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2.3 Water

This section describes the hydrology, water use, and water quality characteristics of the VCS site and surrounding region that could affect or be affected by the construction and operation of nuclear power reactor units. The potential water-related impacts of construction and operations are described in Sections 4.2 and 5.2, respectively.

VCS is located in Victoria County, Texas, near the west bank of the Guadalupe River, at river mile 29.6; approximately 13 miles south of the city of Victoria, Texas; approximately 8 miles west of Bloomington, Texas; and east of U.S. Highway 77 (see Figure 2.3.1-1). The existing ground elevation at the power block site is approximately 80 feet NAVD 88. A cooling basin with approximately 4900 acres of nominal surface area will be constructed south of the power block to function as the normal power heat sink for VCS. The existing ground surface elevations in the area of the cooling basin range from approximately 80 feet NAVD 88 in the northwest corner to approximately 65 feet NAVD 88 along the southern edge.

The minimum finished site grade elevation for the power block area is elevation 95 feet NAVD 88. The top of the cooling basin embankment dam will be at 102.0 feet NAVD 88, with exceptions at the piping penetration areas. These areas have elevated bridges over the piping to allow an uninterrupted roadway on the embankment. The bottom elevation of the cooling basin is designed to be at 69 feet NAVD 88 or lower, hence grading will be necessary primarily in the northern part of the cooling basin where the natural grade is higher than 69 feet NAVD 88. Detailed descriptions of the cooling water systems of VCS and the cooling basin are provided in Section 3.4.

New transmission lines would be constructed to connect VCS with the existing regional electric grid. The final routes of the new transmission corridors have not been selected, but the probable route characteristics have been determined using a macro-corridor study that outlines options for transmission line routes, as described in Subsection 2.2.2. The general hydrological environment of the representative transmission corridors, and potential hydrologic impacts of the transmission lines during construction and operation are described in Sections 4.2 and 5.2, respectively.

2.3.1 Hydrology

This subsection describes the surface water bodies and groundwater aquifers that could affect the plant water supply and effluent disposal or that could be affected by the construction and operation of VCS. The site-specific and regional data on the physical, hydrologic, and hydrogeologic characteristics of these water resources are summarized in the following subsections.

2.3.1.1 Surface Water

The VCS site is located within the Lower Guadalupe River basin. The main hydrologic features near the site include the Guadalupe and San Antonio Rivers, Linn Lake, San Antonio Bay, Kuy Creek, Dry Kuy Creek, the Victoria Barge Canal, and the Guadalupe Blanco River Authority (GBRA) Calhoun County Canal System. Each of these features is described in detail in this subsection.

2.3.1.1.1 The Guadalupe and San Antonio River Basin

The Guadalupe River basin extends from Kerr County in the south central portion of Texas to its mouth in the San Antonio Bay at the Gulf of Mexico. The drainage area for the Guadalupe River basin is 5953 square miles (TWDB 2007). Even though the San Antonio River discharges to the Guadalupe River just upstream from its mouth, the Texas Water Development Board (TWDB 2007) considers the San Antonio River as a separate river basin, and the Guadalupe River basin drainage area listed above does not include the San Antonio River basin drainage area. The San Antonio River basin extends from north of San Antonio, Texas, to its confluence with the Guadalupe River upstream from Tivoli, Texas. The drainage area for the San Antonio River basin is 4180 square miles (TWDB 2007). The San Antonio River basin is adjacent to the Guadalupe River basin and runs in a general northwest to southeast direction as shown in Figure 2.3.1-2. The total drainage area for the combined river basins at the stream gage at Tivoli, Texas, is 10,128 square miles (USGS 2008). Major tributaries to the Guadalupe River include Coleto Creek, Peach Creek, Sandies Creek, and the San Marcos River and its tributaries, the Blanco River, and Plum Creek. The Medina River and Cibolo Creek are principal tributaries of the San Antonio River. All of these rivers and tributaries contribute to the water supply for the raw water makeup (RWMU) system for the VCS cooling basin.

The Guadalupe and San Antonio River basins are located in a climate region classified as humid subtropical. Summers are hot and humid, while winters are often mild and dry. Most of the precipitation from May through September is from occasional thunderstorms, which contribute much of the annual precipitation. The cool season, November through March, is typically the driest season of the year. Mean annual precipitation is 32 inches for the Guadalupe River basin (HDR 2006). There is a general trend of decreasing precipitation from the eastern portions of the basins to the western portions (HDR 2006 and TWDB 2007).

Stream flow gaging data collected in both basins since the 1930s indicate that there have been major droughts in almost every decade since gaging began. During the 30-year time period from 1941 to 1970, there were three major statewide droughts, from 1947 to 1948, from 1950 to 1957, and from 1960 to 1967. The most severe of these droughts occurred from 1950 to 1957. Recent less severe droughts in the south central Texas region have also occurred from 1983 to 1984, 1987 to 1990, and in 1996, 1999, and 2006 (TWDB 2007). The most recent regional drought occurred from 2007 to

2009 (GBRA 2009). Water use information in both river basins is described in Subsection 2.3.2 and the impacts of VCS on the water users in the region are described in Section 5.2.

Flooding is also a frequent event in both basins. Annual peak discharges for the Guadalupe River at Victoria and the San Antonio River at Goliad are shown in Tables 2.3.1-1 and 2.3.1-2, respectively. The largest flood on record on the Guadalupe River at Victoria gaging station (drainage area of 5198 square miles) had a peak flow rate of 466,000 cubic feet per second (cfs) and occurred on October 20, 1998. As shown in Table 2.3.1-1, there are 4 years with flood peak discharges above 100,000 cfs and 16 years with flood peak discharges above 50,000 cfs (for the period of record water years 1935–2007). The annual mean flow rate at the Victoria gaging station is 1978 cfs (USGS 2008A). The largest flood on record on the San Antonio River at Goliad (drainage area 3921 square miles) had a peak flow rate of 138,000 cfs and occurred on September 23, 1967. As shown in Table 2.3.1-2, there are 3 years with flood peak discharges above 50,000 cfs and 12 years with flood peak discharges above 25,000 cfs for the period of record (water years 1914, 1925–1929, 1935, and 1939–2007). The annual mean flow rate of the San Antonio River at Goliad is 781 cfs (USGS 2008B).

The 1998 storm in the Guadalupe and San Antonio River basins was one of the largest storms on record for the area. Severe flooding in parts of south central Texas resulted from this storm. Record rainfall amounts were recorded at several locations, with at least 30 inches recorded at Marcos, Texas. Peak discharges were greater than the 100-year flood at many locations along both the San Antonio and Guadalupe Rivers, and the flood of record at Victoria was recorded during this storm.

Coleto Creek is a tributary of the Guadalupe River, with its confluence located downstream of Victoria, Texas and upstream of the VCS site. Annual peak discharges at the USGS gaging station on Coleto Creek near Victoria, Texas, a short distance downstream of the Coleto Creek Dam, are shown in Table 2.3.1-3. Flows after 1981 on Coleto Creek are regulated by Coleto Creek Dam and reservoir. The reservoir is primarily used as a cooling pond for the Coleto Creek Power coal-fired power plant and water releases are based on both inflows to the reservoir and plant water needs. After the reservoir was built, the stream gage data at the Coleto Creek gage near Victoria, Texas, showed several instances of minimum daily flow that were near zero (USGS 2008C). The largest flood on record for Coleto Creek downstream of Coleto Creek Dam (drainage area 514 square miles) had a peak flow rate of 236,000 cfs in 1967. As shown in Table 2.3.1-3, there are 3 years with flood peak discharges above 50,000 cfs and 13 years with flood peak discharges above 25,000 cfs for the period of record (water years 1939–1954 and 1979–2007). The annual mean flow rate at Coleto Creek Dam is 117 cfs. (USGS 2008C). The flood of record at Coleto Creek occurred outside the period of record. However, high water marks measured during the 1967 flood were used with the gage information to estimate the peak flow during this flood (USGS 2008C).

There are 29 storage reservoirs in the Guadalupe River basin and 34 storage reservoirs in the San Antonio River basin with storage capacities of at least 3000 acre-feet. Tables 2.3.1-4 and 2.3.1-5 (TCEQ 2008) provide detailed information on the dams associated with each of these storage reservoirs. The locations of the storage reservoirs are shown in Figure 2.3.1-3 for the Guadalupe River basin and Figure 2.3.1-4 for the San Antonio River basin. Although both basins have many additional storage reservoirs with volumes less than 3000 acre-feet, their impact on the river flows and basin hydrology is negligible due to their small storage capacities, thus they are not reported. The storage reservoirs in both basins provide flood control as well as water storage for municipal and industrial purposes. As can be seen in Tables 2.3.1-4 and 2.3.1-5, most of the storage capacity is provided in Canyon Lake Dam and Medina Lake Dam, which are located in the upper portions of the Guadalupe and San Antonio River basins, respectively. The storage capacities of the dams in the lower reaches of both river basins are relatively small and provide either localized flood protection or local water storage.

The Guadalupe River gradient near the VCS site is relatively steep with a well defined, but wide floodplain. The average river bed slope near the site is approximately 0.00026 feet/foot for the reach between the southern limit of the city of Victoria near the U.S. Highway 59 crossing to the Union Pacific Railroad crossing near the southern boundary of the site. This portion of the river is located on the San Marcos uplift, which is the reason for the steeper gradient (White and Calnan 1990). The stream channel is fairly shallow and flows can frequently extend into the floodplain area, which is wide and flat with many wetland and marsh areas adjacent to the river. The 100-year floodplain as defined by the FEMA for the Guadalupe River as well as its tributaries near the site is presented in Figure 2.3.1-5 (FEMA 1998). The average width of the 100-year Guadalupe River floodplain near the site is approximately 3.2 miles. Although, the floodplain is wide at this location, ground elevations rise steeply from elevation 25 feet NAVD 88 at the edge of the floodplain to elevation 70 to 75 feet NAVD 88 along the eastern edge of the site.

