The Senate Committee on Natural Resources

Interim Report to the 81st Legislature

Salinity of Surface Waters and Groundwaters in Texas

February 2009

SENATE COMMITTEE ON NATURAL RESOURCES

February 9, 2009

The Honorable David Dewhurst
Lieutenant Governor of Texas
Members of the Texas Senate
Texas State Capitol
Austin, Texas 78701

Dear Governor Dewhurst and Fellow Members:

The Senate Committee on Natural Resources of the Eightieth Legislature hereby submits its interim report including findings and recommendations for consideration by the Eighty-first Legislature.

Respectfully Submitted,

Senator Kip Averitt, Chair

Senator Craig Estes, Vice-Chair

Senator Glenn Hegar

Senator Kim Brimer

Senator Juan "Chuy" Hinojosa

Senator Robert Deuell

Senator Mike Jackson

Senator Robert Duncan

Senator Kel Seliger

Senator Kevin Eltife

Senator Carlos Uresti

P.O. Box 12068 • Austin, Texas 78711
(512) 463-0390 • FAX (512) 463-6769 • Dial 711 For Relay Calls

TABLE OF CONTENTS

INTERIM CHARGE 5

INTERIM CHARGE

Inventory and analyze bodies of water with high salinity. Explore new technologies and approaches to reduce salinity in the state's surface waters and groundwaters. Examine the need for state action to address salinity levels in surface waters of the state. Include an assessment of the following:

- brackish desalinization projects, including brine disposal options;
- permitting of brackish water by groundwater districts;
- the value and potential uses for brackish water; and
- the imposition of export fees for brackish as opposed to potable water.

BACKGROUND

According to the 2007 State Water Plan, Texas' population is expected to double by 2060, resulting in a 27 percent increase in demand for water, and a water shortage of approximately 8.8 million acre-feet.[1] The existence of such a wide water supply gap facing the citizens of Texas has prompted the continued study and development of brackish water as a potential solution to address the impending shortfall. Brackish water has a higher level of salinity than potable water but less salinity than seawater. As technological advances allow for the further utilization of this previously unused water, the resulting water supply will certainly be a component in appropriately planning for the future water needs of the state.

Approximately 2.7 billion acre-feet of brackish groundwater exist in Texas[2]. Brackish water can be found in 26 of Texas' 30 major and minor aquifers and all 16 regional water planning areas.[3] Appendix A contains a table of the estimated brackish groundwater volume by Regional Water Planning Groups (RWPG). Brackish surface water is also found across the state, and is most prevalent in the Upper Brazos, Texas panhandle, and coastal regions of the state.

CAUSES OF BRACKISH GROUNDWATER AND SURFACE WATER

Brackish water is usually caused by various natural causes. In some areas of West Texas, the natural geological formations contain salt deposits created by the evaporation of saline water in the distant past. When groundwater comes into contact with these salt deposits, some of the salt dissolves into the groundwater. This process is the primary cause of brackish groundwater in the vicinity of the headwaters of the Pecos, Colorado, and Brazos rivers.[4] Other factors, such as extensive extraction of groundwater, can also affect the level of groundwater salinity by increasing the concentration.

The Texas Commission on Environmental Quality (TCEQ) produced a database of the State's brackish waters, which is available in Appendix B. The database indicates that major rivers that originate in Colorado and New Mexico and flow east -- such as the Canadian, Pecos, and Rio Grande -- contain high levels of saline water largely due to artesian aquifers and geological deposits in New Mexico. The primary source of salinity in the northern segments of the Brazos, Colorado, and Red rivers are geological salt deposits that are remnants of ancient evaporated seawater in the panhandle region. A

figure showing all major rivers in the Southwest affected by Permian Basin salt can be found in Appendix C. Rivers that flow into the Gulf of Mexico often have areas of elevated salinity near the coast, because the flat coastal terrain allows salty bay and estuary waters to move well upstream into rivers.

INTERIM EFFORTS/ISSUE STATUS

INTERIM COMMITTEE HEARINGS

The Senate Committee on Natural Resources (Committee) held a public hearing in Amarillo, Texas, on August 5, 2008. A portion of the testimony focused on reducing salinity levels and the use of brackish groundwater around the state. The Amarillo hearing agenda can be found in Appendix D.

The Committee also held a public hearing in Dallas, Texas, on May 13, 2008. A portion of the testimony focused on reducing salinity levels, current chloride control projects and the use of brackish surface water around the state. The Dallas hearing agenda can be found in Appendix E.

BRACKISH WATER IN REGIONAL WATER PLANS

Various RWPGs have recognized the increasing viability of brackish groundwater desalination projects, and they have incorporated such projects into their regional water plans. Below are features of several regional water plans all aimed toward increased desalination of brackish groundwater. The following items are found in the 2007 State Water Plan:

- The Far West Texas Regional Water Plan (Region E) includes the import of approximately 50,000 acre-feet per year of desalinated brackish groundwater from Dell City, Texas, to El Paso, Texas, by 2030.
- The Region F Regional Water Plan includes a project that will produce an estimated 16,221 acre-feet per year.
- The Lower Colorado Regional Water Plan (Region K) includes desalination of brackish groundwater by the South Texas Project Electrical Generating Station. The project could potentially produce an estimated 29,568 acre-feet per year by 2010.
- The South Central Texas Regional Water Plan (Region L) includes the San Antonio Water System's Wilcox brackish desalination project with a peaking capacity of 20 million gallons per day by 2010.
- The Rio Grande (Region M) Regional Water Plan includes a policy recommendation to "fund brackish groundwater desalination projects."[5]
- The Llano Estacado (Region O) Regional Water Plan includes a brackish groundwater project producing approximately 3,360 acre-feet per year for Lubbock by 2020.

Several RWPGs have also included projects for brackish surface water use in the 2007 State Water Plan. Region B lists "enhance water quality in the Lake Kemp/Lake Diversion system through the Chloride Control Project" in the select policy recommendations for the region.[6] Current and future Region C water strategies also include the use of saline surface water.[7]

CURRENT PROJECTS AND UTILIZATION

Various salinity control projects are functioning successfully around the state. Methods used to reduce salt pollution include constructing dams, diverting saline water, injecting brine in deep formations, plugging abandoned oil and gas wells, utilizing evaporation ponds, and operating desalination plants.[8] At the May 9, 2008, Committee hearing, TWDB provided a database of the status of all chloride control projects in Texas. The database is available in Appendix F.

At the August 5, 2008, Committee hearing, TWDB provided testimony on the status of several brackish groundwater projects known as the Brackish Groundwater Desalination Demonstration Projects. Facilitated by TWDB grants totaling approximately two million dollars, these eight projects are in different stages of completion. The projects aim to demonstrate the viability of utilizing desalination in different areas of the state while simultaneously conducting research and developing technology. For more details on these projects, see Appendix G.

Another method for utilizing brackish water that is being employed in Texas is the blending of brackish water with fresh water. Blending is a technique for reducing salinity levels to an acceptable Texas Surface Water Quality Standard level.[9] According to the Clean Water Act and the Safe Drinking Water Act, which establish limitations and requirements on introducing saline water into fresh water, the practice of blending should not adversely affect the use of the water for human consumption.[10] The Texas Pollutant

Discharge Elimination System (TPDES), which is coordinated by TCEQ, is a program responsible for regulating discharges into surface waters.[11] The only exception to this is discharge into surface water from oil and gas operations, which is regulated by the Railroad Commission of Texas.[12] Additional details on blending are available on page three of Appendix H.

CONCLUSIONS

According to the *Guidance Manual for Brackish Groundwater Desalination in Texas* prepared for the TWDB by NRS Consulting Engineers:

> Brackish groundwater desalination is considered an attractive water supply option for several reasons. First, the water source is typically reliable, even during periods of drought, when surface water is limited. Second, the construction and operational costs of desalination facilities are becoming more competitive compared to other, more traditional water supply options. Also, brackish groundwater desalination facilities can be developed and implemented in relatively short time periods, and the modular design of the technology allows for easy, quick upgrades.[13]

To date, desalination has proved to be largely cost-prohibitive. However, as desalination costs drop with the development of improved technology, brackish desalination may play a pivotal role in addressing the water supply gap projected in the State Water Plan.[14] In addition to desalination, source control and blending could also provide additional useable water resources, particularly in areas of the state with low average rainfall totals and those prone to drought.

The TWDB should continue programs for water supply planning and research of brackish water utilization and salinity trends. The TWDB's Legislative Appropriation Request for the 2010-2011 biennium includes an exceptional item named Groundwater Science for Groundwater Management. The request will fund a program intended to characterize brackish groundwater aquifers in Texas. For more details on the exceptional item request, see Appendix I.[15] While weighing legislative appropriation requests related to the use of brackish water, legislators should keep in mind the importance of meeting the future water demands of the state.

[1] Texas Water Development Board, *Water for Texas 2007* - Volume II, October 2006.
[2] Texas Water Development Board, *Brackish Groundwater Manual for Texas Regional Water Planning Groups,* February 2003.
[3] Id at 2.
[4] Isaac Jackson, Personal Communication, December 15, 2008.
[5] Texas Water Development Board, *Water for Texas 2007* - Volume II, October 2006, pg.88.
[6] Texas Water Development Board, *Water for Texas 2007* - Volume II, October 2006, pg.24.
[7] Alan H. Plummer, Jr., Testimony before the Senate Natural Resources Committee, May, 13, 2008, Dallas, Texas.
[8] Texas Water Development Board, Status of Chloride Projects in Texas, May 9, 2008.
[9] Id at 7.
[10] Id at 7.
[11] Isaac Jackson, Personal Communication, November 24, 2008.
[12] V.T.C.A., Water Code, § 26.131.
[13] NRS Consulting Engineers, *Guidance Manual for Brackish Groundwater Desalination in Texas*, April 2008, pg.2.
[14] Jacob White, Testimony before the Senate Natural Resources Committee, August 15, 2008, Amarillo, Texas.
[15] Bill Mullican, Testimony before the Senate Natural Resources Committee, August 15, 2008, Amarillo, Texas.

Appendix A

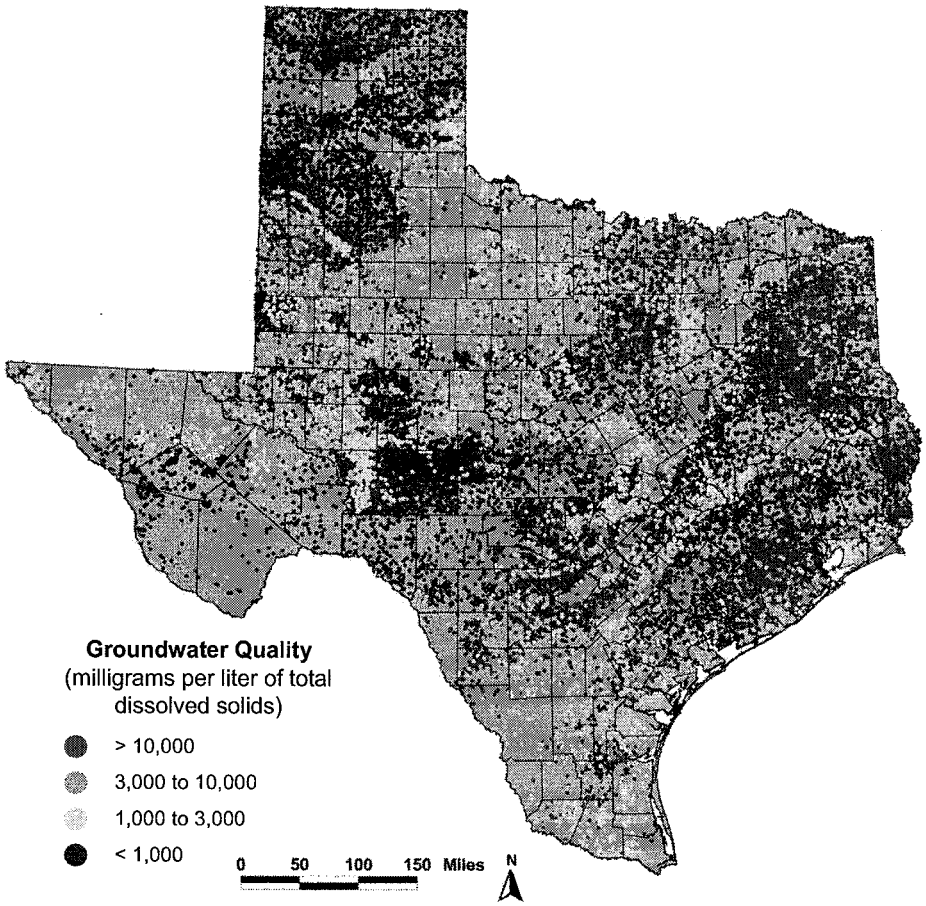


Figure 7
Groundwater quality in Texas, 2003.

The figure is heavily weighted toward fresh groundwater resources because the extent of knowledge of fresh groundwater resources is considerably more complete.

Figure reproduced from LBG-Guyton Associates (2003)

Table 2: Estimated brackish groundwater volume by regional water planning group.
All volumes reported in millions of acre-feet.

