Greater Edwards Aquifer Alliance

Member Organizations

Alamo, Austin, and Lone Star chapters of the Sierra Club
Aquifer Guardians in Urban Areas
Bexar Audubon Society
Bexar Green Party
Boerne Together
Cibolo Nature Center
Citizens Allied for Smart Expansion
Citizens for the Protection of Cibolo Creek
Environment Texas
First Universalist Unitarian Church of San Antonio
Friends of Canyon Lake
Friends of Dry Comal Creek
Friends of Government Canyon
Fuerza Unida
Green Party of Austin
Headwaters at Incarnate Word
Hays Community Action Network
Helotes Heritage Association
Helotes Nature Center
Hill Country Planning Association
Green Society of UTSA
Guadalupe River Road Alliance
Guardians of Lick Creek
Kendall County Well Owners Association
Kinney County Ground Zero
Leon Springs Business Association
Medina County Environmental Action Association
Native Plant Society of Texas – SA
Northwest Interstate Coalition of Neighborhoods
Preserve Castroville
Preserve Lake Dunlop Association
San Antonio Audubon Society
San Antonio Conservation Society
San Geronimo Nature Center
San Geronimo Valley Alliance
San Marcos Greenbelt Alliance
San Marcos River Foundation
Save Barton Creek Association
Save Our Springs Alliance
Scenic Loop/Boerne Stage Alliance
Securing a Future Environment
SEED Coalition
Solar San Antonio
Sisters of the Divine Providence
Travis County Green Party
West Texas Springs Alliance
Water Aid – Texas State University
Wildlife Rescue & Rehabilitation
Wimberley Valley Watershed Association

PO Box 15618
San Antonio, Texas 78212
(210) 320-6294

October 27, 2017

Ms. Macy Beauchamp
Texas Commission on Environmental Quality (TCEQ)
Program Support Section, MC 174
P.O. Box 13087
Austin, TX 78711-3087
macy.beauchamp@tceq.texas.gov

RE: Edwards Aquifer Protection Program 2017 Comments

Dear Ms. Beauchamp:

The following comments are submitted on behalf of the member organizations of the Greater Edwards Aquifer Alliance (GEAA), all of which are united behind a comprehensive plan to protect the Edwards Aquifer, its springs and watersheds, and the Texas Hill Country. The memberships of these organizations represent a large segment of the population that relies on the Edwards Aquifer for their potable water supply, and a broad consensus on how to best protect the aquifer.

We first ask that each member group of our Alliance, all of which have endorsed these recommendations, be listed individually as submitting these comments. Please do not list them collectively as the Greater Edwards Aquifer Alliance. Provided here is a list of the member groups that belong to GEAA for inclusion as supporting these comments.

TCEQ has made improvements to the EAPP over time. However, the last substantive improvements to the Edwards Rules were adopted in 2005 (TCEQ Rule Project 2003-029-213-PR). While the EAPP website displays public comments from the year 2013 EAPP public review process, comments are not available via the web from the 2015 process such that interested stakeholders may not be aware of other concerns or opportunities for collaboration on improving the EAPP.

We respectfully request that TCEQ conduct a stakeholder process to review current science and discuss potential EAPP rule and guidance document modifications in a collaborative setting. Such a conversation would not only provide an opportunity for stakeholders to efficiently coordinate and reduce duplication of efforts, but also provide TCEQ with the best available information to inform EAPP improvements. The City believes that such a stakeholder process is consistent with the TCEQ philosophy to base decisions on sound science, ensure regulations are effective and current, and ensure meaningful public participation in the decision-making process.

Additional, specific comments on the Edwards Rules are attached for your consideration, including recommendations submitted in 2005 and subsequent years. Also included is a 1997 paper "Protecting the Edwards Aquifer, A Scientific Consensus," which was endorsed by 39 scientists, engineers, and planners. We ask that you consider and act on this scientific consensus, and the recommended measures embodied therein, as you go about amending the Edwards Rules. Thank you for your consideration of these comments. If you have any questions, please contact me at your convenience at 210-320-6294 or Annalisa@AquiferAlliance.org.

Sincerely,

Annalisa Peace, Executive Director

Improving and Facilitating use of Sustainable Development Stormwater Structural Control Measures within the Edwards Aquifer Recharge Zone

Stormwater management engineering best practices and scientific knowledge about regulated activities with the potential to pollute the Edwards Aquifer and hydrologically connected surface streams have advanced in recent years. For example, GEAA is very interested in discussing EAPP guidance regarding media composition and liner requirements for certain types of stormwater structural control measures We have been awarded a grant for a stormwater retrofit and research project from the City of San Antonio's Proposition 1 Edwards Aquifer Protection Projects within the Urbanized Areas of Bexar Counties Recharge and Contributing Zone Program. Included in our funding agreement is pre and post construction stormwater monitoring data that will, we hope, be useful to this discussion.

Some specific improvements to the Texas Commission on Environmental Quality (TCEQ) Edwards Aquifer Protection Program (EAPP) and 30 Texas Administrative Code Chapter 213 (Edwards Rules) and associated guidance documents that would improve the level of protection provided to the aquifer include the following:

1. Technical guidance documentation for stormwater structural control measures (SCM) should be reviewed and updated to reflect current engineering science. Design criteria for some SCM may be out dated. For example, TCEQ EAPP biofiltration media requirements include 20% compost, which City of Austin analysis has demonstrated may result in unintended nutrient export comprising the effectiveness of the SCM. Clarification of guidance documents regarding infiltration for certain SCM is also needed for consistency, and could occur in an administrative manner not requiring a rule revision. Additionally, liner requirements for infiltration SCM for some land uses less likely to generate highly contaminated runoff should be reviewed using the best available data to determine if regulatory requirements may be simplified such that additional recharge to the aquifer may be achieved without degrading the quality of recharge by an unacceptable amount.

    a. Performance comparison of stormwater biofiltration designs https://repositories.tdl.org/twdl-ir/handle/2152/10905
    b. Evaluation of potential for water quality impacts from unlined stormwater basins in the Barton Springs Recharge Zone http://www.austintexas.gov/watershed_protection/publications/document.cfm?id=240241

2. The stormwater best management practice performance standard should be reviewed relative to the stated purpose of 30 TAC 213.1 to protect the Edwards Aquifer using the latest engineering and hydrogeologic data. Substantial information on stormwater structural control measure performance has been generated by multiple entities including the City of Austin (see below for examples). Water quality temporal trend analysis for Edwards Aquifer spring, well and hydrologically-connected surface water resources has been generated by multiple entities (see below for examples), and indicates degradation over time for some constituents in Barton Springs. The 80% total suspended solids removal standard of the Edwards Rules remains the benchmark used for assessing compliance for critical infrastructure projects like State Highway 45 Southwest. TCEQ, in a collaborative stakeholder process, should compile and review the latest available stormwater structural control measure performance information in comparison to water quality

data from Edwards Aquifer springs, wells, and hydrologically-connected surface streams to ensure that existing regulations are effective in protecting the Edwards Aquifer.

a. Stormwater Control Measures in Austin, TX: Data Report http://www.austintexas.gov/watershed_protection/publications/document.cfm?id=202219
b. Impacts of Stormwater Control Measures on Water Quality in Austin, TX http://www.austintexas.gov/watershed_protection/publications/document.cfm?id=202218
c. Stormwater Control Measure Bypass Pollutant Concentrations Based On Storm Runoff Concentrations http://www.austintexas.gov/watershed_protection/publications/document.cfm?id=214826
d. Analysis of Water Quality Trends at Barton Springs and surrounding springs in Austin, TX (1995-2015) and an Alternative Framework for Future Analysis http://www.austintexas.gov/watershed_protection/publications/document.cfm?id=263435
e. An Examination of Stormwater Quality and Quantity in Austin Area Creeks http://www.austintexas.gov/watershed_protection/publications/document.cfm?id=283712

Permitting Texas Pollutant Discharge Elimination System (TPDES) should be prohibited in the Contributing Zone of the Edwards Aquifer.

