Field Assessment and Analytical Assessment of the Hydraulic Relationship between the Trinity and Edwards Aquifers

Presented to

Society of American Military Engineers
San Antonio, Texas
May 10, 2011

by
Ronald T. Green, Ph.D., P.G.
Southwest Research Institute

Hydraulic Relationship between the Trinity and Edwards Aquifers

- The hydraulic relationship between the Trinity and Edwards aquifers is not well characterized
- Boundary is 300 km long and is not necessarily uniform
- Water-budget analysis of both aquifers is predicated on accurate characterization of their hydraulic relationship
- Interformational flow is difficult to directly measure, typically need to employ indirect analysis techniques

Hydraulic Relationship between the Trinity and Edwards Aquifers

Working hypothesis:

- Edwards Aquifer and Trinity Aquifer are hydraulically connected
- The southern portion of the Contributing Zone of the Edwards Aquifer (i.e., upper Glen Rose) is more hydraulically similar to the Edwards Aquifer than previously characterized
- Flow is from the Trinity Aquifer (upper Glen Rose) to the Edwards Aquifer
- Quantity of inflow from the Trinity Aquifer(upper Glen Rose) to the Edwards Aquifer is greater than previously characterized

Hydraulic Relationship between the Trinity and Edwards Aquifers

Lines of reasoning in this evaluation:

- The southern portion of the Contributing Zone of the Edwards Aquifer (i.e., Glen Rose) is more hydraulically similar to the Edwards Aquifer than previously characterized

Gain/loss study of Helotes Creek

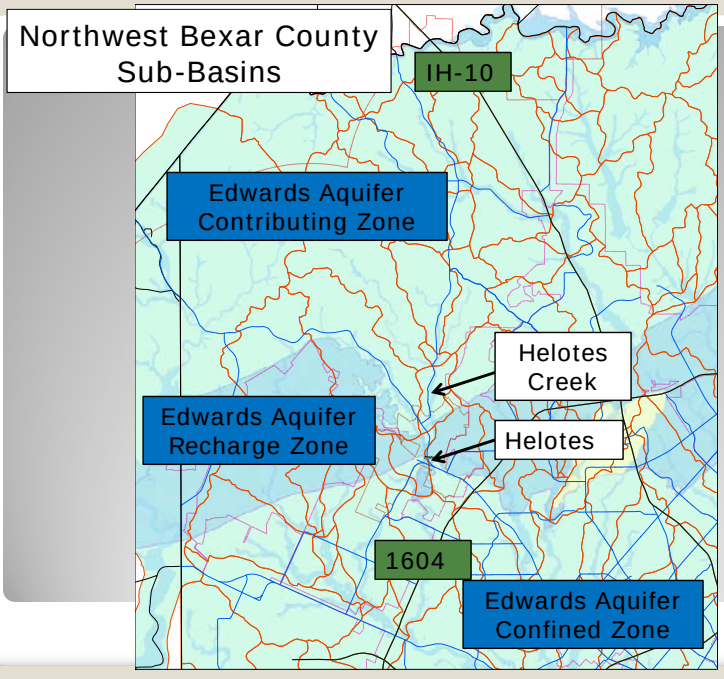
- Flow is from the Trinity Aquifer (upper Glen Rose) to the Edwards Aquifer

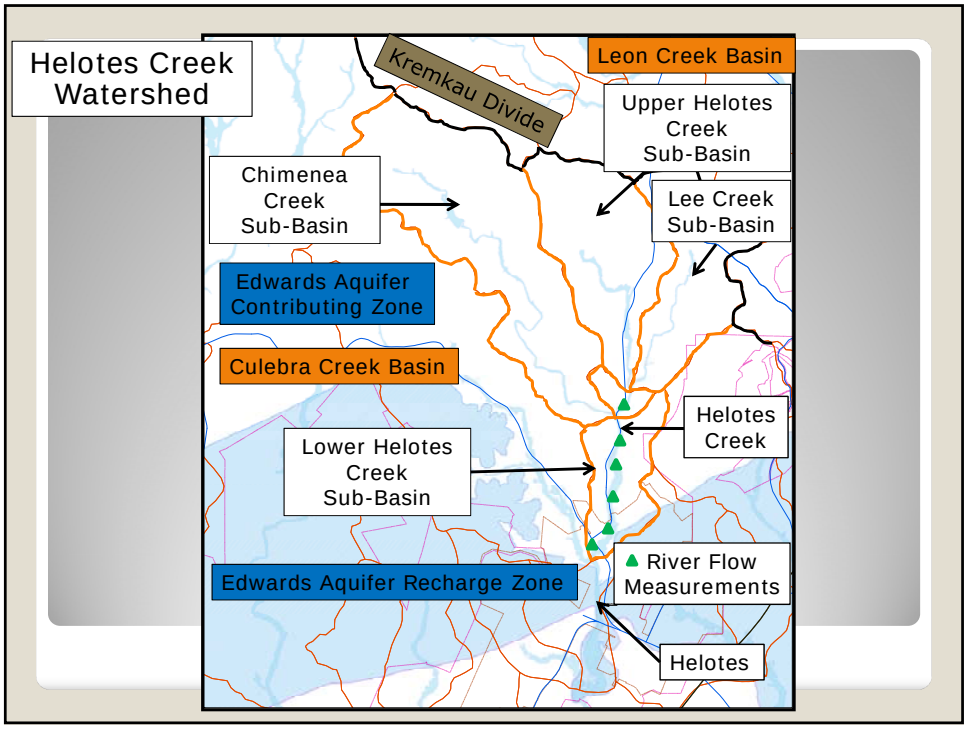
Tracer studies in Panther Spring Creek & Camp Bullis (EAA)

