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Edwards Aquifer Recovery Implementation Program

Initial Study on the Recreational Impacts to Protected Species and Habitats in the Comal and San Marcos Springs Ecosystems





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EXECUTIVE SUMMARY

This report is an initial study and compilation of existing data and research that illustrates the impacts of water-based recreational activities on protected species and habitats in the Comal and San Marcos Springs ecosystems for the Edwards Aquifer Recovery Implementation Program (EARIP). The EARIP limited the project area to those portions of the Comal and San Marcos Springs that are within the city limits of New Braunfels and San Marcos.

This study is a summary of existing data that was made available to Halff Associates by the Edwards Aquifer Recovery Implementation Program, the cities of New Braunfels and San Marcos, Texas Commission on Environmental Quality, U.S. Fish and Wildlife Service and the River Systems Institute of Texas State University. During the course of the study, existing data from various sources was reviewed and evaluated in an effort to identify and locate water-based recreational activities within the limits of the project area. Halff Associates worked to quantify and map the numbers of users, times of use, types of users and the areas they frequent, numbers and locations of endangered species, the locations and limits of their habitats. Halff also conducted review of existing ordinances that pertain to recreation and recreation development on and around the springs. Interviews with various stakeholders were conducted. Water quality data on protected species and their habitats was mapped. A review of existing scientific studies regarding recreational impacts on protected species and economic data from existing studies that was pertinent to the project area was reviewed. The sources of all this data include scientific studies, consultant studies, public agency records and stakeholder interviews.

Existing ordinances from the cities of New Braunfels and San Marcos that relate to water-based recreational activities and development within the limits of the project were reviewed. This section of the report summarizes what those specific ordinances are. Of particular note is the restricted (recreation) use by respective city ordinance on the upper reaches of both the Comal Springs (Mill Run Channel and upstream) and San Marcos Springs (Spring Lake) systems. Also included in this summary are ordinances that pertain to development or potential recreation development adjacent the rivers.

Geographical Information Systems software was utilized to map locations of water-based recreational activities, locations of water quality sampling stations and locations of listed species. While waters of the Comal and San Marcos springs systems are considered State property, access to and from the banks is restricted by land use/ownership; this information is also provided in the mapping data.

Interviews with stakeholders included members of city staff, chambers of commerce, recreation and tourist based business owners/managers, representatives of user groups and members of city council. A questionnaire prepared by Halff Associates, with the assistance of the EARIP was provided to stakeholders in advance of the interviews, to give interviewees the opportunity to elaborate on the questions and requested data.



Scientific studies relative to the impacts of recreational activities on endangered species and their habitats were sought but few were found. Documents and studies included in the reviews were habitat conservation plans, information pertaining to flood control and raw data from an ongoing doctoral study. There were also studies that were cited and referred to by some of the data providers, but several of these were not accessible for review.

Economic information pertaining to recreational activities within each of the cities is very limited. There is no published data for San Marcos, although Halff provides extrapolated figures based on survey data provided by the Texas State University doctoral candidate and the information provided by the one and only tube vendor in this city for one particular year. Two studies for the New Braunfels area on tourism and hospitality were made available, and information on river based recreational activities was extrapolated from data included in both of the studies as there is no specific data on recreation in either study.

The **recreational impacts** on these river systems are cultural, social, economic, and most importantly, physical. The rivers are iconic elements within each of the two cities. With a large portion of the river banks fronting public parks, they are the center of community events and prime socializing spaces. As populations increase in Central Texas, so does the popularity of recreating in these rivers and as such, there were reports of physical degradation of adjacent parks and banks, but quantitative data to identify the extent of the degradation is minimal at best. The physical impact of litter and erosion is evident in the public parks and there are no real controls for capacity other than parking restrictions.

Conclusion

Further study is needed in the pursuit of specific and quantitative correlations between recreational uses and listed species. Most of the important information in this document is anecdotal and perceived, and some of the factual information is peripheral and could definitely be used to support more specific research. In summary, the information that Halff has explored within the body of this report provides a good starting point from which further study could be pursued.



I. DATA COLLECTION

Sources of information for this report were derived from a list of activities and facilities provided by the EARIP, the cities of New Braunfels and San Marcos, their chambers of commerce, stakeholders referred to by the EARIP, the Texas Commission on Environmental Quality, Texas Department of Parks and Wildlife, United States Fish and Wildlife Services and sources of literature provided by the River Systems Institute and the EARIP. Information regarding types of recreation vendors, activities, types of users, times of use, numbers of users, regulations of use, economic information, water quality, and species locations were sought and GIS mapping was developed to illustrate locations of various attributes. The GIS mapping will also provide a base from which further study can be documented. The information provided within this document is known to be limited as some information sources that were referred to are not available.

A. New Braunfels

Recreation activities on the Comal River include: swimming, wading, lounging/picnicking, snorkeling, scuba diving, tubing, fishing, paddle boating, swift water rescue, and rope/tree jumping (though it is not lawful). The most common activities are tubing, swimming, wading and lounging, and fishing. Paddle boating and fishing are the only activities permitted in Landa Lake, closer to the springs although there is very small area in Landa Park that permits wading and there is a spring fed public swimming pool that is dammed off from the Comal River and dates to the 1930's within Landa Park. Most activity in the water is concentrated at the stretch from Landa Falls / Wursthfest grounds downstream to the Union Avenue exit commonly known as the last public exit. Upstream of Landa Lake is Texas Water Recreation District No. 1, which is a legislated area designated for restricted use by adjacent property owners. Wooden docks and stacked canoes were observed along this water front.

Members from the Halff team gathered information and data about recreational activities and events from city staff, members of the convention and visitors bureau/chamber of commerce, recreational outfitters and various users of the springs.

Tubing is the predominant recreational activity in the river. The City has an agreement with the tubing outfitters that limits the number of tubers on the river at any one time. There are significant number of tubers that do not rent tubes however, but choose instead to provide their own tube to enjoy the river. The costs of tube rentals range between \$10-\$15 per person, and the rental fee typically includes a shuttle ride from the tube outfitter to the river drop-off and



pick-up points. \$1.25 of each tube rental is a river management fee that goes directly to the City of New Braunfels.

The following list of water-based recreational outfitters illustrates the variety of recreational activities available along the Comal River. Tube rental outfitters located along the banks of Guadalupe River were excluded from the list even though they are located within the city limits. It is also note worthy to advise that year 2010 was a bit of an anomaly because of the severe flooding experienced in early June; as a result, many outfitters were not accessible for participation.

Table 1				
Type of Vendor	Company	Address	Phone	Hours of operation
Tube Rental	Rock'n R River Rides	1405 Gruene Road New Braunfels, TX 78130	830-629-9999	No information available
Tube Rental	Texas Tubes	250 Meusebach St. New Braunfels, Texas	830-626-9900	March 13 – May 1 11a.m. to 7 p.m. May 2 – Sept. 10 9 a.m. to 8 p.m. Sept. 11 – Sept 30 11 a.m. to 7 p.m. October 1 and later Weather permitting
Tube Rental	Corner Tubes	120 South Liberty Avenue New Braunfels, TX	830-626-6687	No information available
Tube Rental	Felger Tube Rental	161 South Liberty Avenue New Braunfels, TX	830-625-4003	No information available
Tube Rental	Landa Falls/Wurstfest	178 Landa Park Drive New Braunfels, TX	830-627-1440	May-June 10 a.m. – 5 p.m. July 10 a.m. – 8 p.m.
Paddel Boat Rental	City of New Braunfels Landa Park Paddle Boats	Landa Park Boathouse	830-221-4350	March 22 to 26 Noon – 7 p.m. Weekends only Apr – Memorial Day Noon – 7 p.m. Daily Memorial Day – Aug 22 Noon – 7 p.m. Weekends only Aug 28 – Labor Day Noon – 7 p.m.
Campground	Landa RV Park and Campground	565 North Market Street New Braunfels, TX	830-625-1211	Year round
Other	Schlitterbahn Waterpark Resort	381 East Austin Street New Braunfels, TX 78130 And 305 West Austin Street New Braunfels, TX 78130	830-625-2351 830-608-8520	Various hours throughout the year



Other activities that occur in the Comal River but do not generally require rental equipment or professional guidance include wading, swimming / snorkeling, fishing, swift water rescue training, rope/tree jumping, and lounging / picnicking.

In addition, there are numerous locations where river users can purchase tubes, and ad hoc tube outfitters are present along the river intermittently during the summer months.

B. San Marcos

Information gathered from interviews with stakeholders revealed that recreation activities on the San Marcos River include swimming, wading, lounging/picnicking, boat touring, snorkeling, scuba diving, tubing, fishing, rope swinging/jumping, boating (kayak and canoe), white water kayak training, dog playing. The most common activities are tubing, swimming, wading and lounging/picnicking. Spring Lake, where the springs originate, is restricted to research use and guided boat tours either by kayak or glass bottom boat. Cost for glass bottom boat tours range between \$6-\$9; kayak tours are by appointment and are available through an the Aquarena Nature Center, operated by Texas State University. Scuba diving on this lake is permitted research purposes only. The prime areas of activity along the San Marcos River are between Sewell Park and Rio Vista Falls Park falls.

Most of this stretch is adjacent public park property and access to the water is only limited by vegetation on the banks. As the demand for river activity grows, there is compelling physical evidence of trampled vegetation, bank damage and bank erosion caused by visitors to the River in their efforts to access the water.

Information gathered regarding recreational activities and the events that surround them is from city staff, members of the convention and visitors bureau/chamber of commerce, recreational outfitters, various users, and researchers.

The following list of water-based recreational outfitters illustrates the variety of recreational activities available along the San Marcos River.



Table 2				
Type of Vendor	Company	Address	Phone	Hours of operation
Tube Rental	Lion's club Tube Rentals	170 Bobcat Trail San Marcos, TX	512-396-0342	Mid May – Sept 11 a.m. to 4 p.m. Last shuttle 7 p.m.
Kayak and Canoe Rental	TG Kayaks and Canoes	402 Pecan Park Drive San Marcos, TX	512-353-3946	
Kayak Instruction	White Water kayak instruction	Power Olympics Outdoor Center 602 N. Interstate 35 San Marcos, TX		
Other	Aquarena Nature Center	601 University Drive San Marcos, TX	245-7570	

Other activities that occur in the San Marcos River but do not generally require rental equipment or professional guidance include wading, swimming / snorkeling, fishing, swift water rescue training, rope/tree jumping, lounging / picnicking, scuba diving and dog play.

II. EXISTING ORDINANCES

Existing ordinances were collected from the cities of New Braunfels and San Marcos with the assistance of planning staff from each city. The majority of the ordinances in place in each city deal with development restrictions along the rivers, while there are a few ordinances that address particular behaviors or activities that typically occur. New Braunfels has a higher number of ordinances pertaining to recreation activities on the river than San Marcos does.

A. City of New Braunfels

Land use and zoning districts alongside the Comal River within the city of New Braunfels identifies areas of open space, commercial/resort land use districts, as well as low density residential. Each of these land uses and zones permit recreation activity of varying degrees. Ordinances related to development of recreation facilities within the floodplain as well as ordinances that relate directly to activities on the water are summarized in the following text.

Most notable and of specific relevance to river-based activities (not specific to Comal) are the following ordinances:

Ordinances Specific to Recreational Activity on the Rivers	New Braunfels	San Marcos
Prohibition of Alcohol @ riverside parks	X	
Means to Restrict Beverage Consumption on the River (cooler size & limit)	X	
Prohibition of Glass in parks and rivers	X	X
Prohibition of Styrofoam	X	
Prohibition of dangerous jumping	X	X
Prohibition of Litter in the river	X	
Prohibition of Wastewater in rivers		X
Restrictions on Recreation in parts of the spring rivers	X	X
Minimum size of open containers on the river	X	
Noise restrictions at parks	X	X
Restrictions on types of floating devices	X	
River tax collected on Water-based Recreation Equipment	X	
Restricted methods of fishing and bait type	X	X
Fishing bait must be artificial	X	
Unlawful to release any type of aquatic organism into waters of a city park		X
Unlawful to wash bodies/animals, personal belongings in the river		X
Park curfews	12am - 6am	11pm - 6am
No overnight camping in riverside parks unless otherwise designated	X	X
Restrictions on use of motorized vehicles within riverside parks	X	X
Unlawful to damage/destroy vegetation @ parks	X	X
Regulations on Water Rereational Service Shuttles	X	X
Unlawful to disturb wildlife in city parks		X



The following ordinances are focused on the control of recreational activities and providers within the city of New Braunfels.

(NB) Section 23-50(f) – Entering rivers by jumping or dangerous acts

It is a violation of this code to enter any river, lake stream or waterway by jumping, diving or doing any other dangerous act on or off any publicly owned bridge, street, highway, appurtenance, publicly owned land or public right of way unless for reason of rescuing someone from drowning.

It is also a violation to jump dive or perform any dangerous acts on or off of trees, platforms, high banks, dams or other walkways to enter streams, rivers or waterways.

(NB) Sec. 50-57. - Prohibited accumulations; litter; weeds; graffiti; duty of property owner, occupant.

(Code 1961, § 8-34; Ord. No. 98-22, § II, 8-10-98; Ord. No. 2006-22, § 1, 3-13-06)

Owners and supervisors of real property occupied or not are not lawfully permit to allow filth, carrion, weeds, rubbish, junk, trash, waste products, brush and refuse, graffiti of any kind to remain on the property.

Deposit of any such matter into or along any drain, gutter, alley, sidewalk, street or right of way, vacant lot (private or public)

Weeds and Unsightly vegetation greater than 12 inches height within 150 feet of any right of way, alley or utility easement, building or structure is not permitted and Owners of real property shall maintain or remove such.

Graffiti is not permitted on real property and shall be removed within 15 days of notice from health official.

(NB) Section 58-33 Same – Duties and responsibilities (of the floodplain administrator)

(Code 1961)

To review permit applications to determine whether proposed building sites including mobile homes will be safe from flooding

To review permits for proposed development to assure all necessary permits have been obtained from federal, state or local government agencies.

To notify the state water commission and adjacent communities prior to any alteration or relocation of a watercourse and submit copies of such to FEMA

Assure the flood carrying capacity within the altered or relocated portion of any watercourse is maintained

To interpret the exact location of the boundaries of the flood plain in areas of special flood hazards where interpretation is needed

When regulatory floodway has not been designated, the administrator must require no new construction, substantial improvements, or other development be permitted unless it can be demonstrated that the cumulative effect of the



proposed development when combined with all other existing and anticipated development will not increase the water surface elevation of the base flood more than one foot at any point within the community

(NB) Section 58-34 Permit procedures

(Code 1961, ss 5-31, Ord. No. 98-29, ss 1)

Dev Permits must describe extent of alteration or relocation of any watercourse or natural drainage as result of development

(NB) Section 58-36 Provision for flood hazard reduction

In areas of special flood hazard, structures must be adequately anchored to prevent flotation, collapse or lateral movement

Construction methods and practices must minimize flood damage and of materials resistant to flood damage

Water supply systems as well as sanitary sewage systems shall be designed to minimize or eliminate infiltration of floodwaters

Recreation vehicle parks must develop a plan for evacuating residents

All recreation vehicles must not be permitted to have uninflated tires or any condition that would impede, delay or hinder immediate evacuation

With respect to floodways, encroachments are prohibited: including fill, excavation , ew construction, substantial improvements unless certification by a profession engineer or architect is provided to demonstrate encroachments do not increase in flood levels

(NB)Section 74-1. - Park rangers and river project manager authorized to issue citations.

(Ord. No. 2004-24, § 1, 4-12-04)

For the violation of any of the city ordinances under Chapter 86 "Parks and Recreation", Chapter 126 "Traffic and Vehicles", Chapter 6 "Animals" and section 82-9 and section 82-10 of Chapter 82 "Offenses and Miscellaneous Provisions."

(NB) Section 82-10. - Noise prohibitions, public rights-of-way and public property, exceptions; penalty.

(Ord. No. 2003-34, § 1, 5-12-03; Ord. No. 2006-53, § 1, 6-26-06)

It is unlawful to operate any radio, tape recorder, cassette player, CD player, DVD player or MP3 player or any other sound reproducing device any louder than audibility at 50 feet or more while located on public property, exceptions are for athletic and city authorized events



(NB) Section 82-12. - Volume drinking devices prohibited

(Ord. No. 2006-54, § 1, 6-26-06)

(a) *Definitions.* For the purpose of this section, the following definitions shall apply:

Volume drinking devices means an object used, intended for use or designed for use in artificially increasing the speed with which, and/or amount of, alcohol is ingested into the human body by carrying the liquid from a higher location into the mouth by force of gravity or mechanical means, including but not limited to funnels, tubes and hoses. The term includes a beer bong.

It is an offense to use or possess with intent of use in a public place

(NB) Section 82-13. - Amplified sound devices prohibitions on the Comal and It
is unlawful to operate or permit to be operated any amplified sound device or equipment between the hours of 10pm-8am. Violations may result in fines ranging Guadalupe Rivers.

from \$100-\$500.

(NB) Section 86-1 – Overnight camping prohibited; hours parks closed; penalty

No tents for camping and no overnight camping is permitted within parks.

No overnight parking of vehicles, portable buildings, camping units of any type are permitted.

No person, vehicle or equipment or activity is permitted between the hours of 12am and 6 am with exception of grant by the city.

(NB) Section 86-4 – Additional rule and regulations for control of parks and recreation ares and facilities

(Code 1961, ss 14A-6; Ord. No. 2003-51, ss 1(2.))

With the exception of city and city authorized equipment, it is unlawful to launch any type of boat, canoe, water vehicle or flotation device from the banks of Land Park Lake.

It is unlawful to deposit /throw/drop/place loose paper, cans, bottles, sacks, boxes, cloths, waste materials, rubbish alongside any body of water within city limits.

It is unlawful to drive any motor vehicle on any trail/footpath/footbridge spanning a creek or stream with the exception of golf carts or maintenance vehicles

It is unlawful to remove, destroy or damage any vegetation within parks and recreation areas.

It is unlawful to wade or swim in any water body within the Landa Park Golf Course to retrieve golf balls or for any other purpose.



(NB) Section 86-6 Swimming or wading prohibited in Landa park Lake; exception

(Code 1961, ss 14A-5)

It is an offense to enter, wade, swim or engage in any aquatic activity in any area of Landa Park Lake with exception of area posted 'wading area'; exception is law enforcement and public safety agencies operating water craft

(NB) Section 86-7. - Operation of vehicles in parks

(Code 1961, § 14A-7; Ord. No. 98-7, § 1, 2-9-98; Ord. No. 01-18, § 1, 3-12-01; Ord. No. 01-63, § 1, 12-10-01; Ord. No. 2003-51, § 1(3.), 8-11-03; Ord. No. 2004-25, § 1, 4-12-04; Ord. No. 2008-41, § 1, 6-9-08)

Landa Park: operation of motor vehicles on designated portions of Landa Park Drive prohibited by law: 7am-8pm, Saturdays, Sundays and legal holidays from Easter weekend through Labor Day

Hinman Island: operation of motor vehicles of any kind prohibited by lawn on that portion of Hinman Island Drive from its west side intersection with Liberty Avenue in a westerly direction to its east side intersection with Elizabeth Avenue 7am – 8pm Saturdays, Sundays and legal holidays from Easter weekend through Labor Day when the barricades on Hinman Island Drive are closed..

Parking fees in Prince Solms Park East. There shall be a parking fee applicable 9am-6pm Saturdays, Sundays and holidays from Easter weekend through Memorial Day weekend and on weekdays and weekends from Memorial Day weekend through Labor Day, unless exempt by city manager.

Fees are designated for the restoration and improvement of Prince Solms Park East

No through commercial truck traffic except Light trucks including any truck with a manufacturer's rated carrying capacity not to exceed 2,000 pounds and including those trucks commonly known as pickup trucks, panel delivery trucks, vans and carryall trucks shall be excluded from the provisions of this section. Recreational vehicles and passenger buses shall be excluded from the provisions of this subsection.

Any truck which has a destination point, for commercial purposes, within Landa Park or Hinman Island Park shall be permitted to proceed by the shortest route through such parks to its destination, and shall exit by the same route.

Maximum weight limits for bridges in Landa Park:

- (1) Bridge on Landa Park Drive at the Comal River and Landa Railroad Train Depot, TxDOT location number 15-046-8403-15-004, shall have a maximum safe load limit of 12,500 pounds, axle or tandem;
- (2) Bridge in Landa Park at the main spring flow from Panther Canyon area nearest the wading pool, TxDOT location number 15-046-8403-15-003, shall have a maximum safe load limit of 24,000 pounds tandem;
- (3) Arched bridge on Landa Park Drive at the Comal River Springs closest to California Street, TxDOT location number 15-046-8403-15-002, shall have a maximum safe load limit of 24,000 pounds tandem.



(NB) Section 86-8 Glass containers prohibited in park areas and on rivers, lakes and streams

(Ordinance No. 2005-62)

It is a misdemeanor offense to be carrying, using and/or disposing of glass beverage containers in all city parks adjacent rivers, lakes and streams
Cross reference—Waterways, ch. 142.

(NB) Section 86-10. - Prohibition of alcoholic beverages in city parks and city-owned property

(Ord. No. 2007-12, § 1, 2-12-07; Ord. No. 2008-11, § 1, 1-28-08)

(a) It shall be unlawful for anyone to consume liquor or any alcoholic beverage, or possess an open container of intoxicating liquor or alcoholic beverage within the boundaries of the following public parks or city-owned property within the city limits:

(1) Prince Solms Park; (2) Hinman Island Park; (3) Cypress Bend Park; (4) The City-owned tuber exit on the Comal River that borders Lincoln Street and Union Avenue. (5) River Acres Park; (6) H.E.B. Soccer Park; (7) Jesse Garcia Park; (8) Ernest Eikel Field; (9) Haymarket Park; (10) Torrey Park; (11) Kraft Park; (12) Northridge Park; (13) Dry Comal Trails; (14) Solms Park; and (15) Fredericksburg Sports Complex.

(b) It shall be unlawful for anyone to consume intoxicating liquor or any alcoholic beverage, or possess an open container of intoxicating liquor or alcoholic beverage in all designated parking areas or within 25 feet, either side of any roadway, within the boundaries of the following public parks or city-owned property within the city limits:

(1) Landa Park;
(2) Camp Comal.

City permitted functions are exempt. Fine \$500

(NB) Section 86-11. - Noise restrictions in city parks

(Code 1961, § 14A-10.1; Ord. No. 2006-53, § II, 6-26-06)

Unlawful between the hours of 10:00 p.m. and 8:00 a.m.:

(1) Operating of any radio receiving set, tape player, cassette tape player, compact disc player, DVD player, MP3 player, musical instrument, television, phonograph, drum or other machine or device for the production or reproduction of sound.

(2) Operating or permitting to be operated any loudspeaker or sound-amplifying equipment.

It shall be unlawful and considered a misdemeanor offense for any person to play musical instruments or provide live music any time within the boundaries of all city parks within the city limit. City park events exempt.



Violations may result in fines \$100-\$500

(NB) Section 86-13 – Prohibition of use of foam, polypropylene, expanded polypropylene and polystyrene in certain public waters

(Ord. No. 94-36, ss 1)

It is unlawful to use, carry, possess or dispose of any of above referenced on or in the public waters of the portions of Guadalupe River, Lake Dunlap and Comal River with exception of

Foam for boat flotation devices when enclosed within the structural framework of the boat or are fully encapsulated by a water based acrylic coating

Foam minnow buckets which meet or exceed a 2 lb density

Foam dock supports fully encapsulated in a water based latex coating

(NB) Section 86-14 – Coolers that are allowed on rivers, lakes and streams

Cooler size is limited to maximum 16 quarts, must be able to be securely fastened as to prevent contents from falling out cannot be Styrofoam.

Only one cooler per person is permitted on Guadalupe and Comal Rivers.

No containers constructed of Styrofoam or glass are permitted on or in the public waters of Guadalupe and Comal Rivers.

It is unlawful to dispose of any container into the waters or banks of the Guadalupe or Comal River unless it is an authorized and placed trash receptacle. No open containers with capacity of 5 oz or less permitted on Guadalupe, Comal Rivers and Lake Dunlap.

(NB) Section 86-15 – Use of life jackets on rivers

Young children and individuals who cannot swim or are poor swimmers are recommended to wear life jackets on the Comal River.

Outfitters shall provide information to customers concerning recommendations and requirements for life jackets

(NB) Section 86-14 – Coolers that are allowed on rivers, lakes and streams

Coolers: not to exceed 16 quarts, must be secured by zipper, Velcro snap, mechanical latch or bungee cord to prevent contents from falling out cannot be Styrofoam

Only one cooler per person is permitted on Guadalupe and Comal Rivers

No containers constructed of Styrofoam or glass are permitted on or in the public waters of Guadalupe and Comal Rivers

It is unlawful to dispose of any container into the waters or banks of the Guadalupe or Comal river unless it is an authorized and placed trash receptacle

No open containers with capacity of 5 oz or less permitted on Guadalupe, Comal Rivers and Lake Dunlap



(NB) Section 86-16 – Rivers, flotation devices, Ord. No. 2007-20, ss II

It is unlawful to float the Guadalupe or Comal Rivers except by canoe, kayak, boat or raft (including inflatable vessels), not exceeding 18' length.

Sat, Sun and holidays: Persons floating on such vessels are not permitted to exit 'last tubers' exit adjacent to Garden St. and Union Ave. between May 1 and October 1.

Rafts (non-inflatable structures used to transport 2 or more) are not permitted on the Comal River.

On the Comal River, inflatable devices are limited to 2 person capacity and cannot be greater than 5' diameter (or have any length of the vessel greater than 5').

(NB) Section 86-100 Requirements for rental of water-oriented recreational equipment

(Ord. No. 01-22, ss II)

There shall be a written record of (name, DOB, address) all those renting water-oriented equipment

(NB) Section 86-101 – Wristband; public exits, City Tube Chute, Prince Solms Park, Hinman Island Park.

(Ord. No. 01-22, ssII)

All persons on these city premises in possession of water oriented rented equipment or using the public exits on the Comal or Guadalupe rivers between Apr 1 and Oct 1 shall wear a city approved wristband

(NB) Section 86-117. - Public river exits

(Ord. No. 01-32, § II, 5-14-01; Ord. No. 2008-29, § III, 4-14-08)

Each water oriented recreation equipment rental customer is required to remit \$1.25 river management fee to the city for use of any public river exit unless this fee has already been included as a shuttle passenger fee; this river management fee is valid only for the date that it is collected.

(NB) Section 86-118 – Water recreation shuttles

(Ord. No. 01-32, § III, 5-14-01; Ord. No. 2008-29, § IV, 4-14-08)

Water recreation shuttle permit holders collect and remit to the city \$1.25 river management fee for each shuttle passenger transported to the city, unless the fee has already been collected as part of the water oriented recreation equipment rental; this fee is valid only for the date it is collected.



