UVALDE

ALTERNATE GROUNDWATER SUPPLY

INFRASTRUCTURE PLANNING REPORT

(FINAL)

City of Uvalde

Uvalde County

Prepared By:

CDS muery
ENGINEERS • SURVEYORS

3411 Magic Drive, San Antonio, Texas 78219, (210)581-1111

TBPE No. F-1733

AND

DNA GEOSCIENCES, INC.

STATE OF TEXAS
MARK ROETZEL
57660
LICENSED
PROFESSIONAL ENGINEER
7-21-14

TWDB No. 1348321575

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Acknowledgments:

Securing a dependable long-term water supply is a critical goal for the City of Uvalde and its regional neighbors. This infrastructure plan has been commissioned by the City of Uvalde and Uvalde County to begin developing alternate groundwater supplies for the area, a goal to ultimately be met through the cooperation and support of numerous regional parties. Several key parties have actively participated in this initial planning exercise. CDS Muery (CDSm) would like to acknowledge the support of the Planning Group who met several times during this exercise to provide critical input and direction, including:

- Mr. M. Forrest Anderson - Uvalde County UWCD
- Mr. Vic Hilderbran - Uvalde County UWCD, Region L Planning Group
- Mr. Jack Rutledge - Wintergarden UWCD
- Mr. Cary Spurgeon - Spurgeon Drilling Services, Uvalde County UWCD
- Mr. J. Allen Carnes – Mayor, City of Uvalde
- Mr. Joe Cardenas - City of Uvalde
- Mr. Joe Jarosek - City of Uvalde
- Mr. Con Mims - Nueces River Authority, Region L Planning Group Chairman
- Mr. John Harrell - Member-at-Large
- Mr. Doug Shaw - TWDB

We want to thank Mr. Mark Dobson, P.G. and Mr. Eric Wolff, P.G. of DNA Geosciences for their technical assistance related to groundwater resource evaluations and conceptual well field site selections.

Three (3) Planning Group Meetings were held to confirm planning goals, to review interim findings, and to discuss the draft water resource and infrastructure plans. Valuable input was received from the Planning Group and TWDB's representative at each meeting. A total of three (3) Public Meetings were advertised and scheduled after each Planning Group Meeting, however no members of the general public attended. Therefore, no public input was received during preparation of this plan.

Executive Summary

The City of Uvalde (Uvalde) and its regional neighbors rely almost exclusively on groundwater supplies for municipal, agricultural and light industrial water demands in Uvalde County. The majority of this demand is met by the Edwards Aquifer (Edwards), providing a prolific source of high-quality groundwater throughout the county's more developed central region. However, the recent multi-year drought has led to declining water levels of the Edwards, resulting in pumping restrictions imposed by the Edwards Aquifer Authority (EAA). While Uvalde holds adequate Edwards groundwater pumping rights to meet current demands during non-drought conditions, the recent pumping restrictions impose a considerable hardship on Uvalde, requiring reduced consumption and mandatory conservation measures. Such restrictions would ultimately challenge economic prosperity and impede community growth if applied for an extended time period.

This infrastructure plan begins development of a long-term alternate groundwater supply for Uvalde and its regional neighbors. Regional major and secondary aquifers are defined and reviewed for historic production to help identify and locate potential alternate supplies. Reported production of major and secondary aquifer wells is reviewed to help identify potentially reliable supplies and well locations. The availability and cost of potential supplies is considered, as well as historic water quality and distribution blending considerations. Based on results of these evaluations, a conceptual water resource plan is developed, including:

- Continue maximum allowable use of existing Edwards Aquifer wells as the primary supply.
- Develop secondary aquifer supply wells in the Buda and/or Austin Chalk aquifers near Uvalde to supplement demand during drought pumping restrictions on the Edwards supply.
- Develop an Aquifer Storage Recovery (ASR) system in the Carrizo Sands aquifer formation in Zavala County for long-term non-drought storage of surplus secondary aquifer supply water.
- Recover stored secondary aquifer supply water from the ASR system during future recurring drought periods, relieving stress on the Edwards and secondary aquifers.

A preliminary infrastructure plan is then developed to execute the conceptual water resource plan. The infrastructure plan is developed in three (3) phases, allowing staged implementation, including:

- Phase 1 – Secondary Aquifers Well Fields Integration. Two secondary well fields are assumed to provide a target 4,000ac-ft/yr secondary aquifer supply. Each well field initially assumes two wells (4 total), ground storage, disinfection, and transmission to the City's current distribution system. A preliminary capital cost of about $4.3M is projected for the Phase 1 secondary aquifers development.
- Phase 2 – ASR Development. The secondary aquifer well fields will then be integrated into an ASR facility initially assumed to be located in Zavala County about 30 miles south of Uvalde, via a 24-inch transmission/recovery pipeline and pumping facilities. This system will allow non-drought secondary aquifer surplus supply to be transported south for long-term storage, and returned north during future recurring droughts. A preliminary cost of about $32M is projected for the Phase 2 ASR development – not including the ASR well field costs initially assumed to be funded separately. A separate $10M-$20M ASR well field development cost is initially assumed, subject to much more focused evaluations and design definition.

- Phase 3 – Regional Integration. Long-term regional integration includes construction of a transmission pipeline and pumping facilities from Uvalde easterly to Knippa and Sabinal, supplementing current domestic demands met by the Edwards for those communities. A preliminary cost of about $5M is projected for the Phase 3 integration.

The goal of this infrastructure plan is to identify and conceptually define alternate groundwater supply(ies) for Uvalde and its regional planning partners, providing both short-term relief from current drought restrictions, and long-term improved water resource security.

I. Problem Statement

The City of Uvalde (Uvalde) and its regional neighbors rely almost exclusively on groundwater supplies for municipal, agricultural and light industrial water demands in Uvalde County. The majority of this demand is met by the Edwards Aquifer (Edwards), providing a prolific source of high-quality groundwater throughout the county's more developed central region. However, the recent multi-year drought has led to declining water levels of the Edwards, resulting in pumping restrictions imposed by the Edwards Aquifer Authority (EAA). While Uvalde holds adequate Edwards groundwater pumping rights to meet current demands during non-drought conditions, the recent pumping restrictions impose a considerable hardship on Uvalde, requiring reduced consumption and mandatory conservation measures. Such restrictions would ultimately challenge economic prosperity and impede community growth if applied for an extended time period.

Water resource management is a growing priority goal for all Texas communities and consumers, including Uvalde and its regional partners. Continued growth and potentially recurring droughts will require both careful resource conservation planning, and development of viable alternate supplies. This will include developing viable alternate groundwater supplies to supplement the current sole reliance on the Edwards for Uvalde. Surface water supplies are not considered viable for the region, as local river flows depend on associated aquifer levels to maintain spring discharge base flows. These potential surface water sources are therefore nearly depleted during drought conditions, as recently experienced.

The goal of this infrastructure plan is to identify and conceptually define alternate groundwater supply(ies) for Uvalde and its regional planning partners, providing both short-term relief from current drought restrictions, and long-term improved water resource security. Uvalde's continued efforts toward improved water conservation practices will also play an important part in long-term water resource management planning for the City and the region.

II. Aquifer and Well Mapping

There are four major aquifers designated by the Texas Water Development Board (TWDB) in Uvalde County. Those aquifers include the Trinity, Edwards-Trinity, Edwards, and Carrizo-Wilcox, as shown on Exhibit 1. Correlation between the aquifers and their associated geologic formations is presented on Exhibit 2.

The Edwards Aquifer underlies most of the county. The Edwards-Trinity and Trinity Aquifers are limited to the northern portion of the county and the Carrizo-Wilcox Aquifer is limited to the southern edge of the county.

The northern Trinity and Edwards-Trinity Aquifers are Lower Cretaceous in age and composed primarily of limestone. Groundwater in these aquifers generally flows toward the southeast providing recharge to downgradient aquifers. The southern Carrizo-Wilcox Aquifer is a Tertiary-age sand aquifer and is hydraulically isolated from the lower Cretaceous aquifers by multiple low-permeability formations.

The Edwards Aquifer is a water table aquifer in its recharge zone (outcrop) but transitions towards the southeast to a confined, artesian aquifer (subcrop), as shown on Exhibit 1. Most of the production is from the

artesian zone. Confined conditions occur where the Edwards and Associated Limestones have been down-dropped by faulting in the Balcones Fault Zone (BFZ) with the overlying Del Rio Clay providing an upper confining layer. The Edwards Aquifer is also subdivided into a western Uvalde pool and an eastern San Antonio pool separated by a geologic feature known as the Knippa Gap (near Knippa in in eastern Uvalde County).

The Edwards is the only aquifer in Uvalde County controlled by the Edwards Aquifer Authority (EAA). Pumping from all other aquifers is controlled by the Uvalde County Underground Water Conservation District (UCUWCD). Pumping from the Edwards in Uvalde County is limited to a maximum of 82,842 ac-ft/year when the water elevation in the EAA-designated index well, J-27, is at least 850 feet above sea level, referred to as Critical Period - Stage I. When water levels in J-27 drop below 850 feet, pumping is reduced in accordance with four trigger levels established by the EAA. Uvalde is currently under Critical Period - Stage V restrictions with the Edwards below 840 feet, reducing allowable pumping from the Edwards Aquifer by 44 %.

In addition to the four major aquifers identified by the TWDB, there are other aquifers providing significant groundwater resources in Uvalde County. These other aquifers are referred to as "minor or local aquifers" in the Uvalde County Underground Water Conservation District Management Plan (adopted July 26, 2011) and as "secondary aquifers" in publications by The Geosciences and Engineering Division, Southwest Research Institute (Green et al, 2009; Green et al, 2010). This report hereafter refers to these other aquifers as secondary aquifers.

Three of the secondary aquifers produce significant quantities of water, particularly in western Uvalde County. These three secondary aquifers are associated with the Leona Formation, Austin Chalk, and Buda Limestone, as presented on Exhibit 2. The Leona Formation forms an alluvial aquifer adjacent to the Leona, Nueces, Frio and other rivers in Central and South Texas. These alluvial aquifers generally depend on associated stream flow, springs, and recharge from adjacent aquifers, and are therefore subject to depletion during drought conditions as recently experienced.

The Austin Chalk and Buda Limestone are Upper Cretaceous in age. The Del Rio Clay provides a confining layer between the deeper Edwards and shallower Buda formations, and the Eagle Ford Group separates the lower Buda and upper Austin Chalk, as shown on Exhibit 2. There are limited areas where the Buda and Austin are at the right elevations and have sufficient hydraulic conductivity to produce significant quantities of water. These productive areas have been studied and defined by Green et al (2009), as shown on Exhibit 3.

Water quality in Buda and Austin wells are generally similar to the Edwards. Hydraulic interconnectivity with the Edwards has been demonstrated by Green et al (2009), although the degree of interconnectivity varies as a result of varying degrees of faulting, fracturing, and relative elevations of the different formations. Recent water level measurements of the Edwards (J-27 Well, WS Elev. 832.9 on 6/24/13) and the City's PWS Well No.7 (collapsed and plugged in the Del Rio clay zone – now producing as a Buda Well, WS Elev 831.7 on 8/20/13) indicate similar static water level elevations. This supports previous observations by Green and

others of significant hydraulic conductivity of the secondary aquifers with the Edwards, likely most significant near geologic faulting, igneous intrusions and other geologic controls.

Pumping from the secondary aquifers in Uvalde County is controlled by the UCUWCD. UCUWCD's stated desired future condition for the secondary aquifers includes a zero feet drawdown of these aquifers from recent pumping conditions, recognizing that "the aquifers are connected among themselves and with the Edwards (BFZ) aquifer, and are in equilibrium and self-regulating." (UCUWCD, Management Plan, 2011-2021).

Numerous wells have been installed in Uvalde County in the major and secondary aquifers, as shown on Exhibit No.4, based on TWDB's Well Report Tracking well database. The majority are small-flow domestic or livestock supplies. However some, particularly in the Edwards and Austin Chalk/Buda areas, are large-flow municipal and irrigation wells. Exhibit No.5 shows local wells in the Uvalde area, including well production aquifer formation and identified large-flow secondary aquifer wells.