Disposal of wastewater is one of the greatest threats to maintaining water quality in the contributing watersheds to the Edwards Aquifer. Current rules only prevent wastewater discharge within the Recharge Zone. Discharges in the Contributing Zone, even in compliance with current rule, would significantly alter the quality of these oligotrophic surface waters and degrade the aquifer, as demonstrated by recent analysis of a proposed discharge permit to Onion Creek. The quality of water in the Contributing Zone directly impacts the quality of discrete recharge in the Recharge Zone. Direct discharge of wastewater should be prohibited not only within the Recharge Zone, but also within the Contributing Zone of the San Antonio and Barton Springs segments of the Edwards Aquifer. Existing discharge permit procedures should be re-evaluated relative to 2006 U.S. Fish and Wildlife Service recommendations.

f. Recommended water quality for federally listed species in Texas https://www.fws.gov/southwest/es/Documents/R2ES/Recommended_Water_Quality_for_Federally_Listed_Species_in_Texas.pdf
g. Recent (2008–10) Concentrations and Isotopic Compositions of Nitrate and Concentrations of Wastewater Compounds in the Barton Springs Zone, South-Central Texas, and their Potential Relation to Urban Development in the Contributing Zone https://pubs.usgs.gov/sir/2011/5018/
h. WASP Model Analysis of a City of Dripping Springs Proposed Wastewater Treatment Plant Discharge to Onion Creek http://www.austintexas.gov/watershed_protection/publications/document.cfm?id=254063
i. An Analytic Water Quality Model of Onion Creek examining Impacts from a Proposed Wastewater Point Source Discharge http://www.austintexas.gov/watershed_protection/publications/document.cfm?id=266618

GEAA recommends that TCEQ should revise Section 213.6 regarding Wastewater Treatment and Disposal Systems, to prohibit TPDES permits from being approved within the Contributing Zone of the Edwards Aquifer.

We believe that direct discharge of wastewater into waterways on the contributing zone is a growing problem that needs to be urgently addressed. Effluent discharges pose a risk to human health by introducing anthropogenic pharmaceuticals and other unmonitored chemicals into potable water supplies. Sensitive surface waters within the Contributing Zone cannot withstand the reductions in dissolved oxygen and increases in algae producing constituents that are caused by effluent discharge.

j. Emerging contaminants: Current rules for the contributing zone do set minimum levels of effluent treatment for pollution control. However, anthropogenic contaminants only found in sewage effluent, such as unmetabolized pharmaceuticals and personal care products, are not regulated. The effects of allowing these contaminants to accumulate in groundwater which will be used for drinking water are unknown, and potentially dangerous. Many private well owners, local water supply companies, including San Antonio Water Systems that serves the entire City of San Antonio, do not pretreat Edwards Aquifer water prior to distribution and consumption.

k. Rapid, dense residential development over the contributing zone: Three counties in the contributing zone, Comal, Hays, and Kendall, are among the ten fastest growing counties in the USA. Developers are building dense subdivisions and applying for TPDES permits. The growing number of wastewater treatment plants discharging directly into waterways on the Contributing Zone is cause for great concern.

l. We do not, likewise, support a ban of Texas Land Application Permits (TLAP) as a requirement on the Edwards Aquifer Contributing Zone and consider this the safer option for managing wastewater within the Contributing Zone.

Please post comments on the EAPP received during the public comment process on the website, and provide an estimate of when Edwards Rules will be updated.

The EAPP website (https://www.tceq.texas.gov/permitting/eapp) contains public comments from 2013, but not for later years. It would benefit all interested entities to understand what other opportunities exist for collaboration among other stakeholders interested in improving the EAPP. TCEQ responses to some 2013 comments indicate that "(t)he TCEQ EAPP will consider these items in the next rule revision project." It would benefit stakeholders to have a clear understanding of the timeline for the next Edwards Rules update, since substantive revisions to the Edwards Rules have not occurred since 2005.

Please review existing staffing EAPP staffing levels to ensure sufficient staff are available to effectively achieve the stated purpose of the Edwards Rules. Water Pollution Abatement Plans are not consistently verified with proactive inspections in the field, and inspections occur only in response to complaints. However, greenfield developments may occur in areas not visible or accessible to the public, such that no complaints may be generated.

We also ask that TCEQ provide adequate funding for trained and experienced staff, and that monitoring and enforcement of the Edwards rules, where appropriate, be delegated to local agencies that are better equipped to handle these duties.

We are aware that TCEQ staff is under special pressure to process Water Pollution Abatement Plans for approval within 60 days rather than the 90 day period provided for in the Edwards Rules. If anything, the rules should increase the 90 day period to provide for more comprehensive review of WPAPs.

Provide Additional Protection for the Edwards Aquifer Contributing Zone

GEAA urges TCEQ to adopt rules for the Edwards Aquifer Contributing Zone. According to recent studies[1] "Currently, Texas Commission on Environmental Quality (TCEQ) regulations on the Edwards Aquifer Contributing Zone are limited, especially when compared with those for the Edwards Aquifer Recharge Zone. The rules are predicated on the premise that no water from the Contributing Zone directly recharges the Edwards Aquifer and that the role of the Contributing Zone is solely to convey surface water to the Edwards Aquifer Recharge Zone where it can then enter the subsurface.

In reality, the Edwards Aquifer is significantly recharged by water infiltrating the Contributing Zone. This infiltrated water is then conveyed to the Edwards Aquifer from the Trinity Aquifer by interformational flow. Recent studies support the supposition that hydraulic communication between the upper Glen Rose Aquifer (i.e., the upper most unit of the Trinity Aquifer) and the Edwards Aquifer is greater than previously believed. Because of this high level of hydraulic communication, the distinction between the Contributing Zone and the Recharge Zone of the Edwards Aquifer is not great, and in many localities, the Edwards Aquifer Contributing Zone effectively acts to recharge the Edwards Aquifer in a fashion indistinguishable to the Edwards Aquifer Recharge Zone."

Comments submitted by GEAA in 2010

As detailed in our 2005 comments and supported by the Scientific Consensus paper, our recommendations include requiring adequate buffer zones to protect streams, springs and recharge features, limits to impervious cover on the Edwards Recharge and Contributing zones, expanding the pollution reduction standards to include toxic metals, organic chemicals and nutrients, and other measures and strategies that we believe will be adequately protective of our water quality.

The Optional Water Quality Measures (appendices A and B of RG-348, EAPP Technical Guidance Manual) are not adequate to protect Endangered Species and allow unnecessary pollution of the Edwards Aquifer. The optional measures, among other deficiencies, fail to limit impervious cover, only monitor for one constituent (Total Suspended Solids), allow for increases in pollutant loads from developed properties, and allow for sealing of sensitive recharge features rather than preservation and setbacks.

There is widespread scientific consensus that limiting impervious cover in both the recharge and contributing zones is necessary to maintain water quality in the Edwards Aquifer.[2] Scientists agree that engineered controls, even when perfectly maintained, cannot replace impervious cover limits. TCEQ should recognize this sound

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[1] Interconnection of the Trinity (Glen Rose) and Edwards Aquifers along the Balcones Fault Zone and Related Topics Karst Conservation Initiative, February 17, 2011, Meeting Proceedings - Austin, Texas, July

2011http://www.bseacd.org/uploads/AquiferScience/Proceedings_Edwards_Trinity_final.pdf

[2] See *Protecting the Edwards Aquifer: A Scientific Consensus*, signed by 39 scientists, planners, and engineers in 1997, also available at http://www.aquiferalliance.org.

science by implementing impervious cover limits of no more than 10% in the recharge zone and 15% in the contributing zone.

Where engineered water quality controls are used these should be inspected frequently with significant fines assessed for malfunctioning facilities. In general, the penalties for violations of the Edwards Rules seem low in relation to the severity of the violations and should be increased to act as a preventative deterrent.

We have seen frequent examples of inadequate erosion and sedimentation construction controls causing significant pollution events. Off-channel ponds, rock gabions in addition to silt fences, and appropriately limited phasing of clearing and grading all need to be required and strictly enforced to protect the aquifer from construction runoff. Construction staging should also be minimized to allow for immediate revegetation and minimization of pollution risks. These requirements should all be strictly monitored and violations assessed significant penalties to act as a deterrent to non-compliance.

In addition to pollution from construction and urban runoff, sewage and wastewater effluent are among the primary pollutants of the Edwards Aquifer. Many of the sewage plants in the region use irrigation/land application for wastewater effluent disposal. The Edwards rules should be strengthened to include specific requirements for wastewater treatment, storage, and irrigation in the following ways:

- Increase storage required for subsurface irrigation systems to be equivalent to what is currently required for surface irrigation systems.
- Require effluent monitoring for total nitrogen and phosphorous
- Require automatic shut-off soil moisture monitoring using tensiometers
- Baseline sampling of adjacent creeks and quarterly sampling after rainfall during irrigation.
- Measure buffers from creek beds rather than stream center to ensure adequate creek protection as stream beds wash out from development.
- Adopt stricter standards for lift stations, similar to City of Austin standards.

There is widespread scientific consensus, and governmental support for, prohibiting wastewater discharges into the Edwards Aquifer in order to prevent degradation. TCEQ should amend the Edwards rules to prohibit any direct discharges of effluent in the Contributing and Transition Zones of the Edwards Aquifer.