Just downstream of the site, the Guadalupe River crosses over the Vicksburg Fault zone, which passes south of the site. After passing this geologic feature the river gradient becomes shallower and the floodplain wider. At the confluence with the San Antonio River upstream of the USGS gage near Tivoli, Texas, the river bed slope is essentially flat. Near Mission Lake, the floodplain is approximately 4.5miles wide. Also, the Lower Guadalupe Diversion Dam and Saltwater Barrier, commonly referred to as the saltwater barrier, is located at river mile 10.2 near Tivoli, Texas. The purpose of the saltwater barrier is to prevent saltwater intrusion into the freshwater supply and maintain an adequate water level in the river to allow diversion into a GBRA water supply canal, which is described in Subsection 2.3.1.1.7. The saltwater barrier, a fabridam, is designed to maintain upstream water levels at an elevation range between approximately 3.5 feet to 4.0 feet NGVD 29 (GBRA 1994), which is equivalent to elevations 3.06 feet to 3.56 feet NAVD 88 (USNGS 2008). When upstream water levels lower to approximately elevation 3.0 feet NAVD 88, fabric bags are inflated to raise the water level upstream, which also prevents intrusion of saline water further upstream. If the upstream water level rises above approximately elevation 3.6 feet NAVD 88, the bags are deflated to reduce the upstream water level. The elevations at which the fabric bags are inflated and deflated are not fixed and are adjusted depending on river flow conditions (GBRA 1994).

The Victoria Barge Canal is also located in the Guadalupe River floodplain east of the river and runs essentially parallel to the river meander axis. This 35-mile canal connects the Port of Victoria to the Gulf Intracoastal Waterway and provides shipping access to several industrial facilities in the lower Guadalupe River basin from San Antonio Bay to the Port of Victoria turning basin. Although the canal is located in the Guadalupe River floodplain, it is not part of the drainage area for the Guadalupe River. A flood protection levee also runs parallel to the canal and is located between the canal and the river preventing overflows from the Guadalupe River into the Victoria Barge Canal during river flooding events and overflow from the canal to the river during tidal flooding events. Additional short levees also exist in the Guadalupe River floodplain along the west bank of the river, between the river and the site. However, the FEMA Flood Insurance Rate Map (Figure 2.3.1-5) indicates that these levees do not provide protection for the 100-year flood (FEMA 1998).

Information on five USGS-maintained stream flow gage stations on the Guadalupe and San Antonio Rivers near the VCS site are shown in Table 2.3.1-6. The information presented includes the location, drainage area, period of record, and the mean, minimum, and maximum average annual flow for the period of record. The gages cover the major streams near the site, with the exception of Kuy Creek, a tributary to the Guadalupe River that passes south of the site with a drainage area of approximately 62 square miles. More information on Kuy Creek is presented in Subsection 2.3.1.1.3. The locations of these gages as well as other selected gages in the two river basins are shown in Figure 2.3.1-6. A stream gage on the Guadalupe River also exists at Bloomington, Texas, and its location is shown in Figure 2.3.1-6. However, this gage only records water level data and has a sporadic period of record. Thus, this gage was not included in Table 2.3.1-6. The stream gage at Tivoli does not provide accurate stream flow information for high flow data due to the flatness and width of the floodplain at that location, and only sporadic data is available. Additionally, the drainage area at Victoria (5198 square miles) plus the drainage area for Coleto Creek (514 square miles) represent approximately 96 percent of the Guadalupe River watershed. Thus, for the purposes of assessing water availability from the Guadalupe River for VCS, flow data from the gage at Victoria and the gage at Coleto Creek are used.

The raw water makeup (RWMU) system intake for VCS will be located downstream of the confluence of the San Antonio and Guadalupe Rivers, as described in Subsection 2.3.1.1.7, where flows from the San Antonio River are also available for plant use. The RWMU system is described in Sections 3.1and 3.4. The downstream most gaging station on the San Antonio River is located at McFaddin. However, this gage has less than 2 years of data, which is not sufficient to provide a long-term analysis of water supply. The gaging station at Goliad, with a drainage area of 3921 square miles, represents approximately 94 percent of the San Antonio River watershed and is used in combination with the flow data at Victoria and Coleto Creek to assess the flow available for use by the plant.

In order to facilitate the evaluation of water supply characteristics at the VCS site, flow statistics are presented for the Victoria, Goliad, and Coleto Creek gaging stations. The flows at these three stations can be used to establish a reasonable estimate of the flow available in the river near the VCS intake area. Daily and monthly discharge data are available for a period of record from water years 1925 to 1928 and 1939 to 2007 for Goliad on the San Antonio River, from water years 1935 to 2007 for Victoria on the Guadalupe River, and from water years 1981 to 2007 for Coleto Creek. Tables 2.3.1-7, 2.3.1-8, and 2.3.1-9 provide the monthly mean flow rates for each station's period of record. The mean daily flow rates for each station are presented in Tables 2.3.1-10, 2.3.1-11 and 2.3.1-12. The maximum daily-mean flow rates are presented in Tables 2.3.1-13, 2.3.1-14 and 2.3.1-15, while the minimum daily mean flow rates are presented in Tables 2.3.1-16, 2.3.1-17 and 2.3.1-18 (USGS 2008A, USGS 2008B, and USGS 2008C).

Monthly flow data from the Victoria and Goliad stream gages during the three major statewide droughts before September 2007 (1947 to 1948, 1950 to 1957, and 1960 to 1967) are highlighted in Tables 2.3.1-7 and 2.3.1-8 (USGS 2008A and USGS 2008B). Data is not available at Coleto Creek during these drought periods. Because the RWMU system intake is located downstream of the confluence of the San Antonio River, low flow data from the Victoria stream gage on the Guadalupe River and the Goliad stream gage on the San Antonio River are combined to estimate water availability during periods of drought. The minimum combined Victoria and Goliad stream gages 7-day low flow for the period of record is approximately 46 cfs, occurring in August of 1956. Using the combined Victoria and Goliad daily flow data, a frequency analysis was performed using a Log-Pearson Type 3 distribution. The results of this analysis indicate that the 10-year, 7-day low flow (7Q10) on the Guadalupe River downstream of the confluence with the San Antonio River would be approximately 222 cfs.

Blowdown from the cooling basin to the Guadalupe River will be performed as needed to maintain water chemistry control in the cooling basin. The blowdown discharge system will consist of a single 48-inch diameter pipe with multiple diffuser ports at the outfall in the Guadalupe River at the location shown in Figure 2.3.1-7. A bathymetric survey on the Guadalupe River at the proposed discharge location was conducted near the end of March 2009. Three river cross sections at and near the discharge location that depict the river bathymetry are shown in Figures 2.3.1-8 through 2.3.1-10, with the location depicted in Figure 2.3.1-8 being 200 feet upstream of the discharge location, the location in Figure 2.3.1-9 being near the proposed discharge location, and the location in Figure 2.3.1-10 being 500 feet downstream of the discharge location. The cross sections indicate a fairly uniform width and depth for the river channel, with a top width of approximately 80 feet and a depth of approximately 5 feet on the day of the survey. The 7Q10 for the Guadalupe River at the Victoria gage, which is upstream of the proposed discharge location, is estimated to be 110 cfs.

The *Flood Insurance Study for the Unincorporated Areas of Victoria County, Texas* reports the peak discharges for various flood frequencies on the Guadalupe River on the confluence of Coleto Creek just downstream of Victoria, Texas (FEMA 1998). These values are presented in Table 2.3.1-19.

2.3.1.1.2 Linn Lake

Linn Lake is a perennial natural shallow retention area located on the western edge of the Guadalupe River floodplain at the base of the slopes leading to the floodplain along the eastern edge of the proposed VCS cooling basin, as shown in Figure 2.3.1-1. Originally, it was an oxbow bend on the Guadalupe River but has been cut off from the main river channel over time. The lake has an estimated surface area of approximately 470 acres and is principally fed by the Guadalupe River and surface runoff from floodplain areas north of the lake. The lake is at approximately the same elevation as the river and receives overflows even during normal river flows. The lake also receives surface runoff from the eastern portion of the proposed VCS site through small surface tributaries along the western edge of the lake. In addition to receiving flow from the Guadalupe River, flow from the lake also returns to the river, depending on water levels in the lake and river.

2.3.1.1.3 San Antonio Bay System

The Guadalupe River discharges to the San Antonio Bay system approximately 8 miles, or 10 river miles, downstream of the confluence of the San Antonio River. The bay system consists of several smaller bays linked together to form one large bay. These smaller bays include Espiritu Santo, San Antonio Guadalupe, Hynes, Ayres, and Mesquite bays, and Mission Lake. The total surface area of the bay system is approximately 136,240 acres at mean low water and 141,200 acres at mean high water. The average depth of the bays, excluding the shipping channels at mean low water, ranges from 2.4 to 5.9 feet with an average tidal range of 0.2 to 0.3 feet. Salinity concentrations in the upper bay system range from approximately 0.5 to 9.0 parts per thousand (ppt) and in the lower bay from approximately 6.0 to 26.0 ppt (White and Calnan 1990).

