3.2 Water Resources

3.2.1 Hydrologic Setting

The proposed Rusk Permit Area is located in Rusk, Panola, and Harrison counties just south of the Sabine River (**Figure 1-1**). The proposed project is in the Gulf Coastal Plain section of the Coastal Plain physiographic province (Fenneman 1928) and is part of the Piney woods region of East Texas. The most prominent physiographic feature in Rusk County is the Mount Enterprise Fault Zone (**Figure 3.1-1**), which extends in an east-west direction across the southern part of the county and forms a series of hills that attain elevations in excess of 600 feet amsl. The land surface slopes away from this block-fault highland to the north and the south. Springs are common at the higher elevations. Streams in the northeastern portion of the county drain to the Sabine River; streams in the southwestern portion of the county drain to the Neches River (Sandeen 1987). Striker Creek and Bowles Creek drain into Striker Creek Lake, while Beaver Run and Tiawichi Creek drain into Lake Cherokee, and Martin Creek drains into Martin Creek Lake.

Elevations in the study area range from approximately 190 feet amsl on the Sabine River at SH 43, to approximately 400 feet amsl on the hills in the southwestern part of the project area. More typically, however, elevations in the locale range from approximately 275 to 360 feet on uplands and valley sideslopes, and generally from approximately 225 to 275 feet along alluvial fan remnants, the valley floor, and associated stream terraces.

Rusk County has a warm, semi-humid climate. The average annual temperature is approximately 65 degrees Fahrenheit (°F). For the period 1940 through 2007, the average annual lake surface evaporation in the project vicinity was approximately 48 inches. The average annual precipitation for the same period also was approximately 48 inches (Texas Water Development Board [TWDB] 2009). Most rainfall occurs as frontal storms in spring and early summer, with April, May, and June having the greatest monthly rainfall averages. Somewhat drier conditions typically occur from July through October, and soil moisture is usually limited during these months (NRCS 2009). High-intensity thunderstorms and rapid runoff responses are most likely to occur during summer and early fall. Another period of somewhat higher rainfall occurs from November through March. Winter precipitation can be heavy, particularly if tropical storms affect the region (NRCS 2009). Regionally, the average annual runoff is 9 to 11 inches (TWDB 2007).

The largest town in the county is Henderson, which consumes approximately 38 percent of all groundwater pumped in the county (Sandeen 1987). Groundwater use is for public water supply (78 percent), coal mining (10 percent), industrial use (8 percent), and rural domestic water supply (4 percent). The main source of groundwater is the Wilcox Aquifer. The major industrial activity that affects groundwater in the county is the East Texas Field. Oil development in this field requires the removal and eventual reinjection of saline brines from the oil-bearing formations, which lie at depth below the main freshwater aquifers.

Water resources issues include potential direct, indirect, or cumulative impacts to surface water and groundwater quantity and quality and impacts to waters of the U.S., including wetlands associated with the proposed surface disturbance or project-related groundwater drawdown. Additional issues are associated with potential impacts to the City of Tatum's water supply wells, including local water districts' or water suppliers' facilities or service areas, landowners' water rights, disruption of the hydrologic cycle resulting in soils with lower infiltration rates and groundwater recharge, and increased flooding along the Sabine River and its tributaries.

3.2.2 Water Resource-related Regulations

Proposed mine construction, operation, and reclamation activities for the Rusk Permit Area would require water protection measures in accordance with applicable regulations and agency programs. These requirements include:

- Section 404 of the CWA administered by USACE;
- RCT coal mining performance standards regarding protection of the hydrologic balance (16 TAC 12);
- Water quality regulations from TCEQ pertaining to Section 401 (water quality) certification (30 TAC 279 and related guidelines);
- TPDES program (General Permit TXR050000, Sector H); and
- Water rights administration by TCEQ.

Compliance with these regulations and programs, and agency requirements for project reviews and approvals, would reduce the potential for impacts to water resources. The effectiveness of the proposed project activities for the Rusk Permit Area with respect to these regulatory programs was evaluated in the impact assessment, as applicable, as discussed below.

3.2.3 Groundwater

The study area for direct and indirect impacts to groundwater resources includes the proposed permit boundary and the surrounding area within the projected mine-related 5-foot groundwater drawdown zone within the overburden aquifer, which consists of the Carrizo Sand aquifer, water-bearing overlying alluvium, and the upper portions of the Wilcox Group above the lignite coal seams. The groundwater cumulative effects study area encompasses the proposed permit boundary and the surrounding area within the projected cumulative 5-foot groundwater drawdown zone.

3.2.3.1 Affected Environment

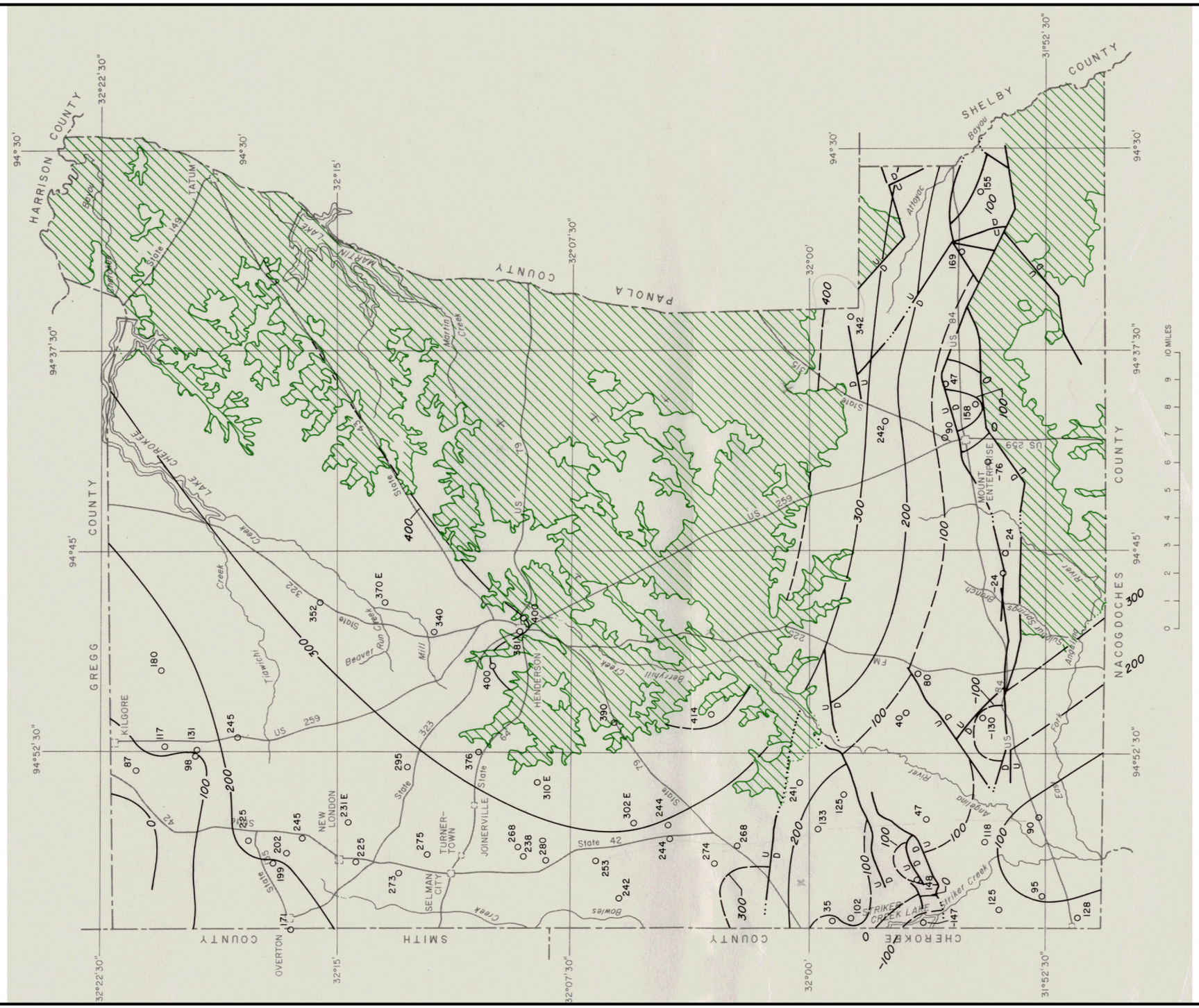
Regional Groundwater Resources

Hydrogeologic Units

The main geologic units in Rusk County that are sources of freshwater are identified in **Table 3.2-1**. The lower Paleocene Midway Group acts as an impermeable base, or aquitard, separating the Tertiary aquifers from the underlying Cretaceous units. The Midway Group is approximately 850 to 1,000 feet in thickness and consists of calcareous clay and minor limestone, with silt and glauconitic clay. This unit dips to the south and has an elevation in the northeastern portion of Rusk County of approximately 300 feet below mean sea level. In the southern part of the county, the elevation is approximately 1,600 feet below mean sea level (Sandeen 1987). The unit contains saline water in the upper 200 feet, and it acts as the lower confining unit for the overlying Wilcox Group aquifer.

The Wilcox Group is the main aquifer in Rusk County. It is exposed at the surface in northeastern and east-central Rusk County, and it underlies the proposed project site. The unit consists of fluvial/deltaic sands, with interbedded clays and lignite coal seams. The Wilcox Group is the coal-bearing unit to be mined by the proposed project. This unit ranges in thickness from 625 to 1,550 feet. **Figure 3.2-1** shows the exposure of the Wilcox Group in Rusk County and the structural contours on the top of the Wilcox in Rusk County. The formation dips to the north at approximately 30 feet per mile (Sandeen 1987).

Stratigraphically above the Wilcox Group is the Eocene Claiborne Group that contains the Carrizo Sand aquifer, the Reklaw Formation aquitard, the Queen City Sand aquifer, the Welches Formation aquitard, and the Sparta Sand aquifer at the top of the group. The Carrizo Sand aquifer is an oxidized, cross-bedded, massive, fine-grained sand that lies unconformably on the Wilcox; it is, however, in hydrologic communication with the Wilcox Group (Sandeen 1987). In some parts of east Texas, the Carrizo and the Wilcox are grouped together and referred to as the Carrizo-Wilcox aquifer. Like the Wilcox, the Carrizo is a major source of freshwater, although it is approximately 80 feet thick on average in Rusk County. The Queen City Sand aquifer and the Sparta Sand aquifer are found primarily in the southern part of the county and would not be affected by the proposed project.



EXPLANATION

231 E — WELL USED FOR CONTROL -- Number indicates altitude of the top of the Wilcox Group. "E" indicates estimated

300 — STRUCTURE CONTOUR -- Shows approximate altitude of the top of the Wilcox Group. Dashed where approximately located. Contour interval 100 feet. National Geodetic Vertical Datum of 1929

PRINCIPAL OUTCROP OF THE WILCOX GROUP -- Includes areas overlain by alluvium and/or terrace deposits. Contacts dotted where concealed

U/D — FAULT -- U is upthrown side, D is downthrown side. Dotted where concealed

Source: Sandeen 1987.

Rusk Permit Area EIS

Figure 3.2-1

Approximate Elevation for Top of Wilcox Group

Table 3.2-1 Water-bearing Properties of Rusk County Geologic Units

System	Series	Group	Unit	Approximate Range in Thickness (feet)	Composition	Water-bearing Properties
Quaternary	Holocene		Alluvium	0 to 35	Sand, silt, clay, and some gravel	May yield small quantities of water to shallow wells
	Pleistocene		Terrace deposits	0 to 30	Sand, silt, and clay	Not known to yield water to wells
Tertiary	Eocene	Claiborne	Sparta Sand	0 to 100	Interbedded sand, clay, and silt	Feeds springs; may yield some water to wells
			Weches Formation	0 to 50	Glauconite, glauconitic clay, and sand – secondary deposits of limestone in outcrop	Not known to yield water to wells in Rusk County
			Queen City Sand	0 to 130	Sand, silt, clay, an some lignite	Yields small to moderate quantities of freshwater
			Reklaw Formation	0 to 130	Glauconitic clay, some sand, weathers to a red clayey soil, limonite seams, iron concretions	Yields small quantities of water to wells
			Carrizo Sand	0 to 135	Gray to white; often massive sand, clay lenses; may be predominantly clayey	Yields large to moderate quantities of freshwater; in hydrologic continuity with the Wilcox
	Paleocene	Wilcox		625 to 1,550	Thin, sometimes massive beds of sand, clay, and lignite. Beds often discontinuous	Yields large to moderate quantities of fresh to slightly saline water
		Midway		850 to 1,000	Calcareous clay and minor amounts of limestone, silt, and glauconitic clay	Not known to yield water to wells in Rusk County; upper sand may contain some slightly saline water

Source: Sandeen 1987.

Figure 3.2-2 shows the stratigraphy of eastern Rusk County along a north-south transect that passes close to the Rusk Permit Area. The most substantial hydrologic unit in Rusk County is the Wilcox Group aquifer (Wilcox aquifer). This aquifer is the source of water for Henderson, Texas, and for most towns in Rusk County. **Figure 3.2-3** shows the thickness of the unit in the county, which ranges from 70 to 400 feet. **Figure 3.2-4** shows the elevation of the freshwater sands, and **Figure 3.2-5** shows the base of the saline water in the Wilcox aquifer.

Groundwater Hydrology

The Carrizo-Wilcox aquifer crops out over approximately 60 percent of Rusk County (Sandeen 1987). Recharge to the aquifers comes from precipitation. The exact percentage of precipitation that recharges the Wilcox aquifer has not been measured; however, Sandeen (1987) estimated that approximately 1.0 inch per year (approximately 2.7 percent) of rainfall recharges the Wilcox aquifer. Where the Wilcox and the Carrizo are exposed, the aquifers are unconfined, and groundwater flow is to nearby drainages. At depth, the Wilcox is a confined aquifer with groundwater flow mainly to the southeast, or to the substantial groundwater depression that surrounds Henderson due to municipal pumpage.

Aquifer tests conducted on the Wilcox, Carrizo, and Queen City aquifers in adjacent counties (Sandeen 1987) have indicated that the Carrizo has a hydraulic conductivity of 15.7 to 63.8 feet per day, with most values falling between 15 and 31 feet per day. The storativity is in the range of 1.0×10^{-4} feet per feet. The Queen City has a hydraulic conductivity of approximately 9.0 feet per day. The Wilcox shows hydraulic conductivity values that fall into two ranges: 1) lower range values from 2.0 to 7.0 feet per day and 2) upper range values mostly between 13.0 and 19.0 feet per day. The measured values for the Wilcox range up to 36 feet per day (Sandeen 1987). Storativity estimates are in the range of 7.0×10^{-4} feet per feet for the Wilcox.

Groundwater Quality

Based on water quality samples from 107 wells in Rusk County, the Wilcox aquifer has a water quality dominated by sodium bicarbonate, with local zones of groundwater dominated by calcium-magnesium-chloride-sulfate water. The total dissolved solids (TDS) values range from 49 to 3,430 milligrams per liter (mg/L), with only 8 out of the 107 wells showing TDS values greater than 1,000 mg/L. Thus, water quality in the Wilcox is classified as freshwater. Based on water quality samples from 31 wells that are less than 100 feet deep, the Carrizo is dominated by calcium-magnesium-chloride-sulfate water, with TDS values generally less than 1,000 mg/L. Only 3 of the wells had a TDS value greater than 1,000 mg/L.

The main potential for groundwater contamination is the development of the East Texas Oil Field. Saline brines pumped from the oil wells were discharged to surface ponds from 1929 to 1961. Since 1961, saline brines have been re-injected at depth. The water used in the oil field wells generally comes from the Wilcox (Sandeen 1987).

Groundwater Use

In 1980, groundwater use in Rusk County totaled approximately 6,049 acre-feet (Sandeen 1987). Public water supply used approximately 4,705 acre-feet, or approximately 77.8 percent of the total. Henderson used 178 gallons per capita for a total of 2.05 million gallons per day (gpd). From 1935 to 1981, groundwater levels in the Wilcox aquifer in the vicinity of Henderson declined up to 134 feet. The average groundwater level decline rate in this area was 2.9 feet per year (Sandeen 1987). Total water consumption in Rusk County in 1980 was 5.4 million gpd.

<u>Groundwater Resources in the Rusk Permit Area</u>

Groundwater in the study area has been characterized by Sabine and its contractors. The following sections are summarized from Sabine's RCT mine permit application (Sabine 2009a).

Groundwater Aquifers

The geologic units present in the study area are described in Section 3.1, Geology and Mineral Resources. The principal water-bearing units are the Wilcox Group aquifer, Carrizo Sand aquifer, and Quaternary terrace and fluviatile deposits. In the study area, the Wilcox Group consists of a fluvial/deltaic sand sequence, with interbedded lignite seams and clay units. The unit in this area ranges up to 1,550 feet in thickness and contains four major lignite seams up to 12 feet thick. It consists of three main hydrologic subunits: 1) the overburden clay-rich sands and silts; 2) the lignite-bearing section; and 3) the underburden sands, silts, and clays. The overburden sands can be greater than 100 feet in thickness, are often in hydraulic communication with the overlying Carrizo Sand aquifer, and contain an unconfined water-bearing zone that is often contiguous with the Carrizo Sand aquifer. The overburden sands are typically 20 to 80 feet thick in the study area; however, they can be up to 140 feet thick near the Sabine River (Sabine 2009). The lignite-bearing section yields little water and acts as a semi-permeable layer separating the overburden and the underburden. The underburden sands and silts contain a confined aquifer.

The Carrizo Sand aquifer is the main source of shallow groundwater in the study area. It is a fine to medium-grained quartz sand with an upper zone of interbedded sand, silt, and clay. The unit overlies the Wilcox Group and ranges mainly from 20 to 60 feet in thickness, but it can be up to 135 feet thick; it often is absent in the higher elevation areas. Groundwater in the Carrizo often is connected with groundwater in the overburden sands of the Wilcox Group. The Quaternary terrace and fluviatile deposits are part of the Sabine River System and are found mostly near the Sabine River or Cherokee Bayou. They consist of sands, silts, and clays deposited by the Sabine River and can be up to 50 feet in thickness. The Carrizo Sand aquifer and the Quaternary terrace deposits are not in hydraulic communication with the Wilcox Group underburden sands because of the intervening lignite coal measures.

The water table in the Carrizo Sand aquifer and the overburden sands of the Wilcox Group follow topography. The aquifer is unconfined and recharged by precipitation. Groundwater flows from the topographically higher areas to streams and ultimately to the Sabine River. Water table depths range from 5 to 20 feet bgs in the lower topographic areas and from 20 to 50 feet bgs in the higher elevation areas. The potentiometric surface in the confined aquifer of the Wilcox Group underburden is found at depths of 25 to 100 feet bgs (**Figure 3.2-6**).

Groundwater Flow

Groundwater flow patterns in the study area are based on measured groundwater levels in 31 monitoring wells (**Figure 3.2-7**). In general, the shallow aquifer in the Carrizo Sand/Wilcox overburden (overburden aquifer) is recharged by precipitation and loses water to streams, springs, surface waterbodies, and plant evapotranspiration. The water table map for the unconfined overburden aquifer is shown in **Figure 3.2-8**. The potentiometric surface for the Wilcox Group confined underburden aquifer is shown in **Figure 3.2-9**.

Most of the groundwater flow in the overburden aquifer is in the Carrizo Sand, and flow follows topography, with groundwater flowing from the higher elevations to nearby streams, seeps, or surface waterbodies. Groundwater table elevations range from 350 feet amsl in the higher areas to a low of 240 feet amsl at Cherokee Bayou. The groundwater gradient is 60 to 80 feet per mile. Seasonal groundwater table fluctuations are in the range of 1 to 3 feet. The hydraulic conductivity of the Carrizo Sand aquifer ranges from 25 feet per day to 40 feet per day based on pumping tests. The storativity is 2.0 to 3.0 x 10^{-3} feet per feet (**Table 3.2-2**). The Wilcox Group overburden has hydraulic conductivity values that range from 0.27 feet per day to 4.5 feet per day because this part of the Wilcox group is mainly muddy silts. The Wilcox Group underburden, which forms the underburden aquifer, has hydraulic conductivities up to 28 feet per day.

Groundwater flow in the underburden aquifer is confined and flows from southeast to northwest, with discharge to the Sabine River. The groundwater gradient is approximately 10 feet per mile. Seasonal groundwater table fluctuations are in the range of 1 to 3 feet. A pumping test in the underburden aquifer

indicated a hydraulic conductivity of 28 feet per day, with a storativity of 3.0 x 10^{-3} feet per feet. Slug tests indicate hydraulic conductivity values up to 1.0 feet per day (**Table 3.2-1**).

Groundwater Quality

Groundwater quality in both the overburden aquifer and in the underburden aquifer is presented in **Tables D-1** and **D-2** in **Appendix D**. Twenty-two wells were screened in the overburden aquifer at depths from 23 to 80 feet. **Figure 3.2-10** displays the groundwater quality for the overburden aquifer using a piper diagram (a trilinear diagram that provides a visual comparison of several water types). The groundwater in the overburden aquifer is mainly sodium bicarbonate water, with local areas high in sodium chloride. The pH ranges from 6.6 to 7.0 standard units, and the TDS ranges from 35 to 751 mg/L, with a mean of approximately 237 mg/L (Sabine 2009). Iron is variable and can range up to 20 mg/L; however, it is generally below 10 mg/L. Metals are low or non-detectable. For the underburden aquifer, 9 wells were screened at depths from 60 to 209 feet. The groundwater quality is shown in **Figure 3.2-11**. The groundwater in the overburden aquifer also is sodium bicarbonate water, with a pH ranging from 6.5 to 7.2, and TDS ranging from 268 to 550 mg/L, averaging around 390 mg/L. Metals are low or non-detectable.

For both aquifers, bicarbonate ranges up to 529 mg/L; it generally falls into two ranges: 1) high values above 400 mg/L and 2) low values below 300 mg/L. Chloride is low; it ranges up to 262 mg/L. Iron is variable in both the total and dissolved analyses, and can range up to 33.2 mg/L for dissolved iron, with most values falling below 10 mg/L. Sulfate is below 100 mg/L, and sodium is considerably greater than calcium and magnesium combined. Metals are low or non-detectable. Overall, the groundwater quality is good, and the analyses from the 31 wells sampled in 2008 suggest freshwater in both the overburden aquifer and the underburden aquifer.

