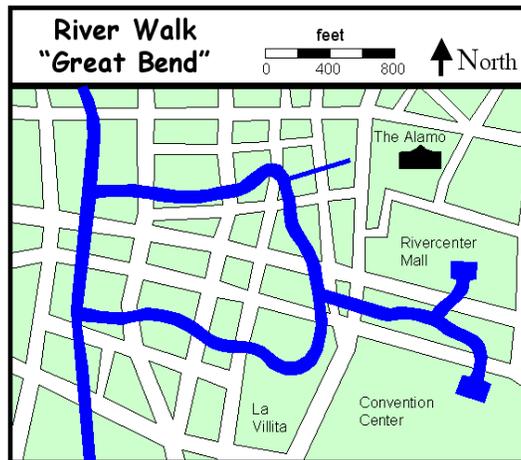


River Walk Water Quality Work Group Report



December 2006

Executive Summary

On June 22, 2006, City staff and various agencies met regarding the maintenance and operation of the San Antonio River. The focus of the meeting centered on the technical water quality of the River Loop and its aesthetics. At that time a special committee was formed including San Antonio Water System (SAWS), San Antonio River Authority (SARA), Bexar County, and City staff to determine appropriate solutions to improve the water quality and clarity of the San Antonio River Loop.

Since the initial meeting, the River Walk Water Quality Work Group has met five (5) times including a river tour, to discuss the scope of the work group and identify possible causes and solutions to improve water quality and clarity. They were also to develop short and long term recommendations to improve upon the water quality and clarity in the river loop. Specifically, the group was tasked with considering possible solutions in relation to cost and impact.

The work group identified the following goals for the San Antonio River Loop:

1. Bacteriological water quality – consistent with the State of Texas stream standards for contact recreation
2. Chemical composition - compatible with state designated high quality aquatic life uses (suitable to sustain frogs, aquatic insects, aquatic plants, and game fish such as bass)
3. Clarity - visual clarity of the water that allows fish and other aquatic life to be seen but not necessarily the bottom of the river

The following improvements and activities have been implemented since June 2006:

- Trash and Debris Removal – On June 6, 2006, the City of San Antonio commissioned a specially designed boat (Lady Eco) for removing all floating debris on the surface and one foot below from the river on a daily basis. The removal of floating debris was readily observed resulting in a significant improvement in visual water quality.
- Additional Flow to the River Loop - On August 2, 2006, SAWS began pumping reuse water near Market Street at the Convention Center. The increase in water supply has improved the flow in the loop. As additional flow to the River Loop is added through other devices, testing will occur to determine any improvement in water quality and clarity.
- Sampling and Analysis - SARA began sampling on August 3, 2006, at seven (7) sites in the loop and two (2) sites in the main channel. The frequency of sampling was conducted once a week through October. As of November 2006, water quality testing is occurring on a monthly basis. In addition, outside consultant services are being evaluated to provide more detailed analysis of the River Loop conditions.
- Recirculation Flow - The Public Works Department will continue to work in coordination with the Downtown Operations Department to supplement the San Antonio River with additional water that is available through the San Antonio River Flood Control Tunnel recirculation feature. This additional flow is provided to the main channel of the river.
- Sanitary Sewer Evaluation & Repair - SAWS inspects and cleans pipelines in the area using a variety of preventative maintenance methods in addition to emergency response on a 24/7 basis. All identified system failures in the system are addressed with a localized “point” repair or scheduled for major pipeline replacement.

In addition to these improvements, the committee also recommends the following short-term solutions. It is anticipated that these improvements can be implemented within a 6 month to 2 year period.

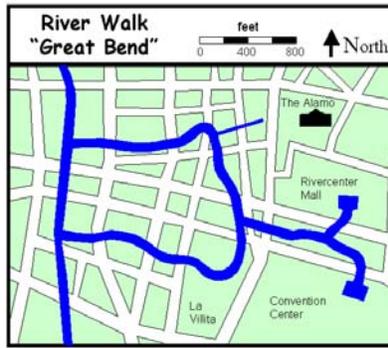
- Improved River Walk Cleaning Practices
- River Walk Equipment Purchases (water recovery power washers)
- Control of Wildlife in the River Walk Area
- Educate Central Business District Stakeholders
- Illicit Connection Inspection
- Compliance Program
- Proposed Watershed Protection Plan

The River Loop will need to be evaluated over a seasonal cycle to determine the effectiveness of the implemented short term solutions to meeting the established goals.

The improvements implemented to date have minimal fiscal impact. The San Antonio River Flood Control Tunnel recirculation feature supplies the San Antonio River with additional water at an estimated cost of \$30,000 per month. The water flow evaluation as described in the report will quantify the impact to the River Loop from the recirculation feature of the flood control tunnel. Additional short-term solutions as well as any additional engineered improvements will have a fiscal impact as detailed in the report.

The committee recommends continuing with the current practices and implementing the identified short-term solutions. After an evaluation of the river over a seasonal cycle, the committee will assess their impacts. It is highly probable that the existing practices and implementation of the short-term improvement recommendations will result in achieving the water quality goals. If, however, the anticipated results are not realized, the long-term solutions can be used to provide additional engineered improvements.

City Manager's Special Committee San Antonio River Loop



Recommendations for Water Quality Improvement

Issue:

Determine the current conditions of the San Antonio River “River Loop” quality, both from an aesthetic and environmental aspect, and to identify and recommend actions, both short and long term, necessary to achieve improved water quality and clarity.

Historical Background:

References to the San Antonio River Loop, also known as the “Great Bend”, can be traced to the first known settlers in the area. Though the San Antonio River valley had been an oasis providing fresh water for centuries, inhabited in the seventeenth century by the Payaya Indians, the first Europeans are believed to have traveled through the area in the years before the first recorded entrada. In 1691, Franciscan missionary Damian Massanet and Governor Domingo Teran de los Rios marched through the area on their way to establish outposts in East Texas by command of the King of Spain, keeping detailed records. It is they who are credited with the discovery and naming of the river today called the San Antonio. Massanet wrote, “...the river is bordered by many trees: cottonwoods, oaks, cedars, mulberries, and many vines. There are lots of fresh fish, and prairie hens are numerous on the high ground...I named this place San Antonio de Padua because it was his day.”

Periodically, the river and creeks brought destruction. The picturesque mile-long horseshoe bend of the river, so famous today, was responsible for many floods when torrential rains filled the banks and sharp turns retarded water flow. In 1921, there was serious talk of covering the river with concrete and making a street above, with the bed serving as a sewer. To some San Antonians, the thought of removing the historic tree-lined horseshoe bend in the heart of the city was incomprehensible. The revised flood control project that was subsequently adopted provided for a bypass channel with a flood gate and two river dams designed to cut the horseshoe bend off from the main channel during high-water periods. The bend was truly saved when the channel was completed in 1929. It was also in 1929 that a young architect, Robert H. H. Hugman met with a group to describe his plans for beautifying the river. In a speech entitled, “The Shops of Aragon and Romula”, Hugman presented a development concept in which “the historic tradition and natural beauty of the river must be sacredly preserved if we would build the right foundation for steady growth and future interest.”