TCEQ should also consider incorporating Edwards-specific rules for quarries and rock crushers in the Recharge and Contributing Zones. Where these facilities are located in Edwards Limestone, the underlying aquifer is particularly vulnerable to contamination, whether or not the quarry actually excavates to below the aquifer water level. Without more stringent TCEQ regulations, quarries and rock crushers will continue to degrade the aquifer and damage the health and water supply of adjacent communities.

Attached to this letter is a copy of our 2005 comments and the Scientific Consensus paper. The Greater Edwards Aquifer Alliance and the many groups who join us ask that you act now to adopt these recommendations into the TCEQ Edwards Rules.

Greater Edwards Aquifer Alliance

August 15, 2005

Ms. Kathleen Hartnett White, Chair
Mr. Ralph Marquez, Commissioner
Mr. Larry Soward, Commissioner
Texas Commission on Environmental Quality
P.O. Box 13087
Austin, TX 78711-3087

Re: **Edwards Aquifer Protection Rules**

Dear Chairman White and Commissioners,

This letter is in substitution for our earlier letter dated August 12, 2005. We signers of this letter represent an alliance of community organizations, environmental groups, planners, scientists, professional engineers, and elected representatives from across the Edwards Aquifer recharge and contributing watersheds. We are united in our demands that the Texas Commission on Environmental Quality (TCEQ) act immediately to implement a program to protect the Edwards Aquifer.

For more than 10 years TCEQ has ignored public requests for adequate Edwards Aquifer protection. Communities across the aquifer region have studied the scientific evidence of the threat of unchecked development to the quantity and quality of aquifer water and have responded by strengthening aquifer protections. Meanwhile TCEQ rules have remained stagnant and woefully inadequate.

Only TCEQ has authority to protect water quality across the entire Edwards Aquifer Region and beyond the regulatory jurisdiction of cities or individual aquifer authorities. While unmanaged development spreads unchecked across the Texas Hill Country, the consequences of TCEQ's failure are painfully evident. We watch as springs and wells run dry, or become contaminated with toxic metals, gasoline and other petroleum products, solvents, herbicides and pesticides.

Local experience as well as national and international scientific research on protecting sensitive water resources like the Edwards Aquifer clearly mandate certain minimum measures if the State of Texas and TCEQ are sincere in their commitment to protecting this aquifer. We demand that TCEQ's Edwards Aquifer protection program reflect sound science by incorporating, at a minimum, these provisions:

1. All development must be limited to no more than 10% impervious area within the Edwards Aquifer recharge zone.
2. All development must be limited to no more than 15% impervious area within the Edwards Aquifer contributing zone.
3. All development must preserve the soil and native vegetation within 300 feet of any known cave opening, karst solution features, springs, or wetland. The

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development must also preserve soil and native vegetation within 300 feet of a stream draining more than 100 acres.

4. The pollution reduction standard for storm runoff must be expanded beyond total suspended solids to reduce toxic metals, organic chemicals, and nutrients to safe or naturally occurring levels.
5. TCEQ must implement a meaningful enforcement program, including:
    - Engineering review of all subdivision and site plans, construction phase erosion and sediment control plans, and permanent storm runoff management and treatment designs.
    - Regular and timely construction inspections.
    - Operating permit requirements and bi-annual maintenance inspections for engineered water quality controls.
6. TCEQ must provide adequate funding for trained and experienced staff. Where local governments demonstrate equivalent or more protective standards and an adequate implementation and enforcement program, primary responsibility for implementing the TCEQ Edwards Aquifer protection program should be delegated. Delegation will reduce costs to both the applicant and the reviewing agencies by eliminating redundancies. TCEQ must, however, retain authority to require compliance with their rules where local jurisdictions fail to do so.

Please review the information we have included in the attachment to this letter and act immediately to provide these protections. Residents of the Texas Hill Country demand Edwards Aquifer protection so that it can continue to sustain our economy, the ecology, and the people of Central Texas for generations to come.

Sincerely,

Lauren Ross

Dr. Lauren Ross, Ph.D., P.E.
On behalf of Greater Edwards Aquifer Alliance

Aquifer Guardians in Urban Areas (AGUA)
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San Antonio, Texas 78212

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Christian Life Commission
Baptist General Convention of Texas
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Bastrop County Environmental Network
P.O. Box 1069
Bastrop, Texas 78602

Bexar Audubon Society
P.O. Box 6084
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Clean Water Action
715 West 23rd Street
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Esperanza Peace & Justice Center
922 San Pedro Avenue
San Antonio, Texas 78212

Government Canyon Natural History Association
12861 Galm Road
San Antonio, Texas 78254

Guardians of Lick Creek
23058 Pedernales Canyon Trail
Spicewood, Texas 78669

Hamilton Pool Road Scenic Corridor Coalition
9600 Crumley Ranch Road
Austin, Texas 78738

Hays Community Action Network
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Kendall County Well Owners Association
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Boerne, Texas 78006

Kinney County Ground Zero
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La Fuerza Unida
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San Antonio, Texas 78211

Lake Medina Conservation Society
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League of Women Voters of the San Antonio Area
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Medina County Environmental Action Association
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Neighbors for Neighbors
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Elgin, Texas 78621

Northwest Interstate Coalition of Neighborhoods
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Oblate School of Theology
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Pines and Prairies Land Trust
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Bastrop, Texas 78602

Progressive Students' Organization of UTSA
c/o Student Leadership & Cultural Programs
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San Antonio, Texas 78249

Public Citizen
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San Geronimo Watershed Alliance
Martha Leatherman, President
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Santuario Sisterfarm
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Save Barton Creek Association
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Save Our Springs Alliance
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Sierra Club, Lone Star Chapter
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Sierra Club, Alamo Group
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Sierra Club, Austin Regional Group
54 Chicon Street
Austin, Texas 78702

Sisters of the Divine Providence
515 Southwest 24th Street
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Smart Growth San Antonio
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Texas Public Interest Research Group
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West Texas Springs Alliance
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8438 Romney
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The Friendship Alliance, as a concerned coalition of Hays County Homeowners Associations and individual homeowners, is committed to the sustainable economic and natural health of the Hill Country. This commitment to its health is not only for our own benefit as residents, but for the benefit of the future generations who will reside here also. The absolute underpinning of this health for us, is a healthy Edwards Aquifer, which so happens to be degrading rapidly in its urban watersheds. Its clean, plentiful waters and our own economic well being are inextricably linked. Additionally, for the hundreds of thousands of us on Edwards wells, our actual physical health is at stake, not just our home values.

We agree with the GEAA in the importance and relevance of the science based requirements to protect the Edwards Aquifer and find their report not only telling, but supportive of our concerns. The evidence, both empirical and theoretical is in; our water supply is being both depleted and degraded and something must be done...now.

We would like to point out that a citizen and science based Regional Water Quality Protection Plan has been accepted by the relevant governmental subdivisions of Hays and Travis counties for the Barton segment of the Edwards Aquifer Recharge and Contributing Zones. We recommend the immediate adoption of the RWQPP measures in conjunction with and/or in place of the recommendations in the GEAA report depending on applicability to the area(s) in question. Like the Hill Country Alliance, we also would like to reinforce the importance of an adequate and stringent TCEQ enforcement program. The Friendship Alliance supports and applauds the GEAA's initiative in this endeavor.

Friendship Alliance
P.O. Box 225
Driftwood, Texas 78619

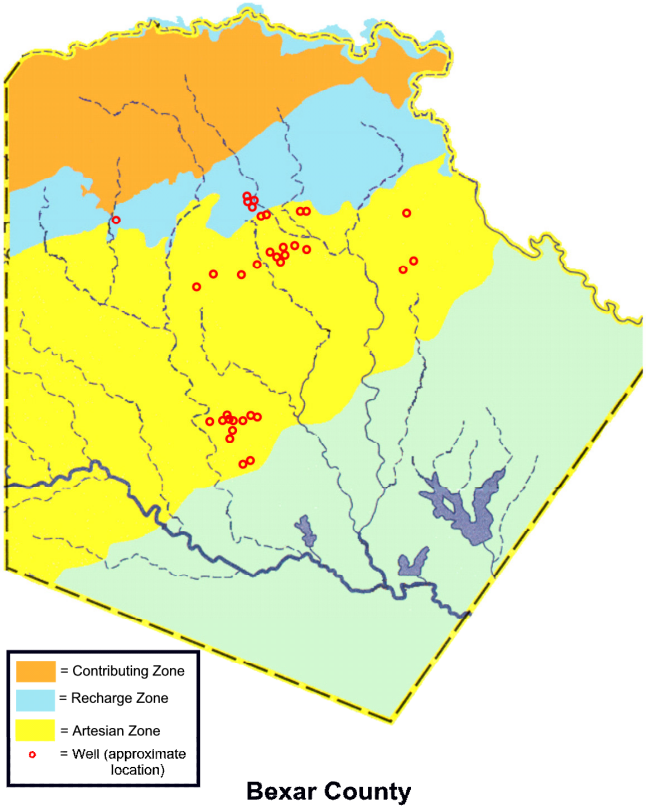
The Hill Country Alliance, an independent group of organizations and individuals committed to the sustainable health of the Hill Country, support the science in this letter. We agree with GEAA in the importance, relevance and immediacy of these measures to protect the Edwards Aquifer. Further, we recommend that TCEQ adopt the measures set forth in the Regional Water Quality Protection Plan in conjunction with GEAA's recommendations. While we recognize there is room for responsible planned growth in the Hill Country, it is time to direct growth away from the Hill Country's sensitive watersheds. We also would like to reinforce the importance of a stronger, adequately funded, TCEQ enforcement program and support all of GEAA's recommendations on this subject. We thank GEAA for their leadership on this issue.