An important factor in determining groundwater availability and the target locations for wells in Uvalde County is the occurrence of igneous intrusions. These intrusions penetrate all aquifers in the County. Two episodes of igneous intrusions occurred approximately 82 – 80 million years ago and 74 – 72 million years ago. Although a few low production wells have been completed in the igneous rocks, these formations are typically an impediment to drilling into the aquifer objective, being much harder to drill through compared to the sedimentary rocks. As a result, most wells that encounter igneous rocks are abandoned and re-drilled at an alternate location avoiding the intrusion.

III. Production Capacity Review

Each aquifer was reviewed for historic production capacity, based on both record well information and known production characteristics.

The Trinity and Edwards-Trinity aquifers of northern Uvalde County are marginally productive in the area. No large-flow wells are known to exist within Uvalde County from these aquifers. The small community of Concan has the largest concentration of wells in the Edwards-Trinity in northern Uvalde County, typically producing about 10-20 gpm flow, and the small community of Utopia has the largest concentration of wells in the Trinity in northeastern Uvalde County, producing up to about 20 gpm flow. Most small-flow wells in the area are private domestic and livestock supplies, and production is generally expected to be limited in the area, associated either with shallow alluvial formations along the Frio River near Concan and Sabinal River near Utopia, or with deeper small-flow limestone aquifer wells. These aquifers are also located about 15 to 20 miles north of Uvalde, limiting viability of access to any such potential groundwater supplies. Recorded pumping of the Trinity and Edwards-Trinity aquifers in Uvalde County averages less than 1,000 ac-ft/yr per UCUWCD data.

The Edwards Aquifer of central Uvalde County is the primary source of domestic, municipal, agricultural and industrial water supplies for the area. Production is most prolific in the artesian zone which underlies most of

the southern half of the county including the City of Uvalde. The Edwards Aquifer is defined by the Edwards Aquifer Act (SB 1477, 1993) to include "water produced from the Edwards and Associated Limestones" In Uvalde County this would include the Salmon Peak, McKnight, and West Nueces formations in the western Uvalde Pool region, and the Devils River formation in the eastern San Antonio Pool region. The younger Salmon Peak and Devils River formations are generally most porous and highly productive. Production is generally less dependable in the northern Edwards Outcrop (Recharge Zone), but a number of small-flow domestic and livestock wells do exist in the area. Numerous wells are located in the Edwards subcrop area in Uvalde County, including a large number of municipal and irrigation supply wells, as shown on Exhibits 4 and 5. However while Uvalde holds adequate Edwards groundwater pumping rights to meet current demands, and the aquifer is generally expected to be capable of meeting such demands, drought pumping restrictions imposed by the EAA during declining aquifer water levels impose significant constraints on Uvalde and other regional users, supporting the goal of identifying and developing alternate supply(ies).

The city currently holds 5,190 ac-ft/yr of Edwards water rights. However, recent EAA pumping restrictions have reduced the allowable withdrawal to 56 percent (2,906 ac-ft/yr). The city pumped 3,800 ac-ft in 2012 and 3,700 ac-ft in 2013, and anticipates demand growing to about 6,300 ac-ft/yr by 2020. Therefore 4,000 ac-ft/yr has been selected by the city as a target alternate groundwater supply. Recorded pumping of the Edwards aquifer in Uvalde County has approached 90,000 ac-ft/yr in recent years (2002) per UCUWCD data, being primarily agricultural use. However, recent drought pumping restrictions and changing agricultural practices have reduced this usage significantly, with a continued decreasing agricultural demand expected over time. Edwards water west of Uvalde County (i.e. Kinney and Val Verde counties) is not under EAA's jurisdictional control. However, import of additional Edwards waters to Uvalde County from the west is not considered viable due to various political and technical complications.

The Carrizo-Wilcox extends a short distance into southern Uvalde County, to within about 5 miles south of Uvalde. However, this area is associated with the outcrop or recharge zone of the formation where the aquifer is unconfined and not nearly as productive as the downgradient confined aquifer in neighboring Zavala County further to the south. A number of wells are located in the Carrizo-Wilcox of southern Uvalde County, being primarily small-flow domestic and livestock supplies. One large-flow irrigation supply well is located in the area toward the southeastern corner of the county, but it is a shallow alluvial well associated with Frio River gravel deposits. No significant production capacity is expected for the Carrizo-Wilcox within Uvalde County. Recorded pumping of the Carrizo-Wilcox in Uvalde County averages less than 100 ac-ft/yr per UCUWCD data.

While not expected to be of significant benefit as an alternate groundwater supply for Uvalde and its regional partners, the Carrizo-Wilcox does offer significant potential benefit as part of a broader long-range water resource strategy. The Carrizo formation within about 30 miles south of Uvalde in Zavala County is well suited for use as a potential Aquifer-Storage-Recovery (ASR) facility. Such regional ASR use of the Carrizo is currently active in southern Bexar County at the very successful San Antonio Water System (SAWS) Twin Oaks ASR facility, and the much larger Carrizo formation is expected to be increasingly used as a state-wide ASR water bank over time. However, the EAA prohibits export of any Edwards water outside of its jurisdiction (i.e. to outside of Uvalde County). Therefore, any such ASR program must be developed utilizing waters not

under that jurisdictional constraint. A legislative framework promoting ASR projects is also needed in Texas before many more ASR projects are developed. Such legislation was considered in the 2013 session but did not become law. ASR legislation is expected to be re-considered in the 2015 session.

The Austin Chalk and Buda secondary aquifers are conveniently located near Uvalde to provide a potentially viable alternate supply, as shown on Exhibit 3. Production from the secondary aquifers varies significantly with location, generally being most productive in the areas just west and southwest of the city, as reflected on Exhibit 5. Several large-flow irrigation wells are located in the Austin Chalk or Buda Limestone in this area, with flows reportedly exceeding 1,000 gpm. However production varies significantly over short distances between such wells, likely related to proximity to faulting, igneous intrusions and other geologic controls. The Austin Chalk and Buda Limestone north and further west of Uvalde appear to be generally less productive, although several high volume wells have been reported. The formations reoccur east of Uvalde near Knippa, however fewer wells have been installed in these eastern areas and reported production is much lower, with many local wells instead being completed in the underlying Edwards aquifer. Recorded pumping of the secondary aquifers in Uvalde County has approached 16,500 ac-ft/yr in recent years (2008) per UCUWCD data, being primarily agricultural use from the Leona Formation. However, recent drought aquifer level impacts and changing agricultural practices have reduced this usage significantly.

IV. Groundwater Availability and Supply Cost

The secondary aquifers are identified as the most viable option for both immediate drought relief and for long-term water resource security for Uvalde and its regional neighbors. Limited groundwater availability and high transport costs associated with the northern Edwards-Trinity and Trinity aquifers discourage their use. Acquiring additional pumping rights to expand access to the Edwards is increasingly costly, and any additional rights would still be subject to pumping restrictions during drought. The northern Carrizo-Wilcox in southern Uvalde County is also expected to provide limited groundwater availability, but may be of significant interest related to potential long-term ASR, particularly in the thicker Carrizo sands formation located further south in Zavala County.

Use of the Leona Formation and similar shallow alluvial aquifers is not considered to be a reliable option, all being subject to depletion during drought conditions. Production capacity of the Austin Chalk and Buda Limestone varies significantly with location, apparently being most productive to the near west and near southwest of Uvalde. Two areas have been identified as promising for development of secondary aquifer wells, as shown on Exhibit 6. The area southwest of town along CR-481 in the general vicinity north of Uvalde Estates appears to be productive for the Austin Chalk and Buda Limestone, and such production may extend northerly to about the County Fairgrounds located on US-90. Adequate production of the Austin Chalk and Buda may also exist east of US-83 where the City owns several large tracts in the vicinity of the wastewater treatment plant. Both of these areas are subject to the occurrence of igneous intrusions, which may prevent installation of wells at some locations. This suggests that existing secondary aquifer wells or new test wells in these areas should be assessed for production as part of subsequent preliminary planning.

The desired production of 4,000 ac-ft/yr (about 2,500 gpm) can be produced by three 850 gpm wells. Two 850 gpm capacity wells at both the southwestern (CR-481) and south (US-83) conceptual well fields are initially assumed for a total of four (4) secondary aquifer production wells, providing both capacity reserve for potential fluctuating aquifer levels and mechanical redundancy for utility operations and maintenance. A maximum allowable combined withdrawal rate of 2,500 gpm is initially proposed, subject to UCUWCD permit definitions. UCUWCD may also agree to additional withdrawals for ASR storage diversion during non-drought periods of surplus secondary aquifer capacity. The UCUWCD Rules address several related topics, including: Transportation Permits for export of controlled water to outside of the county (Rule 9) and Recharge Facilities within the county (Rule 10). However, these provisions do not appear to have been written in consideration of a potential regional ASR facility located outside of the county (in Zavala County), suggesting that more detailed discussions and permit definitions will be needed with both UCUWCD and Wintergarden UWCD as part of potential long-range ASR program development. Potential related state legislative definitions may also assist with potential ASR development.

Supply cost for the conceptual new secondary aquifer wells includes an UCUWCD application fee ($250 per well), site investigation costs, and property costs. Purchase of about 5 acres per well site is initially assumed at a cost of about $100,000 per site. It is anticipated that up to eight (8) potential well sites might first be investigated prior to property purchase, with four (4) sites to be selected. Investigation costs will include temporary access agreements, installation and pumping of test wells, water quality sampling, and abandonment of four wells. A combined supply development cost of about $850,000 is assumed, as summarized in Table No.1.

Table No.1
Secondary Aquifers, Supply Development Cost

Description	***Cost***	***Comment***
UCUWCD Well Permit Fee (8)	$ 2,000	$250 each
Temporary Access Agreements (6)	$ 30,000	Assuming $5,000 per site (1)
Test Wells (8)	$400,000	Installation, Pump testing, WQ sampling
Test Well Abandonment (4)	$ 20,000	Four best wells to be completed as PWS
Property Purchase (4)	$400,000	Assuming 5 acres per site, 4 sites (2)
Total:	**$852,000**	

Notes: (1) No temporary access agreement needed for two (2) County or City owned properties initially identified for evaluation.
(2) Property purchase cost will also be reduced if County or City owner property is selected.

Several existing secondary aquifer wells in the subject area report high capacity flows, as shown on Exhibit 5. One or more of these existing wells may also be considered for purchase by the city in lieu of new well investigations, if more cost effective. Pumping tests should also be performed on any such existing wells to confirm current production capacity, and sampled to assess water quality prior to purchase. Purchased wells

would need to meet TCEQ PWS well standards (or be upgraded as needed), and include adequate property to construct associated site improvements, provide access and meet required sanitary separation setbacks.

The costs presented in Table No.1 above do not include the cost of final well construction, disinfection, pumping, storage and distribution, defined separately in Table 3 below.

V. Groundwater Quality and Blending Compatibility

Groundwater quality of the city's current supply (Edwards) and target secondary aquifers (Austin Chalk and Buda) is anticipated to be generally similar, each being limestone aquifer formations. The Austin Chalk and Buda are generally less porous than the Edwards, thereby providing longer formation residence time and resulting increased mineralization as generally indicated in Table No.2. However, Austin Chalk and Buda wells in the target areas are believed to be in closer communication with the Edwards and more likely to be a higher water quality than groundwater from the less productive areas.

Review of the data summarized in Table No.2 suggests that the Austin Chalk and Buda supplies in the vicinity are somewhat higher in Total Dissolve Solids (TDS) than the Edwards, at about 400 to 600 mg/l compared to the Edwards at about 300 mg/l, but all are still well below the potable standard of 1,000 mg/l. Areas of elevated total dissolved solids (TDS) greater than 1,000mg/l are reported for some Austin Chalk and Buda wells southwest and south of the city, requiring confirmation of water quality for any intended municipal use. Bicarbonate alkalinity and pH of each source is reasonably similar, suggesting basic chemical compatibility. This is an important PWS consideration due to the tendency of dissimilar supplies to cause distribution system upsets (release of scales, precipitation, etc.) when rapidly introduced into a distribution system that has previously been in stable equilibrium. Sulfate also appears to be slightly elevated (about 130 to 190 mg/l) in several Austin Chalk wells located south or southeast of town. Limited data is reported on nitrate for the area wells, but is elevated above the 10 mg/l regulatory limit in several locations, likely due to agricultural fertilization. However, the target areas near-southwest and west of town are initially expected to produce a groundwater quality more similar to the local Edwards supply. It is more likely that introduction of Austin Chalk or Buda supplies to the city's PWS distribution system might result in customer feedback of a slightly more 'mineralized' taste, particularly near the distribution introduction points. This may be mitigated by blending this groundwater into the larger volume storage tanks for improved dilution. Each potential alternate supply well should be sampled and analyzed for all Primary and Secondary drinking water quality parameters prior to selection for integration into the city's existing PWS. If specific concerns are identified, additional consideration may be warranted.