Committee Background:

On June 22, 2006, Sheryl Sculley, the City Manager for the City of San Antonio convened a committee to:

- I. Evaluate the existing conditions in the river loop;
- II. Determine the water quality goals for the river loop;
- III. Establish a framework for improvement activities to meet the water quality goals.

This report identifies the activities that were in progress and provides a series of additional short and long term recommendations. The Committee members included a team of governmental and utility representatives who have a role in the management and use of the San Antonio River and River Loop.



This committee included the following individuals:

Pat DiGiovanni	San Antonio Deputy City Manager and Committee Chairman
Joe Aceves	Bexar County Executive Director of Infrastructure Services
Nancy Beward	City of San Antonio Public Works Assistant Director
Ron Smudy	City of San Antonio Parks & Recreation Assistant Director
Mike Gonzales	San Antonio River Authority Environmental Services Manager
Steve Clouse	San Antonio Water System Vice President

Other staff members from all organizations assisted with technical support as needed.

Project Background:

The River Loop consists of various above ground features such as waterfalls to enhance water quality. The original loop consists of a natural bottom while the “newer” sections of the River Walk, to include the convention center extension and the main flood control channel, have a concrete bottom. Water depths average approximately four (4) to five (5) feet in the original River Loop section, six (6) feet in the convention center extension and 14 to 18 feet deep in the main channel from Houston Street to Gate 5. In addition, there are several street and pedestrian overpasses along the River Loop. Wildlife which includes nesting birds and bats inhabit these structures and the numerous trees that line the river walk. A result of all these factors is constant changing conditions that have an impact on water quality. These changes occur seasonally; from day to day and from day to night. Water quality in the River Loop is also impacted by special events held in the Central Business District (CBD) and by changing weather conditions. Because the River Loop serves as the drainage conduit for the CBD, even minor rain causes the water to change to a turbid condition. Experience shows that after a rain, the water can take up to three days for sediments washed into the river to settle out and the water clarity to return to steady state conditions. General urban runoff, with its assortment of potential contributions from human, pet, and wildlife sources would be expected to be the largest source of pollutants. This expectation would reflect the fact that the watershed is highly urbanized with a complex of residential and commercial land use types. Runoff occurs in response to precipitation that falls

on the land surface. This runoff of incident rainfall then washes pollutants from the land surface and conveys them to receiving streams. In a highly urbanized area, the large amount of impervious cover results in increased runoff quantities and velocities and enhanced ability to scour pollutants from the land surface.

As the Upper San Antonio River and the San Antonio River Loop are directly connected, it is important to recognize that the improvements conducted on behalf of the ongoing Watershed Protection Plan (WPP), discussed below, will provide improvements in the River Loop. Conversely, improvements in the River Loop will provide benefits to the Upper San Antonio River. This report focuses on the improvements needed in the River Loop and assumes that the work identified in the WPP will progress as planned. These recommendations will need to be reevaluated and updated if the WPP is not accepted or implemented as planned.

The City of San Antonio FY 2007 Adopted Budget contains two projects specific to the water quality and clarity of the San Antonio River. The San Antonio River Pre-Treatment Project, managed by the Parks and Recreation Department, is funded at \$1.0 million through Certificates of Obligation that will be issued. This project's goal is to develop water treatment systems for water emanating from the San Antonio Zoo into the San Antonio River in Brackenridge Park.

The San Antonio River Water Quality and Clarity Improvement Project, managed by the Public Works Department and totaling \$250,000 will be funded by the Storm Water Regional Facilities Fund. This project will assess and develop structural and non-structural best management practices for water movement to be implemented in the San Antonio River between flood gates 3 through 6 to improve both water quality and clarity.

Finally, the San Antonio River Authority has been selected to receive an EPA 319 grant in the amount of \$192,276. (The total project cost of the work effort is \$320,460; of which 60% of the total cost is funded by the 319 grant). The 319 grant will provide funding for an education and awareness program that will target River Loop business and their patrons and enlist their support for improving water quality and clarity.

Water Sampling and Analysis

Water sampling data collection began on the River Loop and other nearby sites in August 2006. The San Antonio River Authority is taking the lead role in this process to ensure that water sample collection, analysis and quality assurance protocols are followed. Limited data has been collected to date. It is also important to note that water sampling has occurred mostly during the hot summer months and during a period of prolonged drought. This is significant as it is believed that during this type of weather pattern, water quality is impacted the most.

E.coli Bacteria data collection was conducted at seven (7) sites along the River Loop in addition to two (2) sites in the main channel. The following sites were monitored weekly through October 2006. Monthly sampling started in November 2006 and will continue at a minimum through April 2007. Sample sites and frequency may be adjusted based on sampling results.

Site 1 – Approximately 30 meters north of River Loop inlet across from Mexican Manhattan

Site 2 – At footbridge by the Pesca Restaurant

Site 3 – Under the Presa Street Bridge by the debris screen

Site 4 – Approximately 10 meters downstream (south) of Commerce Street Bridge

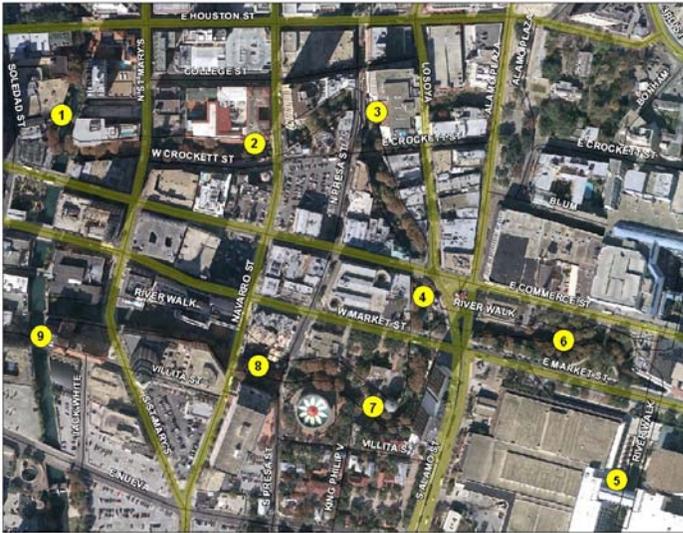
Site 5 – Under the Convention Center Bridge

Site 6 – Near the sidewalk projection (overlook) approximately 10 meters east of waterfalls

Site 7 – In front of the Little Rhein Steak House sign

Site 8 – Between Navarro and Presa Streets on the southern portion of the loop

Site 9 – Approximately 70 meters upstream (north) of Nueva Street at the 1st concrete column



All sites will be sampled for E.coli bacteria.