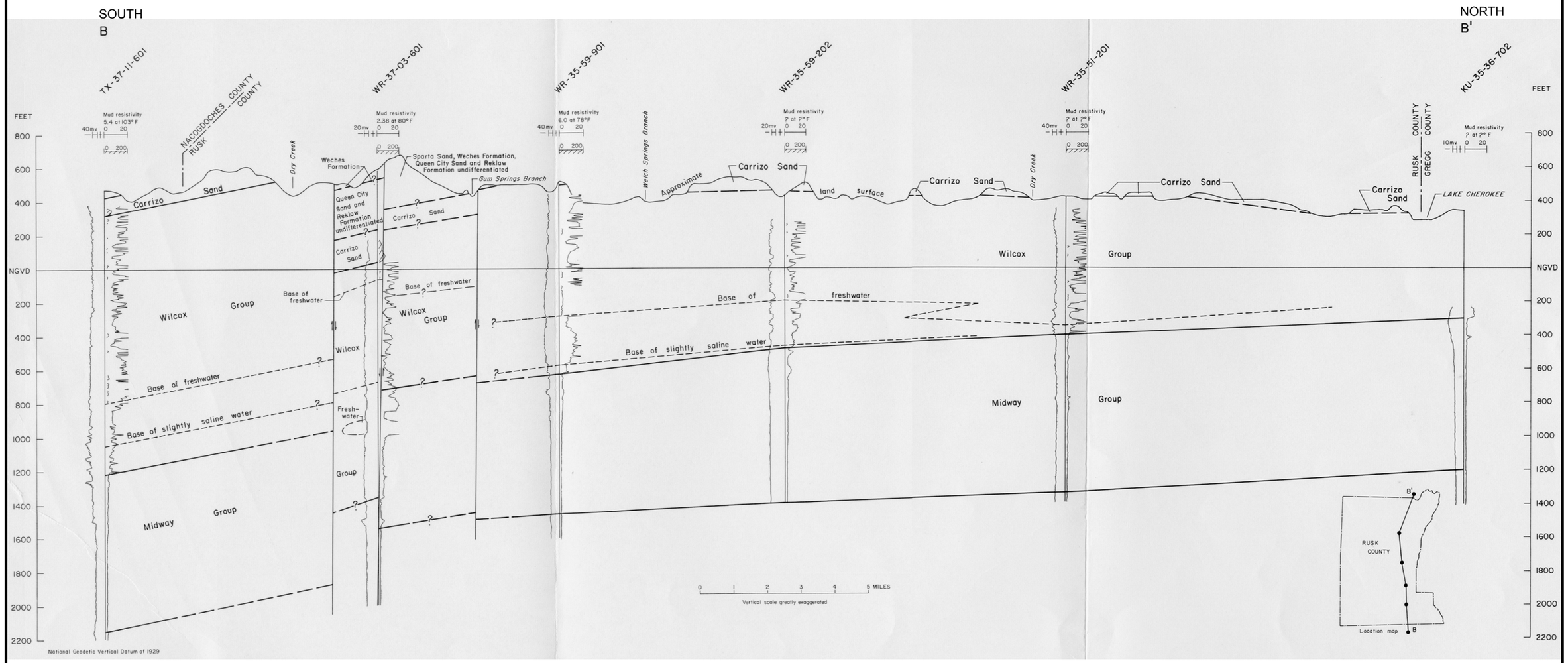
Groundwater Well Inventory

An inventory of wells and springs within 1 mile of the permit boundary was conducted by Sabine (Sabine 2009). The results of this survey, which included site visits and meetings with many individual well owners, are presented in **Table D-3** in **Appendix D**. Well locations are shown in **Figure D-1**. There were 369 wells identified within 1 mile of the permit boundary. Approximately 200 of the wells (50 percent) are oil or gas field industrial wells less than 100 feet in depth. Twenty-eight percent (104 wells) are domestic or agricultural wells screened in the overburden aquifer. Fourteen of the wells are public water supply wells at depths of 280 to 700 feet. Nineteen percent of the identified wells (70 wells) are abandoned wells.

Water Supplies and Suppliers

In Texas, groundwater belongs to the landowner, and may be used or sold as private property. Texas courts have adopted the common-law rule that landowners have a right to take for use (or sale) all the water that they can capture from below their land (Texas A&M Water Program 2010). This approach also is known as the “Right of Capture.” Further complexities of Texas water law are beyond the scope of this assessment.

A number of small, independent water providers supply groundwater for domestic and other uses on a commercial basis in Rusk County. Wellfields and associated plant facilities for these providers are scattered throughout the region. Approximately 19 providers are listed for Rusk County in Texas Water Planning Region D documentation (Schaumberg and Polk, Inc. 2009), and 16 are listed in Panola County. These providers include Crystal Farms Water Supply Corporation, Chalk Hill Special Utility District, the City of Tatum, and others that are in or near the Rusk Permit Area. As discussed above, there are 14 public water supply wells, completed at depths of 280 to 700 feet, located in or within 1 mile of the proposed permit boundary. The populations served by individual groundwater providers range from less than 100 to over 800 people (Schaumberg and Polk, Inc. 2009).



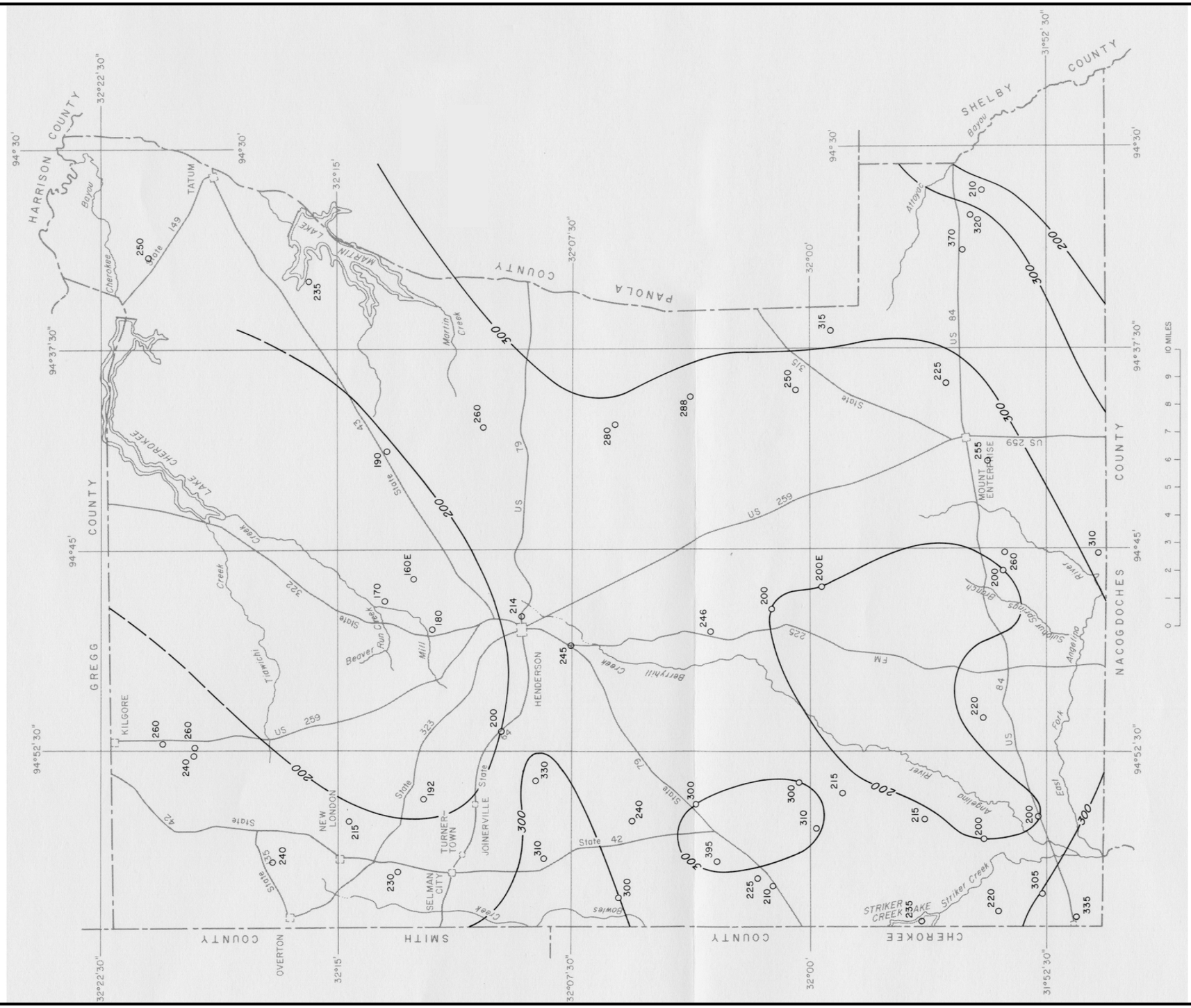
Rusk Permit Area EIS

Figure 3.2-2

North-South
Hydrogeologic Cross-section
Rusk County

Source: Sandeen 1987.

04/15/10



EXPLANATION

200E — WELL USED FOR CONTROL--Number indicates aggregate thickness of sand containing freshwater. "E" indicates estimated.

—200— LINE OF EQUAL THICKNESS OF SAND CONTAINING FRESHWATER--Dashed where approximately located. Interval 100 feet

Source: Sandeen 1987.

Rusk Permit Area EIS

Figure 3.2-3

Thickness of Freshwater-bearing Sands in Wilcox Group

EXPLANATION

-340 WELL USED FOR CONTROL--Number indicates altitude of the base of freshwater

-300 WATER-QUALITY ZONE CONTOUR--Shows approximate altitude of the base of freshwater. Dashed where approximately located. Contour interval 100 feet. National Geodetic Vertical Datum of 1929

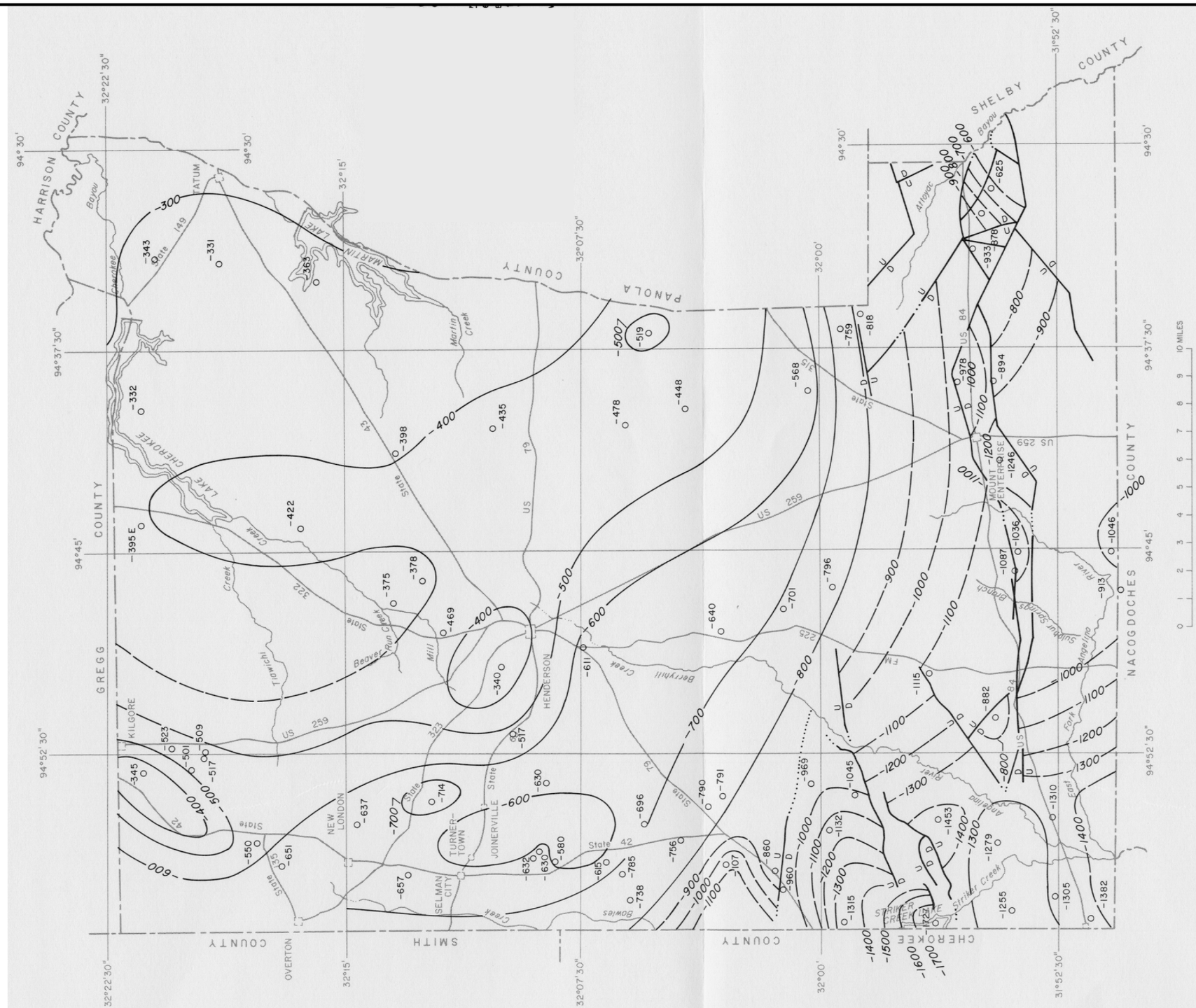
U/D FAULT--U is upthrown side; D is downthrown side. Dotted where concealed

Source: Sandeen 1987.

Rusk Permit Area EIS

Figure 3.2-4

Elevation of the Base of Freshwater in Wilcox Aquifer



EXPLANATION

-343 — WELL USED FOR CONTROL -- Number indicates altitude of the base of slightly saline water

-300 — WATER-QUALITY ZONE CONTOUR -- Shows approximate altitude of the base of slightly saline water. Dashed where approximately located. Contour interval 100 feet. National Geodetic Vertical Datum of 1929

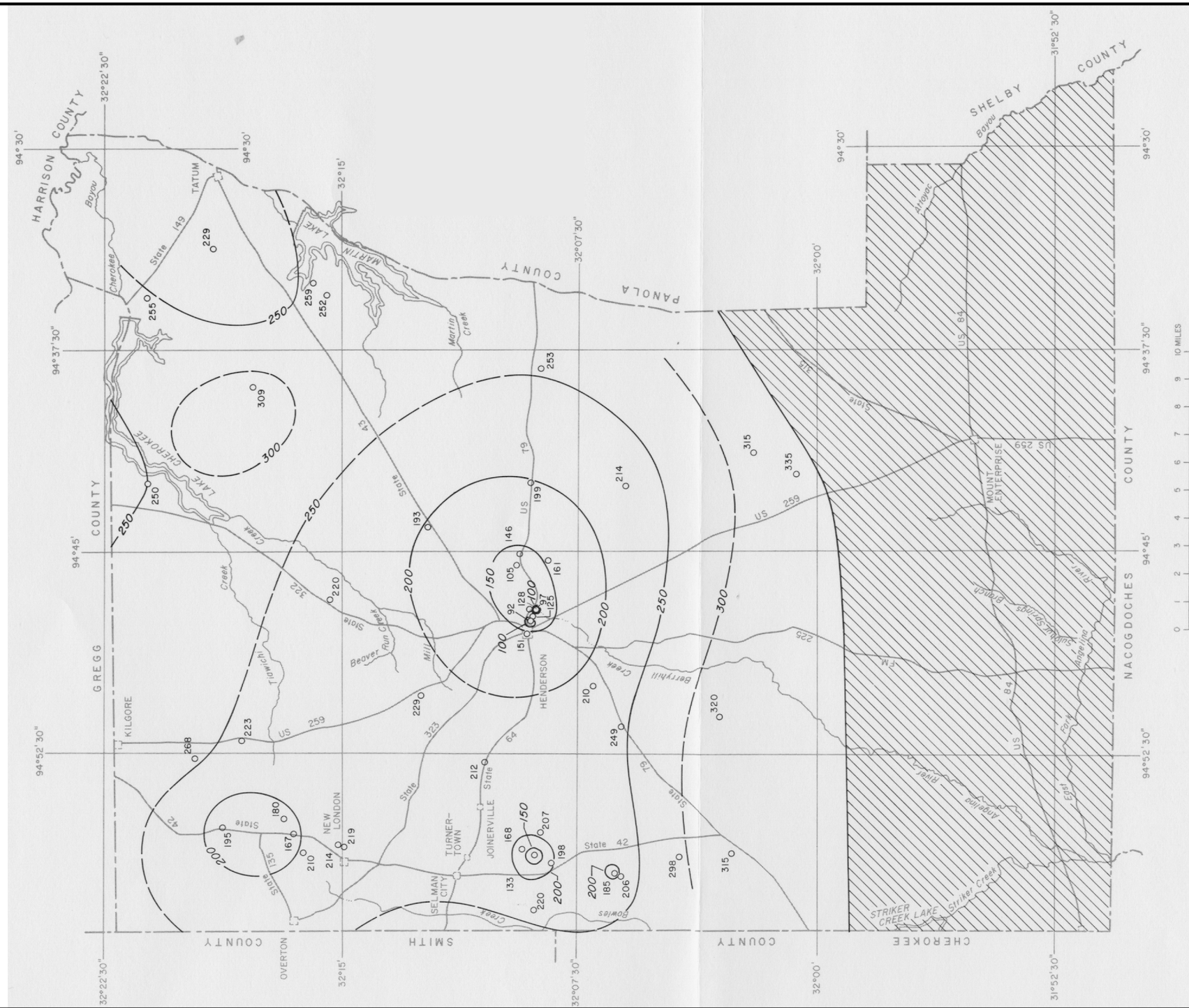
U/D — FAULT -- U is upthrown side; D is downthrown side. Dotted where concealed

Source: Sandeen 1987.

Rusk Permit Area EIS

Figure 3.2-5

Elevation of the Base of Slightly Saline Water in Wilcox Aquifer



EXPLANATION

253 — WELL USED FOR CONTROL -- Number indicates altitude of water level

250 — WATER-LEVEL CONTOUR -- Shows altitude at which water level would have stood in tightly cased well. Contour interval 50 feet. National Geodetic Vertical Datum of 1929

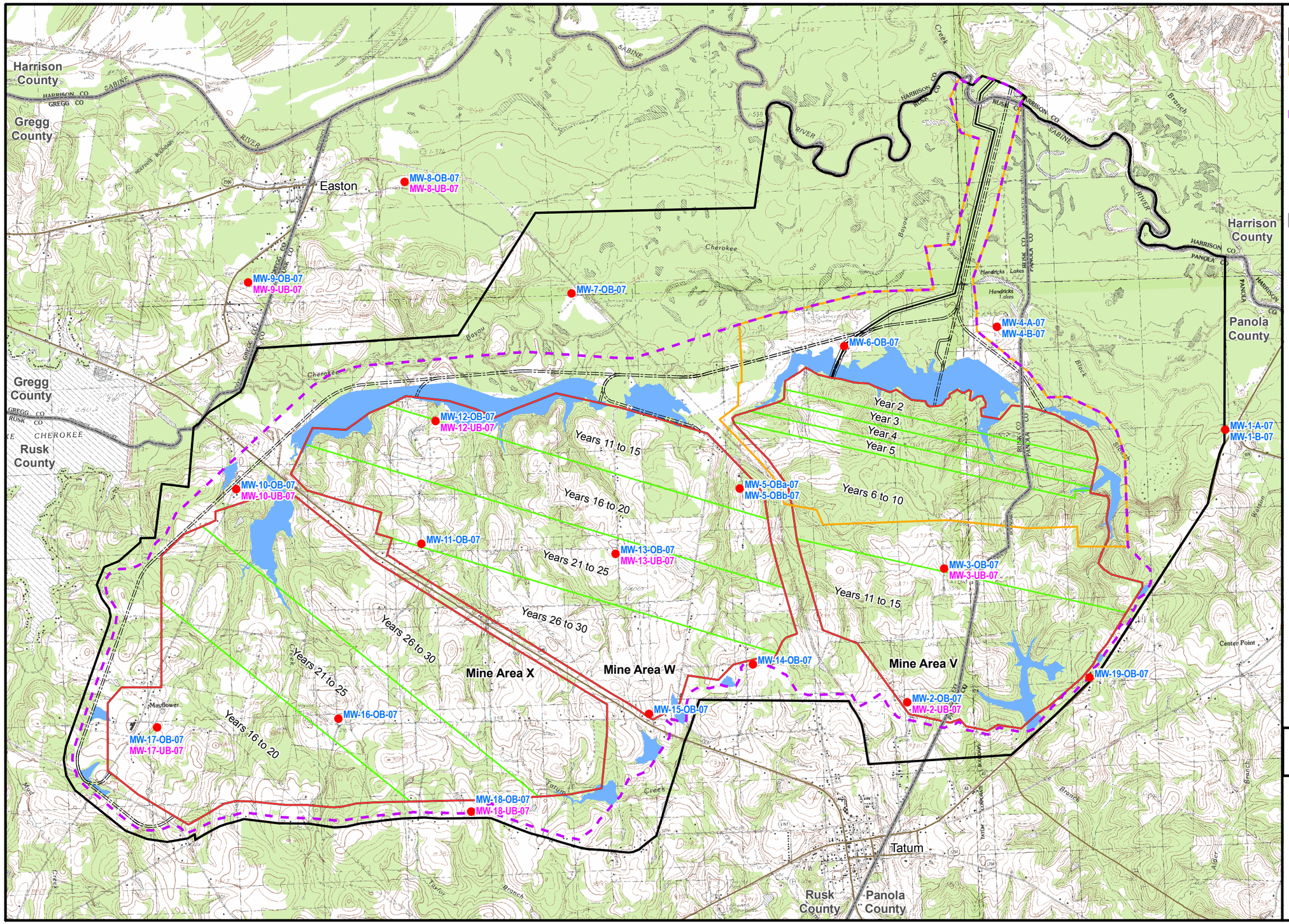
AREA AFFECTED BY MOUNT ENTERPRISE FAULT SYSTEM--Values too erratic to contour

Source: Sandeen 1987.