Planning Region	1,000 to 3,000 milligrams per liter total dissolved solids	3,000 to 10,000 milligrams per liter total dissolved solids	Total
A – Panhandle	7.9	11.2	19.1
B – Region B	6.0	8.6	14.6
C – Region C	43.4	41.6	85.0
D – Northeast Texas	28.9	26.9	55.8
E – Far West Texas	121.9	3.5	125.4
F – Region F	267.2	105.7	372.9
G – Brazos	122.0	73.6	195.6
H – Region H	122.6	73.3	195.9
I – East Texas	114.2	79.2	193.4
J – Plateau	3.2	5.4	8.6
K – Lower Colorado	101.8	100.1	201.9
L – South Central Texas	301.0	116.8	417.8
M – Rio Grande	270.8	125.3	396.1
N – Coastal Bend	200.3	132.1	332.4
O – Llano Estacado	46.7	45.1	91.8
P – Lavaca	1.4	6.5	7.9
Total	**1,759.0**	**954.8**	**2,713.8**

Source: Adapted from Kalaswad and others (2004).

Appendix B

WATERBODY INFORMATION									PROJECT INFORMATION							
ASSESSMENT YEAR	BASIN NAME	SEGMENT ID	SEGMENT NAME	PARAMETER	USE	IMPAIRMENT CATEGORY	INTEGRATED SUPPORT CODE	IMPAIRMENT SOURCE	PARAMETER	PROJECT_TITLE	PROJECT_DESCRIPTION	PROGRAM RESPONSIBLE	PROJECT_TYPE	STATUS	Project Activity Code	Project Activity Long Desc
2008	Canadian River Basin	0102	Lake Meredith	chloride	General Use	5c	NS	NPS- Sources Outside State Jurisdiction or Borders NPS- Natural Sources NPS- Upstream Source								
2008	Canadian River Basin	0102	Lake Meredith	sulfate	General Use	5c	NS	NPS- Sources Outside State Jurisdiction or Borders NPS- Natural Sources NPS- Upstream Source								
2008	Canadian River Basin	0102	Lake Meredith	total dissolved solids	General Use	5c	NS	NPS- Sources Outside State Jurisdiction or Borders NPS- Natural Sources NPS- Upstream Source								
2008	Canadian River Basin	0103	Canadian River Above Lake Meredith	chloride	General Use	5c	NS	NPS- Sources Outside State Jurisdiction or Borders NPS- Natural Sources NPS- Upstream Source								
2008	Red River Basin	0203	Lake Texoma	chloride in finished drinking water	Public Water Supply Use		CS	NPS- Natural Sources NPS- Upstream Source								
2008	Red River Basin	0203	Lake Texoma	total dissolved solids in finished drinking water	Public Water Supply Use		CS	NPS- Natural Sources NPS- Upstream Source								
2008	Red River Basin	0226	South Fork Wichita River	chloride	General Use	5c	NS	NPS- Natural Sources NPS- Upstream Source								
2008	Trinity River Basin	0803	Lake Livingston	sulfate	General Use	5c	NS	UNK- Source Unknown								
2008	Trinity River Basin	0812	West Fork Trinity River Above Bridgeport Reservoir	chloride	General Use	5b	NS	NPS- Non-Point Source PS- Point Source Unknown	chloride	Technical Assistance and Implementation in West Fork of the Trinity River Watershed	This project will provide technical assistance to landowners in developing and implementing WQMPs within the West Fork of the Trinity River Watershed.	TSSWCB	NPS	Report Preparation	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.
2008	Trinity River Basin	0812	West Fork Trinity River Above Bridgeport Reservoir	total dissolved solids	General Use	5b	FS	NPS- Non-Point Source PS- Point Source Unknown	total dissolved solids	Envirocast Phase II	environmental news coverage and building project recognition, credibility and reliability with the public. Watershed-related stories will continue to be featured on-the-air, including promotions for locally driven public education events, thereby encouraging viewers to visit the e-Life Web site to learn more about their watershed and how to participate in local NPS pollution	TSSWCB	NPS	In Progress	IMA	The projects for these impairments implement activities (infrastructure education, etc) specifically targeting the impairment but do not include monitoring activities.
2008	Trinity River Basin	0812	West Fork Trinity River Above Bridgeport Reservoir	total dissolved solids	General Use	5b	FS	NPS- Non-Point Source PS- Point Source Unknown	total dissolved solids	Archer/Jack Counties Saltwater Minimization	The Railroad Comm. is conducting well plugging activities in an effort to reduce TDS and Chloride concentrations in the Red/Trinity River basins	NPS	NPS	Completed	AEF	The projects for these impairments implement activities specifically targeting the impairment identified and collects data to evaluate the effectiveness of implementation
2008	Trinity River Basin	0812	West Fork Trinity River Above Bridgeport Reservoir	total dissolved solids	General Use	5b	FS	NPS- Non-Point Source PS- Point Source Unknown	total dissolved solids	Envirocast: Increasing Nonpoint Source Pollution Prevention Through Watershed Awareness in the Upper Trinity River Watershed	The principal goal of this project is to improve water quality in the Upper Trinity River Watershed by initiating a local public education process to dramatically increase awareness about local environmental conditions and the individual, voluntary	TSSWCB	NPS	Completed	IMA	The projects for these impairments implement activities (infrastructure, education, etc) specifically targeting the impairment but do not include monitoring activities.
2008	Trinity River Basin	0812	West Fork Trinity River Above Bridgeport Reservoir	chloride	General Use	5b	NS	NPS- Non-Point Source PS- Point Source Unknown	chloride	Envirocast Phase II	Phase two consists of increasing local environmental news coverage and building project recognition, credibility and reliability with the public. Watershed-related stories will continue to be featured on-the-air, including promotions for locally driven public education events, thereby encouraging viewers to visit the e-Life Web site to learn more about their watershed and how to participate in local NPS pollution	TSSWCB	NPS	In Progress	IMA	The projects for these impairments implement activities (infrastructure education, etc) specifically targeting the impairment but do not include monitoring activities.
2008	Trinity River Basin	0812	West Fork Trinity River Above Bridgeport Reservoir	chloride	General Use	5b	NS	NPS- Non-Point Source PS- Point Source Unknown	chloride	Archer/Jack Counties Saltwater Minimization	The Railroad Comm. is conducting well plugging activities in an effort to reduce TDS and Chloride concentrations in the Red/Trinity River basins	NPS	NPS	Completed	AEF	The projects for these impairments implement activities specifically targeting the impairment identified and collects data to evaluate the effectiveness of implementation

2008	Trinity River Basin	0812	West Fork Trinity River Above Bridgeport Reservoir	chloride	General Use	5b	NS	NPS- Non-Point Source PS- Point Source Unknown	chloride	Envirocast®: Increasing Nonpoint Source Pollution Prevention Through Watershed Awareness in the Upper Trinity River Watershed	The principal goal of this project is to improve water quality in the Upper Trinity River Watershed by initiating a local public education process to dramatically increase awareness about local environmental conditions and the individual, voluntary measures that the public can take to prevent nonpoint source (NPS) pollution. This effort is designed to initiate systemic change in the attitude and behavior of citizens through a unique blend of media, utilizing environmental science and meteorological expertise packaged specifically to expand the role of TV weather reporting as a recognized	TSSWCB	NPS	Completed	IMA	The projects for these impairments implement activities (infrastructure, education, etc) specifically targeting the impairment but do not include monitoring activities.
2008	Trinity River Basin	0812	West Fork Trinity River Above Bridgeport Reservoir	total dissolved solids	General Use	5b	FS	NPS- Non-Point Source PS- Point Source Unknown	total dissolved solids	Technical Assistance and Implementation in West Fork of the Trinity River Watershed	This project will provide technical assistance to landowners in developing and implementing WQMPs within the West Fork of the Trinity River Watershed.	TSSWCB	NPS	Report Preparation	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.
2008	Trinity River Basin	0819	East Fork Trinity River	chloride	General Use	5b	NS	PS- Point Source Unknown UNK- Source Unknown								
2008	Trinity River Basin	0819	East Fork Trinity River	sulfate	General Use	5b	NS	PS- Point Source Unknown UNK- Source Unknown								
2008	Trinity River Basin	0819	East Fork Trinity River	total dissolved solids	General Use	5b	NS	PS- Point Source Unknown UNK- Source Unknown								
2008	San Jacinto-Brazos Coastal Basin	1102	Clear Creek Above Tidal	total dissolved solids	General Use	4a	NS	NPS- Petroleum/Natural Gas Activities	total dissolved solids	Clear Creek Above Tidal Continuous Water Quality Monitoring (CWQM) Project.	This project supports the ongoing TMDL activities to reduce total dissolved solids in Clear Creek.	SWQM	CWQMN	Sampling	EFM	are collecting data (modelling, monitoring, etc) to evaluate the effectiveness of implementation activities.
2008	San Jacinto-Brazos Coastal Basin	1102	Clear Creek Above Tidal	total dissolved solids	General Use	4a	NS	NPS- Petroleum/Natural Gas Activities	total dissolved solids	Broad-based Communication and Forecasting for Environmental Quality	website for water quality and other environmental issues and environmental quality broadcast spots to educate the public in the target watershed in partnership with StormCenter Communications Inc. and Houston Channel 11 (CBS Affiliate). The project will also develop partnerships with state, federal and regional agencies and local governments as local content providers to provide information for the website and	TSSWCB	NPS	In Progress	IMA	The projects for these impairments implement activities (infrastructure, education, etc) specifically targeting the impairment but do not include monitoring activities.
2008	San Jacinto-Brazos Coastal Basin	1102	Clear Creek Above Tidal	total dissolved solids	General Use	4a	NS	NPS- Petroleum/Natural Gas Activities	total dissolved solids	Clear Creek - Dissolved Solids	TMDL for chloride and total dissolved solids exceeding standards	TMDL	TMDL	Completed	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.
2008	San Jacinto-Brazos Coastal Basin	1102	Clear Creek Above Tidal	total dissolved solids	General Use	4a	NS	NPS- Petroleum/Natural Gas Activities	total dissolved solids	Clear Creek - Dissolved Solids - Implementation Plan	Prepare the Implementation Plan for the Clear Creek - Dissolved Solids TMDL	TMDL	IP	Completed	IPD	The projects for these impairments will develop implementation plans for addressing the impairment.
2008	Brazos River Basin	1205	Lake Granbury	chloride	General Use	5c	NS	NPS- Natural Sources								
2008	Brazos River Basin	1205	Lake Granbury	chloride in finished drinking water	Public Water Supply Use		CS	NPS- Natural Sources								
2008	Brazos River Basin	1205	Lake Granbury	total dissolved solids in finished drinking water	Public Water Supply Use		CS	NPS- Natural Sources								
2008	Brazos River Basin	1205	Lake Granbury	demineralization costs	Public Water Supply Use		CS	NPS- Natural Sources								
2008	Brazos River Basin	1206	Brazos River Below Possum Kingdom Lake	chloride	General Use	5b	NS	NPS- Natural Sources								
2008	Brazos River Basin	1207	Possum Kingdom Lake	demineralization costs	Public Water Supply Use		CS	NPS- Natural Sources								
2008	Brazos River Basin	1214	San Gabriel River	chloride	General Use	5c	NS	UNK- Source Unknown								
2008	Brazos River Basin	1214	San Gabriel River	sulfate	General Use	5c	NS	UNK- Source Unknown								
2008	Brazos River Basin	1227	Nolan River	chloride	General Use	5b	NS	PS- Municipal Point Source Discharges	chloride	Criteria Evaluation	Criteria evaluation for consideration in next surface water quality standards revision.	WQS	SS	Report Preparation	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.