The Hill Country Alliance
3300 Crosswind Drive
Spicewood, Texas 7866

Evidence of Contamination

Even though the Texas Commission on Environmental Quality has failed to conduct any adequate survey of water quality in the Edwards Aquifer, sample measurements by other entities from wells and springs flowing from the Edwards Aquifer provide clear evidence that water in the aquifer has been contaminated by human activities:

1. Chlorinated solvents[1] have been detected in several Bexar County wells in the Edwards Aquifer, at locations indicated on the map below.



Bexar County
Public Supply Wells Found to Contain Chlorinated Solvents
1982 - 1996

Edwards Aquifer water supply wells have been shut in to protect drinking water supplies. In the San Antonio segment of the aquifer wells, these wells have been closed down because of toxic organic chemical contamination:[2]

- Castle Hill well owned by Bexar Metropolitan Water Supply;
- The Jones-Maltsberger well owned by the San Antonio Water System;
- The Bitters Road and Highway 281 well owned by Bexar Metropolitan Water Supply; and
- A city well in Uvalde.

In addition to these wells, which have been closed because of high concentrations of toxic organic chemicals, the San Antonio Water System operates a well on a reduced pumping schedule because of contamination; a private water supply well

[1] Trichloroethylene, tetrachloroethylene, 1, 2 dichloroethylene, 1,1,2,2 tetrachloroethane, vinyl chloride, dichlorobenzene, dichloroethane, chlorobenzene, trichloroethane, 1,1,1 trichloroethane, 1,1,2 trichloroethane, methylene chloride, dichloromethane. Source: George Rice, hydrologist, personal communication, March 2004.

[2] Geary Schindel, Edwards Aquifer Authority, personal communication, August 8, 2005.

has been fitted with expensive activated carbon filtering devices to remove contamination, wells which exhibit nitrate concentrations above the drinking water standards. The San Antonio Water System closed the Braun Station well in 1984 because of a pathogenic outbreak of cryptosporidia.[3]

2. Diethyl phthalate at 120 ug/l was measured in the October 7 1981 sample from Barton Springs. This chemical is a plasticizer in polyvinyl chloride, an industrial solvent, a wetting agent, and a component of insecticides.[4]
3. Tetrachloroethylene (PCE) was measured in 7 of 10 samples collected from Barton Springs between February 1989 and February 1991. Tetrachloroethylene is a man-made compound. The source has never been identified.[5]
4. Wells in the City of Sunset Valley have experience significant problems with siltation and sediment. In July 1993, 1.5 feet of accumulated sediment were removed from the water storage tank, 8 months following the previous cleaning.[6]
5. Total suspended solids concentrations in wells as high as 18,000 mg/l have been reported in wells in the Barton Springs Edwards Aquifer along the Sunset Valley Fault.[7]
6. Samples from a well near the intersection of Barton Creek and Loop 360 were measured with concentration of lead from 20 to 40 ug/l and zinc from 100 to 260 ug/l[8] Hauwert and Vickers[9] reported the presence of lead in 14 and arsenic in 7 Barton Springs Edwards Aquifer wells. Samples from three wells exhibited arsenic concentrations higher than the drinking water standard of 0.01 mg/l.
7. Petroleum hydrocarbons have been measured in 12 wells and springs in the Barton Springs Zone. Total organic halogens have been measured in two wells.[10] These chemicals are largely of human origin and rarely occur naturally in

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[3] Ibid.

[4] Andrews, F. L., Schertz, T. L., Slade, R. M., and Rawson, Jack. *Effects of Storm-water Runoff on Water Quality of the Edwards Aquifer near Austin, Texas.* U. S. Geological Survey Water-Resources Investigation Report 84-4124, 1984.

[5] Buszka, P. M. and R. M. Slade. Determination of the Sources of Organic Compounds in Ground-Water Discharges of Barton Springs, Austin, Texas. 10 April 1991.

[6] Nico Hauwert, Geologist. Personal Communication, June 1994.

[7] Hauwert, N. M. and S. Vickers. *Barton Springs/Edwards Aquifer Hydrogeology and Groundwater Quality,* prepared for the Texas Water development Board by the Barton Springs/Edwards Aquifer Conservation District, September, 1994.

[8] Andrews, F. L., Schertz, T. L., Slade, R. M., and Rawson, Jack. *Effects of Storm-water Runoff on Water Quality of the Edwards Aquifer near Austin, Texas.* U. S. Geological Survey Water-Resources Investigation Report 84-4124, 1984.

[9] Hauwert, N. M. and S. Vickers. *Barton Springs/Edwards Aquifer Hydrogeology and Groundwater Quality,* prepared for the Texas Water Development Board by the Barton Springs/Edwards Aquifer Conservation District, September, 1994.

[10] Ibid.

groundwater. Their presence indicates degradation of the aquifer. Furthermore, the occurrence of these chemicals in some wells and springs is associated with elevated concentrations of pesticides, nitrate, lead, or arsenic, indicating contamination from a broad range of sources.

8. The City of Austin has documented statistically significant trends in the degradation of Barton Springs water for the following parameters: conductivity, dissolved oxygen, organic carbon, sulfate and turbidity.[11]

9. Other data has long been available and relied upon, for example, by Fish and Wildlife scientists. In one biological opinion[12] the scientists explained that

> *"Major highway, subdivision, and other construction projects along Barton Creek increased during the early 1980's and 1990's. While high turbidity has been observed in Barton Springs Pool following major storm events since the early 1980's, the duration and frequency of sediment discharges from Barton Springs increased substantially during the 1990's."*

10. Sediments collected from Barton Springs on April 20, 1995 contained polycyclic aromatic hydrocarbons at levels up to 6.5 times those shown to be toxic to Hyallela azteca.[13] Data in Tables 7-12 of the Biological Opinion show exceedances of EPA probable effects levels (i.e. effects to aquatic organisms) for twenty different metals, pesticides and poly-aromatic hydrocarbons occurring at Barton Springs Pool and Barton Creek.

11. Atrazine has been detected in Barton Creek and Barton Springs Pool. A study by the United States Geological Survey (2000) showed atrazine in the pool after a rain. Peak detected levels were 0.56 ug/l in Barton Springs, 0.80 ug/l in Williamson Creek, and 0.44 ug/l in Barton Creek. One year later, in May of 2001, the USGS again sampled soluble pesticides in Barton Springs and Barton Creek following a rain. This time, USGS detected a peak concentration of 3.19 ug/l atrazine at Upper Barton Springs. The Texas State drinking water standard for atrazine is 3 ug/l.

Evidence Demonstrating the Need to Limit Imperviousness

Impervious areas include rooftops, sidewalks, concrete-lined drainage channels, parking lots, residential streets, and roadways—any man-made feature that prevents water from going directly into the soil. The effect of imperviousness on stream degradation has been widely researched and well-documented:

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[11] City of Austin, *Update of Barton Springs Water Quality Data Analysis – Austin, Texas*, February 2005.

[12] 62 Fed. Reg. 23385.

[13] City of Austin, unpublished data, 1994; Ingersoll et al., in press.

> *". . Scientific evidence . . . relates imperviousness to specific changes in the hydrology, habitat structure, water quality and biodiversity of aquatic systems. This research, conducted in many geographic areas, concentrating on many different variables, and employing widely different methods, has yielded a surprisingly similar conclusion: stream degradations occurs at relatively low levels of imperviousness (~10%). Most importantly, imperviousness is one of the few variables that can be explicitly quantified, managed and controlled at each stage of land development."*[14]

In 1997 thirty-nine scientists, planners, and engineers in the Edwards Aquifer region produced and signed *Protecting the Edwards Aquifer: A Scientific Consensus.*[15] The consensus of virtually every independent scientist familiar with the Edwards Aquifer was that it is not feasible to prevent aquifer contamination without limiting the amount of impervious cover in both the recharge and contributing zones. Furthermore, these scientists specifically agreed that engineered controls, even when perfectly maintained, cannot replace impervious area limits.