The Guadalupe River delta in the upper portions of the bay system is characterized by extensive brackish to fresh-water marshes. The delta has had a history of delta lobe growth, abandonment, and deterioration. Sedimentation in the delta is characterized by stream deposition in a shallow, relatively quiescent body of water. Average annual sediment loads from the Guadalupe and San Antonio Rivers have remained relatively unchanged since the 1940s when measurements began. The average annual suspended sediment load to the bay system has been estimated to be approximately 647 acre-feet (White and Calnan 1990).

2.3.1.1.4 Local Hydrologic Features

There are several intermittent or ephemeral streams traversing the existing site. The locations of these streams are shown in Figure 2.3.1-11. Kuy Creek, which passes by the southwest corner of the site and discharges to the Guadalupe River, has a drainage area of approximately 62 square miles. Dry Kuy Creek, which passes by the northwest corner of the site, flows southeast and discharges to Kuy Creek south of the site. There are a few other unnamed short intermittent and ephemeral streams on the site. Most are tributaries to Dry Kuy Creek; the others flow to Linn Lake or Kuy Creek. All of these streams are hydrologically connected by surface flow to the Guadalupe River.

The external design basis flood, (i.e., excluding the local probable maximum precipitation [PMP] event), for the safety-related structures of VCS is a result of the flooding due to a postulated breaching of the embankment of the proposed VCS cooling basin. The external design basis flood elevation as a result of the postulated embankment breach is 91.0 feet NAVD 88.

2.3.1.1.5 Wetlands

A wetland survey conducted for the VCS site between March and April 2009, indicated that before construction, 62 areas, totaling 1843.42 acres, meet the criteria for designation as wetland in accordance with the Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (USACE 2008). The designated wetland areas are shown in Figure 2.3.1-11. Wetland Wb13/14 has a surface area of 245.42 acres and represents the largest wetland outside of the Wp1 wetland complex (769.75 acres) associated with Linn Lake. Other sizeable wetlands include Wa6 (38.51 acres), Wa7(10.64 acres), Wa8 (18.95 acres), Wa9 (10.92 acres), Wa16 (41.88 acres), Wa17 (10.68 acres), Wa44 (11.63 acres), Wb1 (207.16 acres), Wb5 (25.68 acres), Wb7 (12.97 acres), Wb12 (50.01 acres), Wb15 (222.21 acres), and Wb16 (88.92 acres). The remaining delineated wetlands each occupy less than 10 acres.

Of the 62 wetlands, 42 were determined to be isolated wetlands with no noticeable surface water connection. The extent to which the surveyed wetlands fall within federal jurisdiction will be determined during completion of the permitting activities discussed in Section 1.2, at the COL stage. Two major classes of wetland systems occur on the VCS site; palustrine (freshwater), and lacustrine. A primarily lacustrine wetland (Wp1), with a palustrine forested component, associated with Linn Lake accounts for 769.75 acres (41.8 percent) of the total designated wetlands, and palustrine unconsolidated bottom and palustrine unconsolidated shore wetland systems account for 4.01 acres (0.2 percent) of total designated wetlands. The remaining 1069.66 acres (58.0 percent) of the designated wetlands are palustrine emergent wetland systems.

2.3.1.1.6 Guadalupe and San Antonio River Sediment Transport and Loading

Sediment data has been collected on the Guadalupe and San Antonio Rivers at the Victoria and Goliad gaging stations, respectively. These are the closest upstream stations from the intake location and are used to characterize the suspended sediment concentration for river water available for the VCS RWMU system intake.

The Victoria gaging station has data collected from 1973 through August 1994, with 158 total samples taken. Table 2.3.1-20 presents the suspended sediment concentration measurements for the Guadalupe River at Victoria. The average suspended sediment concentration for the data collected is 128 mg/l. However, this value is heavily influenced by a few high concentration measurements, as evidenced by the median value of 74.5 mg/l for the period of record. The maximum and minimum concentrations during the period of record were 1210 mg/l and 9 mg/l, respectively. (USGS 2008D)

The Goliad station has a period of record from October 1974 through August 1994 with 163 total samples taken. Table 2.3.1-21 presents the suspended sediment concentration measurements for the San Antonio River at Goliad. In general, the suspended sediment concentrations in the San Antonio River are higher than those of the Guadalupe River. The average suspended sediment concentration for the data collected is 260 mg/l. This value is also heavily influenced by a few high concentration measurements, as evidenced by the median value of 122 mg/l for the period of record. The maximum and minimum concentrations during the period of record were 2450 mg/l and 5 mg/l, respectively. (USGS 2008E)

The average annual suspended sediment load from the Guadalupe and San Antonio Rivers combined to the San Antonio Bay systems has been estimated to be approximately 647 acre-feet per year (White and Calnan 1990).

2.3.1.1.7 GBRA Calhoun Canal System

The entrance to the GBRA Calhoun Canal system is located on the Guadalupe River just upstream of the Lower Guadalupe Diversion Dam and Saltwater Barrier as shown in Figure 2.3.1-12. The system diverts water from the Guadalupe River downstream of the confluence of the San Antonio River. The system consists of man-made and natural canals along with siphons and pumping stations to supply fresh water to various GBRA customers. The GBRA Calhoun Canal is evaluated as an alternate raw water makeup system intake location in Section 9.4.

2.3.1.1.8 RWMU System

The water source for the RWMU system is the Guadalupe River, as shown in Figure 2.3.1-12. The RWMU intake structure and pumphouse will be located on ground that is located above the

Guadalupe River floodplain 0.6 mile south of the river, approximately 11.8 miles southeast of the VCS power block. Water would be withdrawn from the Guadalupe River and conveyed to the pumphouse via a 3150-foot-long intake canal. The entrance to the intake canal would also be located upstream of the Lower Guadalupe Diversion Dam and Saltwater Barrier, across the river from the diversion of the GBRA Calhoun Canal system, as shown in Figure 2.3.1-12. A cross section of the Guadalupe River at the intake canal location is shown in Figure 2.3.1-13. Makeup water demands are described in Section 3.3 and the RWMU system intake and pumphouse are described in Section 3.4.

2.3.1.1.9 References

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Table 2.3.1-1
Annual Peak Discharges for the Guadalupe River at Victoria, Texas USGS 08176500

Water Year	Date	Gage Height (feet)	Stream-flow (cfs)	Water Year	Date	Gage Height (feet)	Stream-flow (cfs)
1935	Jun. 20, 1935	29.72	38,500	1971	Sep. 12, 1971	22.48	9,740
1936	Jul. 03, 1936	31.22	179,000	1972	May 16, 1972	30.37	58,500
1937	Oct. 04, 1936	26.77	17,200	1973	Jun. 17, 1973	29.33	33,100
1938	Apr. 30, 1938	28.75	25,400	1974	Oct. 16, 1973	28.98	25,200
1939	Jun. 06, 1939	14.52	4,940	1975	May 29, 1975	29.24	30,200
1940	Jul. 03, 1940	29.67	55,900	1976	Apr. 19, 1976	26.54	14,100
1941	May 03, 1941	29.73	58,000	1977	Apr. 24, 1977	30.09	54,500
1942	Jul. 09, 1942	29.8	56,000	1978	Sep. 14, 1978	25.64	12,700
1943	Oct. 21, 1942	18.8	7,710	1979	May 12, 1979	28.36	19,300
1944	Jun. 01, 1944	23.94	12,300	1980	May 19, 1980	24.68	11,600
1945	Apr. 06, 1945	28.57	22,000	1981	Sep. 02, 1981	31.1	105,000
1946	Sep. 03, 1946	27.7	17,900	1982	May 19, 1982	28.2	18,500
1947	Oct. 17, 1946	29.55	46,000	1983	Nov. 20, 1982	23.95	10,900
1948	May 28, 1948	17.5	6,970	1984	Oct. 21, 1983	11.7	3,280
1949	Apr. 30, 1949	28.53	20,600	1985	Apr. 21, 1985	23.85	10,600
1950	Oct. 28, 1949	24.95	13,300	1986	Nov. 29, 1985	26.29	13,700
1951	Jun. 08, 1951	23.96	12,300	1987	Jun. 07, 1987	30.45	83,400
1952	Sep. 16, 1952	29.46	28,400	1988	Nov. 28, 1987	13.24	3,900
1953	May 04, 1951	23.19	11,600	1989	May 21, 1989	13.89	4,280
1954	Oct. 26, 1953	19.68	8,560	1990	Sep. 12, 1990	15.61	5,230
1955	May 22, 1955	14.83	4,950	1991	Apr. 05, 1991	27.83	17,000
1956	May 18, 1956	7.46	1,730	1992	Dec. 25, 1991	30.13	61,500
1957	May 02, 1957	29.92	35,300	1993	Jun. 30, 1993	27.87	17,700
1958	Feb. 26, 1958	30.28	58,300	1994	May 19, 1994	26.04	13,300
1959	Apr. 15, 1959	22.33	10,100	1995	Oct. 19, 1994	29.37	39,600
1960	Jul. 01, 1960	29.06	23,700	1996	Sep. 22, 1996	22.71	9,760
1961	Jun. 22, 1961	30.35	55,800	1997	Apr. 04, 1997	29.07	32,700
1962	Nov. 17, 1961	23.11	10,800	1998	Oct. 13, 1997	28.3	20,600
1963	Feb. 21, 1963	13.22	4,100	1999	Oct. 20, 1998	34.04	466,000
1964	Nov. 11, 1963	16.19	5,720	2000	Jun. 12, 2000	17.54	6,220
1965	Feb. 21, 1965	27.3	15,000	2001	Sep. 03, 2001	29.36	39,300
1966	Dec. 08, 1965	21.99	9,790	2002	Jul. 10, 2002	30.32	71,700
1967	Sep. 21, 1967	30.67	70,000	2003	Nov. 08, 2002	29.99	58,500
1968	Jan. 25, 1968	29.72	44,300	2004	Jun. 15, 2004	27.48	16,100
1969	Apr. 13, 1969	27.13	15,200	2005	Nov. 26, 2004	30.9	102,000
1970	May 20, 1969	21.7	9,190	2006	Jul. 06, 2006	13.73	4,290
				2007	Jul. 03, 2007	29.33	38,600