Groundwater quality of the Carrizo-Wilcox is not of immediate interest to this resource plan, not being identified as a target supply. However potential long-term ASR use of the Carrizo in Zavala County will require more deliberate evaluation. Sand aquifers tend to produce softer waters, often with higher levels of silica, iron, sulfur and other dissolved minerals. These characteristics can aggravate the distribution stability and aesthetic considerations discussed above. However, the performance of many ASR facilities, including the aforementioned Carrizo Twin Oaks facility in southern Bexar County, suggest that such ASR water banks tend to form an outer 'buffer' zone maintaining a fairly consistent quality of the injected water toward the

interior injection-withdrawal wells, particularly over time with expansion of the stored water volume. That advantage is initially expected to apply to such a potential Carrizo ASR facility in Zavala County. However, it is reasonably possible that some changes between injected and withdrawn water quality may exist, particularly during early operations of an ASR facility. Such changes would likely include increased extract total dissolved solids (TDS), and potentially lower pH resulting from carbonate deposit in the sand storage zone. While focused evaluation of such potential water quality changes is beyond the scope of this preliminary plan, several initial related conclusions include:

- Withdrawn water quality will be a primary consideration in locating appropriate storage zone(s) in the Carrizo Sand aquifer formation south of Uvalde in Zavala County. Geologic samples and in-situ water quality analysis will help identify appropriate storage areas.
- Withdrawn water is expected to meet all regulatory Primary and Secondary water quality standards based on an initial understanding of typical groundwater quality for this region of the Carrizo. Potential increases in dissolved iron and sulphur can be cost-effectively mitigated with aeration and chlorination oxidation to improve finished water aesthetic, and through blending with the larger Edwards supply entering distribution upon return to Uvalde.
- Management of any related treatment process waste streams will require separate consideration, but may include: evaporation; deep well injection; and/or industrial re-use (frac water supply).

Table No.2
Regional Aquifers, Comparative Water Quality (1)

Aquifer (2) (Sample Date)	**TWDB No.**	**Location**	**Depth (Ft)**	**pH**	**Silica**	**Calcium**	**Magnesium**	**Sodium**	**Potassium**	**Carbonate**	**Bicarbonate**	**Sulfate**	**Chloride**	**Fluoride**	**Nitrate**	**TDS**	**Spec.Cond.**	**Hardness**	**SAR**
A (3/1938)	6944403	Knippa	89			341	63	55		0	159	25	760		7	1329		1110	0.7
B (8/1985)	6950315	NE of city	156	7.2						0	339					400(3)	632		
B (8/1985)	6950316	NE of city	183	7.3						0	280					350(3)	574		

Aquifer [2] (Sample Date)	TWDB No.	Location	Depth (Ft)	pH	Silica	Calcium	Magnesium	Sodium	Potassium	Carbonate	Bicarbonat	Sulfate	Chloride	Fluoride	Nitrate	TDS	Spec.Cond.	Hardness	SAR
E (11/1945)	6950302	Near city	265	7.2	12	86	9.5	13	0.9	0	259	16	26	0.1	10	298	481	246	0.3
E (6/1965 – 6/2011)	6950203	Near city	525	7.1	13	86	9.0	13	0.9	0	271	16	27	0.1	10	309	525	254	0.4
A (4/2005)	7056203	Far West	52	6.9	30	125	5.3	21	2.1	0	370	17	33	0.3	12	428	732	334	0.5
A (8/1937 – 10/1972)	7056201	Far West	120	6.8	21	130	4.8	17	2.7	0	390	18	24	0.2	11	420		344	0.4
C (4/1970 – 10/1992)	690201	SE county	250	7.1	35	111	5.1	30	2.2	0	293	25	53		34	440	487	298	0.8
A (4/1957)	6951502	SE of city	350	7.6	16	127	30	55		0	356	192	49	2		644	1010	440	1.1
A (12/1975 – 3/1984)	6950514	S of city	300	7.6		165	22	37		0	290	127	138		11	644	1280	502	0.7

(1) Source; TWDB – Groundwater Database – WQ Report (2013)
(2) **A**-Austin Chalk; **B**-Buda; **C**-Carrizo-Wilcox; **E-**Edwards (BFZ). Sampling Date(s) shown (m/yyyy)
(3) Approximated from Specific Conductance

VI. Conceptual Water Resources Plan

The conceptual alternate groundwater supply will be developed in three phases. Phase 1 will address immediate drought relief, constructing the two secondary aquifer well fields, associated storage and disinfection facilities, and PWS distribution system integration pumping and pipelines. Phase 2 will address long-term water resource security, constructing the dedicated transmission-recovery pipeline from the secondary aquifer well fields southerly to an ASR facility in Zavala County. Phase 3 will include regional

expansion of the water utility infrastructure, easterly toward Knippa and Sabinal. During non-drought surplus aquifer conditions, water from the secondary aquifer well fields will be transported south for injection and storage in the ASR sands, with local consumption demand met by existing Edwards well permitted capacity. During future recurring drought conditions, stored ASR groundwater will be returned north for consumption, reducing demand on the Edwards and secondary aquifers. Location, definition and regulatory permitting of a conceptual ASR facility in Zavala County are beyond this evaluation scope. However, the facility is generally anticipated to be located about 20 to 30 miles southerly of Uvalde in the confined zone of the Carrizo Aquifer where adequate storage capacity and water quality protection is expected to be available.

WGCD's current Rules and Regulations (March 29, 2007) recognize ASR in Section 6.2, and the transfer of groundwater out of the district in Section 11. However, the rules apparently were not written to consider the import, ASR storage and recover transfer of waters from outside of the district. This topic was discussed by the Planning Group during plan development, including the representative of WGCD, and it was agreed that additional regulatory definition between UCUWCD and WGCD will be necessary to better define the conceptual ASR facility.

VII. Preliminary Infrastructure Plan

Following secondary aquifer supply evaluations and testing, Phase 1 conceptual infrastructure will include completion of four (4) PWS wells at the two well fields (2 wells at each site), chlorine disinfection facilities, groundwater storage tanks, transfer pumping, and distribution system connection pipelines, as schematically shown on Exhibit 7. If adequate capacity can be secured at one secondary aquifer well field site, then the second well field can be eliminated, reducing related infrastructure costs. Similarly, if existing secondary aquifer wells can be purchased by the city and converted to PWS use, related infrastructure costs can likely be reduced. Table No. 3 summarizes components and conceptual costs of the Phase 1 infrastructure improvements, initially assuming two (2) secondary aquifer well fields with new wells. Exhibit 10 presents preliminary layout and details of the conceptual secondary aquifer well fields.

Table No.3
Secondary Aquifers, Phase 1 Development
Conceptual Cost

Description	***Cost***	***Comment***
Supply Development Cost	$ 850,000	Per Table No. 1 above
PWS Well Completions (4)	$ 100,000	Well and wellhead per TCEQ standards
Pumps and Accessories (4)	$ 800,000	75HP turbine, valves, appurtenances
Chlorine Disinfection Facilities (2)	$ 100,000	150# Cl2 Cylinders w/ dry scrubber
Ground Storage Tanks (2)	$ 200,000	Two 100,000 gallon tanks
High Service Pumps	$ 200,000	Redundant distribution transfer pumps
Distribution Piping	$ 500,000	Assuming 10,000LF w/ valves-appurtn
Site Improvements	$ 100,000	Roadways, grading, fencing

Site Electrical	$ 200,000	480V, 3-ph supply, power distribution
Instrumentation & Control	$ 100,000	Wireless integration to ex. PWS control
Construction Subtotal:	**$3,150,000**	
Construction Bonds/Ins., GCs (5%)	$ 150,000	
Construction Contingency (15%)	$ 450,000	
Engineering Design (10%)	$ 300,000	
TCEQ Permitting (2%)	$ 60,000	
Construction Administration (5%)	$ 150,000	
Total Capital Cost:	**$4,260,000**	
O&M Cost		
Power	$160,000	2,500gpm (300HP-225kW)@$0.08/kW-hr
Consumables	$4,000	3,300lbs Chlorine @$1.25/lb
Equipment Replacement	$70,000	20yr life-cycle (5%/yr of $1.4M equip)
Labor	$0	No additional labor required for city utility
Total Annual O&M Cost:	**$234,000/yr**	

Consumer rate impact of the Phase 1 infrastructure improvements is expected to be about $7.85 per month based on 5,500 metered customers and 20 year debt amortization at 3% interest. This would increase the average monthly water bill from about $125/month to $133/month (about 6%).

Integration of the Phase 2 conceptual ASR facility will include flow diversion from each secondary aquifer well field ground storage tank to a dedicated 24-inch ASR transmission-recovery line. ASR transfer pumps located at the well fields will convey water through the transfer-recovery pipeline extending about 30 miles south to the ASR facility in Zavala County. Partial pipeline routing in public right-of-ways is assumed, reducing separate property purchase and easement costs. About 10 miles of 30-ft easement (35 acres) is initially assumed for costing. Chlorine disinfection would be suspended while diverting to ASR. During subsequent recovery operations, ASR recovery well pumps located at the ASR facility will convey water northerly through the same 24-inch transfer-recovery pipeline back to the secondary aquifer well fields ground storage tanks for disinfection and PWS distribution, as shown on Exhibit 8. Table No.4 summarizes conceptual costs of the Phase 2 infrastructure improvements, and Exhibit 11 presents preliminary layout and details of the conceptual Carrizo ASR well and transfer system.

Table No.4
Secondary Aquifers, Phase 2 ASR Development
Conceptual Cost

Description	***Cost***	***Comment***
ASR Transfer Pumps	$200,000	One set at each well field
Well Field Piping/Valve Mods	$100,000	To support diversion and recovery flows
ASR Transfer-Recovery 24" Pipeline	$22,400,000	Assuming 150,000LF at $150/LF
ASR Recovery Well Pumps	$150,000	One set (2 wells) at the ASR Facility

ASR Recovery Ground Storage Tank	$100,000	One 100,000 gallon tank
Well Field/ASR Pumps Site Electric	$100,000	480V, 3-ph supply, power distribution
Instrumentation & Control	$100,000	Wireless integration to ASR control
Construction Subtotal:	**$23,150,000**	
Line Easements	$700,000	10miles, 30-ft easement @$20k/acre
Construction Bonds/Ins., GCs (5%)	$1,100,000	
Construction Contingency (15%)	$3,500,000	
Engineering Design (10%)	$2,300,000	
TCEQ Permitting	$100,000	
Construction Administration (5%)	$1,100,000	
Total:	**$31,950,000**	
O&M Cost		
Power	$106,000	2,500gpm (200HP-150kW)@$0.08/kW-hr
Equipment Replacement	$32,000	20yr life-cycle (5%/yr of $0.65M equip)
Labor	$0	No additional labor required for city utility
Total Annual O&M Cost:	**$138,000/yr**	

Consumer rate impact of the Phase 2 infrastructure improvements is expected to be about $34.30 per month based on 5,500 metered customers and 20 year debt amortization at 3% interest. This would increase the average monthly water bill from about $133/month to $167/month (about 26%). This does not include potential rate impacts related to any ASR storage and recovery fees paid separately to the ASR facility owner.