This conclusion has been recently reaffirmed in *Regional Water Quality Protection Plan for the Barton Springs Segment of the Edwards Aquifer and Its Contributing Zone*:[16]

> *"Based on the evaluations of the scientific studies presented, the consulting team determined that the approximate quantity of impervious cover which can occur while remaining protective of water quality in the Planning Region is in the range of ten to fifteen percent (10% to 15%), on a gross site area basis."*

The USGS documented the relationship between urbanization and water quality degradation in streams throughout the Austin area. Nine of the 18 study sites were along streams in the Barton Springs segment and its contributing zone. The study demonstrated statistically significant increases in constituent concentrations with increasing impervious cover.[17]

a) Storm Runoff Pollution

With higher impervious cover, more pollutants are generated and carried into storm runoff. Figure 1 shows estimated pollution increases in storm runoff as impervious cover increases due to development. These relationships are based on data from storm runoff monitoring in Central Texas and are consistent with results from many similar studies around the United States. The figures show that with even modest levels of imperviousness, pollutant loads increase by 5 to 12 times that of an undeveloped site.

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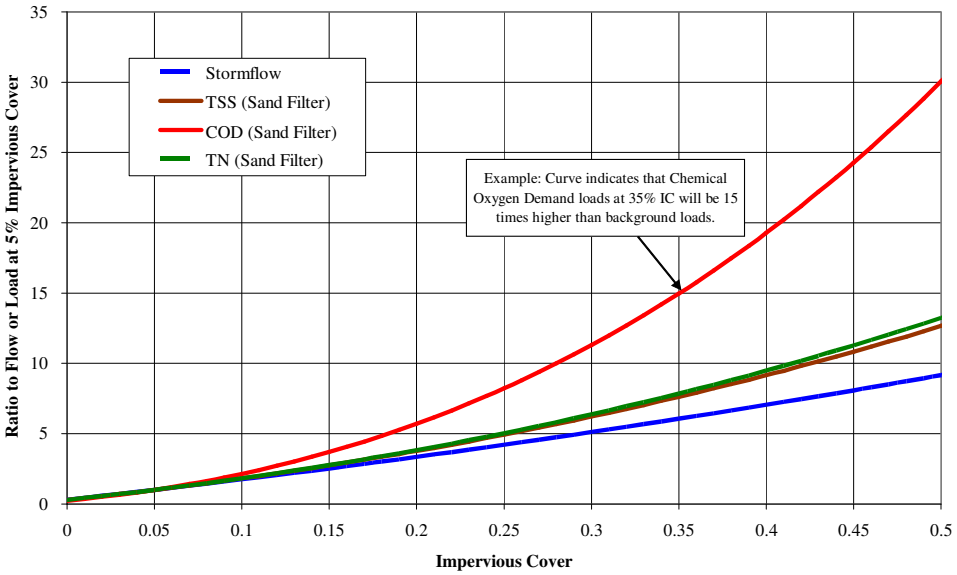
[14] Schuler, Thomas. *The Importance of Imperviousness*, Watershed Protection Techniques, 1(3): 100-111.

[15] A copy of this document and a list of the signers are attached.

[16] June, 2005. http://www.waterqualityplan.org/index.php?BODY=finaldraft.

[17] Veenhuis, J.E., and Slade, R.M., 1990, *Relation Between Urbanization and Water Quality of Streams in the Austin Area, Texas*, USGS Water Resources Investigations Report 90-4107.

Figure 1. Increasing Stormflow and Pollutant Loads with Increasing Impervious Cover

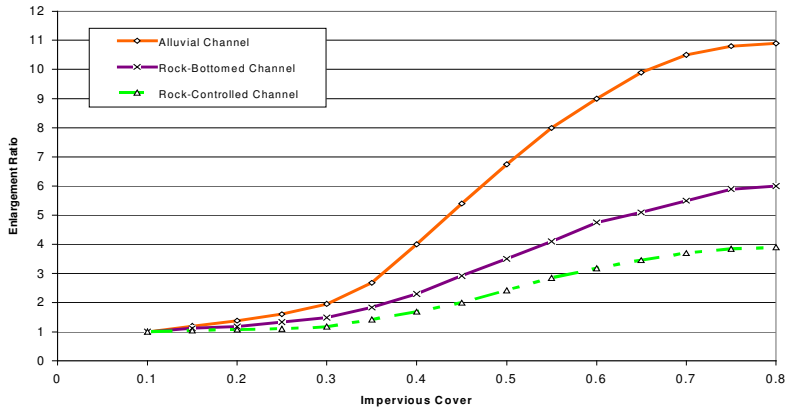


b) Stream Bank Erosion

With larger impervious areas, more water reaches waterways faster and with greater erosive force. The resulting scour widens and deepens channels, abrades aquatic and streamside vegetation, and creates shifting sediment bars. An estimated 80% of the total suspended solids pollution generated from urbanization comes from channel banks downstream from the developed watershed. Engineered water quality controls treating runoff from a developed area do nothing to remove this additional sediment pollution.

Sediments and adsorbed pollutants introduced by this runoff suffocate and contaminate stream ecosystems, and eliminate the natural pool and riffle sequences critical to fish and wildlife. Enlarging channels destroy tree root support and eventually these large trees fall and die. Figure 2 illustrates the effect of impervious cover on the size of stream channels.

Figure 2. Stream Enlargement Ratio versus Impervious Cover



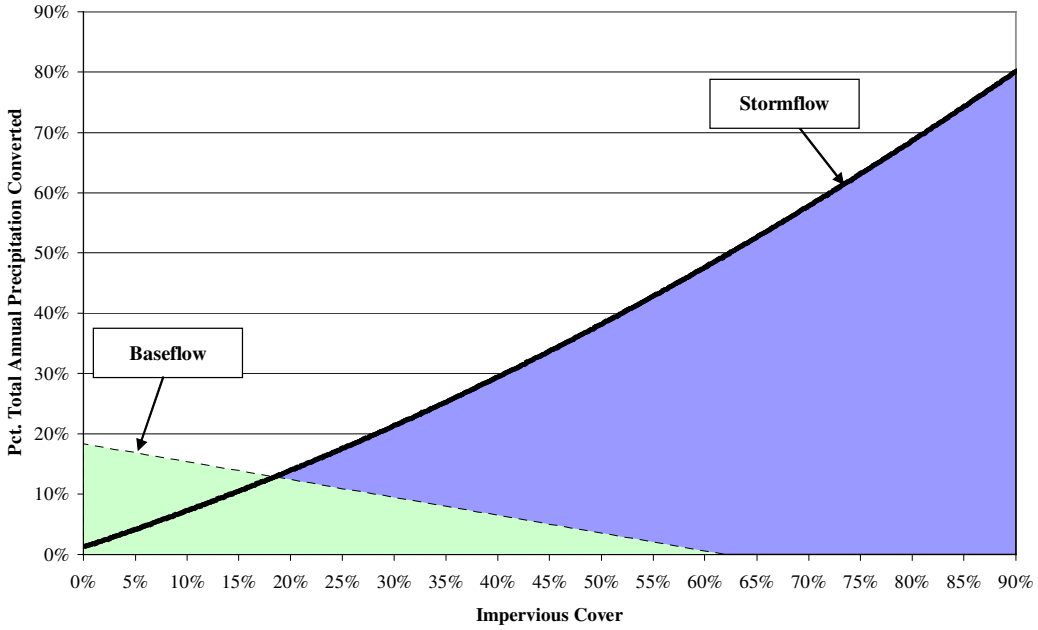
Source: Raymond Chan & Associates, Technical Procedures for the Watershed Erosion Assessments, September, 1997.

c) Decreased Base Flow in Streams Decreases Aquifer Recharge

Baseflow is defined as water in creeks and rivers between storm runoff events. It provides most of the Edwards Aquifer recharge in the Barton Springs Zone and likely in the San Antonio Edwards as well. Baseflow loss translates directly, therefore, into a reduction in available aquifer water. The loss of baseflow also radically alters the natural character of the stream and eliminates the viability of wetlands and aquatic habitat.

Figure 3 shows how baseflow drops and storm runoff increases as imperviousness increases. Impervious surfaces covering about 30% of a site reduce baseflow volumes by one half. At 60% imperviousness, virtually 100% of the baseflow is eliminated. Even if we were to eliminate 100% of the pollutant loads in storm runoff, development still diminishes baseflow volumes, which in turn diminishes the amount of aquifer water available.