Rusk Permit Area EIS

Figure 3.2-6

Potentiometric Surface of Wilcox Aquifer

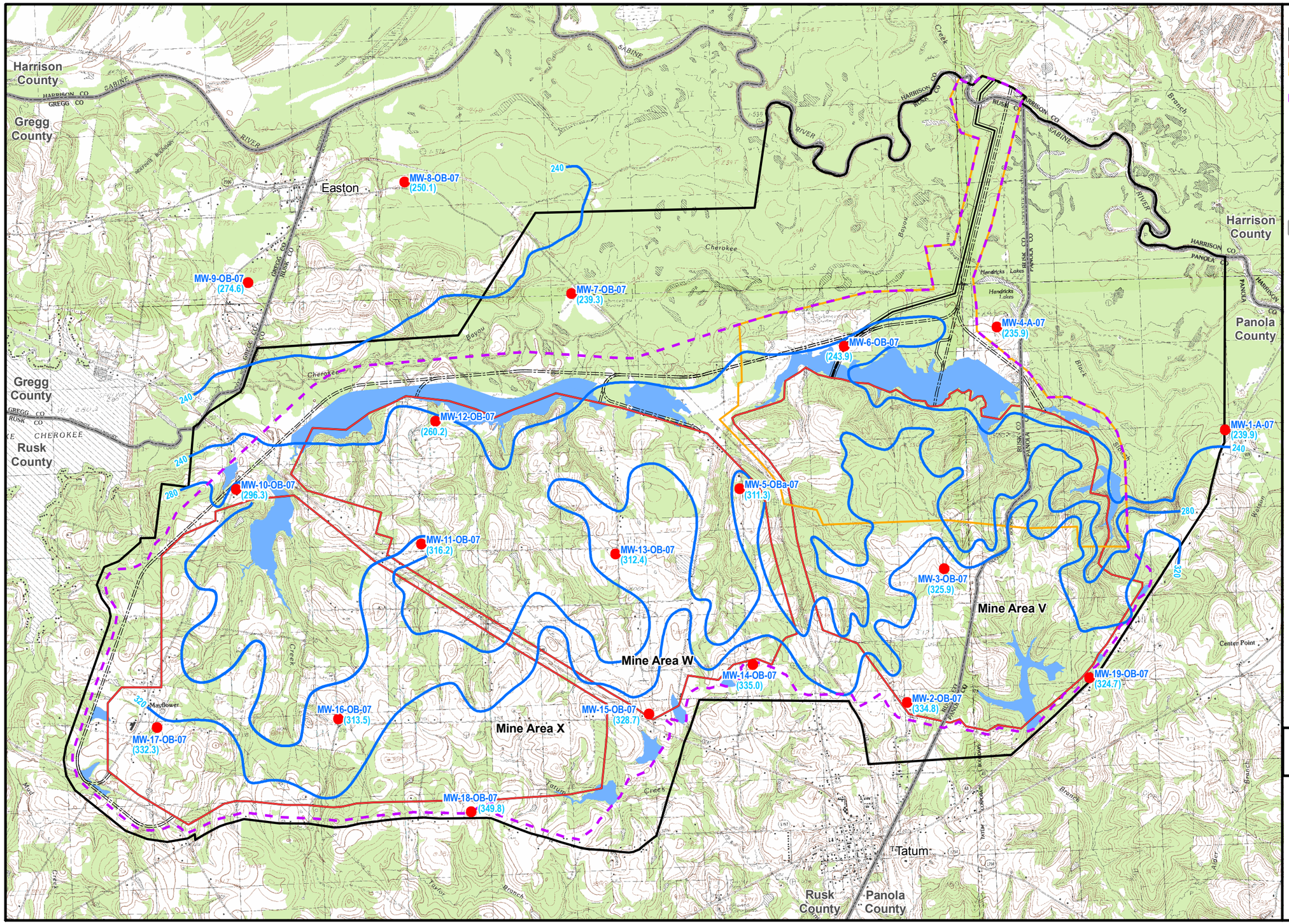


Rusk Permit Area EIS

Figure 3.2-7

Groundwater Monitoring Well Locations

07/21/10

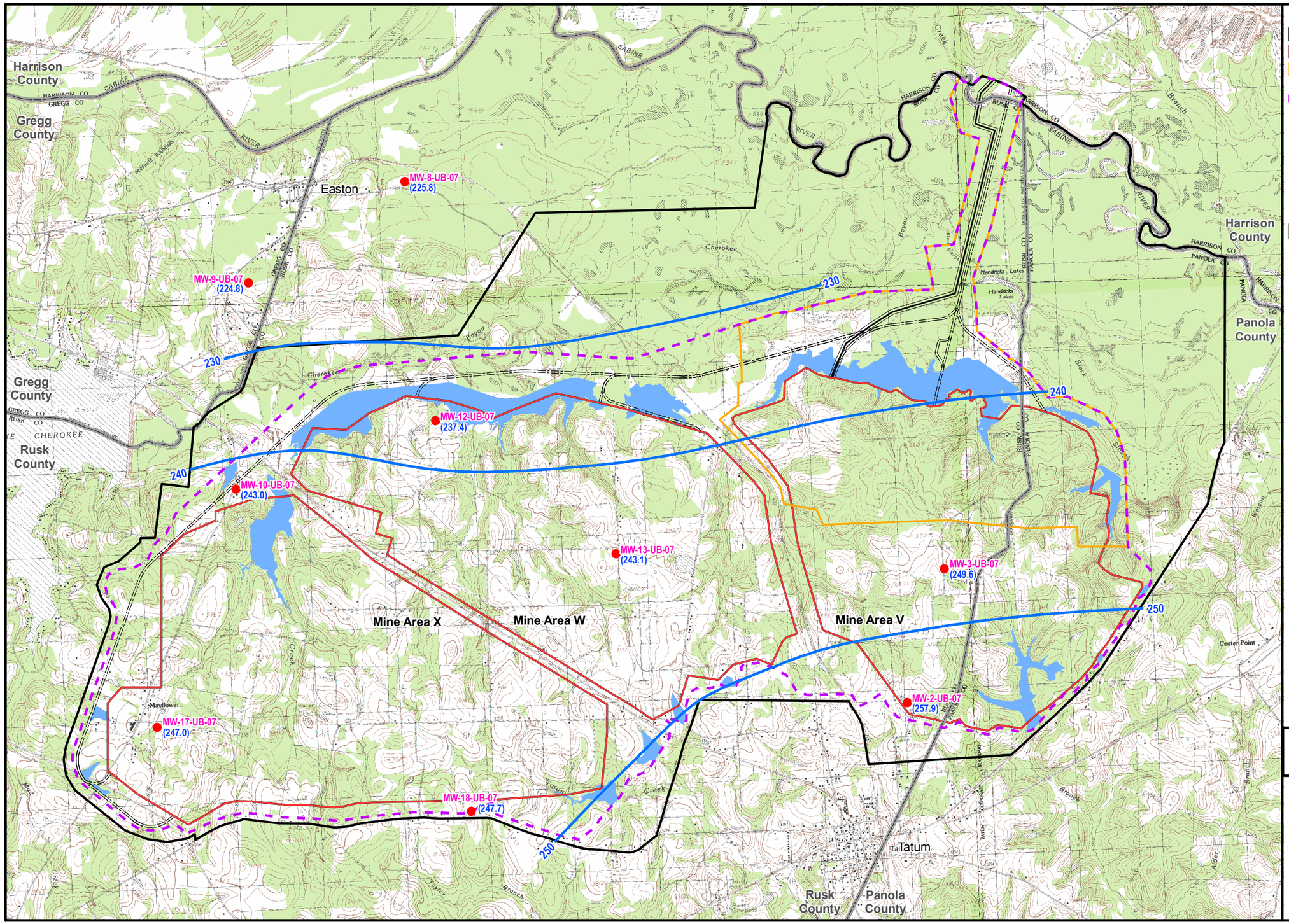


Rusk Permit Area EIS

Figure 3.2-8

Overburden Potentiometric Surface

07/22/10



Legend

- Proposed Rusk Permit Boundary
- Proposed Mine Areas
- First 5-year RCT Permit Term Disturbance Boundary
- Proposed Life-of-mine Disturbance Boundary
- Sediment Control Pond
- Potentiometric Contour (approximate feet amsl)
- Monitoring Well
  - MW - Underburden Well ID
  - (249.0) - Underburden Groundwater Level
- Main Haul Roads
- Dragline Walkway
- County Boundary

Source: Sabine 2009a, 2010c.

N

0 0.5 1 Miles

Rusk Permit Area EIS

Figure 3.2-9

Underburden Potentiometric Surface

07/22/10

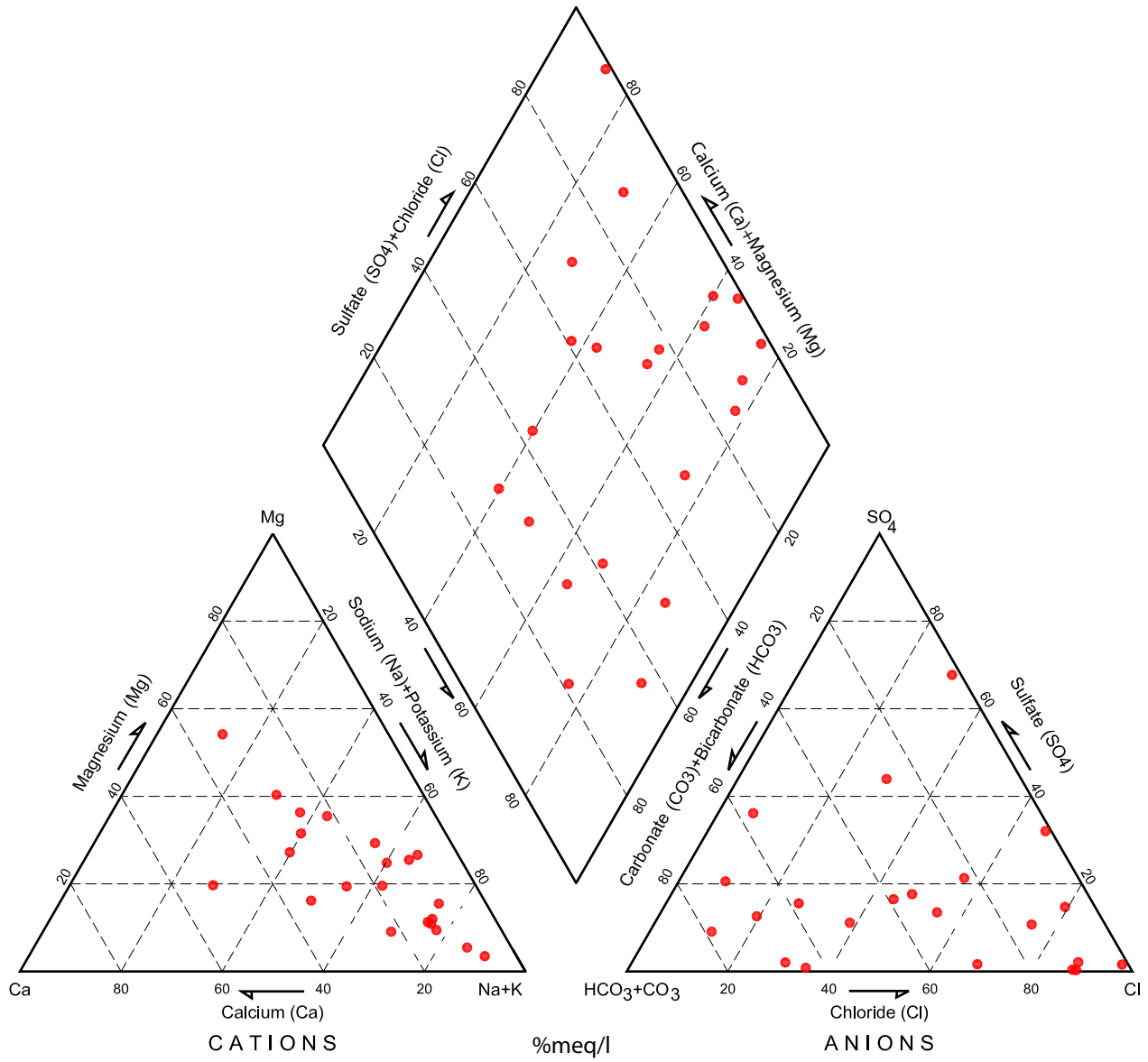
Table 3.2-2 Summary of Aquifer Test Results – Rusk Permit Area

Well Number	Test Type[1]	Aquifer Type	Geologic Formation	Saturated Sand Thickness (feet)	Representative Hydraulic Properties			
					Transmissivity (ft^2/day)[2]	Hydraulic Conductivity		Storage Coefficient (unitless)
						(ft/day)[2]	(cm/sec)[2]	
Overburden								
MW-1-A-07	S	Unconfined	Terrace	11	15.3	1.34	5.E-04	
MW-1-B-07	S	Confined	Wilcox	32	46.4	1.47	5.E-04	
MW-3-OB-07	P	Unconfined	Carrizo	28	699.5	24.92	9.E-03	3.0E-03
MW-7-OB-07	S	Unconfined	Terrace	19	70.1	3.75	1.E-03	
MW-9-OB-07	S	Confined	Wilcox	7	31.8	4.56	2.E-03	
MW-13-OB-07	P	Unconfined	Carrizo	34	1,351.4	39.80	1.E-02	2.0E-03
MW-15-OB-07	S	Unconfined	Wilcox	32	9.1	0.27	1.E-04	
MW-17-OB-07	S	Unconfined	Wilcox	43	19.6	0.40	2.E-04	
MW-18-OB-07	S	Confined	Wilcox	5	1.6	0.27	1.E-04	
Underburden								
MW-3-UB-07	P	Confined	Wilcox	15	425.9	28.41	1.E-02	3.0E-03
MW-9-UB-07	S	Confined	Wilcox	10	0.8	0.13	3.E-05	
MW-17-UB-07	S	Confined	Wilcox	19	18.4	0.94	3.E-04	

[1] Test Type: P = Constant Discharge Pumping; S = Slug.

[2] ft^2/day = square feet per day.
ft/day = feet per day.
cm/sec = centimeters per second.

Source: Sabine 2009a.



Legend

- Existing Monitoring Wells

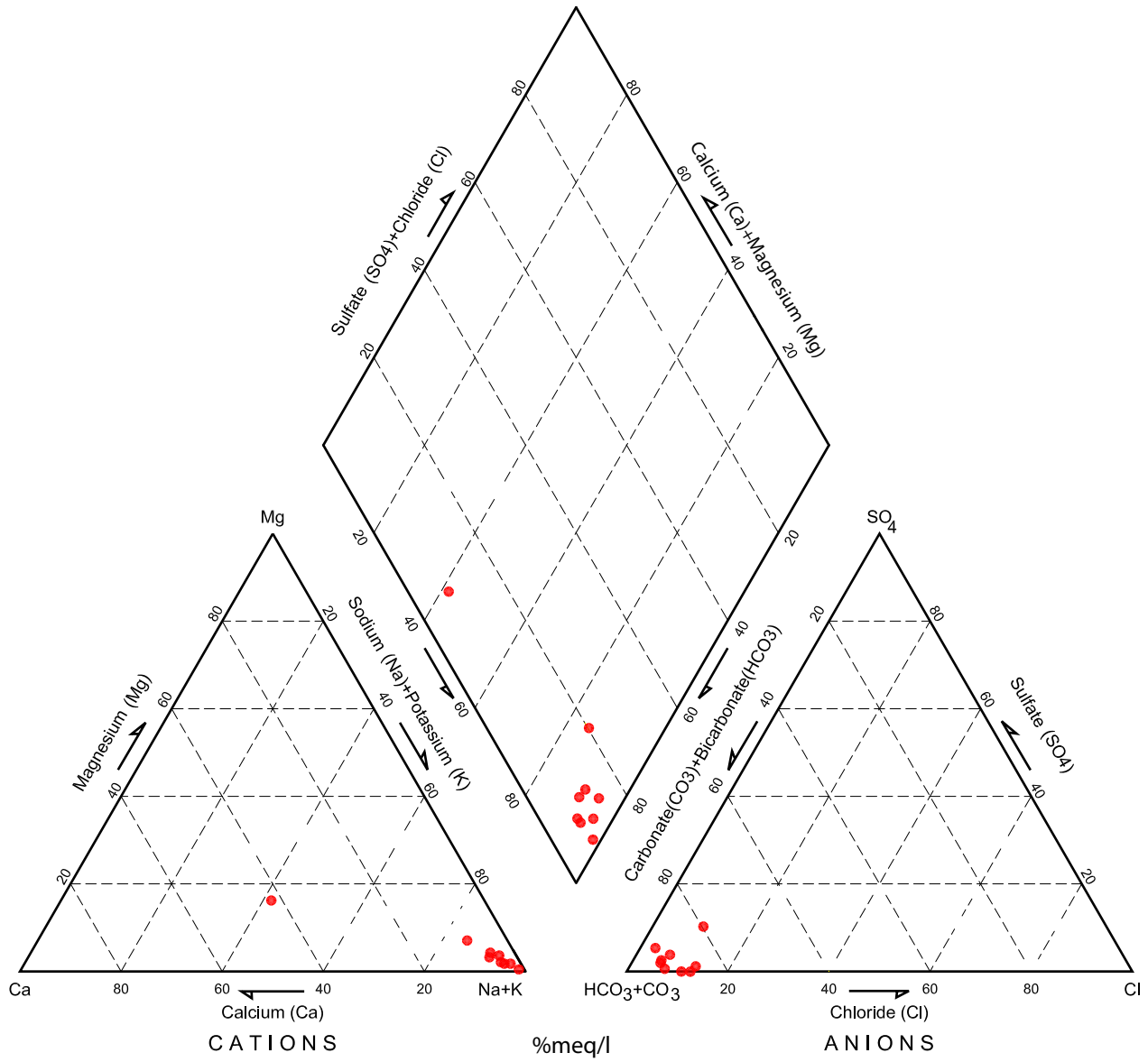
Source: Sabine 2009a.

03/16/10

Rusk Permit Area EIS

Figure 3.2-10

Piper Diagram of Overburden Aquifer



Legend

- Existing Monitoring Wells

Source: Sabine 2009a.

03/16/10

Rusk Permit Area EIS

Figure 3.2-11

Piper Diagram of Underburden Aquifer

3.2.3.2 Environmental Consequences

Proposed Action

Under the Proposed Action, the overburden aquifer would need to be dewatered to mine the proposed Rusk Permit Area. The overburden aquifer, discussed in detail in Section 3.2.3.1, consists of the Carrizo Sand aquifer along with water-bearing alluvial material above the Carrizo Sand aquifer and the sedimentary sections of the Wilcox Group that are found above the lignite seams. The lignite seams are relatively dry, and any water seepage from the coals would be controlled by in-pit sumps. The underburden aquifer, which consists of the Wilcox Group aquifer below the lignite, would not need to be depressurized and thus would not be dewatered. Consequently, municipal wells in the northeastern part of Rusk County would not be affected by groundwater pumpage associated with the proposed Rusk Permit Area because these municipal wells are screened in the Wilcox Group aquifer at depths below the lignite. Also, domestic wells and agricultural/stock wells screened deeper than 200 to 300 feet bgs would not be affected by groundwater pumpage from the overburden aquifer (Sabine 2009).

Groundwater Quantity

The proposed dewatering plan for the Rusk Permit Area includes approximately 129 dewatering wells, each with the capacity to pump approximately 15 gpm. Not all of the wells would be operating concurrently, and the proposed dewatering plan calls for pumpage of 532 acre-feet of water during the first year, 1,065 acre-feet of water during the second year, and from 726 to 339 acre-feet per year of water from years 3 through 5 of the projected mine life. After the fifth year of mining, estimated total pumpage for the remainder of the mine life would be approximately 4,113 acre-feet (Sabine 2009a). The estimated total groundwater pumpage from the overburden aquifer over the 30-year life of the proposed Rusk Permit Area would be approximately 7,235 acre-feet. This water would be discharged to the surface and disposed of in accordance with TCEQ requirements as discussed in Section 2.5.1.2, Dewatering System.

To estimate the extent of groundwater drawdown in the overburden aquifer from the proposed pumpage to dewater the mine pits, Sabine contracted with Pastor, Behling & Wheeler, LLC, to develop a groundwater model using the USGS numerical groundwater flow code MODFLOW (McDonald and Harbaugh 1988). This model consisted of 308 columns, 192 rows, and 1 layer to represent the overburden aquifer. Because the Carrizo Sand aquifer has a complex fluvial geology, the model was designed to provide a conservative (i.e., maximum) estimate of groundwater impacts by assigning uniform hydraulic parameters to the overburden aquifer that represent a conservative average for these parameters. The Carrizo Sands were assigned an average hydraulic conductivity of 2.83 feet per day. In areas of thick sands, the average hydraulic conductivity was increased to 28.3 feet per day. The Wilcox sandy muds were assigned a hydraulic conductivity of 0.28 feet per day. By employing average values over the model domain that represent the lower range of measured hydraulic parameters, the model-generated drawdown represents a conservative, or maximum, estimate of the areal extent of drawdown resulting from dewatering of the overburden aquifer. Thus, the modeled extent of the 5-foot maximum drawdown isopleth represents an estimate of the maximum extent of groundwater drawdown over the life of the proposed mine.

This methodology for modeling the dewatering of shallow coal mines in East Texas has been employed successfully for many mines over the past 10 years by Pastor, Behling & Wheeler and has been reviewed and approved by the RCT for similar mines. As an example, for the Oak Hill Mine, the modeled extent of the maximum 5-foot drawdown isopleth encompasses almost all of the drawdown of 5 feet or more (Wheeler 2009). Only one small localized area has shown greater drawdown than the modeled results. Because no municipal wells are screened in the overburden aquifer within 1 mile of the proposed project boundary, and also because most of the drawdown would be within the proposed permit boundaries, this approach to modeling groundwater impacts is considered appropriate.

Figure D-1 in **Appendix D** shows the modeled maximum extent of the 5-foot drawdown isopleth for the proposed dewatering of the Rusk Permit Area and identified groundwater wells within and near the drawdown isopleth. The 5-foot drawdown isopleth would encompass approximately 9 square miles in eastern Rusk County and the western part of Panola County. The drawdown would be mostly within the

proposed permit boundary, extending a maximum of 2,000 feet from the proposed permit boundary in Panola County. The 5-foot drawdown isopleth would approach Tatum, Texas; however, it would terminate approximately 2,000 feet north of Tatum and would not impact wells in the Tatum area. To the north, the drawdown would be limited by the groundwater sink along Cherokee Bayou. On the west, the drawdown would be limited by Lake Cherokee. On the southeast and the south, the rolling hills that provide recharge to the Carrizo Sand aquifer would restrict migration of the drawdown. Overall, approximately 221 groundwater wells are located within the projected maximum 5-foot drawdown isopleth; most of these wells are within the proposed permit boundary. These wells are listed in **Table D-4** in **Appendix D**. Wells deeper than 200 to 300 feet bgs are not anticipated to be affected by drawdown in the overburden aquifer (Sabine 2009).

During mining and dewatering, any wells within the boundaries of the proposed mine pits would be destroyed. Wells outside of the mine pits but within the projected 5-foot drawdown isopleth could experience a decline in water levels; some wells may go dry. Sabine is committed to replacing lost water sources or reduced water availability for all owners of impacted groundwater wells within the area impacted by groundwater pumpage (Chapter 2.0). In addition to wells, seeps and springs within the projected 5-foot drawdown isopleth that are hydraulically connected to the Carrizo-Wilcox aquifer would be affected. Some seeps and springs may be eliminated by mining, while others would experience a reduction in flow until post-mining groundwater levels recovery. Seeps, springs, and groundwater-fed perennial waterbodies outside the projected 5-foot drawdown isopleths are not anticipated to be affected by mine-related groundwater drawdown. Also, groundwater baseflow to streams within and near the project boundary may be reduced until groundwater recovery to pre-mining conditions following mine closure (Sabine 2009a).

After completion of mining, all mine pits would be backfilled. Backfilling of pits would be conducted concurrently with mining as areas are mined out. The reclaimed backfilled pits would contain overburden material that is more lithologically homogeneous than the pre-mining overburden and lignite coal. This backfill material initially would have a higher hydraulic conductivity and an higher overall permeability than the original pre-mining material. As such, recharge to the backfilled pits initially would be higher than under pre-mining conditions, and the pits would act as groundwater sumps until they have fully resaturated. The estimated time to resaturate the backfilled mine pits in this part of Rusk County is approximately 7 to 8 years (USEPA 1997). Prior to complete resaturation, groundwater flow in the project area would be controlled by the reclaimed mine pits. Following resaturation, the pre-mining groundwater flow patterns gradually would be re-established, possibly with groundwater gradients near the reclaimed backfilled pits that are somewhat different from pre-mining conditions.