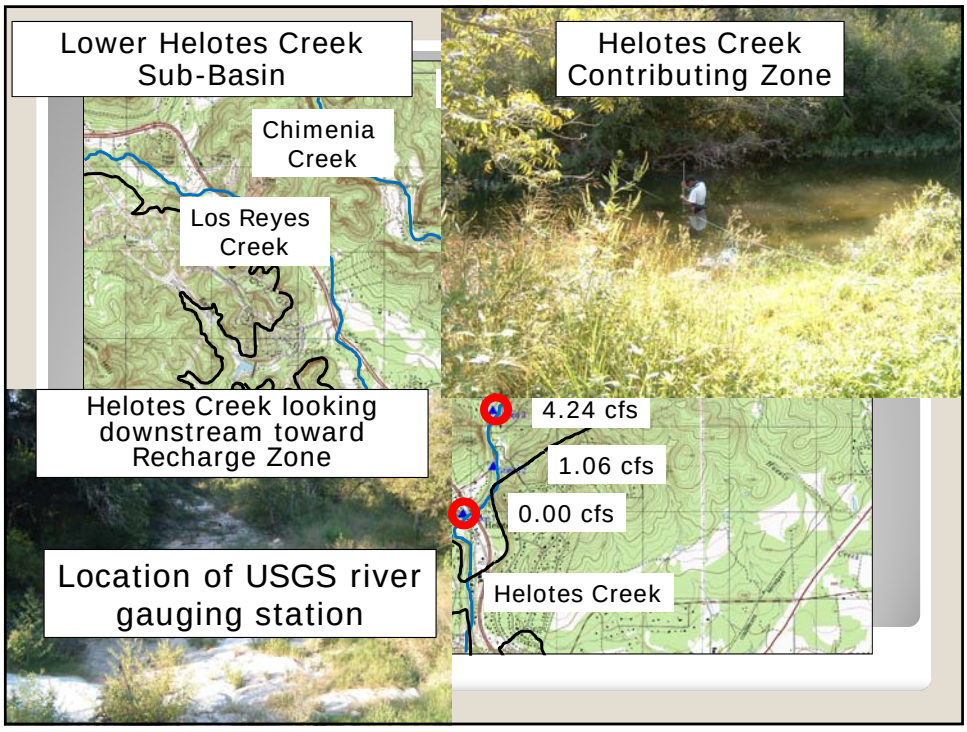
- Quantity of inflow from the Trinity Aquifer (upper Glen Rose) to the Edwards Aquifer is greater than previously characterized

Water budget analysis for Uvalde pool

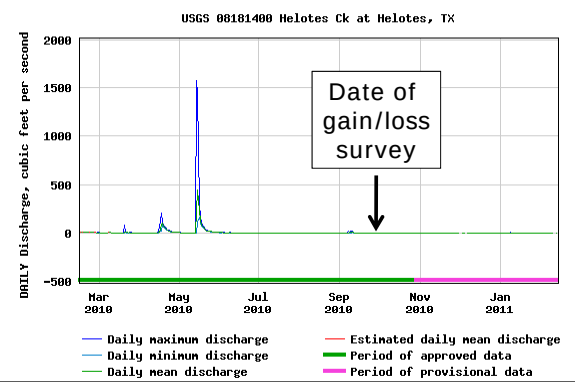
Gain/loss study of Helotes Creek




Helotes Creek Watershed
Kremkau Divide
Leon Creek Basin
Upper Helotes Creek Sub-Basin
Chimenea Creek Sub-Basin
Lee Creek Sub-Basin
Edwards Aquifer Contributing Zone
Culebra Creek Basin
Helotes Creek
Lower Helotes Creek Sub-Basin
River Flow Measurements
Edwards Aquifer Recharge Zone
Helotes


Lower Helotes Creek Sub-Basin
Chimenia Creek
Los Reyes Creek
Helotes Creek Contributing Zone
Helotes Creek looking downstream toward Recharge Zone
4.24 cfs
1.06 cfs
0.00 cfs
Location of USGS river gauging station
Helotes Creek

USGS River Gage on Helotes Creek Upstream of Recharge Zone (cfs) 2010-2011

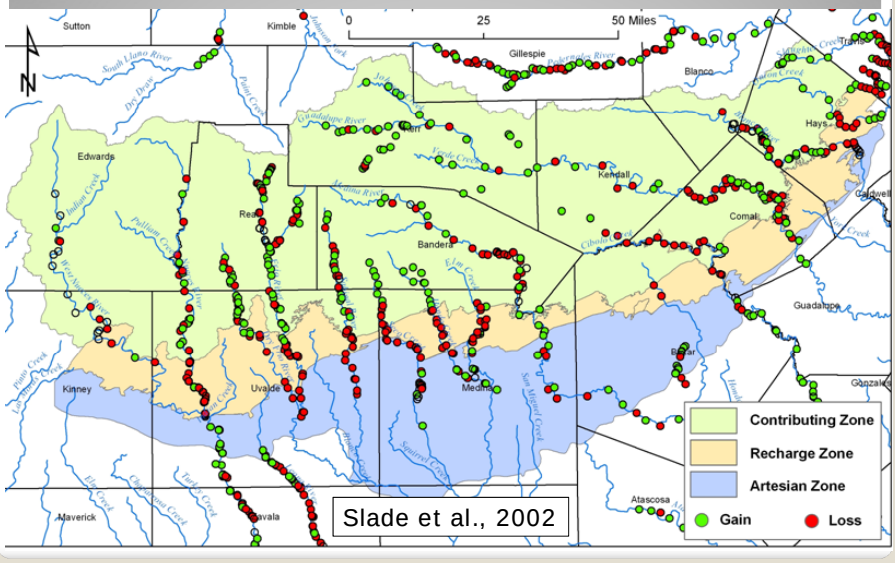


Helotes Creek has continuous flow in the Contributing Zone except for drying out once every 5-7 years. Flow in Helotes Creek only reaches the Recharge Zone during periods of heavy precipitation.