Locating the ASR facility closer to Uvalde would reduce this cost considerable. However, a distance of about 30 miles south of the city is conservatively assumed here for preliminary planning, based on general knowledge of the Carrizo-Wilcox in the area. More detailed hydrogeologic evaluations of potential Carrizo ASR facility sites will be necessary to complete this determination. It is important to note that the Phase 2 costs above **do not include** the ASR facility construction cost, initially assumed to be funded separately with public and/or private capital funds. Depending on facility size and hydrogeologic design definition, such an ASR facility cost may conceptually represent an addition $10-$20M. These costs also **do not include** the ASR facility storage/recovery usage fee. Such usage fee would likely be assessed by the facility owner as a charge per ac-ft stored and recovered. It is also anticipated that Wintergarden UWCD may require some form of 'water tax' reduction in recovered water volume (i.e. 95% maximum volume recovery) to ensure no net export of Carrizo-Wilcox Aquifer groundwater from Zavala County. Any such regulatory definitions will be defined subsequently by UCUWCD and Wintergarden UWCD.

Table No.5 summarizes conceptual costs of the Phase 3 regional integration improvements, extending the secondary aquifers supply to Knippa and Sabinal in eastern Uvalde County. This assessment assumes an approximate service population of 700 for Knippa and 1,700 for Sabinal based on 2012 census data, and a corresponding target per capita supplemental supply of 30gpcd – being about 1/3 of the typical daily domestic demand. This corresponds to a combined demand of about 72,000gpd (50gpm) for the Uvalde to Knippa transmission line, and far-eastern Sabinal demand of about 51,000gpd (35gpm) for the subsequent Knippa to

Sabinal transmission line preliminary infrastructure planning. Transmission pipeline alignment along US-90 is initially assumed, avoiding separate easement costs.

Also note that implementing the Phase 2 ASR integration provides indirect regional benefit to Knippa, Sabinal and other regional communities prior to any Phase 3 direct integration, by reducing demand on the Edwards and thereby making more groundwater available to all area communities relying on that controlled supply.

Table No.5
Secondary Aquifers, Phase 3 Regional Integration
Conceptual Cost

Description	***Cost***	***Comment***
Knippa Transfer Pumps	$50,000	One set at eastern Uvalde PWS tank
Piping/Valve Mods	$10,000	To support Knippa transmission flows
Knippa Transfer 4" Pipeline	$1,680,000	Assuming 56,000LF, 4"HDPE at $30/LF
Sabinal Transfer Pumps	$50,000	One set at Knippa PWS tank
Piping/Valve Mods	$10,000	To support Sabinal transmission flows
Sabinal Transfer 4" Pipeline	$1,800,000	Assuming 60,000LF, 4"HDPE at $30/LF
Instrumentation & Control	$100,000	Wireless integration to Uvalde and Knippa controls
Construction Subtotal:	**$3,700,000**	
Construction Bonds/Ins., GCs (5%)	$190,000	
Construction Contingency (15%)	$550,000	
Engineering Design (10%)	$370,000	
TCEQ Permitting	$10,000	
Construction Administration (5%)	$190,000	
Total:	**$5,010,000**	
O&M Cost		
Power	$2,500	50gpm (5HP-3.5kW)@$0.08/kW-hr
Equipment Replacement	$11,000	20yr life-cycle (5%/yr of $0.2M equip)
Labor	$0	No additional labor required for city utility
Total Annual O&M Cost:	**$13,500/yr**	

VIII. Conclusion

This conceptual infrastructure assessment has been prepared to identify, evaluate and support continued pursuit of the most viable alternate water resource supply(ies) for the City of Uvalde and its regional neighbors. The Austin Chalk and Buda secondary aquifers have been identified as the most viable source for development. Integration of these supplies into Uvalde's PWS will provide short-term relief from recent drought pumping restriction of the Edwards Aquifer imposed by the EAA. More significantly, subsequent integration of these supplies into a regional ASR facility conceptually located in Zavala County will improve long-term regional water security, relieve stress on regional aquifers during future recurring droughts, and

help protect regional economic stability. Long-term regional expansion of the associated water transmission system will benefit all communities in the county.

Ongoing efforts toward improved water conservation and other resource management practices will also continue to be an important part of Uvalde's and the region's response to balancing continued growth and prosperity against limited available water resources.

Phased implementation of this alternate groundwater supply plan presents a viable alternative water resource management program for the City of Uvalde, Uvalde County and their community neighbors as part of shared long-range regional strategic planning.

IX. Funding

The City of Uvalde and its regional planning partners may consider a number of public and private funding options to implement alternate groundwater supply infrastructure projects. Private funding sources include municipal bonds and private capital investment partners. Municipal bonds would more likely be used for the Phase 1 secondary aquifer well field development project, while private capital investment partners would more likely participate in the larger regional ASR integration project.

A number of public funding programs are also available through the United States Department of Agriculture (USDA) Rural Communities Program and through the Texas Water Development Board (TWDB). USDA funding includes both grant (CDBG) and low-interest loan assistance. TWDB administers a number of applicable funding assistance loan programs, including:

- Drinking Water State Revolving Fund (SRF) loans – potentially including partial loan forgiveness
- State Loan Program (DFunds) loans
- Water Infrastructure Fund (WIF) loans – once included with the Regional Water Plan
- State Participation Program equity loan – potentially applying to Phase 2 Regional ASR costs

Implementation of the Phase 2 Regional ASR facility is expected to be part of a much larger use of the Carrizo and similar suitable aquifer formations to develop an ASR water resource infrastructure over time, ranging from west of San Antonio northeasterly along the IH-35 corridor toward Dallas-Ft.Worth in response to continued growth and service demand in Texas. Numerous public and private partners will likely support planning and funding of related projects as securing long-term water resources increasingly becomes part of local community and state-wide sustainable development planning, and legislative initiatives define related frameworks.

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Green, R.T. , and Bertetti, F.P. 2010. Development of a Candidate Drought Contingency Plan for Uvalde County, Texas. Final Report. Prepared for Uvalde County Underground Water Conservation District by Southwest Research Institute, San Antonio, Texas.

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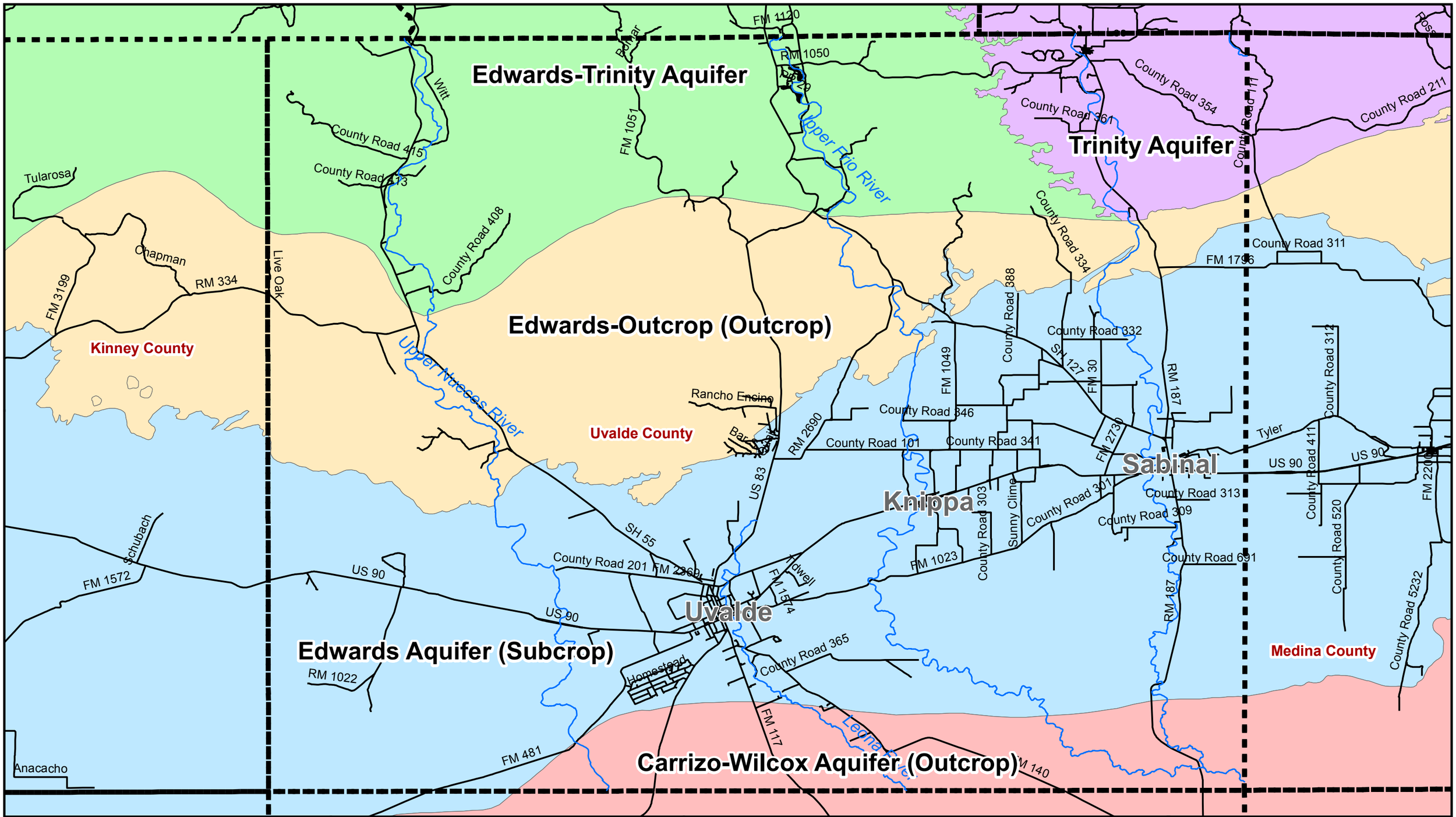
Uvalde County Underground Water District. 2011. Management Plan 2011-2021. Adopted July 26, 2011.

EXHIBITS

1. Uvalde County, Major Aquifers
2. Regional Aquifers Geology
3. Uvalde County, Secondary Aquifers
4. Uvalde County, Recorded Water Wells
5. Uvalde Vicinity, Recorded Water Wells
6. Secondary Aquifers, Preliminary Well Field Siting
7. Secondary Aquifers, Distribution Integration Plan (Phase 1)
8. Secondary Aquifers, ASR Integration (Phase 2)
9. Secondary Aquifers, Regional Integration (Phase 3)
10. Secondary Aquifers, Well Field, Preliminary Layout and Details
11. Carrizo ASR, Preliminary Layout and Details
12. TWDB Comments dated July 16, 2014
13. Comment Responses dated July 21, 2014