The natural hydrologic cycle of rainwater infiltrating into the overburden aquifer and providing recharge to that aquifer would be temporarily altered during mining and after mining until the groundwater levels in the overburden aquifer rebound to pre-mining levels, which is expected to be approximately 7 to 8 years after cessation of dewatering. During mining, any recharge from precipitation would be removed by the dewatering wells. This would affect springs, seeps, and baseflow to streams. After cessation of mining and dewatering, recharge to the overburden aquifer from precipitation would increase until the groundwater levels in the aquifer rebound to pre-mining levels. As the water table rebounds in the overburden aquifer, the increased recharge from precipitation would decline and approach the pre-mining recharge rate. Reclamation of the mined areas is not expected to lower the soil permeability and may increase the permeability in backfilled areas.

Potential direct impacts may occur to water supply facilities associated with the Chalk Hill and Crystal Farms water districts, depending on the specific location of these facilities in relation to the proposed disturbance area. Due to the potential for these impacts to public water supply facilities (e.g., wells, distribution lines, and pipelines to customer residences) additional mitigation is being considered (see Mitigation Measure GW–1 in Section 3.2.3.4, Monitoring and Mitigation Measures).

Groundwater Quality

Removal of the material in the overburden aquifer and mining of the lignite coal seams within the upper portion of the Wilcox Group would result in oxidation of sulfides present in the lignite coal and within the overburden material and the upper part of the Wilcox Group. This oxidation would affect groundwater quality in the reclaimed mine pits as groundwater resaturates the backfill material. Initially, groundwater quality in the backfilled pits could be expected to show an increase in TDS, sulfate, and possibly chloride compared to the pre-mining water quality. The pH of the reclaimed pits may be slightly lower than the pre-mine groundwater pH. A comparison of pre-mine and reclaimed mine pit water quality presented by the USEPA (1997) for a lignite mine in East Texas showed that reclaimed pits had pH values ranging from 3.8 to 7.5 standard units compared to pre-mine pH values in the groundwater of 4.0 to 6.0 standard units. The TDS, sulfate, and chloride values in the reclaimed pits for that mine were slightly elevated but within the range of pre-mine groundwater quality values. Iron and manganese showed the greatest increase in the reclaimed pit groundwater quality.

As previously discussed, groundwater flow would be toward the pits until resaturation is complete. As the reclaimed pits resaturate with groundwater, the oxidized nature of the backfill material and the pit wall material would be replaced by a reducing environment as groundwater saturates the backfill material and any remaining oxygen is forced out of the material. This gradual transition to a reducing environment in the resaturated backfill material would restore the groundwater quality to pre-mining levels. It is not expected that TDS would exceed 5,000 mg/L in the reclaimed mine pit backfill material (Sabine 2009a). Any migration of backfill water out of the reclaimed pits would result in dilution of the water with surrounding groundwater, and this dilution should limit any short-term impacts to groundwater quality outside of the reclaimed pits to the proposed permit boundary. Because resaturation is expected to be mostly complete within approximately 7 to 8 years after cessation of mining (USEPA 1997), any impacts to groundwater quality outside of the backfilled pits is anticipated to be short-term.

Any spoils material removed during mining that is found to have acid-generating capability would be buried in the mine pits and covered with at least 4 feet of cover material to prevent entry of rainwater (Sabine 2009a). This material handling should limit the potential of this material for acid-generation, and burial of the material within the permit boundary would limit the potential impacts to groundwater quality to the permit boundary.

Sabine proposes to install groundwater monitoring wells as shown in **Figure 3.2-7** and presented in **Table 3.2-3**. The proposed monitoring wells would be sampled quarterly for major cations and anions along with TDS, iron, manganese, chloride, and pH. Metals of potential concern, such as aluminum, arsenic, boron, cadmium, chromium, copper, lead, molybdenum, nickel, selenium, and zinc also would be monitored.

<u>No Action Alternative</u>

Groundwater Quantity

Under the No Action Alternative, mining of the lignite in the proposed Rusk Permit Area would not occur, and pumpage of the overburden aquifer to dewater the Rusk Permit Area would not be required. Under this alternative, operations at the existing South Marshall Permit Area of the South Hallsville No. 1 Mine would continue under existing authorizations through final closure and reclamation in 2035; groundwater impacts would not occur within the Rusk Permit Area.

Groundwater Quality

Under the No Action Alternative, the Rusk Permit Area would not be mined, and overburden material would not be removed. Therefore, there would be no potential related impacts to groundwater quality.

3.2.3.3 Cumulative Impacts

As discussed in Section 3.2.3.2, drawdown in the overburden aquifer associated with dewatering of the Rusk Permit Area would occur primarily within the proposed permit boundary. There would be no drawdown in the Wilcox Group aquifer. This proposed pumping of approximately 7,235 acre-feet of groundwater from the overburden aquifer would be in addition to groundwater pumped from other permitted mines and water uses in Rusk County. However, no overlap in drawdown areas is anticipated because drawdown from the proposed project generally would be limited to the Rusk Permit Area and would not overlap with projected groundwater drawdown areas of other projects in the cumulative effects study area.

Table 3.2-3 Proposed Groundwater Monitoring Wells

Well Number	Existing or Proposed Well	Monitoring Target/Purpose
Overburden Wells		
MW-1-A-07	Existing	Terrace overburden east of mining
MW-1-B-07	Existing	Wilcox overburden area east of mining
MW-4-A-07	Existing	Terrace overburden north of mining
MW-4-B-07	Existing	Wilcox overburden area north of mining
MW-6-OB-07	Existing	Terrace overburden north of mining
MW-19-OB-07	Existing	Carrizo overburden southeast of mining
MW-20-OB	Proposed	Terrace (or Wilcox) overburden west of mining
MW-21-OB	Proposed	Carrizo (or Wilcox) overburden south of mining
Spoil Wells		
MW-22-R	Proposed	Spoil in western part of first 5-year permit term
MW-23-R	Proposed	Spoil in central part of first 5-year permit term
Underburden Wells		
MW-20-UB	Proposed	Underburden west of mining
MW-21-UB	Proposed	Underburden south of mining

Source: Sabine 2009a.

3.2.3.4 Monitoring and Mitigation Measures

Based on the EIS analysis, the USACE is considering the following additional mitigation for groundwater resources:

GW-1: Sabine would coordinate with the Chalk Hill and Crystal Farms water districts to identify the location of existing customers and water supply wells and distribution facilities that may be impacted by the Proposed Action. Specific measures would be developed, as applicable, to mitigate identified impacts.

Effectiveness: This measure would provide for early identification of impacts and mitigation implementation, as appropriate. Residual Adverse Impacts

3.2.3.5 Residual Adverse Effects

No residual adverse impacts to groundwater are expected from the Proposed Action because resaturation of the reclaimed backfilled mine pits would occur within an estimated 7 to 8 years of pit backfiling. Any potential impacts to groundwater quantity or quality would be limited mainly to the Rusk Permit Area and should cease within approximately 10 years after mining as the groundwater flow regime is restored during resaturation.

3.2.4 Surface Water

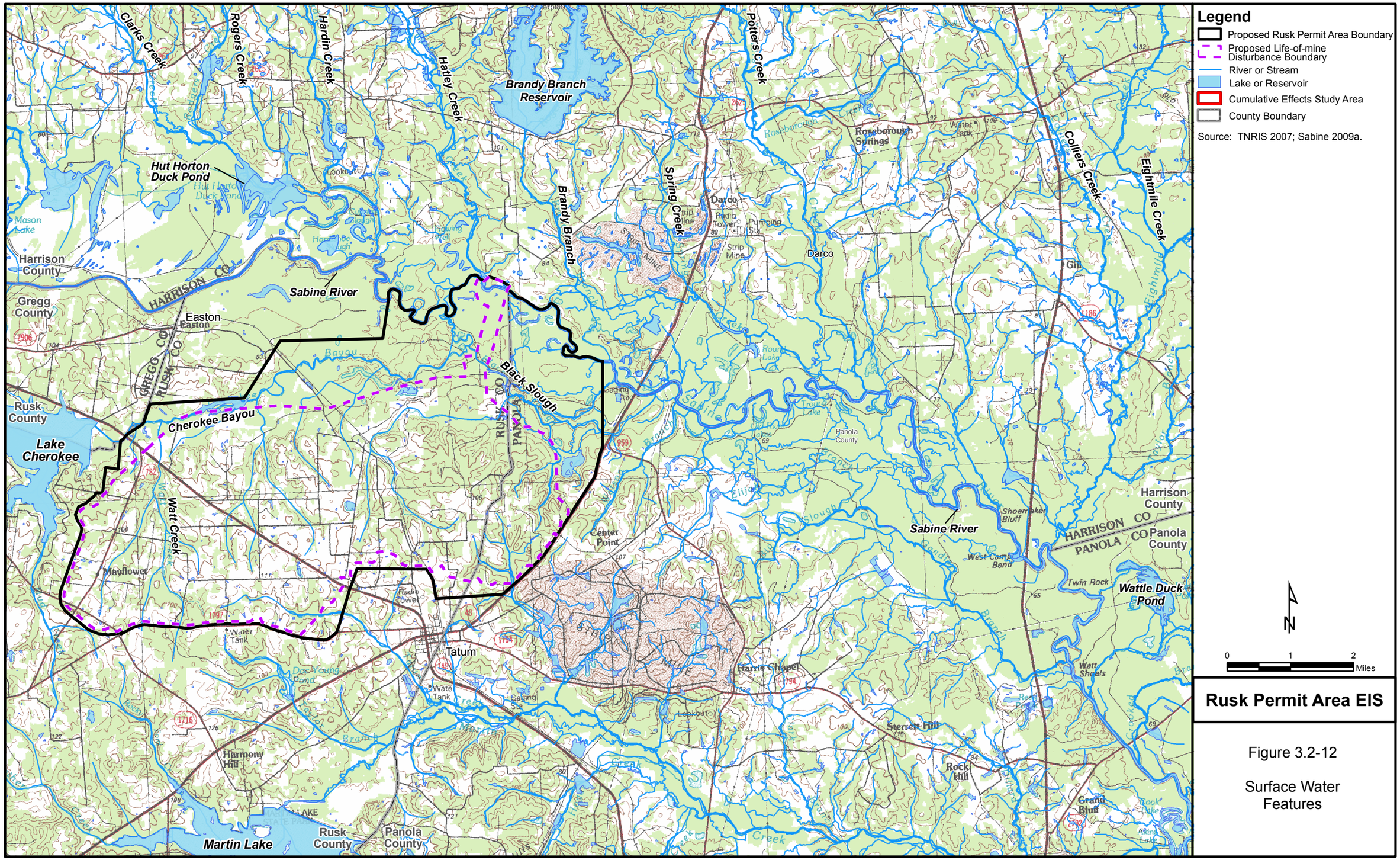
The study area for direct and indirect impacts to surface water resources includes the proposed life-of-mine disturbance and portions of the Sabine River and its floodplain (**Figures 3.2-12** and **3.2-13**). Potential direct and indirect effects of the project are being assessed within the proposed life-of-mine permit boundary, and downstream along both sides of the Sabine River and its Federal Emergency Management Agency (FEMA)-delineated 100-year floodplain from near Easton, Texas, to SH 43. The floodplain south of the river in Panola County to SH 43 is included in the study area.

The cumulative effects study area for surface water includes the drainages within the direct and indirect study area; areas of surface disturbance or diversion associated with past, present, and reasonably foreseeable future actions (see Section 2.7); the Sabine River and its delineated 100-year floodplain (**Figure 3.2-13**) from the vicinity of Easton, Texas, and extending downstream approximately 2.5 miles beyond the U.S. Highway 59 bridge over the Sabine River; and the projected cumulative 5-foot groundwater drawdown areas of the local alluvium and waterbearing zones of the Carrizo-Wilcox aquifer system. This area was selected based on the potential for cumulative sedimentation, watershed impacts, and other flow or water quality effects to occur to the Sabine River or its floodplain and tributaries.

3.2.4.1 Affected Environment

Surface water features in the study area and cumulative effects study area consist of the Sabine River, numerous tributary streams, bayous, sloughs and man-made ponds, and springs (**Figure 3.2-12**). The study area is downstream of four major reservoirs and several smaller man-made lakes. These surface water features regulate flows and affect sediment storage and transport in the upper Sabine River Basin. The larger impoundments include Lake Fork Reservoir (1980), Lake Tawakoni ("Iron Bridge Project" [1960]), Martin Lake (early 1970s), and Lake Cherokee (1948). Smaller impoundments include Lake Holbrook, Lake Quitman, Lake Winnsboro, Lake Hawkins and nearby impoundments, and Lake Gladewater (Sabine River Authority 2009, Handbook of Texas Online 2009). In combination, these impoundments now control approximately 1,545 square miles of watershed, or approximately 44 percent of the Sabine River Basin above SH 43 near Tatum.

Additional impoundments, including Mason Lake, Brandy Branch Reservoir (Pirkey Lake), and surface mine "end lakes," have been constructed for industrial purposes on Sabine River tributaries. Brandy Branch Reservoir has a surface area of approximately 1,390 acres at the normal pool surface elevation of 340 feet amsl. The reservoir stores approximately 29,500 acre-feet of water at that elevation (Sabine 2010a [Darco Mine Permit Appendix 129-A, 2002]). Brandy Branch Reservoir receives trans-basin imports of up to 18,000 acre-feet per year from Lake O' the Pines Reservoir on Big Cypress Creek in the nearby Cypress River Basin (Sabine 2010a; TPWD 2010a). Its maximum discharge capacity is 1,552 cubic feet per second (cfs). In the study area, this water is diverted past the Brandy Branch mine runoff pond to the Sabine River floodplain near SH 43 (Sabine 2010a).

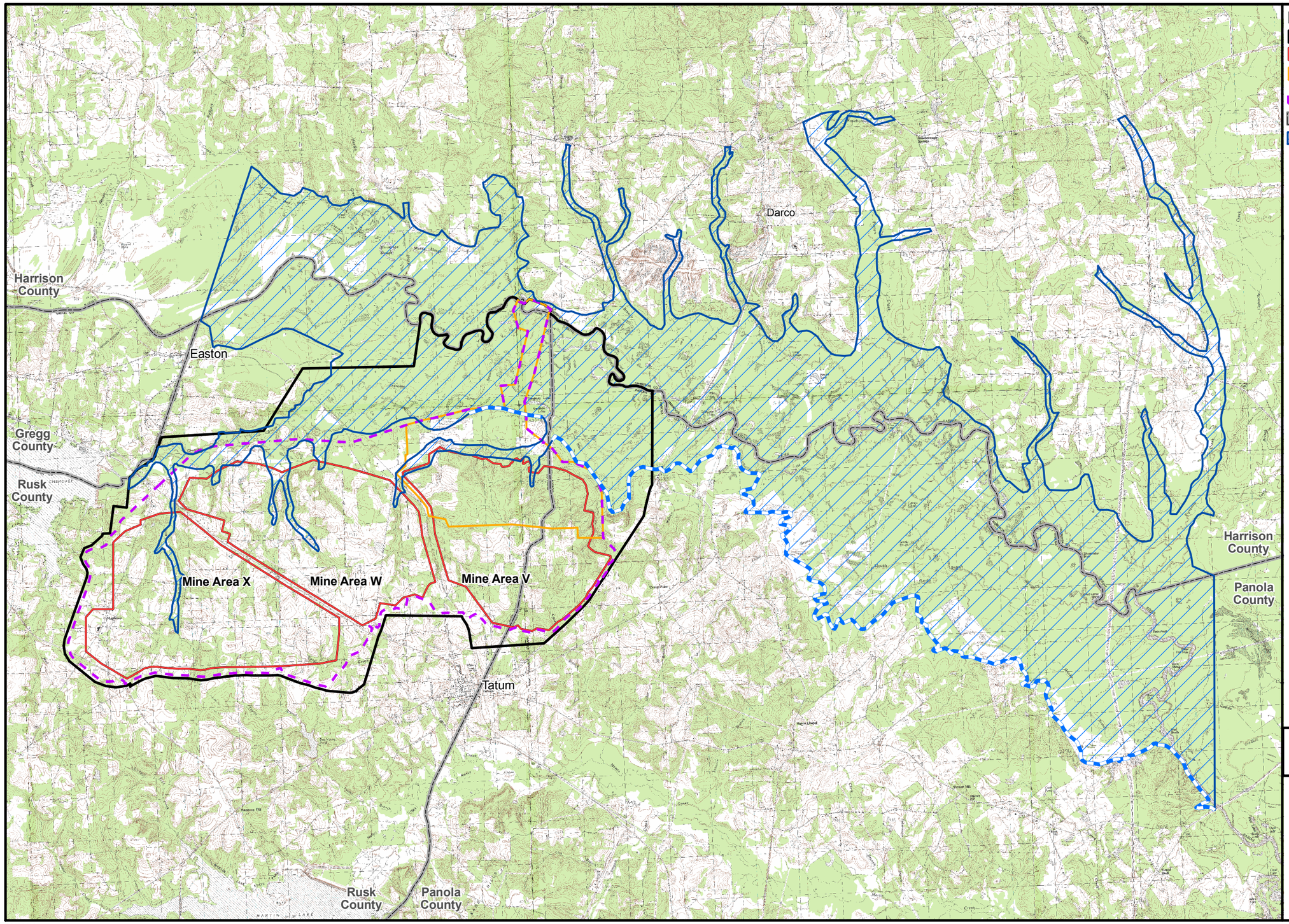


Rusk Permit Area EIS

Figure 3.2-12

Surface Water Features

08/18/10



Legend

- Proposed Rusk Permit Area Boundary
- Proposed Mine Areas
- Proposed First 5-year RCT Permit Term Disturbance Boundary
- Proposed Life-of-mine Disturbance Boundary
- County Boundary
- Floodplain Boundary
- Projected Floodplain Boundary (using approximately 238-foot elevation from FEMA mapping in Harrison County)

Source: FEMA Map Service Center 2010.

N

0 1 2 Miles

Rusk Permit Area EIS

Figure 3.2-13

100-year Floodplain

08/16/10

Downstream of Lake Cherokee, Cherokee Bayou trends west to east across the project area. Other major drainages and related features draining northward toward the Sabine River include Watt Creek, which drains the western part of the study area before joining Cherokee Bayou; unnamed tributaries of Mud Creek draining the extreme southwestern part of the study area toward Lake Cherokee; an unnamed channel flowing into Black Slough to the east; Black Slough itself; and Hendricks Lake. From the watershed divide in the southern part of the study area, Tatum Creek and Caney Branch flow south and east. Within the Rusk Permit Area, there are approximately 186 acres of streams and 224 acres of open water (HDR 2010a).

South and southwest of Tatum, Taylor Branch, Martin Creek, and other tributaries flow eastward to join the Sabine River beyond U.S. Highway 59. Outside the Rusk Permit Area, Watson Branch and Elijah Branch flow northeastward beyond SH 43 to the Sabine River. North of the Sabine River, Clarks Creek, Rodgers Creek, Hardin Creek, Hatley Creek, Brandy Branch, and Spring Creek drain southward onto the Sabine River floodplain (**Figure 3.2-12**). In combination, these named watersheds occupy approximately 78 square miles. Approximately 20 square miles (25 percent) of that combined watershed area has been disturbed by mining within the cumulative effects study area (Sabine 2010a). Rogers Creek is controlled by an impoundment upstream of FM 2625, and similar but larger mine water control features exist on Hardin Creek, Brandy Branch, Spring Creek, and within the Darco Lake watershed. Other runoff control features, primarily smaller impoundments and diversion ditches, exist on the remaining drainages. Floodplain features north of the river include Hut Horton Duck Pond, Fish Trap Slough, Cypress Slough, Horseshoe Slough, Muddy Slough, and a number of unnamed streams, ponds, and sloughs. Although these waterbodies are the major features that regulate or drain the project study area and cumulative effects study area, numerous side-channels, ponds, and sloughs also are located within these areas. Approximately 175 small impoundments of various sizes are located within the proposed life-of-mine permit boundary (Sabine 2009a). North of the river, numerous stock ponds or small impoundments exist between FM 2625 and the floodplain. As mentioned, other larger industrial impoundments are located farther to the north. It is not known how many other small impoundments (e.g., for fishing, erosion control, or livestock watering) exist in the upper Sabine River basin overall. In any case, runoff conditions in the region are highly regulated by reservoirs and other impoundments, as well as being affected by wetlands. There are extensive wetland features in the study area, including both forested and nonforested wetlands. Waters of the U.S., including wetlands, are discussed in detail in Section 3.2.4.

Surface Water Flow

Streamflows have been monitored in the study area primarily by the USGS and Sabine. Within the study area, the USGS recorded Sabine River flows at SH 43 northeast of Tatum from 1939 until 1978. The basin area at that location (Station 08022000) was 3,493 square miles (USGS-National Water Information System [NWIS] 2009). In October of 1978, the gage was moved approximately 7 miles downstream (12 river miles) to the U.S. Highway 59 bridge northeast of Beckville. At this present location (Station 08022040), the basin area is 3,589 square miles (an increase of 2.75 percent). The present gage datum is 190 feet amsl.

The maximum recorded peak flow at Tatum was 123,000 cfs on April 4, 1945. The recorded gage height for that event was 33.8 feet, from a gage datum of 204.2 feet amsl at the Tatum site. Generally, that would put the water surface for the event at approximately 238 feet amsl, not accounting for routing or constriction effects. Additional flow investigations were made for that location, for purposes of making improvements to the SH 43 bridge crossing (Gilbert and Meyers 1989). They confirm the maximum flood elevation for the April 1945 event as 238.0 feet amsl. During the bridge study, other flood event characteristics for the location were derived (see **Table 3.2-4**), based on USGS data from the Tatum gage. It is not known how the construction of lakes and reservoirs over time was factored into the flood-frequency analysis.

Table 3.2-4 Discharges and Water-surface Elevations of Selected Flood Events, Sabine River near Tatum, Texas

Flood Recurrence Interval (years)	Estimated Discharge (cfs)	Water Surface Elevation (feet amsl)
10	45,700	232.8
25	74,000	235.1
50	102,700	236.9
100	139,400	238.8

Source: Gilbert and Meyers 1989.

Other major floods in or near the study area have been documented by the USGS and cooperating agencies (Slade and Patton 2003). In Gregg, Rusk, and Harrison counties, significant flooding occurred in 1959 in the Cherokee Bayou drainage, and in 1989 in the Longview vicinity. More recently, moderate flooding occurred along the upper Sabine River in October 2009 (KLTV 2009; Texas Division of Emergency Management 2009). In addition, the FEMA has approximated the extent of a hypothetical 100-year flood along the Sabine River and its tributaries in Gregg, Rusk, and Harrison counties (FEMA 2009). The FEMA delineations are shown in **Figure 3.2-13**. FEMA delineations are not available for Panola County; therefore, the 100-year floodplain delineations on the figure have been approximated for that part of the study area. This approximation was done by comparing the FEMA delineations within Harrison and Rusk counties to topographic maps and aerial photographs along the river in Panola County.