Note: Flows for 1962 and later affected by regulation or diversion
Source: USGS 2008A

Table 2.3.1-2
Annual Peak Discharges for the San Antonio River at Goliad, Texas USGS 08188500

Water Year	Date	Gage Height (feet)	Stream-flow (cfs)	Water Year	Date	Gage Height (feet)	Stream-flow (cfs)
1914	Oct. 02, 1913	44.9	33,800	1970	Jun. 02, 1970	25.28	6,100
1925	Jul. 13, 1925	11.9	1,830	1971	Aug. 09, 1971	22.01	4,970
1926	Apr. 25, 1926	31	11,900	1972	May 15, 1972	34.16	12,800
1927	Apr. 16, 1927	22.5	5,410	1973	Jul. 24, 1973	34.53	14,900
1928	May 16, 1928	19	3,880	1974	Oct. 02, 1973	40.09	21,800
1929	Jan. 11, 1929	31.79	13,100	1975	May 28, 1975	27.48	8,660
1935	Jun. 15, 1935	44.9	33,800	1976	Apr. 18, 1976	29	9,780
1939	Jul. 12, 1939	11.22	1,900	1977	Apr. 25, 1977	36.07	15,900
1940	Jul. 02, 1940	31.37	11,600	1978	Nov. 05, 1977	23.99	6,770
1941	May 01, 1941	34.55	15,700	1979	Apr. 23, 1979	28.34	9,310
1942	Jul. 09, 1942	44.9	33,800	1980	Sep. 09, 1980	25.68	8,240
1943	Oct. 08, 1942	25.51	7,330	1981	Jun. 21, 1981	31.96	12,800
1944	May 30, 1944	29.01	9,880	1982	Oct. 31, 1981	24.49	7,460
1945	Apr. 03, 1945	21.84	5,170	1983	Sep. 21, 1983	23.43	6,960
1946	Sep. 01, 1946	41.66	25,500	1984	Nov. 08, 1983	14.94	3,120
1947	Oct. 02, 1946	42.67	29,400	1985	Jul. 07, 1985	21.44	5,990
1948	Aug. 28, 1948	29.41	10,200	1986	Jun. 10, 1986	29.45	10,700
1949	Apr. 28, 1949	33.76	14,100	1987	Jun. 07, 1987	43.08	33,200
1950	Oct. 27, 1949	24.04	6,420	1988	Jul. 24, 1988	11.08	1,850
1951	Sep. 14, 1951	26.9	8,370	1989	Jun. 17, 1989	11.3	1,920
1952	Sep. 14, 1952	39.82	23,900	1990	Jul. 21, 1990	27.66	9,480
1953	May 20, 1953	28.76	8,560	1991	Apr. 06, 1991	25.92	8,330
1954	May 27, 1954	12.77	2,050	1992	Dec. 25, 1991	41.58	27,500
1955	Sep. 02, 1955	13.83	2,320	1993	Jun. 30, 1993	35.37	16,200
1956	May 16, 1956	14.33	2,420	1994	May 18, 1994	28.71	10,200
1957	May 02, 1957	31.56	10,300	1995	Oct. 18, 1994	28.5	10,100
1958	Feb. 25, 1958	36.21	16,000	1996	Sep. 26, 1996	13.09	2,460
1959	Nov. 01, 1958	22.82	5,220	1997	Jun. 28, 1997	31.78	12,600
1960	Jun. 29, 1960	23.28	5,440	1998	Mar. 19, 1998	18.78	4,610
1961	Oct. 29, 1960	31.62	11,300	1999	Oct. 22, 1998	51.78	59,200
1962	Jun. 03, 1962	23.16	5,660	2000	Jun. 14, 2000	16.82	4,070
1963	Apr. 30, 1963	10.36	1,680	2001	Sep. 02, 2001	41.97	27,200
1964	Aug. 10, 1964	20.03	4,360	2002	Jul. 09, 2002	52.81	70,600
1965	May 24, 1965	30.79	10,600	2003	Oct. 28, 2002	36.13	18,000
1966	Dec. 06, 1965	18.52	3,880	2004	Jun. 14, 2004	31.43	13,000
1967	Sep. 23, 1967	53.7	138,000	2005	Nov. 27, 2004	40.42	23,400
1968	Jan. 24, 1968	41.98	25,900	2006	May 08, 2006	12.04	2,280
1969	Feb. 17, 1969	24.93	6,380	2007	Aug. 23, 2007	38.52	20,800

Note: All discharges affected by regulation or diversion
Source: USGS 2008B

Table 2.3.1-3
Annual Peak Discharges for the Coleto Creek near Victoria, Texas USGS 08177500

Water Year	Date	Gage Height (feet)	Stream-flow (cfs)	Water Year	Date	Gage Height (feet)	Stream-flow (cfs)
1939	Jul. 12, 1939	11.4	8,820	1985	Jul. 04, 1985	16.35	9,590
1940	Jun. 30, 1940	22.05	39,200	1986	Jun. 13, 1986	8.17	1,090
1941	Nov. 25, 1940	24.25	48,200	1987	Jun. 11, 1987	19.15	15,100
1942	Jul. 06, 1942	20.75	34,300	1988	Nov. 25, 1987	5.32	231
1943	May 31, 1943	6.76	2,530	1989	Apr. 30, 1989	4.23	37
1944	Mar. 18, 1944	13.08	12,200	1990	Jul. 17, 1990	20.86	19,200
1945	Apr. 20, 1945	7.09	2,700	1991	Apr. 05, 1991	28	37,000
1946	May 23, 1946	12.02	10,000	1992	Apr. 17, 1992	27.68	41,700
1947	Oct. 16, 1946	31.64	89,000	1993	May 05, 1993	23.27	25,900
1948	May 24, 1948	8.78	4,260	1994	May 14, 1994	14	6,020
1949	Apr. 26, 1949	6.89	2,700	1995	Oct. 18, 1994	28.41	44,700
1950	Oct. 26, 1949	6.43	2,290	1996	Aug. 30, 1996	4.95	23
1951	Sep. 13, 1951	11.6	9,440	1997	Apr. 04, 1997	32.05	50,100
1952	May 28, 1952	15.18	17,300	1998	Oct. 13, 1997	26.03	28,500
1953	Aug. 30, 1953	13.73	14,400	1999	Oct. 18, 1998	23.25	22,400
1954	May 25, 1954	3.33	731	2000	Jun. 12, 2000	6.75	504
1967	1967[a]	42	236,000	2001	Sep. 01, 2001	22.39	20,200
1979	May 11, 1979	N/A	15,500	2002	Dec. 02, 2001	17.97	11,500
1980	Jan. 20, 1980	15.72	8,550	2003	Oct. 25, 2002	19.97	15,800
1981	Sep. 01, 1981	19.73	16,500	2004	May 14, 2004	18.52	13,200
1982	Oct. 31, 1981	27.02	39,100	2005	Nov. 21, 2004	28.93	41,700
1983	Nov. 19, 1982	19.5	15,900	2006	Jun. 01, 2006	4.94	117
1984	Mar. 12, 1984	18.82	14,400	2007	Jul. 02, 2007	21.67	19,300

(a) Data not based on specific date. High water marks measured during the flood were used with gage information to estimate the peak flow during this flood.

N/A: Data not available
Note: Discharges for 1981 and after are affected by regulation or diversion
Source: USGS 2008C

Table 2.3.1-4 (Sheet 1 of 2)
Guadalupe River Basin Dams (storage greater than 3000 acre-feet)