2008	Brazos River Basin	1227	Nolan River	sulfate	General Use	5b	NS	PS- Municipal Point Source Discharges	sulfate	Criteria Evaluation	Criteria evaluation for consideration in next surface water quality standards revision.	WQS	SS	Report Preparation	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.
2008	Brazos River Basin	1227	Nolan River	total dissolved solids	General Use	5b	NS	PS- Municipal Point Source Discharges	total dissolved solids	Criteria Evaluation	Criteria evaluation for consideration in next surface water quality standards revision.	WQS	SS	Report Preparation	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.
2008	Brazos River Basin	1229	Paluxy River /North Paluxy River	total dissolved solids	General Use	5c	NS	UNK- Source Unknown								
2008	Brazos River Basin	1229	Paluxy River /North Paluxy River	chloride	General Use	5c	NS	UNK- Source Unknown								
2008	Brazos River Basin	1229	Paluxy River /North Paluxy River	sulfate	General Use	5c	NS	UNK- Source Unknown								
2008	Brazos River Basin	1231	Lake Graham	total dissolved solids	General Use		CN	NPS- Natural Sources								
2008	Brazos River Basin	1235	Lake Stamford	chloride in finished drinking water	Public Water Supply Use		CS	NPS- Natural Sources								
2008	Brazos River Basin	1236	Fort Phantom Hill Reservoir	demineralization costs	Public Water Supply Use		CS	NPS- Natural Sources								
2008	Brazos River Basin	1238	Salt Fork Brazos River	chloride	General Use	5b	NS	NPS- Natural Sources	chloride	Criteria Evaluation	Criteria evaluation for consideration in next surface water quality standards revision.	WQS	SS	Report Preparation	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.
2008	Brazos River Basin	1240	White River Lake	chloride	General Use	5c	NS	NPS- Natural Sources	chloride	Criteria Evaluation	Criteria evaluation for consideration in next surface water quality standards revision.	WQS	SS	Report Preparation	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.
2008	Brazos River Basin	1240	White River Lake	chloride	General Use	5c	NS	NPS- Natural Sources	chloride	West Texas - TDS	Assessment of water quality for chloride and total dissolved solids in three west Texas water bodies.	TMDL	SS	Report Preparation	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.
2008	Brazos River Basin	1240	White River Lake	total dissolved solids	General Use	5c	NS	NPS- Natural Sources	total dissolved solids	West Texas - TDS	Assessment of water quality for chloride and total dissolved solids in three west Texas water bodies.	TMDL	SS	Report Preparation	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.
2008	Brazos River Basin	1240	White River Lake	sulfate	General Use		CN	NPS- Natural Sources	sulfate	West Texas - TDS	Assessment of water quality for chloride and total dissolved solids in three west Texas water bodies.	TMDL	SS	Report Preparation	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.
2008	Brazos River Basin	1241	Double Mountain Fork Brazos River	chloride	General Use	5b	NS	NPS- Natural Sources								
2008	Brazos River Basin	1241	Double Mountain Fork Brazos River	total dissolved solids	General Use		CN	NPS- Natural Sources								
2008	Brazos River Basin	1242	Brazos River Above Navasota River	demineralization costs	Public Water Supply Use		CS	NPS- Natural Sources								
2008	Colorado River Basin	1407A	Clear Creek	total dissolved solids	General Use		CN	NPS- Impacts from Abandoned Mine Lands (inactive)								
2008	Colorado River Basin	1407A	Clear Creek	sulfate	General Use		CN	NPS- Impacts from Abandoned Mine Lands (inactive)								

2008	Colorado River Basin	1411	E. V. Spence Reservoir	sulfate	General Use	4a	NS	NPS- Natural Sources	sulfate	Mathematical Model for Dispersal of Leaf Beetle, Diorhabda Elongata from Old World released in US for Biological Control of Invasive Saltcedar	The goal of the project is to aid in the implementation Plan for Sulfate and Total Dissolved Solids (TMDLs) in the J.B. Thomas, E.V. Spence and O.H. Ivey Reservoirs by biological control of saltcedar in riparian areas along the Colorado River of Texas and its tributaries.	TSSWCB	NPS	In Progress	EFM	The projects for these impairments are collecting data (modelling, monitoring, etc) to evaluate the effectiveness of implementation activities.
2008	Colorado River Basin	1411	E. V. Spence Reservoir	sulfate	General Use	4a	NS	NPS- Natural Sources	sulfate	Upper Colorado Saltcedar Control Project: Biological Control Component	The project will demonstrate the usefulness of biologically treating saltcedar in the Colorado River Basin in an effort to reduce NPS pollution loadings resulting from saltcedar on agricultural lands.	TSSWCB	NPS	Report Preparation	AEF	The projects for these impairments implement activities specifically targeting the impairment identified and collects data to evaluate the effectiveness of implementation
2008	Colorado River Basin	1411	E. V. Spence Reservoir	total dissolved solids	General Use	4a	NS	NPS- Natural Sources	total dissolved solids	E.V. Spence Reservoir - TDS	TMDL for total dissolved solids and sulfate in E.V. Spence Reservoir	TMDL	TMDL	Completed	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.
2008	Colorado River Basin	1411	E. V. Spence Reservoir	sulfate	General Use	4a	NS	NPS- Natural Sources	sulfate	E.V. Spence Reservoir - TDS	TMDL for total dissolved solids and sulfate in E.V. Spence Reservoir	TMDL	TMDL	Completed	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.
2008	Colorado River Basin	1411	E. V. Spence Reservoir	total dissolved solids	General Use	4a	NS	NPS- Natural Sources	total dissolved solids	Produced Water Impacts to Surface Water Quality in the Upper Colorado Basin Upstream of EV Spence.	nature and extent of known salinity contamination thought to be contributing to water quality problems in Spence Reservoir, developing remediation/abatement alternatives or Best Management Practices (BMPs), and implementing the BMPs. Additional project information can be viewed at http://www.rrc.state.tx.us/divisions/og/site	NPS	NPS	Sampling	AEF	The projects for these impairments implement activities specifically targeting the impairment identified and collects data to evaluate the effectiveness of implementation activities.
2008	Colorado River Basin	1411	E. V. Spence Reservoir	total dissolved solids	General Use	4a	NS	NPS- Natural Sources	total dissolved solids	Produced Water Impacts to Surface Water Quality in the Upper Colorado Basin Upstream of EV Spence.	The project consists of investigating the nature and extent of known salinity contamination thought to be contributing to water quality problems in Spence Reservoir, developing remediation/abatement alternatives or Best Management Practices (BMPs), and implementing the BMPs. Additional project information can be viewed at http://www.rrc.state.tx.us/divisions/og/site	NPS	NPS	Sampling	AEF	The projects for these impairments implement activities specifically targeting the impairment identified and collects data to evaluate the effectiveness of implementation activities.
2008	Colorado River Basin	1411	E. V. Spence Reservoir	total dissolved solids	General Use	4a	NS	NPS- Natural Sources	total dissolved solids	Upper Colorado Phase II Saltwater Minimization	The Railroad Comm. is conducting well plugging activities in an effort to reduce TDS and Chloride concentrations in the original E. V. Spence project area	NPS	NPS	Completed	AEF	The projects for these impairments implement activities specifically targeting the impairment identified and collects data to evaluate the effectiveness of implementation
2008	Colorado River Basin	1411	E. V. Spence Reservoir	total dissolved solids	General Use	4a	NS	NPS- Natural Sources	total dissolved solids	E.V. Spence Reservoir - TDS - Implementation Plan	Prepare Implementation Plan for E.V. Spence Reservoir - TDS for TDS and sulfate	TMDL	IP	Completed	IPD	The projects for these impairments will develop implementation plans for addressing the impairment.
2008	Colorado River Basin	1411	E. V. Spence Reservoir	total dissolved solids	General Use	4a	NS	NPS- Natural Sources	total dissolved solids	Upper Colorado Saltcedar Control Project: Biological Control Component	The project will demonstrate the usefulness of biologically treating saltcedar in the Colorado River Basin in an effort to reduce NPS pollution loadings resulting from saltcedar on agricultural lands.	TSSWCB	NPS	Report Preparation	AEF	The projects for these impairments implement activities specifically targeting the impairment identified and collects data to evaluate the effectiveness of implementation activities.
2008	Colorado River Basin	1411	E. V. Spence Reservoir	total dissolved solids	General Use	4a	NS	NPS- Natural Sources	total dissolved solids	Targeted Brush Control in the E.V. Spence Reservoir Watershed	The goal of this project is to aid in implementing the Implementation Plan for Sulfate and Total Dissolved Solids TMDLs in the E.V. Spence Reservoir by chemically treating saltcedar in riparian areas along the Colorado River and its tributaries in an effort to reduce nonpoint source (NPS) pollution loadings resulting from invasive brush species on agricultural lands.	TSSWCB	NPS	Report Preparation	IMA	The projects for these impairments implement activities (infrastructure education, etc) specifically targeting the impairment but do not include monitoring activities.
2008	Colorado River Basin	1411	E. V. Spence Reservoir	total dissolved solids	General Use	4a	NS	NPS- Natural Sources	total dissolved solids	Mathematical Model for Dispersal of Leaf Beetle, Diorhabda Elongata from Old World released in US for Biological Control of Invasive Saltcedar	The goal of the project is to aid in the implementation Plan for Sulfate and Total Dissolved Solids (TMDLs) in the J.B. Thomas, E.V. Spence and O.H. Ivey Reservoirs by biological control of saltcedar in riparian areas along the Colorado River of Texas and its tributaries.	TSSWCB	NPS	In Progress	EFM	The projects for these impairments are collecting data (modelling, monitoring, etc) to evaluate the effectiveness of implementation activities.

2008	Colorado River Basin	1411	E. V. Spence Reservoir	sulfate	General Use	4a	NS	NPS- Natural Sources	sulfate	Upper Colorado Phase II Saltwater Minimization	The Railroad Comm. is conducting well plugging activities in an effort to reduce TDS and Chloride concentrations in the original E. V. Spence project area	NPS	NPS	Complete d	AEF	The projects for these impairments implement activities specifically targeting the impairment identified and collects data to evaluate the effectiveness of implementation
2008	Colorado River Basin	1411	E. V. Spence Reservoir	sulfate	General Use	4a	NS	NPS- Natural Sources	sulfate	E.V. Spence Reservoir - TDS - Implementation Plan	Prepare Implementation Plan for E.V. Spence Reservoir - TDS for TDS and sulfate	TMDL	IP	Complete d	IPD	The projects for these impairments will develop implementation plans for addressing the impairment.
2008	Colorado River Basin	1411	E. V. Spence Reservoir	sulfate	General Use	4a	NS	NPS- Natural Sources	sulfate	Targeted Brush Control in the E.V. Spence Reservoir Watershed	The goal of this project is to aid in implementing the Implementation Plan for Sulfate and Total Dissolved Solids TMDLs in the E.V. Spence Reservoir by chemically treating saltcedar in riparian areas along the Colorado River and its tributaries in an effort to reduce nonpoint source (NPS) pollution loadings resulting from invasive brush species on agricultural lands.	TSSWCB	NPS	Report Preparatio n	IMA	The projects for these impairments implement activities (infrastructure, education, etc) specifically targeting the impairment but do not include monitoring activities.
2008	Colorado River Basin	1411	E. V. Spence Reservoir	sulfate	General Use	4a	NS	NPS- Natural Sources	sulfate	Beals Creek and Colorado River above E.V. Spence Reservoir Cont. Water Quality Mon. (CWQM) Project.	CRMWD operates a diverted water supply system which functions to prevent highly mineralized water occuring at base and low flow conditions in the Colorado River and Beals Creek (a tributary to the Colorado River) from reaching E.V. Spence Reservoir. Poor quality "normal flow" surface water is captured and pumped to nearby storage reservoirs for evaporation. The better quality "flood flows" are allowed to bypass the pumping station and travel downstream to E.V. Spence Reservoir. By employing a CWQM system, the data generated is used to monitor changes in salt concentrations (using specific conductance) during base flow and flood conditions to assist CRMWD in managing the diversions and improving the water supply.	SWQM	CWQMN	Sampling	AEF	The projects for these impairments implement activities specifically targeting the impairment identified and collects data to evaluate the effectiveness of implementation activities.
2008	Colorado River Basin	1411	E. V. Spence Reservoir	total dissolved solids	General Use	4a	NS	NPS- Natural Sources	total dissolved solids	Beals Creek and Colorado River above E.V. Spence Reservoir Cont. Water Quality Mon. (CWQM) Project.	CRMWD operates a diverted water supply system which functions to prevent highly mineralized water occuring at base and low flow conditions in the Colorado River and Beals Creek (a tributary to the Colorado River) from reaching E.V. Spence Reservoir. Poor quality "normal flow" surface water is captured and pumped to nearby storage reservoirs for evaporation. The better quality "flood flows" are allowed to bypass the pumping station and travel downstream to E.V. Spence Reservoir. By employing a CWQM system, the data generated is used to monitor changes in salt concentrations (using specific conductance) during base flow and flood conditions to assist CRMWD in managing the diversions and improving the water supply.	SWQM	CWQMN	Sampling	AEF	The projects for these impairments implement activities specifically targeting the impairment identified and collects data to evaluate the effectiveness of implementation activities.
2008	Colorado River Basin	1413	Lake J. B. Thomas	chloride	General Use	5c	NS	NPS- Natural Sources								
2008	Colorado River Basin	1425	O. C. Fisher Lake	chloride	General Use	5c	NS	NPS- Natural Sources	chloride	West Texas - TDS	Assessment of water quality for chloride and total dissolved solids in three west Texas water bodies.	TMDL	SS	Report Preparatio n	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.
2008	Colorado River Basin	1426	Colorado River Below E. V. Spence Reservoir	total dissolved solids	General Use	4a	NS	NPS- Natural Sources	total dissolved solids	Runnels County Saltwater Minimization	The Railroad Comm. is conducting well plugging activities in an effort to reduce TDS and Chloride concentrations downstream of the E. V. Spence Reservoir	NPS	NPS	Complete d	AEF	The projects for these impairments implement activities specifically targeting the impairment identified and collects data to evaluate the effectiveness of implementation activities.