Data for more typical flows in the Sabine River and its tributaries have been collected by the USGS and Sabine (Sabine 2009a; USGS-NWIS 2009a). Based on USGS data, the median flow on the Sabine River at Beckville is 2,400 cfs (TPWD 2009a). Average monthly flows for the station are indicated in **Table 3.2-5**. The high flows that occur early in the year, and then the low-flow season of August through October, are particularly notable.

Table 3.2-5 Average Monthly Flows, Sabine River near Beckville, Texas[1]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3,470	4,020	4,660	3,910	4,220	2,630	1,170	345	449	639	1,530	3,170

[1] All values are cfs; data for water years 1961 through 2008.

Source: USGS-NWIS 2009a.

Although averages are presented in the table, considerable variation occurs from year to year. For example, the monthly average flow in March ranges between 317 to 21,620 cfs for the period recorded (October 1960 through September 2008). Averages for August range from 37 to 2,232 cfs (USGS-NWIS 2009a). The most severe dry periods along the upper Sabine River occurred in the early- to mid-1960s, in the early 1970s, and from March 2005 through May 2007. The period from mid-2003 through mid-2007 was generally much drier than normal.

Representative monthly data for USGS gaging stations on tributaries in the region include those at Prairie Creek (Station 08020200), Mill Creek near Henderson (08020960), and Mill Creek near Longview (08020980). These gages have data and periods of record that are reasonably representative of monthly conditions near the project area, and they generally parallel conditions on the nearby Sabine River during its period of record. Based on the gaging data and basin areas, Sabine has estimated monthly runoff for

average, maximum, and minimum flow conditions on major tributaries in the project area (Sabine 2009). Those extrapolated results are shown in **Table 3.2-6**.

More site-specific flow monitoring also has been conducted by Sabine within the proposed project area as well as north of the Sabine River within the study area (Sabine 2010a, 2009a). In keeping with RCT permit application requirements, 1 year of baseline monitoring was conducted for the proposed Rusk Permit Area. The monitoring period extended from late April 2007 through mid-March 2008. On the Sabine River, this period included a mix of months with average flows, lower than average flows, and higher than average flows; therefore, the monitoring period reflects a range of runoff conditions in the area. The monitoring program involved monthly instantaneous flow measurements, crest-stage gages to measure peak flow conditions, a continuous stage recording station on Caney Branch, and associated water quality sampling as described in the permit application (Sabine 2009a). The monitoring locations and results are summarized in **Table 3.2-7**.

North of the Sabine River, baseline and operational flow monitoring have been conducted for the existing South Hallsville No. 1 Mine and its existing South Marshall Permit Area in compliance with RCT regulations (Sabine 2010a). Within the study area, data from these programs represent Clarks Creek, Roberts Creek, small unnamed tributaries, Hardin Creek, Hatley Creek, Brandy Branch, Spring Creek, and the Sabine River. The monitoring covered a reasonably average period when compared to Sabine River flow records, but the monitoring period results were below average on the basis of rainfall records.

Data indicate that flows in Clarks Creek ranged widely during the monitoring period, from dry conditions to being too large to measure. More typically, Clarks Creek flows ranged from approximately 1 or 2 cfs or lower, to flows that were too small to measure. In general, there was a pattern of small baseflow gains in the late summer and early fall along the approximately 5.2-mile reach between the upstream and downstream stations along Clarks Creek. This trend may have been complicated by factors such as tributary contributions and the location of the downstream station on or adjacent to the Sabine River floodplain alluvium. Nearby, Rogers Creek generally had too little flow to measure or was dry.

Hardin Creek generally exhibited no flow, or insufficient flow to measure, at both the upstream and downstream monitoring locations. When higher flows did occur, gains or losses between the stations did not display a consistent trend.

The 3.4-mile reach monitored on Hatley Creek receives effluent from the City of Hallsville wastewater treatment plant (Sabine 2010a). Flow rates in Hatley Creek were somewhat greater than those in Clarks Creek on the same or adjacent days. Monitored rates still ranged widely; however, they were most often between approximately 0.1 to 4 cfs. A general trend of increasing flow from upstream to downstream appears in late summer and early fall data until 1990. For data from 1990 to 1995, that trend reverses.

For its entire data set, Brandy Branch had an average flow of approximately 2.0 cfs, a median flow of 0.9 cfs, and a minimum flow of 0.05 cfs (Sabine 2010a). The maximum recorded flow was 9.9 cfs, but above-average flows generally remained less than approximately 6.6 cfs. Little or no discharge occurred from Brandy Branch Reservoir. Spring Creek had a slightly higher average flow of approximately 2.8 cfs and a median flow of approximately 1.4 cfs for its entire data set (Sabine 2010a). The maximum recorded flow on Spring Creek was 15.2 cfs, and the minimum flow was 0.05 cfs.

Other flow-related information in the study area includes the Texas Instream Flow Program (TIFP), state and national recognitions of the Sabine River, aquifer interactions, and wetland interactions. In 2001, the 77th Texas Legislature enacted Senate Bill 2, which established the TIFP to define “appropriate methodologies for determining flow conditions in the state’s rivers and streams necessary to support a sound ecological environment” (Sabine River Authority [SRA] 2009b). To date, no instream flow studies have been conducted or recommendations made for the upper Sabine River, including the reach within the study area. However, the ecological environment has been noted along the upper river.

Table 3.2-6 Estimated Monthly Runoff Volumes for Study Area Tributaries[1]

Month	Cherokee Bayou[2]			Watt Creek			Tatum Creek[3]			Caney Branch[3]			Black Slough[2]		
	Drainage Area: 171 sq. mi.			Drainage Area: 5.0 sq. mi.			Drainage Area: 4.7 sq. mi.			Drainage Area: 5.9 sq. mi.			Drainage Area: 6.9 sq. mi.		
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
Jan	11,295	2,874	18,792	330	84	548	310	79	515	389	99	647	389	99	647
Feb	10,972	4,565	19,300	320	133	563	301	125	529	378	157	664	378	157	664
Mar	13,248	4,561	27,638	386	133	806	363	125	758	456	157	951	456	157	951
Apr	13,103	3,105	26,053	382	91	760	359	85	714	451	107	897	451	107	897
May	12,745	8,921	22,716	372	260	663	349	245	623	439	307	782	439	307	782
Jun	6,214	2,019	12,632	181	59	368	170	55	346	214	69	435	214	69	435
Jul	3,007	619	5,871	88	18	171	82	17	161	104	21	202	104	21	202
Aug	807	275	1,534	24	8	45	22	8	42	28	9	53	28	9	53
Sep	3,163	628	8,648	92	18	252	87	17	237	109	22	298	109	22	298
Oct	2,549	398	7,068	74	12	206	70	11	194	88	14	243	88	14	243
Nov	4,715	1,628	10,939	138	47	319	129	45	300	162	56	377	162	56	377
Dec	7,136	2,787	14,655	208	81	428	196	76	402	246	96	504	246	96	504
Year	88,955	63,454	148,017	2,595	1,851	4,318	2,439	1,740	4,059	3,062	2,184	5,095	3,062	2,184	5,095

[1] Values in acre-feet.

[2] Watershed delineated downstream to the Sabine River floodplain. The Cherokee Bayou drainage area includes Watt Creek.

[3] Watershed delineated downstream to the Martin Creek floodplain.

Source: Sabine 2009a.

Table 3.2-7 Study Area Surface Flow Monitoring Summary

Station ID	Stream Name	Monitored Watershed (acres)	Station Type	Range of Flow Conditions During Monitoring
SW-1	Cherokee Bayou	101,694	Crest gage	Stagnant (no flow) to over 68 cfs
SW-2	Watt Creek	3,155	Crest gage	Stagnant to approximately 6 cfs
SW-3	Unnamed tributary of Cherokee Bayou	2,237	Crest gage	Dry (no water) to approximately 0.3 cfs
SW-4 [1]	Cherokee Bayou	109,624	Crest gage	Stagnant to approximately 95 cfs
SW-5	Unnamed tributary of Black Slough	3,619	Crest gage	0.04 to approximately 5.8 cfs
SW-6	Caney Branch	873	Continuous stage recorder	0.05 to approximately 2.3 cfs
SW-7	Tatum Creek	2,416	Crest gage	Isolated pools to approximately 4.9 cfs

[1] The area monitored by Station SW-4 includes areas monitored by stations SW-1 through SW-3.

Source: Sabine 2009a.

The National Park Service (NPS) recognized this section of the Sabine River as having significant scenic, wildlife, and historical values in its Nationwide Rivers Inventory (NRI) (NPS 2010). Such streams are believed to possess one or more "outstandingly remarkable" natural or cultural values that may be of national significance (NPS 2010; TPWD 2009b). Under a 1979 Presidential Directive and related CEQ procedures, federal agencies must seek to avoid or mitigate actions that would adversely affect the listed NRI segments (NPS 2010). In parallel, the Texas Parks and Wildlife Department (TPWD) has identified part of the upper Sabine River as an "Ecologically Significant River Segment" within the Region D Water Planning Area of Texas (TPWD 2009b). As such, the reach is a candidate for protection under the Texas State water planning program administered by the TWDB and its designated regional planning groups. The candidate river reach extends from approximately the Village of Easton upstream of the study area, to U.S. Highway 59 downstream of the study area. Attributes that TPWD listed in recommending this portion of the river for Texas candidate status include (TPWD 2009b):

- Biological Function – nominated as a Texas Natural Rivers System; contains a diverse riparian assemblage including hardwood forest wetlands and significant natural areas; priority bottomland hardwood forest displays significant overall habitat value.
- Hydrologic Function – bottomland hardwood forest and associated wetlands perform valuable hydrologic functions relating to water quality and flood control.
- Riparian Conservation Area – none identified.
- High Water Quality/Exceptional Aquatic Life/High Aesthetic Value – displays exceptional aesthetic value.
- Threatened or Endangered Species/Unique Communities – significant due to presence of state-threatened paddlefish.

Aquifer interactions also support streamflows in the region through groundwater seeping into channels. This condition creates what are known as "gaining reaches." Bedrock, including coal seams, outcrops in the Sabine River through the study area (Mills 1972; Ferguson 2009b; Parsons Engineering Science 1999). On average, approximately 0.82 cfs per river mile is gained by the Sabine through the area from

the Carrizo-Wilcox aquifer system (Slade et al. 2002). Elsewhere, springs within the study area discharge to surface waters (Sabine 2009a), and it is likely that groundwater/surface water exchanges occur seasonally along the downstream portions of streams in the study area.

Wetlands in the project area and nearby are described in Section 3.2.5, Waters of the U.S. including Wetlands. Hydrologic interactions between surface water, groundwater, and related geomorphic settings are major influences on wetlands and their associated environmental values. The USACE has developed a number of regional guidebooks for applying an integrated hydrogeomorphic approach to assessing wetland functions and potential project impacts to these functions (USACE 2009). Although no guidebook specific to the West Gulf Coastal Plain in Texas has been developed, one has been published for the same physiographic region in Arkansas (Klimas et al. 2005). The Arkansas region has a climatic, geomorphic, and ecological setting that generally is similar to the study area, and the Carrizo-Wilcox aquifer system or similar geologic formations extend into this region.

Based on that guidebook, most wetland hydrology in the study area may be categorized by one of the classes below (Klimas et al. 2005):

- Flats – This class has little or no surface gradient, and the principal water source is precipitation. There is minimal overland flow into or out of the wetland except when the watershed surface is saturated. These areas typically are elevated above, or otherwise isolated from, the more frequently flooded river bottoms.
- Riverine – This bottomland class is directly flooded by streamflow, including backwater and overbank flow, at least once in 5 years on average. This class does not include depressions or lake-fringe wetlands within the 5-year floodplain. Wetlands along headwater streams draining from the hills to the river valleys usually are included in this category.
- Depression – This class occurs as distinct, closed units in topographic low points where water accumulates and remains for extended periods. Sources of water include precipitation, runoff, groundwater, and stream flooding. Depressions hold water for long periods because of their size, depth, and ability to collect surface and subsurface flows from an area much larger than the depression itself.
- Fringe – This class occurs along the margins of lakes (conventionally, greater than 2 meters deep). Natural lakes are most common in abandoned river channels (oxbows), but man-made impoundments also support fringe wetlands. Regional examples include the bald cypress fringe common on oxbow lakes and the black willow fringe often associated with borrow pits.

Wetland hydrology also may be described from the standpoint of process geomorphology, as the land surface changes over time. Near the Sabine River or its tributaries, wetlands are most likely to be associated with meander belt features such as abandoned channels, natural levees, and coarser-textured point bar deposits. Usually, wetlands on these features persist as isolated open lakes, or they may maintain a drainage connection to the channels. Elsewhere, backswamps are formed as flat, poorly drained areas that become isolated from streams by upland boundaries or the accumulation of sediment barriers. They tend to accumulate runoff, pool floodwaters, and accumulate finer sediments (Klimas et al. 2005). Therefore, they may be incompletely drained, and may remain ponded well into the growing season (Klimas et al. 2005). Along the sloping margins of alluvial fans and older terrace faces, wetlands may form at seeps where groundwater slowly leaks to the surface.

Channel Characteristics

Natural drainageways in the study area are strongly meandering, relatively deep channels. The Sabine River is strongly sinuous through parts of the study area, as are Cherokee Bayou and Black Slough. Numerous oxbow lakes or sloughs, and incised tributaries ("crevasse channels") occur along the river floodplain. In addition, flood-deposited sediments have formed natural levees and backswamps. The overbank areas are heavily wooded with some thick underbrush. The Sabine River in the region is dominantly a sandbed channel with some shale and lignite outcrops, and much of its suspended sediment

load also is sand (Gilbert and Meyers 1989; Heitmuller et al. 2006; Ferguson 2009a; Coonrod et al. 1998). Based on USGS gaging station datum elevations, the river bed slope between Longview and the SH 43 bridge is approximately 0.7 feet per mile. This relatively gently sloping section of the river is thought to be caused by the presence of bedrock in the channel (Mills 1972).

Overall, sheet and rill erosion in the region is estimated to be approximately 1.0 ton per acre, with additional gully and streambank erosion estimated at approximately 0.6 ton per acre per year. Of this, between 0.5 and 0.7 ton per acre per year is estimated sediment yielded to area streams and rivers (Greiner 1982). A substantially different estimate was made in the early 1970s, when suspended sediment loads in the Sabine River at Tatum were reported to be 39 tons (or 90 acre-feet) per square mile per year (Dougherty 1979). This is equivalent to 0.06 ton (0.14 acre-feet) per acre per year. Coonrod et al. (1998) indicate a 14-year average suspended sediment load at Tatum of 38 tons per square mile per year, which is consistent with data reported by Dougherty, and an average concentration of 53 mg/L. Sediment accumulation rates for reservoirs near the study area are approximately 0.68 acre-feet per square mile per year at Lake Cherokee, and approximately 0.73 acre-feet per square mile per year at Martins Lake (East Texas Regional Water Planning Group 2006). Differences in these estimates may be due to differences between sampling methods, periods of sampling, and conditions in flows or impoundments.

In addition to sediment, the Sabine River carries a substantial amount of large, woody debris. This may affect local flow conditions by accumulating in the river or on its floodplain (McBroom 2007; Ferguson 2009a).

Surface Water Quality

The State of Texas protects water quality through several regulatory programs and agency interactions between the TCEQ, USEPA, RCT, USACE, and SRA. Included in these programs are rules and regulations administered primarily under the Federal Water Pollution Control Act (CWA), the Safe Drinking Water Act, and the Texas Clean Rivers Act. Major aspects of water quality regulation and management in the state are set forth in the TAC, and include (TAC 2010a,b, 2009a,b):

- Designation of waterbody segments and their associated beneficial uses;
- Assigning water quality standards for the designated uses in general and for waterbody segments specifically;
- Rules governing standards for low-flow conditions and mixing zones;
- A formal process for evaluation and modification of standards applied to specific waterbodies; including temporary variances;
- An antidegradation policy administered through a tiered approach;
- Control of pollutants in storm water;
- Protection of drinking water;
- A tiered approach to water quality certification with respect to dredge and fill activities in Waters of the U.S.; and
- Monitoring and management of water quality at watershed or river-basin scales, through agency partnerships.

Based on TCEQ regulations, the Sabine River and its tributaries through the study area lie within state-designated Segment 505, the “Sabine River above Toledo Bend Reservoir.” This segment starts from the upstream side of the river confluence with Murvaul Creek in Panola County, and extends upstream to a point 110 yards downstream of U.S. Highway 271 in Gregg County (TCEQ 2009a). There are numerous industries, oilfields, and six cities with populations greater than 5,000 within this segment. There are more than 100 permitted dischargers within Segment 505, and it contains the highest population

concentration in the Sabine River basin (SRA 2009c). Classified beneficial uses within this 104-mile-long segment include (TAC 2009):

- High aquatic life
- Contact recreation
- General uses
- Fish consumption
- Domestic water supply (sub-category public water supply)

As tabulated in TAC Rule 307.7 ("Site-Specific Uses and Criteria"), the attributes of the High Aquatic Life Use subcategory include the "usual association of regionally expected species, the presence of sensitive species, high species diversity and richness, and a trophic structure that is balanced to slightly imbalanced" (TAC 2009). Freshwater dissolved oxygen general criteria are 5.0 mg/L as a mean, and a minimum of 3.0 mg/L for this use. Spring seasonal criteria for freshwater dissolved oxygen are a mean of 4.0 mg/L, and a minimum of 3.0 mg/L (TAC 2009). Other values may pertain to low flow conditions for various bed slopes (TAC 2009).

Contact recreation includes activities involving a significant risk of ingestion of water, such as wading by children or swimming. Water quality criteria for this use are expressed in terms of fecal coliform bacterial counts per 100 milliliters (ml) of water (TAC 2009).

General uses include navigation, agricultural water supply, industrial water supply, and wetland water quality functions. These uses are to be maintained and protected for all waters in the state in which they can be achieved (TAC 2009). Navigation on this portion of the Sabine River and its tributaries is limited to recreational boating. Early attempts to use the river in this area for commercial shipping failed (Handbook of Texas Online 2010). This river segment is used for canoeing and fishing, although log jams, overhanging branches, and shoals at low flows interfere with these activities (TPWD 1974). Boat ramps are located at several road crossings. At most times of the year, recreational boating is feasible on the river between SH 42 (southwest of Longview) to FM 2517 near Carthage and beyond (TPWD 1974). See Section 3.9, Land Use and Recreation, relative to recreational boating.

Per Texas regulations, the chemical and microbiological quality of surface waters used for domestic water supply should conform to drinking water standards. Segments designated for the domestic water supply (sub-category public water supply) are those known to be used, or those that exhibit characteristics allowing them to be used, as a supply source for public water systems (TAC 2010a, 2009). Action levels (concentrations at which treatment becomes necessary) and Maximum Contaminant Levels for primary and secondary pollutants are prescribed in state drinking water regulations (TAC 2010a). Freshwater criteria for metals are expressed in terms of the dissolved metal in the water column.

As of the 2002 Texas Water Quality Inventory, all designated uses except contact recreation were fully supported by water quality conditions along this river segment (TCEQ 2009b). More recently, dissolved oxygen depletions or high bacterial counts have impaired some beneficial uses in tributaries outside the study area, such as Grace Creek and Wards Creek (TCEQ 2009c). Other water quality concerns have been described for the Grace Creek watershed near Longview (SRA 2001); however, that drainage is primarily urban and outside the surface water study area. Adjacent to the study area, fish consumption from Brandy Branch Reservoir historically has been impaired due to selenium concentrations in fish tissue. However, that use and the public water supply use are fully supported based on inventories conducted in 2004 (TCEQ 2009b). No beneficial uses other than contact recreation are currently documented by agencies as being impaired on the Sabine River or its tributaries within the study area.

Other segment-specific constituent standards associated with Segment 505 involve temperature, pH, bacterial counts and dissolved oxygen, as well as concentrations of dissolved minerals such as chlorides, sulfates, and TDS. These values are (TAC 2009a):

- Chloride 175 mg/L
- Sulfate 100 mg/L
- TDS 400 mg/L
- Dissolved oxygen 5.0 mg/L
- pH range 6.0 to 8.5 standard units
- Indicator bacteria 126 colonies per 100 ml
- Temperature 93°F (33.9°C)

Data for surface water quality in the study area and surrounding region have been collected by several organizations, primarily including the USGS, SRA, and Sabine (USGS-NWIS 2009a; SRA 2009c; Sabine 2009a). USGS data were collected for tributaries outside the study area and for the Sabine River near Beckville. Recent USGS data from the gage near Beckville extend from October 1978 through October 2000, and generally were recorded on a quarterly basis (USGS-NWIS 2009). TDS measurements from the river display a number of exceedences, primarily from the mid-1980s and earlier; however, concentrations mostly ranged from approximately 80 to 220 mg/L. Suspended solids concentrations date from before the mid-1980s. They typically were less than 100 mg/L, and usually less than 50 mg/L. Combustible suspended solids concentrations (e.g., organic matter) ranged widely, from approximately 10 to 90 percent of the overall suspension. Highest water temperatures typically occurred in July or August; however, recorded exceedences were infrequent (USGS-NWIS 2009). The pH standard rarely was exceeded, but exceedences did occur in August 1981 and June 1986. When higher pH values do occur, they seem to do so during the period from summer through fall.

In cooperation with the Texas Clean Rivers Program, the SRA conducts water quality monitoring at a number of sites along the segment. Monthly data reports and annual summary reports are published by the SRA (SRA 2009c,d). In general, the annual reports confirm that water quality has substantially improved in the upper Sabine River basin with the implementation of cooperative water quality programs. Beneficial uses are typically fully supported, and this conclusion is supported by TCEQ findings (TCEQ 2009b). During droughts such as in 2006, sulfates and TDS exceeded numerical criteria. In addition, occasional bacteriological exceedences impair water quality, notably in the urban area near the upstream end of the segment (SRA 2009c,d). Larger domestic wastewater treatment plants near the study area in the upper Sabine River basin (and their permitted discharge capacities) include Longview (21 million gallons per day [MGD]), Kilgore (3.0 MGD), and Gladewater (1.4 MGD). Typically, these plants operate at a fraction of their permitted capacities.

Surface water quality monitoring has been conducted within the proposed project area by Sabine and its consultants in accordance with mine permit application requirements (Sabine 2010a, 2009a). Baseline surface water quality sampling was conducted at the seven flow monitoring locations discussed previously, as well as at selected springs and ponds within the proposed permit boundary. Constituent values were recorded both in the field and from laboratory analyses. Results are presented in tables and Appendix 129-E accompanying Section 129 of the RCT permit application (Sabine 2009a), and in earlier permit documentation for mining activities north of the river (Sabine 2010a). Within the proposed permit boundary, samples generally were collected from the baseline streams even if stagnant water conditions were present. Samples also were collected at least once during high flows after a storm.