Sites 3, 5, and 7 are being sampled for Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphorus, Turbidity, Total Suspended Solids, Volatile Suspended Solids, Chlorophyll a, and Biochemical Oxygen Demand. Water quality testing instruments or Sondes were temporarily deployed at these three sites to continuously monitor dissolved oxygen, temperature, conductivity, and pH. This provided changes that occurred over a 24 hour period to the measured parameters. (Appendix B) The San Antonio River Authority attempted to measure flow at these three sites. However due to the lack of flow, a more sensitive measuring procedure needs to be implemented.

The Upper San Antonio River TMDL Study

It is important to note that this committee was tasked to evaluate and provide recommendations for improvements in the River Loop segment of the San Antonio River. The Texas Commission on Environmental Quality (TCEQ) initiated a total maximum daily load (TMDL) study for the Upper San Antonio River Segment 1911, an 86 mile stretch that begins at the Brackenridge Park headwaters of the San Antonio River and terminates in Karnes County near Falls City. This TMDL is a technical evaluation that is designed to determine allowable levels of discharge or release of bacteria to Segment 1911. This work includes a detailed definition of the problem, specification of an appropriate end point, identification of potential sources of bacteria, linkage of the sources to the in-stream water quality, and allocation of bacteria loads. The specific sources that contribute bacteria to a river are difficult to identify precisely, but they are a combination of point sources (e.g. a pipe discharging into the river) and non-point sources (e.g. water entering the river across a large area during rainfall events). The WPP is a cooperative effort to outline a series of structural and program improvements that will bring the upper eight miles of the San Antonio River back into compliance with the State of Texas Water Quality Stream Standards for bacteria. The largest single identifiable load to the Upper San Antonio River is from the San Antonio Zoo. Control of the bacterial loading from the San Antonio Zoo is expected to bring the upper eight miles of the San Antonio River, one of the five reaches of Segment 1911 identified by the TCEQ as impaired due to bacteria, into compliance with these standards on most days.

In preparation for the TMDL report, the Bexar Regional Watershed Management Partners, to include the San Antonio Water System, the San Antonio River Authority, Bexar County and the City of San Antonio initiated the development of a Watershed Protection Plan (WPP) for submittal to the TCEQ. A WPP is a voluntary study of the sources and control measures for bacteria in a defined area. The study makes recommendations for addressing an identified impairment in the upper San Antonio River for bacteria. Because the flood control gates at the River Loop segregate the water from the main channel, the River Loop was not included in the sampling or analysis for the Upper San Antonio River Watershed Protection Plan.

The WPP is a cooperative effort to outline a series of structural and program improvements that will bring the upper eight miles of the San Antonio River back into compliance with the State of Texas Water Quality Stream Standards for bacteria.

I. Existing Conditions In The River Loop

A. Bacteriological Water Quality

The bacterial quality of the River Loop is influenced by wildlife, primarily birds and bats and other discharges to the river to include – river walk business and tourist activities, potential illicit connections, transient populations, and bacteriological loadings from the main channel. The presence of bacteria does not have a direct impact to water clarity.



The most significant bacterial loading to the River Loop is suspected to be from wildlife droppings, predominately from birds and to a lesser extent bats. With the abundance of trees, water and available food, birds are naturally attracted to the river loop area. Tourist regularly feed the birds with food from the area restaurants. Regular sidewalk and seating area cleaning activities along the River Walk washes additional bird droppings into the river. Bat colonies attempt to find roost under the bridges that cross the River Loop. Other loadings from illicit connections to pipes that discharge in the river, or loadings from transient populations will need to be carefully evaluated to determine quantity or impact to the river.

The State of Texas has established a geometric mean of 126 org/100ml or 126 cfu (colony forming units) as the numerical standards for levels of E.coli bacteria in a water body designated for contact recreation use. Using limited data of recently obtained samples, the River Loop E.coli range of 12 to 53,000 cfu has been noted. (Appendix A)

B. Chemical Water Quality

The chemical quality of the river is influenced by improper waste disposal, wash downs of public areas with soaps or cleaners, street runoff, and illicit discharges to the storm water collection system.

Chemicals introduced into the river will need to be evaluated to determine what areas are contributing the largest amounts, and where to best target control measures for implementation. Waste disposal practices can be a contributor of chemicals to the river via storm water runoff or illicit use of drains for disposal. Washing and cleanup practices can contribute ammonia nitrogen and phosphates, and recycled



water can add nitrogen and phosphorus to the river. Nitrogen and phosphorus are nutrients which, under the right conditions can result in the growth of algae in a water body.

There are currently no State of Texas water quality standards for nutrient concentrations in a stream or river. Nutrient levels in freshwater streams use screening criteria recommended by the State. These are not standards, but are used to identify areas of possible concern. The numbers apply State wide and while some groups believe they need to be refined, they are currently being used to assess nutrient data. The State screening levels for Nitrate + Nitrite is 2.76 mg/l with the levels for Total Phosphorus being 0.8 mg/l. Very limited data exists, but the available data suggests that the river does have available nutrients (nitrogen and phosphorus), but is not heavily loaded with other inorganic chemicals. Water testing through November 2006, showed nutrient levels in the River Loop to be considerably higher than the screening levels, therefore testing over an extended period should continue. This will help determine if nutrient levels in the River Loop are a long term concern. The BOD (biochemical oxygen demand) is a relative measure of the strength of the oxygen consuming chemicals in the river. The BOD of the River Loop is <2 ppm (parts per million) which is very low, indicating that the river is not significantly influenced by oxygen demanding chemicals entering the river. The available chemical water quality data in the River Loop is included as Appendix A.

C. Water Clarity

The visual water quality (clarity) in the River Loop is influenced by the quantity and quality of the incoming water (flow), boat traffic, and debris in the water, the depth and bottom composition of the river, and the amount of algae growing in the water. The extended drought during the summer of 2006 has led to a stressed condition and deteriorated aesthetic quality throughout the River Loop. At times, the River Loop water appears thick, murky green to brown in color.



Historically, wells were used to augment flow to the river loop for improvement of water clarity. To comply with restrictions on use of Edwards aquifer water, discharges of aquifer water directly into the river have been eliminated. When the freshwater supply to the river loop was limited, the main channel remained the only area where significant freshwater supply continued. Currently there is no mechanism to force freshwater from the main channel through the river loop. The reduction in freshwater supply combined with the drought of 2006 effectively made the river loop into a stagnant body of water.

Whenever a river ceases to flow, it no longer functions as a riverine ecosystem and rapidly deteriorates. With the loss of flow, a river loses its ability to transport organic material, nutrients, sediments and pollutants downstream where they can be processed and assimilated. The loss of a transport mechanism creates two problems. First, a build up of nutrients, sediments, organic material and pollutants causing an unbalance in the aquatic ecosystem occurs. This can manifest itself as bacterial and or algal blooms, anoxic conditions, increases in turbidity and strong odors. The second problem that is created is that the downstream reaches of the river become starved of needed organic material, nutrients and sediments that nourish a balanced aquatic ecosystem.