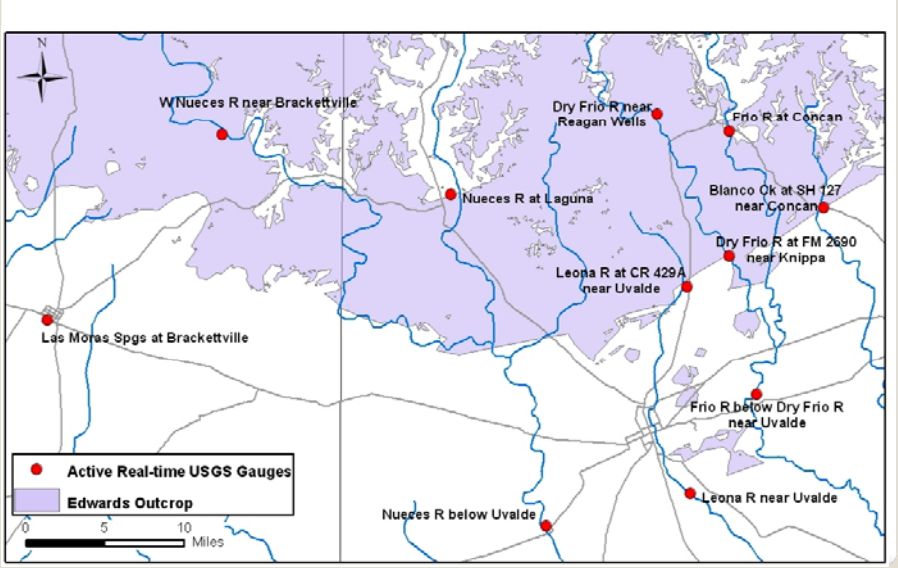
The Edwards Aquifer Contributing Zone does not act only as a collecting area for recharge as reflected in TCEQ regulations

Clark (2003), Veni (2004), Schindel et al. (2005), and Ferrill et al. (2009) characterized the upper portion of the Glen Rose, particularly the upper 150 ft, to be hydraulically similar to the Edwards Aquifer

Other localities with river loss in the Edwards Aquifer Contributing Zone



Locations of river gauging stations in the western Edwards Aquifer do not account for all recharge

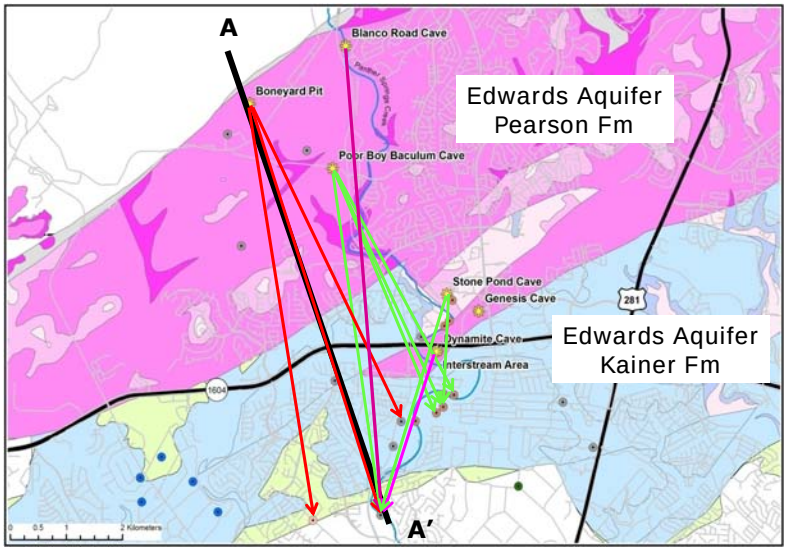


Tracer studies in Panther Springs Creek & Camp Bullis (EAA)

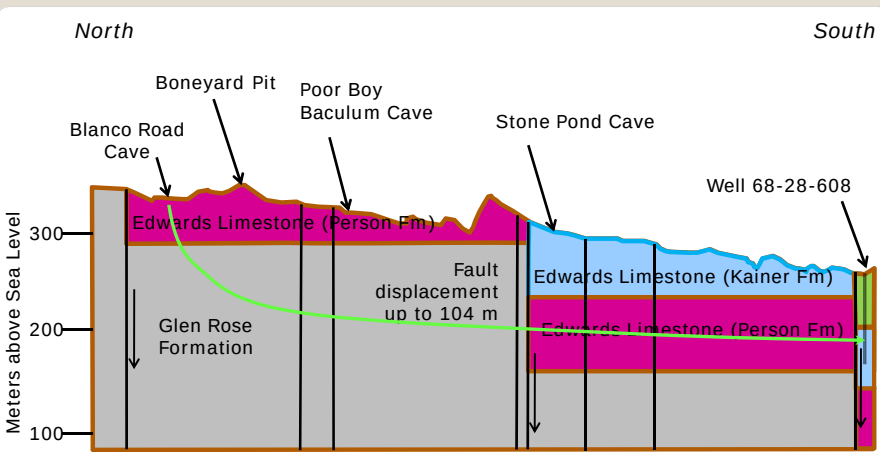
Multiple tracer surveys indicate that groundwater flow is from the Trinity Aquifer (upper Glen Rose) to the Edwards Aquifer

No tracer data indicate the groundwater flow from the Trinity Aquifer (upper Glen Rose) does not go to the Edwards Aquifer

Panther Springs Creek Tracer Tests (EAA, 2010)



Geologic Map

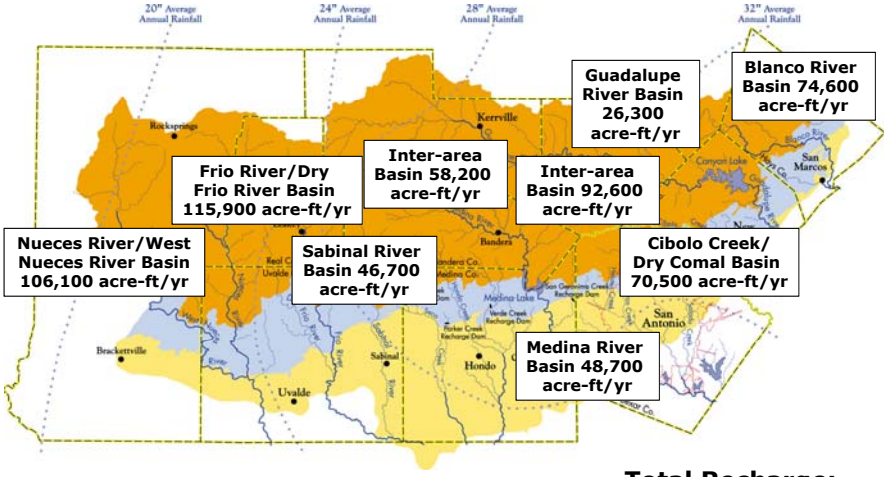


Schematic Cross Section

(EAA, 2010)