During the baseline sampling period, TDS values generally varied over similar ranges between streams within the study area. Concentrations ranged from 48 to 507 mg/L with an average concentration of 134 mg/L. TDS concentrations typically were higher with stagnant or ponded conditions. The average TDS concentrations for stations SW-5 and SW-6 were slightly lower than concentrations from the other stations; however, flows at these stations were never observed to go stagnant (Sabine 2009a). The field pH of the streams ranged from 5.2 to 7.6.

The average TSS concentration for the baseline stream samples was 29 mg/L, with a range from approximately 4 to 864 mg/L. The maximum concentration may be due in part to disturbance at the time of sampling. This value was recorded at station SW-5, and the lowest stream stage observed at this station occurred during this sampling event. The average TSS concentration at SW-5 was 99 mg/L (Sabine 2009a).

The acidity was below the detection limit of 10 mg/L at all stations during the baseline monitoring period for the study area, with the exception of stations SW-5 and SW-6. At SW-5, acidity was detected above the detection limit once, with a concentration of 23 mg/L. Acidity was detected above the detection limit in five instances at station SW-6. At that station, the average baseline concentration was 14 mg/L with a maximum concentration of 18 mg/L.

Baseline chloride concentrations for streams in the study area typically were less than 25 mg/L. The highest average concentration was at SW-3 (25 mg/L), and the highest instantaneous concentration was at SW-7 (38 mg/L) in late August 2007. Higher chloride concentrations may track with low-flow, stagnant, or ponded conditions (Sabine 2009a). Baseline sulfate concentrations generally averaged from approximately 25 to 35 mg/L at stations SW-1 through SW-4. Average sulfate concentrations were much lower at SW-5 and SW-6 (5 mg/L and 3 mg/L, respectively), and in the middle-ground (17 mg/L) at SW-7.

The average baseline dissolved iron concentration was 1.2 mg/L and ranged from less than 0.05 to 16.2 mg/L. The average baseline dissolved manganese concentration was approximately 0.5 mg/L and ranged from less than 0.05 to 3.2 mg/L. Other than iron and manganese, baseline dissolved metals and metalloids in the streams typically were below detection limits.

Water quality sampling results for the springs and ponds in the study area generally reflect similar baseline conditions of generally neutral pH, with relatively low concentrations of TDS and other constituents. TSS values were elevated in the samples from spring SEOTS-14 and Pond 4 (Sabine 2009a).

Water quality also has been characterized for baseline and operating conditions at mines north of the Sabine River (Sabine 2010a). Within the cumulative effects study area, these monitoring data mainly were collected for the existing South Hallsville No. 1 Mine in the Clarks Creek and Hatley Creek drainages and in the South Marshall Permit Area of the South Hallsville No. 1 Mine and Darco Mine areas for Brandy Branch and Spring Creek.

In the South Hallsville No. 1 Mine area, baseline (1978) results for Clarks Creek and Hatley Creek indicate that dissolved oxygen ranged widely and often was below the state standard (5.0 mg/L). This most likely was due to the low-flow conditions frequently encountered during sampling, or possibly from biological oxygen demand due to finely divided organic matter in the flow. In addition, fecal coliform counts occasionally were elevated. These conditions may have originated from wildlife and livestock use in the Clarks Creek and Hatley Creek watersheds, and from the City of Hallsville wastewater contribution to Hatley Creek (Sabine 2010a). Baseline nitrogen and phosphorus concentrations often were elevated, likely due to the same sources. Of note, fecal coliform, nitrogen, and phosphorus concentrations generally decreased in a downstream direction, away from these probable source contributors and land uses. However, systematic differences in overall water quality were not observed from upstream to downstream (Sabine 2010a). Baseline iron (and sometimes manganese) concentrations generally were high, possibly due to geologic origins.

On upper Clarks Creek, baseline TDS concentrations ranged from 75 to 266 mg/L, pH ranged from 6.3 to 7.4, and TSS ranged from 5 to 26 mg/L. Downstream on Clarks Creek, baseline TDS concentrations ranged from 60 to 174 mg/L, pH ranged from 5.6 to 7.4, and TSS ranged from 3 to 16 mg/L. On Hatley Creek, upstream baseline TDS concentrations ranged from 92 to 568 mg/L, pH ranged from 6.4 to 8.1, and TSS ranged from 8 to 53 mg/L. Downstream baseline TDS concentrations on Hatley Creek ranged from 78 to 154 mg/L, pH ranged from 6.4 to 7.3, and TSS ranged from 4 to 48 mg/L (Sabine 2010a).

During the baseline sampling period, the Sabine River occasionally exhibited dissolved oxygen levels below the state standard, and TDS concentrations occasionally were greater than the 400 mg/L standard (Sabine 2010a). At station S1 approximately 7 miles upstream of SH 43, TDS concentrations ranged from 130 to 480 mg/L, pH ranged from 6.4 to 7.4, and TSS ranged from 18 to 75 mg/L. Downstream at SH 43, station S2 TDS concentrations ranged from 138 to 808 mg/L, pH ranged from 6.3 to 7.3, and TSS ranged from 12 to 84 mg/L. Water quality comparisons between the streams and the river generally exhibited insignificant differences, with some notable exceptions. Concentrations of TDS, chlorides, and sulfates generally were elevated in the river, whereas iron and manganese concentrations generally were higher in the tributary streams (Sabine 2010a).

In the South Marshall Permit Area of the South Hallsville No. 1 Mine and Darco Mine areas, baseline water quality for Brandy Branch and Spring Creek were collected by Norit Americas, Inc., beginning in 1985. The periods of record vary for stations on these creeks, ranging from approximately 2.5 to over 10 years. On Brandy Branch, TDS ranged from 3 to 572 mg/L, with an average of approximately 84 mg/L for all data at all stations. Similarly, TSS and pH ranged widely, between 1 to 288 and 5.8 to 8.2, respectively. Average TSS was approximately 20 mg/L for all data from all stations. Reported average pH was 6.7. On Spring Creek, TDS for all data at all stations ranged from 6 to 406 mg/L, pH ranged from approximately 6.0 to 7.7, and TSS ranged from 1 to 368 mg/L. The average TDS concentration was approximately 106 mg/L, and reported average pH and TSS values were 6.9 and 24.3 mg/L, respectively.

Water Supplies and Suppliers

Surface water rights for 15 holders are recorded in the vicinity of the project area (Sabine 2009b). Only one (Water Right 4556) is held by a downstream user; the others are for uses on site. The downstream right is for irrigation use and diverts from Martin Creek with a priority date in April 1985. Other rights listed reflect a mixture of recreation, industrial, and mining uses.

Texas water law provides for water rights to be held for both surface water sources and groundwater sources (Texas A&M Water Program 2010). Surface water belongs to the State of Texas and can be used only with the State's permission. Under the system of riparian rights, the rights are tied to the ownership of land bordering a natural river or stream; thus, riparian rights are controlled by land ownership. Under the Prior Appropriation system, rights are held by statute according to seniorities that depend on the date and place of the recorded use of the water. In 1967, the State merged the riparian rights system into the prior appropriation system with passage of the Water Rights Adjudication Act (Texas A&M Water Program 2010).

3.2.4.2 Environmental Consequences

Proposed Action

For surface water resources, potential direct impacts from the proposed project generally would include flow and water quality effects on part of the Sabine River and its floodplain, modifications of existing runoff and sediment yield conditions within or adjacent to the proposed project area, removal of surface water features such as streams and ponds, and effects to surface water quality in the project area and nearby. Indirect impacts potentially would include the effects of river crossings on aquatic habitat, on other ecological or scenic values, on wetland hydrology, or on existing road infrastructure. The proposed mining activity potentially could contribute to existing cumulative effects on surface water quantity and quality in the region.

Sabine River and Floodplain Crossings

With respect to the important resource values recognized along the Sabine River by NPS in the Nationwide Rivers Inventory (NPS 2010), and the ecological importance of the river segment identified by TPWD (TWPD 2009b), potential hydrologic impacts are discussed in the following surface water text. Potential impacts to “Waters of the US, including Wetlands” are discussed in Section 3.2.5. Other resource

considerations for the river, such as biological functions and aesthetic (visual) values, are analyzed in EIS subsections specific to those resources.

As described in Chapter 2.0 and in Sabine's planning and design documents, the proposed transportation and utility corridor crossing of the Sabine River would involve bridge construction and a dragline walkway. Construction would take place during the low-flow season, which generally occurs in late summer and fall. The proposed location is on the downstream part of a meander sequence, and upstream of a reasonably straight river reach (**Figure 2-6**). A reasonable design event (the 100-year flood) has been investigated and incorporated into the proposed bridge and walkway designs and associated drainage infrastructure (H and H Resources 2009; Sabine 2010a). USGS gaging data were used to determine the mean daily peak flow for design, and standard hydraulic engineering tools were applied to determine mean daily peak water surface elevations for the design flood. Based on the investigations, the design flood discharge was determined to be approximately 120,000 cfs, and calculated water surface elevations ranged from approximately 241.8 to 243.7 feet amsl, depending on location. These are in broad accord with earlier investigations in the locale (Gilbert and Meyers 1989); however, they are approximately 3 to 5 feet higher. The water surface elevation design value used was 242.95 feet amsl, which reasonably agrees with the 100-year flood delineations approximated on available FEMA mapping (see **Figure 3.2-13**).

In keeping with common floodplain management practice, the draft crossing designs were developed to limit increases in water surface elevations to within 1 foot of the pre-project values for the 100-year event (H and H Resources 2009). As a result, minimal impacts are anticipated to floodplain boundaries or to existing structures in or near the Sabine River floodplain. Formal review of flooding and floodplain issues would be required to take place with designated floodplain management staff in Rusk, Harrison, and Panola counties, in compliance with the National Flood Insurance Program.

The proposed haul road crossing of the Sabine River and its floodplain would take approximately 6 or 7 weeks to construct with one shift per day (Sabine 2010a). Embankment materials would come from ancillary mine areas in initial Mine Area V (see **Figure 2-2**). Unsuitable material would be placed in either oxidized stockpiles or overburden stockpiles. Based on this approach, no water quality impacts from geochemical constituents in the fill material are anticipated.

As described in Chapter 2.0, eight 130-foot bridge spans would form the channel section, and six sets of 10-foot-diameter culverts would provide flow relief on the floodplain. Bridge abutments would be sloped, and riprap would be installed on sideslopes and at culvert ends to provide erosion protection (Sabine 2010a). The draft nominal roadway elevation is 244 feet amsl, allowing approximately 1 foot of freeboard under the design event. Appropriate regulatory agencies are responsible for reviewing the engineering design and construction of the proposed bridge, dragline walkway, and related drainage features with respect to peak water surface hydrographs, hydraulic routing, channel and overbank roughness coefficients, debris effects, and engineering design-related issues.

Potential impacts on the Sabine River main channel and its floodplain would result from construction and operation of the proposed crossing features. These activities would involve dredging and filling across the river and its floodplain. Short-term temporary increases in suspended sediment concentrations, turbidity, and sediment deposition would be minimized by implementation of erosion control measures. Dewatering and excavation for the embankment foundation would release sediments and organic matter onto the floodplain and eventually into the river. Channel bed scour likely would result from local hydraulic effects at bridge piers, as well as from constriction effects near the bridge crossing sections. Constriction scour also would occur at the relief culverts on the floodplain, particularly if supercritical (high kinetic energy) flow conditions occur. Woody debris is common in Sabine River flows, as mentioned in Section 3.2.4.1. Debris clogging at bridge and culvert entrances would increase the potential for flooding and scour damages to proposed components in the floodplain, accompanied by sediment transport, turbidity, and deposition downstream. Because of these potential impacts, additional mitigation is being considered as discussed in Section 3.2.4.4, Monitoring and Mitigation Measures (see Mitigation Measure SW-1).

As discussed in Chapter 2.0 (Section 2.5.1.6), the dragline walkway would require culvert installations in the old Sabine River channel and floodplain, construction of a by-pass channel, and placement of fill (see **Figure 2-6**). Initial construction of the dragline walkway would require approximately 9 weeks using one shift (Sabine 2010a). The main channel would be diverted to the by-pass for approximately 3 to 7 days during dragline crossings (four total). Following each crossing, fill would be re-excavated in select locations and stockpiled as shown in **Figure 2-6**. For each subsequent dragline crossing, approximately 2 to 3 months would be required to recomplete the walkway, move the next dragline, and re-excavate and stockpile the fill (Sabine 2010a).

At a design flow of 420 cfs based on a 3-month (July 15 to October 15) average from USGS gaging data, flow velocity would be approximately 2.7 feet per second in the bypass culverts. In addition, the other culverts would be installed along the walkway would allow drainage back and forth along the floodplain. The channel diversion structure would be closed but left in place to allow later use of the walkway. Gaps in the walkway would be opened during inactive periods (see **Figure 2-6**), and excavated materials would be placed on top of the remaining walkway sections. With a material borrow approach similar to the haul road, no water quality impacts from geochemical constituents in the fill are anticipated.

The Sabine River segment in the vicinity of the Rusk Permit Area is not used for commercial navigation. Therefore, no impacts to regional commercial shipping would occur. See Section 3.9, Land Use and Recreation, relative to potential impacts to recreational boating and canoeing.

Building the walkway and channel bypass would release sediment into the river from excavation and equipment tracking. As with the proposed haul road crossing, short-term temporary increases in suspended sediment concentrations, turbidity, and sediment deposition would occur from project-related disturbance. Short-term temporary increases in suspended sediment concentrations, turbidity, and sediment deposition would be minimized by implementation of erosion control measures. During the inactive periods, high flows would subject the stockpiled walkway materials to erosion. Flow paths between the walkway openings, and between the remaining material stockpiles and the haul road, would promote additional erosion, turbidity, and sedimentation between the embankments and into the river during overbank flows. These effects may limit the hydraulic performance of relief culverts under the haul road nearby. These flow and water quality impacts would be short-term in nature. Because of the potential for these impacts from excavation, stockpiling, and equipment tracking during wet periods, monitoring and mitigation is being considered as discussed in Section 3.2.4.4, Monitoring and Mitigation Measures (see Mitigation Measure SW-2).

Construction effects and the long-term presence of the crossing structures may induce channel migration. Upstream or downstream effects could occur; old channel scars occur in both directions. A relatively straight reach of the river is downstream (see **Figure 2-5**), and with adequate foundations, the proposed bridge and embankment would help anchor the channel. These factors likely would minimize downstream bank shifting and channel migration. The river is strongly meandering upstream of the crossing. Flow acceleration through the bypass culverts or through scoured or constricted channel transitions would encourage additional bar and bank shifts in those meanders. Additional sediment transport, turbidity, and deposition would result. If they occur, these effects would vary widely in their intensity and timing.

As described in Section 3.2.4.1, the Sabine River is dominantly a sand-bed channel underlain by lignite and sedimentary rock outcrops. Soil descriptions in Section 3.3.1 identify grain sizes ranging from sands to clays. Based on general sand sizes and flocculation of smaller particles in the flow, suspended sediments from construction during low flows likely would settle out within a mile or so downstream of the proposed channel crossing. For example, with a flow depth of approximately 4.5 feet and a mean downstream velocity of approximately 1.2 to 1.5 feet per second, a small sand particle will settle out of reasonably calm flow in approximately 100 feet or less. Re-suspension could increase that distance, but it gives a general idea of a potential downstream impact area for sands. Under the same conditions, dispersion and settling of clay aggregates from the water column typically would occur over a much greater river distance. Depending on water chemistry and a concentration criterion, silts and clays in that flow may require 0.5 mile or more to settle out to the criterion or to a background concentration. Changes in flows,

turbulence, and re-suspension would modify those settling distances as well as background concentrations. Nonetheless, increases in suspended sediment concentrations, turbidity, and sediment deposition would occur from project disturbance in and adjacent to the river, generally on the order of the distances mentioned here. These water quality changes would be short-term in nature. Because of the potential for channel mitigation, sedimentation, and turbidity impacts to a waterbody that is a candidate "Ecologically Significant River Segment" (see Section 3.2.4.1), additional mitigation is being considered as discussed in Section 3.2.4.4, Monitoring and Mitigation Measures (see Mitigation Measure SW-3).

As described in Section 3.2.4.1, wetland hydrology in the floodplain is a varying combination of surface and sub-surface contributing factors. Riverine overflow is one mechanism that maintains wetlands on the floodplain. After construction, relief culverts at existing wetland locations would provide drainage through the embankment in approximately the same major wetland locations as prior to construction (**Figure 2-6**). There may be changes in overbank flow velocities through wetlands; they only would be during rare, large floods. Hydrologic impacts are anticipated to be negligible; however, vegetation could be pushed down and broken up during infrequent events. More gradual effects on wetlands would result from alteration of runoff patterns and sub-surface flow conditions. Over the long-term, changes toward wetter or drier drainage conditions could occur along the haul road embankment, and may alter nearby vegetation communities. These would be localized hydrologic impacts, if they occurred. Other bridge fills in the area are not known to have caused substantial surface or subsurface drainage impacts on nearby vegetation. Because of the potential for drainage impacts on vegetation and wetland functions, however, additional monitoring is being considered as discussed in Section 3.2.4.4, Monitoring and Mitigation Measures (see Mitigation Measure SW-4).

If large spills and leaks occur along the haul road during operations, released materials could migrate toward wetlands or the Sabine River. Releases could include fuel, lubricants, or other materials transported over the road. Depending on the nature and volume of released materials and the spill location, water quality impacts would range from negligible to substantial. An SPCC Plan has been prepared for the project (Sabine 2009a). The plan sets forth the materials and practices, communication and response protocols, and training background to prevent and respond to potential spill events. Because of the potential for water quality impacts to the Sabine River and/or waterbodies on its floodplain associated with a hazardous materials spill, additional mitigation is being considered as discussed in Section 3.2.4.4, Monitoring and Mitigation Measures (see Mitigation Measure SW-5). (Potential impacts associated with the proposed transport of fuel deliveries to the Rusk Permit Area via the transportation and utility corridor is discussed in Section 3.13, Hazardous Materials.)

Runoff from the haul road during its operational life would transport sediment and traffic residues to the Sabine River or to waterbodies on the floodplain. During large storm events, the roadway drainage and sediment yield would contribute to water quality impacts. Individual occurrences of these impacts would be local, short-term, and minor to moderate in intensity. If road drainage and sediment were to periodically reduce water quality over the operating life of the road, repeated effects may create impacts of greater extent and severity. Because of the potential for these impacts to affect water quality in the Sabine River, additional mitigation is being considered as discussed in Section 3.2.4.4, Monitoring and Mitigation Measures (see Mitigation Measure SW-6).

Surface Water Quantity

Removal of Surface Water Features

As stated in Section 3.2.4, approximately 186 acres of streams are located in the Rusk Permit Area (HDR 2010). Of these, 89.3 acres would be removed by the proposed project, including 5.4 acres of perennial streams, 13.5 acres of intermittent streams, and 22.1 acres of ephemeral streams (HDR 2010). In addition, of the 223.8 acres of open water in the Rusk Permit Area, 48.3 acres of impoundments would be removed. These actions would result in short-term to long-term impacts to surface water resources in the project area.

In response to these potential impacts, Sabine has prepared a proposed Conceptual Mitigation Plan for waters of the U.S., including wetlands (see **Appendix C**). Successful implementation of the plan would mitigate impacts to these resources. Small impoundments would be replaced as part of proposed mitigation plan, or according to landowner agreements during reclamation to post-mining land uses (Sabine 2009a). Examples of stream restoration and stabilization practices are presented in the proposed Conceptual Mitigation Plan (**Appendix C**). These conceptual approaches would be applied after further site assessment and selection of appropriate practices, techniques, or structures. Generalized categories of stream and pond restoration approaches, which are discussed in greater detail in the proposed Conceptual Mitigation Plan include, but would not be limited to:

- Channel designs, recontouring, terracing, and erosion controls to create stable streams and ponds;
- Prompt revegetation using mulches, anchored cuttings, and plant species selected to promote establishment of riparian conditions; and
- As necessary, structural placements to control stream gradients, dissipate energy, and create micro-habitats.

It is anticipated that the proposed direct and compensatory mitigation ratios for replacement of jurisdictional streams, ponds, and wetlands would restore or increase the extent of these resources. Successful implementation of the proposed plan would reduce impacts to surface water features to negligible or minor levels. (Also see Section 3.2.5, Waters of the U.S., including wetlands.)

Watersheds and Runoff Conditions in the Project Area

During the life-of-mine, the proposed project would alter watershed and runoff conditions as mining disturbance advances in the proposed mine areas. Compliance with RCT permit requirements and operating rules would reduce the level of impacts and generally restrict them to the project area. Section 146 of the RCT permit application describes probable hydrologic consequences anticipated during the first 5-year RCT permit term and beyond. Sabine has evaluated potential surface water impacts in accordance with state and federal regulations, and further independent review has been conducted for this EIS.

The overall surface water handling system for the project is described in Section 2.5.2.1. The channels within and immediately around the proposed mine areas would flow primarily in response to local precipitation events, attenuated in lower stream reaches by the presence of sediment control ponds. The Sabine River, the major perennial stream located immediately north of the mine areas, would be the receiving waterbody for water discharged from the mine dewatering activities. Although runoff volumes would increase during the mining period, releases to the river would be attenuated by the water management system. Additional managed discharges would not substantially increase downstream flows in the river during the period of water discharges.

Drainage within the proposed mine permit boundary would be controlled by ditches, sediment control ponds, and monitored TPDES outfalls to receiving waters during the mining process. Additional perimeter ditches would route runoff from outlying undisturbed areas away from the mine activities. Ditch alignments, linings, and energy dissipation would control runoff velocities and stabilize outlets during mining. As mining proceeds, bare soil or overburden surfaces would contribute greater runoff volumes and discharge rates than pre-mining surfaces. Ditch routing and sediment control pond detention (with treatment, if necessary) are proposed to control these effects and minimize off site impacts. Over time, runoff modifications would be further reduced by recontouring, growth media restoration, and revegetation taking place concurrent with mining as mine pits are backfilled.

Sixteen watersheds within the life-of-mine disturbance area were modeled by Sabine using SEDCAD4 (a standard modeling approach approved by the Federal Office of Surface Mining). The pre-mining, mining, and post-mining runoff conditions were examined (Sabine 2009a). Exhibit 146-3 in the RCT permit

application shows the locations of these watersheds. Based on compliance with regulatory requirements to restore the approximate original land contour during reclamation, pre-mining and post-mining conditions have been compared. During mining, effects may vary as land surface conformation and water management practices modify drainage conditions.

Overall, runoff volumes and peak flow rates are expected to increase in almost all of the watersheds during and after mining. Changes are due to changes in land use, infiltration, and corresponding vegetation cover. The land use would change from primarily undeveloped woodland and pastureland before mining, to predominantly pastureland and forest land following reclamation (Sabine 2009a). Although the incremental increases in runoff volume and peak flows are fairly small on a per-acre basis, they become more substantial at the outlet of a larger watershed area. **Tables 3.2-8** and **3.2-9** show changes for several affected watersheds.