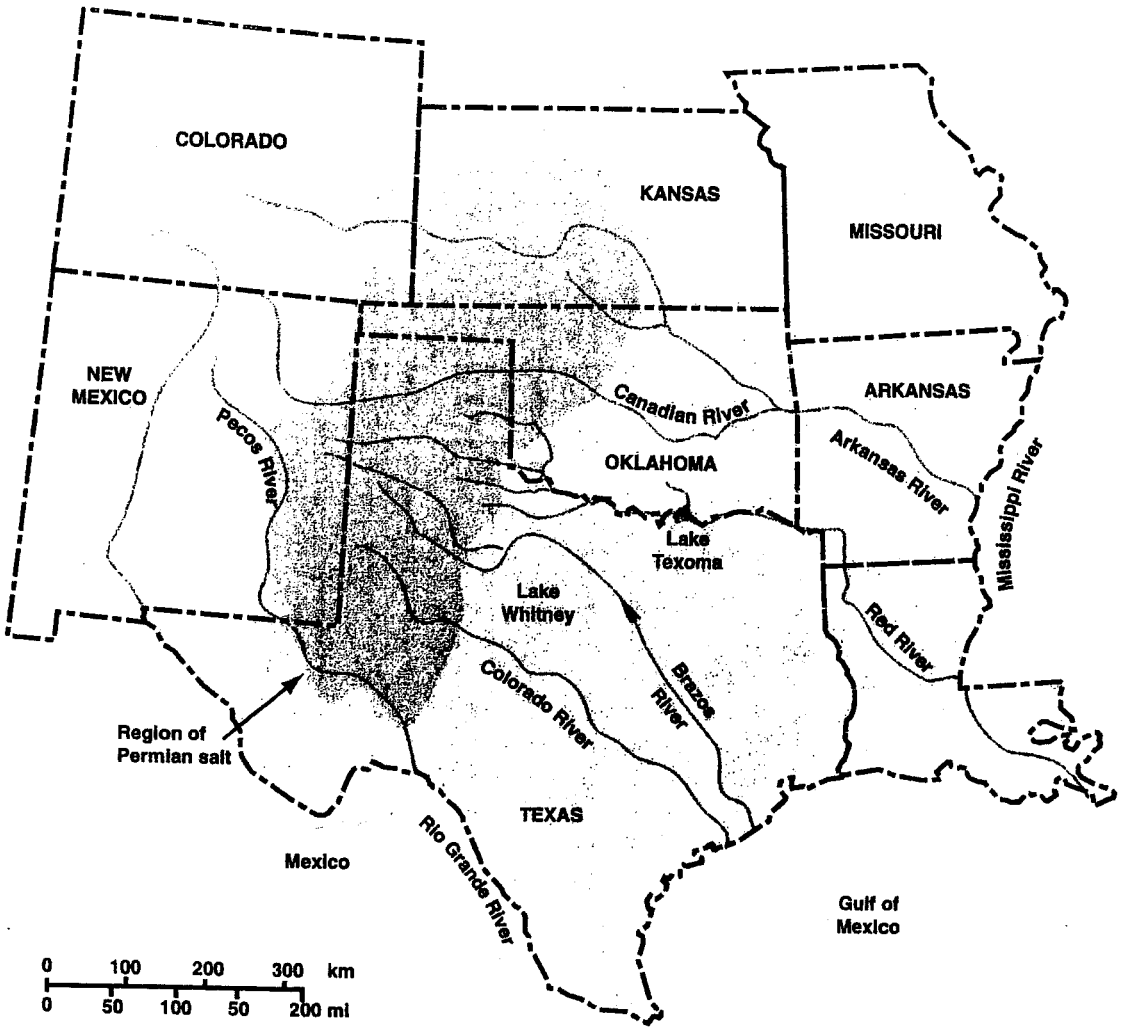
2008	Colorado River Basin	1426	Colorado River Below E. V. Spence Reservoir	total dissolved solids	General Use	4a	NS	NPS- Natural Sources	total dissolved solids	Produced Water Impacts to Surface Water in the Upper Colorado River Basin Downstream of the E. V. Spence Reservoir	nature and extent of known salinity contamination thought to be contributing to water quality problems in Spence Reservoir, developing remediation/abatement alternatives or Best Management Practices (BMPs), and implementing the BMPs. Additional project information can be viewed at http://www.rrc.state.tx.us/divisions/og/site	NPS	NPS	Sampling	AEF	The projects for these impairments implement activities specifically targeting the impairment identified and collects data to evaluate the effectiveness of implementation activities.
2008	Colorado River Basin	1426	Colorado River Below E. V. Spence Reservoir	total dissolved solids	General Use	4a	NS	NPS- Natural Sources	total dissolved solids	Produced Water Impacts to Surface Water Quality in the Upper Colorado Basin Upstream of EV Spence.	nature and extent of known salinity contamination thought to be contributing to water quality problems in Spence Reservoir, developing remediation/abatement alternatives or Best Management Practices (BMPs), and implementing the BMPs. Additional project information can be viewed at http://www.rrc.state.tx.us/divisions/og/site	NPS	NPS	Sampling	AEF	The projects for these impairments implement activities specifically targeting the impairment identified and collects data to evaluate the effectiveness of implementation activities.
2008	Colorado River Basin	1426	Colorado River Below E. V. Spence Reservoir	total dissolved solids	General Use	4a	NS	NPS- Natural Sources	total dissolved solids	Produced Water Impacts to Surface Water Quality in the Upper Colorado Basin Upstream of EV Spence.	nature and extent of known salinity contamination thought to be contributing to water quality problems in Spence Reservoir, developing remediation/abatement alternatives or Best Management Practices (BMPs), and implementing the BMPs. Additional project information can be viewed at http://www.rrc.state.tx.us/divisions/og/site	NPS	NPS	Sampling	AEF	The projects for these impairments implement activities specifically targeting the impairment identified and collects data to evaluate the effectiveness of implementation activities.
2008	Colorado River Basin	1426	Colorado River Below E. V. Spence Reservoir	total dissolved solids	General Use	4a	NS	NPS- Natural Sources	total dissolved solids	Upper Colorado River Below E.V. Spence - Chloride, TDS - Implementation Plan	Prepare the Implementation Plan for the Upper Colorado River Below E.V. Spence - Chloride, TDS TMDL	TMDL	IP	Completed	IPD	The projects for these impairments will develop implementation plans for addressing the impairment.
2008	Colorado River Basin	1426	Colorado River Below E. V. Spence Reservoir	total dissolved solids	General Use	4a	NS	NPS- Natural Sources	total dissolved solids	Upper Colorado River Below E.V. Spence - Chloride, TDS	TMDL for exceeding chloride, and total dissolved solids standards	TMDL	TMDL	Completed	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.
2008	Colorado River Basin	1426	Colorado River Below E. V. Spence Reservoir	chloride	General Use	4a	NS	NPS- Natural Sources	chloride	Runnels County Saltwater Minimization	The Railroad Comm. is conducting well plugging activities in an effort to reduce TDS and Chloride concentrations downstream of the E. V. Spence Reservoir	NPS	NPS	Completed	AEF	Implement activities specifically targeting the impairment identified and collects data to evaluate the effectiveness of implementation activities.
2008	Colorado River Basin	1426	Colorado River Below E. V. Spence Reservoir	chloride	General Use	4a	NS	NPS- Natural Sources	chloride	Upper Colorado River Below E.V. Spence - Chloride, TDS	TMDL for exceeding chloride, and total dissolved solids standards	TMDL	TMDL	Completed	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.
2008	Colorado River Basin	1426	Colorado River Below E. V. Spence Reservoir	chloride	General Use	4a	NS	NPS- Natural Sources	chloride	Upper Colorado River Below E.V. Spence - Chloride, TDS - Implementation Plan	Prepare the Implementation Plan for the Upper Colorado River Below E.V. Spence - Chloride, TDS TMDL	TMDL	IP	Completed	IPD	The projects for these impairments will develop implementation plans for addressing the impairment.
2008	Colorado River Basin	1426	Colorado River Below E. V. Spence Reservoir	total dissolved solids	General Use	4a	NS	NPS- Natural Sources	total dissolved solids	Produced Water Impacts to Surface Water in the Upper Colorado River Basin Downstream of the E. V. Spence Reservoir	nature and extent of known salinity contamination thought to be contributing to water quality problems in Spence Reservoir, developing remediation/abatement alternatives or Best Management Practices (BMPs), and implementing the BMPs. Additional project information can be viewed at http://www.rrc.state.tx.us/divisions/og/site	NPS	NPS	Sampling	AEF	The projects for these impairments implement activities specifically targeting the impairment identified and collects data to evaluate the effectiveness of implementation activities.
2006	Colorado River Basin	1426A	Oak Creek Reservoir (unclassified water body)	sulfate in finished drinking water	Public Water Supply Use		CS	NPS- Natural Sources								
2006	Nueces River Basin	2106	Nueces/Lower Frio River	total dissolved solids	General Use	5c	NS	UNK- Source Unknown NPS- Non-Point Source								

2008	Nueces-Rio Grande Coastal Basin	2204	Petronila Creek Above Tidal	sulfate	General Use	4a	NS	NPS- Petroleum/Natural Gas Production Activities (Permitted)	sulfate	Petronilla Creek Continuous Water Quality Monitoring (CWQM) Project.	The CWQM site on Petronila Creek was requested by the TMDL Team to assist the Texas Railroad Commission in an attempt to quantify and locate sources of chloride, sulfate, and TDS impairments to Segment 2204. The site is anticipated to operate for at least four years.	SWQM	CWQMN	Planning	EFM	The projects for these impairments are collecting data (modelling, monitoring, etc) to evaluate the effectiveness of implementation activities.
2008	Nueces-Rio Grande Coastal Basin	2204	Petronila Creek Above Tidal	total dissolved solids	General Use	4a	NS	NPS- Petroleum/Natural Gas Production Activities (Permitted)	total dissolved solids	Produced Water Impacts to Surface Water in the Nueces-Rio Grande Coastal Basin (Petronila Creek)	nature and extent of known salinity contamination thought to be contributing to water quality problems in the impaired reach of Petronila Creek, developing remediation/abatement alternatives or Best Management Practices (BMPs), and implementing the BMPs. Additional project information can be viewed at http://www.rrc.state.tx.us/divisions/og/site	NPS	NPS	Sampling	AEF	The projects for these impairments implement activities specifically targeting the impairment identified and collects data to evaluate the effectiveness of implementation activities.
2008	Nueces-Rio Grande Coastal Basin	2204	Petronila Creek Above Tidal	total dissolved solids	General Use	4a	NS	NPS- Petroleum/Natural Gas Production Activities (Permitted)	total dissolved solids	Petronila Creek - Sulfate, Chloride, TDS	TMDL for exceeding chloride, sulfate, and total dissolved solids standards	TMDL	TMDL	Complete d	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.
2008	Nueces-Rio Grande Coastal Basin	2204	Petronila Creek Above Tidal	total dissolved solids	General Use	4a	NS	NPS- Petroleum/Natural Gas Production Activities (Permitted)	total dissolved solids	Petronilla Creek Continuous Water Quality Monitoring (CWQM) Project.	The CWQM site on Petronila Creek was requested by the TMDL Team to assist the Texas Railroad Commission in an attempt to quantify and locate sources of chloride, sulfate, and TDS impairments to Segment 2204. The site is anticipated to operate for at least four years.	SWQM	CWQMN	Planning	EFM	The projects for these impairments are collecting data (modelling, monitoring, etc) to evaluate the effectiveness of implementation activities.
2008	Nueces-Rio Grande Coastal Basin	2204	Petronila Creek Above Tidal	total dissolved solids	General Use	4a	NS	NPS- Petroleum/Natural Gas Production Activities (Permitted)	total dissolved solids	Produced Water Impacts to Surface Water in the Nueces-Rio Grande Coastal Basin (Petronila Creek)	nature and extent of known salinity contamination thought to be contributing to water quality problems in the impaired reach of Petronila Creek, developing remediation/abatement alternatives or Best Management Practices (BMPs), and implementing the BMPs. Additional project information can be viewed at http://www.rrc.state.tx.us/divisions/og/site	NPS	NPS	Sampling	AEF	The projects for these impairments implement activities specifically targeting the impairment identified and collects data to evaluate the effectiveness of implementation activities.
2008	Nueces-Rio Grande Coastal Basin	2204	Petronila Creek Above Tidal	total dissolved solids	General Use	4a	NS	NPS- Petroleum/Natural Gas Production Activities (Permitted)	total dissolved solids	Petronila Creek Phase II Saltwater Minimization	The Railroad Comm. is conducting well plugging activities in an effort to reduce TDS and Chloride concentrations in the original Petronila Creek project area	NPS	NPS	Report Preparatio n	AEF	The projects for these impairments implement activities specifically targeting the impairment identified and collects data to evaluate the effectiveness of implementation activities.
2008	Nueces-Rio Grande Coastal Basin	2204	Petronila Creek Above Tidal	sulfate	General Use	4a	NS	NPS- Petroleum/Natural Gas Production Activities (Permitted)	sulfate	Petronila Creek - Sulfate, Chloride, TDS	TMDL for exceeding chloride, sulfate, and total dissolved solids standards	TMDL	TMDL	Complete d	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.
2008	Nueces-Rio Grande Coastal Basin	2204	Petronila Creek Above Tidal	sulfate	General Use	4a	NS	NPS- Petroleum/Natural Gas Production Activities (Permitted)	sulfate	Petronila Creek Phase II Saltwater Minimization	The Railroad Comm. is conducting well plugging activities in an effort to reduce TDS and Chloride concentrations in the original Petronila Creek project area	NPS	NPS	Report Preparatio n	AEF	The projects for these impairments implement activities specifically targeting the impairment identified and collects data to evaluate the effectiveness of implementation activities.
2008	Nueces-Rio Grande Coastal Basin	2204	Petronila Creek Above Tidal	chloride	General Use	4a	NS	NPS- Petroleum/Natural Gas Production Activities (Permitted)	chloride	Petronila Creek - Sulfate, Chloride, TDS - Implementation Plan	Preparation of Implementation Plan for Petronila Creek - Sulfate, Chloride, TDS TMDL	TMDL	IP	Complete d	IPD	The projects for these impairments will develop implementation plans for addressing the impairment.
2008	Nueces-Rio Grande Coastal Basin	2204	Petronila Creek Above Tidal	chloride	General Use	4a	NS	NPS- Petroleum/Natural Gas Production Activities (Permitted)	chloride	Petronila Creek - Sulfate, Chloride, TDS	TMDL for exceeding chloride, sulfate, and total dissolved solids standards	TMDL	TMDL	Complete d	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.