Water budget analysis for Uvalde pool

EDWARDS AQUIFER MEDIAN RECHARGE HSPF 1950-2003

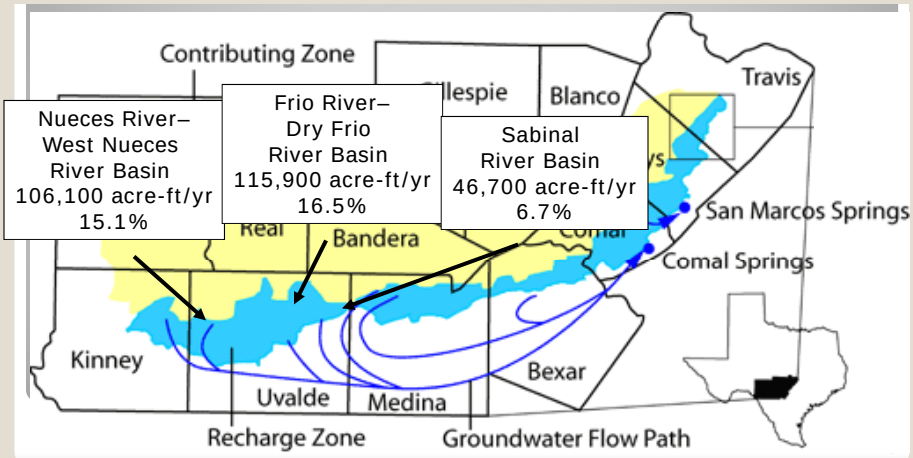


Source: Edwards Aquifer Authority 2008

Total Recharge: 701,600 acre-ft/yr

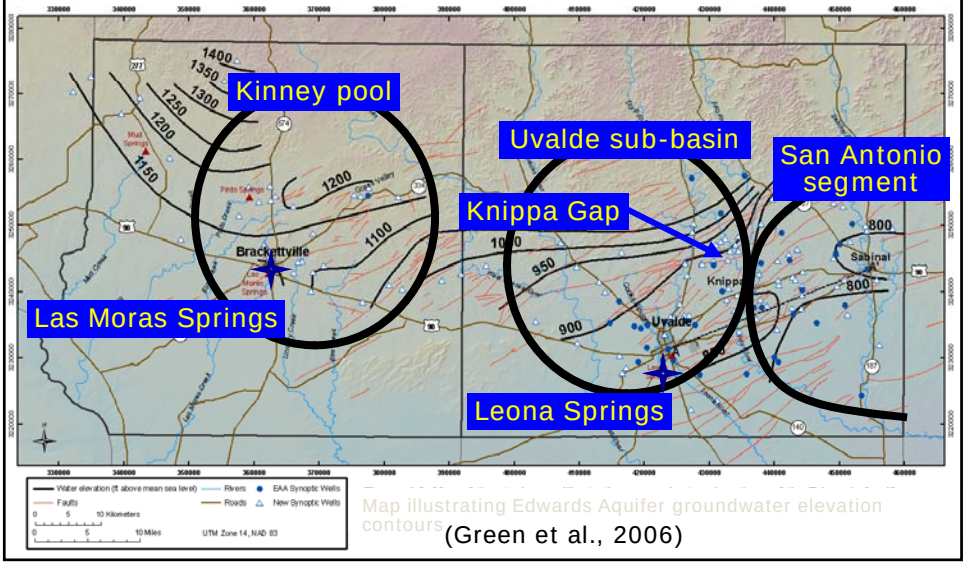
"Conventional" Conceptualization of the Western Edwards Aquifer

Uvalde County is credited for 38.3% of the Edwards Aquifer recharge



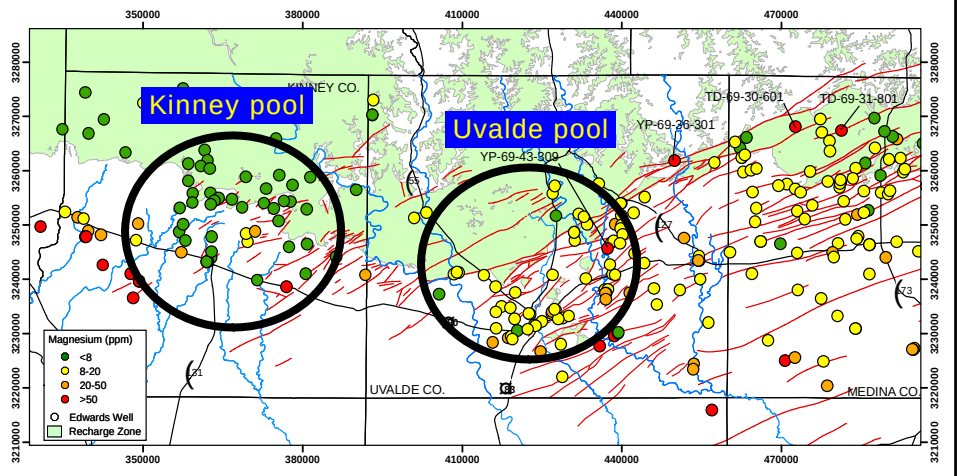
(ESI, 2010)

Recent studies indicate that Kinney County forms a separate pool in the western Edwards Aquifer