(NB) Section 86-119 – Fee payment; reports

(Ord. No. 01-32, § IV, 5-14-01; Ord. No. 2008-29, § V, 4-14-08)

River management fees are required to be recorded and reported to the city monthly between April 1st and November 1st of each year. Reports are to include, numerical counts for each day, total counts for the month and a calculation of fees based on \$1.25 per person. This revenue is directly allocated to the city management of the river.

(NB) Section 86-120 – Penalty

River management fees are required to be submitted to the city within 15 days of the following calendar month; the penalty for failure to comply is a suspension of the water recreation shuttle permit and use of the public river exits.

(NB) Sec. 126-334. - Trailers, time limit

(Code 1961, § 23-140)

Trailers or semitrailers may not be parked or left standing on a public street for one continuous period of more than 30 minutes without authority from the chief of police

(NB) Sec. 126-346. - Stopping, standing or parking prohibited in specified places

(Code 1961, § 23-127; Ord. No. 93-15, §§ 1, 2, 4-12-93; Ord. No. 94-9, § I, 2-28-94; Ord. No. 94-15, § I, 4-25-94; Ord. No. 94-34, § I, 8-22-94; Ord. No. 96-22, § I, 4-8-96; Ord. No. 97-40, § I, 11-24-97; Ord. No. 98-19, § I, 7-27-98; Ord. No. 98-28, § I, 10-26-98; Ord. No. 99-10, § I, 2-22-99; Ord. No. 99-27, § I, 4-26-99; Ord. No. 99-40, § 6-28-99; Ord. No. 99-45, § I, 7-12-99; Ord. No. 99-68, § I, 10-25-99; Ord. No. 00-09, § I, 2-28-00; Ord. No. 2000-44, § I, 11-13-00; Ord. No. 2000-54, § I, 11-13-00; Ord. No. 01-25, § I, 4-9-01; Ord. No. 2001-39, § I, 8-13-01; Ord. No. 2001-62, § I, 12-10-01; Ord. No. 2002-13, § 1, 4-8-02; Ord. No. 2002-47, § I, 12-9-02; Ord. No. 2003-37, § I, 5-27-03; Ord. No. 2003-69, § I, 10-13-03; Ord. No. 2004-18, § I, 3-8-04; Ord. No. 2004-36, § I, 5-10-04; Ord. No. 2004-41, § I, 6-14-04; Ord. No. 2005-51, § I, 6-13-05; Ord. No. 2005-83, § I, 11-28-05; Ord. No. 2005-84, § I, 11-28-05; Ord. No. 2006-04, § I, 1-23-06; Ord. No. 2006-19, § I, 2-27-06; Ord. No. 2006-27, § I, 4-10-06; Ord. No. 2006-39, § I, 5-8-06; Ord. No. 2007-40, § I, 5-29-07; Ord. No. 2008-14, § I, 1-28-08; Ord. No. 2008-25, § I, 3-24-08; Ord. No. 2008-72, § I, 11-10-08; Ord. No. 2008-75, § I, 12-8-08; Ord. No. 2009-06, § I, 2-9-09; Ord. No. 2009-42, § I, 7-27-09)

Pedestrians shall not stand nor stop in vehicular areas that will put them in conflict with other traffic.

There is no parking permitted on many of the streets and intersections near and surrounding public access points to the river: streets surrounding Landa Park, Hinman Island, Prince Solms Park and the public tuber exits at Garden Street and Union Avenue. Some locations are restrictive only from 8am to 8pm and from May 1st to September 15th. Other locations are restrictive between 7am and 8pm weekends and holidays from Easter weekend through to Labor Day weekend.



(NB) Section 126-368. - Fifteen-minute parking on Lincoln Street

(Code 1961, § 23-136.1; Ord. No. 2000-46, § I, 11-27-00; Ord. No. 01-25, § III, 4-9-01; Ord. No. 2001-39, § II, 8-13-01; Ord. No. 2003-32, § I, 5-12-03; Ord. No. 2004-39, § I, 6-14-04; Ord. No. 2006-92, § I, 9-25-06; Ord. No. 2009-05, § I, 2-9-09; Ord. No. 2009-42, § I, 7-27-09)

No parking is permitted on the southeast curb of Lincoln Street at Union Ave. for a distance of 710 feet west.

No parking for more than 15 minutes is permitted on the north side of Lincoln from 600 feet west of Union for a distance of 100 feet between 8am and 8pm weekends and holidays from Memorial Day through Labor Day

On certain parts of Liebsher Drive, parking is restricted to water recreation shuttle vehicles (by permit) from 7am – 8pm April 1st to October 31st; these areas are loading zones for such permitted vehicles and are restricted to 15 minutes.

A 15 minutes loading zone is designated for water recreation shuttles on parts of Lincoln Street near Union Avenue, and on Union Avenue near Lincoln Street. There is no parking on Common Street near Liberty Avenue other than for water recreation shuttles for the purposes of loading and unloading.

Same for Liberty Avenue near the near W. South Street.

(NB) Part II

Chapter 138 – Vehicles for Hire

Article VI – Water Recreation Shuttle Services

Commercial shuttle operators used for water recreation require an annual permit from the city. The number of seats permitted for the Comal River is limited to 1,205 annually, whereas it is unlimited for the Guadalupe River. By Ordinance, shuttle entry and exit points for the Comal River are restricted to city property: Shuttle Zone at Prince Solms Park Garden Street and Union Avenue tubing exits

(NB) Section 138-2 – Annual permit required

(Ord. No. 01-10, § I, 2-12-01)

An operating permit from the city authorizing transport of passengers for compensation from a point within the city is required.

(NB) Section 138-3 – Transferability of operating permit

(Ord. No. 01-10, § I, 2-12-01)

Operating permits are not transferrable unless approved in writing by the city manager or his designee. Transfers may be made to different operators after all ordinance requirements are met and a fee of \$75 collected by the city secretary for administering permit records.



(NB) Section 138-4. - Application for operating permit

(Ord. No. 01-10, § I, 2-12-01)

Applications for a taxicab permit are filed with the city secretary and must be filed before December of each calendar year with the following information: owner(s), address, telephone, make, hp, vehicle identification number, seating capacity, license number of every vehicle to be used for service, evidence of insurance, names, addresses, dates of birth and DL#'s of each driver operating vehicles for the company, schedule of rates, statement that no felony convictions or other offense involving moral turpitude exist which adversely affects the applicant's ability to provide safe and reliable passenger transportation, history of any revocation or suspension of like permits. A fee of \$75 plus \$10 for each vehicle is collected.

(NB) Section 138-5. - Issuance of permit

(Ord. No. 01-10, § I, 2-12-01)

Upon written proof of insurance and determination all documents for application are met, a permit is issued for period of January 1 to December 31

(NB) Section 138-167 - permit

(Code 1961, ss 25-71; Ord. No. 01-17, ss I, Ord. No. 2005-12, ss I, Ord. No. 2005-30, ss1, Ord. No. 2008-35, ss II)

Guadalupe and Comal River permits are required for operating water recreation vehicles

Limited shuttle zones for Guadalupe River

Guadalupe River Shuttle seats are annually unlimited

Limit of 1,205 Shuttle seats permitted annually for Comal River

(NB) Section 138-170 – shuttle entry/exit points

(Code 1961, ss 25-74; Ord. No. 01-22, ss IX; Ord. No. 01-32, ss VI; Ord. No. 2005-12, ss I; Ord. No. 2005-30, ss I; Ord. No. 2008-29, ss VII)

Comal River entry and exit points on **city property**:

Shuttle zone at Prince Solms Park

Union Street tubing exit

Guadalupe River exit point on **city property**:

Public river exit at Cypress Bend Park

(NB) Part II Chapter 142 – Waterways

(NB) Section 142-2 – powers of city concerning water bodies; responsibilities of property owners

(Code 1961, ss4-4, Ord. No. 01-24,ss I)

the city shall have the power to alter or improve any water body within its limits; no owner of property fronting any river within city limits shall alter any



body of water without first obtaining and permit and without the approval of the city engineer.

(NB) Section 142-3 – Comal River; Guadalupe River

(Code 1961, ss4-2,4-2.1(a),(b))

Rafts, boats or floats are not permitted beyond speed limit of 5 mph on any portion of the Comal River and on the Guadalupe River: between Textile Mill Dam and where the G River meets the city limits (excludes law enforcement and public safety agencies)

Horsepower of motor; exception

On Comal River: no motors rated in excess of 10 hp

This does not apply to any existing franchise, concession, lease or license to operate any boat, float or raft on the Comal.

(NB) Section 142-4 – Methods of fishing

(Code 1961,ss4-3)

Fishing is lawful only by pole & line, casting rod and reel, artificial bait, trotline or set line; seines may be permitted in accordance with state laws or parks and wildlife commission regulations

(NB) Section 142-5Control of aquatic activities on Mill Race (Comal Channel)

(Code 1961,ss 4-5)

It is an offense to enter or engage in any aquatic activity between Landa Park Lake and the confluence with the Comal River (dry Comal Crk)

It is unlawful to launch in water vessel or flotation device on any portion of the same

This does not apply to law enforcement and public safety agencies

(NB) Section 144-5.12 Bowling alleys, dance halls, shooting galleries, shooting ranges, skating rinks, commercial or public tuber entrance or take out facilities, and similar commercial recreation buildings or activities

(Ord. No. 2006-99, ss 1 (exh. A))

No commercial or public tuber entrance or take out facility shall be developed without a special use permit



B. City of San Marcos

Recreation activity on the San Marcos River predominantly occurs along city owned parkland, however, there is also privately owned property where recreation is permitted within their zoning so long as development of recreation within the floodplain is in accordance with the municipal code. These development ordinances, and those that relate directly to activities on and in the water aim to protect the waterways (biological diversity, natural and traditional character) and water quality are reported. All these related ordinances found for the City of San Marcos are reported.

Ordinances that pertain specifically to recreation activities include:

- ordinances pertaining to parks adjacent the San Marcos River: curfew, hunting, fishing, camping, disruptive conduct, restriction of motorized vehicles on trails, possession of alcohol, horseback riding restrictions
-

Ordinances that pertain specifically to activities of the river include:

- prohibition of glass
- Release of any organisms into the waters
- Washing of bodies, pets and personal items are prohibited
- Restriction of activities in Spring Lake
- Prohibition of speargun use
- Jumping into the river from bridges is prohibited
- Restrictions regarding operation of river shuttles: including parking allowances and franchise application detailing routes, stops, seating capacity, parking allowances, documentation of revenue

(SM) Chapter 58 Public Facilities, Parks and Recreation Article 3 Water Activities

(SM) Section 58.029 Night curfew in city parks 11pm – 6am

(SM) Section 58.030 Disruptive conduct

It is unlawful to remove, destroy, deface, tamper with or disturb any artifact, or cultural feature to take, remove, disturb any rock, soil, gem mineral except by permit.

It is unlawful to mutilate, injure, destroy, pick, cut or remove and any plant life except by permit



(SM) Section 58.032 Motor vehicles

It is unlawful to drive a motor vehicle in a city park area that is not an improved roadway or park in area not designate for such

No motors on trails or bike paths

Abandoning, storing or leaving a vehicle, boat, trailer or other personal property beyond park facility hours if not permitted

(SM) Section 58.033 Possession of alcoholic beverages in certain parks

It is unlawful to possess any alcoholic beverage within 500' of a softball or baseball field, within a children's park, within a fenced area surrounding a city swimming pool

(SM) Section 58.034 Glass beverage containers are prohibited

In any city park

In or on the waters of the San Marcos River

(SM) Section 58.037 Hunting, fishing and camping in city parks

It is unlawful to hunt, harm, harass, disturb trap, confine, catch, possess or remove wildlife from or in city parks

To release any fish, bait-fish, plant or other aquatic organism into the waters of a city park

Fish, grapple or catch and release in an area where fishing is prohibited by sign

No fires unless designated otherwise

No wood gathering

No camping unless otherwise designated

No washing of bodies, clothing, pets or other personal belongings in drinking fountains, pools, sprinklers, reservoirs, lake, river or any other water body in a park

No depositing wastewater, sewage or effluent from sinks, toilets or other plumbing fixtures onto grounds or waters of a city park

(SM) Section 58.040 animals

No riding, driving, leading or saddling of horses without a permit in a city park unless designated a horseback riding trail

(SM) Section 58.067 Using public waters of Spring Lake

Restrict uses to:

Sightseeing, excursion boats, archaeological and scientific projects



(SM) Section 58.068 Possessing of or shooting spearguns in San Marcos River
It is unlawful to possess or shoot a speargun while in or upon the San Marcos River

(SM) Section 58.069 Activities on bridges crossing San Marcos River
It is unlawful to jump or dive into San Marcos River from any bridge crossing the river

(SM) Section 58.072 Bridge construction over river; prohibited entry ; warning signs
During periods of construction over the San Marcos River, city manager may prohibit entry of persons within or along the San Marcos River into the areas, unless contracted to work in the area

(SM) Chapter 90
Article 5 River Shuttles
Division 1. Generally

(SM) Section 90.3903 Restrictions to operation
Written approval of routes and stops, dates and times from city manager ('s office)

(SM) Section 90.310 Franchise required and application
Application to include seating capacity, maps detailing routes, dates of operation, parking allowances for customers, statement of gross revenues generated from river related activities for the previous year, a comprehensive description of type and nature of business

(SM) Section 90.313 Fees
Annual franchise fee valid May 1 – Apr 30

(SM) Chapter 5 – Environmental Regulations

(SM) Section 5.1.1.2 Erosion Control Standards

Preserve natural drainage patterns whenever possible

Limit loss of pervious character of soil

Utilize open surface drainage through grass lined swales

Located stormwater runoff to avoid sinkholes, fractures, faults

Channelizing stormwater permitted by Engineering Director

Dissipate point discharges in sheet flow

Minimize erosion impacts of runoff and control contaminants with sediment control devices



Vegetate detention ponds
Provide internal rock berm baffles in ponds
Trap floating matter in ponds
Provide maintenance access to ponds

(SM) Section 5.1.1.3 Runoff Attenuation

Utilize strategies for energy dissipation, sediment and pollutant traps
Detention required to maintain runoff rates at pre-development levels

(SM) Section 5.1.1.4 Wastewater collection and Disposal

Not permitted in water quality corridors: septic tanks, holding tanks, evapotranspiration units, cesspools or other sewage disposal systems

(SM) Section 5.1.1.5 Impervious Cover Limitations

A percentage is permitted and varies with grade/slope of hillside

(SM) Section 5.1.1.6 Street and Drainage Improvements

Must be designed to 25 year frequency rainfall
Drainage improvement costs at sole responsibility of property owner
Drainage improvements serving multiple developments shall be dedicated to the public
(in an easement that contains all storm water flows to the limits of the 100 year floodplain; drainage improvements serving streets or other public property may be dedicated in a public street ROW rather than a drainage easement); Easements must be 25'5" in width for open drainage systems or 15' width for enclosed
Maintenance of drainage easement corresponds with ownership

(SM) Section 5.1.1.7 BMP Improvements Maintenance Criteria

Holder of an approved watershed protection plan is required to maintain any required permanent BMP's after construction; submit an annual maintenance report to Engineering Director

(SM) Section 5.1.1.8 Continuing Responsibilities

Passes on with any transfer of property

(SM) Div.2 Stream and River Corridor Water Quality Standards

(SM) Section 5.1.2.1 Purpose, Applicability and Exceptions

To protect water quality and prevent flood damage, applies to SMRC and Edwards Aquifer recharge zone, exception is a drainage basin of less than 120 acres upstream from development



(SM) Section 5.1.2.2 Water Quality Zones

FEMA mapped waterway & for each stream, river or waterway in SMRC and Edwards Aquifer Recharge zone: 50' extending out from each side of CL of minor waterway, 100' extending out on each side of the CL of intermediate waterway or 100 yr floodplain resulting from full developed conditions in the watershed
Required when a plat is required for development

(SM) Section 5.1.2.3 Buffer zones

= 100' width measured from the outer boundary of the water quality zone, buffer and WQZ not to exceed width of 100 yr floodplain

(SM) Section 5.1.2.4 Impervious Cover Limitations

Not permitted in a water quality zone
Permitted within a buffer zone, dependent on gradients
Exceptions permitted where access (vehicular) across waterway is limited

(SM) Section 5.1.2.5 Clustering and Development Transfers

Clustering of residential density and impervious cover allowed in accordance with Table 5.1.16.1, when approved under a cluster development plan

(SM) Section 5.1.2.6 Performance Standards in Water Quality and Buffer Zones

Shall be stabilized with 70% vegetation/ground cover; areas disturbed shall be restored

Sheet flow point discharges

No fertilizers nor pesticides permitted within water quality zones

Limitations on excavation and fill (see Article 4, Div. 2 Chapt 5)

(SM) Art 3: Development Related to the San Marcos River Corridor

Div. 1: General Provisions

(SM) Section 5.3.1.1

(a)(6) corridor is facing potential for intense development

(10) city Mgr has directed staff to conduct a study of characteristics of the corridor, adverse impact of development activities and how to mitigate

(b) (1) prevent stripping of native vegetation

(2) prevent soil erosion and sedimentation

(3) prevent increase in stormwater runoff

(4) prevent or reduce pollution concentrations

(5) protect biological integrity of SMR habitat

(6) preserve natural and traditional character of the land and waterway



Map of areas located at City Clerk's Office

(d) (1) additional requirements of this article shall not apply to SF detached residence on a properly platted subdivision lot that has been properly platted before the effective date of the ordinance

(SM) Div.2 Development Standards

(SM) Section 5.3.2.1 Ecological Preservation

Restoration of disturbed areas containing native plants shall be approved by Engineering Director.

Stabilization of eroding creek banks is permitted to protect threatened property, as approved by federal and state agencies and the Engineering Director.

Excavating or filling permitted as necessary for structural engineering for a building or structure.

(SM) Section 5.3.2.2 Water Quality Standards

Impervious cover not permitted except for trails for walking, running and non-motorized biking or for access to another public road (within distance limitations of other crossings)

Disposal of contaminants must be approved by Engineering Director and in accordance with the Contaminant Removal Guidelines of the City

Input and release from water quality basins shall utilize grass lined swales and /or overland dispersion measures.

(SM) Section 5.3.2.3 Overland Flow and Natural Drainage

Limit to prevent erosion and attenuate impact of contaminants transported by flow

Open surface drainage via grass lined swales preferred (leave in undeveloped or natural state for runoff to occur); use of streets as central drainage network is prohibited

Storm Sewers

Enclosed and impervious channels by permission of Engineering Director

(SM) Section 5.3.2.4 Velocity Attenuation and Surface Drainage Channels

Channelization of San Marcos and Blanco Rivers and any tributary of the SMR within the SMRC is prohibited

(SM) Section 5.3.2.5 Creation of Impervious Cover

Permitted outside water quality zone, % varies with various slopes



III. GIS DATABASE PREPARATION

Section 1. Data Collection

Recreation use data provided during stakeholder interviews, as described in Section IV, was collected and mapped for the San Marcos River in San Marcos, Texas and the Comal River in New Braunfels, Texas. The San Marcos River study area extends from Spring Lake downstream to the San Marcos City Limit. The Comal River Study area extends from Landa Park to the confluence with the Guadalupe River.

The following data sets were obtained for use in delineation of recreation uses on the Comal River and the San Marcos River. Halff coordinated with the Capital Area Council of Governments (CAPCOG), the City of San Marcos, the City of New Braunfels, Texas Water Development Board (TWDB), Texas Commission on Environmental Quality (TCEQ), and the United States Geological Survey (USGS) to gather available data. The following is a summary of data obtained for the purpose of executing this study effort.

- CAPCOG Aerial Imagery, 0.5 meter resolution, February 2008
- National Hydrography Dataset (NHD) Streams and water bodies, USGS
- San Marcos City Parks, City of San Marcos
- TNRIS Stratmap (TWDB) Parks, Roads, and City Limits
- TCEQ Clean Rivers Water Quality Stations

The Comal County Regional Habitat Conservation Plan Environmental Impact Statement (Draft) was also referenced to delineate areas of potential wildlife habitat of protected species within the study area.

In addition to the basemap data collected as described above, Halff Associates conducted two days of stakeholder meetings to collect recreation use information as discussed in Section I, IV, V, and VI. Recreational activities identified in these meetings are listed in Table 4.



A limited amount of temporal use data was provided during stakeholder interviews, as described in Section IV. The temporal use data that was collected was presented in terms of intensity, not numerical values. Based upon the data gathered during stakeholder interviews, temporal use data was grouped into four categories of intensity: high, medium, low, and unknown to best describe the intensity of use occurring at the recreation area. Based on the limited data available at this time, no temporal patterns of use intensity were indentified. However, the GIS geodatabase attribute table was prepared such that any future data may be added to the database and analyzed. Entrance and exit locations were also identified and delineated from interviews and surveys. Locations shown are those described by stakeholders during interviews and do not necessarily represent all points of access. Critical habitat areas for the species, as discussed in Section VI, have also been delineated. Tubing, kayak, canoe, and paddleboat vendors were identified from interviews, surveys, and internet data searches. Preparation of the data is discussed in Section 2.

Table 4
Reported Recreation Activity
Swimming
Picnicking
Paddle Boats
Swift Water Rescue Training
Tubing
Fishing
Wading
Rope Swing
Lounging
Playing
RV Campground
Snorkeling
SCUBA
Kayak
Canoe

Section 2. GIS Database Preparation

Recreational areas were delineated using ArcGIS version 9.3.1.

A file geodatabase feature class was set up with the attribute fields listed in Table 5.

Table 5		
Attributes – Recreation Area		
Field Name	Data Type	Description
OBJECTID	Object ID	Unique id
SHAPE	Geometry	Type of feature (Polygon, point, etc.)
LOCATION_ID	Long Integer	Identifier for entries using common SHAPE.
ACTIVITY	Text	Recreation activity reported for the area
INTENSITY	Text	Intensity of recreation activity reported for area
ENTRY_EXIT	Text	Identifies if area is reported as a specific entry/exit area.
NOTE	Text	Additional notes if applicable
SHAPE_Length	Double	Perimeter length of area (feet)
SHAPE_Area	Double	Area of recreation area (square feet)
Public_or_Private	Text	Identifies if area is reporteddc as public or private access.

Metadata for the Recreation_Area feature is summarized below:

File Geodatabase: EARIP_Recreation.gdb

Feature Dataset: EARIP_Recreation

Feature: Recreation_Area



--Coordinate System: NAD 1983 State Plane Texas South Central 4204
 Projection: Lambert Conformal Conical
 Geographic Coordinate System: GCS North American 1983
 Horizontal Datum: North American 1983

The recreation areas were delineated for each type of use reported. The reported recreation areas can be queried and symbolized by activity. Areas reported as specific entry and exit areas are identified in the ENTRY_EXIT field. Additional fields were also included to identify the intensity of use and if the area is for public or private use. These attributes can be updated if information becomes available.

Section 3. Associated Exhibits

The attached exhibits illustrate recreation areas and areas of potential wildlife habitat of protected species. Table 6 summarizes these exhibits. They are grouped by city and further arranged by type of area.

Table 6		
Exhibit Index		
Exhibit #	Title	Description
New Braunfels Recreation Areas		
NB.1	Tubing	Identifies areas where tubing occurs in the Comal River.
NB.2	Paddle Boats	Identifies areas where paddle boats are used in the Comal River.
NB.3	Picnic Areas, RV Campground	Identifies areas along the banks of the Comal River where picnic areas and RV Campgrounds occur.
NB.4	Swift Water Rescue Training	Identifies the area where swift water rescue training occurs in the Comal River.
NB.5	Swimming	Identifies areas in the Comal River where swimming occurs.



Table 6 continued

NB.6	Tube, Paddle Boat, Kayak, Canoe Rentals	Illustrates the locations of rentals categorized by tube rental and paddle boat, kayak, and canoe rentals near the Comal River in the City of New Braunfels.
NB.7	Fishing	Identifies areas of fishing along the banks and in the Comal River
NB.8	Wading, Lounging, Playing, Rope Swing	Identifies areas where wading occur in the Comal River and the locations of lounging, playing, and rope swing use occur along the banks.
NB.9	All Uses	Summarizes all of the identified recreation uses along and in the Comal River, all entry/exit areas, and the storm water quality stations.
New Braunfels Potential Wildlife Habitat Areas		
NB.10	Comal Springs Dryopid Beetle, Peck's Cave Amphipod	Illustrates areas of potential wildlife habitat.
NB.11	Comal Springs Riffle Beetle	Illustrates areas of potential wildlife habitat.
NB.12	Fountain Darter	Illustrates areas of potential wildlife habitat.

San Marcos Recreation Areas		
Exhibit #	Title	Description
SM.1	Dog Parks Tubing	Identifies areas where tubing occurs in the San Marcos River.
SM.2	Fishing	Identifies areas of fishing along the banks and in the San Marcos River.
SM.3	Kayaking, Canoeing	Identifies areas where kayaking and canoeing occur in the San Marcos River.
SM.4	Picnic Area	Identifies areas along the banks of the San Marcos River where picnicking occurs.



Table 6 continued

SM.5	Swimming	Identifies areas in the San Marcos River where swimming occurs.
SM.6	Tube, Kayak, Canoe Rental Locations	Illustrates the locations of rentals categorized by tube rental and kayak and canoe rentals near the San Marcos River in the City of San Marcos.
SM.7	Tubing Dog Parks	Illustrates three locations where dogs are allowed.
SM.8	Wading, Lounging	Identifies areas where wading occur in the San Marcos River and the location of lounging along the banks.
SM.9	All Uses	Summarizes all of the identified recreation uses along and in the San Marcos River, all entry/exit areas, and the storm water quality stations.
San Marcos Potential Wildlife Habitat Areas		
SM.10	Fountain Darter	Illustrates areas of potential wildlife habitat.
SM.11	San Marcos Gambusia	Illustrates areas of potential wildlife habitat.
SM.12	San Marcos Salamander, Texas Blind Salamander, Comal Springs Riffle Beetle	Illustrates areas of potential wildlife habitat.
SM.13	Texas Wild-rice	Illustrates areas of potential wildlife habitat.



IV. STAKEHOLDER INTERVIEWS

Stakeholder interviews were conducted June 29th and 30th 2010. The lists of interviewees were provided by EARIP representatives and city staff in both cities. A questionnaire was provided to all individuals in advance of the interviews. Stakeholders from San Marcos and New Braunfels were comprised of city representatives, river committee members, active river users and commercial operators.

Twenty two (22) stakeholders from San Marcos were sent questionnaires and invited to be interviewed. Eleven responded, and ten (10) attended the interview and answered the questionnaire. One(1) submitted the questionnaire but did not attend the interview.

Thirteen (13) stakeholders from New Braunfels were invited to be interviewed and sent a questionnaire. Nine (9) responded and seven (7) attended the interview and answered the questionnaire. Two (2) submitted the questionnaire but did not attend the interview.