2008	Nueces-Rio Grande Coastal Basin	2204	Petronila Creek Above Tidal	chloride	General Use	4a	NS	NPS- Petroleum/Natural Gas Production Activities (Permitted)	chloride	Petronilla Creek Continuous Water Quality Monitoring (CWQM) Project.	The CWQM site on Petronila Creek was requested by the TMDL Team to assist the Texas Railroad Commission in an attempt to quantifiy and locate sources of chloride, sulfate, and TDS impairments to Segment 2204. The site is anticipated to operate for at least four years.	SWQM	CWQMN	Planning	EFM	The projects for these impairments are collecting data (modelling, monitoring, etc) to evaluate the effectiveness of implementation activities
2008	Nueces-Rio Grande Coastal Basin	2204	Petronila Creek Above Tidal	chloride	General Use	4a	NS	NPS- Petroleum/Natural Gas Production Activities (Permitted)	chloride	Petronila Creek Phase II Saltwater Minimization	The Railroad Comm. is conducting well plugging activities in an effort to reduce TDS and Chloride concentrations in the original Petronila Creek project area	NPS	NPS	Report Preparation	AEF	The projects for these impairments implement activities specifically targeting the impairment identified and collects data to evaluate the effectiveness of implementation
2008	Nueces-Rio Grande Coastal Basin	2204	Petronila Creek Above Tidal	sulfate	General Use	4a	NS	NPS- Petroleum/Natural Gas Production Activities (Permitted)	sulfate	Petronila Creek - Sulfate, Chloride, TDS - Implementation Plan	Preparation of Implementation Plan for Petronila Creek - Sulfate, Chloride, TDS TMDL	TMDL	IP	Completed	IPD	The projects for these impairments will develop implementation plans for addressing the impairment.
2008	Nueces-Rio Grande Coastal Basin	2204	Petronila Creek Above Tidal	total dissolved solids	General Use	4a	NS	NPS- Petroleum/Natural Gas Production Activities (Permitted)	total dissolved solids	Petronila Creek - Sulfate, Chloride, TDS - Implementation Plan	Preparation of Implementation Plan for Petronila Creek - Sulfate, Chloride, TDS TMDL	TMDL	IP	Completed	IPD	The projects for these impairments will develop implementation plans for addressing the impairment.
2008	Rio Grande River Basin	2307	Rio Grande Below Riverside Diversion Dam	chloride	General Use	5c	NS	NPS- Flow Alterations from Water Diversions NPS- Irrigated Crop Production NPS- Sources Outside State Jurisdiction or Borders	chloride	Upper Rio Grande Continuous Water Quality Monitoring (CWQM) Project.	Segment 2307 was identified as impaired on the 2002 Texas Water Quality Inventory 303 (d) list for chloride and TDS. A CWQM station will help characterize the water quality in this water body.	SWQM	CWQMN	Sampling	ANM	The projects for these impairments or concerns are collecting ancillary data specific to the impairment/concern identified and will contribute to the understanding of water quality conditions but is not designed to do more than this.
2008	Rio Grande River Basin	2307	Rio Grande Below Riverside Diversion Dam	total dissolved solids	General Use	5c	NS	NPS- Flow Alterations from Water Diversions NPS- Irrigated Crop Production NPS- Sources Outside State Jurisdiction or Borders	total dissolved solids	Rio Grande Dissolved Minerals Evaluation Project	This project is a desktop analysis specifically designed to address the standards associated with total dissolved solids and chlorides on the Rio Grande below the Riverside Diversion Dam.	WQS	SS	In Progress	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.
2008	Rio Grande River Basin	2307	Rio Grande Below Riverside Diversion Dam	total dissolved solids	General Use	5c	NS	NPS- Flow Alterations from Water Diversions NPS- Irrigated Crop Production NPS- Sources Outside State Jurisdiction or Borders	total dissolved solids	West Texas - TDS	Assessment of water quality for chloride and total dissolved solids in three west Texas water bodies.	TMDL	SS	Report Preparation	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.
2008	Rio Grande River Basin	2307	Rio Grande Below Riverside Diversion Dam	total dissolved solids	General Use	5c	NS	NPS- Flow Alterations from Water Diversions NPS- Irrigated Crop Production NPS- Sources Outside State Jurisdiction or Borders	total dissolved solids	Upper Rio Grande Continuous Water Quality Monitoring (CWQM) Project, Part 2.	Segment 2306 will be identified as impaired on the 2006 Texas Water Quality Inventory 303 (d) list for TDS. Two CWQM stations will help characterize the water quality in this water body.	SWQM	CWQMN	Sampling	ANM	The projects for these impairments or concerns are collecting ancillary data specific to the impairment/concern identified and will contribute to the understanding of water quality conditions but is not designed to do more than this.
2008	Rio Grande River Basin	2307	Rio Grande Below Riverside Diversion Dam	total dissolved solids	General Use	5c	NS	NPS- Flow Alterations from Water Diversions NPS- Irrigated Crop Production NPS- Sources Outside State Jurisdiction or Borders	total dissolved solids	Upper Rio Grande Continuous Water Quality Monitoring (CWQM) Project.	Segment 2307 was identified as impaired on the 2002 Texas Water Quality Inventory 303 (d) list for chloride and TDS. A CWQM station will help characterize the water quality in this water body.	SWQM	CWQMN	Sampling	ANM	The projects for these impairments or concerns are collecting ancillary data specific to the impairment/concern identified and will contribute to the understanding of water quality conditions but is not designed to do more than this.
2008	Rio Grande River Basin	2307	Rio Grande Below Riverside Diversion Dam	chloride	General Use	5c	NS	NPS- Flow Alterations from Water Diversions NPS- Irrigated Crop Production NPS- Sources Outside State Jurisdiction or Borders	chloride	West Texas - TDS	Assessment of water quality for chloride and total dissolved solids in three west Texas water bodies.	TMDL	SS	Report Preparation	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.
2008	Rio Grande River Basin	2307	Rio Grande Below Riverside Diversion Dam	chloride	General Use	5c	NS	NPS- Flow Alterations from Water Diversions NPS- Irrigated Crop Production NPS- Sources Outside State Jurisdiction or Borders	chloride	Upper Rio Grande Continuous Water Quality Monitoring (CWQM) Project, Part 2.	Segment 2306 will be identified as impaired on the 2006 Texas Water Quality Inventory 303 (d) list for TDS. Two CWQM stations will help characterize the water quality in this water body.	SWQM	CWQMN	Sampling	ANM	The projects for these impairments or concerns are collecting ancillary data specific to the impairment/concern identified and will contribute to the understanding of water quality conditions but is not designed to do more than this.
2008	Rio Grande River Basin	2307	Rio Grande Below Riverside Diversion Dam	chloride	General Use	5c	NS	NPS- Flow Alterations from Water Diversions NPS- Irrigated Crop Production NPS- Sources Outside State Jurisdiction or Borders	chloride	Rio Grande Dissolved Minerals Evaluation Project	This project is a desktop analysis specifically designed to address the standards associated with total dissolved solids and chlorides on the Rio Grande below the Riverside Diversion Dam.	WQS	SS	In Progress	WQP	The projects for these impairments perform water quality management planning activities (TMDL, UAA for a specific impairment, assessment monitoring, etc) that develop a strategy to address the impairment.

Appendix C

FIGURE 1 Major rivers in the Southwest affected by Permian Basin salt



Appendix D

AGENDA
Senate Committee on Natural Resources
August 5, 2008, 10:00 a.m..
Region 16 Education Service Center – Head Start Center
Conference Center
1601 S. Cleveland
Amarillo, TX 79102

I. Call to Order
- Welcome - Mayor Debra McCartt, City of Amarillo

II. Texas Water Development Board
- Kevin Ward, Executive Administrator
- Robert Mace, Director, Groundwater Resources Division
- Bill Mullican, Deputy Executive Administrator, Water Science and Conservation

III. Priority Groundwater Management Area (PGMA) Update
- Kelly Mills, Team Leader, Groundwater Planning and Assessment Team, Water Supply Division, Texas Commission on Environmental Quality

IV. Emerging Groundwater Issues Panel
- Billy Howe, State Legislative Director, Texas Farm Bureau
- Greg Ellis, Executive Director, Texas Alliance of Groundwater Districts
- Brian Sledge, Attorney-at-Law, Lloyd Gosselink Rochelle & Townsend, P.C.
- Monique Norman, Attorney-at-Law

V. Groundwater Management Areas (GMA) Panels

GMA 1 Panel
- GMA 1 Chair - Danny Krienke, Board Member, North Plains GCD
- C.E. Williams, General Manager, Panhandle GCD
- Janet Guthrie, General Manager, Hemphill GCD

GMA 2 Panel
- GMA 2 Chair - Jason Coleman, General Manager, South Plains UWCD
- Jim Conkwright, General Manager, High Plains GCD
- Harvey Everhart, General Manager, Mesa UWCD
- Gary Walker, General Manager, Sandy Land UWCD

Other GMAs Panel
- Mike Mahoney, General Manager, Evergreen UWCD
- Janet Adams, General Manager, Jeff Davis and Presidio County UWCDs
- Mike Massey, General Manager, Upper Trinity GCD

VI. Municipal Supply Panel

- Kent Satterwhite, General Manager, CRMWA
- John Grant, General Manager, CRMWD
- Jarrett Atkinson, Assistant City Manager, City of Amarillo
- Tom Adams, Deputy City Manager, City of Lubbock

VII. Disposal Wells and the Reuse and Recycling of Wastewater from Oil and Gas Operations

- Doug O. Johnson, PE, Manager for Injection-Storage Permits and Support, Technical Permitting Section, Oil and Gas Division, Railroad Commission of Texas

Industry Panel

- Donna Warndof, Director of Public Affairs, TIPRO
- Bill Stevens, Executive Vice President, Texas Alliance of Energy Producers
- Ben Shepperd, Executive Vice President, Permian Basin Petroleum Association
- Jason Herrick, President of the Board of Directors, Panhandle Producers and Royalty Owners Association
- Jay Ewing, Completion/Construction Supervisor- North Texas Operations, Devon Energy
- Janet Guthrie, General Manager, Hemphill UWCD
- Jason Hill, Attorney-at-Law, Lloyd Gosselink Rochelle & Townsend, P.C.

VIII. Brackish Groundwater Panel

- Jacob M. White, EIT, NRS Consulting Engineers
- Steve Kosub, Corporate Counsel-Water Resources, San Antonio Water System
- Bill Mullican, Deputy Executive Administrator, Water Science and Conservation, Texas Water Development Board

IX. Public Testimony

X. Recess

Appendix E

AGENDA
Senate Committee on Natural Resources
May 13, 2008, 10:00 a.m.
Erik Jonsson Public Library - First Floor Auditorium
Dallas, Texas

I. Call to Order

II. Overview - Texas Water Development Board
- Carolyn Brittin, Deputy Executive Administrator, Water Planning and Information Resources
- Bill Mullican, Deputy Executive Administrator, Water Science and Conservation

III. Regional Water Supply and Conservation Panel
- Jody Puckett, Water Utilities Director, Dallas Water Utilities
- Jim Parks, General Manager, North Texas Municipal Water District
- Jim Oliver, General Manager, Tarrant Regional Water District

IV. Update on Region C Study Commission
- Jim Parks, General Manager, North Texas Municipal Water District
- Tom Duckert, Regional EHS Manager, International Paper

V. Surface Water Salinity Panel
- Herman Settemeyer, Interstate Compacts, Texas Commission on Environmental Quality, Water Supply Division
- Matt Phillips, Government and Customer Relations Manager, Brazos River Authority
- J.W. Thrasher, Commissioner, Pecos River Interstate Compact Commission
- Allan Jones, Director, Texas Water Resources Institute
- Alan Plummer, Chairman of the Board, Alan Plummer Associates, Inc.
- Sonny Kretzschmar, Project Manager, HDR Engineering, Inc.