No.	NAT ID	Dam Name	County	Lat (deg)	Long (deg)	Year	Dam Height (ft)	Dam Length (ft)	Max Storage (ac-ft)	Effective Top of Dam (ft NGVD 29)
1	TX00004	CANYON DAM	COMAL	29.8667	-98.2000	1964	219	6,830	1,129,300	974.0
2	TX01546	COMAL RIVER WS SCS SITE 4 DAM	COMAL	29.6500	-98.2767	1965	73	2,000	5,293	806.3
3	TX01548	YORK CREEK WS SCS SITE 1 DAM	COMAL	29.8133	-98.0483	1967	81	1,157	4,570	742.8
4	TX01550	COMAL RIVER WS SCS SITE 3 DAM	COMAL	29.7383	-98.1583	1974	58	1,850	6,911	783.3
5	TX01575	PLUM CREEK WS SCS SITE 5 DAM	HAYS	30.0017	-97.8383	1963	38	2,510	3,368	668.0
6	TX01576	PLUM CREEK WS SCS SITE 6 DAM	HAYS	30.0017	-97.8217	1967	36	3,340	5,663	643.1
7	TX01584	YORK CREEK WS SCS SITE 5 DAM	HAYS	29.7767	-97.9833	1963	41	1,897	3,426	589.0
8	TX01599	LAKE MEADOW DAM	GUADALUPE	29.5283	-97.9383	1930	27	2,525	3,100	475.6
9	TX01600	LAKE PLACID DAM	GUADALUPE	29.5467	-98.0000	1964	25	2,057	5,400	N/A
10	TX01601	LAKE MCQUEENEY DAM	GUADALUPE	29.5933	-98.0400	1928	40	1,555	5,050	540.0
11	TX01602	LAKE DUNLAP DAM	GUADALUPE	29.6533	-98.0667	1928	41	1,626	5,900	589.4
12	TX01611	YORK CREEK WS SCS SITE 13 DAM	GUADALUPE	29.8200	-97.9250	1964	33	2,782	5,045	595.3
13	TX01912	LAKE GONZALES DAM	GONZALES	29.4950	-97.6250	1931	42	2,170	23,520	346.5
14	TX01913	LAKE WOOD DAM	GONZALES	29.4683	-97.4917	1931	42	6,450	8,120	304.0
15	TX03418	LOWER PLUM CREEK WS SCS SITE 34 DAM	CALDWELL	29.8650	-97.7550	1965	41	3,106	4,741	573.6
16	TX03420	LOWER PLUM CREEK WS SCS SITE 28 DAM	CALDWELL	29.8567	-97.5117	1963	34	4,300	5,404	479.5
17	TX03423	PLUM CREEK WS SCS SITE 14 DAM	CALDWELL	29.9533	-97.7433	1967	46	3,640	8,715	542.3
18	TX03425	PLUM CREEK WS SCS SITE 17 DAM	CALDWELL	30.0000	-97.7100	1969	35	1,860	5,312	N/A
19	TX03428	PLUM CREEK WS SCS SITE 21 DAM	CALDWELL	29.9567	-97.6533	1962	41	3,400	5,318	522.3
20	TX04547	COMAL RIVER WS SCS SITE 1 DAM	COMAL	29.6867	-98.2883	1978	70	2,530	6,763	919.3
21	TX04657	PLUM CREEK WS SCS SITE 16 DAM	HAYS	30.0033	-97.7400	1975	41	2,800	3,642	559.9
22	TX04693	LOWER PLUM CREEK WS SCS SITE 27 DAM	CALDWELL	29.8333	-97.5617	1974	28	3,830	3,170	N/A
23	TX04744	COLETO CREEK DAM	VICTORIA	28.7233	-97.1667	1980	65	21,000	169,000	120.0
24	TX04788	COMAL RIVER WS SCS SITE 2 DAM	COMAL	29.6750	-98.2517	1981	75	3,100	19,024	866.8

Table 2.3.1-4 (Sheet 2 of 2)
Guadalupe River Basin Dams (storage greater than 3000 acre-feet)

No.	NAT ID	Dam Name	County	Lat (deg)	Long (deg)	Year	Dam Height (ft)	Dam Length (ft)	Max Storage (ac-ft)	Effective Top of Dam (ft NGVD 29)
25	TX05945	UPPER SAN MARCOS RIVER WS SCS SITE 1	HAYS	29.9183	-97.9733	1983	80	2,905	18,399	N/A
26	TX06328	UPPER SAN MARCOS RIVER WS SCS SITE 2	HAYS	29.9333	-97.9617	1985	51	1,465	3,034	726.7
27	TX06329	UPPER SAN MARCOS RIVER WS SCS SITE 4	HAYS	29.8850	-98.0317	1985	100	1,365	5,972	889.8
28	TX06432	UPPER SAN MARCOS RIVER WS SCS SITE 3	HAYS	29.9067	-97.9450	1991	60	1,630	4,323	N/A
29	TX07247	UPPER SAN MARCOS RIVER WS NRCS SITE 5	HAYS	29.8683	-97.9681	1989	71	2,950	7,329	667.2

Source: TCEQ 2008
N/A: Data not available

Table 2.3.1-5 (Sheet 1 of 2)
San Antonio River Basin Dams (storage greater than 3000 acre-feet)

No.	NAT ID	Dam Name	County	Lat (deg)	Long (deg)	Year	Dam Height (ft)	Dam Length (ft)	Max Storage (ac-ft)	Effective Top of Dam (ft NGVD 29)
1	TX01432	VICTOR BRAUNIG DAM	BEXAR	29.2400	-98.3717	1963	76	9,638	32,324	515
2	TX01448	CALAVERAS CREEK DAM	BEXAR	29.2783	-98.3050	1969	79	5,920	97,441	498
3	TX01450	CALAVERAS CREEK WS SCS SITE 3 DAM	BEXAR	29.3700	-98.3317	1954	37	3,100	3,400	595
4	TX01453	MITCHELL LAKE DAM	BEXAR	29.2700	-98.4733	1967	10	3,500	5,000	530
5	TX01459	CALAVERAS CREEK WS SCS SITE 6 DAM	BEXAR	29.3800	-98.2917	1957	43	2,463	4,801	556
6	TX01461	MARTINEZ CREEK WS SCS SITE 1 DAM	BEXAR	29.4717	-98.3283	1964	38	2,172	3,509	681
7	TX01464	MARTINEZ CREEK WS SCS SITE 6A DAM	BEXAR	29.4783	-98.2900	1966	34	2,420	5,200	631
8	TX01467	SALADO CREEK WS SCS SITE 8 DAM	BEXAR	29.6450	-98.4767	1973	61	1,675	7,100	1,077
9	TX01468	SALADO CREEK WS SCS SITE 4 DAM	BEXAR	29.6233	-98.5200	1972	57	1,760	30,798	1,053
10	TX01469	SALADO CREEK WS SCS SITE 2 DAM	BEXAR	29.6634	-98.5792	1971	65	2,200	4,317	1,162
11	TX01787	MEDINA LAKE DAM	MEDINA	29.5400	-98.9333	1913	165	1,550	327,250	1,076
12	TX01788	MEDINA DIVERSION LAKE DAM	MEDINA	29.5100	-98.9000	1913	51	450	4,500	928
13	TX02028	HONDO CREEK WS SCS SITE 1 DAM	KARNES	28.7483	-97.8033	1968	41	3,250	6,288	N/A
14	TX02031	ESCONDIDO CREEK WS SCS SITE 11 DAM	KARNES	28.8600	-97.8450	1958	37	2,823	7,523	325
15	TX02034	ESCONDIDO CREEK WS SCS SITE 3 DAM	KARNES	28.7717	-97.9283	1956	41	2,310	3,180	425
16	TX02035	ESCONDIDO CREEK WS SCS SITE 4 DAM	KARNES	28.8150	-97.9017	1956	32	2,900	3,743	334
17	TX02040	ESCONDIDO CREEK WS SCS SITE 9 DAM	KARNES	28.8667	-97.9983	1957	30	2,674	4,330	419
18	TX02042	ESCONDIDO CREEK WS SCS SITE 13 DAM	KARNES	28.8133	-97.8767	1973	36	4,000	4,060	319
19	TX04208	SALADO CREEK WS SCS SITE 12 DAM	BEXAR	29.6267	-98.3917	1974	70	3,250	7,425	946
20	TX04313	OLMOS DAM	BEXAR	29.4733	-98.4733	1926	68	1,941	14,240	N/A
21	TX04315	ESCONDIDO CREEK WS SCS SITE 12 DAM	KARNES	28.8300	-97.9217	1974	28	2,667	3,388	342
22	TX04364	SALADO CREEK WS SCS SITE 13A DAM	BEXAR	29.6050	-98.3950	1976	43	1,690	3,026	N/A
23	TX04481	BOERING CITY LAKE DAM	KENDALL	29.8217	-98.7667	1978	87	6,130	15,668	1,546
24	TX04655	UPPER CIBOLO CREEK WS SCS SITE 3 DAM	KENDALL	29.7783	-98.7833	1980	76	2,436	4,732	1,584
25	TX04716	SALADO CREEK WS SCS SITE 1 DAM	BEXAR	29.6633	-98.6000	1975	80	2,640	8,680	1,162
26	TX04717	SALADO CREEK WS SCS SITE 5 DAM	BEXAR	29.6383	-98.5117	1976	64	3,200	5,807	1,099
27	TX04760	SALADO CREEK WS SCS SITE 11 DAM	BEXAR	29.6017	-98.4317	1979	65	1,775	6,318	893
28	TX05798	PANNA MARIA TAILINGS POND DAM	KARNES	28.9600	-97.9367	1978	60	9,810	4,598	375
29	TX06398	SALADO CREEK WS SCS SITE 7 DAM	BEXAR	29.5583	-98.5033	1987	47	22,640	7,016	N/A
30	TX06600	SALADO CREEK WS SCS SITE 10 DAM	BEXAR	29.5958	-98.4375	1994	66	1,264	4,054	N/A

Table 2.3.1-5 (Sheet 2 of 2)
San Antonio River Basin Dams (storage greater than 3000 acre-feet)

No.	NAT ID	Dam Name	County	Lat (deg)	Long (deg)	Year	Dam Height (ft)	Dam Length (ft)	Max Storage (ac-ft)	Effective Top of Dam (ft NGVD 29)
31	TX06646	ECLETO CREEK WS NRCS SITE 9A DAM	DE WITT	29.0008	-97.7083	1993	30	3,183	4,100	373
32	TX06912	ECLETO CREEK WS SCS SITE 4 DAM	KARNES	29.0778	-97.8492	1994	28	2,886	3,910	341
33	TX07211	SALADO CREEK WS NRCS SITE 15R DAM	BEXAR	29.5504	-98.4500	2004	49	6,536	8,704	773
34	TX07263	ECLETO CREEK WS NRCS SITE 3 DAM	WILSON	29.1767	-97.8632	2000	31	2,700	3,340	404