Interviews were conducted by two members of the Halff team and interviewees were scheduled individually or as part of group of not more than three (3) at 30 minute intervals. Questionnaires and maps were made available at the interviews and participants were given the option to respond to the questionnaire during the interview or provide them via email following our dates. The list of questions not only aimed to obtain information directly regarding recreation activity but also peripherally and indirectly to identify potential impacts recreation activities have on the cities, be they economic, operational or physical. Not all individuals provided an answer to every question and answers provided may be based on the perceptions of the stakeholder and not necessarily factual data. (See Appendices B and C for specific responses)

Responses common to both cities include:

- Peak use occurs between Memorial Day weekend and Labor Day
- During this period, weekends and holiday long weekends have the highest use numbers
- occur between 11am and 4 pm
- The most highly used areas of these springs are along city owned parks that run adjacent the rivers.
- During high use periods, parking is an issue for both these cities
- and the current rate of use of these rivers is having a degrading effect on these surrounding parks
- Litter is a constant maintenance issue



- Despite the crowds and trash, these rivers are highly valued for the economic opportunities, and social as well as health benefits they provide to their respective communities.

A. New Braunfels

Stakeholders from New Braunfels hold their rivers in high regard for the quality of life they provide and as an economic resource. Based on a 2009 economic study commissioned by the City of New Braunfels, tourism contributed \$469.7 million in revenue for the area.

There is no definitive study or tracking methodology in place to determine how many people use the river as a recreational resource as it is an open source of recreation without fee. While one respondent perceived between 3000-5000 people per typical weekend during the peak season used the river, another thought there might be three times this many.

Prime activities are tubing and picnicking in the peak season. Hinman Island and the Tube Chute at Prince Solms Park seem to draw the most crowds as they are considered both launch and exit points, but also the surrounding parks offer plenty of free space for picnickers.

Although there is a perception that the parks are overcrowded and the amount of users are negatively impacting the condition of the parks, there is also the feeling that there is a reasonable amount of control on number of (tube) users on the river, as it is monitored by the river manager and commercial (tube) outfitters, who have learned to work together to prevent congestion on the river. The river manager has the authority to prohibit use of the river if he feels there is such numbers to cause safety concerns.

The use of water recreation shuttles is common in New Braunfels. Stakeholders estimated that 50-70% of all tubers use this service. Shuttles provide service to satellite parking lots as well as tuber pick up and drop off points along the river. In the off season, the river is used for swift water rescue training by fire departments from all over Central Texas and beyond.

New Braunfels has ordinances in place to minimize the amount of trash, reduce potential for misconduct on the river as well as protect the users of the river, but some offer that though these are admirable, people find a way around every rule and that there is inadequate enforcement to enforce the rules that exist. The issue of alcohol consumption is an ongoing contentious issue. Alcohol is not permitted to be consumed in public parks, however, once in the water,



standing or floating, consumption cannot be regulated as the river is within the State’s jurisdiction. The consumption of alcohol is often enjoyed with recreation on the river; however, many stakeholders commented that they felt it also contributed to altercations and unfavorable public behavior.

Although not ranked by priority, the following table illustrates number of respondents who identified specific issues.

Table 7	
New Braunfels Comal Springs River Stakeholder Perceived Issues	of 8 respondents:
Trash / Litter	6
River is Overregulated	4
Behavior	4
Adequate Enforcement (Non-issue)	4
Alcohol	3
Wear on the Landscape / Deterioration of Environment	2
Crowding	1

New Braunfels Stakeholder Interview Responses June 30, 2010

1. **What are the peak times of recreation use: days, seasons, months, holidays, hours?**
 - *Memorial Day – Labor Day*
 - *Weekends / Long weekends, more Saturday than Sunday*
 - *Afternoon hours (11am-4pm)*
 - a) **How many people are using the river at these times?**
 - *Comal: 3,000-5,000 (per typ. Peak season weekend)*
 - *Unknown because there is no entry fee*
 - *Estimate: 187,000/yr on both rivers over approx. 110 days = approx 1700 people/day*
 - b) **What areas of the river see the highest amount of use?**
 - *@ Tube Chute*
 - *Hinman Island to Last Tubers Exit (@ Union)*
2. **Should there be restrictions on times of use or hours of use?**
 - *Yes, to daylight hours only, as safety factor*
3. **Does use have any correlation with water flow or river levels?**
 - *No, Comal springs brings constant flow*
 - *Perception of flooding events around central Texas reduces #'s*
4. **Can recreational activities on the river continue at current levels of activity?**
 - *Mixed response, see below*
 - a) **Why or why not?**
 - *Yes because recreational outfitters are active about controlling their rate of users*
 - *Yes, because habitats are surviving and thriving*
 - *No because parks where people access are free and are over-capacity now*
5. **If arriving at the river by vehicle, where do people park (private lots, owned by recreation outfitters or other private lots? Street? Public park?).**
 - *City: Public parks, public owned lots, streets*
 - *Private businesses (satellite lots)*
 - a) **Do the majority of recreational users use commercial shuttle buses and are those desirable?**
 - *50% -70% of tubers use shuttle*
 - b) **How many people (or what percentage of people) arrive at river tubing/raft launch locations by private vehicle versus shuttle bus?**
 - *60% private*
 - *40% shuttle*



c) Is one method of arrival preferable over the other?

- *Shuttle is preferred*

6. Do most users access / launch from public/city owned property or private property?

- *Public:City Parks*

a) Please list all known points of access and launching.

- *Hinman Island*
- *Tubers Chute (Prince Solms)*
- *Wurst Fest (Landa Falls)*
- *Texas Tubes*
- *Resort properties on the Comal*

7. Do most users exit the river at public/city owned property or private property?

- *70% exit on public*

a) Please list all known points of exit.

- *Last tubers/public exit (@Union)*
- *Garden St.*
- *Resort Properties*
- *Rock'n R*

8. What recreational activities other than tubing, rafting and fishing occur along the river?

- *Rope swinging*
- *Camping*
- *scuba*
- *Wading/water play /water lounging/ drinking/sunbathing*
- *grilling/picnicking*
- *swimming*
- *fire dept. swift water rescue training*
- *nefarious activity*

9. What specific locations are most frequented by these other users?

- *Tube Chute*
- *Hinman Island*
- *Landa Park*
- *Wurstfest*

10. What are the positive aspects of recreation on the river?

- *Economic: tourism \$, Jobs for young people*
- *Education about the river*
- *Outdoor enjoyment: mental, physical health*



- 11. What are the negative aspects of recreation on the river?**
- *Trash*
 - *Negative behavior (3-5% of users cause trouble, of which half are local)*
 - *Wear on the landscape*
- 12. How important are river-based recreational activities to the local economy?**
- *Extremely as it is the 'brand' of New Braunfels; impacts everything, not just water related activities*
- a) What are its contributions: i.e. sales tax, property taxes, other taxes/fees, spin-off businesses (related revenue sources for the city)?**
- *Employment & wages*
 - *City & other local taxes from hospitality industry*
- b) How much does recreation activity contribute to the local economy? (in \$ or % of city revenue)**
- *\$12 million annually in tax revenue (response closely approximated what was reported by Impact Data Source, 2009)*
 - *\$469.7 million in 2009 (response closely approximated what was reported by Impact Data Source, 2009)*
- 13. What is your perception of the level of enforcement on the river? Too much, not enough? Why?**
- *Good, sometimes excessive*
- 14. Is the amount of regulation with regards to activities on the river acceptable? Should there be more? Or less?**
- *Less*
- a) Are there certain things that should be regulated that aren't currently?**
- *Alcohol on the river*
 - *Access points aren't managed/controlled*
 - *Pop up tents and crowding at access points*
- b) Are there certain things that are currently regulated that shouldn't be?**
- *No other than: number of coolers per tube and size of ice cooler*
- 15. What is your perception of the level of maintenance? Too much, not enough? Why?**
- *Ok, Acceptable*
- 16. Are there operational issues with regards to emergency flood situations?**
- *None*



Additional Notes:

- *Tubers: 50% rent, 50% bring their own*
- *The amount of negative behavior associated with river activity is within normal range of any 'open source, no price point activity'; placing a \$ value on the activity would make a difference*
- *NBU has a wastewater facility that has flooded 3x in the last 12 years: contamination downhill, especially @ Lake Dunlap*
- *A study done in 2008(interviewee did not specify) showed overall positive economic impact of recreation but not as great as thought (see page 63: average daily expenditure per individual)*
- *Regulating alcohol is an ongoing contentious issue*



B. San Marcos

The San Marcos River, as compared to the Comal, has a greater variety of uses in specific zones of the river. Spring Lake, near the San Marcos springs is an area with restricted recreation activities: sightseeing (glass bottom boats), and scuba diving and snorkeling for the purposes of research.. Down river has much greater activity with tubing and swimming as the primary day use activities and canoeing and kayaking as the night time activities. It is informally agreed upon that the kayak / canoe community uses the river during night time hours, in addition to the off-season.

It is unknown as to how many total users there are of the San Marcos River at any given time. Data from year 2000 reported 500,000 people visit the river each year (Greater San Marcos Economic Development Council 2000); it is also reported that there is approximately 2500 kayaks per year that travel the river and that the only tube rental outfitter in town reported to have rented out 29,829 tubes in the year 2005, which estimated to account only for about 50-60% of tubers. These numbers do not account for all others that swim, snorkel, dive, picnic, wade, play, lounge or bring their dogs.

The city has restrictions on hours of use (nighttime curfew: 11pm-6am) for their parks, however, kayakers and canoeists are tolerated during these hours. When asked if there should be restrictions on hours of use of the river, most of those that responded said no while one responded that the hours should be restricted to 6pm when the less desirable users seem to arrive.

Recreation seekers in San Marcos typically arrive by private vehicle and though there is a shuttle in place to transport those who rent tubes back upstream, most people tubing will use the park trails (walk) to return upriver, which is unlike those tubing the Comal River in New Braunfels. It is important to note also that the tube trip in San Marcos is approximately 45 minutes as compared to 2 to 2-1/2 hours on the Comal River in New Braunfels.

Aside from the already stated positive and negative aspects of recreation on the San Marcos River, there is perceived gang activity, social disorder, degradation of the river banks and bed.

It is undetermined as to how much recreation on the river contributes to the local economy but it is an attraction to visitors whose primary focus may not necessarily be recreation on the river. Regardless, visitors contribute to the local economy via patronizing local retail and hospitality services and businesses.

Although the level of law enforcement didn't seem to be an issue, it was reported that there is only one park ranger on staff and part time staff is added



to patrol the parks during peak times. With the growing population and popularity of the river, more law enforcement is welcomed.

San Marcos does not have restrictions regarding litter (food/beverage packaging) type, cooler size, or alcohol consumption in their parks though it was reported that some individuals felt alcohol should be banned and that there should be stricter rules regarding litter including prohibiting Styrofoam containers. In general, it was expressed that maintenance-wise, it was challenging to keep up with the amount of trash generated at these park sites. There is perception that the growing popularity of the river is degrading the surrounding parks and that there is conflicted sentiment about the lack of dredging of the river bed, to remove the wild rice, as once was the practice, with some users perceiving the water not as clean as it once was.

Although not ranked by priority, the following table illustrates number of respondents who identified specific issues.

Table 8	
San Marcos Springs River Stakeholder Perceived Issues	of 11 respondents:
Trash / Litter	10
Traffic / Parking	9
Crowding	7
Alcohol	6
Behavior	4
Noise	4
Wear on the Landscape / Deterioration of Environment	3
Dog Feces	3
Information Lacking regarding Natural River & Ecosystem	3
Not Enough Enforcement	3

San Marcos Stakeholder Interview Responses

June 29, 2010

1. What are the peak times of recreation use: days, seasons, months, holidays, hours?

- *Memorial Day to Labor Day*
- *Weekends/Long weekends*
- *11am-4pm*

a) How many people are using the river at these times?

- *Approx 2500 kayaks/ year*
- *May-Sept 2005: tube rentals: 29,829 (estimate to represent only about 50% of tube users)*
- *Data from 2000 (Greater San Marcos Economic Development Council): 500,000 visitors/yr*

b) What areas of the river see the highest amount of use?

- *University & City parks on the river*

2. Should there be restrictions on times of use or hours of use?

- *No*

3. Does use have any correlation with water flow or river levels?

- *No, because the spring is a constant flow*

4. Can recreational activities on the river continue at current levels of activity?

- *No*
- *Increasing levels each year but somewhat capped by having on 1 tube rental outfitter*

a) Why or why not?

- *No due to degradation to water quality and parks*
- *Yes, if it is possible to create a culture of respect and stewardship for the river*

5. If arriving at the river by vehicle, where do people park (private lots, owned by recreation outfitters or other private lots? Street? Public park?).

- *There is current exploration on utilizing a shuttle to/from remote (private) parking lots*
- *Public: streets, parks, city owned lots*
- *Private: illegally on TSU campus*

a) Do the majority of recreational users use commercial shuttle buses and are those desirable?

- *Most people walk the park trails for tubing*
- *Most arrive to/nr river by private vehicle*

b) How many people (or what percentage of people) arrive at river tubing/raft launch locations by private vehicle versus shuttle bus?

- *Most arrive at river via private vehicle*

c) Is one method of arrival preferable over the other?

- *Non motor is preferable*

6. Do most users access / launch from public/city owned property or private property?

- *City Park (90%)*

a) Please list all known points of access and launching.

- *City Park*
- *Sewell Park*
- *Dog Park (San Marcos Plaza)*
- *All City parks along the river*
- *Rio Vista*
- *Immediately south of I-35 (kayaks)*
- *Stokes Park*
- *Nr. Water treatment plant/ Animal Shelter Rd.*
- *Ramon Lucio (ball) Park (dogs)*
- *Children's Park*

7. Do most users exit the river at public/city owned property or private property?

a) Please list all known points of exit.

- *Rio vista*
- *Beyond City Limits*

8. What recreational activities other than tubing, rafting and fishing occur along the river?

- *Swimming*
- *Wading, water lounging (lawn chairs in the water)*
- *barbecuing/ picnicking*
- *canoeing, kayaking dog swimming*
- *Ducky Derby (no longer)*
- *special olympics (kayak) practice*
- *junior (kayak) olympics trials (both at Rio Vista)*
- *canoe racing*
- *tours on glass bottom boats at Spring Lake*
- *scuba @ Spring Lake*
- *Power Olympic outdoor kayak courses*

9. What specific locations are most frequented by these other users?

- *Swimming at the Spring Lake Dam (all over but this is the ideal location because of clarity of the water)*
- *dog swimming at Dog Park (San Marcos Plaza)*
- *Wading at all park locations: City Park, Sewell Park, Rio Vista Park*
- *Kayak instruction at Rio Vista Falls*
- *Canoes at City Park*
- *All city and university parks*



10. What are the positive aspects of recreation on the river?

- *Economic benefits: liquor sales, restaurants, employment, tourism*
- *Wellness, health, quality of life*

11. What are the negative aspects of recreation on the river?

- *Environmental degradation: pollution, litter, erosion*
- *Parking issues/ traffic congestion*
- *Water safety issues*
- *Crowding issues*

12. How important are river-based recreational activities to the local economy?

- *Hard to determine exactly*
 - *Important but does not drive the economy*
- a) What are its contributions: i.e. sales tax, property taxes, other taxes/fees, spin-off businesses (related revenue sources for the city)?**
- *Tourism & entertainment businesses*
- b) How much does recreation activity contribute to the local economy? (in \$ or % of city revenue)**
- *Lions Club tube rentals returns between \$110k-\$125k/yr to local charities*
 - *Unknown. Check with Michael Ravel & Richard Earl of TSU geography department for studies*

13. What is your perception of the level of enforcement on the river? Too much, not enough?

Why?

- *Enforcement is not an issue, but more is better*

14. Is the amount of regulation with regards to activities on the river acceptable? Should there be more? Or less?

- *Need regulation to protect wild rice and prevent overcrowding issues*
- a) Are there certain things that should be regulated that aren't currently?**
- *More stringent litter laws including restrictions on food and beverage containers (glass & Styrofoam)*
 - *Ban or limit alcohol from the river (4x)*
 - *Crowding issues & river access points to disperse crowds*
- b) Are there certain things that are currently regulated that shouldn't be?**
- *No*

15. What is your perception of the level of maintenance? Too much, not enough? Why?

- *With regards to litter: there is never enough trash maintenance*
- *Sentiment that the river should be dredged annually as in previous years*

16. Are there operational issues with regards to emergency flood situations?

- *Well prepared: dams control many of the severe floods*



OTHER COMMENTS

- *Much degradation over last 8 years*
- *People feel conflicted over the alcohol consumption on the river/parks*
- *The revenue from the river helps maintain the river*
- *Though the city parks are closed after dark, canoeists and kayakers operate during this time and the city is tolerant of canoeists and kayakers moving through the parks at this time; there seems to be a general understanding that daytime (summer) is for tubers and all else times are best for canoeists and kayakers*
- *There is only 1 tube vendor for San Marcos: Lions Club; they run the shuttle*
- *Richard Earl, Geography Dept. at Texas State has studies regarding number of users and revenue generated from river activities*

OTHER CONTRIBUTORS TO THE ECONOMY:

- *Outlet malls: 25-30% sales tax revenue (over 11 million visitors /yr, 3rd highest visitor attraction in Texas)*
- *University Conference Center*
- *River in general is a draw; people attend TSU because of the setting, people move here because of the setting*

OPERATIONAL ISSUES

- *Not enough restrooms & drinking fountains to support the peak capacities*
- *Need to disseminate information about the river as a natural entity so users can more fully understand what the experience of tubing on the river will be*
- *The Lions Club contributes between \$110k-\$120k/year to local charities*
- *There is abuse of the Domestic Water Rights in that certain land owners have been drawing water to stock their ponds for uses other than agriculture (TCEQ permits 200 acre/ft / year)*
- *Cummings Dam at the confluence of the Blanco has had a possible effect on Fountain Darter population as it stagnated a 3 mi. length and the population has shown decline (Tom Goynes article)*
- *San Marcos's water supply is 73-74% surface drawn, city has made effort to minimize their draw on the aquifer*



V. WATER QUALITY DATA

Water quality in the San Marcos and Comal Rivers is a measurable parameter that is being monitored on a regular basis by the TCEQ Clean Rivers Program. The data obtained through monthly sampling at specific locations can be a useful tool to assess the current health of the protected species in the two river systems, and possibly draw correlations between the frequency/type of recreation that contribute to measurable changes in water quality, and how these changes could affect protected species.

Initially for this study, it was proposed that aquatic specialists would review existing water quality data trends and identify potential spatial and temporal correlations between water quality data, recreational use, and protected species habitat. However through recreational research for this study, it was realized that there is not a comprehensive monitoring program to count the number of recreational users, or reliable user counts readily available. Data for protected species was limited and thus this initial recreational study was limited to only providing the available historical water quality data in the GIS geodatabase to build a framework for future analysis. No correlations were made during this process due to lack of data for recreation and limited data for protected species.

GIS analysts obtained data from the TCEQ Water Data Management & Analysis, Water Quality Planning division. This information is considered to be the most recognized, comprehensive scientific data for this area that is readily available in GIS format. The TCEQ surface water quality monitoring program coordinates the monitoring and assessment of surface water resources and oversees the statewide network of monitoring sites. The Texas Clean Rivers Program (CRP) is a state fee-funded program for water quality monitoring, assessment, and public outreach. The CRP is a collaboration of 15 partner agencies and the TCEQ. The TCEQ monitors the quality of surface water to evaluate physical, chemical, and biological characteristics of aquatic systems. Water quality is monitored in relation to human health concerns, ecological condition, and designated uses. (TCEQ website, 2010)

During this study, additional water quality data sources were identified. These studies are either in progress or have just recently been published. For example, the contracted study between TCEQ and Guadalupe-Blanco River Authority (2009 and 2010) to collect water quality samples is a newer ongoing study. The results of this study are scheduled to be incorporated into the future published TCEQ Clean Rivers Program.

Tables 9 and 10 list the TCEQ Clean Rivers Program monitoring stations within the study area identified on map exhibits A-1 to A-25. The Comal River section of the study area consists of 18 surface water monitoring sites. The San Marcos River section consists of 8 surface water quality monitoring sites. Of these 26 sampling locations, monitoring data presented in the GIS geodatabase spans various months over a nineteen year period from 1990 to 2009.



Table 9	
TCEQ Clean Rivers Program Monitoring Stations: Comal River	
15412	COMAL RIVER AT MULBERRY AVE UPSTREAM OF LANDA PARK
13510	COMAL RIVER AT ISLAND AT END OF BOONEVILLE AVENUE IN LANDA ESTATES IN NEW BRAUNFELS
12574	COMAL SPRINGS AT FOOTBRIDGE NEAR GAZEBO IN LANDA PARK IN NEW BRAUNFELS
18525	PANTHER CANYON IMMEDIATELY UPSTREAM OF LANDA PARK DR NEAR COMAL SPRINGS IN NEW BRAUNFELS TX
15413	COMAL RIVER AT LANDA LAKE IMMEDIATELY WEST OF LANDA PARK IN NEW BRAUNFELS .25 KM DIRECTLY EAST OF CALIFORNIA RD
12572	COMAL SPRINGS AT CALIFORNIA BLVD IN NEW BRAUNFELS
12573	COMAL SPRINGS DOWNSTREAM PANTHER CANYON IN NEW BRAUNFELS
15204	COMAL RIVER/LANDA LAKE AT BOATHOUSE IN LANDA PARK
12654	COMAL RIVER AT MINIATURE TRAIN DEPOT IN LANDA PARK IN NEW BRAUNFELS
15082	COMAL RIVER AT LANDA PARK AREA 16 2.45 MI UPSTREAM FROM CONFLUENCE WITH GUADALUPE RIVER IN NEW BRAUNFELS
15146	COMAL RIVER AT HINMAN ISLAND 2.1 MI UPSTREAM OF CONFLUENCE WITH GUADALUPE RIVER
14933	DRY COMAL CREEK AT SEGUIN ST NEW BRAUNFELS
12570	DRY COMAL CREEK AT MISSOURI-KANSAS-TEXAS RAILROAD CROSSING IN NEW BRAUNFELS
12652	COMAL RIVER DOWNSTREAM STEINKE FALLS BETWEEN CONCRETE STAIRWAYS BEHIND COTTAGE NO. 13 IN NEW BRAUNFELS
15401	COMAL RIVER IMMEDIATELY SOUTH OF UNION BLVD 0.2 KM UPSTREAM OF THE GUADALUPE RIVER IN NEW BRAUNFELS
12651	COMAL RIVER NEAR GUADA COMA/UNION BLVD COMAL RIVER 50 M UPSTREAM OF END OF GUADA COMA DR WEST/UNION BLVD BRIDGE IN NEW BRAUNFELS
12657	GUADALUPE RIVER 1.1 MI UPSTREAM FROM COMAL RIVER IN NEW BRAUNFELS
12656	GUADALUPE RIVER AT THE BEGINNING OF CYPRESS BEND PARK IN NEW BRAUNFELS

Table 10	
TCEQ Clean Rivers Program Monitoring Stations: San Marcos River	
15496	SPRING LAKE AT AQUARENA SPRINGS BRIDGE IN SAN MARCOS
15497	SPRING LAKE AT DAM .10 MI UPSTREAM FROM LOOP 82 IN SAN MARCOS
15498	UPPER SAN MARCOS RIVER AT CONFLUENCE OF SESSOM CREEK AT LOOP 82 IN SAN MARCOS
15499	UPPER SAN MARCOS RIVER AT CONFLUENCE OF PURGATORY CREEK AT CITY PARK .10 MI DOWNSTREAM OF SH 12 IN SAN MARCOS
15500	UPPER SAN MARCOS RIVER AT RIO VISTA PARK FOOTBRIDGE .20 MI DOWNSTREAM OF SH 12 IN SAN MARCOS
12672	UPPER SAN MARCOS RIVER IMMEDIATELY UPSTREAM OF IH 35 BRIDGE AT SAN MARCOS
14153	SAN MARCOS/A.E. WOODS TPWD FISH HATCHERY DISCHARGE POINT TO SAN MARCOS RIVER
12671	UPPER SAN MARCOS RIVER 0.7 MILE DOWNSTREAM FROM IH 35

Future investigations can utilize the GIS geodatabase created during this study, and update it with the most current readily available data from the TCEQ Clean Rivers Program. Once numerical recreation use data becomes available, it can be compared to the water quality data to ascertain any correlations between the frequency and intensity of recreational use and water quality. Then layering any protected species mapping data may allow analysis of any potential relationship between species sustainability or proliferation and recreation use. Two recognizable studies conducted by the USGS in the 1990's can be used as a model for future studies (See Appendix D). The GIS geodatabase of TCEQ data includes the parameters that the



USGS used: pH, temperature, dissolved oxygen, major ions, nutrients, trace elements, selected organic compounds, and stream flow. A list of all of the parameters monitored by TCEQ are illustrated in Table 11.

TABLE 11.
TCEQ WATER QUALITY SAMPLING PARAMETERS
00060 FLOW, STREAM, MEAN DAILY (CUBIC FEET PER SEC)
00061 FLOW STREAM, INSTANTANEOUS (CUBIC FEET PER SEC)
00078 TRANSPARENCY, SECCHI DISC (METERS)
00090 OXIDATION REDUCTION POTENTIAL (MILLIVOLTS)
00094 SPECIFIC CONDUCTANCE, FIELD (UMHOS/CM @ 25C)
00095 SPECIFIC CONDUCTANCE, LAB (UMHOS/CM @ 25C)
00300 OXYGEN, DISSOLVED (MG/L)
00301 OXYGEN, DISSOLVED (PERCENT OF SATURATION)
00400 PH (STANDARD UNITS)
00403 PH (STANDARD UNITS) LAB
00410 ALKALINITY, TOTAL (MG/L AS CaCO3)
00480 SALINITY - PARTS PER THOUSAND
00530 RESIDUE, TOTAL NONFILTRABLE (MG/L)
00535 RESIDUE, VOLATILE NONFILTRABLE (MG/L)
00593 NO2 PLUS NO3-N, TOTAL, WHATMAN GF/F FILT (MG/L)
00608 NITROGEN, AMMONIA, DISSOLVED (MG/L AS N)
00610 NITROGEN, AMMONIA, TOTAL (MG/L AS N)
00613 NITRITE, DISSOLVED (MG/L AS N)
00615 NITRITE NITROGEN, TOTAL (MG/L AS N)
00620 NITRATE NITROGEN, TOTAL (MG/L AS N)
00623 NITROGEN, KJELDAHL, DISSOLVED (MG/L AS N)
00625 NITROGEN, KJELDAHL, TOTAL (MG/L AS N)



TABLE 11.