Because the River Loop serves as the drainage conduit for the Central Business District, even minor rain causes the water to change to a degraded condition. Experience shows that after a

rain, the water can take up to three days for sediments deposited in the water to settle out and the water clarity to return to steady state conditions.

During the summer of 2006, algal growth continued in the main channel of the River Loop downstream of Nueva Street without positive displacement to the stream below the River Loop. These conditions highlighted the need for flow to displace algae rich water and provide a continuous fresh supply.

Because of the very shallow conditions in the river loop (approximately 4 to 5 feet deep) the movement of barge traffic lifts silt from the bottom of the river and suspends a silt plume in the river for a short period of time. Regular traffic provides considerable mixing resulting in a murky water appearance. The bottom of the River Loop in many locations is natural rock, gravel, sand or soil. Even with clear water in the river, this bottom will affect the apparent color of the water.

Data sampling for clarity has consisted of sampling for turbidity at sites 3, 5 and 7 within the River Loop. In addition turbidity sampling is also being taken upstream of the river loop at the Witte Museum (Site 10). Sampling results are located in Appendix A.

Secchi tube measurements were initially taken both upstream and downstream of the River Loop to establish a baseline. Secchi tubes measure water clarity in terms of depth of water by utilizing a simple visual method of measuring how deep the water is in the tube at the point a person can no longer see the bottom of the tube. It was the committee's recommendation to measure water clarity as it exists in the San Antonio River outside the loop area as a comparison for potential impact of the boat traffic on water clarity.



Secchi tube measurements were taken at the following locations:

- Josephine Street (San Antonio River Tunnel Inlet – Upstream)
- Josephine Street (San Antonio River Tunnel Inlet – Downstream)
- Brooklyn Street
- Lexington Street
- Houston Street
- Commerce street
- Lone Star (San Antonio River Tunnel Outlet – Upstream)
- Lone Star (San Antonio River Tunnel Outlet – Downstream)



Some of the factors affecting biological and chemical water quality include sidewalk washing, illicit drains, and Zoo activities.

II. Committee Recommendations - Water Quality Goals for the River

A. Bacteriological Water Quality

The committee recommends that the bacteriological water quality in the river be consistent with the State of Texas stream standards for contact recreation for dry weather conditions. The river's bacteria content should be below 126 cfu of *E. coli.*, and would be measured as a geometric mean over a one year period.

B. Chemical Water Quality

The committee recommends that the chemical composition of the river should be compatible with state designated high quality aquatic life uses (suitable to sustain frogs, aquatic insects, aquatic plants, and game fish such as bass, etc). The committee agrees that the goal for chemical water quality be compliant with applicable state stream standards or state screening criteria where they exist. According to SARA monitoring data, the Upper San Antonio River, segment 1911, which includes the River Loop, is in compliance with the physical and chemical state stream standards for dissolved oxygen, pH, chloride, sulfates, temperature, conductivity and total dissolved solids. Additionally, the committee suggests water quality goals for nutrients (nitrogen and phosphorous) be consistent with screening criteria recommended by the state for freshwater streams. Temperature should also be measured with the understanding that temperature plays a vital role in health of a stream however there are limited practices available to change the water temperature of the River Loop.

C. Water Clarity

The committee recommends a visual clarity of the water that allows fish and other aquatic life to be seen. All trash and debris in the water should be consistently and regularly removed.

The public at large has a wide range of expectations for what the water quality in the River Loop should be. Public comments on water quality goals in the river range from a clear stream to the existing green conditions. It is anticipated that some degree of color will always remain in the River Loop due to the growth of aquatic plants and the natural bottom that exists in many sections of the River Loop. Water clarity in the natural bottom section of the river changes once barge traffic begins. In addition, because the River Loop serves as the drainage conduit for the CBD, even minor rain causes the water to change to a turbid condition. Experience shows that after a rain fall event, the river can take up to three (3) days for sediments washed into the river

to settle out and have conditions return to steady state. Therefore, water clarity goals should take this into account.

The perception of water clarity and water color is subjective according to the individual making the assessment. To participate in development of recommended visual water quality goals, the committee proposes to establish a focus group of River Loop stakeholders to assist in quantifying the expected water clarity. The targeted quality will be compared to a measured secchi disk depth (how far one can see a disk down the water column) or a turbidity (cloudiness measured by instruments). Turbidity data collection began in mid July 2006 and is provided in the Appendix A.

III. Framework to Meet the Water Quality Goals

Recommended improvements to the river are provided in groups over time segments. This grouping is provided to allow the river improvements to be planned, funded and implemented. The committee recommends “phased improvements to allow the river ecosystem to adjust to the changed condition, and then to conduct an evaluation of the river through sampling and analysis. Each group of improvements will need to be measured for the progress toward meeting the overall goals.

The recommendations will be listed as:

- A. Improvements and activities implemented at the time of the report
- B. Short term improvements (6 months to 2 years)
- C. Long term improvements (2 years and beyond)

A. Improvements and activities implemented at the time of the report

i. Trash and Debris Removal

On June 6, 2006, The City of San Antonio commissioned a specially designed boat (Lady Eco) for removing all floating debris on the surface and one foot below from the river on a daily basis. The removal of floating debris was readily observed resulting in a significant improvement in visual water quality.

In addition to the use of Lady Eco, removing debris from the bottom of the river is accomplished as follows:

- Incidental or spot debris is removed daily using swimming pool nets. (Downtown Operations Department)
- River Loop natural bottom debris removal is accomplished during the annual river draining. Due to the natural river bottom and abundance of exposed utility lines, all work in this area is accomplished by hand. (Downtown Operations Department)
- Main channel debris removal is accomplished during the annual river draining. Heavy equipment is used to remove accumulated debris and silt on those portions of the River Walk that have been constructed with a concrete bottom. It should be noted that fish and aquatic habitats are protected during the cleaning timeframe. (Public Works Department)



ii. Additional Flow to the River Loop

The San Antonio Water System completed construction of a recycled water outfall and additional flow from high quality recycled water was provided to the river beginning on August 8, 2006. The average flow to the river is anticipated to be approximately 650,000 gallons per day and will be introduced at the H.B. Gonzalez Convention Center. The additional flow to the river has made significant improvements to the visual clarity of the River Loop water.