VI. Dam Safety Audit Report
- Michael Stiernberg, Assistant Project Manager, State Auditor's Office
- John Young, Audit Manager, State Auditor's Office

VII Dam Safety Overview
- Warren Samuelson, Dam Safety Program Coordinator, Field Operations Division, Texas Commission on Environmental Quality

VIII. Dam Safety Panel
- Rex Isom, Executive Director, Texas State Soil and Water Conservation Board
- John Foster, Statewide Programs Officer, Texas State Soil and Water Conservation Board
- Mark Jordan, Manager, River Management Services, Lower Colorado River Authority
- Louie Verreault, Dam Safety Engineer, Tarrant Regional Water District
- Dean Robbins, Assistant General Manager, TWCA

IX. Public Testimony

X. Recess

Appendix F

Status of Chloride Control Projects in Texas

Project Name	Location	Status	Project Sponsor(s)	Water Supply Impacted	Project Cost	Notes
Lake Meredith Salinity Control Project	Lake Meredith (Potter, Moore, Hutchinson counties) **Region A**	Operational since September 2001	U.S.Bureau of Reclamation State of Texas Canadian River Municipal Water Authority	Canadian River Lake Meredith	Total: $10 mil Texas: $3.3 mil USBoR: $3.4 mil CRMWA: $3.6 mil O&M: $355K/year	The cause of the high chloride in the river and reservoir (reaching concentrations of up to 475 mg/l) is a shallow brine aquifer located near Logan, NM. The solution was to pump groundwater from the brine aquifer using 7 interceptor wells located near Logan, NM and inject the water back into a deeper formation.
Red River Chloride Control Projects		Two projects operational, others planned.	U.S. Army Corps of Engineers. Authorized by Flood Control Acts 1962, 1966, 1970 and modified by Water Development Act, 1970.	Red River Basin	See below	In Region B Plan as a WMS projected to supply 26,500 ac-ft of water per year by 2060.
Estelline Springs	Prairie Dog Town Fork of Red River (Hall County) **Region A**	Operational since 1964	U.S. Army Corps of Engineers	Prairie Dog Town Fork of Red River	Not available	The spring contributes almost 300 tons of chloride per day to the river. The solution was to encircle the spring with a 9-foot-high, 340-foot-diameter earthen dike to seal off flow into the river. The dike stops about 240 tons of chloride from entering the river each day.
Bateman Dam and Truscott Brine Storage Facility	South Fork Wichita River (King, Knox counties) **Regions B, G**	Operational since 1987	U.S. Army Corps of Engineers	South Fork Wichita River Lake Kemp	Not available	Brine is pumped from the low-flow Bateman Dam to the Truscott Reservoir where it is allowed to evaporate. The dam has stopped about 165 tons of chloride per day from entering the river system.
Wichita River Basin Reevaluation Projects	Wichita and Pease River basins (various counties) **Regions A, B**	Planned. These projects have been authorized and are awaiting construction pending availability of funds.	U.S. Army Corps of Engineers	Wichita River Pease River Red River Lake Kemp	$78 mil for all remaining projects over the 2009-2014 time period	The planned projects include constructing brine collection areas, evaporation fields and conveyance pipelines, and installing pumps. The projects are designed to remove about 244 tons of chloride per day from streams entering the Wichita and Red rivers.
Brazos River Natural Chloride Control Project	Brazos River (Garza, Kent, Stonewall counties) **Regions B, O**	Planned	Salt Fork Water Quality Corporation Brazos River Authority Exxon-Mobil Corporation South Plains Electric Company	Salt and Double Mountain Forks of the Brazos River Lake Possum Kingdom	In planning stage. Capital costs may range from about $4.5 mil to $152 mil depending on strategy chosen.	The planned project consists of installing shallow recovery wells in Kent and Stonewall counties. The collected water will be transported by pipeline to a solar evaporation facility near Post and the salt sold commercially. Alternatively, the water will be transported by pipeline to and treated at a Exxon-Mobil thermal evaporation facility in Kent County and distilled water extracted for sale. It is expected that this method will reduce chloride concentrations in Lake Possum Kingdom by 45%.

Status of Chloride Control Projects in Texas

Project Name	Location	Status	Project Sponsor(s)	Water Supply Impacted	Project Cost	Notes
Colorado River Chloride Control Projects						
Big Springs Chloride Control Project	Beals Creek (Howard County) **Region F**	Operational since 1985	Colorado River Municipal Water District	Beals Creek E.V. Spence Reservoir	Not Available	Poor quality, normal-flow surface water is captured and pumped into the nearby Red Draw Reservoir to evaporate.
Colorado City Chloride Control Project	Deep Creek (Mitchell County) **Region F**	Operational since 1969	Colorado River Municipal Water District	Deep Creek E.V. Spence Reservoir	Not Available	Poor quality, normal-flow surface water is captured and pumped into the nearby Barber Reservoir near Colorado City to evaporate.
Mitchell County Reservoir	(Mitchell County) **Region F**	Operational	Colorado River Municipal Water District	E.V. Spence Reservoir	Not available	Not available
Natural Dam Lake	Beals Creek (Howard County) **Region F**	Operational	Colorado River Municipal Water District	Beals Creek E.V. Spence Reservoir	Not available	Not available
Sulphur Spring Draw Reservoir	(Martin County) **Region F**	Planned (?)	Colorado River Municipal Water District	E.V. Spence Reservoir	Not available	Not available
Upper Colorado River Basin Investigation (Segment 1411)	Colorado River (Coke, Mitchell, Nolan counties) **Region F, G**	TMDL study completed in 2000. Approved by EPA in 2003.	Railroad Commission of Texas Texas Commission on Environmental Quality	Colorado River E.V. Spence Reservoir	$2.6 mil to plug 171 abandoned oil and gas wells.	Salinity in the Upper Colorado River Basin (Segment 1411) is a major water quality issue. Water quality testing of E.V. Spence Reservoir showed excessive levels of salinity. The probable cause for the elevated salinity is oil and gas activity in the region. There may be some natural contribution from the Coleman Junction Formation. In 1999, TCEQ and RRC entered into a partnership to fund plugging of 171 abandoned oil and gas wells by 2002.
Upper Colorado River Basin Investigation (Segment 1426)	Colorado River (Coke, Runnels counties) **Region F**	In Progress	Railroad Commission of Texas U.S. Environmental Protection Agency Texas Commission on Environmental Quality	Colorado River E.V. Spence Reservoir	Not available	Salinity in the Upper Colorado River Basin is a major water quality issue and has led to the river segment downstream of E.V. Spence Reservoir (Segment 1426) being included in the state's 303(d) list. The probable cause for the elevated salinity is oil and gas activity in the region. There may be some natural contribution from the Coleman Junction Formation. In 1999, TCEQ and RRC entered into a partnership to fund plugging of 197 abandoned oil and gas wells by 2003. Another 115 wells will be plugged by end 2008.

Status of Chloride Control Projects in Texas

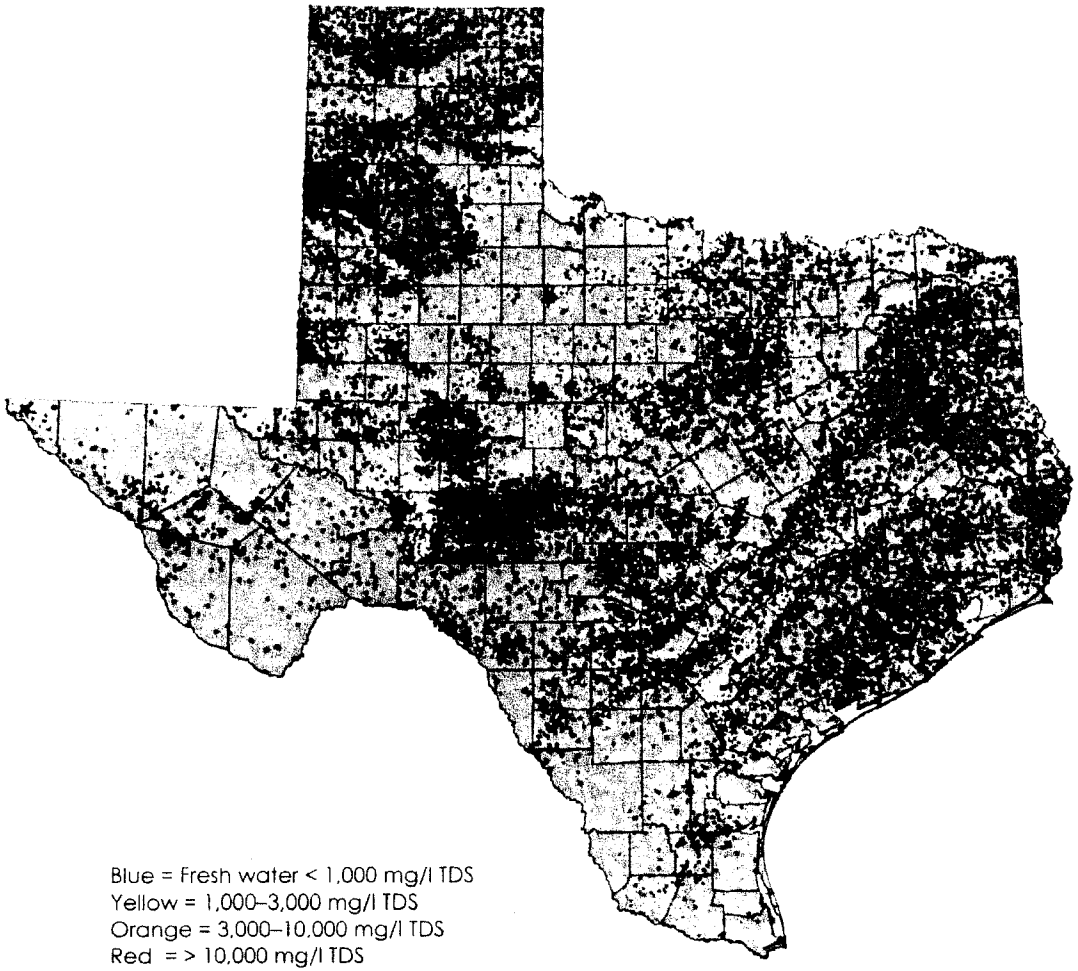
Project Name	Location	Status	Project Sponsor(s)	Water Supply Impacted	Project Cost	Notes
Malaga Bend Salinity Alleviation Project	Red Bluff Reservoir (Reeves, Loving counties) **Region F**	Operational between 1963-1976 and 2001-2003. Resumed in 2004.	Pecos River Compact Commission Red Bluff Water Power Control District State of New Mexico U.S. Geological Survey	Pecos River	Not available	The Pecos River at Malaga Bend, NM, is hydrologically connected to a saline aquifer which discharges into the river. The aim of the project is to improve the quality of water that NM delivers to TX. In the project's current form, the Red Bluff Irrigation District pumps water from a groundwater well and discharges it into several artificial ponds for evaporation. Due to several technical difficulties, the USGS has been unable to monitor the quality of water downstream.
El Paso Chloride Geophysical Investigation	Rio Grande (El Paso County) **Region E**	Investigation stage (started in 2007)	U.S. Geological Survey U.S. Bureau of Reclamation	Rio Grande	In investigation stage	Studies have shown that salinity in the Rio Grande can rise to more than 1,000 mg/l in the summer months. Using geophysical methods, the USGS has been working with the Bureau of Reclamation to determine potential sources of chloride in the El Paso area. This is a pilot study.
Rio Grande Basin Study	Rio Grande (El Paso and Hudspeth counties) **Region E**	Proposed	U.S. Army Corps of Engineers U.S. Geological Survey Texas Water Development Board	Rio Grande	Not available	Scope of work has been developed to compile existing salinity data in the Rio Grande Basin between San Acacia, NM, and Ft. Quitman, TX. The USACE has requested assistance from the USGS in this effort.
Chloride Exceedances 303(d) List	Various	Investigation in progress	Texas Commission on Environmental Quality	Various	Not applicable	TCEQ has listed at least 39 instances of chloride exceedances in its 303(d) list for 2008. Thirteen exceedances fall under Category 5b (a review of the water quality standards for this water body will be conducted before a TMDL is scheduled) while 26 fall under Category 5c (additional data and information will be collected before a TMDL is scheduled).

TWDB: 05/09/2008

Appendix G

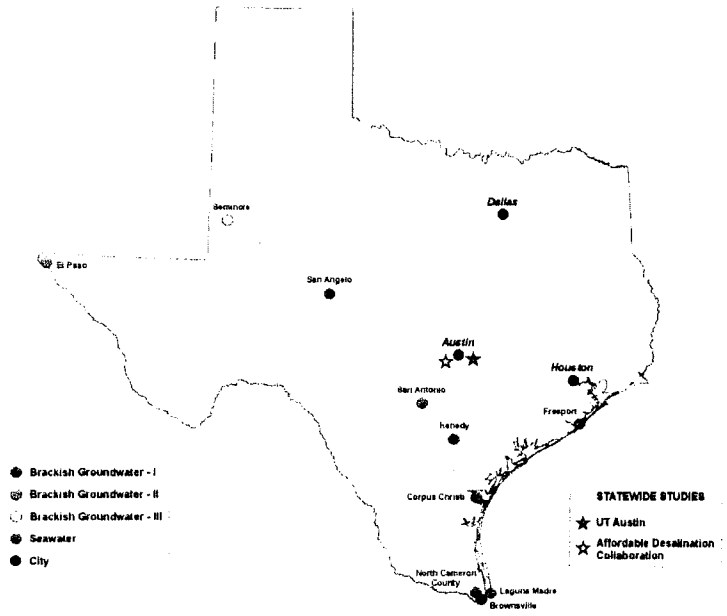
Texas Water Development Board
Brackish Groundwater Program

Brackish Groundwater Availability



Blue = Fresh water < 1,000 mg/l TDS
Yellow = 1,000–3,000 mg/l TDS
Orange = 3,000–10,000 mg/l TDS
Red = > 10,000 mg/l TDS

Brackish Groundwater Desalination Demonstration Projects



- Eight projects funded
  - $2 million in grants
  - 2 completed
  - 4 in progress
  - 2 in contract negotiation
- Demonstrate water desalination processes
- Identify and address technical challenges to implementing desalination projects
- Improve the scientific knowledge about membrane filtration processes

List of Projects and Status as of August 5, 2008

Projects authorized in 2004

Project	Project Description	Status as of August 5, 2008
	2004 Authorization	
City of Kenedy/San Antonio River Authority	The project will demonstrate the efficiencies gained by installing a new reverse osmosis (RO) system in an existing brackish groundwater desalination plant in the City of Kenedy, Karnes County.	In progress
City of San Angelo/Upper Colorado River Authority	The project assessed the suitability of the Whitehorse aquifer in eastern Irion County as a source (desalination) of brackish groundwater for the City of San Angelo.	Research completed. Report posted.
North Cameron Regional Water Supply Corporation	The project involved preparing an engineering facility roadmap for the North Cameron Regional Water Supply Corporation's brackish groundwater desalination plant which became operational in mid 2006.	Research completed. Report posted.