TCEQ WATER QUALITY SAMPLING PARAMETERS

00630 NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)
00631 NITRITE PLUS NITRATE, DISS 1 DET. (MG/L AS N)
00665 PHOSPHORUS, TOTAL, WET METHOD (MG/L AS P)
00666 PHOSPHORUS, DISSOLVED (MG/L AS P)
00671 ORTHOPHOSPHATE PHOSPHORUS,DISS,MG/L,FLDFILT<15MIN
00680 CARBON, TOTAL ORGANIC, NPOC (TOC), MG/L
00681 CARBON, DISSOLVED ORGANIC, DNPC (DOC), MG/L
00689 CARBON, SUSPENDED ORGANIC - POC (MG/L)
00900 HARDNESS, TOTAL (MG/L AS CaCO ₃)
00915 CALCIUM, DISSOLVED (MG/L AS Ca)
00925 MAGNESIUM, DISSOLVED (MG/L AS Mg)
00930 SODIUM, DISSOLVED (MG/L AS Na)
00935 POTASSIUM, DISSOLVED (MG/L AS K)
00940 CHLORIDE (MG/L AS Cl)
00945 SULFATE (MG/L AS SO ₄)
00950 FLUORIDE, DISSOLVED (MG/L AS F)
00955 SILICA, DISSOLVED (MG/L AS SiO ₂)
01000 ARSENIC, DISSOLVED (UG/L AS As)
01005 BARIUM, DISSOLVED (UG/L AS Ba)
01010 BERYLLIUM, DISSOLVED (UG/L AS Be)
01025 CADMIUM, DISSOLVED (UG/L AS Cd)
01030 CHROMIUM, DISSOLVED (UG/L AS Cr)
01035 COBALT, DISSOLVED (UG/L AS Co)
01040 COPPER, DISSOLVED (UG/L AS Cu)



TABLE 11.

TCEQ WATER QUALITY SAMPLING PARAMETERS

01046 IRON, DISSOLVED (UG/L)
01049 LEAD, DISSOLVED (UG/L AS PB)
01056 MANGANESE, DISSOLVED (UG/L AS MN)
01060 MOLYBDENUM, DISSOLVED (UG/L AS MO)
01065 NICKEL, DISSOLVED (UG/L AS NI)
01075 SILVER, DISSOLVED (UG/L AS AG)
01090 ZINC, DISSOLVED (UG/L AS ZN)
01095 ANTIMONY, DISSOLVED (UG/L AS SB)
01106 ALUMINUM, DISSOLVED (UG/L AS AL)
01145 SELENIUM, DISSOLVED (UG/L AS SE)
01351 FLOW:1=No Flow,2=Low,3=Normal,4=Flood,5=High,6=Dry
22703 URANIUM, NATURAL, DISSOLVED
31616 FECAL COLIFORM, MEMBR FILTER, M-FC BROTH, #/100ML
31648 E. COLI, MTEC, MF, #/100 ML
31673 FECAL STREPTOCOCCI, MBR FILT, KF AGAR, 35C, 48HR
31699 E. COLI, COLILERT, IDEXX METHOD, MPN/100ML
32211 CHLOROPHYLL-A UG/L SPECTROPHOTOMETRIC ACID. METH
32218 PHEOPHYTIN-A UG/L SPECTROPHOTOMETRIC ACID. METH.
32764 7,12-DIMETHYLBENZ(A)ANTHRACENE, SED, DRY WT
32772 DIBENZ(AJ)ACRIDINE, SEDIMENT, DRY WT, UG/KG
32778 M,P-CRESOL, SEDIMENT, DRY WT, UG/KG
34203 ACENAPHTHYLENE, DRY WT, BOTTOM (UG/KG)
34208 ACENAPHTHENE, DRY WT, BOTTOM (UG/KG)
34223 ANTHRACENE DRY WT BOT UG/KG



TABLE 11.

TCEQ WATER QUALITY SAMPLING PARAMETERS

34233 BENZO(B)FLUORANTHENE,SEDIMENTS, DRY WT,UG/KG
34245 BENZO(K)FLUORANTHENE DRY WTBOT UG/KG
34250 BENZO-A-PYRENE DRY WTBOTUG/KG
34276 BIS (2-CHLOROETHYL) ETHER DRY WTBOTUG/KG
34281 BIS (2-CHLOROETHOXY) METHANE DRY WTBOTUG/KG
34286 BIS (2-CHLOROISOPROPYL) ETHER DRY WTBOTUG/KG
34295 N-BUTYL BENZYL PHTHALATE, SEDIMENTS,DRY WT,UG/K
34323 CHRYSENE DRY WTBOTUG/KG
34339 DIETHYL PHTHALATE DRY WTBOTUG/KG
34344 DIMETHYL PHTHALATE DRY WTBOTUG/KG
34349 1,2-DIPHENYLHYDRAZINE, DRY WT, BOTTOM (UG/KG)
34379 FLUORANTHENE DRY WTBOTUG/KG
34384 FLUORENE DRY WTBOTUG/KG
34389 HEXACHLOROCYCLOPENTADIENE DRY WTBOTUG/KG
34399 HEXACHLOROETHANE DRY WTBOTUG/KG
34406 INDENO (1,2,3-CD) PYRENE DRY WTBOTUG/KG
34411 ISOPHORONE DRY WTBOTUG/KG
34431 N-NITROSODI-N-PROPYLAMINE DRY WTBOTUG/KG
34436 N-NITROSODIPHENYLAMINE DRY WTBOTUG/KG
34441 N-NITROSODIMETHYLAMINE DRY WTBOTUG/KG
34445 NAPHTHALENE DRY WTBOTUG/KG
34450 NITROBENZENE DRY WTBOTUG/KG
34455 PARACHLOROMETA CRESOL DRY WTBOTUG/KG
34464 PHENANTHRENE DRY WTBOTUG/KG



TABLE 11.

TCEQ WATER QUALITY SAMPLING PARAMETERS

34472 PYRENE DRY WTBOTUG/KG
34524 BENZO(GHI)PERYLENE1,12-BENZOPERYLENDRYWTBOTUG/KG
34529 BENZO(A)ANTHRACENE1,2-BENZANTHRACENDRYWTBOTUG/KG
34539 1,2-DICHLOROBENZENE DRY WT, BOTTOM (UG/KG)
34554 1,2,4-TRICHLOROBENZENE DRY WTBOTUG/KG
34559 1,2,5,6-DIBENZANTHRACENE DRY WTBOTUG/KG
34569 1,3-DICHLOROBENZENE, DRY WT, BOTTOM (UG/KG)
34574 1,4-DICHLOROBENZENE, DRY WT, BOTTOM (UG/KG)
34589 2-CHLOROPHENOL, DRY WT, BOTTOM (UG/KG)
34594 2-NITROPHENOL DRY WTBOTUG/KG
34599 DI-N-OCTYL PHTHALATE DRY WTBOTUG/KG
34604 2,4-DICHLOROPHENOL DRY WT, BOTTOM (UG/KG)
34609 2,4-DIMETHYLPHENOL DRY WT, BOTTOM (UG/KG)
34614 2,4-DINITROTOLUENE DRY WT, BOTTOM (UG/KG)
34619 2,4-DINITROPHENOL DRY WT, BOTTOM (UG/KG)
34624 2,4,6-TRICHLOROPHENOL ,DRY WT, BOTTOM (UG/KG)
34629 2,6-DINITROTOLUENE DRY WT, BOTTOM (UG/KG)
34634 3,3'-DICHLOROBENZIDINE, DRY WT BOTTOM (UG/KG)
34639 4-BROMOPHENYL PHENYL ETHER, DRY WT, BOT (UG/KG)
34644 4-CHLOROPHENYL PHENYL ETHER, DRY WT, BOT (UG/KG)
34649 4-NITROPHENOL ,DRY WT, BOTTOM (UG/KG)
34660 DNOC (4,6-DINITRO-ORTHO-CRESOL) DRY WTBOTUG/KG
34695 PHENOL(C6H5OH)-SINGLE COMPOUND DRY WTUG/KG
34721 2,3,4,6-TETRACHLOROPHENOL SEDIMENT, DRYWT(UG/KG)



TABLE 11.

TCEQ WATER QUALITY SAMPLING PARAMETERS

39036 ALKALINITY, FILTERED SAMPLE AS CaCO ₃ MG/L
39061 PCP (PENTACHLOROPHENOL) IN BOT DEPOS DRY UG/KG
39102 BIS(2-ETHYLHEXYL) PHTHALATE SED, DRY WT,UG/KG
39112 DI-N-BUTYL PHTHALATE, SEDIMENTS,DRY WT,UG/KG
39118 PENTACHLOROBENZENE IN SEDIMENT UG/KG
39121 BENZIDINE IN BOTTOM DEPOS (UG/KG DRY SOLIDS)
39191 TOTAL CHLORONAPHTHALENE (1AND 2) IN SED, UG/KG
39631 ATRAZINE IN BOTTOM DEPOS (UG/KG DRY SOLIDS)
39701 HEXACHLOROBENZENE IN BOT DEPOS (UG/KG DRY SOLIDS)
39705 HEXACHLOROBUTADIENE BOT. DEPOS. (UG/KG DRY WT)
70300 RESIDUE,TOTAL FILTRABLE (DRIED AT 180C) (MG/L)
70507 ORTHOPHOSPHATE PHOSPHORUS,DISS,MG/L,FILTER >15MIN
72053 DAYS SINCE PRECIPITATION EVENT (DAYS)
73031 PRONAMIDE IN SEDIMENT, DRY WEIGHT (UG/KG)
73116 P-DIMETHYLAMINOAZOBENZENE, SED, DRY WT, UG/KG
73117 PHENACETIN IN SEDIMENT, DRY WEIGHT (UG/KG)
73118 ETHYLMETHANSULFONATE IN SEDIMENT, DRY WT (UG/KG)
73119 METHYLMETHANESULFONATE IN SEDIMENT, DRY WT (UG/K
73122 2,6-DICHLOROPHENOL IN SEDIMENT, DRY WT (UG/KG)
73124 2-NAPHTHYLAMINE IN SEDIMENT, DRY WEIGHT (UG/KG)
73125 4-AMINOBIHENYL, SEDIMENT, DRY WT (UG/KG)
73129 N-NITROSOPIPERIDINE IN SEDIMENT, DRY WT (UG/KG)
73143 1-NAPHTHYLAMINE IN SEDIMENT, DRY WT (UG/KG)
73156 3-METHYLCHLORANTHRENE, SEDIMENT, DRY WT(UG/KG)



TABLE 11.

TCEQ WATER QUALITY SAMPLING PARAMETERS

73158 2-METHYLPYRIDINE IN SEDIMENT, DRY WEIGHT (UG/KG)
73159 N-NITROSO-DI-N-BUTYLAMINE, DRY WT,SEDIMENT (UG/K
74069 STREAM FLOW ESTIMATE (CFS)
75212 BENZYL ALCOHOL IN SEDIMENT, DRY WEIGHT (UG/KG)
75315 BENZOIC ACID IN SEDIMENT, DRY WEIGHT (UG/KG)
75647 DIBENZOFURAN, SEDIMENT, DRY WT (UG/KG)
78299 2-NITROANILINE IN SEDIMENT, DRY WEIGHT (UG/KG)
78401 2,4,5-TRICHLOROPHENOL IN SEDIMENT,DRY WT (UG/KG)
78543 CARBAZOLE IN SEDIMENT, DRY WEIGHT (UG/KG)
78755 ACETOPHENONE, SEDIMENT, DRY WT (UG/KG)
78866 ANILINE IN SEDIMENT, DRY WEIGHT (UG/KG)
78867 4-CHLOROANILINE, SEDIMENT, DRY WT (UG/KG)
78868 2-METHYLNAPHTHALENE IN SEDIMENT, DRY WEIGHT (UG/K
78869 3-NITROANILINE, SEDIMENT, DRY WEIGHT (UG/KG)
78870 4-NITROANILINE, SEDIMENT, DRY WT (UG/KG)
78872 2-METHYLPHENOL(O-CRESOL) SEDIMENT DRY WT. (UG/KG
80154 SUSP. SEDIMENT CONCENTRATION-EVAP AT 110C (MG/L)
80256 SEDIMENT PRTL.SIZE CLASS >2.0MM GRAVEL %DRY WT
81373 SOLIDS IN SEDIMENT, PERCENT BY WEIGHT (DRY)
81808 PENTACHLORONITROBENZENE IN SEDIMENT, DRYWT (UG/K
81818 SEVIN IN SEDIMENT DRY WEIGHT (UG/KG)
81951 TOTAL ORGANIC CARBON,NPOC(TOC), SED DRY WT,MG/KG
82003 MOISTURE CONTENT IN SEDIMENT (%)
82008 SEDIMENT PRTL.SIZE CLASS.0039-.0625 SILT %DRY W



TABLE 11.
TCEQ WATER QUALITY SAMPLING PARAMETERS
82009 SEDIMENT PRCTL.SIZE CLASS <.0039 CLAY %DRY WT
82079 TURBIDITY,LAB NEPHELOMETRIC TURBIDITY UNITS, NTU
88811 CRESOL IN SEDIMENT, DRY WEIGHT, (UG/KG)
88817 N-NITROSODIETHYLAMINE, SED DRY WT (UG/KG)
88823 PYRIDINE SEDIMENT DRY WEIGHT (UG/KG)
88826 1,2,4,5-TETRACHLOROBENZENE SEDIMENT DRY WT (UG/K
89835 FLOW MTH 1=GAGE 2=ELEC 3=MECH 4=WEIR/FLU 5=DOPPL
89991 SEDIMENT PRCTL.SIZE CLASS,SAND .0625-2MM %DRYWT

In addition to data collection, the TCEQ assesses water quality throughout the state. Formerly called the "Texas Water Quality Inventory and 303(d) List," the Integrated Report evaluates the quality of surface waters in Texas, and provides resource managers with a tool for making informed decisions when directing agency programs. The Texas Integrated Report describes the status of Texas' natural waters based on historical data. It identifies water bodies that are not meeting standards set for their use on the 303(d) list. The Texas Integrated Report satisfies the requirements of federal Clean Water Act Sections 305(b) and 303(d). The TCEQ produces a new report every two years in even-numbered years, as required by law. The 303(d) List must be approved by the EPA before it is final. The TCEQ monitoring program also reports the status of water quality in the biennial Texas Water Quality Inventory and 303(d) List of Impaired Waters. The Texas Water Quality Inventory and 303(d) List reports the information on Texas' surface waters, including concerns for public health, fitness for use by aquatic species and other wildlife, and specific pollutants and their possible sources (TCEQ website, 2010).

Table 12 lists the stream segments within the study area. According to the 2008 Texas Water Quality Inventory and 303(d) List of Impaired Waters, no segments (1811, 1812, and 1814) within the study area were considered impaired. See Appendix D for the results of this analysis.



TABLE 12

2008 TEXAS WATER QUALITY INVENTORY STREAM SEGMENTS IN STUDY AREA

1811 – Comal River	From the confluence with the Guadalupe River in Comal County to Klingemann Street in New Braunfels in Comal County (4 miles)
1811A – Dry Comal Creek Unclassified (Not assessed in 2008)	From the confluence of the Comal River in New Braunfels in Comal County to the upstream perennial portion of the stream southwest of New Braunfels in Comal County (30 miles)
1814 – Upper San Marcos River	From a point 1.0 km (0.6 miles) upstream of the confluence of the Blanco River in Hays County to a point 0.7 km (0.4 miles) upstream of Loop 82 in San Marcos in Hays County (5 miles)

VI. PERTINENT SCIENTIFIC STUDIES

Sources for the following studies come from the City of San Marcos, the City of New Braunfels, and River Systems Institute. Halff is aware there are relevant studies beyond what has been summarized in this document, however those relevant studies were either not accessible or not made available at the time of this report. It would likely be of benefit for the EARIP to take into consideration the results of those complementary studies.

The studies reviewed include habitat conservation plans, academic theses, articles and books and provide insight into the management of rivers for the sake of habitat and/or the physical and chemical affects on rivers from human activity, including recreation. Of greatest relevance is the current on-going study of Texas State University student Jenna Winters; although methodologies were not specifically revealed, her data on the San Marcos River is the most site specific and significant of information gathered.

A. Pertinent Studies

Doctoral Study of San Marcos River between Sewell Park and Rio Vista falls by Jenna Winters, unpublished data from 2007-2009

Geographical points of study of San Marco River from upstream to downstream order:

Last bridge
Just before City Park
Just after City Park
Hopkins St. Bridge
Bicentennial Park
Beginning of Rio Vista Park
Dam at Rio vista Park

Turbidity:

- Measurements of turbidity were taken at 6' from each bank and center of current channel
- Correlation was found between number of people and turbidity levels.
- Levels of turbidity in San Marcos River between Sept and April: mostly recorded at 2.00 NTUs and under, rarely more than 3.00 NTUs. Spikes in turbidity during this time correlated with rainfall events. Turbidity increased with summer months. The correlation was found to be consistently 0.72 in both 2008 and 2009.



- Years when flow of the river was low, turbidity was higher and vice versa.

Peak days were summer season (Memorial Day weekend – Labor Day) Saturdays and Sundays, with greater amount of people on Saturdays. Holiday Mondays showed higher numbers as well and in general, Thursdays and Fridays averaged greater numbers than Tuesdays and Wednesdays. In one counting survey performed during a July 4 weekend taken between 12pm and 2pm, 1756 people (swimming or tubing) and 6 dogs were counted to be in the river. On June 5, 2009 (a Friday), a count was documented at 706 people and 4 dogs. In her 2008 survey of 717 people, the following information was revealed:

- Reported primary activity of visitors to the San Marcos River:
- 33% swim
- 28% socialize
- 16% tube
- 6% boat
- 2% fish
- Mean age of user: 34
- 53% were from San Marcos area
- 76% were from the Austin- San Antonio IH 35 corridor
- 98% were Texas residents
- 98% reported they would return
- 87% were repeat visitors
- Average duration of stay at the river: 4 hours
- This duration does not vary with weekend or weekday days
- 50% brought their own tubes

For that particular visit:

- 75% spent less than \$25
- 13% spent between \$25-\$50
- 6% spent between \$50-\$75
- 7% spent >\$100
- 6% were overnight guests
- 24% advised that fuel prices would affect their decision to visit

Awareness of listed species in the San Marcos River:

- 59% advised they were aware
- 27% advised they learned this from school programs



- 18% advised they learned this from friends
- 13% advised they learned this from signage
- 67% of Caucasians were aware
- 44% of Hispanics were aware

Cleanliness of the River:

- 29% perceived the water as very clean
- 50% perceived the water is mostly clean

Perception of crowding

- 82% reported to have no issues with levels of crowd
- 94% reported to not feel crowded or only slightly crowded

Ethnicity

Percentage of Hispanic and Caucasian visitors proportionately mirrored the San Marcos city demographic

USFWS, Summary of 2009 sampling efforts related to Edwards Aquifer Authority Variable Flow Study under USFWS permit number TE037155-0, 2009

Methods and findings of federally listed species in specific locations of the Comal and San Marcos Rivers were explained.

This report provides current and specific information of where and in what kinds of densities each of the Fountain Darters, San Marcos Salamander, Texas Wild Rice, Comal Spring Riffle Beetle was found, along with other fish and crustaceans, arachnids and insects. Information regarding current flow, time of year and water quality was also provided, as well as findings from previous years for comparison.

This report is useful in ascertaining information about population fluctuations and habitat conditions and may provide clues as to where recreation use could be altered to accommodate for these habitats.

Owens, Chetta S., John D. Madsen, R. Michael Smart and Michael Stewart
Dispersal of Native and Nonnative Aquatic Plant Species in the San Marcos River, Texas

Five sites were sampled 5 times each on a quarterly schedule reflecting seasonal trends for introduced and native vegetation types. The article focuses on the proliferation of hydrilla and East Indian hygrophila and their effects on the native listed species Texas Wild Rice. References to other sources noted times and season of recreation use and the finding that recreation negatively impacts



Texas wild rice, additionally that recreation users disturb, tear and uproot native species allowing more aggressive nonnative species to proliferate.

Bussemey, Michelle, *Analysis of Landscape Change of the Rio Vista Dam in San Marcos, Texas*. MS Thesis, Texas State University, San Marcos, Texas, 2007

Repeat photography documents the changes of the river and adjacent banks at the location of the current day Rio Vista Dam dating back from 1917. A cultural and physical history is documented and concludes the landscape changes which include opening this part of the river to the community (for recreation use) and the reconstruction of the dam and construction of step pools has resulted in congestion, increased turbidity and trash in and around the river. The author also warns the alterations in the dams and the introduction of pools will also result in sediment bars and ultimately could alter the channel and the flow of the river.

City of San Marcos Habitat Conservation Plan (Draft – not yet implemented)

This report outlines options in strategies in which to protect and minimize disturbance and limit take (to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct) of federally listed aquatic species found in the San Marcos River during the course of maintenance and construction projects and activities for the next twenty (20) years. Those species include the fountain darter, the Comal Springs riffle beetle, the San Marcos salamander and Texas wild-rice.

Requirements under the take permit, known as a Section 10(a)(1)(B) permit, issued by US Fisheries and Wildlife Service (USFWS) include biological data, impact assessments, geographical area, activities of listed species within the project area, provisions to monitor, minimize, and mitigate impacts and procedures to deal with unforeseen circumstances.

This report aims to support a comprehensive watershed management plan for the San Marcos River within the city limits which includes the city's Recreation Master Plan as well as the Environmental Protection Agency Phase II Storm Water Management Program.

The projects and activities that apply to this study are those surrounding the San Marcos River corridor between the springs at Spring Lake and Rio Vista Falls. This draft publication describes the physical attributes of the affected area, including hydrology, climate, water quality, existing land use, vegetation and wildlife including the listed species. The draft publication also makes an assessment of threats which include sedimentation, increased pollution, increased nutrient levels, expanding population of non-natives and recreational activity, on which this report focuses.



River recreation activities cited include scuba, swimming, tubing, canoeing/kayaking, fishing, wading, dog playing, snorkeling and boat touring. Recreation causes disturbance to the river bottom and vegetation, streamside issues include erosion, litter and pollution, while fishing specifically can introduce non-native bait species.

Maintenance is performed to maintain a clear corridor for water recreation; this includes clearing vegetation from the central 5 meters of the current channel to a depth of 12". The city will manage a strategically timed incremental removal of high growth and non-native vegetative species while replacing with low growth native species, in addition to sediment removal.

The proximity of Texas State University golf course incurs strict regulations by USFWS on use of fertilizers and pesticides, as well as watering regimes.

In addition to outlining on-going maintenance activities within the area, this draft publication also lists future projects by Texas State University, including construction of a new hike/bike trail and an expanded academic curriculum of water activities (at Spring Lake) by Texas State University. City projects include bank stabilization projects and provision of controlled river access points taking care to remediate with native rock and riparian vegetation.

Edwards Aquifer Authority. 'Comprehensive and Critical Period Monitoring Program to Evaluate the Effects of Variable Flow on Biological Resources in the Comal Springs/River Aquatic Ecosystem Final 2009 Annual Report' . BIO-WEST Inc. March 2010

This report was made known to the Halff team late in the process of producing this report and was thus not thoroughly reviewed. Relevant information found in this document includes monitoring efforts by the Master Naturalist volunteers who collected data on river users (numbers, types/activities) and water quality (pH, carbon dioxide) on a weekly basis in the years 2006 through 2009. Five (5) sites were visited regularly at roughly the same time for the same duration at each of the five locations. Tubing was found to be the dominant recreation activity, with emphasis between May and September of each year and 2009 showed a higher number of users at four of the five locations over 2007 and 2008. With regards to water quality, pH levels were shown to be consistently lower nearer the springs than downstream and carbon dioxide concentrations showed higher levels nearer the springs and less downstream.

Edwards Aquifer Authority. 'Comprehensive and Critical Period Monitoring Program to Evaluate the Effects of Variable Flow on Biological Resources in the San Marcos Springs/River Aquatic Ecosystem Final 2009 Annual Report' . BIO-WEST Inc. March 2010



This report was made known to the Halff team late in the process of producing this report and was thus not thoroughly reviewed. This document summarizes the methodology and findings of two comprehensive monitoring events and three critical period low-flow events. These samplings examined water chemistry, current flow, water levels, water temperature, aquatic vegetation and changes in channel morphology. This type of detailed investigation found correlations between the establishment of Texas wild rice with water levels and current flow and subsequently, recreation use as a result of water levels and their impact on the establishment of Texas wild rice. The report cites mechanical disturbance on river banks and bottom and fragmentation of wild rice stands from recreationists. Quantitative data comes from mapping of wild rice stands and measurement of current flows, water levels, and changes in channel morphology. Observed recreation use (areas and activities) correlated with accessibility of the river and water depths. Similarly, fountain darter found locations correlated with stands of aquatic vegetation and was thus also found to be affected by recreationists.

Edwards Aquifer Area Expert Science Subcommittee for the Edwards Aquifer Recovery Implementation Program. 'Analysis of Species Requirements in Relation to Spring Discharge Rates and Associated Withdrawal Reductions and Stages for Critical Period Management of the Edwards Aquifer'. Report to Steering Committee for the Edwards Aquifer Implementation Program. December 28, 2009.

This report was made known to the Halff team late in the process of producing this report and was thus not thoroughly reviewed. Quantitative documentation of water flow and physical changes to vegetation and stream channel were provided for the three (3) years of this study. Information regarding population size and locations of the various species at various times of the year were also provided and qualitative observations were made regarding the context of each sampling period, including human (recreation) activity. The report provides information on which and how listed species are affected by flow rates and the various factors flow rates affect (that ultimately affect the habitat for listed species): turbidity (sunlight), scouring effects (establishment of Texas wild rice and opportunities for more aggressive (competitive) non-native aquatic vegetation), sedimentation, recreation (opportunities for greater human contact with banks and river bottoms, accessibility of shallow depth stream areas). The report clearly indicates recreation has a direct and indirect effect on fountain darters and a direct effect on Texas wild rice but cites such factors as sedimentation, turbidity, presence of exotic species are also variables in their populations. Populations of the Texas blind salamander and listed beetle species are noted to be physically found closer to or within the spring sources and are thus much less affected by recreation but more so by water table depth (draw), water flow rates (draw and drought) and water quality (pollution within recharge zones). The San Marcos blind salamander riverbed habitat was found to be



impacted near Spring Lake Dam by siltation (allowing extensive vegetation growth) and (accessibility of water) recreation during low discharge years of 2006 and 2009. The report makes conclusions about minimum flow rates for species survival.

Bradsby, D.D. 1994. *A Recreational Use Survey of the San Marcos River*. MS Thesis, Southwest Texas State University, San Marcos, Tx 82pp.

This study was not accessible but was referred to by several sources.

Breslin, S.L. 1997. *The impact of recreation on Texas wild rice*. MS Thesis, Southwest Texas State University, San Marcos, Tx. 69pp.

This study was not accessible but was referred to by several sources. One reference found stated Texas wild rice is found only in the upper 2.5 km of the San Marcos River. Recreation visibly causes considerable damage to Texas wild rice stands with highest occurrence during peak recreational months in the hours between 2-3pm.