N/A: Data not available
Source: TCEQ 2008

Table 2.3.1-6
USGS Stream Gages near VCS

Gage No.	Name	River	Lat (deg)	Long (deg)	County	Drainage Area (square mile)	Period of Record From Year	Years of Record	Historical Annual Mean Flow Rate(cfs)		
									Max.	Min.	Ave.
08176500	Victoria	Guadalupe	28.79	-97.01	Victoria	5198	1935	73	6993	132	1978
08177500	Victoria	Coleto	28.73	-97.14	Victoria	514	1939	46	302	2	117
08188500	Goliad	San Antonio	28.65	-97.38	Goliad	3921	1924	76	3289	98	781
08188570	McFaddin	San Antonio	28.53	-97.04	Refugio	4134	2006	1	N/A	N/A	N/A
08188800	Tivoli	Guadalupe	28.50	-96.88	Refugio	10,128	2000	0	N/A	N/A	N/A

Note: No complete years of data are available at Tivoli before September 2007
N/A: Data not available
Sources: USGS 2008, USGS 2008A, USGS 2008B, USGS 2008C, USGS 2008F

Table 2.3.1-7 (Sheet 1 of 3)
Monthly Mean Flows for the Guadalupe River at Victoria, Texas USGS 08176500

Year	Monthly mean in cfs											
	January	February	March	April	May	June	July	August	September	October	November	December
1934	—	—	—	—	—	—	—	—	—	—	—	1,674
1935	788.7	1,941	762.6	1,120	7,866	9,037	1,860	1,170	4,594	1,981	1,081	2,057
1936	1,412	1,038	1,056	817.2	4,818	2,328	18,430	1,311	3,246	4,341	1,767	1,548
1937	1,404	1,355	2,834	1,365	959.6	2,733	936.1	685.3	652.8	810	659.7	1,154
1938	2,632	1,722	1,453	5,228	4,920	1,367	952.8	771.9	702.7	603.3	641.2	669
1939	712.5	654.1	611.6	597.2	715.9	728.4	772	419	417.8	516.2	449.8	495.6
1940	513.2	723.4	632	972.4	745	1,110	6,633	524	460.3	629.2	6,397	5,672
1941	2,570	3,964	4,398	4,721	12,990	4,782	2,521	1,410	1,164	1,359	1,195	934.4
1942	864.5	804.3	793.1	2,619	1,598	916.4	6,290	931.9	4,381	2,773	1,768	1,456
1943	1,411	1,109	1,131	1,033	905.6	1,387	939.2	669.8	755.6	658	651.1	732.1
1944	1,337	1,645	2,968	1,519	3,399	3,044	1,208	893.3	1,757	862.6	1,260	2,131
1945	3,235	3,257	2,761	5,570	1,521	1,337	919.2	708.9	645.9	1,268	802.1	1,037
1946	1,264	1,846	3,086	1,542	2,067	2,348	807.6	1,045	4,834	4,137	3,666	2,241
1947	3,588	2,141	2,162	2,185	2,160	1,167	907.3	1,351	693	583.1	637.7	719.6
1948	669.4	824	768.2	552.3	1,414	561	744.3	547.8	395.3	465.9	396.6	426.7
1949	488.1	1,001	1,567	4,101	2,768	1,130	893	660.6	575	2,731	854	990.8
1950	707.5	900	675.1	1,285	910.5	2,340	587.8	368.4	381.2	354.5	353.6	408.6
1951	393.1	423.7	427.5	455.3	564.1	2,279	309.9	186	375.4	238.2	314.6	326.1
1952	336.3	401.3	334.5	590.1	1,350	1,355	471.7	180.3	3,993	706.6	963.2	1,884
1953	1,652	833.8	650.5	730.9	2,551	336.4	319.3	485	1,730	1,684	692.6	885.7
1954	581.8	505	412.6	483.5	702.1	246.2	146.5	107.9	107.2	121.3	200.5	241.5
1955	258.5	950	329	290.3	770.9	797.3	214	210.7	158	100.1	106.9	182.7
1956	194.6	255.3	158.1	157.2	224.4	59.7	53.9	37.6	51.6	163.7	59.6	486.2
1957	118.2	410.1	1,165	4,147	6,954	5,312	676.4	355.4	3,859	7,945	4,209	1,990
1958	4,070	8,645	3,922	2,015	4,293	1,764	1,248	742.9	2,013	1,852	2,229	1,450
1959	1,271	1,967	1,302	3,304	1,675	1,132	1,290	825.7	739.1	2,504	1,299	1,114
1960	1,431	1,509	1,204	1,300	2,392	2,854	2,635	1,805	1,091	9,217	7,761	3,289
1961	3,833	4,640	2,459	1,619	1,151	6,855	2,637	1,175	1,901	1,035	2,235	996.6
1962	905.8	902.4	781	944.6	745.8	880.7	511.3	332	735.8	651.3	687.2	804.5

Table 2.3.1-7 (Sheet 2 of 3)
Monthly Mean Flows for the Guadalupe River at Victoria, Texas USGS 08176500

Year	Monthly mean in cfs											
	January	February	March	April	May	June	July	August	September	October	November	December
1963	697.4	1,043	663.2	738.1	489.4	368.1	303.8	172.3	200.7	213.5	775.3	473.6
1964	450.3	807.6	1,198	678	446.7	558.8	259.7	271.4	716.5	833.7	965.7	526.2
1965	1,599	4,735	1,271	1,220	4,327	4,018	1,116	698.5	706.9	1,275	1,969	2,620
1966	1,235	1,669	1,589	2,051	2,606	1,200	892.8	640.3	869.3	878	703.5	596.3
1967	596.3	540.9	512.5	474.1	392.4	280.3	208.9	302.3	9,335	2,270	2,213	1,114
1968	7,130	2,348	1,869	2,907	4,991	6,178	1,669	961.7	1,649	837.9	943.3	2,048
1969	933.6	3,326	2,982	3,671	3,255	1,535	861.7	708.4	841.5	1,353	1,225	1,532
1970	1,797	1,864	2,814	1,921	3,433	2,757	1,204	852.7	797.6	1,052	730.6	694.9
1971	670.8	612.6	583.2	429.6	367.1	377.8	322.6	1,570	2,914	1,453	1,448	2,026
1972	1,446	1,583	1,056	756.2	12,230	2,789	1,648	1,343	971.4	933	878.4	836.7
1973	1,128	1,635	2,531	5,174	2,253	7,511	4,277	2,721	2,189	10,550	3,397	2,144
1974	3,648	1,892	1,463	1,191	2,211	1,723	861.6	992.4	3,928	1,422	4,685	2,847
1975	2,100	4,611	2,249	2,234	8,850	6,441	3,308	1,995	1,461	1,155	991.2	1,169
1976	930.3	879.8	912.6	5,069	6,339	3,346	2,276	1,706	1,600	4,050	5,101	6,786
1977	2,975	4,726	2,289	10,320	4,645	2,566	1,743	1,169	1,058	929.2	1,561	938.6
1978	921.7	1,013	916.1	971.5	775.6	1,441	624.1	3,724	3,739	1,535	1,878	1,028
1979	4,767	3,911	3,828	5,223	7,601	5,865	2,286	1,988	1,681	923.8	859.9	820.9
1980	1,074	931.2	795.8	732.7	2,674	1,107	603.4	440.7	1,267	948.9	825.5	828.9
1981	847.9	913.5	1,263	1,666	2,146	10,020	3,833	1,875	11,340	2,178	4,397	1,703
1982	1,257	1,641	1,080	965.6	5,427	1,345	770.8	498.5	479.4	598.3	1,032	680.7
1983	707.5	1,525	2,152	1,375	1,457	1,271	1,325	640.9	760.2	702.4	891.8	526.4
1984	748.2	659.1	770.4	456.2	367.3	290.6	111.5	104.7	125.1	629.6	673.4	870.9
1985	2,027	1,564	2,327	2,570	1,595	2,684	2,514	1,022	722.2	1,640	3,527	3,227
1986	1,801	1,763	1,245	976	1,549	3,182	1,193	676.9	1,198	2,380	2,536	5,529
1987	4,476	3,190	4,563	2,136	2,229	23,750	6,759	4,473	2,363	1,692	1,379	1,210
1988	953.8	884.3	1,051	796.4	807.4	1,005	937.6	1,081	603.7	541.8	485.8	541.4
1989	704.5	767.9	768.1	750.9	1,408	640	314.6	186.1	141.6	235.5	397.6	452.2
1990	420.1	421.4	659.3	965.8	1,386	747.9	776	821.8	982.2	527.5	601.3	566
1991	3,000	2,645	1,330	3,992	2,596	1,438	1,495	695.2	1,022	865.8	907.7	9,753
1992	10,650	17,250	10,600	9,821	8,757	8,855	3,103	2,150	1,660	1,360	1,806	1,661

Table 2.3.1-7 (Sheet 3 of 3)
Monthly Mean Flows for the Guadalupe River at Victoria, Texas USGS 08176500

Year	Monthly mean in cfs											
	January	February	March	April	May	June	July	August	September	October	November	December
1993	1,902	2,521	3,132	1,800	5,851	5,473	1,938	918.9	768	912.2	920	887.7
1994	840.6	833.3	1,033	939.1	4,208	1,435	717.1	600.5	657.6	3,768	1,172	1,898
1995	2,080	1,109	2,525	2,018	990.2	3,136	1,231	764	636.3	610.5	689.9	728.6
1996	634.4	591.4	530.3	472	382.5	313.6	163	265	1,963	415.1	444.9	597.9
1997	1,001	767.8	2,546	6,536	3,738	9,942	6,293	2,690	1,272	2,960	1,137	1,221
1998	1,478	3,391	3,509	2,033	996.9	740.2	587.7	1,308	3,026	30,440	9,440	4,711
1999	2,210	1,589	1,494	1,307	1,475	1,942	1,124	713.6	531.4	510.9	558.4	565
2000	661.1	655.5	718.7	636.2	892.9	1,475	424.6	289.5	271.9	485.4	5,365	2,431
2001	2,672	2,267	3,368	1,856	1,701	1,051	792.6	894.1	7,430	1,429	3,493	5,343
2002	2,033	1,525	1,245	2,227	891.2	776	17,060	4,741	5,515	6,091	9,964	5,771
2003	3,878	4,888	3,556	1,900	1,528	1,405	1,385	1,070	1,479	1,401	1,226	1,011
2004	1,399	1,394	1,473	3,276	3,597	6,258	5,420	1,836	1,561	3,395	17,500	7,453
2005	3,157	4,595	6,122	2,228	2,638	1,633	1,237	1,064	953.8	827.5	753.9	773.4
2006	767.6	757.4	737.3	648.9	685.3	588.6	602	296.3	438.2	443.5	396.4	473.2
2007	1,758	835.6	4,824	3,994	4,860	3,870	12,040	7,406	5,105	—	—	—
Mean of Monthly Discharge	1,740	1,990	1,850	2,130	2,810	2,820	2,120	1,110	1,800	2,080	2,030	1,750

Notes:
Shaded months depict periods of extended drought.
October, November and December 2007 are part of the 2008 water year and are not included.