The committee agrees that a better understanding of the movement of water needs to be achieved. Understanding the flow of water is necessary to evaluate the impact various structural and non-structural improvements will have on the River Loop water quality and clarity. Conducting flow analysis on the river will most likely involve dye testing of the loop area. Due to the high citizen and tourist visibility, all efforts will be made to minimize the impact a “dye test” could have. Proper notifications to businesses and other stakeholders must be done to minimize the possibility of interference with the test. Past efforts of conducting dye testing where advance notification was not provided has led to unnecessary emergency responses and a “shutdown” of portions of the river.

iii. Sampling and Analysis

The San Antonio River Authority began a water quality sampling and monitoring program in August 2006. Analysis of the sampling and monitoring data at this time shows the following results:

1. Site 10 (downstream of the Witte; adjacent to re-use water discharge; upstream of zoo discharge) has much better water quality in regards to bacteria and water clarity.
2. Nutrient levels at the reference site are higher than at all but one of the River Loop sites (site 5, which is adjacent to the re-use water discharge and has comparable nutrient levels to the reference site).
3. Nutrient levels at sites 3 and 7 generally decrease with the addition of storm water (however, site 5 which is adjacent to re-use discharge stays about the same).
4. Water clarity in the River Loop has improved with the introduction of re-use water flow augmentation.
5. The range of bacteria concentration in the River Loop varies greatly in time and by site.
6. Site 3 near, the Presa St. Bridge, has unusually high and low bacteria concentrations (in relation to adjacent sites). Additional analysis over time is required to help explain potential cause.
7. The average bacteria concentrations in the main stem of the River are higher than in the River Loop, which are in turn higher than in the River Loop extension.
8. The average bacteria concentrations are highest at the downstream SA River site (site 9) and lowest at the Convention Center site (site 5) near the re-use discharge.
9. At this time there appears to be no trend (up or down) for the bacteria over time. The Convention Center site (site 5) increased similar to the other sites after rain in mid-September. However, all the sites decreased over time except for site 5, requiring further analysis.

The confirmations of improvements to the River Loop are not possible without a series of analytical parameters being monitored over a length of time. The analysis of the water quality parameters will be required over the term of these recommendations or until the water quality

goals have been achieved. It is recommended that the contractor responsible for the Watershed Protection Plan development be considered to conduct an analysis of the collected water quality data and results of the dye study. This will ensure a comprehensive understanding of the flow directions, volumes, and applied best management practices and how they can impact water quality in this reach of the river. Long term funding for monitoring is recommended. The San Antonio River Authority will investigate the possibility of adding the River Loop monitoring to future Clean Rivers Program contracts. The Clean Rivers Program is funded by the State of Texas and is a statewide water quality initiative. The goal of the Texas Clean Rivers Program is to maintain and improve the quality of surface water within each river basin by monitoring water quality and educating the public. The program is administered at the State level by the TCEQ.

It should be noted that in September 1996, the San Antonio River Authority evaluated the River Loop water quality and prepared a technical memorandum covering the results. This report consisted of limited water quality testing data, but may be beneficial in trending the water quality of the river loop over an extended period of time.

iv. San Antonio River Tunnel Recirculation Flow

The Public Works Department has been working in coordination with the Parks and Recreation Department to supply the San Antonio River with additional water that is available through the San Antonio River Flood Control Tunnel recirculation feature. This additional flow is provided to the main channel of the river. Water is pumped from the downstream section of the river near Lone Star street, through the tunnel, and discharged just upstream of Josephine Street. This allows supplemental flow into the river during drought conditions. The benefit of this increased flow is realized most in the main channel however some benefit to the River Loop is believed to be occurring. The water flow evaluation as described in item III.A.ii. will quantify the impact to the River Loop from the recirculation feature of the flood control tunnel.



v. Sanitary Sewer Evaluation and Repair

The sanitary sewer collection system in San Antonio originated in the area of the river loop in the 1880s. Although numerous improvements and replacements have occurred over the years, failures in the sanitary system could represent a potential source of bacteria to the river loop. Failures in a sanitary sewer system include pipe breaks, joint separations or overflows. The San Antonio Water System (SAWS) operates the collection system in the majority of the Bexar County region and is the exclusive sanitary system operator in the river loop area.

SAWS inspects and cleans pipelines in the area using a variety of preventative maintenance methods in addition to providing emergency response on a 24/7 basis. All identified system failures are addressed with a localized “point” repair or scheduled for major pipeline replacement. SAWS operates on a daily basis with best management practices outlined in the WPP.

An inspection of their pipe system using non-invasive televising system in the Central Business District is a proactive option to evaluate the integrity of the system. In addition, as the City reconstructs streets or undergoes major renovations in the downtown area such as the proposed Main Plaza Project, consideration to upgrade aging infrastructure should be evaluated. Funding

for such activities would have to be identified and appropriated by the San Antonio Water System.

B. Short term improvement recommendations (6 months to 2 years)

The committee unanimously agrees that the following improvements will make significant progress toward meeting some, if not all, of the committee's water quality goals and the committee recommends moving forward with the short term improvements. The quality of the river will need to be evaluated over a seasonal cycle to determine how close these enhancements will come to meeting the goals.

i. River Walk Sidewalk Cleaning Practices

Downtown Operations has held one workshop for owners/operators to provide information regarding sidewalk cleaning practices along the River Walk and Central Business District. The first workshop was on October 25, 2006 and explained the rules and regulations on power washing sidewalks. The City, along with the Paseo Del Rio Association and the Downtown Alliance, invited vendors to demonstrate different types of equipment for power washing sidewalks and how to collect contaminated water by reclaiming and disposing of properly. A copy of the flyer announcing the initial training is provided in Appendix C.

The City is scheduling additional workshops throughout December 2006 for the River Walk restaurant operators. The Downtown Operations Department will continue to work with the Paseo Del Rio Association, Downtown Alliance and other identified stakeholders to provide best practices methods for cleaning of sidewalks along the River Walk.

ii. River Walk Equipment Purchases

The Downtown Operations Department River Operations staff will start power washing and reclaiming with one new system on January 10, 2007. The City is currently mounting equipment on the maintenance barge and training Equipment Operators on proper use of power washing equipment. Two additional systems will be purchased in fiscal year 06/07. The San Antonio Water System has committed to purchase two power washers with water recovery systems for sidewalk cleaning activities. The Downtown Operations Department and the Downtown Alliance will each be issued one of these power washing systems. River Operations will have a total of four power washers with reclaim systems cleaning sidewalks and stairways along the San Antonio River Walk.

iii. Control of Wildlife on River Walk

The Parks and Recreation Department has contacted Texas Parks and Wildlife Department (TPWD) concerning urban wildlife issues and asked for recommendations on controlling roosting birds, bats and the migratory grackle population. Staff is currently working with the TPWD's local urban biologist to plug the Houston Street Bridge, which is currently occupied by a colony of Mexican free tail bats. The bats migrate back to Mexico in late November each year. Once the bats migrate, the TPWD will visually inspect that all bats are gone and the plugging operation can begin. It is anticipated that the Houston Street plugging activities will be completed in December 2006. The Downtown Operations Department has scheduled a final visual inspection with the Texas Parks and Wildlife on December 8, 2006 to confirm that the bat colony has migrated for the winter from Houston Street Bridge. The Texas Parks and Wildlife will then authorize approval to the City to start with the bat proofing of the bridge. Downtown

Operations has already issued a purchase order for \$2,800 to the vendor for the work to be done under the Houston Street Bridge. This work is scheduled to begin on December 12, 2006 and is estimated to take one week to complete.

