surface waters.
- Photos of monitoring locations will be taken and stored in the computer

Water Well

- Depth of water in closest water well(s) (Mean Sea Level (MSL)).
- Quality of well water - temperature, conductivity, pH, and dissolved oxygen.

Stream - at a minimum of two locations (above and below well site)

- Quality of stream water - temperature, conductivity, pH and dissolved oxygen.
- Flow rate of stream (cfs)
- Surface elevation of stream (MSL)
- Air temperature
- Weather conditions
- River stage at closest USGS gage (ft, converted to MSL)

Data Analysis and Storage:

Calculations for each data set will include

- The difference in elevation between the depth of water in the well and the surface level of the stream measured in feet.
- The difference in the elevation between the depth of water in the well and the stage of the river measured in feet.
- The difference in stream flow between each stream location measured in cubic feet per second to determine if the stream gains or loses water between each location.
- All data will be recorded in a waterproof scientific notebook and recorded and stored on the computer provided. Each page of the notebook will be dated signed by the monitoring specialist. Each page will be reviewed and signed by a witness.

Monitoring Procedures:

- Monitoring protocols will be developed and available in a manual located in the trailer and on the computer.

Monitoring Training:

- Each monitoring specialist will go through a training program and supervised during monitoring until fully competent.

Monitoring Equipment:

1. Trailer (Dale's Tool Box) outfitted with lab bench, sink, lights, electrical outlets, water tank, and stocked with equipment and lab supplies (owned by ES).

2. SonTek FlowTracker2 handheld stream flow display unit with probe assembly consisting of a 2D side-looking 10 MHz ADV probe with tilt sensor and Auto-velocity Range selection, mounted on a 1.5-m cable, wading rod and case.

3. YSI ProDDS handheld water quality meter with temperature, conductivity, pH, optical dissolved oxygen sensors, and calibration standards.

4. Eno Scientific WellSounder 2010 Pro sonic water level meter to measure static water level in wells.

5. Altimeter to record stream level at monitoring site.

6. Computer for storing data.

APPENDIX 3. Environmental Stewardship's Waterkeeper Alliance Exclusive Territorial Jurisdiction

Environmental Stewardship (Affiliate)

Legend

Current Environmental Stewardship Jurisdiction

NOTES:
Map Date: 1/20/2022
Datum: WGS84
Projection & Coordinate System: UTM Zone 14 N
Service Layer Credits: National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.
Document File Path: C:\Users\RaenaBallantyneDeMar\Documents\Waterkeeper\Mapfiles\Jx_A-F\EnvironmentalStewardship.mxd

1:500,000
0 16 Miles
0 16 Kilometers

APPENDIX 4. Finding of Facts from Corix permit application public comment period.

Environmental Stewardship and its members have compiled evidence from the State Water Quality Inventory, the TCEQ's Executive Director's responses to public comments, and ES' independent analysis of TCEQ collected data available in online databases that indicate that the Colorado River segments 1428 and 1434 are likely currently impaired and have been for about 20+ years.

Finding of Facts