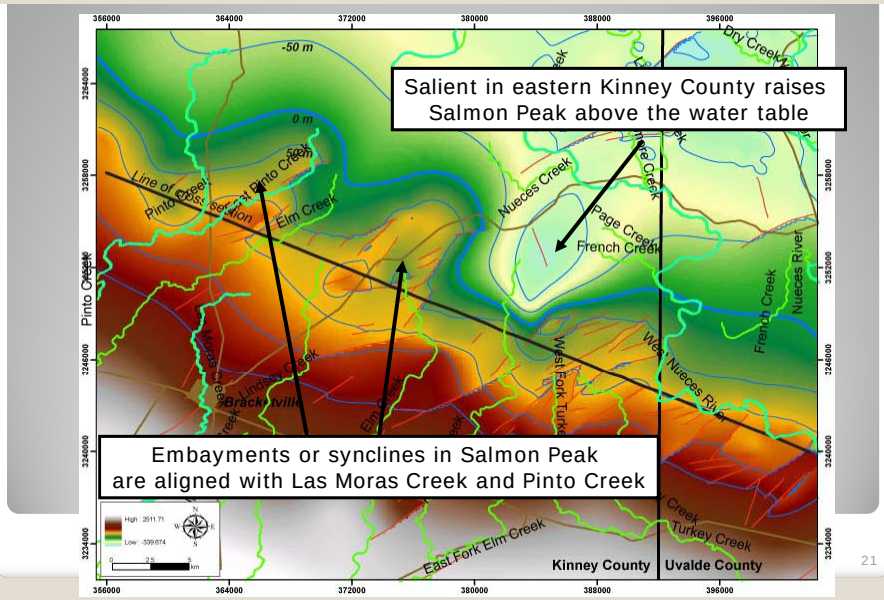


Map illustrating Edwards Aquifer groundwater elevation contours (Green et al., 2006)

Magnesium illustrates difference in water chemistry of Edwards Aquifer in Kinney and Uvalde counties

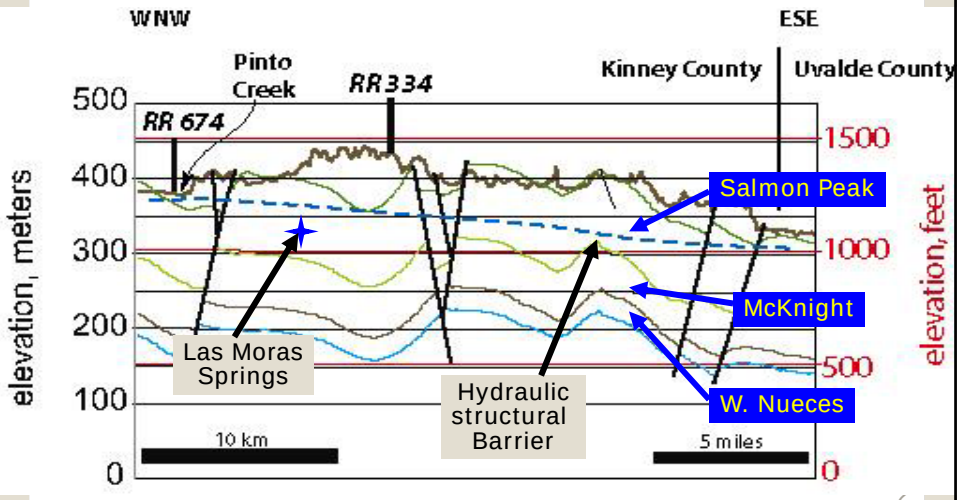


Saturated thickness of the Salmon Peak: permeable section of the Edwards Aquifer defines the structural hydraulic barrier between Kinney and Uvalde counties



21

Geologic cross-section illustrates structural hydraulic barrier between Kinney and Uvalde Counties



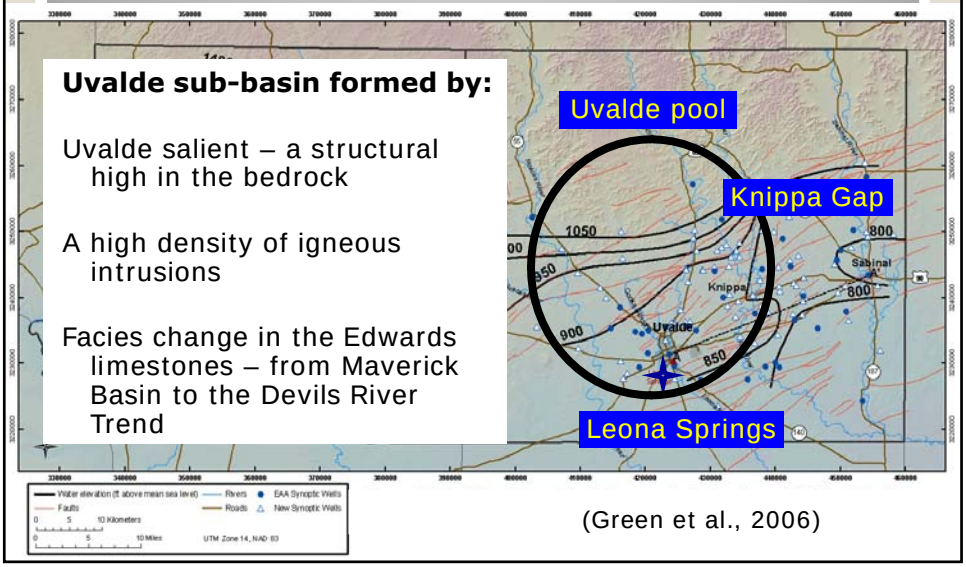
<u>Western Uvalde County forms a separate sub-basin</u>
Not as separate as a pool (i.e., Kinney pool)
Not as hydraulically connected as within San Antonio pool

Uvalde sub-basin formed by:

Uvalde salient – a structural high in the bedrock

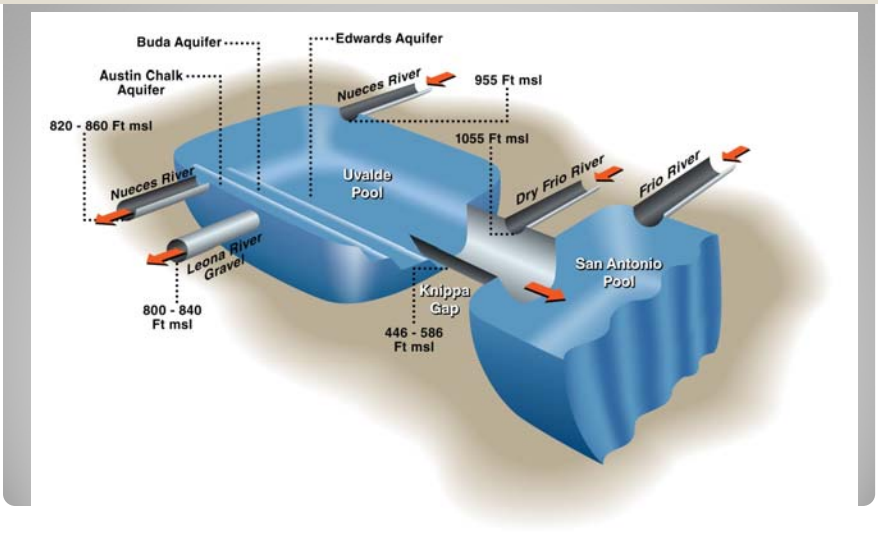
A high density of igneous intrusions

Facies change in the Edwards limestones – from Maverick Basin to the Devils River Trend