Table 2.3.1-8 (Sheet 1 of 3)
Monthly Mean Flows for the San Antonio River at Goliad, Texas USGS 08188500

Year	Monthly mean in cfs											
	January	February	March	April	May	June	July	August	September	October	November	December
1924	—	—	—	—	—	—	361.9	232.8	283.3	214.4	205.2	278.9
1925	222.4	219.5	193.9	151.7	211.2	104.2	145.3	113.2	215.1	871.6	222.1	153.1
1926	203.1	132.2	385.5	2,023	1,067	298.7	248.3	137.6	100.3	232.7	184.7	188.3
1927	162.3	204.4	299	491.9	149.3	417.7	114.5	53.7	91.2	291.5	91.6	106.5
1928	117.5	112.2	173	145.1	419.8	502.7	91.4	51	391.5	135.7	763.8	289.5
1929	N/A	121	844	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1939	N/A	N/A	175.2	145.6	138.4	166	257.7	185	119.6	95	98.1	134.8
1940	133	249.9	134.7	372.9	207	594.2	1,392	395.6	138.4	302	2,574	1,655
1941	612.5	1,082	692.1	1,438	3,610	1,628	886.2	454.6	917.6	555.5	480	314.1
1942	283.9	311.2	234.7	521.7	431.5	279.6	4,196	409.6	4,924	2,161	666	510.1
1943	484.1	408	464.3	393.5	452.5	871.4	479.7	252.8	339.1	256.3	316	283.1
1944	457.5	369.4	466.8	291.5	1,860	521.8	275.9	356.5	559.8	267.9	268.4	466.4
1945	714.2	870.6	533.1	1,144	401	505.1	260.5	240.1	214.3	438.4	253.9	262.4
1946	341.4	397	501.1	741.7	1,583	1,097	266.4	833.6	4,313	5,531	927.3	561.4
1947	795	515.6	553.1	453.7	933.4	344.9	256.6	347.5	271.7	224.7	274.6	284.5
1948	260.9	301.1	254.4	238.6	308.5	136.5	398.7	763.3	287.9	329.6	167.4	163
1949	186.9	298.6	264	2,288	716.7	1,010	778.6	295.8	209.4	1,195	312.4	425.4
1950	269.7	221.7	231.3	272.8	227.6	617.7	188.5	213.4	179.5	131.3	126.4	132
1951	124.6	198.6	174.5	195	493.5	1,113	121.4	90.2	789.5	150.4	155.6	150.5
1952	137	214.4	175	316.2	498.7	175.5	165.9	77.4	3,306	149.3	225.5	255.8
1953	271.4	163.6	171.1	206.5	940.6	85	123.6	324.5	1,319	233.7	155.8	195.9
1954	149.7	123.6	112.4	159.1	261.3	125.5	82.5	49.9	66.8	124.4	133	86.5
1955	126.6	352.2	177.3	89.3	314.2	166.4	69	165.1	242.5	75.1	76.2	114.9
1956	104.1	106.6	83.9	86.8	192.2	26.2	52.4	60.6	200.1	368	155.6	382.3
1957	109.9	166.8	492.1	2,515	2,904	2,321	164.3	108.8	2,025	952.4	895.7	295.8
1958	1,641	2,884	638.1	366.8	2,065	454.2	505.3	196	932.1	1,202	1,608	582.4
1959	464.5	516.2	398.5	637.7	621.4	349.8	341.5	226.2	221.4	678.9	396.5	335.4

Table 2.3.1-8 (Sheet 2 of 3)
Monthly Mean Flows for the San Antonio River at Goliad, Texas USGS 08188500

Year	Monthly mean in cfs											
	January	February	March	April	May	June	July	August	September	October	November	December
1960	393.8	381.7	393.8	349.5	318.5	572	518.1	553.1	248	2,520	1,769	943.9
1961	867.9	1,358	684.7	422.6	266.6	1,368	1,012	382.7	363.2	554.4	799.2	342.4
1962	331	325.3	244.6	326.8	251.7	696.7	165.7	146.2	317.7	152.6	235	378.5
1963	215	385	198.4	209.3	153.6	125.9	113.5	47.9	150.1	294.6	344.1	245.3
1964	213.7	536.9	446	193.2	152.4	289.6	88.8	472	206.8	316	599	288.8
1965	567.7	1,778	323.6	462	2,605	732.2	230.7	173	176.8	595.9	239.9	709.9
1966	291.6	359.9	322	487.2	595.8	267.9	186.8	240.8	377.1	207.1	162	183.4
1967	194.2	175	175.4	186.3	168.9	71.4	175.1	394.3	12,050	1,052	968.8	384.9
1968	4,309	1,014	647	678.2	2,063	843.1	538.4	292.4	853.6	315.1	317.1	584.4
1969	359.9	989.9	577.1	709	1,333	573.7	170.1	231.9	334.4	383.4	249.6	355.1
1970	458.4	471.2	695.5	350.1	1,134	1,296	232.8	234.3	221.3	272	204.5	202.8
1971	237.2	208.4	193.6	174.2	136.9	225.4	142.7	1,285	961.4	1,402	912.9	794.6
1972	536.5	451.2	353.9	555.6	4,235	1,073	516.9	521.1	517	609.5	463.8	395.9
1973	441.7	618.2	521.3	1,792	596.9	4,253	4,723	1,400	2,244	7,084	1,625	942.2
1974	825	676.1	587.2	513.4	779.4	521	254.4	1,041	1,660	678	1,088	715.3
1975	768.1	2,066	911.3	783.7	2,518	2,272	980.4	591	510	451.5	394.5	517.5
1976	420.9	351	369.7	1,558	2,680	713.1	1,121	573	865	1,847	2,403	1,836
1977	1,460	1,542	996.3	4,357	2,438	1,290	687.6	466.3	794.6	511.8	1,348	567.2
1978	513.6	594.4	532.2	686.2	452.5	937.6	198.4	1,736	1,860	633.8	1,001	572.2
1979	1,539	1,127	1,265	2,864	2,255	2,785	1,062	708.5	492.8	364.4	406.6	485.4
1980	565	483.6	328.9	383.4	1,316	358.2	207.3	701.8	1,018	310.5	404.2	407.5
1981	426.8	417.3	422	464.4	881	4,747	1,520	618.1	2,444	1,505	1,097	578.1
1982	509.7	815.6	546.1	431.3	1,063	420.6	286.8	288.4	254.5	534.8	529.6	440.2
1983	414.4	480.3	642.3	329.5	417.4	374.4	320	337.8	822.1	371.2	480.2	293.3
1984	376.4	338	400.1	254.5	248.5	201.5	156	177	145.1	1,048	603.6	431.1
1985	664.3	437.5	805.4	796	421.2	909.7	950.8	247.3	432	982.9	1,324	560.3
1986	418.6	448.7	279	246	447.9	2,925	511	249.9	535.7	984.3	597.9	2,153
1987	1,495	1,436	1,591	787.7	1,600	15,370	1,774	819.1	719.1	480.7	606.5	626.6

Table 2.3.1-8 (Sheet 3 of 3)
Monthly Mean Flows for the San Antonio River at Goliad, Texas USGS 08188500