Earl, Richard A. and Wood, Charles R. 'Upstream Changes and Downstream Effects of the San Marcos River of Central Texas'. The Texas Journal of Science February 2002

The San Marcos River is recognized as a unique resource; it is attracting a growing population to the city as well as Texas State University. It is documented to have the potential to produce a floodflow of 247 square kilometers. The flood of May 15, 1970 which resulted in a discharge of 76,600 cubic feet per second was the impetus for the formation of the Upper San Marcos Watershed Reclamation and Flood Control District. Another flood on June 13, 1981 prompted the funding for a series of five (5) control dams upstream San Marcos River, the last of which was completed in 1991. These dams have a combined capacity of 23 million cubic meters (19,000acre feet) and consequently reduced the uncontrolled drainage area from 247 square km to 47 square km. Although effective in controlling flood damage (as evidenced by larger than 100 year flood event of October 1998, which produced a peak discharge of what would have been a 25 year event), the construction of the dams have resulted in decreased scouring action (reduced flow), and consequently, increased sedimentation of the river, by as much as 0.5 meters depth in the main channel. The changes have caused issue with the increases in exotic riparian and aquatic vegetation, and thereby affecting the natural habitats of the four (fountain darter, texas wild rice, san marcos salamander, comal springs riffle beetle)US Fish and Wildlife Services aquatic species. While flooding control measures are effective, they have brought on a new set of management issues. The Texas Parks and Wildlife Department and the City of San Marcos Parks and Recreation Department since 1990 have been closely monitoring the river for critical habitat and for protection of the river as an aesthetic and tourism resource.



Comal County, Texas and Comal County Commissioners Court. Comal County Regional Habitat Conservation Plan. April 2010

The rate of growth in Comal County has induced a desire for a strategy in which to ensure the protection and preservation of open space for the benefit of the County's citizens, to conserve the County's endangered species and to help landowners comply with Endangered Species Act (ESA) compliance efficiently and cost effectively. Participation in the County's process by landowners is voluntary, although compliance with the Endangered Species Act is not.

A Habitat Conservation Plan (HCP) by Comal County would help establish a 30 year regional permit that would allow authorization under the ESA for land development activities that could affect the 'take' (to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct) of federally listed or endangered wildlife species listed under the ESA. This type of regional plan specifies the conservation measures that would be implemented in exchange for a US Fisheries and Wildlife Service section 10(a)(1)(B) permit. The Regional HCP addresses habitats for the golden cheeked warbler and the black capped vireo. (Federally) Listed species not addressed in this HCP are aquatic species associated with Edwards Aquifer: the fountain darter, Peck's cave amphipod, Comal Springs riffle beetle, and the Comal Springs dryopid beetle.

Comal County, Texas and Comal County Commissioners Court. Comal County Regional Habitat Conservation Plan Environmental Impact Statement. April 2010

This report describes the potential impacts of the 'take' permit described in the Comal County Regional Habitat Conservation Plan (RHCP) of April 2010. Although the aforementioned plan addresses only the take of the golden cheeked warbler and the black capped vireo, this environmental impact statement describes the affect on habitats of other species as a result of land development; the report provides three (3) scenarios for Comal County: no regional permit (alternative A), regional permit granted (alternative B), reduced take regional permit (alternative C, does not cover habitats of the black capped vireo). Each scenario is described in terms of the direct, indirect and cumulative effects of take and mitigation as proposed by the RHCP.

The proposed action, as the favored scenario is referred to, is alternative B: to obtain a regional permit that would allow Comal County to process and monitor land development in terms of take and to ensure that the RHCP is adhered to in terms of mitigating environments and allocating habitat in perpetuity for the survival of the golden cheeked warbler and the black capped vireo.

A regional permit would require a commitment of resources, including revenue, to monitor and support the RHCP. This direction is described as most strategic in that it



is projected to least hinder the pace of economic growth in the area while also yielding the greatest potential for preservation.

A detailed analysis of various topics is part of this environmental impact assessment: water resources, vegetation, general wildlife, covered species, socioeconomic resources. Of the covered species, the listed species of interest in our river recreation study are identified as other protected species (other = those negligibly or minor affected by land (woodland) development as outlined in the RHCP): San Marcos salamander (*Eurycea nana*), Texas blind salamander (*Typhlomolge rathbuni*), Fountain Darter (*Etheostoma fonticola*), San Marcos gambusia (*Gambusia georgei*), Comal Springs Dryopid Beetle (*Stygoparnus comalensis*), Comal Springs Riffle Beetle (*heterelmis comalensis*), Texas wild-rice (*Zizania texana*). It should also be noted that The San Marcos salamander, Texas blind salamander, San Marcos gambusia and Texas wild rice are not evident in Comal County.

The consequential impacts from land development that may affect our species of interest would be any affects to the Edwards Aquifer (development will not be permitted to draw from this aquifer) such as any draw/reduction in flow and any sedimentation or toxic deposits in surface waters as a result of development and the reduction of pervious ground (unfiltered recharge). Changes in water levels, temperature and toxicity would be the largest threat, but because there are strict regulations on aquifer withdrawal, water quality control and development over the Edwards Aquifer recharge zone, and with the development of the Edwards Aquifer Recovery Implementation Program (EARIP), our three species of interest in Comal County (Comal Springs Riffle beetle, Comal Springs dryopid beetle and the fountain darter) would be minor to negligible. It is also stated that developing programs such as the EARIP, of which this study is a part, could be beneficial to such species. The primary focus of this RHCP is the take of black capped vireo and golden cheeeked warbler habitat, which is woodland and is thus theoretically unlikely to affect the habitats of our species of interest.

The following ongoing or planned authorities, rules and regulations are expected to minimize the impacts on water resources and aquatic species:

- Edwards Aquifer Authority Rules
- Texas Pollutant Discharge Elimination System regulations
- Environmental Protection Agency and Army Corps of Engineers wetlands program
- Texas Commission on Environmental Quality total maximum daily load program
- Groundwater pumping regulation of the Edwards Aquifer Authority
- Texas House Bill 1763: requiring groups of Groundwater Districts to plan for the desired future condition of the groundwater resources in their Groundwater Management Area



- Texas Senate Bill 3: process leading to establishment of minimum environmental flow standards for each river basin in the state
- Water quality regulations of the city of San Antonio
- Edwards Aquifer Recovery Implementation Program
- Creation of a groundwater district over parts of the Trinity Aquifer occurring over Comal County

This environmental impact statement states the maintenance of water levels within the Edwards Aquifer area as established and regulated by the Edwards Aquifer Authority is the strongest measure in protecting the aquatic listed species so much so that it concludes that the RHCP measures proposed would minimally reduce cumulative adverse impacts on such species.

The report lastly discusses the possibility of climate change and other unavoidable adverse impacts and that they would be offset by the preservation of larger blocks of unfragmented habitat.

B. Related Studies:

Bowles, David E., and Arsuffi , Thomas L. *Karst aquatic ecosystems of the Edwards Plateau region of central Texas, USA: A consideration of their importance, threats to their existence, and efforts for their conservation.* 28 Jun 2006 (on-line publication), from *Aquatic Conservation: Marine and Freshwater Ecosystems: Special Issue: Endangered Aquatic Habitats - A Symposium of the Entomological Society of America December 1992 Volume 3, Issue 4, pages 317-329, December 1993 John Wiley & Sons, Ltd 1993*

This article identifies the endangered species within the Edwards Aquifer, along with the endemic and unique aquatic biota of the Edwards Plateau. It identifies specific threats from expanding human population including overpumping of aquifers, agricultural practices, pollution, development, recreational activities, introductions of exotic species and changes in regional and global climatic patterns and means for protection and remediation.

This article is most relevant to our focus of study by means of its discussion of water conservation, development of alternative water sources and land management and stewardship programmes.

Newsome, David. Moore, Susan A.. Dowling, Ross Kingston. Natural Area Tourism, ecology, impacts and management. Channel View Publications, 2002.

A book that looks at the evolution of natural area tourism, creation of national parks, preservations areas globally and the means by which



environmental consciousness is leading us to find more comprehensive means of planning and managing the impacts of environmental tourism in such a way that not only heightens the experience of the tourist but also benefits the environment simultaneously. The book has many examples of monitoring and surveying techniques used globally to measure various physical and social aspects to first establish a baseline of use and secondly, direction in which to maximize benefits to both users and the environment. Of particular interest in this document related to our study of the San Marcos and Comal systems are the physical variables that are measured with regards to soil compaction and bank stabilization/erosion. It also lists some effects that have not been discussed previously: noise levels, changes in nutrient availability and distribution caused by disturbing river bottoms as well as disturbance of mating rituals and deposited eggs of various species. This book is a wealth of examples of how and what could be sampled to help monitor the effects of recreation for further study.

GCAGS Transactions Volume 48 (1998)

Barton Creek watershed and springs located under the Glen Rose Formation : found differences in chemistry of shallow ground water between urban and rural settings, including nutrient levels, pH, temperatures, nitrates, ammonia, Kjeldahl nitrogen, specific conductance and total dissolved solids and potential sources of increased nitrogen levels.

Edwards Aquifer Authority. ‘Variable Flow Study: Seven Years of Monitoring & Applied Research’ . BIO-WEST Inc. August 2007.

This report was made known to the Halff team late in the process of producing this report and was thus not thoroughly reviewed. Over the course of seven years, multiple studies by various academic and government agencies have helped contribute to the findings of variable flows on aquatic habitat with a focus on the federal list of endangered species, the population dynamics and their habitat conditions. Water flow (rates), water quality, water levels, temperature, chemistry, aquatic vegetation, stream morphology were all studied with a focus on the effects on the biological communities. One of the major findings is the importance of aquatic vegetation to the biological community whose changes are measurable and relevant with spring discharge/current flow. The findings include an expanded range of habitat for the Comal Spring riffle beetle, stable populations for the San Marcos and Comal Springs salamanders as well as the fountain darter (but found to correlate with establishment of aquatic vegetation) and that the greatest threats to these species include recreation as well as sedimentation, introduction of exotic species and



aquatic vegetation mats. As so much of water quality is a factor for biological species, such is the importance of aquatic vegetation and Texas wild rice which are most greatly impacted by recreation activities. The document cites direct impacts from recreation on Texas wild rice stands indirectly affect the habitat availability and quality for fountain darters. The study found stable populations in the beetles, salamander species of the endangered species list.

Gramann, James H. *Toward a behavioral theory of crowding in outdoor recreation: An evaluation and synthesis of research*

This document provides research on physical density versus psychological crowding in outdoor recreation.

Kuss, FR | Graefe, AR *Effects of recreation trampling on natural area vegetation.*

Journal of Leisure Research [J. LEISURE RES.], Vol. 17, no. 3, pp. 165-183. 1985.

The injurious effects of recreational use on vegetation of natural areas is influenced by not only plant responses to the direct mechanical effects of trampling, but also by stress factors internal to the ecosystem as well as changes in the physical, chemical and, biological nature of the soil medium. These effects are reviewed by tracing the dimensions of impact through selected stages in the life cycle of vascular plants beginning with seed germination and seedling establishment, growth functions after establishment, vigor and biomass production, flowering, seed production, and finally recolonization of impacted areas.

Sabine River Authority of Texas, Orange, Tx, Sabine River Authority, *Recreation Use and Needs Assessment Study Plan, Revised Study Plan Toledo Bend Relicensing Project FERC Project No. 2305.State of Louisiana, Many, LA, July 2009*

By use of surveys and site analyses, the study explains a methodology for assessing the recreation facilities around the Toledo Bend Reservoir, the demand and factors to look at for carrying capacity. This study may be useful in providing a list of variables in which to help determine limits on the various recreation activities that currently exist on our rivers of study and for any future land (recreation: camping, sports fields, amphitheaters, picnic sites, trails and the like) developments adjacent.

Smith, Kellen A. *Providing the best of both worlds: balancing conservation and recreation in a system of protected areas in Texas.*



MS thesis, Louisiana State University and Agricultural and Mechanical College, August 2007

Texas Parks and Wildlife Department is charged with the task of providing conservation while offering recreational activities. Using the salient points of the Rio Summit of 1992 on Environment and Biodiversity as a guide, the questions of (a) whether the designated wildlife management areas (WMAs) are successful at providing enough area to adequately represent the various ecoregions of Texas (b) what do visitation rates tell us about what these WMAs offer and (c) do these WMAs adequately fulfill the desires of Texans regarding protection of wildlife and providing outdoor recreation. A list of societal, park management, and individual benefits and goals are presented as well as the variables that limit or attract visitors: proximity to urban areas/highly populated areas, size of WMA, clustering of WMAs, types of recreation activities (consumptive and non-consumptive), existence and number of endangered or threatened species. Though the San Marcos and Comal River systems are not WMAs, it could be asked if they should be treated or managed as such considering their locations in highly populated areas, the benefits they provide and the number of federally listed species within these ecosystems.

VII. ECONOMIC INFORMATION

A. New Braunfels

'The Impact of Tourism in Comal County', TXP, Inc. December 2007

This study looks at growth between years 2001 through 2006 in the county in terms of employment, population, single family building permits, and sales tax as indicators of the local economy. The graphs presented in the report express an accelerated growth with time. The report notes that tourism has grown at a slower pace than the local economy and cites probable causes such as 9-11, unusual weather patterns, and loss of shopping outlets.

Under the Bureau of Economic Analysis of the U.S. Department of Commerce, 'tourism' is not a distinct industry classification and therefore the numbers in this report are extrapolated from tourist related activity such as restaurant/bar sales and amusement and recreation sales.

Using ratios and adjustments in accordance with statistics of growth in factors like employment, population and building permits, it is estimated the full direct economic impact of tourism for Comal County in year 2002 was \$143.6 million, and by year 2006 had grown to \$224.9 million.

For the year 2006, sales taxes from tourism generated approximately \$5 million for the City of New Braunfels and Comal County, of which river recreation accounted for approximately 20 percent.

2006 River Tourism Calculation:

A survey of 1,046 tubers using the Comal and the Guadalupe entry and exit points at various times in the summer of 2007 yielded the following results:

52 respondents resided in Comal County

48 respondents reported that tubing was not their primary reason for their visit to the area

approximately 486 were day trip visitors

Approximately 460 were overnight visitors

The average dollar expenditure of a day trip visitor was \$27

The average dollar expenditure of an overnight visitor was \$187.64

River tourism spending and calculated numbers were based on the following: In 2006, the City of New Braunfels reported more than 208,000 tubers who paid



the tube fee, of which it is estimated (based on the 2007 survey of percentages of out-of-towners and locals) that there were approximately 199,122 tubers who were not local (overnight guests). TXP estimated a blended average daily expenditure to be \$113, yielding direct river tourism at \$22.5 million for 2006. The full economic impact of river tourism was calculated based on direct spending, indirect spending (such as the additional costs of cleaning supplies for a hotel operator) and the increase in the overall local economy due to the added income by all the above, known as an induced effect. The results of river tourism are expressed in the report as output (equivalent to all sales directly related to recreation users)= \$34.3 million, value-added (describes net revenue by reported firms)= \$19.2 million, earnings (amount paid out to employees)=\$8.3 million and employment = 387 jobs. This output amount represents 12.5% of Comal County's total travel and tourism economic impact for 2006.

In terms of tax revenue, it is based on revenue from categories with a defined tax rate, such as lodging and the additional tax of indirect services and goods, and the spending of local workers who benefit from the need of additional services due to tourism.

For 2006 in Comal County, it was estimated that river recreation users contributed \$630,270 to lodging taxes and \$230,435 to sales taxes, totaling \$860,705.

While the study recognizes the attraction of the rivers and lakes are the driving force behind tourism in Comal County, it also notes that other aspects of tourism have great potential and that all growth will be synergistically beneficial to Comal County as a whole.

Greater New Braunfels Economic Development Foundation, prepared by Impact Data Source.

'The Economic Impact of New Braunfels' Hospitality Industry 2009'

This report is derived from information available from the City of New Braunfels sales tax collections for the year 2009, and US government data sources, including US Census Bureau's Business and Industry Economic Census and NAICS (North American Industry Classification System) standard ratios. It is important to note that taxable sales do not represent the total economic output for the hospitality industry since not all economic output is taxed by the city; this then is adjusted for by analyzing the various tax types (hotel occupancy, mixed beverage). Direct and indirect economic output in terms of employment and earnings is calculated based on census and NAICS ratios.



Based on the information above, the hospitality industry yielded \$469.6 million (direct and indirect sales, induced spending) in 2009. This amount includes various taxes (sales, hotel occupancy , beverage) totaling \$12.8 million to the city of New Braunfels alone, with a total of \$16 million to all local taxing authorities. \$12.8 million represents 19% of the city's total revenue and almost 22% of all sales tax revenue for the city.

\$469.7 million is the total hospitality economic output in New Braunfels which represents almost 20% of the total economic activity in New Braunfels. Of that dollar amount:

- 48% can be attributed to direct economic impacts
- 52% to indirect or spin off economic impacts
- by subcategory:
 - 65% restaurants/ eating establishments
 - 19% entertainment
 - 15% lodging
 - 1% transportation

\$70.3 million was paid in wages to those 5,181 people working directly in the hospitality industry and \$51.5 million was paid to those 1,798 people working in indirect jobs that support the hospitality industry. The number of jobs represents 27% of the employment in New Braunfels.

Similar to hospitality representing approximately 20% of the economic output of New Braunfels, job earnings represented 19% of the total earnings in New Braunfels.

In addition to providing jobs and revenue to the city, the hospitality industry has a philanthropic component and is reported to have contributed more \$722,000 in cash donations, scholarships and in-kind charitable donations in 2009.

Growth

The growth in economic output by the hospitality industry showed a steady increase over the years 2005 through 2009, with an annual growth rate of more than 6%.

The growth in workers' earnings grew 37% in the same period of time and employment grew by 32%



Visitors

The report states over 200,000 people participated in water recreation in the Comal and Guadalupe Rivers in 2009, yielding over \$300,000 in river management fees to the City of New Braunfels.

The civic and convention center expanded in 2007-2008. In 2008, approximately 65,000 people attended more than 380 meetings, celebrations, performances, conferences and trade shows, yielding a \$232,000 in revenue in their fiscal year with projected revenue of \$350,000 for the 2009-2010 fiscal year.

Lodging in the city increased by 4 hotels in 2009, contributing \$2.2 million in hotel occupancy taxes. In addition to this economic contribution, construction jobs were created and local sales taxes were increased; cost of construction projects was estimated at more than \$21 million. Hotel rooms in the city in 2009 increased to 2,400 rooms.

Wurstfest is a fall event that pays homage to the city's German heritage; it had over 100,000 visitors and yielded over \$3 million in 2009. Other events are scheduled at the same time to maximize the draw of visitors to shop, stay and dine.

B. San Marcos

Total number of visitors to San Marcos annually is estimated to be 10 million and is derived from traffic counts from the outlet malls; it is not a scientifically based number but is commonly quoted.

Information from the unpublished dissertation of Texas State University Ph. D candidate Jenna Winters, a 2008 survey of 717 visitors to the San Marcos River was conducted; the following spending was reported:

- 75% spent less than \$25
- 13% spent between \$25-\$50
- 6% spent between \$50-\$75
- 7% spent >\$100

Based on her survey, 16% of visitors were tubing and that approximately 50% of these tubers rented their tubes. From San Marcos Lions Club Tube Rentals numbers of year 2005 (approximately 30,000), we extrapolate the total number of visitors to the river to be in the realm of 375,000 people.



Based on the percentages of dollars spent, we also extrapolate the revenue from river visitors to be in the order of \$12.9 million. (This amount does not account for any change in number of tube users between 2005 and 2008) So although we estimate 375,000, the Greater San Marcos Economic Development Council in year 2000 estimated 500,000 annually visit the San Marcos River for water based recreation and civic activities adjacent to its banks (Earl & Wood art. 'Upstream Changes and Downstream Effects of the San Marcos River of Central Texas, February 2002).

There is no documentation on the number of river visitors during the period from Memorial weekend to Labor Day, nor is there any data available for revenue generated by tourist activity during that same period.

As of July 15, 2010 , The total number of booked/contracted and actual (Jan-July) events for 2010 was 780 events (this includes groups from 3 to 3,000) for an estimated total attendance of 70,393. The average attendance number per event is 90 persons. 84 conferences have been booked between May 2010 and December 2010 with 14,470 rooms dedicated. . (quotation: Ramirez, San Marcos Convention and Visitor Bureau, July, 2010).

Approximately 2,500 canoes and kayaks (TeGrotenhuis, TG canoes and kayaks, June 2010) are rented out annually and almost 30,000 tubes were rented out in the year 2005 (Fairchild, Lions Club). It is estimated from survey information (Winters, TSU, July 2008 data) that tube rentals represent only about 50% of tubers on the river. No other data was provided and there is no data on total number of boats on the river annually;



VIII. RECREATIONAL IMPACTS & FURTHER STUDY

A. New Braunfels

From stakeholder interviews, public parks are the predominant locations for access to the Comal River. Landa Park, as expressed by one interviewee, is felt to be at or beyond capacity as evidenced by the compaction and erosion along the banks of Landa Lake from foot traffic as well as from deterioration of vegetation caused by the foot traffic. The sentiment of general wear on the landscape was reported by a majority of the interviewees. Litter and negative behavior were also cited by stakeholders as on going issues due to recreation. In the more active recreation areas of the river, access is concentrated in various locations such as at Landa Falls, and downstream at various points along Hinman Island and Prince Solms Park and the public exit at Union Avenue. The river banks along these parks have mostly been reconstructed so erosion of the banks are not as much an issue in these areas, however, the limited availability of picnicking makes them most vulnerable to both the behavioral and litter issues, as well as overcrowding, which impedes access and egress to the river and continues to damage the vegetation and increases erosion.

In spite of these social issues, stakeholders held the value of the river in high regard, citing environmental stewardship, economics and mental and physical rejuvenation as benefits.

Quantitative information from weekly monitoring activities of the Texas Master Naturalist volunteers between 2006 and 2009 inclusive (Bio-West for Edwards Aquifer Authority, March 2010a) provide insight into optimum habitat variables for the listed species. This report provides a good basis from which to observe how recreation affects these variables.

As for reported direct effects, it appears that paddle boats on Landa Lake contribute to the reduction of both exotic and native vegetation (Bio-West for Edwards Aquifer, August 2007) which would both reduce the physical habitat of fountain darters as well as affect the amount of carbon dioxide in the water. Sedimentation and turbidity, which are both affected by recreation users, may also affect listed species albeit on a short term basis, but most significantly, as a result of low flow and shallow water depths, enabling water recreation enthusiasts to access more of the stream bed (Bio-West for Edwards Aquifer, August 2007) . Tubing is reported to be the most popular activity within the water with swimming, fishing as other common activities and rope jumping and



swift water rescue as seemingly less common activities. Along the banks, picnicking and wading and water lounging are activities that one could expect to affect the river. All these activities have varying degrees of direct physical contact/disturbance to the stream bed/bank and thereby affect the river in terms of turbidity but to what degree these activities affect sedimentation (through erosion of banks) and water quality was not precisely found, although water quality data is available for various parts of the river at various times of the year (Bio-West for Edwards Aquifer Authority, March 2010).

In the Comal Springs system, recreation occurs mostly downstream of the confluence of the Old Channel and Landa Lake, where salamanders and macro invertebrate species populations remain stable (BioWest for Edwards Aquifer Authority, August 2007) and higher quality habitat exists for the fountain darters (Edwards Aquifer Authority, December 2009) and thus the recreation along these downstream stretches are not of great concern (Edwards Aquifer Authority, December 2009). The salamander and macro invertebrate species were mostly found within the springs or near the springs and the fountain darters were found to be most populous in native *Cabomba* vegetation found in the deeper waters in the upper reaches of the Comal Springs system including Landa Lake (Bio-West for Edwards Aquifer Authority, March 2010a). Where more careful monitoring of recreation could take place then is within Landa Lake and all areas upstream as these areas are noted to be quality habitat (Edwards Aquifer Authority, December 2009).

As there are so many variables (nutrient levels, pH level, dissolved oxygen, carbon dioxide, temperature, sediment, flow, water depth, time of year, pollutant infiltration, herbivory, precipitation) that can affect listed species populations, it may be challenging to directly link any one source of species disruption. In so far as water-based recreation is seen as a cause for concern, it may be helpful to more closely examine the quality habitat areas (upper reaches of the Comal Springs system) and document the following at various times of the year for several cycles to augment other data that exists:

- Types of recreation (and direct physical contact with banks and stream channel)
- Number of users
- Documentation of pollutants and non-native species (organisms, plants and vertebrates)
- Water levels within the river channels
- Turbidity levels associated with specific recreation types
- Water quality: temperature, pH, nutrient levels
- Current flow



- Precipitation
- Substrate composition and changes in sedimentation in the riverbed
- Bank condition / geology / vegetation

At the same time, it would be useful to continue to:

- Map locations of species found
- Document habitat conditions
- Document life cycle stage of specimens

B. San Marcos

As reported by stakeholders, recreation activity along the San Marcos River is concentrated between Sewell Park on the Texas State University (TSU) campus and Rio Vista Park. This stretch of river is almost completely lined with public park lands with the exception of one residential area on the north bank. As such, much of this stretch of river is accessible except where riparian vegetation creates an obstacle.

From interviewing stakeholders, prime bank activity occurs at Sewell Park, City Park and Rio Vista Park, where people mostly picnic, socialize and access the river with tubes or for swimming. The banks along Sewell Park and City Park are, for the most part, walled with concrete so access in these areas is by ladder or steps. Erosion of the banks is not necessarily a concern in these parts of the river, but erosion of stream bank vegetation within the parks is a concern, along with a concern about disturbance to the stream bottom (Bio-West for Edwards Aquifer Authority, March 2010b) where people tend to congregate not far from their picnic sites.

Where there are no concrete walls there is evidence of trampled vegetation and eroded ground cover (Winters, 2010, unpublished). City of San Marcos park staff indicated river bank erosion issues. The City currently has begun a river bank stabilization project that occurs between Rio Vista falls and Interstate Highway 35. City representatives reported that their community parks master plan aims to provide controlled access points to the river (by planting native riparian vegetation) in an effort to protect their parks and banks from further erosion.

The overall sentiment from the various stakeholders is that even though these river side parks provide an opportunity for environmental stewardship and education, an economic resource and a source of mental and physical rejuvenation, the parks (and associated river banks) are experiencing a



noticeable degradation of landscape through trampling of vegetation, erosion, pollution and litter by the park users themselves.

An economic study in the year 2000 indicated 500,000 river recreation users come to the City on an annual basis (Greater San Marcos Economic Council, 2000). There was no other published information found in this regard. A doctoral research candidate at Texas State University who is currently studying recreation on the river, provided one account of 1,756 users on/in the river during a peak 2 hour period of time on one summer holiday Monday (peak season, but not necessarily a peak day) in 2007.

Over the course of a 3 year period in which this student has been working, she also documented precipitation rates and dates, turbidity, levels of the water, and also prepared a user survey with more than 700 participants over the course of a three year research project. The survey of park users (along the San Marcos River) indicated that 33% stated swimming as their primary activity and 16% stated tubing as their primary activity with an overall of 57% reporting their primary activity was some type of recreation in or on the water.

Other than this unpublished data, and information gathered from stakeholders, we found no other specific information on numbers, types of users nor specific locations for San Marcos users was identified.

Recreation posed the most direct and indirect effect on Texas wild rice (Bio-West for Edwards Aquifer Authority, March 2010b) with mechanical disturbance (by pulling, walking, wading) and in so doing, indirectly affecting fountain darters by compromising this habitat. Data documenting changes in Texas wild rice stands, along with corresponding flow and water levels quantifies the observation of deterioration and fragmentation of Texas wild rice stands by recreation in the San Marcos River (Bio-West for Edwards Aquifer Authority, August 2007). Correspondingly, population dynamics and habitat conditions were examined for each of the listed species.