0 8 Miles

1 inch equals 23,000 feet

N W E S

EDWARDS (SUBCROP)
CARRIZO RECHARGE
EDWARDS (OUTCROP)
EDWARDS-TRINITY
TRINITY
Counties

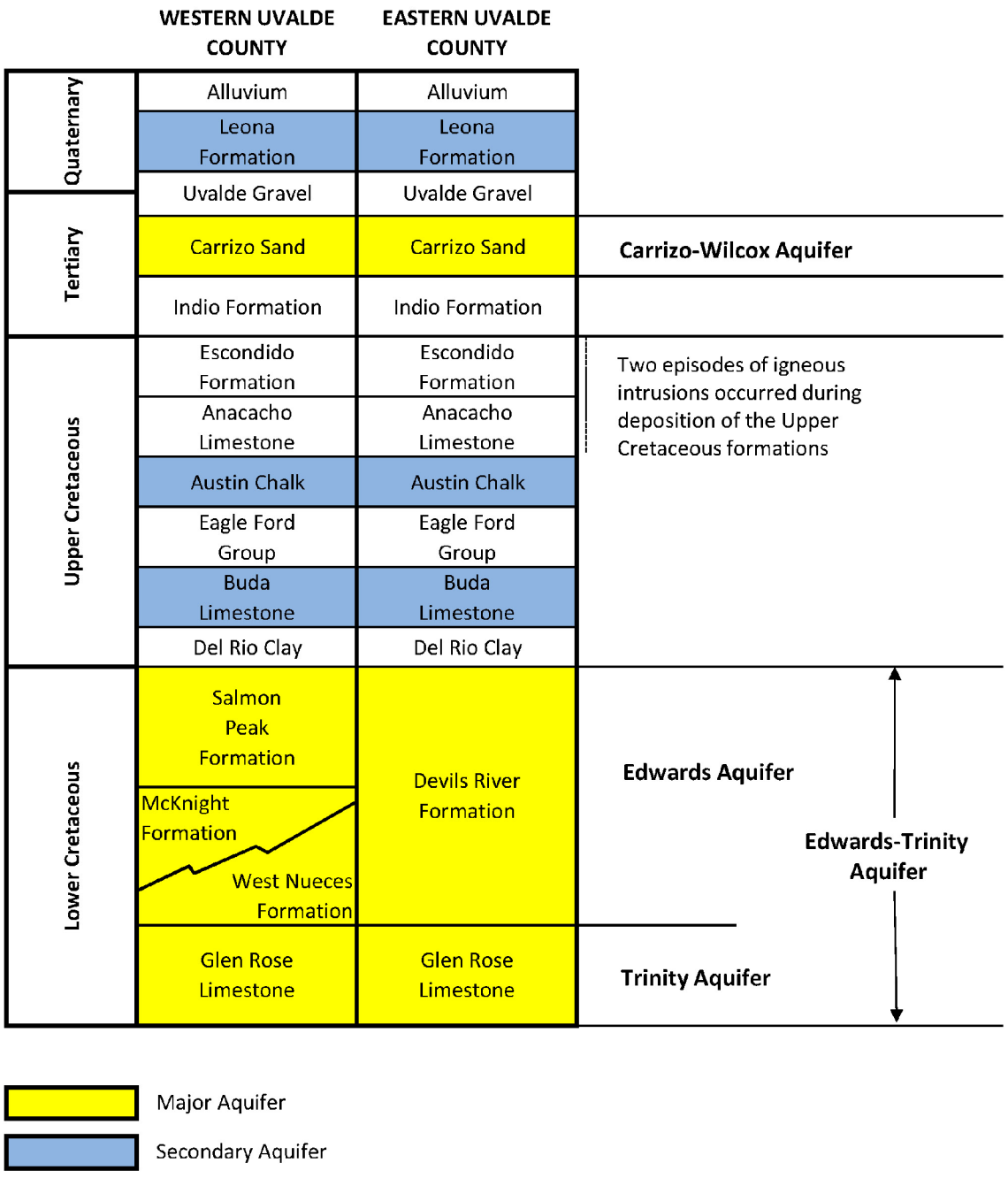
Uvalde County Major Aquifers

Exhibit 1

Data Source: Texas Water Development Board

CDS muery
ENGINEERS • SURVEYORS
1411 MAGIC DRIVE SAN ANTONIO TEXAS•(210)581-1111•TBPE NO F-1733•TBPLS NO 100495-00

ROCK FACIES



Modified from Green et al, 2009

Regional Aquifers Geology

Exhibit 2

CDS muery
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TBPE NO. F-1733 • TBPLS NO. 100495-00

Edwards-Trinity Aquifer

Trinity Aquifer

Upper Frio River

Kinney County

Edwards Aquifer (Outcrop)

Uvalde County

Upper Nueces River

Medina County

Sabinal

Knippa

Buda Limestone

Uvalde

Austin Chalk

Edwards Aquifer (Subcrop)

Leona River

Carrizo-Wilcox Aquifer (Outcrop)

0 8 Miles

1 inch equals 23,000 feet

N W E S

Counties
Austin Chalk Aquifer
Buda Aquifer
EDWARDS (SUBCROP)
CARRIZO RECHARGE
EDWARDS (OUTCROP)
EDWARDS-TRINITY
TRINITY

Uvalde County Secondary Aquifers

Exhibit 3

Data Source: Texas Water Development Board

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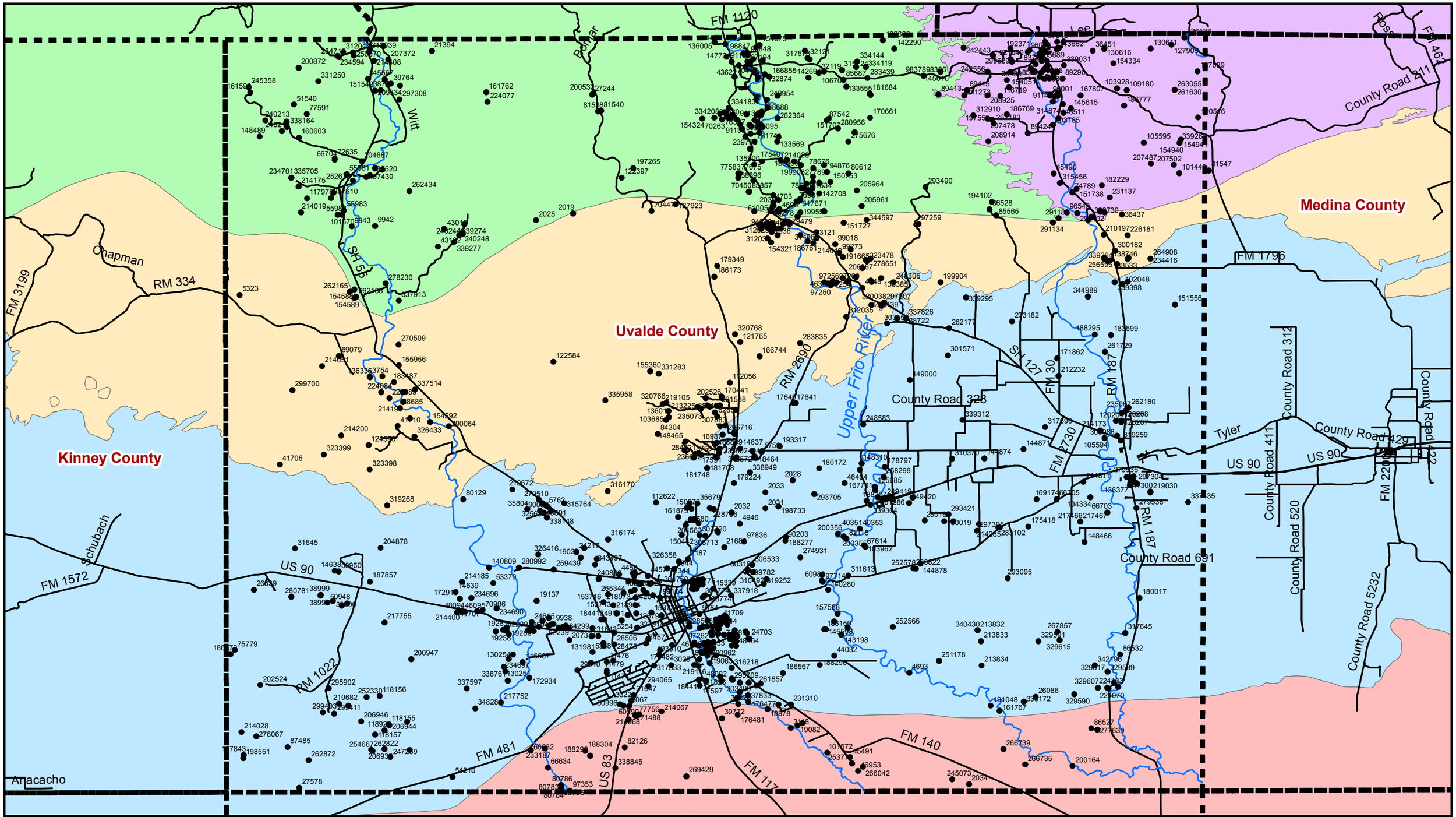
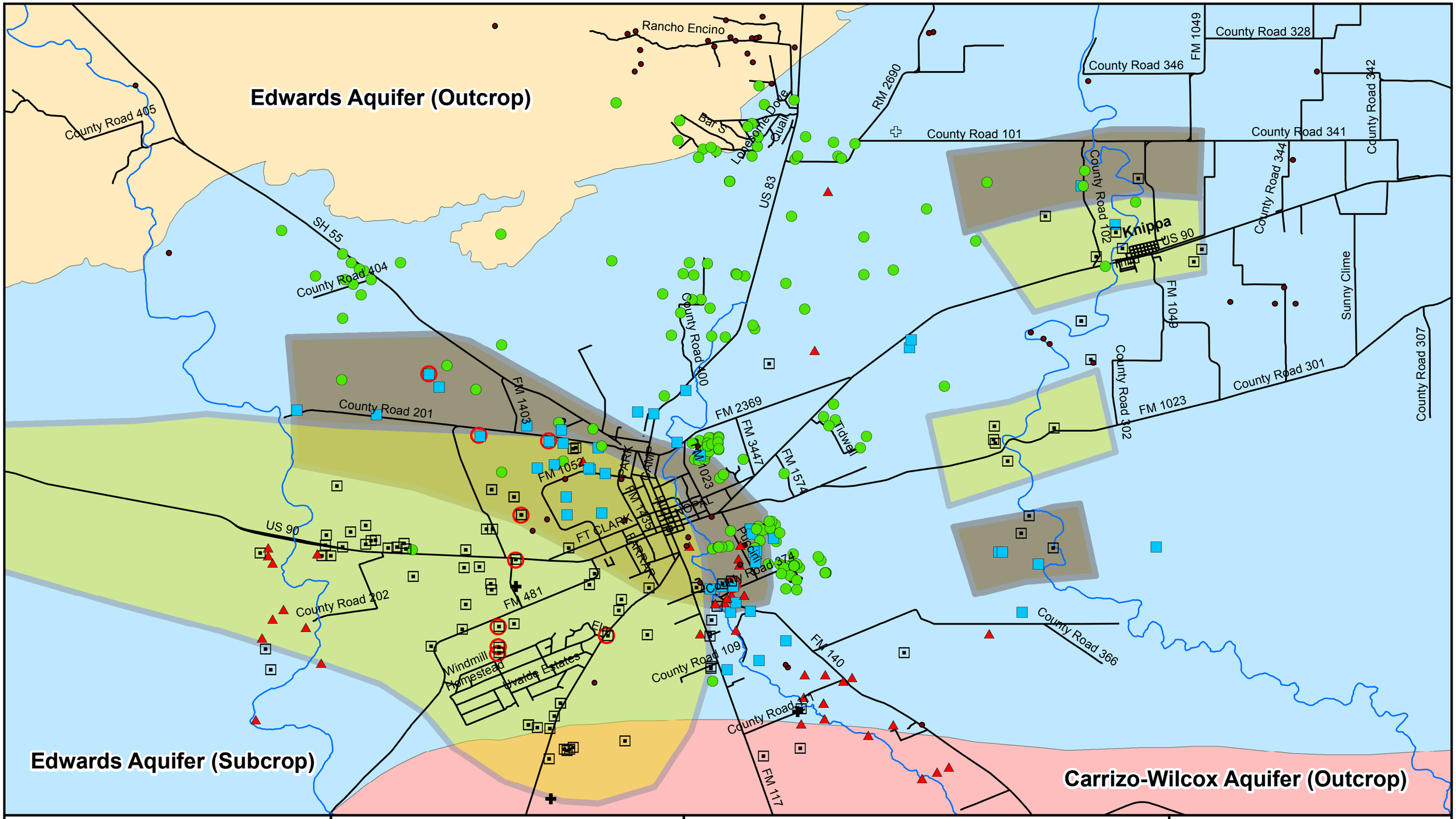

Medina County
Uvalde County
Kinney County
Atascosa
Upper Frio River
Chapman
RM 334
FM 3199
Schubach
FM 1572
US 90
SH 55
Witt
FM 1120
Bandera
FM 1796
RM 2690
SH 127
FM 30
RM 187
FM 2730
County Road 328
County Road 311
County Road 312
County Road 411
County Road 520
County Road 5232
County Road 691
County Road 429
County Road 422
Tyler
FM 2200
RM 1022
FM 481
US 83
FM 117
FM 140
0
8
Miles
1 inch equals 23,000 feet
N
W
E
S
EDWARDS (SUBCROP)
CARRIZO RECHARGE
EDWARDS (OUTCROP)
EDWARDS-TRINITY
TRINITY
Water Well (TWDB-Database)
Counties
Uvalde County Recorded Water Wells
Exhibit 4
Data Source: Texas Water Development Board
CDSmuery
ENGINEERS • SURVEYORS
3411 MAGIC DRIVE SAN ANTONIO TEXAS (210)581-1111 TBPE NO F-1733 TBPLS NO 100495-00