List of Projects and Status as of August 5, 2008

Projects authorized in 2006

Project	Project Description	Status as of August 5, 2008
	2006 Authorization	
San Antonio Water System	The project is pilot testing and assessing the cost and technical feasibility of the Vibratory Shear Enhanced Process (VSEP) as a tool for reducing the volume of brackish groundwater desalination concentrate. Additionally, the project will develop a model for evaluating enhanced recovery processes to aid in selecting concentrate management solutions for brackish groundwater desalination.	In progress
The University of Texas - Austin	The objective of the proposed research is to develop strategies to increase the recovery in reverse osmosis (RO) desalination of brackish groundwater. The researchers are investigating two possible systems to enhance recovery in conventional RO systems: anti-scalant deactivation and precipitation, and electrodialysis.	In progress
El Paso Water Utilities - PSB	Testing various technologies for enhancing recovery and reducing concentrate volume at the Kay Bailey Hutchison Desalination Plant by El Paso Water Utilities.	In progress

List of Projects and Status as of August 5, 2008

Projects authorized in 2008

Project	Project Description	Status as of August 5, 2008
	2008 Authorization	
Affordable Desalination Collaboration	Assess and demonstrate energy optimization strategies for brackish groundwater desalination.	In contract negotiation.
City of Seminole	Proposed desalination of brackish water from the Dockum Aquifer in Gaines County using wind-powered energy. The treated water will be integrated with the city's existing water treatment and distribution system for municipal use.	In contract negotiation.

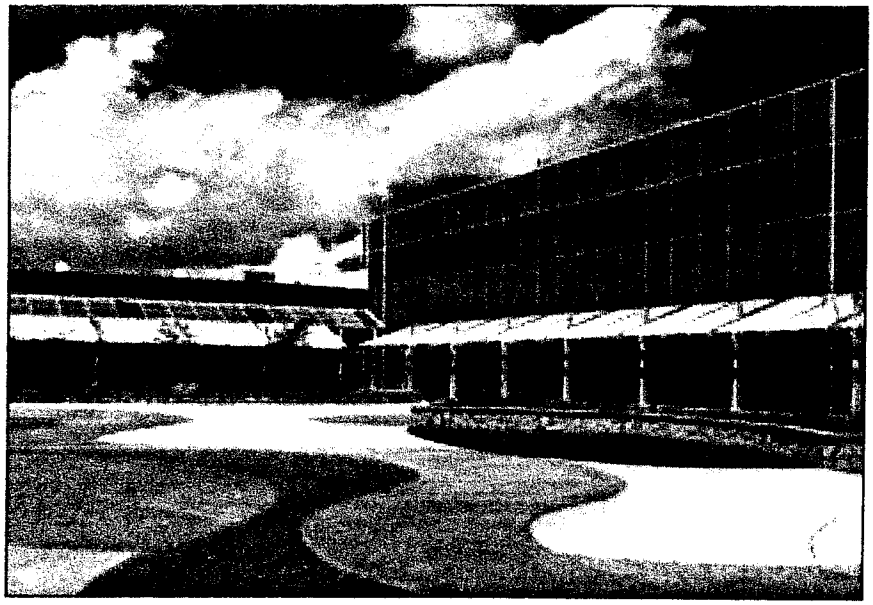
Brackish Groundwater Resource Characterization

- Lack of brackish groundwater resource data is critical challenge to implementing brackish groundwater desalination projects
- Exceptional Item in the 2010-2011 TWDB Legislative Appropriations Request:
  - $950,000 to begin a program to characterize brackish groundwater aquifers in Texas
    - $500,000 for contracts and data acquisition
    - $450,000 for 2.5 FTEs (2 geo-scientists and .5 program coordinator)

Southmost Regional Water Authority

- Treatment by reverse osmosis membranes
- Surface discharge of concentrate byproduct
- Design capacity: 7.5 million gallons per day
- Start-up: April 2004
- Cost: $26.2 million
- Unit Production Cost: $525/acre-foot

Kay Bailey Hutchison Brackish Groundwater Desalination



- Treatment by reverse osmosis membranes
- Underground injection of concentrate byproduct
- Design capacity: 27.5 million gallons per day
- Start-up: August 2007
- Cost: $87 million
- Unit Production Cost: $534/acre-foot

Appendix H

A BRIEFING

SALINE SURFACE WATER: AN IMPOTRANT WATER SOURCE

Presented To:

SENATE COMMITTEE ON NATURAL RESOURCES

By:

Alan H. Plummer, Jr., P.E., B.C.E.E.
Alan Plummer Associates, Inc.

ALAN PLUMMER ASSOCIATES, INC.
ENVIRONMENTAL ENGINEERS • DESIGNERS • SCIENTISTS

May 13, 2008

SALINE SURFACE WATER:
AN IMPORTANT WATER SOURCE

SUMMARY

- Utilizing surface saline waters can potentially satisfy a significant portion of the State's future water needs.
- Planning for the current water management strategies for Region C includes saline surface water imported from the Red River basin by the North Texas Municipal Water District (NTMWD) and Greater Texoma Utility Authority (GTUA) and potentially by the City of Dallas
- Utilizing saline surface water involves a number of challenges and impediments.
- Introducing saline surface water into our fresh water supplies will result in increasing levels of salinity in the State's fresh water bodies.
- Utilizing saline surface water must be achieved in a manner that complies with the Safe Drinking Water Act (SDWA) and the Clean Water Act (CWA), which both establish limitations and requirements relative to introducing salinity into non-saline waters.
- Monitoring salinity trends in the State's fresh water bodies is an important component of a long-term strategy.
- Achieving salinity management involves the Texas Water Development Board (TWDB) for water supply planning and research and the Texas Commission on Environmental Quality (TCEQ) and Texas Railroad Commission (TRRC) for regulatory programs.
- Using saline surface water as a water supply and protecting the State's fresh water bodies will require implementation of Best Management Practices (i.e. controlling natural salinity at the source, blending with new sources of fresh water, etc.) and performing advanced treatment (i.e. desalination, etc).
- Performing research is critical to developing science based technology relative to using saline surface water as a water supply and to protecting the State's fresh water bodies.

INTRODUCTION

Meeting the projected water demands to accommodate anticipated population growth and sustain economic development in Texas will require the implementation of a number of water management strategies, including the utilization of saline water. Saline water occurs in the Gulf, in some groundwater aquifers, and in some surface water bodies. The 2007 Texas Water Plan water management strategies include the use of about 313,000 acre-feet/year of Gulf water and brackish groundwater that will undergo desalination treatment. This quantity of water will provide approximately four percent of the State's water needs. Additional surface saline water is also included in the 2007 Texas Water Plan. The quantity of saline surface water identified across the state has not been summarized; however, in the Region C area, saline surface water from the Red River basin (Lake Texoma) is a Recommended Strategy for the NTMWD (approximately 113,000 acre-feet/year) and GTUA (approximately 56,500 acre-feet/year) and is an Alternative Strategy for the City of Dallas (approximately 105,000 – 113,000 acre-feet/year).

SALINE SURFACE WATER UTILIZATION

Saline surface water can be used directly if there are water demands that can be satisfied with saline water. It can also be used by reducing the salinity to acceptable levels (i.e. Federal Safe Drinking Water Act / State Drinking Water Criteria values, and Federal Clean Water Act / Texas Surface Water Quality Standards, etc.). Reducing the salinity concentrations can be done by controlling the source of salinity that causes the water to be highly saline, blending saline water with fresh water, and desalination. There are a number of challenges involved with the successful application of each of these techniques. The approaches to utilizing saline surface water are discussed below.

Use Highly Saline Water

Using the highly saline waters to meet certain demands could be beneficial in preserving valuable fresh water bodies for other uses. Identifying and increasing the number of direct uses of the highly saline water requires research into a number of issues associated with this type of

application. It is not anticipated that this approach will provide an opportunity to directly use significant quantities of surface saline water.

Salinity Control

In the case of controlling the source of salinity, the sources may be dispersed over a large area and preventing them from getting into a water course may not be feasible or may be cost prohibitive. However, valuable partial control may be achieved by capturing or stopping the flow of highly concentrated saline streams, thereby reducing the amount of salinity being introduced downstream. Source control alone cannot be relied upon to totally achieve an objective to change the characteristics of existing saline water to that of fresh water, but it is a strategy to be considered in combination with other strategies.

Blending

Blending highly saline water with low salinity water from another water source represents a viable technique for reducing salinity levels to a value that would avoid Texas Surface Water Quality Standards issues and would cause the resulting salinity levels to be acceptable for using for augmenting potable water supplies. In the North Central Texas Region, the availability of adequate quantities of fresh water to blend with the highly saline water is dependent upon importation of fresh water from existing reservoirs or from planned new reservoirs. Although the blending approach reduces the concentration of salinity to acceptable levels, this approach results in adding salinity load to the receiving water supply bodies. Therefore, the use of this approach will probably be restricted to a few applications and cannot be relied upon to totally achieve an objective of fully utilizing saline surface water.

A prime example of employing the blending strategy is the NTMWD's current operations and its Recommended Strategy in the 2007 State Water Plan to use additional water from the Red River. The NTMWD currently blends what is considered to be a near maximum amount of Red River water in Lake Lavon; therefore, increasing the importation of Red River water will necessitate identifying other sources of non-saline waters for blending purposes. Currently the planning envisions blending additional Red River water with fresh water from the proposed Lower Bois D'Arc reservoir and other future fresh water supplies. The City of Dallas' Alternative Strategy

in the 2007 State Water Plan envisions blending Red River saline water with other sources of fresh water.

Desalination

The technology for desalination of the highly saline water is available and has become more economical in recent years. Major issues associated with relying on desalination include the high energy requirement, cost, and the lack of disposal options for the concentrated brine discharge. Disposal of concentrated brine discharge is the topic of a great amount of research worldwide. The primary candidates applicable to Texas include discharge to the Gulf of Mexico, discharge to streams and/or lakes, and deep well injection. Each of these techniques involves challenges regarding their feasibility. Energy requirements associated with the disposal techniques, particularly deep well injection, can be a significant impediment. Obtaining Texas Pollutant Discharge Elimination System (TPDES) permits for discharging the concentrated brine to surface waters will only be possible for certain projects, depending upon the impact of such a discharge on the receiving water body. Taking these issues into account, results in limiting the application of this technique to smaller quantities of water and to selected situations. Because of the issue of concentrated brine disposal, desalination will be limited to some practicable quantity that will be much less than the available sources of saline surface water. The NTMWD is performing assessments to determine if there is a viable method for concentrated brine discharge disposal, which is perhaps the primary impediment of implementing a desalination project, and assessments of the financial feasibility of a desalination project.

Summary of Approaches

Recognizing the challenges associated with the approaches cited above suggests that employing a combination of two or more of them will probably be required to fully utilize available highly saline surface water. The saline surface water represents an important component of the State's Water Plan and it is critical that actions be taken to facilitate using this saline water.

SURFACE WATER SALINITY MANAGEMENT

As water from saline water sources is introduced into the State's fresh water bodies, it has the potential of impacting the salinity of these water bodies. Additionally, as the use of Reuse Water increases, this water management strategy can also contribute salinity to surface water bodies. There are other activities that affect surface waters. Oil and gas exploration activities result in "produced water" which is of highly saline content and requires disposal, which in some cases could involve discharging to a surface water body. Also, the tremendous requirements for electric power generation results in concentrated saline water that requires disposal, which in some cases involve discharging to a surface water body.

Therefore, it will be critical to monitor the trends of salinity in the State's water bodies (i.e., streams and lakes). A comprehensive monitoring program, designed by the TWDB and TCEQ, will be critical to determining the appropriate management actions to avoid fresh water from becoming saline surface water. Collaborating with the US Geological Survey (USGS) to complement existing monitoring locations and to perform required sampling and testing is important in achieving this objective. Therefore, it is important to encourage Federal funding support of USGS for its monitoring program and for the State and other agencies to participate in "local match" funding for the monitoring. The Texas Water Conservation Association (TWCA) and the TWDB have been participating in an annual Texas Water Day in Washington to encourage our Congressional representatives to support funding of the USGS monitoring program.