For these representative watersheds, **Table 3.2-8** indicates that runoff would increase during mining, and then decrease after mining for all major storm events. The post-mining runoff volume would be somewhat greater than the pre-mining condition. For example, for the modeled 10-year, 24-hour storm estimates, runoff from the overall Caney Branch watershed would be approximately 374 acre-feet under pre-mining conditions. This estimate would increase to approximately 583 acre-feet during mining, and then decrease to approximately 490 acre-feet after mining and reclamation. The increase in runoff from pre-mining to post-mining conditions would be approximately 116 acre-feet (31 percent) under this severe storm event, as estimated by modeling.

For the modeled 100-year, 24-hour storm estimates, runoff from the overall Watt Creek watershed would be approximately 1,496 acre-feet under pre-mining conditions. This estimate would increase to approximately 1,669 acre-feet during mining, and then decrease to approximately 1,607 acre-feet after mining and reclamation. The increase from pre-mining to post-mining conditions would be approximately 111 acre-feet (7 percent) under this extreme storm event, as estimated by modeling.

Table 3.2-8 Predicted Effects on Runoff Volumes for Representative Project Watershed Outlets (acre-feet)

Storm Event and Condition	Caney Branch Yield	Tatum Creek Yield	Unnamed Tributary 9 (at Hendrick's Lake) Yield	Watt Creek Yield
10-year, 24-hour storm before mining	374	522	640	732
10-year, 24-hour storm during mining	583	580	984	871
10-year, 24-hour storm after mining	490	554	906	819
25-year, 24-hour storm before mining	553	726	920	1,007
25-year, 24-hour storm during mining	733	792	1.315	1,162
25-year, 24-hour storm after mining	691	761	1,228	1,105
100-year, 24-hour storm before mining	888	1,091	1,433	1,496
100-year, 24-hour storm during mining	1,102	1,166	1,892	1,669
100-year, 24-hour storm after mining	1,054	1,132	1,795	1,607

Source: Sabine 2009a.

Table 3.2-9 Predicted Effects on Peak Flows for Representative Project Watershed Outlets (cubic feet per second)

Storm Event and Condition	Caney Branch Peak Discharge	Tatum Creek Peak Discharge	Unnamed Tributary 9 (at Hendrick's Lake) Peak Discharge	Watt Creek Peak Discharge
10-year, 24-hour storm before mining	1,157	1,299	1,996	2,130
10-year, 24-hour storm during mining	1,811	1,441	2,438	2,561
10-year, 24-hour storm after mining	1,663	1,372	2,278	2,405
25-year, 24-hour storm before mining	1,750	1,820	2,350	2,930
25-year, 24-hour storm during mining	2,482	1,974	3,240	3,387
25-year, 24-hour storm after mining	2,328	1,900	3,070	3,226
100-year, 24-hour storm before mining	2,852	2,743	3,646	4,325
100-year, 24-hour storm during mining	3,760	2,909	4,611	4,801
100-year, 24-hour storm after mining	3,514	2,830	4,438	4,636

Source: Sabine 2009a.

For these representative watersheds, **Table 3.2-9** indicates that peak discharges would increase during mining, and then decrease after mining for all major storm events. The post-mining peaks would be somewhat greater than pre-mining. For example, for the modeled 10-year, 24-hour storm estimates, the peak discharge rate from the overall Caney Branch watershed would be approximately 1,157 cfs under pre-mining conditions. This estimate would increase to approximately 1,811 cfs during mining, and then decrease to approximately 1,663 cfs after mining and reclamation. The increase in the peak flow rate from pre-mining to post-mining conditions would be approximately 506 cfs (44 percent) under this severe storm event, as estimated by modeling.

For the modeled 100-year, 24-hour storm estimates, the peak discharge rate from the overall Watt Creek watershed would be approximately 4,325 cfs under pre-mining conditions. This estimate would increase to approximately 4,801 cfs during mining, and then decrease to approximately 4,636 cfs after mining and reclamation. The change from pre-mining to post-mining conditions would be approximately 311 cfs (7 percent) under this extreme storm event, as estimated by modeling.

It should be noted that these comparisons are for severe to extreme storm events, which are relatively to extremely rare. Under more common conditions, much smaller differences in runoff and peak flow rates would result from the project. In addition, the surface water modeling that was performed does not include the mitigating effects of the proposed sediment control ponds, which would retain runoff, reduce peak discharges, and mitigate flooding potential (Sabine 2009a). Proposed surface water controls, which would be built in phases as the mine advances, are shown in **Figure 2-5**. As described in Section 2.5, all surface water runoff from disturbed areas (except roads) would pass through a sediment control pond or series of sediment control structures prior to discharge through TPDES-regulated outfalls. Each structure would be planned and constructed in accordance with RCT requirements. The proposed program for managing runoff, controlling sediment, and controlling discharges from the proposed disturbance areas in accordance with state regulations would reduce the impacts to surface water resources to negligible levels. The sediment control ponds would redistribute storm water runoff by detaining and releasing it at a lower, controlled rate, mitigating the potential for flooding. The total volume of runoff would not be

appreciably changed by the use of sediment control ponds; however, the peak flow leaving the mine area would decrease (Sabine 2009a). Formal review of flooding and related floodplain issues would be required to take place with designated floodplain management staff in Rusk, Harrison, and Panola counties in compliance with the National Flood Insurance Program.

As presented in Section 2.5, some of the sediment control ponds may remain as permanent landscape features, pending final agency approval and landowner agreement. These ponds would enhance post-mining land uses while controlling the increased runoff volume and peak flows from the mine area (Sabine 2010a). As with other small ponds that may be built within the proposed disturbance area, remaining sediment control ponds, if retained, also would enhance runoff water quality. Sediment control ponds or earthen structures that would remain in the Rusk Permit Area as permanent water impoundments would be designed to comply with state regulation §12.347 (TAC, Title 16, Chapter 12, Subchapter K, Division 2) (Sabine 2009a).

Open water at the proposed sediment control ponds would increase local evaporation rates somewhat, which as described in Section 3.2.4, are approximately equal to precipitation on an average annual basis. Evaporation losses from the sediment control ponds would be a negligible impact, since they would represent a negligible portion of open water that already exists in the locale and the region. In summary, the average annual net evaporative loss represents approximately 0.02 percent of the average annual discharge of the Sabine River through USGS Station 08022040 (Sabine 2009a). This is a negligible value, particularly when compared to more sizable existing impoundments and open water wetlands in the river basin. As proposed, the construction and use of the sediment control ponds would mitigate increases in surface runoff during mining, and also would mitigate potential reductions in water quality by providing settling basins for sediment and opportunities for water treatment, if needed, prior to controlled discharge to receiving waters. Discharges would be controlled as necessary by energy dissipaters, riprap in channels, sumps, or other practices or devices to reduce erosion and to prevent deepening or enlargement of stream channels (Sabine 2009a). Negligible impacts to surface water resources during mining are anticipated as a result.

After mining, drainage patterns would be re-established (see **Figure 2-11**) and suitable growth media replaced as described in Section 2.5. Channels would be constructed to approximate pre-mining conditions to the extent possible and configured to ensure that any drainage features upstream of the mined area flow freely into the new drainage system. Contour furrows would be installed to provide surface stabilization and erosion control in the post-mining landscape, until vegetation has been re-established. Long-term erosion control measures would include rock check dams, concrete block drop structures, and semi-permanent erosion control fabrics as described in Section 2.5. These procedures, in compliance with state regulations, would reduce post-mining impacts to water resources within the mine area to negligible levels.

Post-mining impacts to off site water resources would result from increased runoff from within the mined area after reclamation. As identified in RCT Permit Section 146 and **Tables 3.2-8** and **3.2-9** above, increased runoff volumes and peak discharge rates would occur after reclamation, and some sediment control structures may remain as permanent detention structures, pending landowner agreements and agency approval. It is not known which sediment control structures potentially would remain as permanent, and which potentially would be removed. Most runoff changes likely would be absorbed by the extensive floodplain and wetland systems downgradient of the mine site. Channels such as Cherokee Bayou, Black Slough, Martin Creek, and Tatum Creek likely would absorb additional runoff volume through seepage losses into the floodplain alluvium. However, additional sediment yield and higher storm peak flows from the mine watersheds may induce downstream channel migration, bank erosion, and scour. These de-stabilizing effects could propagate both downstream to existing streams, and upstream into the reclaimed mine area. Stream adjustments would be local in extent and likely would reach a new equilibrium. Effects would range in duration from short-term to long-term. Because of the potential impacts to stream stability near the proposed project boundary, additional mitigation is being considered as discussed in Section 3.2.4.4, Monitoring and Mitigation Measures (see Mitigation Measure SW-7).

Drawdown effects from groundwater pumping have been assessed in Section 3.2.3.2. The modeled 5-foot drawdown area shown in **Figure D-1** in **Appendix D** indicates that this effect would be largely limited to the proposed life-of-mine disturbance area and a small perimeter zone. Based on the groundwater analysis, minor impacts to surface water resources are anticipated from mine-related groundwater drawdown.

Surface Water Quality

The proposed mining activities temporarily would reduce runoff water quality in the project area; compliance with RCT and TCEQ permit requirements and operating protocols would reduce the intensity of this impact and generally restrict effects to within the permit boundary.

As described previously, Sabine has conducted a substantial surface water monitoring program as part of the RCT permitting process. This program documents baseline surface water quality conditions before any mining would take place. During mining, after mining, and through the reclamation monitoring period, intensive water quality monitoring and reporting would be conducted by Sabine in accordance with state regulations and in coordination with state agencies. Major aspects of these programs are detailed in the RCT permit application (e.g., Section 148) (Sabine 2009a). Substantial increases in sediment yield are anticipated during mining (Sabine 2009a). As described previously, sediment control ponds would be used to collect, monitor, treat (as necessary), and control surface water releases. Additional proposed practices, such as those defined in the SPCC Plan, would further mitigate potential surface water quality impacts. Similar programs have been successfully implemented by Sabine at the existing South Hallsville No. 1 Mine located north of the Sabine River. The proposed monitoring and control practices would minimize the impacts of surface water quality leaving the Rusk Permit Area, and enable adaptive management if further practices were needed to protect water quality. Based on these programs and historical performance, minor impacts to surface water quality during mining are anticipated from the Proposed Action.

After mining and reclamation, impacts to surface water quality would be largely mitigated by recontouring, revegetation, and stream network restoration, as proposed in the RCT permit application and the proposed Conceptual Mitigation Plan submitted as part of the Section 404 IP application to the USACE. Selective overburden handling, the use of suitable topsoil or growth media substitute, liming (if needed), and the proposed 4-foot cover depth for less suitable materials, would mitigate the potential for acid drainage or other pollutant constituents from overburden/interburden materials to reduce surface water quality.

Following reclamation, sediment and dissolved constituents from runoff and seepage from suitable earth materials may reduce surface water quality leaving the reclaimed area. Increases in sediment yield generally are predicted by SEDCAD4 modeling conducted during project planning (Sabine 2009a). Post-reclamation monitoring would track these conditions, if they occurred, and would enable additional erosion and water control practices to be implemented in accordance with RCT and TCEQ regulations if necessary. As the revegetated cover matures and soil infiltration rates recover over time, the increases in runoff and sediment yield should decline in the long term. Mathewson et al. (1982) determined that mine spoil runoff initially contained slightly elevated concentrations of dissolved and suspended solids, iron, and sometimes manganese. However, based on runoff data obtained from native and reclaimed spoil plots at similar lignite mines located in Grimes, Angelina, and Harrison counties, Texas, these concentrations declined within a year, approximately reaching the background levels in runoff from the native pre-mine soils. SEDCAD4 modeling of sediment yields from the project area watersheds indicated that after mining and reclamation, sediment concentrations in runoff would decline to regional background conditions or less. In studies of runoff water from recently revegetated spoil plots at existing and proposed lignite mines in Texas, runoff quality was found to be within acceptable limits for pH, iron, and manganese (Mathewson et al. 1982). Immediately following seedbed preparation and until vegetation is re-established, fertilizers or pesticides (inclusive of herbicides) may be applied to the areas being reclaimed. Runoff water quality may be reduced by these amendments if sufficient rainfall occurs on unprotected land surfaces. The risk of substantial water quality impacts from this source would decline as site stabilization and

revegetation proceed. Based on reclamation requirements and planning studies, impacts to surface water quality after mining are anticipated to be minor.

The slight increases in baseflow under the Proposed Action would not cause a noticeable impact on downstream low-water crossings. No low-water crossings are known to be located immediately downstream of the project area. If increases in runoff or discharge due to mining activities adversely affect low-water crossings downstream of such activities, Sabine would mitigate such conditions (Sabine 2009a).

Water Rights of Record

The potential impacts to water well owners are discussed in Section 3.2.3, Groundwater. Downstream surface water rights are not expected to be adversely affected, due to the continuing release of monitored water from the Rusk Permit Area before and after mining. The total volume of runoff after mining would increase. In addition, baseflow to streams would increase slightly as a result of storage and seepage from sediment control ponds. This would increase the duration of streamflows in intermittent or ephemeral streams. From a water resources standpoint, this effect would be a beneficial impact.

No Action Alternative

Under the No Action Alternative, the Rusk Permit Area would not be developed and associated impacts to surface water resources would not occur. Existing operations at the South Marshall Permit Area of the South Hallsville No. 1 Mine would continue through 2027, with final closure and final reclamation in approximately 2035. In the absence of the proposed project, there would be continued regional potential for erosion/sedimentation and other water quality challenges, as noted from NRCS information cited in Section 3.2.4.1. Region-wide potential for water quality impacts from urban and industrial development in Segment 505 of the Sabine River watershed would continue. These would be addressed by ongoing regional monitoring, improvement of floodplain and watershed conditions, and improved water quality resulting from the Texas Clean Rivers program, state and district water planning, and other state/county/local programs.

3.2.4.3 Cumulative Impacts

As described in Section 3.2.4, the surface water cumulative effects study area continues north of the Sabine River onto the uplands, between a line projected north from the Rusk-Gregg county line at Easton to the north boundary of the South Hallsville No. 1 Mine; from that boundary, the uplands south of I-20 also are included. The cumulative effects study area includes other existing and proposed mines and other projects in the region as described in Section 2.7 and shown in **Figure 2-12**.

Runoff from existing operations at the Martin Lake Mine south of the watershed divide at Center Point (northeast of Tatum) drains to Martin Creek via Caney Branch and Alder Branch. Martin Creek is perennial according to historical USGS flow records, probably due to dam releases and upstream seepage from Martin Lake. Runoff from the Proposed Action also would drain to Martin Creek through Caney Branch and Tatum Creek (see **Figure 2-2**).

Cumulative impacts would be negligible upstream of the confluence of Tatum Creek with Martin Creek; no cumulative impacts would occur northward to Watson Branch or Elijah Branch. Downstream, contributions to cumulative effects on Martin Creek probably would be similar from all of the lands disturbed by surface mining and reclamation. Only minimal cumulative impacts would be contributed by the Proposed Action, since no disturbance would occur beyond SH 43. However, runoff from the Proposed Action would drain down Caney Branch, contributing to cumulative effects from other mining activity in the Martin Creek watershed. Based on the SEDCAD4 runoff and sediment transport modeling conducted for the Proposed Action by Sabine (Sabine 2009a), cumulative impacts would include greater runoff volumes and peak flows, and possibly a temporary reduction in water quality. Runoff and sediment yield from mined lands would increase during mine operations, but would be controlled by sediment control structures. After mining and reclamation, cumulative runoff and sediment yield would be reduced from operational conditions. Sediment yield may be reduced below pre-mining conditions.

If permanent impoundments were placed after mining and reclamation, cumulative runoff and peak flow impacts downstream on Martin Creek would be reduced. Slight increases in evaporation losses, and slight increases in stream baseflows, would result from permanent impoundments. These effects would be unnoticeable a short distance downstream on Martin Creek and in the Sabine River. Given the additional watershed area and contributions from Hogan Creek, any minor flow impacts that do occur probably could not be distinguished on Martin Creek beyond FM 959 north of Beckville. With respect to the river, as described in Section 3.2.4; over 40 percent of the basin is regulated by reservoirs and small ponds. In general, the placement of small permanent impoundments within the middle Sabine River basin would have a negligible impact, given the much more extensive network of water retention structures that already control much of the basin.

If no permanent impoundments or other stabilization practices were placed in reclaimed areas in the Martin Creek watersheds, the cumulative increases in peak discharges during runoff events would cause some channel scour and bank migration along Martin Creek and Caney Branch. If they occurred, these impacts would extend locally from the Caney Branch confluence both upstream (in the form of nick points) and downstream (in the form of sedimentation and channel widening and/or meandering). The potential for such impacts would be mitigated by placement of additional erosion and flow controls in the contributing disturbed watersheds and along the nearby streams would be undertaken as part of reclamation to comply with regulatory programs. For example, a series of small check dams, rock weirs, or other proposed practices would be employed. As these practices were applied or features constructed, cumulative impacts from higher flow rates would be minor.

Cumulative water quality impacts would be negligible to minor, based on review of existing data from lignite operations north of the river that are similar to the Proposed Action. Available historical monitoring data for Rodgers Creek, Hardin Creek, Hatley Creek, and Potters Creek indicate that water quality at mine outfalls typically is similar to water from upstream undisturbed areas, and occasionally is improved in terms of such basic constituents as pH, electrical conductivity (EC), TSS, and TDS, sulfates, and acidity. Occasional increases in EC, TSS, and TDS beyond the undisturbed inflow values usually are minor and remain within state standards. Paired examples of such data are indicated in **Table 3.2-10**, for different creeks and associated monitoring points.

In addition, water sampled in the mined and reclaimed areas along Clarks Creek and Potter Creek often is better in quality than samples retrieved well out on the Sabine River floodplain. Based on SEDCAD4 modeling and monitoring documentation, overall watershed sediment yields after reclamation would be similar to or lower than pre-disturbance levels (Sabine 2009a). Based on these historical data and modeled impacts for the Proposed Action, overall water quality would be maintained through the disturbed areas. Any cumulative water quality impacts would be minor and local in extent.

The Oak Hill operations drain northeast to Cherokee Lake or east to Martin Lake. None of these watersheds or waterbodies within them would be affected by the Proposed Action; therefore, cumulative impacts associated with the Proposed Action would not occur to those watersheds or waterbodies.

Based on surface geology (Bureau of Economic Geology 1975) and mining practices at the existing South Hallsville No. 1 Mine, the proposed Marshall Lignite Mine east of U.S. Highway 59 would be located on terrace deposits elevated above the Sabine River floodplain. Water management practices and other environmental controls on runoff and surface water quality would be planned, conducted, and reclaimed in accordance with state regulations, as with other mines in the area. Based on appropriate implementation and monitoring of surface water controls, cumulative impacts from the proposed Marshall Lignite Mine would include minor, temporary effects on local surface water runoff, sediment yield, and water quality.

Wetland removal or modifications may create cumulative impacts to flood storage and routing. These impacts would be considered minor to moderate in nature, and would occur locally. Related impacts to surface water flow conditions in the cumulative effects study area would be reduced to negligible or minor intensity due to runoff controls, stream protection or restoration, and reclamation.

Table 3.2-10 Examples of Historic Water Quality Data Paired with Flow Variations

Project Area	Creek	Sample Date	Location with Respect to Mining	Flow[1] (cfs)	pH[2]	EC (µmhos/cm^3)[3]	TSS (mg/L)	Total Dissolved Solids (mg/L)
South Hallsville	Rodgers	08/11/94	upstream	NMF	5.4	773	42	556
			downstream	NMF	7.6	106	35	92
		12/30/94	upstream	0.95	6.9	68	11	80
			downstream	1.5	6.6	78	10	76
		04/08/09	upstream	NMF	7.0	508	25	386
			downstream	1.8	7.0	247	19	158
	Hardin	01/11/05	upstream	NMF	6.4	299	24	224
			downstream	NMF	6.8	289	66	214
		05/31/05	upstream	NMF	6.7	293	96	172
			downstream	NMF	7.0	163	13	120
		12/30/94	upstream	3.80	6.8	174	8	116
			downstream	TGM	6.4	329	10	260
	Hatley	07/14/09	upstream	NMF	7.2	290	44	186
			downstream	1.67	71	277	56	174
		04/09/08	upstream	11.0	6.4	149	70	134
			downstream	9.0	7.2	194	24	136
		12/30/94	upstream	TGM	7.1	80	4	80
			downstream	TGM	6.8	95	19	88
South Marshall	Potters [4]	01/07/09	downstream	90.0	7.1	169	24	114
		04/08/09	downstream	8.0	6.9	166	40	120
		07/14/09	downstream	4.67	6.9	250	36	176
		10/06/09	downstream	TGM	6.7	218	22	180

[1] NMF = No Measurable Flow; TGM = Too Great to Measure.

[2] pH in standard units.

[3] µmhos/cm^{3}micromhos per centimeter.

[4] Potters Creek is sampled downstream of disturbance; comparative upstream data were not available.

Source: SMC 2010a.

3.2.4.4 Monitoring and Mitigation Measures

Based on the EIS analysis, the USACE is considering the following additional mitigation for surface water resources:

SW-1: BMPs to reduce erosion and sedimentation within the Sabine River floodplain and along transitional haul road ramps would be specifically defined and located on design plans along the proposed haul road and the proposed dragline walkway. Practices and features would ensure shoreline and stockpile protection, as well as scour protection at and near bridge abutments and piers for the 100-year design event. Additional scour or channel migration investigations would be conducted to define the potential locations, depth, and extent of such processes, and findings would be integrated into protective measures for final designs. Culvert diameters, configurations of culvert transitions (inlets, outlets), and flow velocities through culverts would be further investigated to reasonably ensure the stability of flow paths and the embankment at and near culverts. Final designs and construction of the haul road and walkway would incorporate reasonable estimates of the hydraulic effects of woody debris on bridge and culvert conveyance, local scour, and backwater conditions. Since mean daily flow observations were used in preliminary designs, ongoing design efforts would distribute the mean daily peak flow into an hourly flow hydrograph based on existing representative data or accepted practice. Bridge and roadway freeboard values would accommodate the hourly peak flow in final design.

Effectiveness: This measure would reduce or mitigate impacts to the Sabine River from erosion and sedimentation, and promote the stability of project components against river flows. By reducing or mitigating potential flood effects on proposed features in the floodplain, potential surface water impacts from damages to those features also would be reduced or mitigated.

SW-2: Work in the Sabine River floodplain would cease during severe storms or out-of-bank flows. If after a storm event, construction traffic on the river floodplain causes soil ruts deeper than 3 inches, equipment mats would be used or construction delayed until drier conditions occur.

Effectiveness: This measure would reduce equipment tracking of mud and organic materials, and reduce the channeling of rainfall into tracks. Both results would reduce the potential for floodplain sediments to be transported into the Sabine River and associated adverse effects on water quality.