The overall conclusions were that salamander species and fountain darter populations were stable while invertebrate populations fluctuated (without conclusive factors) for the period between 2000 and 2007 inclusive, while the range of the Comal Spring riffle beetle expanded (Bio-West for Edwards Aquifer Authority, August 2007). However, in looking more closely at population relationships with recreation activity, drought and corresponding low water levels in year 2006 provided greater opportunities for recreation and physical contact with the riverbed and in so doing, habitats of fountain darters (aquatic



vegetation and namely, Texas wild rice) and salamanders were directly adversely affected by increased recreation activity. Reasons cited for the overall stable trend in listed species populations are due to various factors of spring flow, precipitation events (making the salamander habitat spillway at Spring Lake Dam less accessible) and likely most significantly, the sanctifying and restriction of recreation use of Spring Lake, helping preserve quality habitat (characterized by certain vegetation types and low velocities) for namely fountain darters whose reproductive numbers help offset diminished numbers downstream (Bio-West for Edwards Aquifer Authority, August 2007).

In efforts to more closely examine the correlation between river recreation and listed species habitats, it may be of interest to investigate and document a comparison of river environment and habitat factors between Spring Lake and points between Sewell Park and Rio Vista Park where most recreation occurs. Factors to evaluate include temperature, current Flow, water depth, water quality: pH, nutrient levels, vegetation, bank condition, turbidity levels associated with various activities, substrate composition and changes in the riverbed, numbers and types of recreation users and documentation of pollutants and non-native species (organisms, plants and vertebrates). It would also be prudent to record this data over a course of several seasons and for any critical events (such as flood or high precipitation, hazardous spills etc.).



CONCLUSION

It is clear that the delicate balance of society's needs for recreating while maintaining a healthy perpetually viable natural environment will become more of a challenge with time as population increases create growing demands on these spring and river resources.

While there are definitive observations that recreational activity is adversely affecting the river environment, there is an apparent lack of raw data that could lead to a conclusive threshold of numbers and types of recreational activities in which populations of endangered and threatened species are critically compromised.

Studies reviewed and data collected suggest recreational activities put great pressure on species habitat. With the exception of the unpublished data of Winters and the inaccessible Breslin and Bradsby studies, very little information was found that specifically evaluated recreation as a source of species habitat disruption. In studies about water flow and its affects on species, recreational activities were observed as a consequential impact. In studies about Texas wild rice, low current flow, resulting recreational activities and opportunities were noted to be factors affecting the wild rice populations.

To be conclusive about the impacts recreational activities have on listed species and habitats, a study that is focused on the effects of recreational activities should be conducted. Using water quality data taken from locations where habitats supported the highest populations as a basis, one could compare the same factors where recreation activity actually occurs or immediately downstream from where recreation activity occurs. Type and intensity of recreation use and physical contact, and resulting changes within the banks and river bed would need to be documented, measured and evaluated. From stakeholder interviews, crowding, litter and alcohol are top issues. Beyond the wear and tear human activities cause on the landscape, including riverbed disruption (and resulting turbidity) from shear numbers, humans contribute all kinds of pollutants to these rivers via food, alcohol (excrement, vomit and urine) and lotions worn on the skin.

These rivers offer unique and highly valued recreation opportunities and as the population of Central Texas grows, recreational users will undoubtedly correspondingly increase. Although the upper reaches of each of these springs are restricted in terms of recreation, it should be determined if these areas are adequate in cultivating the growth or at least stabilizing the listed species populations. The questions of adverse and beneficial attributes (of recreation) and threshold and capacity (of recreation users) remain to be determined.

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Appendix A: GIS Mapping Exhibits





EARIP
Recreation Areas
New Braunfels
Comal County, Texas

Map Key

- Recreation Area
- Entry/Exit Area
- Parks
- TCEQ Clean Rivers Water Quality Stations

Recreation Areas
Tubing
NB.1





EARIP
Recreation Areas
New Braunfels
Comal County, Texas

Map Key

- Recreation Area
- Entry/Exit Area
- Parks
- TCEQ Clean Rivers Water Quality Stations

Recreation Areas
Paddle Boats
NB.2





EARIP
Recreation Areas
New Braunfels
Comal County, Texas

- Map Key**
- Recreation Area
 - Entry/Exit Area
 - Parks
 - TCEQ Clean Rivers Water Quality Stations

Recreation Areas
Picnic Areas,
RV Campgrounds
NB.9





EARIP
Recreation Areas
New Braunfels
Comal County, Texas

Map Key

- Recreation Area
- Entry/Exit Area
- Parks
- TCEQ Clean Rivers Water Quality Stations

Recreation Areas
Swift Water Rescue Training
NB.4



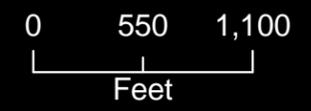


EARIP
Recreation Areas
New Braunfels
Comal County, Texas

Map Key

- Recreation Area
- Entry/Exit Area
- Parks
- TCEQ Clean Rivers Water Quality Stations

Recreation Areas
Swimming
NB.5

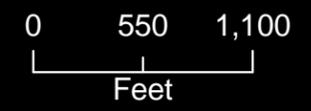




EARIP
Recreation Areas
New Braunfels
Comal County, Texas

- Map Key**
- Recreation Area
 - Entry/Exit Area
 - Tube Rental Locations
 - Paddle Boat, Kayak, Canoe Rental Locations

Recreation Areas
Tube, Paddle Boat, Kayak,
Canoe Rentals
NB.6



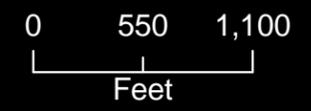


EARIP
Recreation Areas
New Braunfels
Comal County, Texas

Map Key

- Recreation Area
- Entry/Exit Area
- Parks
- TCEQ Clean Rivers Water Quality Stations

Recreation Areas
Fishing
NB.7





EARIP
Recreation Areas
New Braunfels
Comal County, Texas

Map Key

- Recreation Area
- Entry/Exit Area
- Parks
- TCEQ Clean Rivers Water Quality Stations

Recreation Areas
Wading, Lounging,
Playing, Rope Swing
NB.8





EARIP
Recreation Areas
New Braunfels
Comal County, Texas

Map Key

- Recreation Area
- Entry/Exit Area
- Parks
- TCEQ Clean Rivers Water Quality Stations

Recreation Areas

All Uses
NB.9





EARIP
Potential Wildlife Habitat
New Braunfels
Comal County, Texas

Map Key

-  Area of Potential Habitat
-  Parks
-  TCEQ Clean Rivers
-  Water Quality Stations

Potential Wildlife Habitat
Comal Springs Dryopid Beetle,
Peck's Cave Amphipod
NB.10





EARIP
Potential Wildlife Habitat
New Braunfels
Comal County, Texas

Map Key

-  Area of Potential Habitat
-  Parks
-  TCEQ Clean Rivers
Water Quality Stations

Potential Wildlife Habitat
Comal Springs Riffle Beetle
NB.11





EARIP
Potential Wildlife Habitat
New Braunfels
Comal County, Texas

Map Key

-  Area of Potential Habitat
-  Parks
-  TCEQ Clean Rivers
Water Quality Stations

Potential Wildlife Habitat
Fountain Darter
NB.12



OCT 2010 AVO 27520



EARIP
Recreation Areas
San Marcos
Hays County, Texas

- Map Key**
- Recreation Area
 - Entry/Exit Area
 - Parks
 - TCEQ Clean Rivers Water Quality Stations

Recreation Areas
Tubing
SM.1





EARIP
Recreation Areas
San Marcos
Hays County, Texas

- Map Key**
- Recreation Area
 - Entry/Exit Area
 - Parks
 - TCEQ Clean Rivers Water Quality Stations

Recreation Areas
Fishing
SM.2





EARIP
Recreation Areas
San Marcos
Hays County, Texas

- Map Key**
- Recreation Area
 - Entry/Exit Area
 - Parks
 - TCEQ Clean Rivers Water Quality Stations

Recreation Areas
Kayaking, Canoeing
SM.3

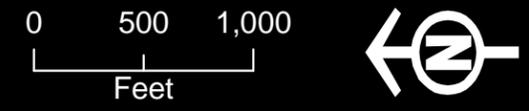




EARIP
Recreation Areas
San Marcos
Hays County, Texas

- Map Key**
- Recreation Area
 - Entry/Exit Area
 - Parks
 - TCEQ Clean Rivers Water Quality Stations

Recreation Areas
Picnicking
SM.3

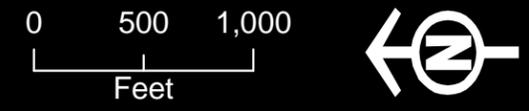




EARIP
Recreation Areas
San Marcos
Hays County, Texas

- Map Key**
- Recreation Area
 - Entry/Exit Area
 - Parks
 - TCEQ Clean Rivers Water Quality Stations

Recreation Areas
Swimming
SM.5

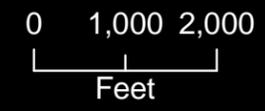




EARIP
Recreation Areas
San Marcos
Hays County, Texas

- Map Key**
- Recreation Area
 - Entry/Exit Area
 - Tube Rental Location
 - Kayak, Canoe Rental Locations

Recreation Areas
Tube, Kayak, Canoe
Rental Locations
SM.6

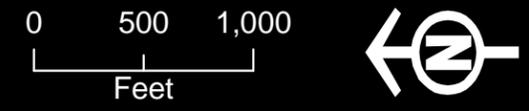




EARIP
Recreation Areas
San Marcos
Hays County, Texas

- Map Key**
- Recreation Area
 - Entry/Exit Area
 - Parks
 - TCEQ Clean Rivers Water Quality Stations

Recreation Areas
Dog Parks
SM.7





EARIP
Recreation Areas
San Marcos
Hays County, Texas

- Map Key**
- Recreation Area
 - Entry/Exit Area
 - Parks
 - TCEQ Clean Rivers Water Quality Stations

Recreation Areas
Wading, Lounging
SM.8



OCT. 2010 AVO 27520



EARIP
Recreation Areas
San Marcos
Hays County, Texas

- Map Key**
- Recreation Area
 - Entry/Exit Area
 - Parks
 - TCEQ Clean Rivers Water Quality Stations

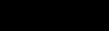
Recreation Areas
All Uses
SM.9



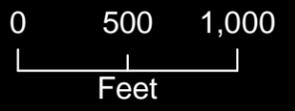


EARIP
Potential Wildlife Habitat
San Marcos
Hays County, Texas

Map Key

-  Area of Potential Habitat
-  Parks
-  TCEQ Clean Rivers
-  Water Quality Stations

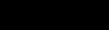
Potential Wildlife Habitat
Fountain Darter
SM.10





EARIP
Potential Wildlife Habitat
San Marcos
Hays County, Texas

Map Key

-  Area of Potential Habitat
-  Parks
-  TCEQ Clean Rivers
-  Water Quality Stations

Potential Wildlife Habitat
San Marcos Gambusia
SM.11



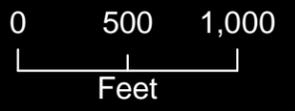


EARIP
Potential Wildlife Habitat
San Marcos
Hays County, Texas

Map Key

-  Area of Potential Habitat
-  Parks
-  TCEQ Clean Rivers Water Quality Stations

Potential Wildlife Habitat
 San Marcos Salamander, Texas Blind Salamander, Comal Springs Riffle Beetle
SM.12





EARIP
Potential Wildlife Habitat
San Marcos
Hays County, Texas

Map Key

-  Area of Potential Habitat
-  Parks
-  TCEQ Clean Rivers
-  Water Quality Stations

Potential Wildlife Habitat
Texas Wild-rice
SM.13



APPENDIX B: EARIP Interviews 6/30/2010 NEW BRAUNFELS

	NB-1	NB-2& NB-3	NB-4	NB-5	NB-6	NB-7	NB-8
1. What are the peak times of recreation use: days, seasons, months, holidays, hours?	Peak times 1-6 pm. Saturdays heavier than Sunday unless it is a holiday weekend.	Rent tubes/allow kayak on property – let tubers *** on shuttle back to drop in point. J/1 weekends – week before Monday – close Labor Day. Holidays busiest. July/May busiest months. (10a.m. – 5p.m. July – close @ 8p.m.	Year round open -- Memorial Day to Labor Day. River used anytime school is out and weather is warm. Memorial Day was over crowded. Canyon Lake was at right level in January, which guaranteed continue flow at 300cfs throughout the summer on Guadalupe River. Last 2 seasons there was 60 cfs flow (slow), now good flow is 200 cfs for good tubing on Guadalupe	Herron Island closed to vehicle traffic (weekends during Memorial/Labor Day) No need to restart times of use.	Memorial Day to Labor Day, primarily weekends, during afternoon hrs.	April thru first of September with peak useage on two holiday weekends	
a. How many people are using the river at these times?			Heat, drought, crowding made last year rough.	Hinman Island Drive 16 th and 17 th Lots of trash blows in from River area. Noise from adjacent foot traffic toward golf 18 th fairway has stray golf balls into parking lot. Not enough parking for patrons.	Per typical peak season weekend: Comal – 3,000 – 5,000; Guadalupe in city limits 500 – 2,000	Unknown as the fee is not broken out by river. In one year the total in the City Limits between the rivers was 187,000 Divided by the 110 days of season is about 1700 people per day split between 10+ miles of rivers	
b. What areas of the river see the highest amount of use?	Hinman Island to last tubers exit				Comal: Hinman Island to last exit; Guadalupe: Gruene Bridge to Cypress Bend Park Exit	Those with free entrance	
2. Should there be restrictions on times of use or hours of use?					Daylight hours only – safety factor	You can legally limit public property access but not private So use of the river cannot be restricted by State Law	No
3. Does use have any correlation with water flow or river levels?	Comal River is almost constant flow. Guadalupe river varies with season and year. When Guadalupe River has low flow, tubers switch to Comal River.		Perception people have of water flow – flood is worse because visitors think it is unsafe.	POS visual beauty of river adjacent to golf course, wonderful experience. Small % of golfers use river.	Use increases with CFS flow > 150. Declines when <750 CFS	Use is limited based on too much or too little flow and limits to public access, however, State Law supersedes and enables access to all Texans unless under a Declaration of Disaster	Yes. This user recirculates the river water, and there was a time in the 1980's that the river was low enough to cause concern about availability to recirculate the water. But in general, what occurs on one part of the river, or rivers, affects use on the other parts. For example, a flooding event on the Guadalupe River might have a negative affect on the Comal because visitors would think both rivers had been damaged in the flood. The New Braunfels Chamber recently did a study that indicated that the City lost over \$1 million of potential business each day as a result of the recent flood.
4. Can recreational activities on the river continue at current levels of activity?	#'s in park are highest. Lots of wear and tear in park. Picnic areas are always at or beyond capacity. City trying to limit # of people who rent pavilion areas, and also breaking rental units up into smaller components (Dance Slab only rented with Area #4).			Fishing; tubing; camp out; swimming;	Yes	Price point dictates volume, behavior, and resource support.	Yes
a. Why or why not?	Trying to use capacity of restrooms to determine maximum number of people who can be in an area, or when to rent porta-potties. City needs to update picnic ordinances (killing grass, stopped up restrooms) Real solution is to develop Fisher Park. Spring Fed Pool, Hinman Island.				Very limited already due to summer vacation schedules. Basically 20/30 days/afternoon per year for peak use.	The above and State Law says it belongs to Texas Citizens	Activities have occurred on the river for years and the habitats are surviving and thriving.

APPENDIX B: EARIP Interviews 6/30/2010 NEW BRAUNFELS

5. If arriving at the river by vehicle, where do people park (private lots, owned by recreation outfitters or other private lots? Street? Public park?).	All outfitters run shuttles, All outfitters at Prince Solms across street.				Designated lots by city ordinance. Businesses/outfitters provide majority of space.	Satellite lots and shuttled in, small on street parking, and public owned lots	
a. Do the majority of recreational users use commercial shuttle buses and are those desirable?	Shuttle 50/50 tube rental vs. bring own tube. Circle Arts parking lot allows parking. Elizabeth Street parking lots used by picnickers.				No. Trend is for private equipment/tubes and non-use of outfitters.	70% use outfitters and 30% or less have the ability to access public locations or public parking. Outfitters shuttle 20% of private equipment users	
b. How many people (or what percentage of people) arrive at river tubing/raft launch locations by private vehicle versus shuttle bus?					60 private/40 shuttle	15%	
c. Is one method of arrival preferable over the other?					Prefer all shuttle	Shuttle is preferable	
6. Do most users access / launch from public/city owned property or private property?					Public	On the Comal – public 50% Private 50% (including Texas Tubes and Wurstfest) On Guadalupe all access via Private Property with one publicly owned exit on the Guadalupe	Most of the users form this providers facility enter and exit the river on this user's property.
a. Please list all known points of access and launching.	Hinman Island, Prince Solms				Comal: Wurstfest grounds, Hinman Island, Prince Solms Park/Tube Chute	Comal – launch at Wurstfest, Texas Tubes, Hinman & Prince Solms as well as from Resort properties that line the Comal River. Guadalupe launch from private property	
7. Do most users exit the river at public/city owned property or private property?	Public				Public	70% public exit on Comal and 30% private. On Guadalupe 100% launch private and 35% exit public	
a. Please list all known points of exit.	Last tubers exit (Union St.) Garden Street Tube Chute Gruene Bridge @ Cypress Bend Park (Guadalupe River)				Comal: Last exit & Union St. & Garden St. Guadalupe: Gruene Bridge or Cypress Bend Park	Resort Properties, Rockin R, and Last Public Exit on Comal, Guadalupe – private property and Cypress Bend or River Acres	
8. What recreational activities other than tubing, rafting and fishing occur along the river?	Tubing/swimming majority on Comal. Scuba diving. Swift water training at tube chute during off season. Socializing, wading, water play, drinking, grilling Off season: swift water rescue training Difference between tubers and picnickers – picnic and barbeque all day. No open containers in Herron Island Park	Picnicking Nefarious activity		picnicking	Camping along Guadalupe. Comal is primarily Wurstfest Grounds, City property and Schlitterbahn before private residences. Not much camping along comal except across Wurstfest grounds.	Scuba, Swift water rescue and triathlon training on Comal, Fishing, Kayaking, and rafting on the Guadalupe	
9. What specific locations are most frequented by these other users?	Hinman Island, Prince Solms, Landa Park	Picnicking at Wurstfest & parks Wading at parks Nefarious activity up stream from Wurstfest		Hinman Island	Gruene	Tube Chute and Hinman Island	The new channel

APPENDIX B: EARIP Interviews 6/30/2010 NEW BRAUNFELS

10. What are the positive aspects of recreation on the river?	Rivers are best of what NB know for, character, notoriety. Reason was settled. Positive on the economy	Economics – employment for young people, education for young in town (31 employees) **** large part of business is visitors. *****		Nice backdrop for the golfcourse	Outdoor enjoyment, fresh air, relaxation, cool water	Tourism generated 469.7 million dollars to the New Braunfels economy in 2009.	Positive impacts to local economy; job creation, pleasure or recreation in natural setting.
11. What are the negative aspects of recreation on the river?	Behavior/mess and trash/infrastructure needs re-investment (the stairway going down to the Tube Chute needs a face lift) Parks are at overcapacity/degradation of parks, landscape	Kayakers stop at their property without paying	70% of trouble on the river is alcohol related	Trash on the golfcourse that is carried in by wind	Sunburn, dehydration	Same as at any major attraction with high visitation – litter and behavior	River has to be managed. Police it, preserve it, maintain it.
12. How important are river-based recreational activities to the local economy?					Water is the brand of New Braunfels. Impacts entire economy of tourism, even those not water-related.	Huge – they are the anchors to our community from a heritage point of view, a cultural point of view, industrial relocation, as well as quality of life – besides being the “only place in Texas” anchor for our number 1 industry – tourism – as it has been for over 150 years.	VERY
a. What are its contributions: i.e. sales tax, property taxes, other taxes/fees, spin-off businesses (related revenue sources for the city)?				Convention \$: some people golf, some people tube		According to a recent study done by Impact Data Sources – 469.7 Million in 2009, employed 5181, another 1798 indirect jobs, paid over 70-.3 million in local wages and supported another 51.5 Million in wages to indirect workers. Hospitality industry paid over 10.5million in taxes and other revenues to the City of New Braunfels and in total contributed 13.7 million in taxes and all local taxing districts.	
b. How much does recreation activity contribute to the local economy? (in \$ or % of city revenue)		Lots of restaurants, souvenir shops, etc. Water 72-degrees year round; people use water year round.	River makes it desirable as a backdrop and as an attractant.		\$12 million annually direct to tax rev. contribution/economy. Indirect - \$1 Million per day if not operating.	\$469.7 million in 2009	
13. What is your perception of the level of enforcement on the river? Too much, not enough? Why?	Enforcement in fluid situation – changes every day, every year. More people, more behavior issues. 3 to 5% of visitors cause trouble – 1/2 of them for New Braunfels (less than River Walk) Attraction-based leisure visitation. The River has been an attraction for over 125 years. Hard to enforce so many rules.	Locking lid requirement for coolers is good. The size restriction limitation is bad.		Good as it is. Police Dept. does good job at keeping rowdy people off (golf) course.	Anouth. Has been consistent for several years – needed.	Admirable and good Why? Courteous and proud of our community.	Fine as is. July 4 th holiday seemed to be a little overstaffed, but other than that is OK.



APPENDIX B: EARIP Interviews 6/30/2010 NEW BRAUNFELS

14. Is the amount of regulation with regards to activities on the river acceptable? Should there be more? Or less?	Alcohol is an issue. Hard to enforce all rules. Park rangers not certified peace officers, they collect picnic fees. Can't legislate stupidity; price point dictates everything; value correlates with expectations	Too many regulations to be enforced. Cooler law increases # of tubes b/c of limit of cooler size and limited # of coolers per tube. City occasionally closes river due to bacteria due to overcrowding (but not public access points) Union Street is better exit point (free) Garden Street is smaller, less developed exit point. Entrance at **** no regulation to dropping off tubers.	Alcohol causes 70% of problems on river. Mob mentality; legal to drink. Visitors are slob, they litter and they have basic disregard for environmental responsibility. Enforcement difficult with large masses or people.	Better regulation/reduction in alcohol use.	No more. Just right.	Yes Should there be more? Or less? No more – price point dictates behavior, demographic, etc...	Fine as is, but maybe a little over regulated. Some ordinances seem to be attempts to control issues that no longer exist. Regulations need to be periodically reevaluated for applicability.
a. Are there certain things that should be regulated that aren't currently?			Editor of local paper called for a ban of alcohol on the river		Access points aren't managed - controlled	No	
b. Are there certain things that are currently regulated that shouldn't be?					No	Maybe	
15. What is your perception of the level of maintenance? Too much, not enough? Why?	Pay company to scuba dive and clean river. Trash is big issue. Litter contract to clean parks and separate contract to work river edge. River fund contributes to this (in addition to other river management issues).	OK as is; Trash Fest in October at end of the summer season, and another night after Labor Day and small ones throughout season			Good. Consistent last 3 years with new river manager	Infrastructure needs some help...	Acceptable
16. Are there operational issues with regards to emergency flood situations?	Fees – \$1.25 for every tube that's rented goes to river fund litter bags, litter pick-up, the Watershed Program Manager's salary, police overtime, and ½ of a Park Ranger salary. Study done 2 years ago about river recreation impacts to economy. Overall impact positive, but not as great as people thought				None	Our community takes care of itself and always has.	
	Additional notes: regulating alcohol is an ongoing contentious issue		Additional Notes: NBU has waster water plant that has flooded 3 times in last 12 years. Unnecessary contaminate; 100 yards away is land above 100 year floodplain				



APPENDIX C: EARIP Interviews 6/29/2010 SAN MARCOS

	SM-1	SM-2 SM- 3	SM-4, SM-5, SM-6	SM-7, SM-7	SM-8	SM-9	SM-10
1. What are the peak times of recreation use: days, seasons, months, holidays, hours?	Long weekends and in general: Memorial Day to Labor Day/Kids out of school/would start during Spring Break, but didn't happen this year because no bldg. (at Lions Club). Rio Vista Dam brought new group to the city. Very popular with visitors – not allow pop up tents or barbecue pits on Cheatham Street side of River. Limited space for people to get out of river w/tents and pits in the way there at Cheatham Street.	Sat/Sun in the Summer Canoes & kayaks 9am-9am during tubing months to avoid conflicts	11 – 4 pm on weekends for tubers. Lots of kayakers in the off season. .Kayakers allowed at Rio Vista Falls after 10 p.m. and before 9 a.m. Last Lion's Club shuttle at 7p.m.. Lions Club dictates when season starts (1-2 weeks before Memorial Day.)	Canoeing in early May & September. All during school year when weather is nice people are at Sewell Park (TSU).		Weekends, summer time, June-early August, especially holidays, noon-4 pm	
a. How many people are using the river at these times?	There have been tube counts, Melanie has some of these. Weekends highest use.	+/- 3400 people/year on river in kayaks. Boaters/swimmers #'s dwindling. Majority of users are tubers/waders, but also a lot of people on the shore barbequing and waiting on bus.	Jack has counts of people on river. 2005 tube rentals: 29,829 (May- Sept)			I don't know, but either the numbers or the practices indicate too many.	
b. What areas of the river see the highest amount of use?	Rio Vista; Sewell Park	Launch @ City Park and pick people up 7 miles out of town. Swimming by Salt Grass Restaurant (former Ice House)	Ducky Derby – Duck Raffle; Occasional big raft w/rafting groups; kayak events 2 times/year (kayak basketball or rugby) Cables are installed at Rio Vista from Oct thru Feb for kayak events.		Rio Vista	City Park and Rio Vista (bank users) and from city park to Rio Vista (tubers)	
2. Should there be restrictions on times of use or hours of use?	Restrictions on alcohol use have been suggested, but might not be good for city because of actual volume of alcohol sales.	No restrictions on times of use		April – May for this park. 10 a.m. – 6 p.m. Outdoor center closes @6 pm. "Thug" community comes out at 6 pm	No issue w/ current hours restrictions	No	
3. Does use have any correlation with water flow or river levels?	Float time varies with river flow. 45 minutes to 1 hour depending on amount of flow.	River is hardly used in winter months, except by kayakers (Nov-May). Water flow has no real impact on # of users. If Guadalupe River slows down, and/or Comal gets too busy, San Marcos River use increases.	City has low flow/high flow #'s. Melanie has city counts. Katherine Nichols has #'s posted on website. TX State has done studies. Geography Dept has done counts. 50 – 60% of tubes are Lion's Club tubes	More a correlation with Weather than water flow. If Guadalupe floods, will see more users on the San Marcos		No, not direct river use. Aquifer use does.	
4. Can recreational activities on the river continue at current levels of activity?	Tubing is limited by having only one tubing vendor	Too many tubers in river spoil experience for other users. Yes ..see a. below	Appendix in Master Plan discusses overcrowding issues and encroachments on bank at Rio Vista by shore users; lack of signage or bad signage		No issue with # people on river, don't want any limitations.	Yes it can, but	
a. Why or why not?		With good rules, good patrol, good park maintenance Huge increases would be detrimental to everyone's enjoyment				Yes it can, but the quality of water and parks will continue to be degraded at this rate. If we wish to see the quality of water and parks maintained or even enhanced then something has to give. Either the recreational activities, including the sheer number of users, or the practices of recreational users must change. I'd prefer that it be done by creating a culture of respect and stewardship of the river, rather than totalitarian regulations. I believe this can be achieved, but then again I have full faith in my fellow man and woman.	
5. If arriving at the river by vehicle, where do people park (private lots, owned by recreation outfitters or other private lots? Street? Public park?).	Parking is an issue; not enough	I do not think we should building parking lots anywhere near the river to accommodate river use. Having people park in university parking lots on the weekend and getting shuttled to the river is a good idea. Those parking lots are basically empty except during occasional special events. This would require an interlocal agreement with the university.	Street & park parking	Parking is an issue in County. Lots of people parking illegally on campus property. (no public parking at TSU) Crowding/traffic		City parking lots (public parks)	Parking is always an issue. Will change configuration of parking around the river corridor; purchased 3 trolleys from Austin to move people between hotels. Could use as a pilot program to move people around.
a. Do the majority of recreational users use commercial shuttle		Blue Bus. Shuttle around (leased bus for Lions Club.	Majority use trails along the river to repeat tube float		Springtown Shopping Center is vacated; could be used for remote	No. Most people drive. Even those that use commercial shuttle buses	