0 10,000 Feet

1 inch equals 10,000 feet

N W E S

Unclassified
Wilcox
Austin Chalk
Buda
Carrizo
Edwards
Leona
Austin Chalk Aquifer
Buda Aquifer
Large Flow Secondary
EDWARDS (SUBCROP)
CARRIZO RECHARGE
EDWARDS (OUTCROP)

Uvalde Vicinity, Recorded Water Wells

Exhibit 5

Data Source: Texas Water Development Board

CDS muery
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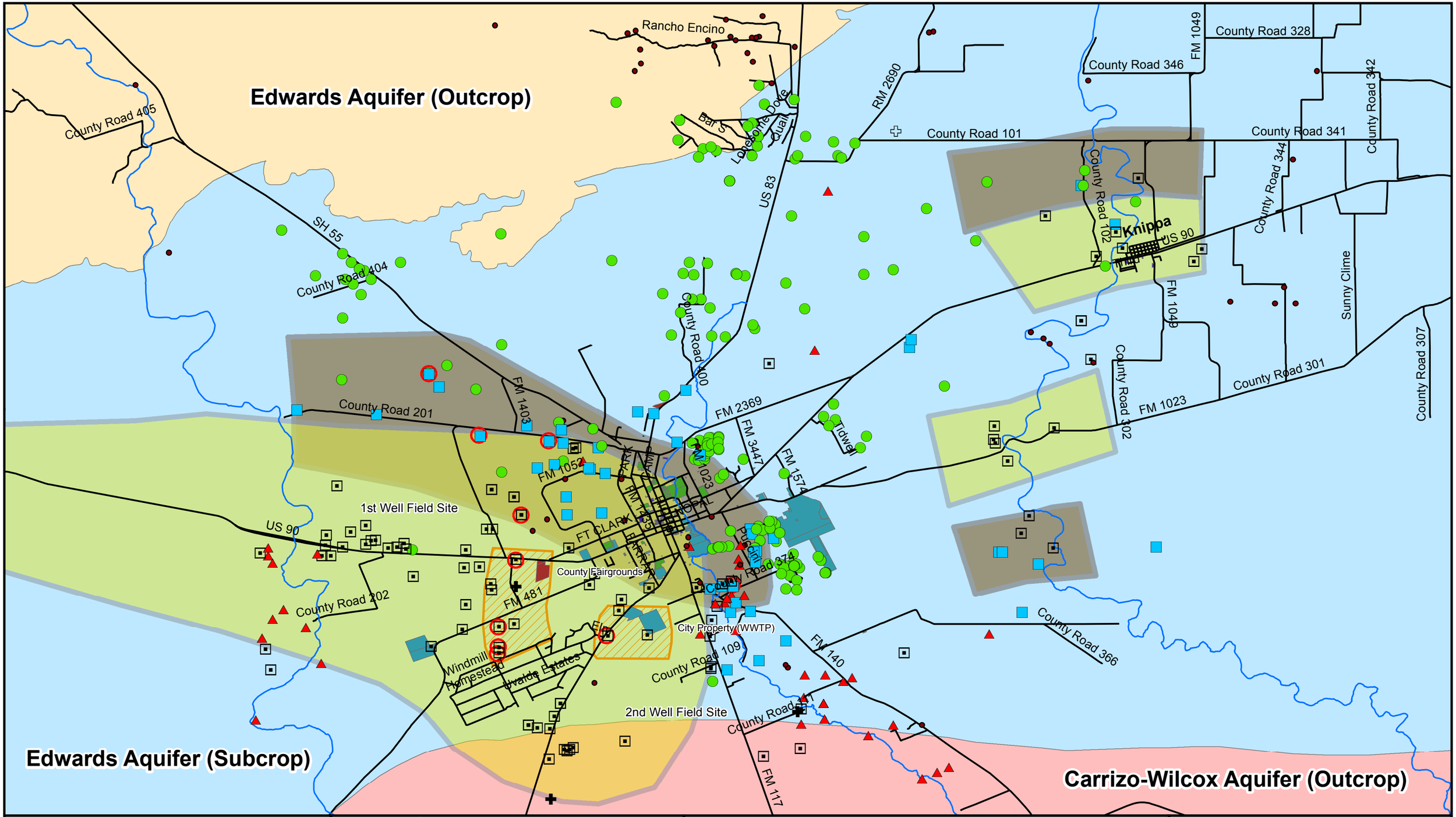

Secondary Aquifers, Preliminary Well Field Siting

Exhibit 6

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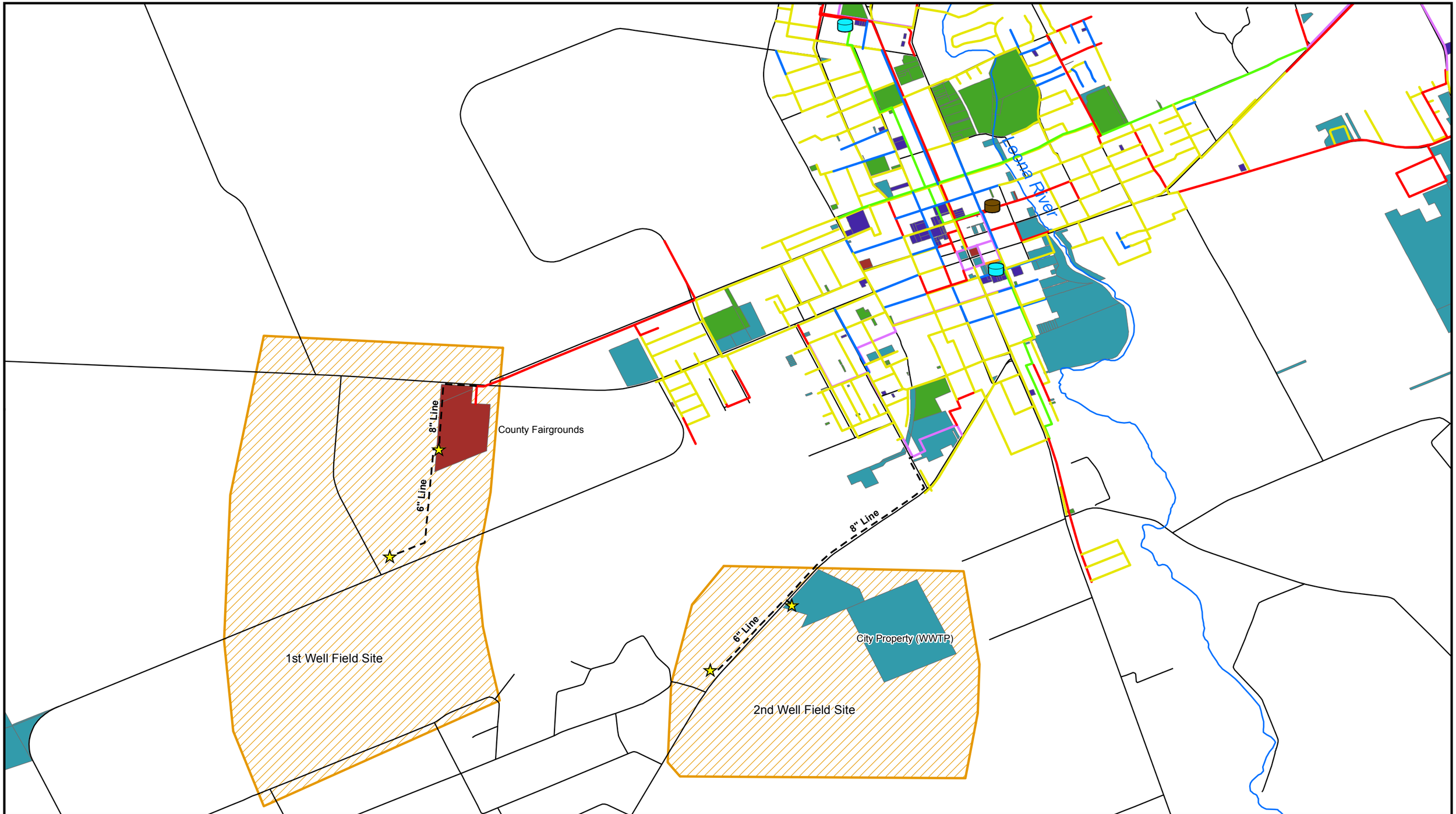

0 2,500 Feet

1 inch equals 2,500 feet

N W E S

- Water Storage: Ground
- Water Storage: Overhead
- Future Well Field/Tank
- Well Field Siting
- Proposed Water Lines

Ownership
- City
- County
- Religious
- School

Water Lines
- 10" Water
- 12" Water
- 16" Water
- 4" Water
- 6" Water
- 8" Water

Secondary Aquifers, Distribution Integration Plan (Phase 1)

Exhibit 7

CDS muery
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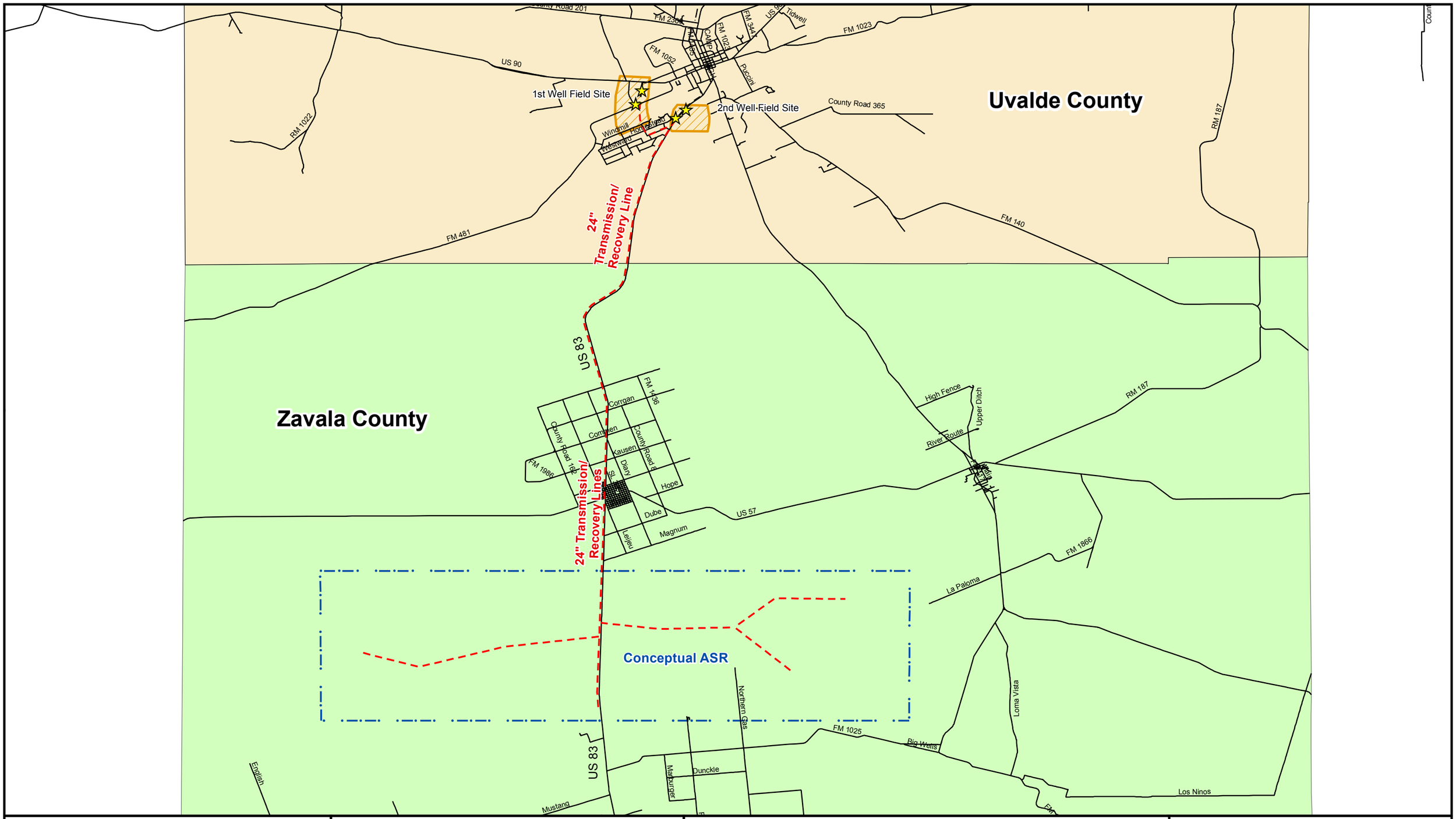