Figure 3. Percent of Precipitation Converted to Stormflow and Baseflow versus Impervious Cover



Developers and their engineers have consistently argued that impervious cover limits are unnecessary because engineer water quality controls can protect the Aquifer. This perspective is reflected in the existing TCEQ Edwards Aquifer protection regulations which require some water quality treatment but do nothing to limit imperviousness.

This perspective, however, fails to recognize the clear scientific information and experience that engineered systems cannot replace the water quality benefits of undeveloped land, open space, park areas, and low impervious cover development for two significant reasons.

One reason is that the treatment systems required by TCEQ do not address all of the water quality problems that are generated by development. These systems do not, for

example, eliminate the sediment load created by increased stream bank erosion downstream from the control. These systems also do not replace clear and clean base flow in the streams between the storm runoff events, which provides most of the aquifer recharge.

The second reason that these treatment systems do not eliminate the need for impervious cover restrictions is that they degrade and fail. Where the natural landscape that remains on a low-imperviousness development remains day after day and year after year to provide high-quality and sustaining aquifer recharge, engineered systems fail routinely. Many of the engineering designs are based on faulty assumptions. They are often not constructed to the engineered specifications. Once constructed, they are rarely maintained. A survey of constructed engineered systems built to comply with the existing TCEQ Edwards rules would demonstrate inadequacies in the vast majority.

The Need for Preserving Natural Soil and Vegetation Surrounding Known Cave Openings, Solution Features, Springs, Wetlands, and Streams.

Buffers serve three important functions to protect Edwards Aquifer recharge:

1. Buffers separate development and associated pollution from entry-ways into the aquifer. This physical separation improves the likelihood that entry-ways into the aquifer will remain open and continue to provide aquifer recharge. This physical separation also provides a safety zone in which to capture and contain hazardous spills and accidental releases of toxic chemicals.
2. Buffers filter runoff, removing sediment, nutrients, pesticides, heavy metals, or toxic organic chemicals before water enters the aquifer where these filtering processes do not occur.
3. Buffers provide an area where runoff can soak into the soil and migrate to karst openings within the aquifer.

Evidence Regarding Inadequacy of TCEQ Storm Runoff Pollution Reduction Standards

Allen White, a U. S. Fish and Wildlife contaminants expert, offered these comments on the TCEQ storm runoff pollution reduction standard requiring removal of only 80% of the increase in total suspended solids (TSS):

> *"Emphasis on TSS removal is based on the assumption that TSS is an adequate surrogate for all other contaminants of concern that may be in run-off from all land uses covered by this document/initiative. TSS may not be an adequate surrogate for certain toxic pollutants of concern (soluble pesticides, nutrients or heavy metals)."*[18]

[18] Email from Robert Pine to Michael Barrett (January 31, 2005), provided by U. S. Fish and Wildlife Service to SOS Alliance pursuant to Freedom of Information Act request.

Even with the TCEQ-required reduction in total suspended solids, other chemicals remain in urban storm runoff at higher than natural levels. These elevated chemical concentrations are damaging to human health and to the diversity of species in the natural world.

Evidence Regarding Inadequate Enforcement of Existing TCEQ Edwards Protections

A fundamental flaw of the Edwards Rules is that they depend on self-reporting, rather than relying on independent review by TCEQ. On the rare occasion when independent scrutiny is brought to bear on the regulatory process, noncompliance is revealed.

For example, in November of 2003, Cunningham-Allen, Inc. submitted a Water Pollution Abatement Plan (WPAP) to TCEQ for the construction of a Lowe's Home Improvement Warehouse in the recharge zone, along the border between the City of Austin and City of Sunset Valley. The document contained the seal and signature of professional engineer Elias G. Haddad. Within the WPAP was a Geologic Assessment signed by David Hill, P.E. and John E. Cook from Professional Service Industries, Inc. The report said the following:

> *"The purpose of this report is to . . . identify the location and extent of significant recharge features present in the development area.*
>
> *The purpose of the site investigation was to delineate features with recharge potential that may warrant special protection or consideration.*
>
> *[F]ield observations indicate that no obvious recharge features are onsite.*
>
> *The . . . lack of recharge features onsite . . . .*
>
> *No recharge features were found on the subject site.*
>
> *No recharge features were found onsite.*
>
> *No recharge features were found on the subject site."*

Based on this submission, Executive Director Margaret Hoffman issued a letter approving the WPAP on February 18, 2004 containing the following language:

> *"According to the geologic assessment included with the application, no geologic features exist on the site. . . [B]ased on the engineer's concurrence of compliance, the planning materials for construction of the proposed project and pollution abatement measures are hereby approved . . . ."*

However, in subsequent litigation, when an independent engineer was able to obtain entry to the site during construction, she observed and photographed an obvious recharge feature through which virtually 100% of storm runoff was draining from most of the site. Water on the site contained an oil-product spilled from an onsite fuel storage tank as well as high levels of sediment and nitrogen—all being delivered directly into the Aquifer.

Before the court, Lowe's disputed the existence of this now photographed and documented recharge feature. But the court issued a temporary injunction, ordering Lowe's to divert storm water runoff "from flowing into aquifer recharge features[,] remove fuel tanks [and] remove . . . water contaminated by hydrocarbons . . . ."

Similarly, when SOS Alliance filed suit to challenge a development along Little Barton Creek in the Village of Bee Cave, SOS Alliance site visits pursuant to the litigation revealed numerous violations of the TCEQ WPAP requirements. As a result the developer was penalized by TCEQ, something that was unlikely to have occurred if the violations had not been independently investigated by SOS Alliance.

Evidence Regarding Inadequate Funding of TCEQ Edwards Protection Program

TCEQ regulations apply to the Edwards Aquifer recharge and contributing zones in all or portions of Medina, Bexar, Comal, Kinney, Uvalde, Hays, Travis and Williamson Counties. The total area to which they apply is more than 3,500 square miles. More than 200 Water Pollution Abatement Plan applications in each of the last several years have been submitted to the San Antonio district office for review.

Implementation of the Edwards protection program is the responsibility of TCEQ district offices in Austin and San Antonio. Total TCEQ expenditures to protect the entire Edwards Aquifer region were $585,058 in 2004. By comparison, the expenditures of the City of Austin watershed protection department, covering a much smaller portion of Texas, amount to more than $5 million per year.

Protecting the Edwards Aquifer: A Scientific Consensus

Introduction

The Edwards Aquifer is an irreplaceable natural resource. The Aquifer provides water for drinking, business, agriculture, and recreation; for essential streamflows for river and estuary ecosystems downstream of the major spring outflows (at Comal, San Marcos, Barton, Hueco, Salado, and elsewhere); and for necessary habitat for over fifty species of plants and animals found in Central Texas and nowhere else in the world.

There is broad public support to protect and manage the Edwards Aquifer so that it will continue to provide high-quality water for future generations of Texans. Protecting the Aquifer requires public and private action based on sound science. The following statements and recommendations reflect the common views of the undersigned scientists, engineers, and planners. These individuals are familiar with the best scientific information about the Edwards Aquifer.