APPENDIX C: EARIP Interviews 6/29/2010 SAN MARCOS

buses and are those desirable?					parking and shuttled to the river.	drive to get to the river and then they get a shuttle back to their car. I'd prefer that those who are able bodied walk back to their car. It's about a 10-15 minute walk.	
b. How many people (or what percentage of people) arrive at river tubing/raft launch locations by private vehicle versus shuttle bus?						I don't think that the person who wrote this questionnaire lives in, or understands how people use the San Marcos River. Again, the majority of people drive to the river. Then some people tube the river from City Park to Rio Vista. Then some of those people take a shuttle back to their car, which again is parked at a city park parking lot.	
c. Is one method of arrival preferable over the other?						Walking and/or riding a bicycle. Driving to the river is kind of like shitting in the river.	
6. Do most users access / launch from public/city owned property or private property?	Parks & University	Most use public property to launch	90% of users launch at City Park and take out at Rio Vista. City will eventually have designated in and out locations				
a. Please list all known points of access and launching.	Sewell Park, City Park, Dog Park(San Marcos Plaza), Don's Fish Camp (tube rentals)	City Park	City Park			Public. City parks and university property.	
7. Do most users exit the river at public/city owned property or private property?	*** Outdoor Center has kayak week at Rio Vista Falls to teach kayaking						
a. Please list all known points of exit.		Beyond city limits	out at Rio Vista		Other than Rio Vista: Cape's Camp and Don's fish Camp, Hwy 123, Redwood	City parks.	
8. What recreational activities other than tubing, rafting and fishing occur along the river?	Swimming/kayaking/canoeing	Wading, Swimming, canoeing & kayaking (3400/yr), dog play, picnicking, Running, wading, sitting and staring. Used to be diving but now too shallow	Kayak, canoe	Picnicking & glass bottom boat tours	Water lounging (chairs in the river/drinking/eating) Special Olympics and junior Olympic kayak trials, veteran's rehabilitation program	Well, swimming constitutes the highest percentage of all uses. There is also the praying, the drinking, the snorkeling, the thinking, the watching, the eating, the singing and the living.	
9. What specific locations are most frequented by these other users?	Outdoor Center has kayak week at Rio Vista Dam to provide kayak instruction & kayak course	Spring Lake Dam/Icehouse (swim), wading @ Rio Vista, dog play at Dog Park (San Marcos Plaza)	Kayak slalom in October Canoe Race from Aquarena City Park to Rio Vista	Picnics & glass bottom boat tours at Spring Lake	Above occur at Rio Vista	All city and university parks.	
10. What are the positive aspects of recreation on the river?	Tourism; enjoy beauty of river. Constant 72 water temperature. November – March	Positive: exercise, being in nature, economic good, creating an appreciation for nature and the river will help protect it (stewardship) No restrictions on times of use.		Spring Lake recreation is good because it frames the golf course		The re-creation of ourselves	Health/wellness of community; Quality of life; more families to river together, sense of community, increase use increases care stewardship of river
11. What are the negative aspects of recreation on the river?	Trash; parking shortage; more traffic; perception of gang activities because of sports wear.	Not a lot of funds to clean up/maintain river, so nip it in the bud. Erosion on the banks, litter, damage to endangered species, loud obnoxious boom boxes, smell of smoking, cars congestion, bad language, dog feces	Water safety problem – people do un-smart things. More warning signs? More education. People don't pay attention. Provide a video to show users various features along the river. Not Schiltebahn – natural river that changes daily. Have users understand (not a man made environment. Naturally flowing stream.)			The lack of respect and stewardship, or culture, leads to all of the negative aspects of river usage. This leads to trash, degraded banks, ripped up stands of Texas wild-rice, loud music, fist fights, dog poop, point and non-point source pollution.	Population growth has issues; lewd acts, illicit & nefarious activities, Flow of water over falls and currents that people aren't prepared for. EMS response/access and /crowd control/management. Too many people: sanitary issues

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			Crowding issues including pop-up tents & too many barbecues Not enough facilities: restrooms				
12. How important are river-based recreational activities to the local economy?		Recreational aspects are important to the economy, but not driving factor. Politicians should realize this and help to keep river nice. 900k/year to maintain river use in New Braunfels is not effective. Fairly important but there are a lot of costs to patrolling and keeping the river clean, and the additional congestion to city streets (probably a wash)		It is the setting for TSU and students are attracted here because of it. River is a draw for Golfers			
a. What are its contributions: i.e. sales tax, property taxes, other taxes/fees, spin-off businesses (related revenue sources for the city)?	Restaurants/bars close to river. (Herbert's on Riverside Drive)			River recreation is a desirable feature to economics and quality of life, if not able to quantify amount. Tom Keys, Wal Mart busy w/visitors to his camp. Water Safari – Starts at Aquarena Springs and to the coast. 6, 4, 3 solo teams. Several thousand people buy gas, stay @ nearby lodging, etc. .		<i>I don't know the numbers, but you can attribute every single dollar that I've ever spent in this town to the river.</i>	
b. How much does recreation activity contribute to the local economy? (in \$ or % of city revenue)	A lot, but hard to calculate improvements to river are starting to generate businesses year round.		Lion's Club gives \$110-125k/yr to local charities. That amount again for training staff to help tube business. TSU geography dept may have studies (Michael Ravel) (geography dept: Richard Earl)	Quality of life facility attracts people to move to the area.		<i>I would imagine a large amount, but I don't know.</i>	Not major economic draw, but a reason for people to come. One of top 10 reasons to come to town.
13. What is your perception of the level of enforcement on the river? Too much, not enough? Why?	OK w/current, but more OK. A 'surcharge' for river maintenance would be OK.	About right in town, too little east of the interstate.	1 full time park ranger. More part time staff (rangers) along the river during peak season. Have off duty police officers and use volunteers. All EMT certified.		Enforcement not really an issue	<i>I've never seen an officer cite someone for littering, yet I see trash at all parks all the time.</i>	Law enforcement – add more officers/enforcement each year.
14. Is the amount of regulation with regards to activities on the river acceptable? Should there be more? Or less?		It would be great to regulate the use of Styrofoam, glass, aluminum, and plastic bags in and around the river. It would be great to keep dogs out of the SM river within the city limits. It would be great to have a designated area for BBQing that was not to close to the river. It would be great to limit alcohol consumption in the river and parks within town. I'd also be in favor of eliminating loud music – but that is probably not possible.		No, Be careful about restricting recreation on river because users need to learn about the river. Save the wild rice, but don't prohibit use of the river as a recreational resource.			Ensure that there is order and safety, but not ever regulate. Stabilizing banks at City Park and at Rio Vista could help disperse crowds better
a. Are there certain things that should be regulated that aren't currently?		Better litter control/laws needed. Better regulations on type of containers that food/drinks are stored in. Tubers have more impact to environment than swimmers or canoers. No BBQ pits close to river at Rio Vista Dam. Pull them away. Looks like Woodstock. Dangerous for coal disposal. Dog Beach good for dog owner use – but no designated dog area. Dogs are supposed to be on leash. Alcohol is big cause of problems along river. Regulations are administered well with current regulations. Need more trash pick up: would be ice to park rangers or volunteer rangers in the river in canoes going up and down the river on weekends picking up trash and reminding tubers of the litter rules.	Eliminate alcohol in river and in parks. Make it a family friendly river. City caters to families.	Limit # of people at Rio Vista; Limit # of people at Sewell Park; Limit # of people at Lion's club tube rental. Limit access to spring Lake – Texas river safari already limits access to Spring Lake, scuba diver are all people allowed in the lake.		<i>No Styrofoam. No pop-up tents within 100' of the river. No bar-b-q pits within 100' of the river. No loud stereo systems.</i>	Provide more access points to disperse the crowds. More public access and****.
b. Are there certain things that are currently regulated that shouldn't be?	Don't understand concern w/saving natural organisms	Limit dog areas More stringent litter laws				No.	Alcohol on the river may be an issue.
15. What is your perception of	More would be good. Better manage	Never enough; too much trash	More funding needed for	Maintenance – good job w/yearly		<i>Not enough. The University has</i>	Perception that dredging should

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<p>the level of maintenance? Too much, not enough? Why?</p>	<p>floating islands of debris.</p>		<p>maintenance and cleanup along river. Trash; bbq coals/pup up tents are an issue. Pop up tent overcrowd access points to river and cause conflicts with tubers and swimmers.</p>	<p>cleanups all the way to Gonzalez, but not enough funding. Numerous small cleanups on upper river are good idea. Better control of use and abuse of river – more funding. Volunteers make it a lease viable. Too much trash along the shores – more control in this area would be good. Ban glass bottles on river. Container deposit would be a good idea. with more education. Limit alcohol</p>		<p><i>removed a trash can from the headwaters. Trash cans should also be located 100' from the river. The city and university should also abide by storm water protection standards and practice erosion control.</i></p>	<p>resume to keep flows to where they used to be. People don't trust science or understand it (dredging the river & it's positive and negative impacts).</p>
<p>16. Are there operational issues with regards to emergency flood situations?</p>	<p>Dams control a lot of severe floods.</p>					<p><i>The university should regularly clean the silt out the retention ponds on Sessom's creek so that this sediment doesn't continue to be deposited into the river at times of flooding.</i></p>	<p>Well prepared for floods/****. Well invested in the facilities More wild****</p>
	<p>Additional Notes: Nobody taking initiative w/signage along the River. "Everything" is about the experience of tubing on the river.</p>	<p>Having some informational/ warning signs around the wild rice areas would probably be a good idea.</p>	<p>Additional Notes: Mem. Day – Labor Day – TIBH Easter Seal Group 1 – 9 p Sat/Sun pick trash & empty trashcans. City removed over 60 cubic yards of trash at Rio Vista Dam during memorial day 2010. Provide "boat trash cans" in river to throw empties in. Parking is a huge issue due to shortage of available spaces. Issue more extreme of the extremities of park areas. Parking out of neighborhoods is a good thing. Restrooms are an issue. Drinking fountains are concern as well, and are a big issue during heavy use period of the year. Need to seek balance for demand. Changing rooms needed as well. Lion's Club will have better location.</p>	<p>Additional Notes: Land owners fill stock ponds w/river water and claim it is for domestic use (Smith Ranch) San Marcos River Ranch uses river water to fill lakes on site</p>	<p>Additional Notes: Education Center. Off Site Parking? What about entity?</p>		<p>Additional Notes: Rehab – for veterans coming back from war & folks with disabilities. Junion Olympic trials (kayak)</p>



**Appendix D: USGS Water-Quality Assessment of the Comal Springs
Riverine System, New Braunfels, Texas, 1993-94**

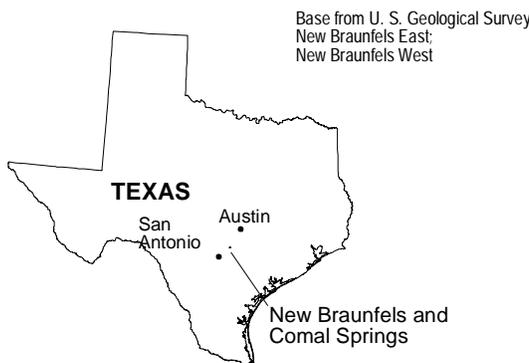
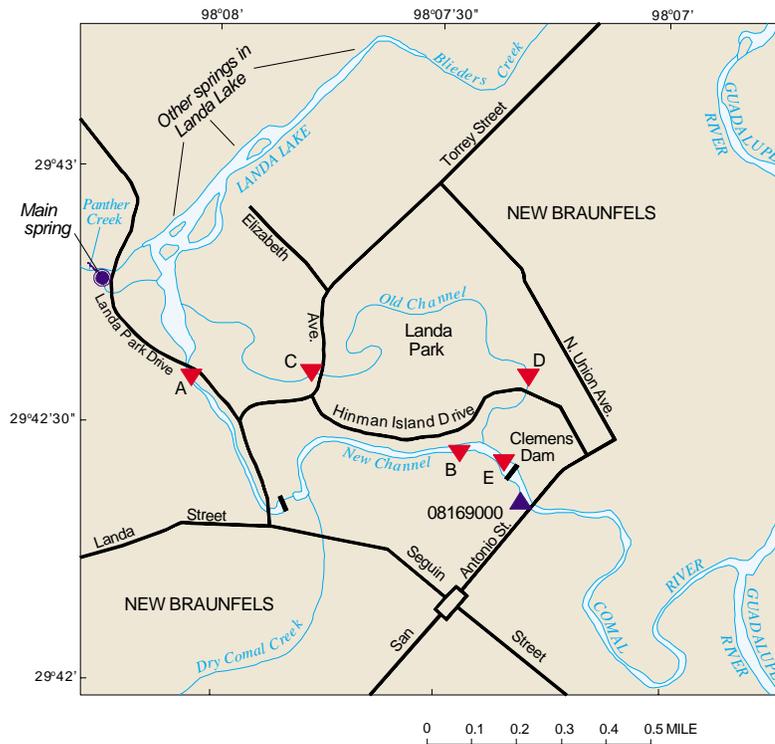


Comal Springs of Central Texas are the largest springs in the southwestern United States. The long-term average flow of the Comal River, which essentially is the flow from Comal Springs, is 284 cubic feet per second (ft³/s). The artesian springs emerge at the base of an escarpment formed by the Comal Springs fault. The Comal River (fig. 1) is approximately 2 miles (mi) long and is a tributary of the Guadalupe River. Most of the Comal River follows the path of an old mill race, here referred to as New Channel, then flows through a channel carved by a tributary stream (Dry Comal Creek), eventually rejoining its original watercourse. The original watercourse, here referred to as Old Channel, has been reduced to a small stream, the source of which is water diverted from Landa Lake and several springs in

the channel. In addition to being an important economic resource of the region, the springs and associated river system are home to unique aquatic species such as the endangered fountain darter (*Etheostoma fonticola*). The Comal Springs riffle beetle (*Heterelmis comalensis*), which exists in the springflow channel upstream of Landa Lake, has been proposed for listing as endangered. The Comal Springs dryopid beetle (*Stygoparmus comalensis*) and the Peck's cave amphipod (*Stygobromus pecki*) are two subterranean species associated with Comal Springs also proposed for endangered listing.

The population in the region has increased 20 to 30 percent per decade for the last 3 decades. This increase in population has correspondingly increased the use of both surface- and ground-

water resources in the region, which in turn has prompted concern for habitats of endangered species that depend on the spring water. To better understand the environmental needs of threatened or endangered species, the U.S. Fish and Wildlife Service (USFWS) undertook an intensive ecological assessment of the Comal Springs riverine system. One component of the study involved the effects of varied springflows on water chemistry and aquatic-species habitat in the riverine system. For that study component, the U.S. Geological Survey (USGS) provided continuous monitoring of selected water-quality properties and collected discrete water samples for analysis at selected sites along the Comal Springs riverine system. The purpose of this fact sheet is to summarize the principal results of the USGS water-quality monitoring, sampling, and analyses for selected properties, major ions, nutrients, trace elements, and pesticides during selected periods in the summer and winter of 1993–94. Only high flow (greater than 300 ft³/s) occurred during the monitoring periods; therefore, effects of lesser flows on water quality were not measured. Data collected from this study and subsequent monitoring



- EXPLANATION**
- A Water-quality monitoring and sampling site and site ID
 - 08169000 U.S. Geological Survey streamflow-gaging station and number
 - Spring

Figure 1. Comal Springs riverine system, New Braunfels, Texas.

can be used to evaluate instream flow habitat requirements of the fountain darter and other aquatic species.

During the monitoring periods, the New Channel received approximately 92 percent of the total volume of springflow by way of Landa Lake. New Channel has a uniform stream channel and higher velocities than Old Channel. In the upper reach of New Channel, west of Landa Park Drive, stream velocities are lowest and the bottom is predominantly large gravel and cobbles. In the lower reach, from Landa Park Drive to Clemens Dam, the velocities are highest and the streambed predominantly is bedrock and large gravel. In contrast, Old Channel received about 8 percent of the total volume of springflow. Old Channel has the meandering characteristics of a natural stream. In the upper reach of Old Channel, from Landa Lake to Elizabeth Avenue, are intermittent riffles and pools and a streambed of silt and assorted gravels. Downstream of Elizabeth Avenue, the stream mostly comprises slow runs and pools with very little riffle habitat; water velocities are minimal and the water appears turbid. The streambed is mostly coarse sediment and mud.

Collection of Water-Quality Data

Site selection and data collection were designed to evaluate physical and chemical properties of the riverine system. Five sites were selected for monitoring the upper and lower reaches of the two stream channels. These sites were evaluated to ensure uniform mixing of water and that monitoring points were representative of the sites. Two sites were selected on New Channel. Site A is at the Landa Lake outfall into New Channel. This site

represents the start of the riverine system and a composite of the spring-fed lake waters. Site B is immediately upstream of the confluence of Old and New Channels. This site was selected to monitor changes to water chemistry that might have occurred as water passed through New Channel. Within Old Channel, two sites also were selected. Site C is immediately upstream of Elizabeth Avenue and represents a composite of spring-fed lake water as it enters Old Channel. Site D is on Old Channel upstream of Hinman Island Drive and the confluence of Old and New Channels. Data from site E, downstream of the confluence of the two channels and on the Comal River immediately upstream of Clemens Dam, represent the cumulative effects of Old and New Channels.

The properties of pH, temperature, specific conductance, and dissolved oxygen were monitored continuously during selected periods in the summer and winter of 1993–94. Continuous monitoring of water properties required use of a four-parameter monitoring probe, which was connected to a data storage device and powered by a solar battery. The sites are inaccessible and required use of portable, self-contained floating shelters. To ensure data quality, the instruments were calibrated before and periodically during operation. Monitors measured and logged parameters at 30-minute intervals for periods of 3 to 8 weeks, depending on the site. Property data at the New Channel sites were monitored in the summer from August 20 to September 20, 1993, and in the winter from January 4 to February 3, 1994. Property data at the Old Channel sites were monitored in the summer from June 30 to August 18, 1993, and in the winter from

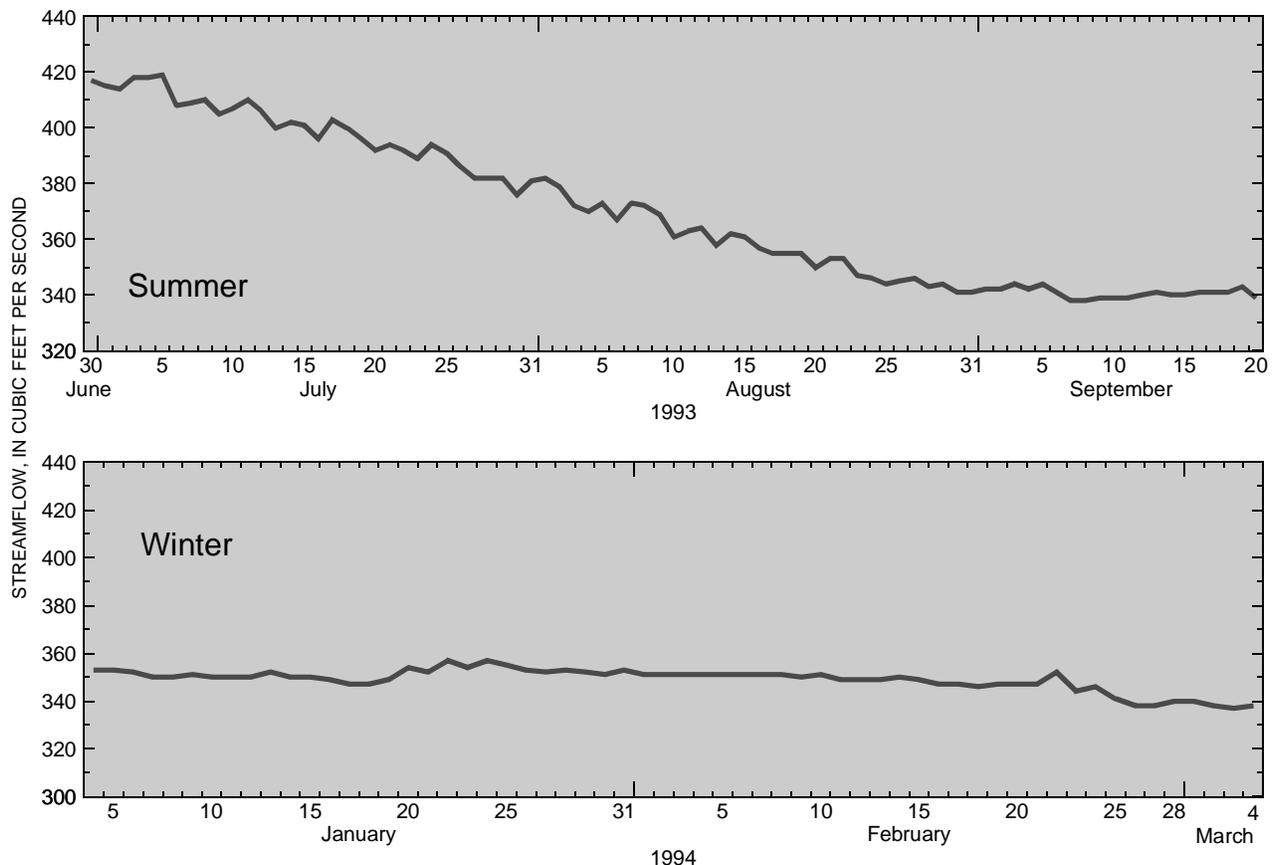


Figure 2. Daily mean streamflow, Comal River at New Braunfels, Texas, during water-quality monitoring periods, 1993–94.

February 7 to March 4, 1994. Property data at the Comal River site were monitored during all four periods. Periodic water-quality samples were collected at each of the five sites. Samples from New Channel and the Comal River were collected near the end of the monitoring periods on September 20, 1993, and February 3, 1994. Samples from Old Channel and the Comal River were collected on August 20, 1993, and March 3, 1994. Samples for major ions, nutrients, and trace elements were collected using a depth-integrated method at multiple intervals along the cross section, then composited. Samples for pesticides were collected using a depth-integrated method at a single interval at the midpoint of the stream.

Streamflow

Continuous streamflow data (fig. 2) were collected from USGS streamflow-gaging station 08169000 Comal River at New Braunfels during the water-quality monitoring periods. Initial daily mean streamflow of the Comal River for the summer monitoring period was 417 ft³/s on June 30, 1993, and ending streamflow was 339 ft³/s on Sept. 20, 1993. A peak flow of 419 ft³/s occurred on July 5, 1993, and a minimum flow of 338 ft³/s occurred on Sept. 7 and 8, 1993. Initial daily mean streamflow for the winter monitoring period was 353 ft³/s on January 4, 1994, and ending streamflow was 338 ft³/s on March 4, 1994. A peak flow of 357 ft³/s occurred on January 22 and 24, 1994, and a minimum flow of 337 ft³/s occurred on March 3, 1994.

Water Quality

Water Properties

Boxplots summarize the distributions of continuously monitored water-property data at the five sites (fig. 3). In some instances, the median is the same as the 25th or 75th percentile.

Table 1. Water properties and major ion concentrations, Comal Springs riverine system, New Braunfels, Texas, 1993–94

[$\mu\text{S/cm}$, microsiemens per centimeter at 25 °C; °C, degrees Celsius; mg/L, milligrams per liter; CaCO₃, calcium carbonate; <, less than; NA, not available; ft³/s, cubic feet per second]

Constituent	New Channel				Comal River ¹	
	Site A		Site B		Site E	
	Summer (9/20/93)	Winter (2/3/94)	Summer (9/20/93)	Winter (2/3/94)	Summer (9/20/93)	Winter (2/3/94)
Specific conductance ($\mu\text{S/cm}$)	548	509	547	509	544	514
pH (standard units)	7.6	7.4	7.8	7.3	7.8	7.1
Temperature (°C)	24.0	23.0	24.0	22.5	24.5	22.0
Dissolved oxygen (mg/L)	7.2	8.2	9.0	9.5	9.0	9.4
Calcium, dissolved (mg/L)	83	82	81	82	80	82
Magnesium, dissolved (mg/L)	16	16	16	16	16	16
Sodium, dissolved (mg/L)	9.9	9.7	11	10	10	10
Potassium, dissolved (mg/L)	.70	1.3	.70	1.3	.70	1.3
Alkalinity (mg/L as CaCO ₃)	230	230	230	230	240	230
Sulfate, dissolved (mg/L)	23	24	24	24	23	24
Chloride, dissolved (mg/L)	15	16	15	16	15	16
Fluoride, dissolved (mg/L)	.20	.20	.20	.20	.20	.20
Silica, dissolved (mg/L)	12	11	12	11	12	11
Dissolved solids, sum of constituents (mg/L)	307	309	308	309	307	310

Constituent	Old Channel				Comal River ¹	
	Site C		Site D		Site E	
	Summer (8/20/93)	Winter (3/3/94)	Summer (8/20/93)	Winter (3/3/94)	Summer (8/20/93)	Winter (3/3/94)
Specific conductance ($\mu\text{S/cm}$)	552	529	565	523	547	541
pH (standard units)	7.7	6.9	7.5	7.3	7.6	7.3
Temperature (°C)	24.0	21.5	25.5	20.5	26.0	23.0
Dissolved oxygen (mg/L)	8.1	11.4	4.4	11.8	9.2	12.0
Calcium, dissolved (mg/L)	83	82	85	81	84	81
Magnesium, dissolved (mg/L)	16	16	16	16	16	16
Sodium, dissolved (mg/L)	9.6	10	10	11	9.5	11
Potassium, dissolved (mg/L)	1.9	1.3	1.6	1.3	<.10	1.3
Alkalinity (mg/L as CaCO ₃)	230	240	240	240	230	240
Sulfate, dissolved (mg/L)	25	24	26	24	25	24
Chloride, dissolved (mg/L)	16	15	16	16	16	15
Fluoride, dissolved (mg/L)	.30	.20	.20	.20	.20	.20
Silica, dissolved (mg/L)	12	12	11	10	12	11
Dissolved solids, sum of constituents (mg/L)	309	310	314	310	NA	309

¹ Daily mean flow, 08169000 Comal River at New Braunfels: 350 ft³/s - 8/20/93, 339 ft³/s - 9/20/93, 351 ft³/s - 2/3/94, 337 ft³/s - 3/3/94.