The City has explored ways to prevent herons from roosting, as well as address the grackle population along the River Loop. Downtown Operations has contacted Ronin Air Falconry who has submitted a proposal for “Environmental Grackle Abatement Survey Impact Report” to include a falcon demonstration, a possible strategy for grackle control. The cost of survey will be \$834.00. Once the survey report is submitted, Downtown Operations will present the findings to the River Walk Water Quality Work Group.

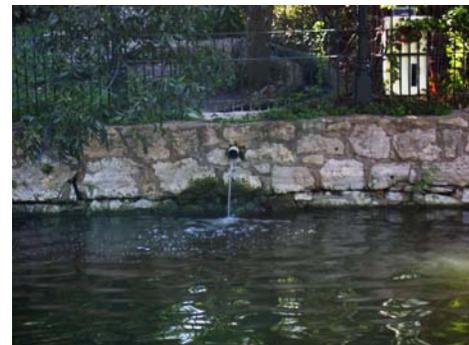
iv. Educate Downtown Stakeholders

The San Antonio River Authority has been selected to receive an EPA 319 grant in the amount of \$192,276. (The total project cost of the work effort is \$320,460; of which 60% of the total cost is funded by the 319 grant). The 319 grant is intended to provide funding for an education and awareness program that will target River Loop business and their patrons and enlist their support for improving water quality and clarity. Once grant funding is received, SARA will develop and implement a series of collaborative workshops where City of San Antonio, Bexar County, San Antonio Water Systems, and San Antonio River Authority staff will work in partnership with members of the Paseo Del Rio Association, Downtown Alliance, Hotel Motel Association, and the Tourism Council to identify problem areas, recommend solutions, and develop Best Management Practices including a public awareness/public education campaign. The first phase of public awareness/education campaign will provide outreach to River Walk restaurant and business owner’s, seek their assistance identifying business practices and patron activities that degrade water quality, and will educate them on operational changes that can improve water quality.

The second phase of the public awareness / education campaign will enlist the support and cooperation of the River Walk restaurant and business owners and their staffs in the development and promotion of an awareness program that will encourage patrons to help in the elimination of feeding birds, fish or squirrels and will inform the public about the problems discarded food products can create along the River Walk.

v. Illicit Connection Inspection

There are a multitude of pipes that discharge flows to the river, and many discharge below the river water surface. These flows are in compliance with the City’s Texas Pollutant Elimination System Permit if they are groundwater infiltration drainage from underground basements, or condensate from air conditioning systems. However, the integrity and quality of these discharges must be evaluated.



Monitoring of these pipelines is conducted to the maximum extent possible with the time available during the annual cleaning of the River Loop. During the upcoming annual cleaning of the River Loop scheduled for January 2007, a complete sampling, analysis and televising of all pipe discharges into the river channel should be performed. This may require additional time for the river to be in the drained condition. Any discharge that is providing unacceptable bacteriological or chemical

loadings can be identified and effectively addressed. Any unacceptable discharge will be terminated or rerouted to the sanitary sewer system.

Prior to the extensive analysis of ancillary flows to the River Loop, the following activities could be undertaken to begin monitoring each contribution and take necessary action to eliminate illicit connections.

1. Use an underground camera to map all the downtown storm drain pipes. This will show not only the location of the inlets that drain into the river but may identify if there are any illicit connections to the system.
2. Research available data to see what businesses potentially have a drain connection to the River Loop area and then inspect the businesses to ensure allowable discharges.
3. Walk the river, locate all visible drain pipes and track back to origin to ensure only allowable discharges.

vi. Compliance Program in Support of the City's EPA Clean Water Program Permit

The City of San Antonio Public Works Department and the San Antonio Water System actively enforce against entities who continue to use practices that contribute contaminants to the River Loop. Waste disposal practices or washing procedures that result in additional loadings to the river, either directly or through rainfall, transporting contaminants into the river will be addressed. It is the intent of the City to encourage compliance with all regulations and allow violators the opportunity to install best management practices to correct illicit discharges. However the City's Texas Pollutant Discharge Elimination System Permit (TPDES) requires the elimination of illicit discharges as expeditiously as possible and the immediate ending of improper disposal practices upon identification of responsible parties. Where elimination of an illicit discharge within 30 days is not possible, the responsible party is required to provide a schedule for removal of the discharge. Penalties can be imposed for non-compliance in accordance with the EPA's Clean Water Act, the Texas Water Act and City Code.

Chapter 26 - Pollution Control, Article VI – Water Quality Control and Pollution Prevention; Division 5 Prohibitive Discharges provides information as it relates to compliance of discharges to the municipal separate storm sewer system (MS4). The San Antonio River and the River Loop are considered a component of the MS4. Section 34-708 through Section 34-710 identify criminal, civil and additional enforcement remedies applicable to this issue and are as follows:

Sec. 34-708. Criminal Penalty

- a. A conviction for violation of this division shall constitute a class C misdemeanor. A person convicted of a violation of this division shall be fined a minimum amount of not less than two hundred dollars (\$200.00) per violation and a maximum amount of not more than two thousand dollars (\$2,000.00) per violation. Each violation of a particular section of this division shall constitute a separate offense, and each day an offense continues shall be considered a new violation for purposes of enforcing this division. A culpable mental state is not required to prove an offense under this ordinance.
- b. The President/CEO of SAWS is hereby authorized to designate qualified SAWS personnel to serve notices of violations of this section and to take all necessary actions to file a complaint.

(Ord. No. 80574, § 16, 8-4-94)

Sec. 34-709. Civil penalty

A civil penalty in an amount not to exceed five thousand dollars (\$5,000.00) per violation of this division may be imposed. Each violation of a particular section of this division shall constitute a separate offense, and each day such an offense continues shall be considered a new violation for purposes of enforcing this division.

(Ord. No. 80574, § 16, 8-4-94)

Sec. 34-710. Additional enforcement remedies.

- a. In addition to any other remedies provided by this division, the City of San Antonio and SAWS may, at any time, seek legal and/or equitable remedies or may file charges against any person, corporation, or other entity believed to be in violation of this division. In furtherance thereof, the SAWS legal department is hereby authorized and instructed to commence any action, in law or in equity, including the filing of charges for the purpose of enforcing this division.
- b. The use of negotiated civil settlements or other methods of alternative dispute resolution to reach a civil settlement is hereby authorized; provided that the civil penalty imposed by any such agreement or settlement is of a sufficient amount in relation to the violations to which they provide a sanction.

(Ord. No. 80574, § 16, 8-4-94)

vii. Proposed Watershed Protection Plan

As identified at the beginning of this report, the Bexar Regional Watershed Management Program, a partnership between Bexar County, The City of San Antonio, the San Antonio River Authority and twenty suburban cities, is finalizing a Watershed Protection Plan to address the anticipated TCEQ Bacteriological TMDL study. It is anticipated that the WPP will propose improvements to be implemented at the San Antonio Zoo which will have a significant impact on the bacterial level in the main channel. Once this improvement is on line, increased recirculation options from the main channel into the River Loop may help improve water quality in the segment.