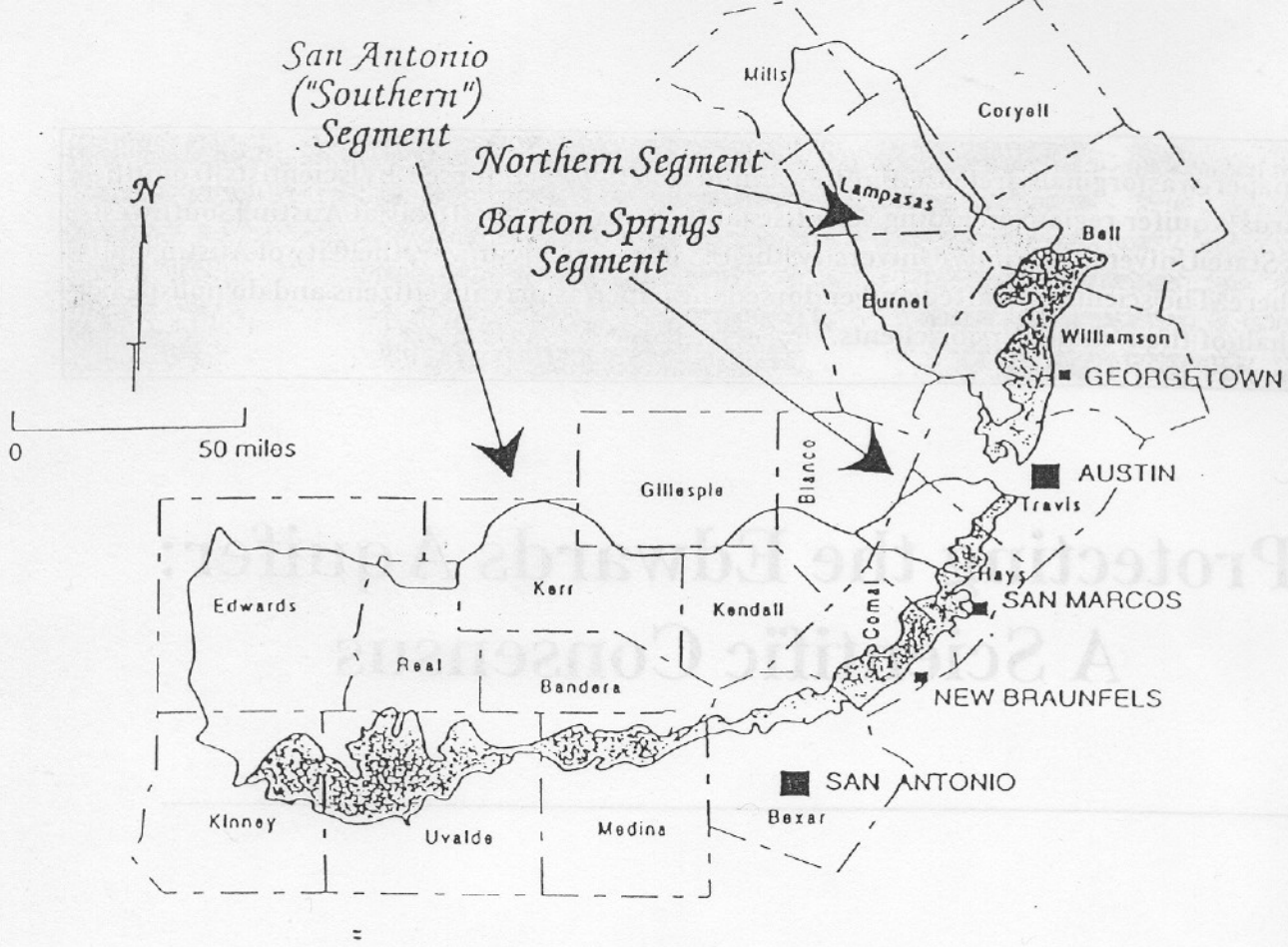


Figure 1. Contributing and Recharge Zones of the three segments of the Edwards (Balcones Fault Zone) Aquifer. *The Contributing Zones are the unshaded areas to the north and west, and the Recharge Zones are the shaded areas to the south and east.*

Factual Background

The Edwards Aquifer, (shown in Figures 1 and 2), currently provides a high-quality source of water whose quantity is limited by rainfall, recharge capacity, storage capacity, and withdrawals.

The Edwards Aquifer is a karst limestone aquifer, characterized by conduits through which water travels rapidly and a thin to absent soil cover, as shown in Figure 3. These characteristics allow minimal filtration or adsorption of contaminants. Thus the aquifer is particularly vulnerable to contamination from human activities occurring in its watershed.

While the overall water quality in the Aquifer remains high, scientists have documented occurrences of water quality degradation at wells and springs.

- Contaminant levels associated with human activity have been detected at levels exceeding natural background in wells, springs, and sediments in creeks that recharge the Aquifer. These contaminants include pesticides, metals, and petroleum hydrocarbons (footnote 1). At times, concentrations have been at levels that are harmful to aquatic life and human health.

- Development has increased contaminant and sediment loads in the surface waters that recharge the Aquifer (footnote 2).

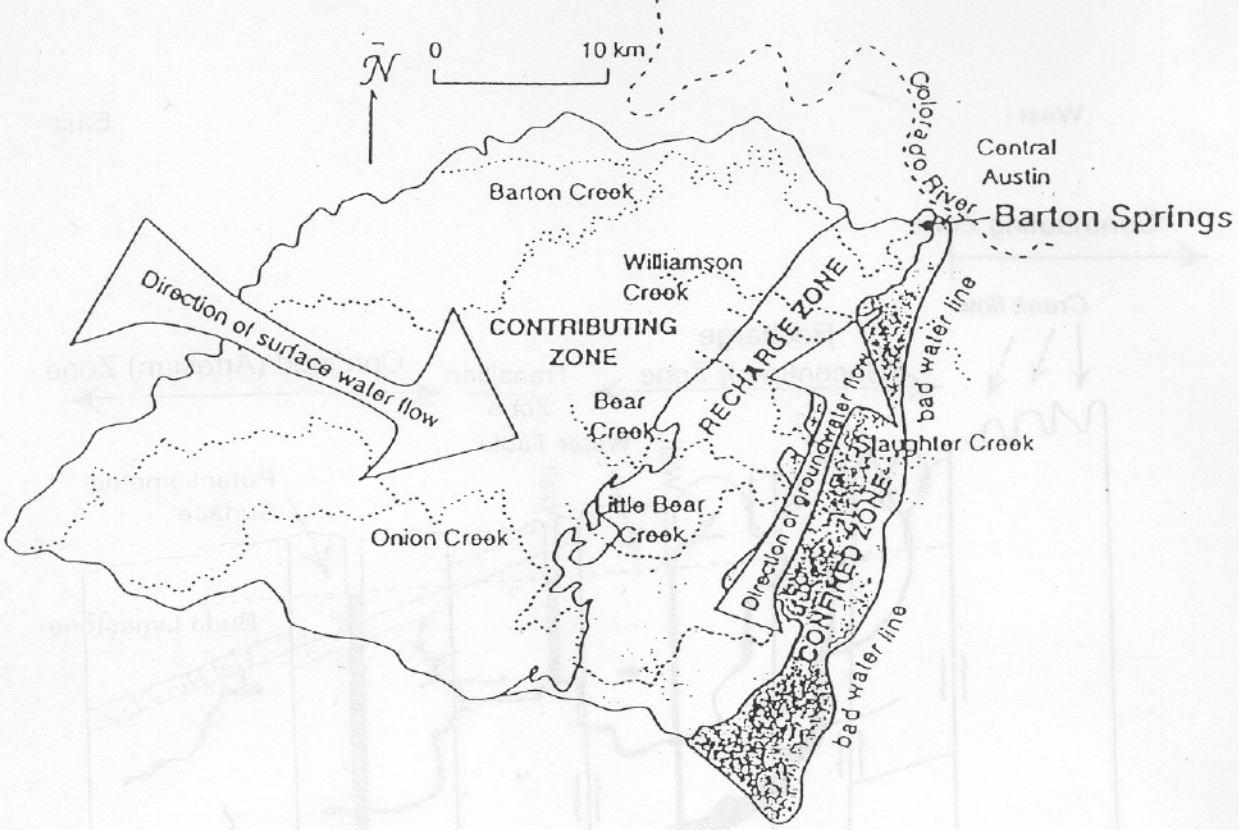


Figure 2. Runoff from precipitation falling on the Contributing Zone flows eastward in creeks until it crosses onto the porous Edwards Limestone (Recharge Zone), where it infiltrates into the aquifer through fissures in creekbeds. *Precipitation falling on the Recharge Zone enters the aquifer both as direct infiltration and through fissured creekbeds. Once recharge from the surface enters the aquifer, it flows north as groundwater through conduits dissolved along faults and fractures to discharge at Barton Springs.*