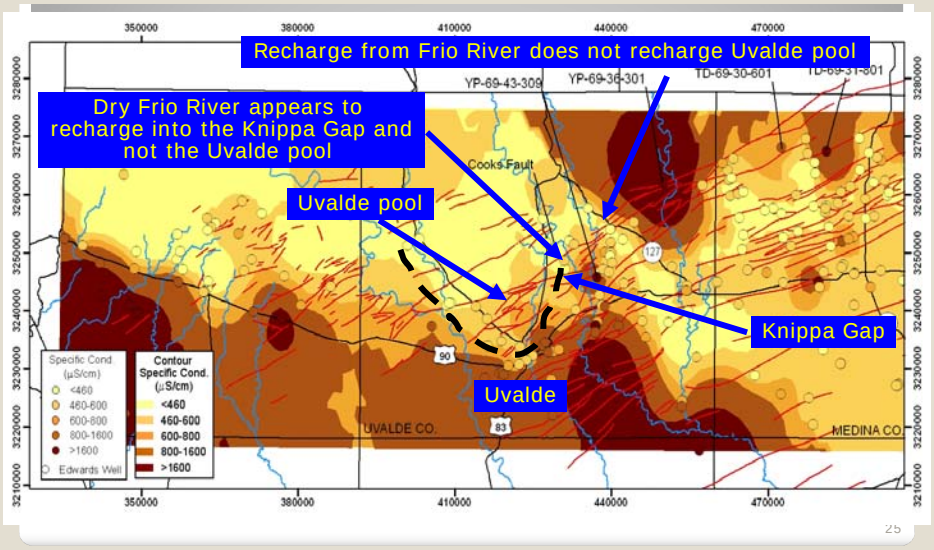


(Green et al., 2006)

Revised conceptual model is a Uvalde pool that has <u>high flow capacity</u>, but <u>limited storage</u>



Water chemistry illustrates flow path of water where Dry Frio and Frio Rivers recharge the Edwards Aquifer (Specific Conductance)