0 20,000 Feet

1 inch equals 20,000 feet

N W E S

☆ Future Well Field/Tank
Well Field Siting
Proposed Water Lines
Transmission_Line
Conceptual ASR

Secondary Aquifers, ASR Integration (Phase 2)

Exhibit 8

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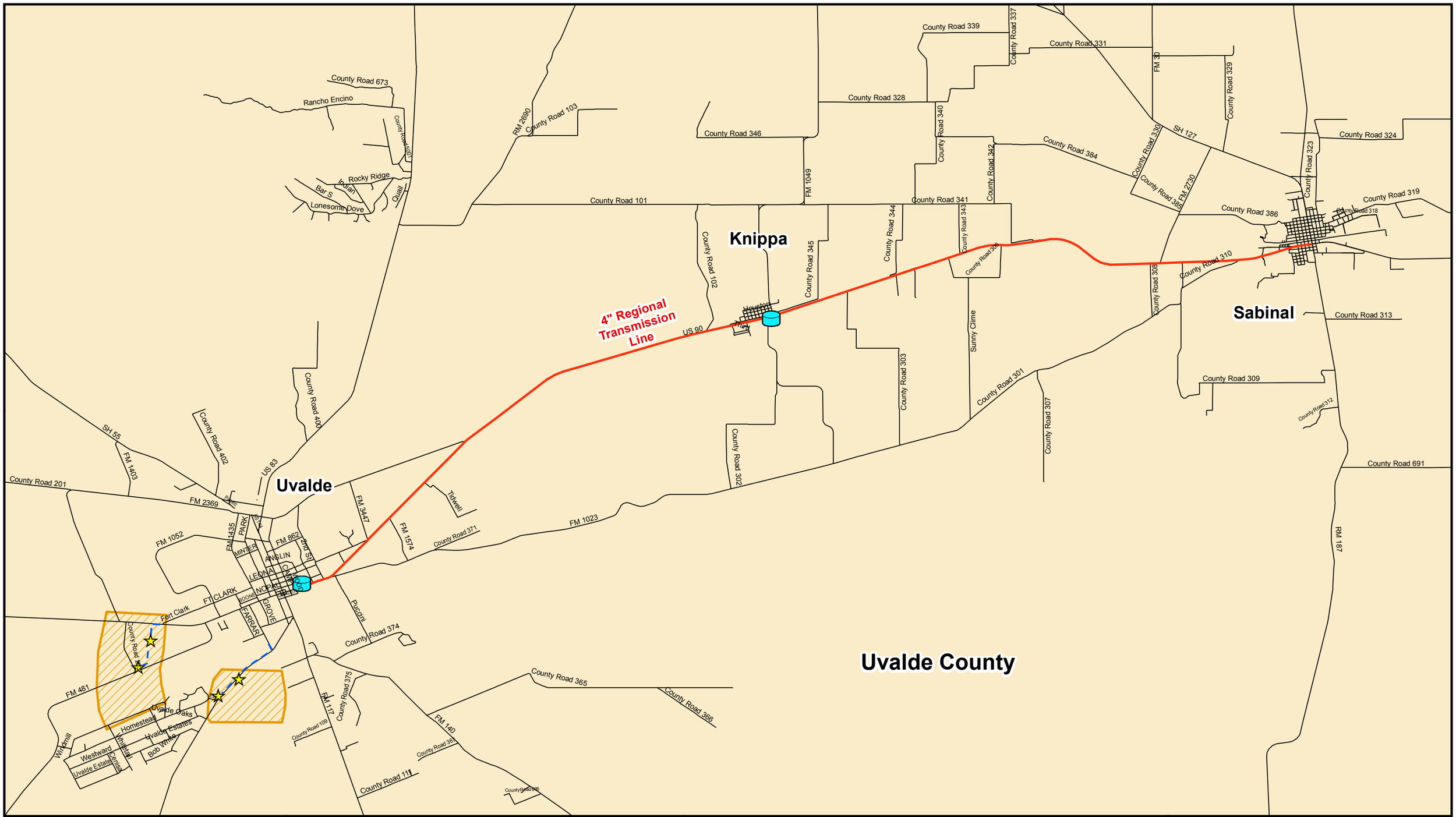

0 10,000 Feet

1 inch equals 10,000 feet

N W E S

Future Well Field/Tank

Transfer Pump Station

4" Regional Transmission Line

Well Field Siting

Proposed Water Lines

Secondary Aquifers, Regional Integration (Phase 3)

Exhibit 9

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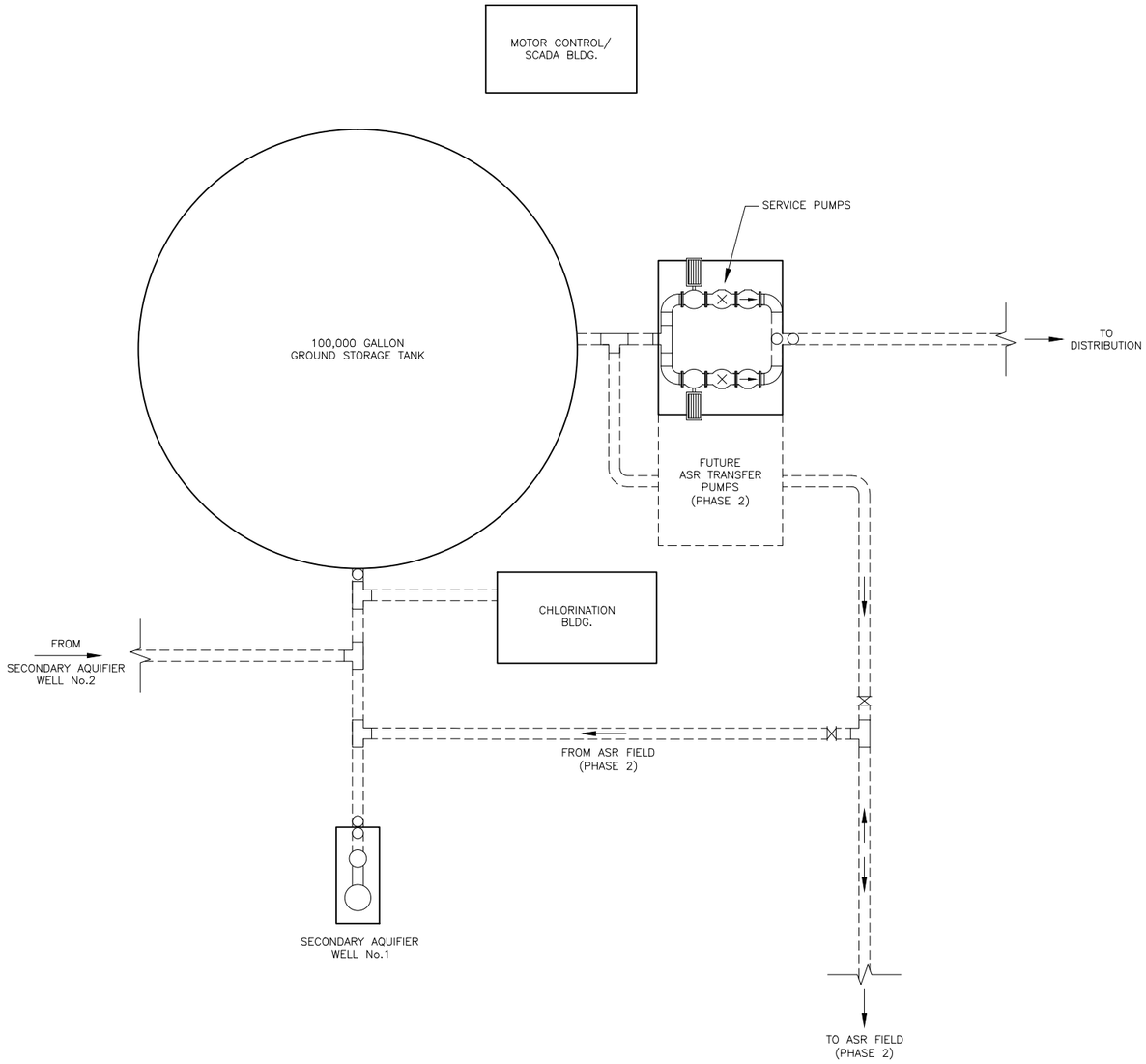
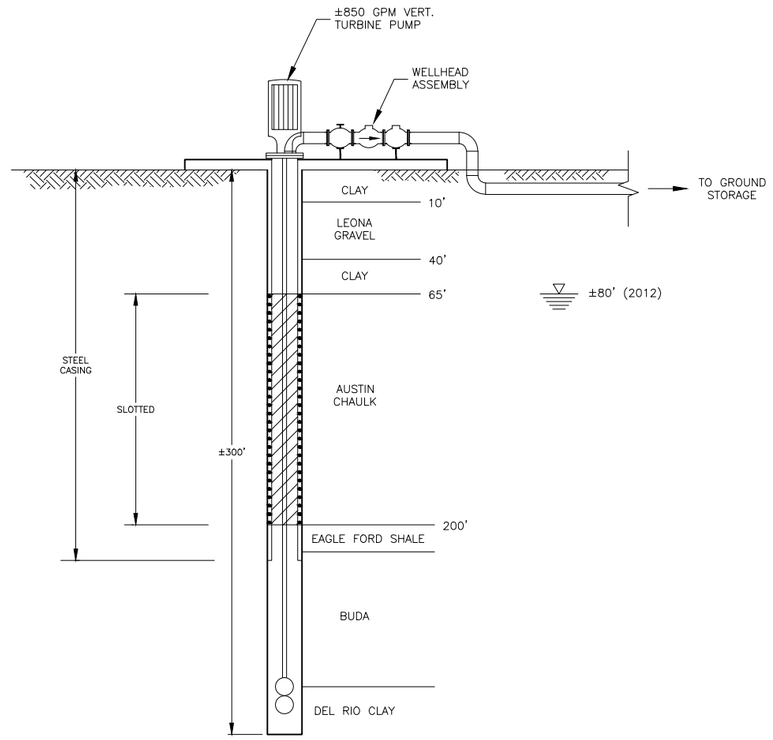


SECONDARY AQUIFIERS WELL FIELD LAYOUT

N.T.S.



TYPICAL AUSTIN CHALK-BUDA WELL

N.T.S.