The WPP is anticipated to recommend that the most cost effective BMP for reducing bacteria loads to the San Antonio River would be to disinfect the dry weather flow leaving the zoo. The discharge from the zoo is the primary cause of impairment from Brackenridge Park through the downtown area. A 95% or greater reduction in the bacteria load from the zoo could be most efficiently achieved through the utilization of disinfection treatment facilities. The report is expected to recommend an ultraviolet (UV) disinfection process be installed at the zoo's primary outfall.

It is highly probable that the existing improvements and short-term improvement recommendations will result in achievement of the water quality goals. If, however, quality problems remain, the long-term improvements can be used to provide additional engineered improvements.

C. Long term improvement recommendations (2 years and beyond)

The following list of improvement actions will require detail engineering and planning for implementation. Funding for construction and operation of the listed improvements will also need to be considered.

i. Improve Recirculation within the River Loop

The Committee believes that if increased recirculation within the River Loop is provided, water quality and perhaps water clarity will improve. However prior to initiating additional recirculation over the increased flow provided by the introduction of the SAWS reuse water, it must be determined what an acceptable flow is. It is widely agreed that it would be beneficial if the River Loop acted like a river again which would provide sediment transport versus a stagnant body of water. Once an acceptable flow has been set, there are potentially interim actions that can be taken to achieve this, such as temporary pipes and pumps placed in strategic locations.

It should be noted that until bacteriological water quality improvements are made both in the River Loop and in the main channel, the impact of increased recirculation will only have an impact on water clarity. Since this improvement would increase the rate of water moving through the River Loop segment by directing water from the main channel into the loop segment or increasing the rate of circulation using existing River Loop water, the bacteriological water quality will not be affected until the source of the bacteria is reduced.

ii. Installation of Gate in the Main Channel near the Existing Gate 3

Using the additional flow provided in the main channel through the recirculation ability of the San Antonio River Tunnel, directing the flow through the loop segment is necessary. The installation of a gate on the main channel just downstream of the gate 3 opening is an option. The gate would periodically be used to divert the water. Operation of the gate could be planned to not impede the riverboat traffic. If submerged, the gate would only be raised to a height that would allow the boats to pass with ease during the daytime. Otherwise the gate would only be used at night when there is no riverboat traffic. This option would have to be evaluated and engineered to ensure flood conveyance would not be impacted. In addition, the United States Corps of Engineers would have to be consulted since this potentially has an impact to the existing flood control channel.

iii. Enhanced Flows

Several methods of enhancing flow exist:

- Additional recirculation through pumps between the main channel of the river
- Water wheels or water movement systems within the River Loop
- Additional outfall extensions of the recycled water system

To determine the most effective option, an engineering analysis including performance expectations and cost-benefit calculations will need to be performed. Any of these options will result in increases to operational costs for the responsible entity.

iv. Cleaning Systems

There are numerous systems that can be evaluated for providing a biological or mechanical treatment to the water in the river. Each system is unique and should be evaluated. Systems range from ecological technology using biological processes of plants and microbes to treat the water; natural inversion diffuser systems that would help circulate and oxygenate the water; or water treatment facilities.

An engineering analysis including performance expectations and cost-benefit calculations will need to be performed. Any of these cleaning system options will result in increases to operational costs for the responsible entity.

v. Dredge or Deepen Parts of the River Loop

The river in the loop section is approximately 4 to 5 feet deep and composed of a natural bottom channel. Much of the turbidity or cloudiness within the River Loop is the result of turbulence created by the barge traffic as it churns up the accumulated sediment. Plumes of fine silt can be seen behind the passing barges or around the barges as they maneuver through turns in the River Loop. Efforts have been made to relocate or remove silt with heavy equipment with limited results due to the difficulty of working in a silt bottom with limited access. The Parks and Recreation Department has explored options to address the silt accumulation problem. A preliminary estimate from a contractor of \$280,000 to remove the fluff (top layer of silt) from the river loop and river extension areas of the River Walk was obtained in 2005. This work could be accomplished with the river up and operational.

APPENDIX A

River Loop Water Quality Summary Tables*
(Rounded)

Site 1: San Antonio River approx. 30m upstream of River Loop Inlet										
	E. coli	BOD	Nitrate	Nitrite	TKN	Total P	Turbidity	Chl-a	TSS	VSS
Average	7,306									
Maximum	34,000									
Minimum	480									
Median	4,950									
Geo-Mean	3,657									

Site 2: River Loop by foot bridge at La Mansion										
	E. coli	BOD	Nitrate	Nitrite	TKN	Total P	Turbidity	Chl-a	TSS	VSS
Average	4,944									
Maximum	34,000									
Minimum	240									
Median	2,250									
Geo-Mean	2,112									

Site 3: River Loop near Presa Street bridge										
	E. coli	BOD	Nitrate	Nitrite	TKN	Total P	Turbidity	Chl-a	TSS	VSS
Average	2,804	<2	6.9	0.032	0.643	0.89	5.9	1.1	9.4	3.4
Maximum	17,000	<2	13.2	0.055	0.935	1.51	18.0	2.7	36.7	19.3
Minimum	12	<2	1.0	<0.02	0.236	0.16	2.2	<1	2.3	<1
Median	1,250	<2	7.1	0.026	0.647	0.87	4.7	<1	7.0	1.7
Geo-Mean	927									

Site 4: River Loop approx. 10m downstream (south) of Commerce Street bridge										
	E. coli	BOD	Nitrate	Nitrite	TKN	Total P	Turbidity	Chl-a	TSS	VSS
Average	4,588									
Maximum	44,000									
Minimum	260									
Median	970									
Geo-Mean	1,265									

Site 5: River Loop extension at sidewalk projection approx. 10m upstream of waterfalls										
	E. coli	BOD	Nitrate	Nitrite	TKN	Total P	Turbidity	Chl-a	TSS	VSS
Average	530	<2	19.1	0.047	1.19	2.61	2.4	2.1	7.3	2.1
Maximum	14,000	<2	20.7	0.219	3.86	3.09	5.3	5.4	25.3	6.3
Minimum	82	<2	16.7	<0.02	0.73	2.31	1.4	<1	2.7	1.0
Median	320	<2	19.1	0.02	1.00	2.61	2.1	1.0	6.3	1.7
Geo-Mean	362									

Site 6: River Loop extension under Convention Center bridge										
	E. coli	BOD	Nitrate	Nitrite	TKN	Total P	Turbidity	Chl-a	TSS	VSS
Average	2,543									
Maximum	25,000									
Minimum	120									
Median	340									
Geo-Mean	586									