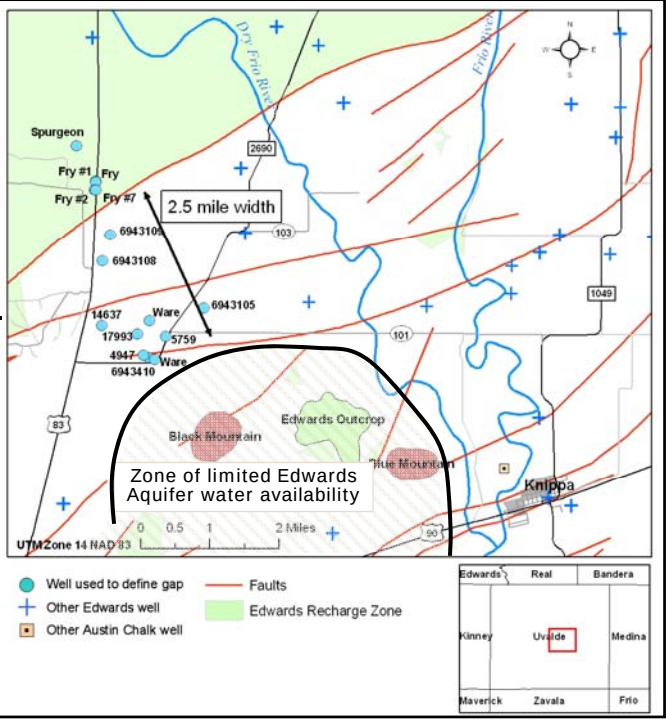
Knippa Gap

Deepest discharge point from Uvalde pool

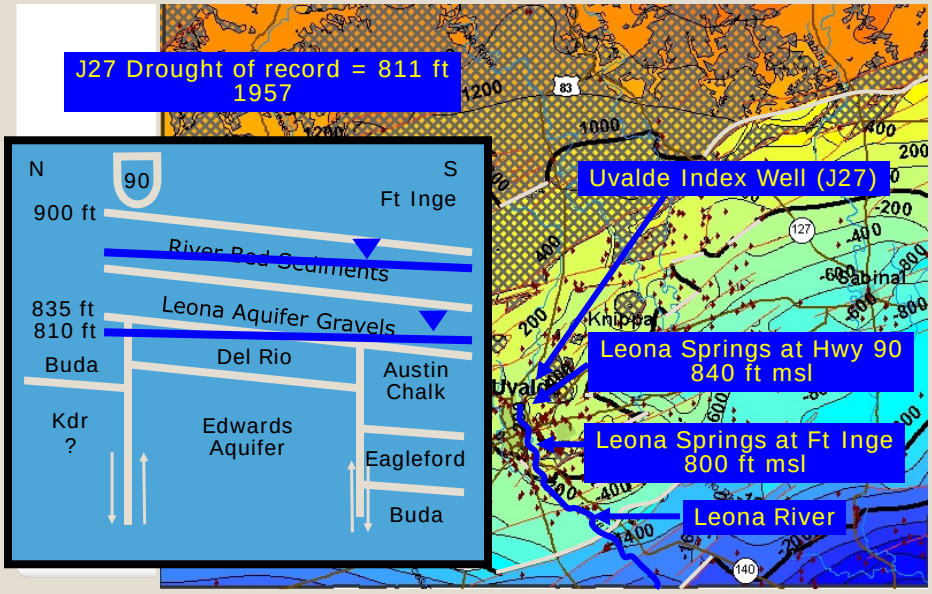
Knippa Gap depth 446 to 586 ft msl

Igneous intrusions and Uvalde Salient structure limit flow south of gap

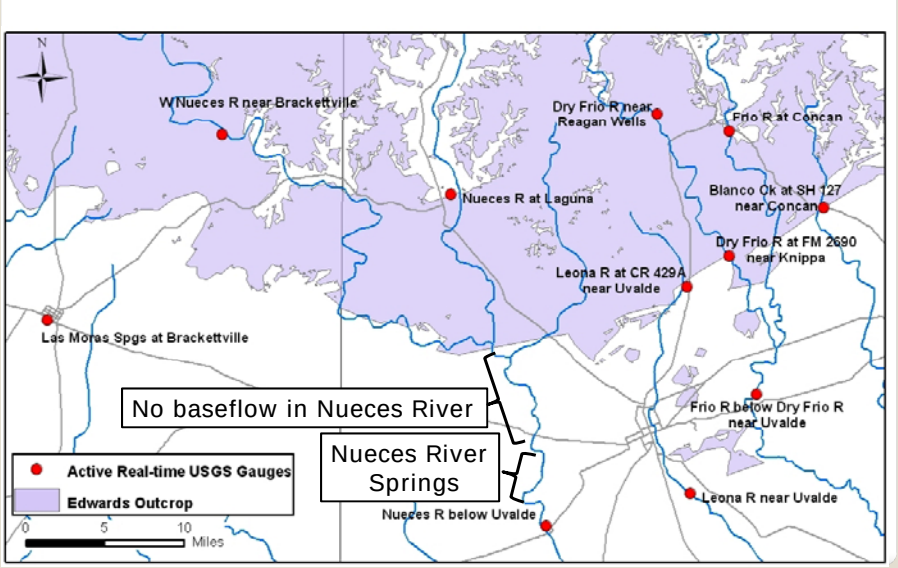
Capacity: Highly variable



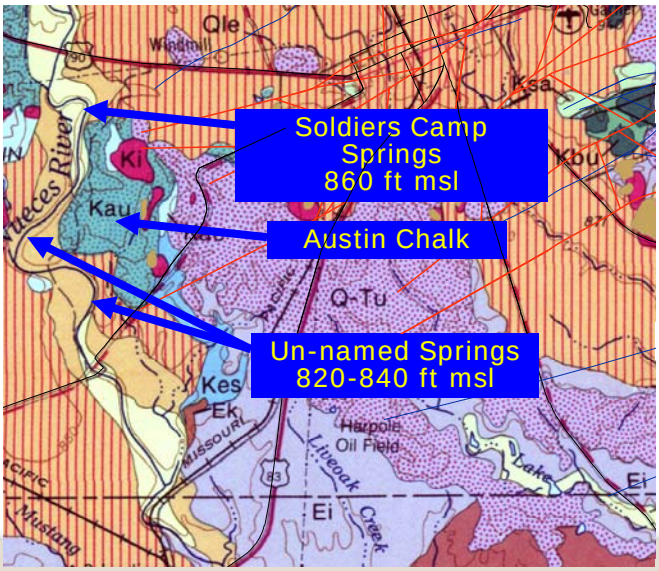
Leona Gravels in the Leona River Floodplain
Subsurface discharge via the Buda Limestone and the Austin Chalk



Nueces River south of Uvalde
Discharge to the Nueces River is via the Austin Chalk at springs south of Uvalde



Nueces River south of Uvalde
Discharge to the Nueces River
is via the Austin Chalk at springs south of Uvalde



29

The only time of no flow in the Nueces River south of Uvalde was during the drought of the 1950s

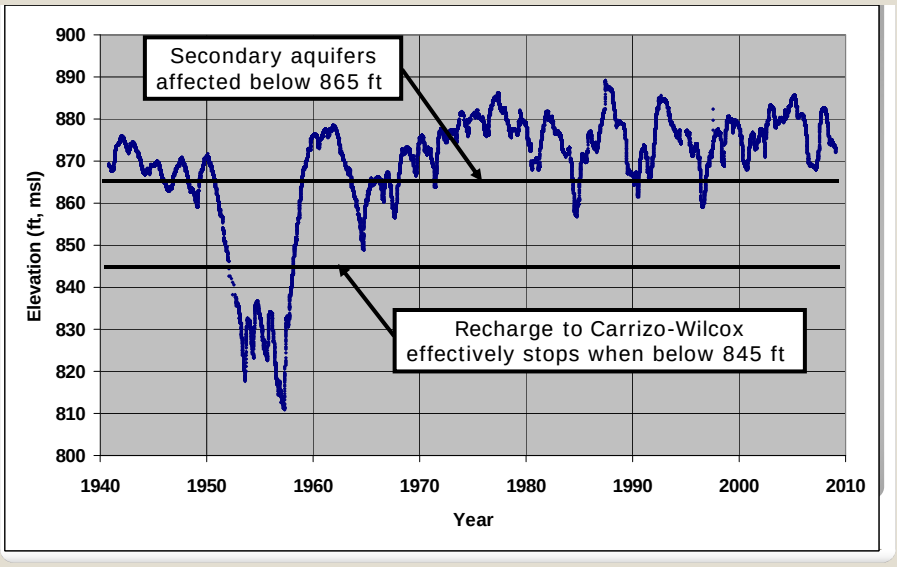
YEAR	Nueces River below Uvalde 12110103 Discharge, cubic feet per second											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1950	28.5	24.5	20.1	17.2	14.7	12.9	10.8	6.27	7.73	7.95	5.94	6.49
1951	5.85	4.64	4.83	3.34	5.59	2.44	0.00	0.00	0.00	0.574	0.463	0.00
1952	0.00	0.00	0.00	0.00	48.6	3.67	0.129	0.00	0.00	0.00	0.00	0.00
1953	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	167.9	3.25	1.33	0.00
1954	0.00	0.00	0.00	0.00	155.3	649.0	92.4	5.72	1.89	1.48	0.617	0.245
1955	0.00	0.00	0.00	0.00	0.00	0.00	1.07	0.065	2,456	28.8	8.09	3.26
1956	2.18	0.845	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1957	0.00	0.00	0.00	9.56	146.7	141.8	11.6	5.70	4.16	4.15	2.94	2.04
1958	2.29	1.95	59.4	3					601	405.9	380.0	196.4
1959	119.7	78.1	56.4	4					8.4	832.7	170.5	114.5

Long-term average
Median: 20,260 acre-ft/yr
Mean :47,050 acre-ft/yr

Discharge from the springs stopped when J-27 was less than approximately 845 ft ms.