Secondary Aquifers Wellfield Prelimanary Layout and Details

Exhibit 10

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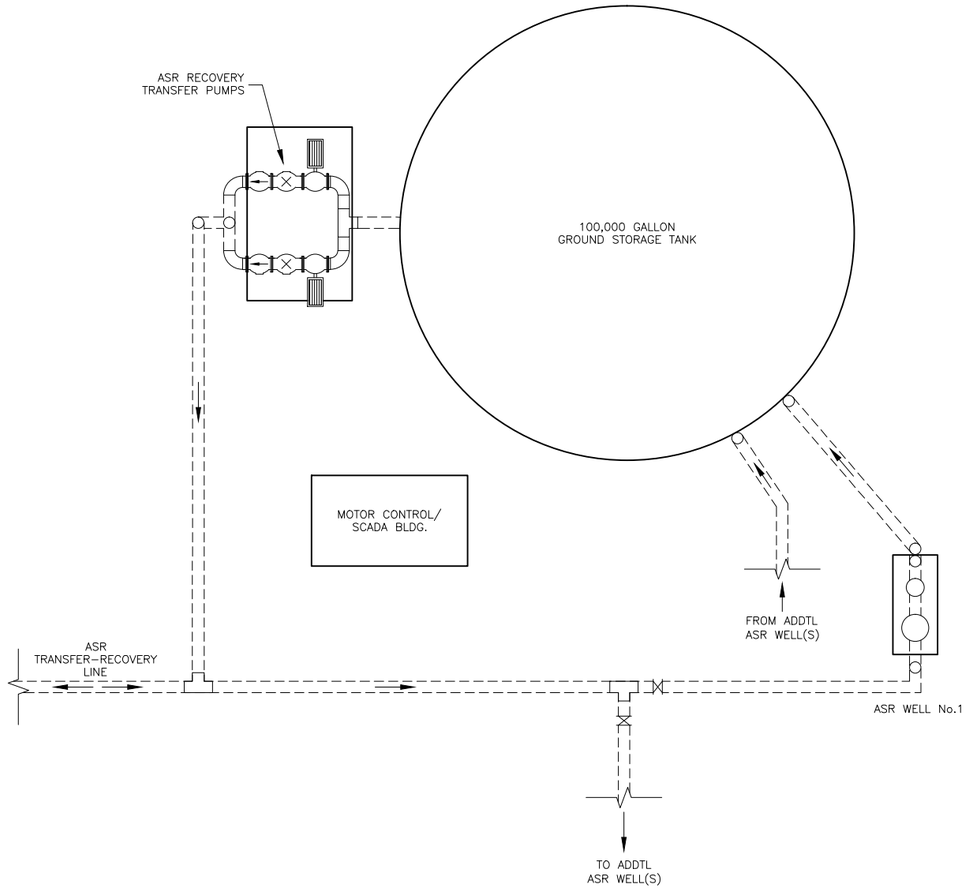
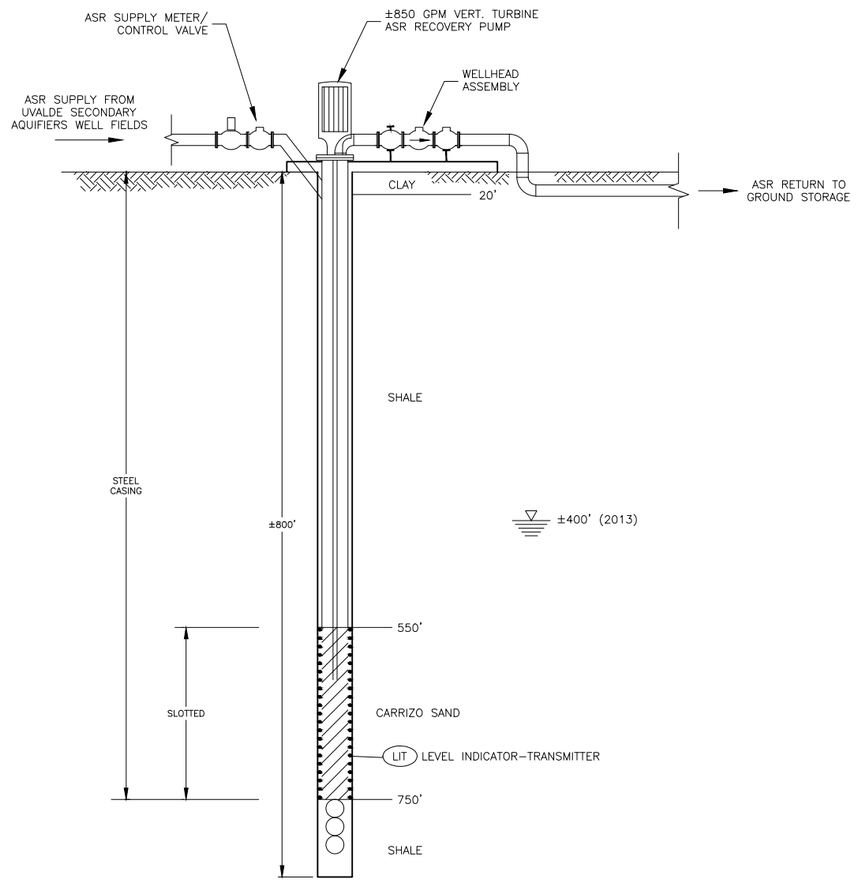


CARRIZO ASR WELL-TRANSFER LAYOUT

N.T.S.



TYPICAL CARRIZO ASR WELL

N.T.S.

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Carrizo ASR Preliminary Layout and Details

Exhibit 11

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Texas Water Development Board

P.O. Box 13231, 1700 N. Congress Ave.
Austin, TX 78711-3231, www.twdb.texas.gov
Phone (512) 463-7847, Fax (512) 475-2053

July 16, 2014

Jennifer E. Garver
City Manager
City of Uvalde
101 E. Main Street
Uvalde, Texas 78801

RE: Regional Water Supply Facility Grant Contract between the Texas Water Development Board (TWDB) and the City of Uvalde (City); TWDB Contract No. 1348321575, Proposed Subcontract by the City with CDS Muery (CDSm) Draft Report Comments for Alternate Groundwater Supply Infrastructure Planning Report

Dear Ms. Garver:

Staff members of the TWDB have completed a review of the draft report prepared under the above-referenced contract. ATTACHMENT I provides the comments resulting from this review. Please address these comments from the Executive Administrator and other staff appropriately in the final report. In addition, CDSm will include a copy of the Executive Administrator's draft report comments in the Final Report.

The TWDB looks forward to receiving one (1) electronic copy of the entire Final Report in Portable Document Format (PDF) and six (6) bound double-sided copies. **Please further note, that in compliance with Texas Administrative Code Chapters 206 and 213 (related to Accessibility and Usability of State Web Sites), the digital copy of the final report must comply with the requirements and standards specified in statute. For more information, visit http://www.sos.state.tx.us/tac/index.shtml.** If you have any questions on accessibility, please contact David Carter with the Contract Administration Division at (512) 936-6079 or David.Carter@twdb.texas.gov

CDSm shall also submit one (1) electronic copy of any computer programs or models, and, if applicable, an operations manual developed under the terms of this Contract.

If you have any questions concerning the contract, please contact David Meesey, the TWDB's designated Contract Manager for this project at (512) 936-0852.

Sincerely,

Jeff Walker
Deputy Executive Administrator
Water Supply & Infrastructure

Enclosures

c: David Meesey, TWDB

Attachment 1

Uvalde Alternative Groundwater Supply Infrastructure Planning Report Comments

TWDB Contract #1348321575

General

1. Please include an executive summary in the final report as required by the TWDB contract.
2. Please include a summary of the three required public meetings and any public comments in the final report as referenced in scope of work task 300. Consider including sign-in sheets and meeting handouts.
3. Please include a section on financial options that could be used to implement study results as required in the TWDB contract. Please include descriptions of TWDB financial assistance and other applicable programs in the final report.
4. On page eight, the last sentence states "costs presented above in Table 1 do not include the cost of final well construction...and distribution, defined separately below". It is not apparent where in the report these additional costs are located. Please clearly reference their location in the final report.
5. Task 400: Please consider identifying in the text, legends, etc. that the well numbers are Well Report Tracking numbers rather than state well numbers.
6. Task 400: On page 7, paragraph 1, the report mentions variable production in the secondary aquifers that may be related to proximity to faulting, igneous intrusions, and other geologic controls. Please specifically address the possibility of hydraulic connectivity or movement of groundwater between the secondary aquifers (Austin Chalk and Buda) and the deeper Edwards Aquifer.
7. Task 500: The scope of work reads "Where reasonably available, assess historic well water levels and hydraulic performance (draw-down, etc.)." The report does not include mention of any current or historic water levels for the aquifers/wells analyzed. Please include more detailed analysis of this type for both the source and storage aquifers in order to better assess feasibility.
8. Task 600: The scope of work states "Review commercial availability... considering...regional groundwater controls..." Please consider elaborating on the Winter Garden GCD's position regarding pumping limits and export as noted in the district's Rule 7.
9. Task 700: The scope of work states, "Review available TWDB, TCEQ, City and other sources' record information defining groundwater quality of potential alternate groundwater supplies... where appropriate, conduct targeted sampling and laboratory analysis...Basic water chemistry data for existing representative wells of potential groundwater supplies is summarized in Table 2; however, there is no reference to the sample date. Please consider including the sampling date.

10. Task 700: Please consider discussing any historical or expected change in water quality over time, or the need for targeted sampling and laboratory analysis, as appropriate. The San Antonio Water System (SAWS) has found that even at relatively low recovery percentages, the recovered water often shows blending with native Carrizo water.
11. Task 800: Please confirm the costs for the test wells noted in Table No. 1; the cost estimate of $30,000 per well seems very low.
12. Task 900: The scope of work states, "Refine selected conceptual definition to reflect preliminary engineering definition and cost opinion of associated physical improvements, property costs, and O&M costs to support budgetary planning. Include preliminary customer rate impact evaluations as part of cost assessments." Operation and maintenance (O&M) costs of additional well fields and an ASR facility are not included, and there is not a customer rate impact evaluation presented. Please include O&M cost considerations and a customer rate impact evaluation in the final report.

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ENGINEERS • SURVEYORS

UVALDE ALTERNATE GROUNDWATER SUPPLY
INFRASTRUCTURE PLANNING REPORT (FINAL DRAFT)

TWDB REVIEW COMMENTS – RESPONSE
July 21, 2014

Texas Water Development Board (TWDB) issued review comments dated July 16, 2014 for the referenced final draft report. Following are CDSm's comment responses.

Comment 1: General - Please include an Executive Summary
Response: An Executive Summary has been added at the front of the report.

Comment 2: Please include summary of three required public meetings.
Response: Three (3) Public Meetings were advertised to follow the three Planning Group Meetings. No members of the public participated in the schedule meetings. A statement to this effect is now included in the report Acknowledgements section.

Comment 3: General - Include financial options for plan implementation
Response: A new Section IX – Funding has been added to the report, discussing potential implementation funding options.

Comment 4: General - Table 1 notes final well and distribution costs defined separately – where?
Response: The Table No.1 note has been expanded to refer the reader to Table No.3 for these separate costs.

Comment 5: Task 400. Identify that well numbers are TWDB Well Report Tracking numbers.
Response: Clarified in text and on Exhibit No.4.

Comment 6: Task 400 - Edwards and Secondary Aquifers Interconnectivity.
Response: The report notes the widely recognized hydrogeologic interconnectivity between the Edwards aquifer and secondary aquifers (Austin Chalk / Buda) particularly in the area of known and suspected faulting, and further notes the separate jurisdictional control of these aquifers. We are not able to further speculate as to the EAA's or others potential opinions regarding use of the secondary aquifers under UCUWCD's control. However, two members of UCUWCD participated on the Planning Group for development of this report.

Comment 7: Task 500. Include more detail on well water levels.
Response: The Edwards and secondary aquifers (Austin Chalk/Buda) are widely recognized as being hydrogeologically interconnected in the subject area, as discussed in Section II – Aquifer and Well Mapping. Additional discussions are now included here comparing recent water level of the EAA J-27 well (832.9 on 6/24/13) and the City's PWS Well No.7 (now operating as a Buda supply – 831.7 on 8/20/13), supporting this observation.

Comment 8: Task 600. Understanding of WGCD's position on pumping and export per their Rule 7
Response: WGCD's current Rules and Regulations (March 29, 2007) recognize ASR in Section 6.2, and the transfer of groundwater out of the district in Section 11. However, the rules apparently were not written to consider the import, ASR storage and recover transfer of waters from outside of the district. This topic was discussed by the Planning Group during plan development, including the representative of WGCD, and it was agreed that additional regulatory definition between UCUWCD and WGCD will be necessary to better define the conceptual ASR facility, as note in the report. However, there was unanimous consensus support of the concept amongst the Planning Group. This is now additionally noted in Section VI – Conceptual Water Resources Plan.

Comment 9: Task 700. Water chemistry data sampling dates?
Response: Sampling dates have been added to Table No.2.

Comment 10: Task 700. Potential ASR recover WQ impacts over time?
Response: Additional discussions of potential ASR recovery water quality impacts have also been added with Section V – Groundwater Quality and Blending.

Comment 11:Task 800. Table No.1 test well $30k cost seems low.
Response: The Austin Chalk/Buda formations in the target areas are shallow (generally less than 150-ft), reducing the cost of ±1,000gpm temporary test wells. Test well cost has been conservatively increased to $50k per well for preliminary planning purposes.

Comment 12:Task 900. Include O&M costs and preliminary customer rate impact costs.
Response: Phase 1 (Secondary Well Fields Integration) and Phase 2 (ASR Integration) preliminary cost opinions have been expanded to include O&M costs, and associated preliminary customer rate impacts have been added.

Comment: General - Bibliography
Response: A bibliography of cited works has been added at the end of the report.