Data were edited to correct for instrument drift and to exclude instrument malfunction. The number of data values per property per site ranged from 1,054 to 2,644.

For New Channel and Comal River, summer median specific conductance shows little variability along the reach, ranging from 547 to 551 microsiemens per centimeter at 25 °C ($\mu\text{S/cm}$). Winter median specific conductance shows more variability than summer, ranging from 525 $\mu\text{S/cm}$ at site A to 551 $\mu\text{S/cm}$ at site E. Summer median pH increases downstream from 7.3 at site A to 7.6 at sites B and E. Similarly during winter, median pH increases from 7.2 to 7.5. Summer median water temperature increases downstream from 23.5 degrees Celsius (°C) at sites A and B to 23.7 °C at site E.

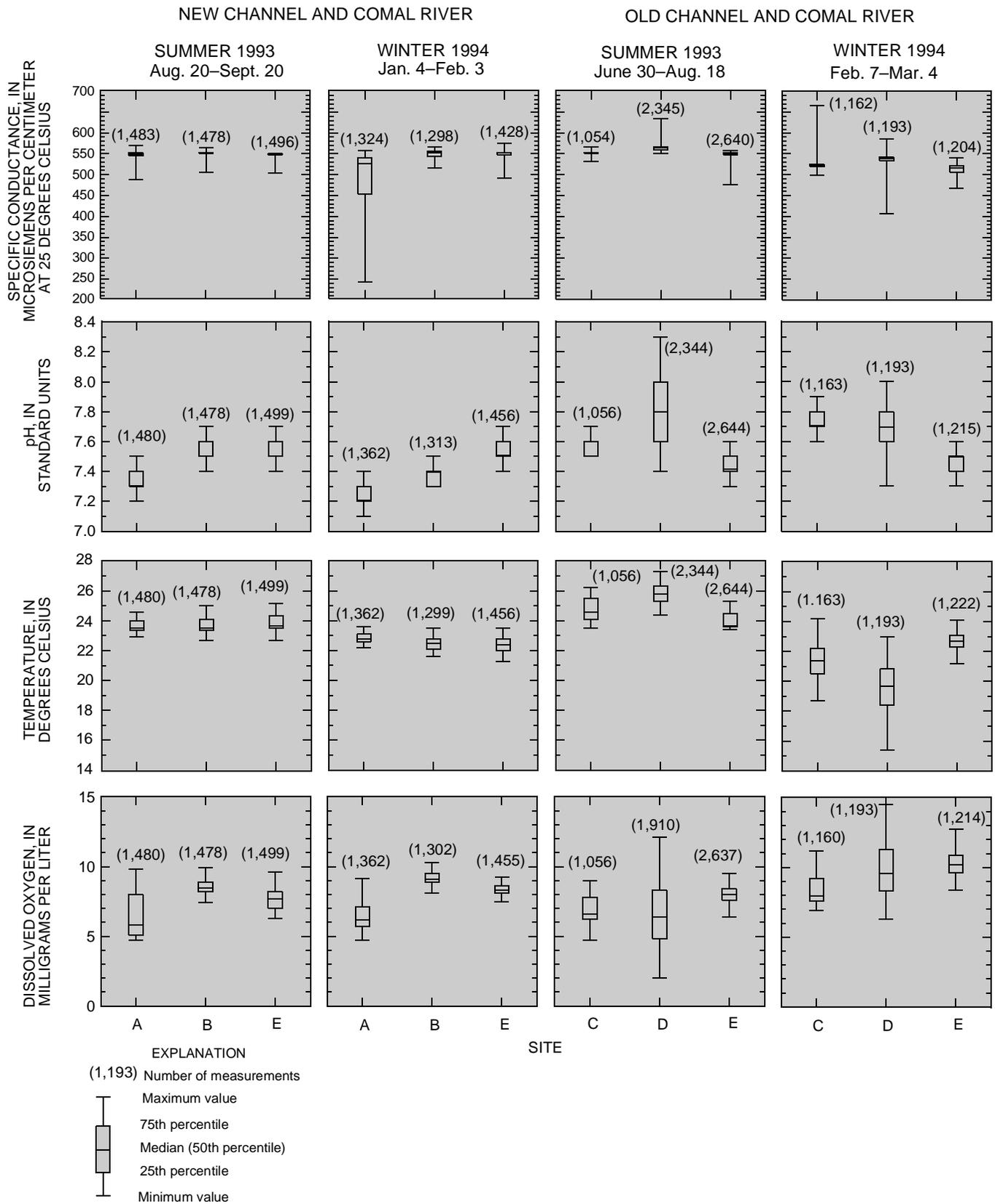


Figure 3. Distributions of specific conductance, pH, temperature, and dissolved oxygen, Comal Springs riverine system, New Braunfels, Texas, 1993–94.

Conversely, winter median water temperature decreases from 22.8 to 22.4 °C. Summer median dissolved oxygen increases

downstream from 5.8 milligrams per liter (mg/L) at site A to 8.5 mg/L at site B and subsequently decreases to 7.7 mg/L at site E.

Table 2. Nutrient concentrations, Comal Springs riverine system, New Braunfels, Texas, 1993–94

[mg/L, milligrams per liter; NA, not available; <, less than; ft³/s, cubic feet per second]

Constituent (mg/L)	New Channel				Comal River ¹	
	Site A		Site B		Site E	
	Summer (9/20/93)	Winter (2/3/94)	Summer (9/20/93)	Winter (2/3/94)	Summer (9/20/93)	Winter (2/3/94)
Nitrogen, nitrate, dissolved	NA	1.87	NA	1.87	NA	2.38
Nitrogen, nitrite, dissolved	<0.010	.030	<0.010	.030	<0.010	.020
Nitrogen, ammonia, dissolved	.030	.020	.030	.030	.030	.050
Nitrogen, organic, dissolved	NA	NA	NA	NA	NA	NA
Phosphorus, dissolved	<.010	<.010	<.010	<.010	<.010	<.010
Phosphorus, ortho, dissolved	NA	NA	NA	NA	.03	NA
Phosphate, ortho, dissolved (as P)	<.010	<.010	<.010	<.010	.010	<.010

Constituent (mg/L)	Old Channel				Comal River ¹	
	Site C		Site D		Site E	
	Summer (8/20/93)	Winter (3/3/94)	Summer (8/20/93)	Winter (3/3/94)	Summer (8/20/93)	Winter (3/3/94)
Nitrogen, nitrate, dissolved	NA	NA	1.39	NA	NA	NA
Nitrogen, nitrite, dissolved	<0.010	<0.010	.010	<0.010	<0.010	<0.010
Nitrogen, ammonia, dissolved	.030	.020	.060	.030	.030	.010
Nitrogen, organic, dissolved	NA	NA	NA	0.27	NA	NA
Phosphorus, dissolved	<.010	.010	<.010	.050	<.010	.010
Phosphorus, ortho, dissolved	.03	NA	.06	NA	.03	NA
Phosphate, ortho, dissolved (as P)	.010	<.010	.020	<.010	.010	<.010

¹ Daily mean flow, 08169000 Comal River at New Braunfels: 350 ft³/s - 8/20/93, 339 ft³/s - 9/20/93, 351 ft³/s - 2/3/94, 337 ft³/s - 3/3/94.

Similarly, winter median dissolved oxygen increases from 6.2 mg/L at site A to 9.1 mg/L at site B, then decreases to 8.3 mg/L at site E.

For Old Channel and Comal River, summer median specific conductance increases from 550 µS/cm at site C to 562 µS/cm at site D, then decreases to 549 µS/cm at site E. Similarly, winter median specific conductance increases from 523 µS/cm at site C to 540 µS/cm at site D, then decreases to 517 µS/cm at site E. Summer median pH increases downstream from 7.6 at site C to 7.8 at site D, then decreases to 7.4 at site E. Winter median pH is 7.7 at sites C and D and 7.5 at site E. Summer median temperature increases from 24.6 °C at site C to 25.8 °C at site D and subsequently decreases to 23.8 °C at site E. Conversely, winter median temperature decreases from 21.4 °C at site C to 19.7 °C at site D, then increases to 22.7 °C at site E. Summer median dissolved oxygen decreases from 6.6 mg/L at site C to 6.4 mg/L at site D and increases to 8.0 mg/L at site E. Winter median dissolved oxygen increases from 8.0 mg/L at site C to 10.2 mg/L at site E.

In general, specific conductance, pH, temperature, and dissolved oxygen measured at the time of collection of discrete samples (table 1) fall within the range of measurements made by the continuous monitors.

Major Ions

Only slight variability in concentrations of major ions either along reaches or between seasons (along a reach) is observed for the periodic water-quality samples collected during high-flow conditions (table 1). For example, dissolved solids range from 307 to 309 mg/L for New Channel and from 309 to 314 mg/L for Old Channel.

Nutrients

Where measured, concentrations of nutrients and variations in concentrations (table 2) are small. For all sites, nitrate nitrogen concentrations range from 1.39 to 2.38 mg/L, nitrite nitrogen concentrations range from less than 0.010 to 0.030 mg/L, and ammonia concentrations range from 0.010 to 0.060 mg/L. Phosphorus concentrations range from less than 0.010 to 0.050 mg/L, orthophosphorus concentrations range from 0.03 to 0.06 mg/L, and orthophosphate concentrations range from less than 0.010 to 0.020 mg/L.

Trace Elements

Trace elements (table 3) show little variability in concentration either along the reaches or between seasons. Differences in concentrations between sites in the same reach and seasons are small, less than 5 micrograms per liter (µg/L), except for strontium in Old Channel, which decreases by 50 µg/L from site D to site E in both seasons and increases by 50 µg/L from summer to winter at site C. Concentrations of strontium (610 to 690 µg/L) are 1 to 2 orders of magnitude larger than that of other trace elements. Trace elements for which analyses were below detection limits are beryllium (less than 0.5 µg/L), cadmium (less than 1.0 µg/L), chromium (less than 5 µg/L), cobalt (less than 3 µg/L), copper (less than 10 µg/L), mercury (less than 0.1 µg/L), molybdenum (less than 10 µg/L), nickel (less than 10 µg/L), silver (less than 10 µg/L), and vanadium (less than 6 µg/L).

Pesticides

Of 29 pesticides for which samples were analyzed (table 4) only diazinon was detected during the summer at sites D and E, in concentrations of 0.01 and 0.02 µg/L, respectively.

Selected References

Brown, D.S., Petri, B.L., and Nalley, G.M., 1992, Compilation of hydrologic data for the Edwards aquifer, San Antonio area, Texas, 1991, with 1934–91 summary: San Antonio, Edwards Underground Water District Bulletin 51, 169 p.

Table 3. Trace element concentrations, Comal Springs riverine system, New Braunfels, Texas, 1993–94

[Constituents not detected include beryllium, cadmium, chromium, cobalt, copper, mercury, molybdenum, nickel, silver, and vanadium. µg/L, micrograms per liter; <, less than; ft³/s, cubic feet per second]

Constituent (µg/L)	New Channel				Comal River ¹	
	Site A		Site B		Site E	
	Summer (9/20/93)	Winter (2/3/94)	Summer (9/20/93)	Winter (2/3/94)	Summer (9/20/93)	Winter (2/3/94)
Arsenic, dissolved	<1	<1	<1	<1	<1	<1
Barium, dissolved	51	51	52	51	52	51
Iron, dissolved	<3	<3	<3	<3	3	<3
Lead, dissolved	<10	<10	10	<10	<10	<10
Lithium, dissolved	7	6	8	6	7	7
Manganese, dissolved	<1	<1	<1	<1	<1	<1
Selenium, dissolved	1	<1	1	<1	1	<1
Strontium, dissolved	610	610	620	620	610	620
Zinc, dissolved	3	<3	<3	5	<3	<3

Constituent (µg/L)	Old Channel				Comal River ¹	
	Site C		Site D		Site E	
	Summer (8/20/93)	Winter (3/3/94)	Summer (8/20/93)	Winter (3/3/94)	Summer (8/20/93)	Winter (3/3/94)
Arsenic, dissolved	<1	2	<1	1	<1	1
Barium, dissolved	51	55	53	55	49	51
Iron, dissolved	3	<3	4	<3	<3	<3
Lead, dissolved	<10	10	<10	10	<10	<10
Lithium, dissolved	12	8	13	8	12	8
Manganese, dissolved	2	2	5	4	<1	2
Selenium, dissolved	<1	<1	<1	<1	<1	1
Strontium, dissolved	620	670	650	690	600	640
Zinc, dissolved	6	<3	4	<3	<3	5

¹ Daily mean flow, 08169000 Comal River at New Braunfels: 350 ft³/s - 8/20/93, 339 ft³/s - 9/20/93, 351 ft³/s - 2/3/94, 337 ft³/s - 3/3/94.

Rothermal, S.R., and Ogden, A.E., 1987a, Hydrochemical investigation of the Comal and Hueco Springs systems, Comal County, Texas: Edwards Aquifer Research and Data Center Report R1–87, 182 p.

_____, 1987b, Hydrochemical investigation of the Comal and Hueco Springs systems, Comal County, Texas: Edwards Aquifer Research and Data Center Report R2–86, 151 p.

Wells, F.C., 1985, Statistical summary of water-quality data collected from selected wells and springs in the Edwards aquifer near San Antonio, Texas: U.S. Geological Survey Open-File Report 85–182, 162 p.

William F. Guyton and Associates, 1979, Geohydrology of Comal, San Marcos, and Hueco Springs: Texas Department of Water Resources Report 234, 85 p.

—Lynne Fahlquist and R.N. Slattery

Table 4. Pesticide concentrations, Comal Springs riverine system, New Braunfels, Texas, 1993–94

[µg/L, micrograms per liter; compound in bold was detected]

Pesticide	Detection limit (µg/L)
PCB	0.1
Polychlorinated naphthalenes	.10
Aldrin	.010
Chlordane	.1
DDD	.010
DDE	.010
DDT	.010
Diazinon	.01
Dieldrin	.010
Disyston	.01
Endosulfan	.010
Endrin	.010
Ethion	.01
Heptachlor	.010
Heptachlor epoxide	.010
Lindane	.010
Malathion	.01
Methoxychlor	.01
Methylparathion	.01
Mirex	.01
Parathion	.01
Perthane	.1
Phorate	.01
Silvex	.01
Toxaphene	1
Trithion	.01
2,4-D	.01
2,4-DP	.01
2,4,5-T	.01

Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Information on technical reports and hydrologic data related to this and other studies can be obtained from:



San Antonio Subdistrict Chief
U.S. Geological Survey
435 Isom Road, Suite 234
San Antonio, Texas 78216
Phone: 210–321–5200
FAX: 210–530–6008
E-mail: gbozuna@usgs.gov
World Wide Web: <http://txwww.cr.usgs.gov/>

Appendix E: Lodging Revenues

New Braunfels

Hotel / motel tax receipts (rate = 13%) full year		1 st & 2 nd Quarters
2005	\$ 1,875,936.60	\$1,424,537.30
2006	\$ 1,991,734.20	\$ 1,452,416.00
2007	\$ 2,116,439.60	\$ 1,458,819.80
2008	\$ 2,319,141.70	\$ 1,682,902.80
2009	\$ 2,151,495.20	\$ 1,548,257.20

San Marcos

Hotel / motel taxes

2008	\$ 1,698,905.00
2009	\$ 2,030,247.00



Appendix F: Response to TWDB Comments



November 4, 2010
AVO 27520

Mr. Robert L. Gulley, Program Director
Edwards Aquifer Recovery Implementation Program
2632 Broadway, South Building, Suite 301
San Antonio, Texas 78215

RE: Response to TWDB comments to Draft Report for “Initial Study of Recreational Impacts to Protected Species and Habitats in the Comal and San Marcos Springs Ecosystems”, as a part of the Research Contract for the Implementation of the Edwards aquifer Recovery Program between the Texas Water Development Board (TWDB) and the Texas AgriLife Extension Service (TAES). TWDB Contract No. 1004831037

Dear Mr. Gulley:

Halff Associates has read the comments to the draft report identified above, submitted by the TWDB. As an aid to clarify our responses and proposed actions, we will refer to Attachment I of the TWDB comments by paragraph. Our responses are as follows:

Paragraph One – Executive Summary

The Executive Summary portion of the report revised during preparation of the Final Report to conform to the requirements of Task 11j of the Contract Scope of Work.

Paragraph Two – Tabular Format

Available information has been presented in tabular format throughout the report when possible.

Paragraph Three – Recreational Providers (Pages 4-7)

The list of tube rental and other recreational providers was current during assembly and preparation of data for the report. As mentioned in the body of the report, the tube rental business is a seasonal enterprise, and new businesses readily come and go. Significant flooding events also occurred immediately before and during the time when data was assembled along the Comal River, which resulted in several businesses ceasing to operate for the remainder of the summer season or until further notice. The information shown reflects what was available at the time of the study.

Paragraph Four – Data Collection (Page 7)

Data collection activities conformed to the approved scope of work for the project. All information provided by and for recreational providers is illustrated in the report.

HALFF ASSOCIATES, INC.

4030 WEST BRAKER LANE, SUITE 450
AUSTIN, TX 78759-5356

TEL (512) 252-8184
FAX (512) 252-8141

WWW.HALFF.COM

Paragraph Five – Interview Documentation (Pages 28-38)

Stakeholder participation has been documented in the final report, including number of participants, and locations and dates of interviews.

Paragraph Six – Prioritized Needs and Desires List (Pages 28-38)

Based on comments received from stakeholders who participated in the study, a list of issues, both negative and positive, was compiled. This list of issues is ranked by priority, to coincide with the number of responses and issue related comments provided by stakeholder participants.

Paragraph Seven – Sampling Appendix (Page 39)

In the Final Report, a list of the TCEQ Clean Rivers Program water quality sampling parameters has been included in a tabular format. There is no longer a reference to an appendix in the document.

Paragraph Eight – TCEQ Water Quality (Page 39)

The Final Report discusses the two fact sheets prepared by the USGS between 1994 and 1998, and the relevance to future studies. The TCEQ Clean Rivers data, which includes the same parameters as the previous USGS, is the preferred source for electronic water quality data. The TCEQ data includes more sampling point locations, and is the umbrella program for the state that includes data collected by various agencies such as Texas State University data.

Paragraph Nine – Scientific Studies (Page 41)

The final report includes several scientific studies that are pertinent to the issue of recreational impacts on the two springs and their ecosystems, in addition to those provided in the draft report. As noted in the final report, there were several previous studies that were not accessible by members of the Halff Associates team, including three previous studies cited in the TWDB comment letter. There are also several other research teams and consulting groups conducting on-going projects in the two spring watersheds. Information from these on-going studies was largely unavailable to the Halff team, but may have a bearing on the final outcome of the study of recreational impacts in either watershed.

Paragraph Ten – Economic Studies (Page 50)

The three previous economic studies cited in the final report were the only resources available for review, according to the Chambers of Commerce for both New Braunfels and San Marcos.

Paragraph Eleven – Assessment of Recreational Impacts (Page 55)

In accord with our scope of services, Halff Associates reviewed and recorded data provided by the EARIP, the cities of New Braunfels and San Marcos, their Chambers of Commerce, and various other participants in the study. The final report identifies the results of this data gathering, and summarizes the next steps in the study process that might be undertaken by the EARIP. The final report also offers a conclusion that there is a



significant shortfall in available data related to recreational impacts to listed species and their habitats within either spring's ecosystems. In the absence of any studies that specifically identify recreational activities as an impact or hazard to the ecosystems, there can be no assessment of recreational impacts, or suggestions for mitigation measures to lessen impacts from recreational activities

As stated in the letter from the TWDB to the TAES, Halff Associates will include a copy of this response letter, along with the review comments from the TWDB to the TAES, bound into our final report. Please feel free to contact me via e-mail at wcooper@halff.com, or via telephone at (512) 252-8184 with any questions or comments that you may have.

Sincerely,
HALFF ASSOCIATES, INC.

A handwritten signature in blue ink that reads "H. Wayne Cooper".

H. Wayne Cooper, ASLA, AICP
Vice President

Attachments





TEXAS WATER DEVELOPMENT BOARD



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Joe M. Crutcher, *Member*

October 22, 2010

Dr. Edward G. Smith
Director
Texas AgriLife Extension Service
2147 TAMU
College Station, Texas 77843-2147

Re: Research Contract for the Implementation of the Edwards Aquifer Recovery Program between the Texas Water Development Board (TWDB) and the Texas AgriLife Extension Service (TAES), TWDB Contract No. 1004831037, Draft Report Comments for "Initial Study of the Recreational Impacts to Protected Species and Habitats in the Comal and San Marcos Springs Ecosystems"

Dear Dr. Smith:

Staff members of the TWDB have completed a review of the draft report prepared under the above-referenced contract. ATTACHMENT I provides the comments resulting from this review. As stated in the TWDB contract, the TAES will consider incorporating draft report comments from the EXECUTIVE ADMINISTRATOR as well as other reviewers into the final report. In addition, the TAES will include a copy of the EXECUTIVE ADMINISTRATOR'S draft report comments in the Final Report.

The TWDB looks forward to receiving one (1) electronic copy of the entire Final Report in Portable Document Format (PDF) and six (6) bound double-sided copies. The TAES shall also submit one (1) electronic copy of any computer programs or models, and, if applicable, an operations manual developed under the terms of this Contract.

If you have any questions concerning the contract, please contact Matt Nelson, the TWDB's designated Contract Manager for this project at (512) 936-2550.

Sincerely,

Carolyn L. Brittin
Deputy Executive Administrator
Water Resources Planning and Information

Enclosures

c: Matt Nelson, TWDB

Our Mission

To provide leadership, planning, financial assistance, information, and education for the conservation and responsible development of water for Texas

P.O. Box 13231 • 1700 N. Congress Avenue • Austin, Texas 78711-3231
Telephone (512) 463-7847 • Fax (512) 475-2053 • 1-800-RELAYTX (for the hearing impaired)
www.twdb.state.tx.us • info@twdb.state.tx.us

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Attachment I

Review of TWDB Contract No. 1004831037
“Initial Study on the Recreational Impacts to Protected Species and Habitats in the Comal and San Marcos Springs Ecosystems”

Executive Summary: Report does not provide an executive summary “suitable for distribution to third party reviewers and the general public that provides an overview of the study process and resulting recommendations.” Please provide an executive summary in the final report that is in accordance with Task 11j of the Contract Scope of Work that includes specific recommendations out of the report.

Throughout report: Report findings in report are not provided in tabular format. Please present report findings in tabular format in accordance with Tasks 11a, 11b, 11c, 11e, 11f, 11g of the Contract Scope of Work.

Pages 4-7: Report lists 6 entities that rent inner tubes in New Braunfels and San Marcos. Please confirm that there are not additional entities that should be included in the report (e.g., R B’s Tube Rental, New Braunfels; Riverbank Raft & Tube Rentals, New Braunfels). Please confirm that the report includes a comprehensive list of recreational providers in accordance with Task 11a of the Contract Scope of Work.

Page 7, Section I: Data collection appears incomplete. Information cited as deliverables in the Contract Scope of Work Task 1a (e.g., areas of service, access points, periods of operation, number of participants etc.) are absent for many of the recreational providers. Please include all information for recreational providers in accordance with Task 1a of the Contract Scope of Work.

Pages 28-38: Interviews are not documented in the draft report. Please document the number of interviewees, locations, and dates of occurrence of interviews performed for both the Comal and San Marcos systems under task 11d of the Contract Scope of Work.

Pages 28-38: Report does not provide a prioritized list of needs, desire, likes, and dislikes or an evaluation matrix. Please provide 1) a prioritized list of needs, desire, likes, and dislikes, and 2) an evaluation matrix in accordance with Task 11d of the Contract Scope of Work.

Page 39: In the final paragraph on page 39 there is mention of an appendix containing the parameters that were sampled, yet there is no such appendix. Please include the appendix in the final report.

Page 39 Section V: Report only mentions TCEQ water quality data under Task 11f. Other sources of water quality data should also be considered under Task 11f of the Contract Scope of Work, (if appropriate) including, for example, USGS and Texas State University data. The US Geological Survey collected four water quality samples at the Highway 82 Bridge below Spring Lake (location of USGS gage 08170500) between August 1994 and October 1996. The USGS



has produced a fact sheet related to water quality data collections at other locations on the San Marcos (<http://pubs.usgs.gov/fs/Fs05997/05997.pdf>). On the Comal River, the USGS collected 29 water quality samples at the San Antonio Street Bridge (location of USGS gage 08169000) between August 1995 and June 1998. A fact sheet <http://pubs.usgs.gov/fs/Fs09997/09997.pdf>) describes a water quality assessment of the Comal River carried out in 1993 and 1994. Water quality data from the USGS is available online (<http://nwis.waterdata.usgs.gov/>).

Page 41: Report Section VI includes five scientific studies. Please consider summarizing other pertinent studies under Task 11g of the Contract Scope of Work including, for example:

- Variable Flow Study published in August 2007 (http://edwardsaquifer.org/files/Summary_of_Monitoring_and_Research_for_2000-2007.pdf) which provides information about the impact of recreation on threatened and endangered species in these systems. Other studies of the Comal and San Marcos systems that should be summarized include:
- Bradsby, D.D., 1994, A recreational use survey of the San Marcos River: San Marcos, Tex., Southwest Texas State University, M.S. thesis, 82 p.
- Breslin, S. L. 1997. The impact of recreation on Texas wild rice. M.S. thesis, Southwest Texas State University, San Marcos, TX. 69 pp.
- Stanton, L. L. 1992. Assessment of changes in the aquatic macrophyte community in the upper San Marcos River. M.S. thesis, Southwest Texas State University, San Marcos, TX.
- Owens, et al. 2001 <http://www.apms.org/japm/vol39/v39p75.pdf>

Page 50, Section VII: Report identified and summarized three economic study components. It is unclear if these are all the existing economic study components that are available. Please clarify if these are the only existing study components available related to Task 11h of the Contract Scope of Work.

Page 55, Section VIII: Report does not include two key scope of work deliverables: assessment of recreational impacts; and, suggested actions to reduce negative impacts as required by Task 11e, 1 and 4 of the Contract Scope of Work (Task 11e budget \$10,140). Please provide further explanation for why this information required under the scope of work was not included in the report.