Of major importance to salinity management is the achievement of the appropriate planning and compliance with regulatory requirements (i.e. SDWA, CWA, etc). The TWDB is providing effective leadership to promote and encourage the Regional Planning Groups to plan for the use of the saline surface water. Additionally, the TWDB performs and administers a very effective research program that, with proper funding support, can be extremely beneficial in developing solutions to the challenges and/or impediments to fully utilizing saline surface waters. The TCEQ is effectively contributing to managing salinity through its TPDES discharge permitting program and Texas Surface Water Quality Standards programs. Additionally, TRRC is

administering its program to control the introduction of salinity into the State's surface waters from oil and gas operations.

PATH FORWARD ACTIONS

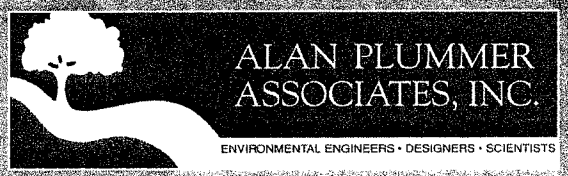
- Performing an assessment to quantify the amounts of highly saline water that could potentially be used to augment the State's water supply.
- Performing a baseline salinity condition of the State's water bodies.
- Determining the quantities of salinity that can be added to specific water bodies while continuing to maintain desired water quality conditions.
- Performing an analysis to assess the feasibility, costs, and probable success of saline source control. Assessing opportunities for the State to collaborate with other local and regional entities and Federal agencies to implement source control of salinity loads being introduced into the Red River/Lake Texoma, Brazos River Basin, Pecos River, Rio Grande River and other saline surface water bodies.
- Reviewing and enhancing the surface water quality sampling and testing program as required to properly monitor saline conditions.
- Developing, funding, and performing a research program to develop measures for disposing of concentrated brine discharge
- Developing, funding, and performing a research program to develop information for implementing desalination of selected saline surface water bodies.

CONCLUSION

Use of saline surface water represents an opportunity to be good stewards of water resources. There are a number of challenges and impediments. Utilization must be done in a manner that is consistent with regulations. The solution to the use of saline surface water will probably incorporate combinations of strategies that can be worked in concert to achieve an economical and practicable product. Key Path Forward actions should include surface water monitoring to establish baselines and measure trends and performance of research related to treatment technology and disposal options.

Saline Surface Water

Senate Committee on Natural Resources

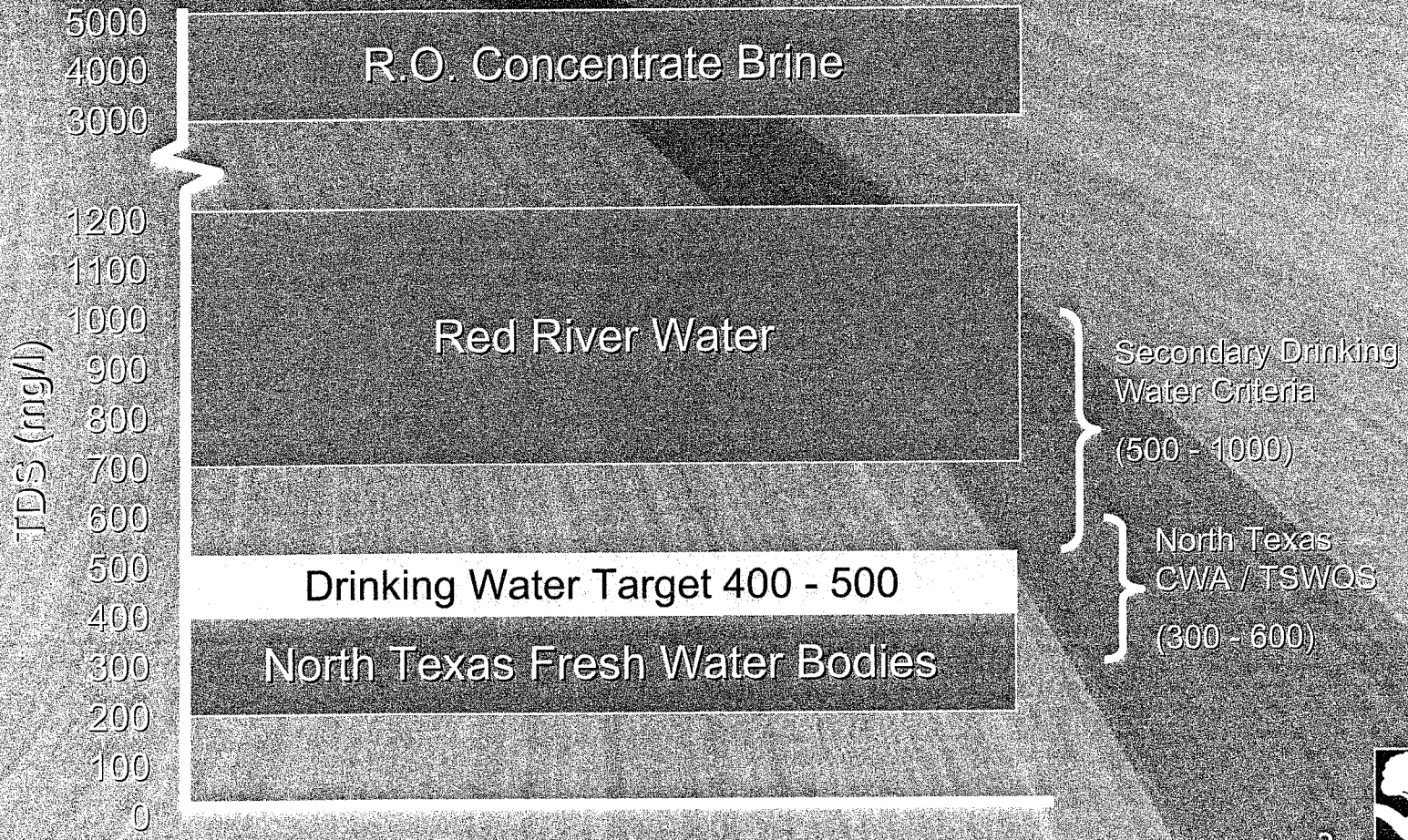


Alan H. Plummer, Jr., PE, BCEE

May 13, 2008

Saline Surface Water: an Important Water Source

Perspectives



Saline Surface Water: an Important Water Source

Opportunities

- Saline Surface Water has potential as a significant water supply source
- Current and future Region C water strategies include Saline Surface Water
- Research continues to improve in developing sound science and technology
- State agencies (TCEQ, TRRC, and TWDB) are well-positioned to provide reliable and reasonable regulatory protection / planning

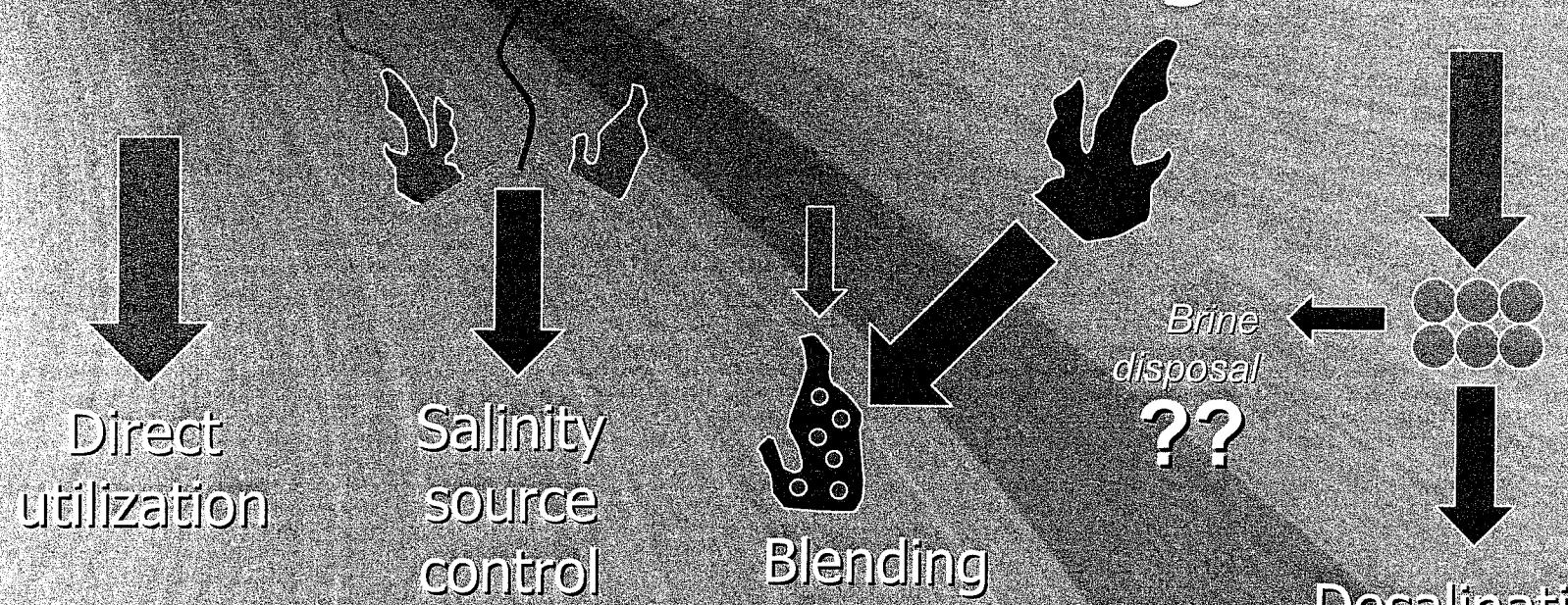
Saline Surface Water: an Important Water Source

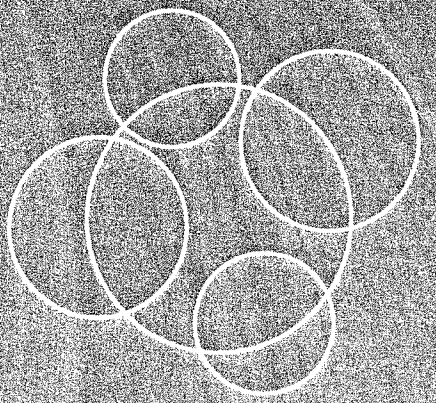
Challenges

- Utilizing Saline Surface Water may increase salinity in fresh waters
- Utilizing Saline Surface Water must comply with SDWA and CWA
- Preventing saline waters from adversely affecting fresh water quality will require a combination of measures
- Federal and state interagency cooperation will be essential

Saline Surface Water: an Important Water Source

Utilization Strategies





Combination

Saline water

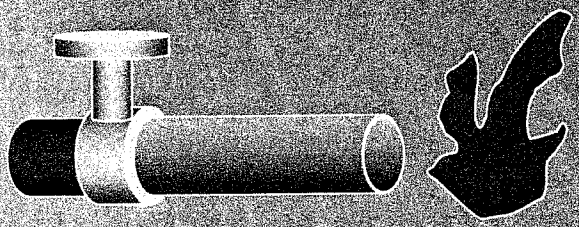
Fresh water

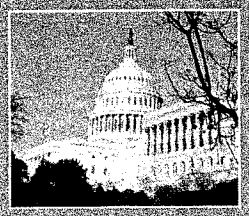
Major Issues

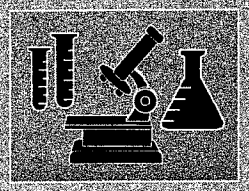
- Blending results in addition of salinity into fresh waters
- Treatment impediments
  - Treatability
  - Concentrated brine disposal
  - Energy
  - Costs

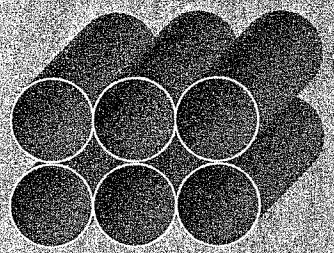
Saline Surface Water: an Important Water Source

Management Strategies









- Control introduction of salinity in fresh water bodies
- Meet SDWA and CWA regulations
- Monitor salinity trends over time
- Implement BMPs and Advanced Treatment

Saline Surface Water: an Important Water Source

Path Forward

- Optimize Saline Surface Water use
- Implement Saline Surface Water strategies
  - Saline source control, if practicable
  - Blending with fresh water, if available
  - Desalination if:
    - Concentrate brine disposal option available
    - Economically feasible (energy costs, etc.)
  - Combination of measures

Saline Surface Water: an Important Water Source

Path Forward

- Perform comprehensive salinity trend monitoring
- Perform research to develop science-based technology
  - Concentrate brine disposal
  - Desalination treatment for specific saline waters

Saline Surface Water: an Important Water Source

Conclusion

- Saline Surface Water use provides opportunity for good stewardship
- Challenges and impediments exist
- Regulatory requirements must be met
- Key path forward actions:
  - Surface water monitoring
  - Research