Key Points of Consensus

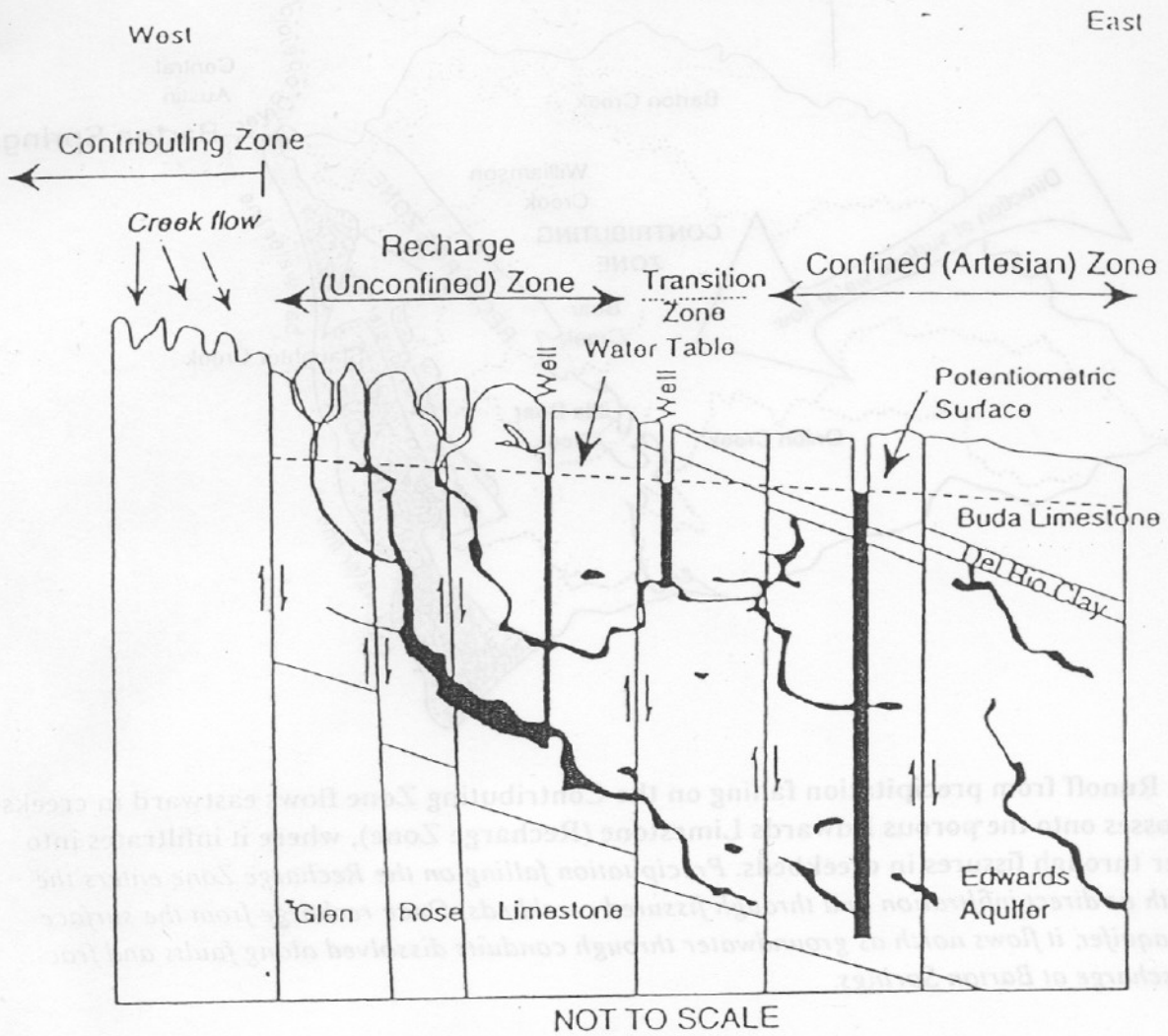
1) Development in the Edwards Aquifer recharge zone and contributing zone is projected to increase rapidly in the immediate future (footnote 3). We anticipate this development will lead to increased contamination of and withdrawals from the Aquifer.

2) Existing rules, regulations, and practices have not been and are not adequate to prevent contamination of the Edwards Aquifer, or to prevent withdrawals that threaten the flow at Barton Springs.

3) It is neither technically nor economically feasible to prevent contamination of the Edwards Aquifer without limiting the amount of impervious cover in its recharge zone and contributing zone (footnote 4).

4) Engineered controls, known also as BMPs, can decrease but not eliminate contamination of the Edwards Aquifer. Even if perfectly maintained, BMPs are not a substitute for limits on impervious cover. While current BMP designs can be improved, no technology will ever be perfect, and improper maintenance degrades the performance of even the best engineered controls.

5) An important strategy to prevent contamination of the Edwards Aquifer is to minimize the use, transport, and storage of chemicals and contaminants in



Schematic cross-section of the Barton Springs portion of the Edwards Aquifer. *Water flows eastward, via creeks, across the surface of the Contributing Zone until it crosses onto the extremely permeable Edwards Limestone (Recharge Zone). It then flows northward ("into" this page) to Barton Springs via conduits dissolved along faults and fractures. Adapted from Slade et al. (1986).*

Key Points of Consensus, continued

its watershed. Measures are needed to protect the Aquifer from contamination by roadway runoff, pipelines, chemical storage and transport, pesticides, and herbicides.

6) Pumping from the Edwards Aquifer must be limited to prevent depletion of the Aquifer, cessation of spring flows, local intrusion of "bad water", and extinction of native species.

7) The quality of surface water in all of the contributing and recharge zones affects the quality of water in the Edward Aquifer.

Recommendations

Governments, private corporations, and citizens should:

Act promptly to direct urban development away from the Edwards Aquifer's recharge and contributing zones through control of infrastructure investment and the use of zoning and other appropriate planning techniques;

Institute safeguards that will reduce contamination and the risk of catastrophic events from ongoing activities in the Edwards Aquifer's watershed, and minimize contamination from future development;

Develop and enforce rules and regulations across both the recharge and contributing zones to strengthen protections of water quality in the Edwards Aquifer;

Restrict impervious cover in the recharge and contributing zones to levels that will sustain existing water quality;

Support measures that reduce consumption of water from the Edwards Aquifer and that preserve recharge to the Aquifer; and

Promote public education, the acquisition of preserves and conservation easements, the protection of recharge features, and other strategies to complement the regulations designed to prevent contamination and overpumping of the Edwards Aquifer.

Footnotes

1. Contamination has been particularly well-documented in the Barton Springs segment of the Edwards Aquifer. Some of the findings there include:

- Water samples from one outlet of Barton Springs (Sunken Garden) has shown high levels of lead. The total concentration of lead was 0.024 mg/l in a sample from 1994 (Hauwert and Vickers, 1994). That concentration exceeds the EPA maximum contaminant level for total lead in drinking water, which is 0.015 mg/l. Arsenic is a highly toxic metal that is used in the manufacture of agricultural pesticides and other products, and that is found in roadway runoff. It has been found in Aquifer wells at levels in excess of 0.05 mg/l (Hauwert and Vickers, 1994), which is the EPA maximum contamination level for arsenic in drinking water.
- Polycyclic aromatic hydrocarbons, of PAHs, are toxic and carcinogenic compounds formed by the breakdown of motor oil and other manmade products. Sediment collected from Barton Springs Pool on April 20, 1995, contained PAHs at concentrations up to 6.5 times over that known to be toxic to Hyallela azteca, an invertebrate that is common in the Aquifer's springs (City of Austin, 1994, 1997; Ingersoll et al., 1996).
- Total nitrogen concentrations measured in wells in the more urbanized areas of the Barton Springs watershed are typically two to six times higher than in rural areas (Slade, 1992).
- Elevated levels of total phosphorus and orthophosphorus have been detected in wells and springs (Slade, 1992; Hauwert and Vickers, 1994; City of Austin, 1997).

Footnotes, continued

2. Water quality in each of the six streams that recharge the Barton Springs segment of the Edwards Aquifer has been studied (Veenhuis and Slade, 1990). The water quality during baseflow conditions is similar for many of the sites that were sampled, but the water of stormflow is much degraded for the sites in developed basins. For example, the highest values for nitrogen, suspended solids, total organic carbon, phosphorus, and fecal bacteria were found in Williamson Creek and two sites in the lower reaches of Barton Creek--sites that receive runoff from the most developed basins. The stormflow concentrations of contaminants in the lower reaches of Barton Creek exceed the values found in the upper reaches of Barton Creek by several hundred percent or more. Most of the development in the Barton Creek drainage basin is limited to the lower reaches. Water-quality data for the other streams reveal similar patterns: water quality degrades with increased development.

3. By one estimate, the population of the Edwards Aquifer region will grow approximately 46% in the 15 years between 1995 and 2010. This figure is based on the number of people using public water supplies that take their water from the Edwards Aquifer south of the Colorado River. In 1995, that number was estimated at 1,625,384, while in 2010 it is projected to be 2,374,549 (Barton Springs/Edward Aquifer Conservation District, 1997; Texas Water Development Board, 1994, 1996).

4. Impervious cover is defined as the total area of roads, parking lots, sidewalks, rooftops, and other impermeable surfaces on the urban landscape. In effect, it can be considered as the percentage of area that is not natural or "green" (Schueler, 1994). It has been demonstrated that a relatively low percentage of impervious cover (10% to 15%) can induce adverse and irreversible changes in the quality of streams (Veenhuis and Slade, 1990). The effects are related to changes in the hydrology, water quality, habitat structure, and biodiversity of the aquatic system (Schueler 1994, 1995, 1996). Further, monitoring studies indicate that urban contaminant loads are directly related to the amount of impervious cover in the watershed. In most models, impervious cover is the key predictive variable used to estimate contaminant loads. Once the percentage of impervious cover exceeds about 25%, many streams become "non-supporting" and are characterized by fair to poor water quality, highly unstable channels, and poor biodiversity. Because streams flowing across the recharge zone and contributing zone resupply the Edwards Aquifer as the water infiltrates, maintenance of high water quality in these streams is a major concern.

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This document
Protecting the Edwards Aquifer:
A Scientific Consensus
as well as its figures, list of signatories,
press release, and contact information
can viewed online by visiting www.glenrose.com

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