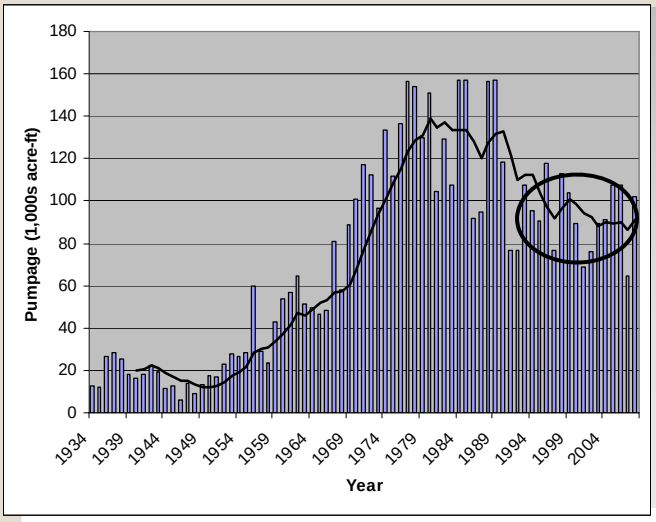
30

Groundwater elevation at Uvalde index well (J-27) provides indication when Uvalde pool is stressed



(EAA, 2009) (Green et al., 2010)

Total estimated pumping for Uvalde County for 1934 - 2009



Decrease is, in part, due to conversion of pumping from the Edwards Aquifer to pumping from the secondary aquifers

Conversion to pivot irrigation led to 10-15% increase in efficiency

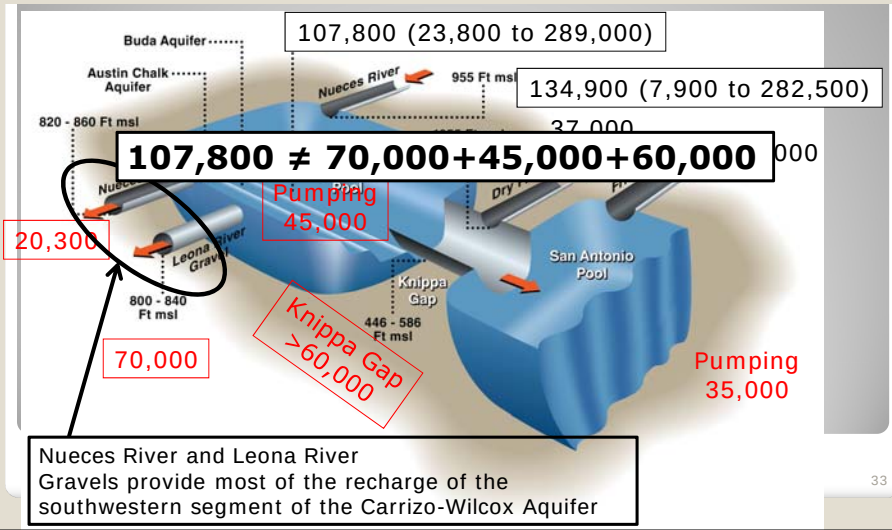
Fuel costs escalation in late 1970s stopped increasing trend in irrigation, exceptions are due to dry years and high crop values

(EAA, 2009)

32

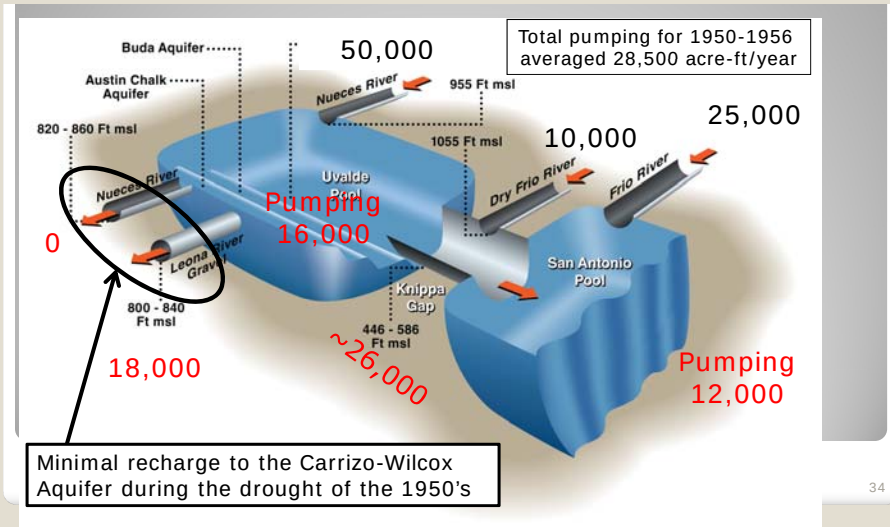
Uvalde pool water budget (acre-ft/year) averages for 1950-present (USGS)

***Annual averages are highly variable**



Uvalde pool groundwater availability is dependent on quantity recharged from Edwards Plateau

1950-1956 Uvalde pool water budget (acre-ft/year)



Summary

- The upper Trinity Aquifer (top 150 ft of the Glen Rose) is more hydraulically similar to Edwards Aquifer than previously thought
- Protecting the southern Edwards Aquifer Contributing Zone is critically important to protecting Edwards Aquifer
- Kinney County forms a separate pool in the Edwards Aquifer
- Western Uvalde County (west of Knippa Gap) forms a pool that is not separate, but hydraulically restricted from San Antonio pool of the Edwards Aquifer

Contact Information

Ronald T. Green, Ph.D., P.G.
Institute Scientist
Geosciences and Engineering Division
Southwest Research Institute
6220 Culebra
San Antonio, Texas 78238
1.210.522.5305 (office)
1.210.522.5184 (fax)
1.210.316.9242 (cell)
rgreen@swri.edu

36