SW-3: Channel conditions upstream and downstream of embankments, the haul road bridge, and culverts would be monitored using scheduled periodic field observations and a sequence of historical aerial photos (such as from the Texas Natural Resources Information System [TNRIS]). A professionally qualified fluvial geomorphologist would be retained to provide input regarding monitoring methods and protection for channels and streambanks during project design and the development and implementation of a river monitoring program. As needed and if notable changes in the trends of planform (plan view) banks/bars are observed from the existing and historical conditions, upstream and downstream stabilization would be implemented according to accepted engineering/geomorphic practices. In addition, water quality conditions in the Sabine River downstream of any project-related disturbance in the river or floodplain would be monitored for sedimentation impacts or other reductions in background water quality. In cooperation with TPWD and USACE, Sabine would develop and satisfactorily implement a water quality monitoring plan to inform the agencies of project activity schedules and to characterize turbidity and suspended sediment concentrations in the Sabine River flow both upstream and downstream of project-related disturbance. Monitoring activities would extend sufficiently far downstream to ascertain and quantify any sedimentation impacts to the mussel sanctuary 4 miles downstream, as well as other zones that may support aquatic special status species and aquatic species of special concern within a distance to be prescribed by TPWD. The timing of these water quality monitoring activities would include pre-, during-, and post-activity monitoring at timeframes prescribed by TPWD. A written summary report and data compilation would be submitted to TPWD and USACE by Sabine within 1 month of any monitoring sequence. Thresholds that would trigger mitigation activities would be developed in cooperation with TPWD. Criteria could include, for example, increases in turbidity and/or TSS concentrations above

upstream sample values (or normal values for the flow and season), an incremental depth of burial from sedimentation in occupied downstream habitat, or some other measurable stressor.

Effectiveness: This measure would provide for early identification of potential impacts from erosion and sedimentation, flooding, and flood damages by monitoring river conditions and trends over time. Potential problems from channel and bank migration, if identified, would be mitigated as they arise. This measure also would quantify actual impacts to water quality in the Sabine River from project-related disturbance.

SW-4: Scheduled periodic monitoring would be conducted to evaluate potential impacts to vegetation or flow paths from restricted surface/subsurface drainage around the main haul road and dragline walkway crossing embankments. Revisions to an approved mitigation plan would be made in coordination with USACE if monitoring over time indicates impacts greater than local and minor.

Effectiveness: This measure would provide for monitoring of wetland hydrology and vegetation and trigger additional wetland mitigation if changes from subsurface drainage should occur.

SW-5: The SPCC Plan would include a separate section for the Sabine River floodplain. The section would emphasize response protocols, training and communication; the location and availability of cleanup kits and other control equipment or materials at the north end of the haul road for spills involving haul trucks, fuel trucks, or other supply vehicles. No movable equipment would be parked or staged overnight within the floodplain boundaries; refueling within floodplain boundaries would be conducted on a limited basis; and no fuels, solvents, or other potentially hazardous materials would be stored within the floodplain boundaries during haul road and dragline walkway construction or operations.

Effectiveness: This measure would reduce or mitigate water quality impacts to the Sabine River from potential spills.

SW-6: Storm water controls and, if needed, sediment control ponds would be installed on drainage pathways along the haul road and dragline walkway. These facilities would be designed, constructed, and monitored to control runoff and water quality to within state standards before road and embankment drainage empties into the Sabine River.

Effectiveness: This measure would reduce or mitigate water quality impacts to the Sabine River from erosion and sedimentation caused by storm water or floodplain disturbance.

SW-7: The locations and characteristics of permanent sediment control ponds would be defined on final project plans and narratives, and incorporated into mitigation and monitoring plans for the Section 404 permit. Embankment heights, typical retention volumes, and design-event storm water retention volumes would be defined and incorporated into designs for state and federal agency review. Typical normal outlet and emergency spillway configurations would be defined to meet state dam safety requirements, and outlet controls to minimize downstream channel adjustments would be defined and incorporated into designs for state and federal agency review. Long-term post-reclamation ownership responsibilities would be detailed in mitigation and reclamation plans.

Effectiveness: This measure would be used in floodplain management reviews and state dam safety permitting, inspection, and maintenance programs. Review of structures would reduce the potential for embankment or outlet failure and resulting impacts from flooding, channel migration, and reduced water quality.

3.2.4.5 Residual Adverse Effects

For surface water resources, potential impacts would be substantially mitigated by successful performance of Sabine's applicant-committed environmental protection measures for runoff and sediment controls, water quality management, overburden/interburden handling, recontouring and reclamation, and restoration or mitigation of surface water features. Successful application of the additional monitoring and

mitigation measures identified in Section 3.2.4.4 for surface water resources would reduce potential impacts to minor levels over the short term. In the long term, residual adverse effects would be reduced to negligible levels after implementing the proposed and additional agency identified watershed management and water quality measures for the project.

3.2.5 Waters of the U.S., including Wetlands

The study area for direct and indirect impacts to waters of the U.S., including wetlands, includes the proposed disturbance area; the projected mine-related 5-foot groundwater drawdown area within the Carrizo-Wilcox aquifer system; and segments of the Sabine River, Cherokee Bayou, Black Slough, and Watt Creek (inclusive of their tributaries), extending downstream from the points of proposed mine water discharge to the SH 43 bridge over the Sabine River (approximately 5 miles). The study area was selected based on the potential for impacts to waters of the U.S. (including wetlands) within the proposed life-of-mine area and potential mine-related impacts on river water quality and quantity (including waters of the U.S. and wetlands) from proposed dragline and haul-road crossing activities. The waters of the U.S., including wetlands, cumulative effects study area includes the proposed project disturbance area; areas of surface disturbance associated with past, present, and reasonably foreseeable future actions (see Section 2.7); the projected mine-related cumulative 5-foot groundwater drawdown area within the Carrizo-Wilcox aquifer system; and segments of the Sabine River and its 100-year floodplain from the vicinity of Easton and extending downstream to the SH 43 bridge over the Sabine River (approximately 5 miles). The downstream extent of the cumulative effects study area was selected based on the potential for cumulative surface water quality or quantity impacts on the Sabine River or its floodplain (including waters of the U.S. and wetlands).

3.2.5.1 Affected Environment

The principal surface water features in the study area are shown in **Figure 3.2-12**. The study area lies within a portion of the Sabine River watershed in Rusk, Panola, and Harrison counties. As discussed in Section 3.2.4, Surface Water Resources, the major surface water feature in the study area is the Sabine River (see **Figure 3.2-12**). The USACE considers the Sabine River and its tributaries, to their ordinary high water marks and adjacent wetlands, waters of the U.S. For USACE regulatory purposes, the Sabine River is considered navigable under Section 10 of the Rivers and Harbors Act of 1899 downstream from its confluence with Big Sandy Creek in Upshur County, Texas (USACE 1999). Major tributaries of the Sabine River within the study area include Cherokee Bayou, Black Slough, and Watt Creek.

The southern approximately 85 percent of the Rusk Permit Area generally is characterized by undulating to steep, erosional uplands that are moderately dissected (on a local basis) by first and second order streams and (on a more regional scale) by the larger streams that originate within or traverse the area enroute to the Sabine River. The northern approximately 15 percent consists of the nearly level Sabine River/Cherokee Bayou floodplain. Approximately two-thirds of the Rusk Permit Area is wooded, with predominantly pine or mixed pine/hardwood plant communities on uplands and predominantly hardwood plant communities on bottomlands. Virtually all wooded portions of the Rusk Permit Area (both wetlands and non-wetlands) have been timbered, and the current condition of most wooded areas is early to mid-successional. Substantial areas within the Sabine River/Cherokee Bayou floodplain have been harvested, primarily by clear-cutting.

Field surveys were conducted from February 2008 through April 2009 to identify waters of the U.S., including wetlands, within the proposed Rusk Permit Area (Janak 2009). Prior to conducting wetland delineations, Sabine and its contractors reviewed NRCS soil survey information, USGS topographic maps, high-resolution aerial photography (dated spring 2007 or earlier), and photogrammetrically generated topographic data at 2-foot contour intervals to identify the general locations of waters of the U.S., including wetlands. Identified waters of the U.S., including wetlands, within the proposed permit boundary subsequently were field verified (Janak 2009). Wetland delineations were conducted according to the methodology described in the USACE 1987 Wetland Delineation Manual (USACE 1987) and Atlantic and

Gulf Coastal Plain Interim Regional Supplement (USACE 2008). Waters of the U.S., including wetlands, are shown in **Figure 3.2-14**.

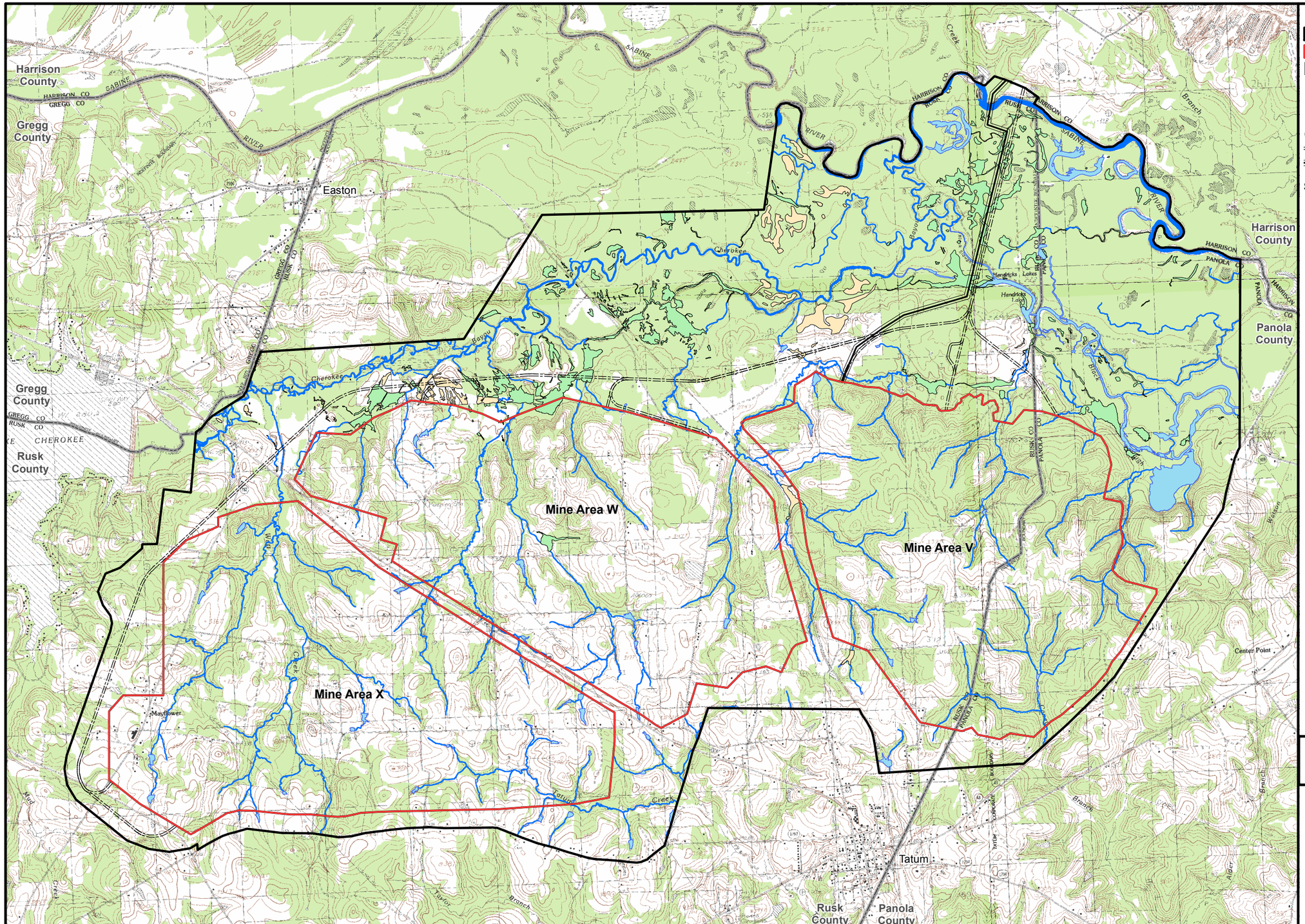
Based on survey results, a preliminary jurisdictional determination was submitted to the USACE on June 16, 2009, as part of Sabine's 404 IP application (HDR 2009). The preliminary jurisdictional determination was amended to meet the USACE Fort Worth District Office's field determination requirements, with the final submitted on January 28, 2010 (HDR 2010a). The preliminary jurisdictional determination was signed by the USACE on February 11, 2010 (see **Appendix D**); it reflects the total acreage for those waters of the U.S. that would be completely or partially impacted by the proposed mine construction and operation.

Based on a desktop data review and subsequent field verification, a total of 927.3 acres of waters of the U.S. were delineated within the Rusk Permit Area boundary (approximately 4.6 percent of the permit area). Of the total acreage, 389.7 acres were classified as forested wetlands, 128.3 acres were classified as non-forested wetlands, 223.8 acres were classified as open water (ponds and oxbow lakes), and 185.5 acres classified as streams (approximately 530,552 linear feet) (HDR 2010a).

Wetlands within the Rusk Permit Area were classified as palustrine forested, palustrine scrub shrub, or palustrine emergent following the Cowardin classification system (Cowardin 1979). The majority (approximately 85 percent) of the observed wetlands were classified as palustrine forested wetlands and were located in sloughs and depressions within the floodplain of the Sabine River, Cherokee Bayou, and their tributaries. A lesser area of forested wetlands was identified on the lower slopes bordering floodplains (Janak 2009). Dominant tree species observed within these wetland areas included bald cypress (*Taxodium distichum*), hazel alder (*Alnus serrulata*), water hickory (*Carya aquatica*), water oak (*Quercus nigra*), overcup oak (*Quercus lyrata*), willow oak (*Quercus phellos*), red maple (*Acer rubrum*), black willow (*Salix nigra*), American elm (*Ulmus americana*), sweetgum (*Liquidambar styraciflua*), and green ash (*Fraxinus pennsylvanica*). Observed sapling and shrub species in the understory included buttonbush (*Cephalanthus occidentalis*), hazel alder, willow oak, hawthorn (*Crataegus* spp.), and black willow. The wetland soils primarily consist of frequently flooded clays and silt loams in floodplains grading to sandy loams in upland portions of the Rusk Permit Area (Janak 2009). Wetland vegetation is discussed in detail in Section 3.4, Vegetation.

Additional waters of the U.S. within the Rusk Permit Area were classified as either open water or streams. The open water classification includes both natural open water areas and man-made open water areas created by impoundment of streams for livestock or recreational use. The natural open water areas include Hendricks Lake and numerous oxbow lakes primarily associated with the Sabine River floodplain. Streams within the Rusk Permit Area include first and second order ephemeral drainages to channels of major waterbodies such as the Sabine River, Black Slough, Cherokee Bayou, and Watt Creek.

Potential waters of the U.S., including wetlands, within the cumulative effects study area were evaluated using USGS topographic maps, color infrared imagery, and FEMA 100-year floodplain maps, where available. Numerous waterbodies exist within the cumulative effects study area north of the Sabine River, including Clarks Creek, Rodgers Creek, Hardin Creek, Hatley Creek, Brandy Branch, and Spring Creek. Existing mining-related impoundments within the cumulative effects study area include those present on Hardin Creek, Brandy Branch, Spring Creek, Hut Horton Duck Pond, Fish Trap Slough, Cypress Slough, Horseshoe Slough, Muddy Slough, those within the Darco Lake watershed, and a number of unnamed streams, ponds, and sloughs. As the majority of the surface water features within the cumulative effects study area are intermittent or perennial, the waterbodies are likely waters of the U.S.



Legend

- Proposed Rusk Permit Area Boundary
- Proposed Mine Areas
- Forested Wetland
- Non-forested Wetland
- Open Water
- Stream
- County Boundary
- Main Haul Roads
- Dragline Walkway

Source: Sabine 2009b, 2010c.

N

0 0.5 1 Miles

Rusk Permit Area EIS

Figure 3.2-14

Waters of the U.S.

07/22/10

3.2.5.2 Environmental Consequences

Proposed Action

Physical Disturbance, Removal, and Replacement of Waters of the U.S. Including Wetlands

Under the Proposed Action, mine construction and operation directly would impact a total of 303.1 acres of waters of the U.S., including 151.2 acres of forested wetlands, 62.6 acres of non-forested wetlands, 22.1 acres of ephemeral streams, 13.5 acres of intermittent streams, 5.4 acres of perennial streams, and 48.3 acres of ponds (HDR 2010a). As reflected in functional assessment of these waters of the U.S., the majority of the non-forested wetlands in the proposed disturbance areas of the Rusk Permit Area have been heavily disturbed, cleared, or cleared and currently used for livestock grazing (HDR 2010g).

The impacts to waters of the U.S., including wetlands, would occur incrementally over the 30-year life of the mine. Waters of the U.S., including wetlands, that would be affected are shown in **Figure 3.2-14**. These impacts would be minimized by limiting surface disturbance in the mine areas to a maximum of 500 acres at one time, through implementation of the proposed reclamation program that would be initiated following backfill of the initial mine pit and would continue concurrent with mine operations, and through implementation of Sabine's proposed Conceptual Mitigation Plan (**Appendix C**) that was developed per the requirements of the USACE's Section 404 permitting process.

Per the proposed Conceptual Mitigation Plan, waters of the U.S. (including wetlands) impacted by mining and mining-related activities would be reconstructed within the reclaimed mine area in their approximate pre-mine locations through the use of creation, restoration, enhancement, or preservation techniques. As discussed in Section 2.5,3,6, Restoration of Waters of the U.S., Including Wetlands, direct impacts to streams and open water areas (ponds) would be mitigated at a replacement ratio of 1:1, non-forested wetlands would be mitigated at a replacement ratio of 1.5:1, and forested wetlands would be mitigated at a replacement ratio of 2:1 (HDR 2010a). Based on these proposed mitigation ratios, the total mitigation acreage for direct impacts would include restoration of approximately 485.6 acres of waters of the U.S., including 41.0 acres of streams, 48.3 acres of ponds, 93.8 acres of non-forested wetlands, and 302.4 acres of forested wetlands within the Rusk Permit Area. In addition to the on site aquatic creation and/or restoration at the proposed ratios, enhancement and preservation of existing on or off site resources would be implemented at higher ratios that would be approved by the USACE on a site-specific basis. Mitigation typically would be in-kind for each resource type, since historical lignite mine reclamation and mitigation efforts in the region generally have been successful. Out-of-kind mitigation could be considered a last resort for replacement of aquatic resources (USACE 2010).

The loss of 213.8 total acres of wetlands over the life of the mine would result in the loss of the functions associated with each area (e.g., runoff and sediment retention), affecting water quality. This loss would be mitigated through creation and restoration of wetlands incrementally during operations and during final closure and reclamation at the replacement ratios identified above. The resulting net increase of 182.5 acres of wetlands following reclamation would provide for additional capture of runoff and increased storm water and sediment retention. Additionally, the removal of jurisdictional streams and ponds would reduce the available flow pathways and retention for runoff water. However, implementation of the proposed storm water management plans, including the construction of sediment control ponds and fresh and storm water ditches, likely would provide comparable or greater storm water management capacities than the affected waters of the U.S. In addition, mitigation of impacted streams and ponds incrementally during operations and during final closure and reclamation at the proposed replacement ratios identified above would restore the flow pathways and retention capacity for runoff water in the affected area.

Water Quantity Impacts

As discussed in Section 3.2.3, Groundwater, based on groundwater modeling results, mining-related groundwater pumping would result in a 5-foot drawdown area that primarily would be limited to the proposed life-of-mine disturbance boundary plus a small perimeter zone on the west, south, and east sides (see **Figure D-1** in **Appendix D**). As discussed in Section 3.2.4, Surface Water, it is anticipated that the projected mining-related groundwater drawdown would have minor impacts to surface water

resources. Therefore, it is anticipated that water quantity impacts to waters of the U.S., including wetlands, as a result of groundwater pumping also would be minor.

Water Quality Impacts

Project construction and operation could result in temporary increases in sedimentation to perennial (Sabine River, Cherokee Bayou), intermittent, and ephemeral water resources in the project area. These impacts likely would be minor and short-term in duration. As discussed in Section 3.2.4, Surface Water, water quality impacts during construction, operation, and post-mining are anticipated to be minor based on the proposed surface water control facilities and installation of BMPs to minimize sediment transport. In addition, implementation of the proposed reclamation program incrementally during operations would minimize erosion and sediment transport from mine-related disturbance areas. These measures would minimize sediment loading of the Sabine River, the receiving stream for proposed mine-related water discharges. Also, restoration and creation of wetlands during reclamation activities likely would improve water quality in the Rusk Permit Area, as more surface area (roots, vegetation) would be available for sediment entrapment. No other impacts to water quality for waters of the U.S. are anticipated.

No Action Alternative

Under the No Action Alternative, the proposed Rusk Permit Area would not be developed. As a result, the associated impacts to waters of the U.S., including wetlands, resulting from the proposed project would not occur. The existing features, flow regimes, and water quality characteristics would remain in their existing condition. Annual and seasonal changes in water level, flow, and water quality characteristics would continue as they have in the past. Currently authorized operations at the South Marshall Permit Area of the South Hallsville No. 1 Mine and existing mine-related effects to waters of the U.S., including wetlands, would continue through approximately 2035.

3.2.5.3 Cumulative Impacts

The past and present actions and RFFAs are identified in Section 2.7 and are shown in **Figure 2-12**. The past and present actions in the waters of the U.S., including wetlands, cumulative effects study area include four existing lignite mines (inclusive of the existing South Hallsville No. 1 Mine), two existing power plants and their associated cooling water reservoirs, and other actions for which USACE Section 404 Permits have been issued. Two RFFAs (the proposed Marshall Lignite Mine and a potential conveyor for the Rusk Permit Area) also occur in the cumulative effects study area; however, specifics relative to proposed disturbance areas in relation to waters of the U.S., including wetlands, is not available at this time. Past and present operations and activities have resulted in 1,910.2 acres of disturbance to waters of the U.S., including wetlands, with a cumulative direct and compensatory mitigation of 3,464.2 acres. The proposed Rusk Permit Area incrementally would increase the cumulative disturbance to waters of the U.S., including wetlands, by 303.1 acres, all of which would be incrementally reclaimed over the life of the mine. Based on Sabine's proposed direct and compensatory mitigation as shown in **Table 2-10**, 485.6 acres of waters of the U.S., including wetlands, would be reclaimed. Therefore, the total cumulative disturbance and reclamation acreages for waters of the U.S., including wetlands, within the cumulative effects study area would be 2,213.3 and 3,949.8 acres, respectively. This would result in a net cumulative gain of 1,736.5 acres of waters of the U.S., including wetlands, within the cumulative effects study area.

3.2.5.4 Monitoring and Mitigation Measures

Sabine's proposed Conceptual Mitigation Plan (**Appendix C**) currently is under review by the USACE. Included in the plan are proposed mitigation ratios for impact compensation and guidelines for implementation of mitigation and assessment of created habitat health. Additional monitoring and mitigation measures may be considered for waters of the U.S., including wetlands, pending the outcome of this review.

3.2.5.5 Residual Adverse Effects

Residual adverse effects to waters of the U.S., including wetlands, have not been identified. Losses to waters of the U.S., including wetlands, during mine construction and operation would be mitigated through implementation of the proposed Conceptual Mitigation Plan for the 404 IP.