Site 7: River Loop in front of Little Rhein Steak House sign										
	E. coli	BOD	Nitrate	Nitrite	TKN	Total P	Turbidity	Chl-a	TSS	VSS
Average	4,018	<2	13.3	0.036	0.90	1.85	4.6	1.5	8.8	2.1
Maximum	33,000	3	19.2	0.078	1.50	2.80	13.0	2.8	22.0	5.7
Minimum	590	<2	7	0.024	0.57	1.00	1.5	<1	3.0	<1
Median	1,450	<2	13.6	0.032	0.84	1.85	3.7	1.3	8.3	2.0
Geo-Mean	1,863									

Site 8: River Loop between Navarro and Presa Streets (south part of Loop)										
	E. coli	BOD	Nitrate	Nitrite	TKN	Total P	Turbidity	Chl-a	TSS	VSS
Average	2,666									
Maximum	15,000									
Minimum	480									
Median	1,350									
Geo-Mean	1,586									

Site 9: San Antonio River approx. 70m upstream of Nueva Street downstream of River Loop										
	E. coli	BOD	Nitrate	Nitrite	TKN	Total P	Turbidity	Chl-a	TSS	VSS
Average	7,956									
Maximum	53,000									
Minimum	240									
Median	3,550									
Geo-Mean	2,789									

Site 10: San Antonio River – Reference Site at Witte Museum										
	E. coli	BOD	Nitrate	Nitrite	TKN	Total P	Turbidity	Chl-a	TSS	VSS
Average	250	<2	20.87	<0.023	0.76	2.62	1.7	<1	4.5	1.7
Maximum	540	<2	22.10	0.027	1.10	2.89	2.4	<1	5.3	2.0
Minimum	120	<2	20.10	<0.020	0.096	2.34	1	<1	3.0	<1
Median	170	<2	20.86	<0.025	0.91	2.63	1.8	<1	4.8	1.9
Geo-Mean	207									

* August 3, 2006 - November 2, 2006

APPENDIX B

River Loop 24-Hour Water Quality Data*
(Rounded)

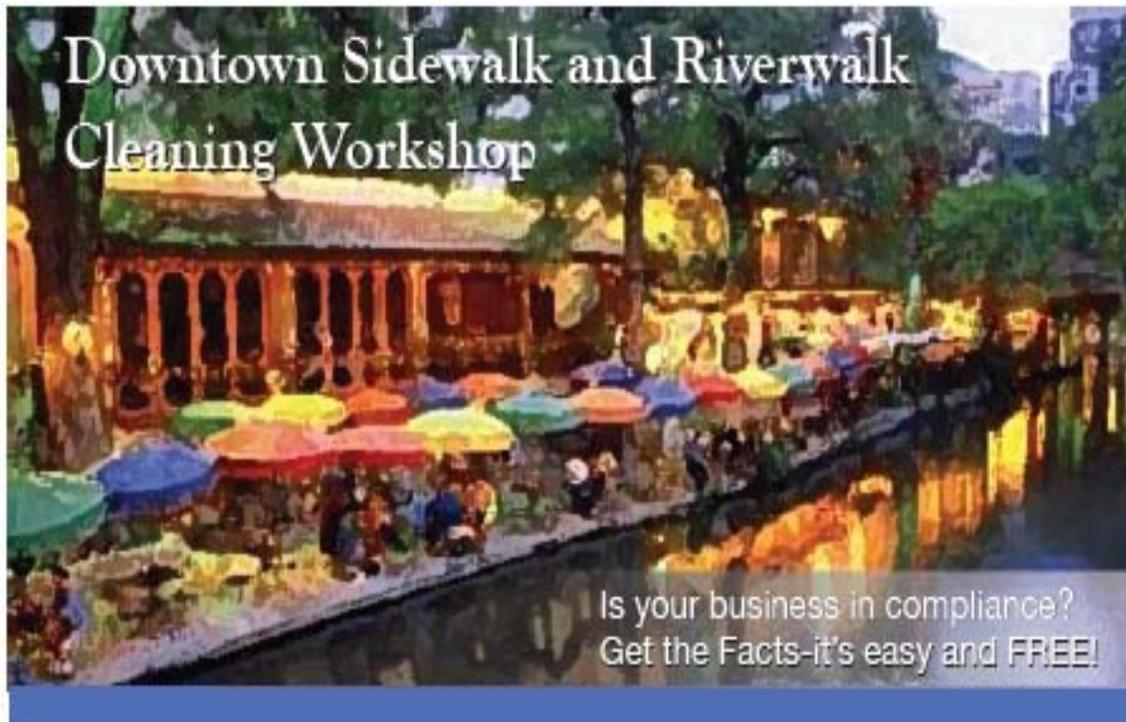
Site 3: River Loop near Presa Street bridge (Aug. 9 to 24, 2006)				
	D. O.	Temperature	pH	Conductivity
Minimum	4.2	27.4	7.3	534
Maximum	7.7	29.0	7.9	974
Average	6.5	28.1	7.6	767

Site 3: River Loop near Presa Street bridge (Aug. 24 to Sept. 9, 2006)				
	D. O.	Temperature	pH	Conductivity
Minimum	0.4	25.1	7.1	489
Maximum	7.2	29.2	7.8	993
Average	2.0	27.4	7.5	801

Site 5: River Loop extension at sidewalk projection approx. 10m upstream of waterfalls (Aug. 9 to 24, 2006)				
	D. O.	Temperature	pH	Conductivity
Minimum	2.4	30.1	7.1	1,036
Maximum	7.7	32.0	7.2	1,187
Average	5.7	31.2	7.2	1,132

Site 5: River Loop extension at sidewalk projection approx. 10m upstream of waterfalls (Aug. 24 to Sept. 9, 2006)				
	D. O.	Temperature	pH	Conductivity
Minimum	3.7	28.1	7.1	794
Maximum	7.8	32.1	7.3	1,171
Average	6.5	30.1	7.2	1,077

*Collected every 15 minutes



Date: Wednesday, October 25, 2006
Location: International Center
203 S. St. Mary's, 3rd floor
San Antonio, Texas 78205
Time: 1:30 - 4:30 pm
Cost: FREE

This educational workshop is designed for anyone who does any type of any downtown sidewalk and riverwalk cleaning including: hospitals, schools and restaurants.

The FREE Workshop Will Include

- Best Management Practices
- Environmental Mobile Power-Washing rules and procedures
- Compliance with City and State Ordinances
- Guidelines for washing down sidewalks
- Q & A

This is the first of a series of downtown presentations that the City of San Antonio will be providing.

Officials from the City of San Antonio Downtown Operations Department, Parks & Recreations, Public Works, Metropolitan Health, and the San Antonio Water System will be there as well to field any questions that you may have. Save money and trouble by avoiding the common mistakes that can cost YOU!



To reserve your spot, please RSVP to
Sonia Veliz at 210-207-8482 or sonia.veliz@sanantonio.gov.
Walk-ins are welcome.



Additional dates will be provided for future downtown sidewalk and riverwalk cleaning workshops.