Year	Monthly mean in cfs											
	January	February	March	April	May	June	July	August	September	October	November	December
1988	568.1	504.3	521.2	430.6	344.9	383	404.1	252.6	309.9	249.3	260.6	265.3
1989	371.4	376.5	330.1	409.7	360.5	367.7	149.2	184.4	142.1	223.9	403.5	314.1
1990	242.7	360.5	478.1	724.3	515.3	140.4	1,603	389.5	432.3	333.5	365.3	278.8
1991	755.4	1,026	395.9	1,772	822.7	527.8	478.9	289	379.4	266.8	328	4,628
1992	2,869	7,682	4,379	4,488	6,169	5,759	1,456	937.8	728.5	542.1	1,256	876.5
1993	796	920.3	817.9	687.5	3,403	3,037	1,179	419	355.9	462.9	479.1	391.1
1994	449	473.9	863.9	629.8	2,216	534.1	269.2	250.4	457.8	1,244	449.9	502.2
1995	494.8	392.5	645.9	456.2	393.8	738.6	733.3	231.9	424.9	264.9	252.8	329.9
1996	287.8	248.1	250.4	205.1	184.3	203.6	160.1	216	747.8	189.8	235.2	291.6
1997	253.7	297.4	384.5	1,227	853.3	3,623	1,425	319.8	286.2	560.8	368.3	468.2
1998	503.9	1,113	1,053	514.3	241.7	166.6	162.7	699.7	671.3	7,543	2,050	984.5
1999	747.1	588.3	667.4	561.4	573.9	937.6	493.6	259.2	215.9	232.8	277.8	286.2
2000	371.7	393.6	336.7	425.7	495.5	796.7	198.7	136.6	209.7	738	2,747	672.8
2001	863.6	639.3	755.7	889.4	961.3	451.1	201	667	6,176	728.6	1,496	1,474
2002	713.1	533.7	480.7	964.2	382.4	269	15,330	1,392	3,056	4,731	3,805	2,186
2003	1,457	1,540	1,251	824.9	525.9	673.1	965.2	430.6	1,553	816.7	604.6	553.7
2004	587.2	650.8	719.3	2,411	2,460	2,928	2,630	946.7	813.3	1,327	5,914	1,923
2005	1,246	1,568	2,059	905.8	837.8	763.4	490	420.1	471.6	398.1	322.7	420
2006	397.2	273.1	375.5	261.6	453.1	228.5	239.7	136.9	449.2	284	291	351.8
2007	874.8	341.5	2,551	1,675	1,650	1,135	7,235	5,736	2,417	—	—	—
Mean of Monthly Discharge	598	695	589	788	1,050	1,150	904	485	1,010	887	751	585

N/A = data not available

Notes:

Shaded months depict periods of extended drought.

October, November and December 2007 are part of the 2008 water year and are not included.

Table 2.3.1-9 (Sheet 1 of 2)
Monthly Mean Flows for Coleto Creek Near Victoria, Texas USGS 08177500

Year	Monthly Mean in cfs											
	Calculation period restricted by USGS staff due to special conditions at/near site											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1980	—	—	—	—	—	—	—	—	—	4.62	5.45	5
1981	5.84	5.09	5.44	5.84	447.6	1,115	87.7	89.3	245.3	579.4	273	24.2
1982	15.3	479.2	33.6	21.4	429.5	13.1	4.89	5.18	4.03	4.66	338.3	5.55
1983	5.44	117.4	182.5	6.51	5.61	5.94	335.6	22.9	6.08	208.3	152.8	8.87
1984	58.6	19.9	220.2	4.74	7.05	5.08	5.01	5	5.11	43.6	24.6	22.6
1985	27.7	23.5	291.9	338.7	31.3	13.5	123	5.23	4.73	5.75	5.18	5.01
1986	5.51	5.08	4.85	4.76	5.53	37.5	4.06	2.8	2.62	156	10.9	295.6
1987	90.3	303.4	42.9	11.8	4.46	1,168	10	5.18	6.73	5.3	9.48	5.98
1988	5.65	5.73	6.53	5.1	4.78	5.25	4.7	2.04	2.11	2.53	3.66	2.39
1989	3.01	2.6	3.01	3.75	2.91	2.5	1.97	1.06	1.56	1.65	2.21	2.37
1990	2.34	2.46	2.92	65	2.88	1.82	397.4	3.08	2.13	2.39	2.14	2.4
1991	3.66	3.15	2.67	719.3	3.86	114	50.9	4.14	3.71	3.14	2.46	434.1
1992	347	960.6	32	956	442.2	64	5.34	4.89	4.47	4.09	4.95	5.26
1993	5.34	52.4	236.3	19.2	939.9	1,426	13.9	6.5	7.36	5.41	5.1	4.55
1994	5.5	5.97	40.5	5.13	328.6	27.3	4.46	4.51	4.63	1,074	5.86	5.81
1995	64.6	4.95	85.8	27.9	7.11	4.85	3.67	2.43	1.81	1.61	2.01	2.18
1996	1.93	1.98	2.05	2.07	2.09	2.41	1.31	2.14	1.98	1.71	1.9	2.01
1997	4.58	3.11	545.2	1,817	117.6	1,133	10.9	6.2	5.69	657.5	13.5	5.56
1998	28.5	191.6	149.3	5.02	4.62	4.43	4.15	3.47	989.8	1,313	949.5	83.9
1999	24.2	15.6	14	7.5	6.28	50.3	11.5	4.61	4.97	4.86	5.37	2.61
2000	4.09	3.26	13.4	17.2	14.1	36.1	8.77	3.91	1.78	2.1	2.57	3.06
2001	85.6	2.35	20.6	6.43	158.1	0.043	0.009	369.9	1,202	52.7	249.8	272.1
2002	11.1	3.02	3.08	3.48	2.83	5.1	341.2	0.931	136.3	458.6	511.3	212.4
2003	94.5	57.3	18.6	2.22	2.56	3.07	89.4	3.04	371.7	77.4	144.5	9.09

Table 2.3.1-9 (Sheet 2 of 2)
Monthly Mean Flows for Coleto Creek Near Victoria, Texas USGS 08177500

Year	Monthly Mean in cfs											
	Calculation period restricted by USGS staff due to special conditions at/near site											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	133.5	33	94.7	423.6	725.1	278.6	68.4	5.44	5.32	5.6	1,186	29.3
2005	141.3	465.3	358.7	28.1	225.1	21.9	5.3	5.13	5.31	5.06	5.31	5.28
2006	5.23	5.88	5.66	6.46	5.68	6.99	4.66	4.51	3.48	3.77	3.02	3.95
2007	27.7	9.39	562.9	98.1	76	6.61	1,518	61.3	55.1	—	—	—
Mean of monthly Discharge	45	103	110	171	148	206	115	24	114	174	145	54

Note: October, November, and December 2007 are part of the 2008 water year and are not included.

Table 2.3.1-10
Mean Daily Flows for the Guadalupe River at Victoria, Texas, USGS Gage 08176500

Day of Month	Mean of Daily Mean Values for Each Day of Record in, cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1,790	1,700	2,180	1,630	2,900	2,730	2,600	1,200	1,760	1,720	1,750	1,680
2	1,770	1,530	1,890	1,690	3,360	2,750	3,030	1,170	2,770	1,290	1,940	1,610
3	1,720	1,500	1,760	1,860	3,540	2,700	4,420	1,160	2,970	1,180	2,260	1,570
4	1,580	1,530	1,650	2,050	3,280	2,740	3,880	1,150	2,470	1,180	2,170	1,520
5	1,450	1,720	1,610	2,100	2,980	2,820	3,100	1,150	1,760	1,080	2,030	1,610
6	1,420	1,960	1,670	1,980	2,890	3,440	2,580	1,190	1,380	1,010	2,030	1,620
7	1,430	2,250	1,750	1,850	2,810	3,990	2,530	1,160	1,280	1,110	2,040	1,700
8	1,460	2,420	1,950	1,930	2,850	3,750	2,440	1,150	1,300	1,240	2,410	1,790
9	1,450	2,190	2,040	2,010	2,910	3,280	2,760	1,120	1,380	1,280	2,390	1,820
10	1,430	1,970	1,810	1,910	2,870	2,970	3,090	1,120	1,450	1,300	1,850	1,750
11	1,520	1,790	1,590	1,970	2,740	2,790	2,740	1,110	1,610	1,330	1,570	1,570
12	1,610	1,780	1,550	2,130	2,880	2,730	2,270	1,070	1,870	1,460	1,550	1,530
13	1,760	1,800	1,490	2,020	2,780	2,700	1,990	1,040	1,730	1,570	1,590	1,650
14	1,730	1,790	1,770	1,900	2,880	2,960	1,800	1,040	1,960	1,590	1,650	1,830
15	1,780	1,820	1,980	1,840	3,120	2,970	1,720	1,050	2,020	1,550	1,640	1,800
16	1,770	1,780	2,200	1,910	3,000	2,830	1,750	1,050	1,870	1,880	1,660	1,670
17	1,730	1,770	2,420	2,000	2,810	2,800	1,790	1,050	1,780	2,050	1,750	1,660
18	1,560	1,830	2,230	2,160	2,640	2,780	1,720	1,020	1,530	2,100	1,860	1,730
19	1,630	1,810	2,140	2,200	2,890	2,760	1,640	1,050	1,480	2,890	1,830	1,740
20	1,860	1,810	2,080	2,270	2,770	2,890	1,630	1,080	1,540	6,570	1,780	1,690
21	2,040	1,920	2,010	2,470	2,500	2,720	1,580	1,070	1,910	5,390	1,770	1,680
22	2,110	2,020	1,880	2,340	2,330	3,040	1,470	1,050	1,970	3,610	1,870	1,720
23	1,960	2,030	1,780	2,340	2,540	2,850	1,460	1,070	1,960	2,770	1,910	1,740
24	1,930	2,120	1,760	2,450	2,790	2,540	1,450	1,110	2,010	2,360	1,910	1,830
25	2,220	2,540	1,800	2,320	2,710	2,260	1,490	1,110	1,860	2,220	2,690	2,260
26	2,200	2,950	1,850	2,400	2,380	2,280	1,580	1,080	1,680	2,450	3,150	2,200
27	2,020	2,710	1,740	2,430	2,300	2,410	1,570	1,090	1,630	2,330	2,930	1,990
28	1,860	2,500	1,660	2,460	2,510	2,300	1,450	1,060	1,530	2,250	2,670	1,890
29	1,690	2,810	1,660	2,570	2,720	2,250	1,410	1,110	1,660	2,160	2,330	1,790
30	1,660		1,710	2,650	2,740	2,420	1,390	1,230	1,840	1,890	1,950	1,760
31	1,710		1,700		2,700		1,280	1,360		1,730		1,830

Table 2.3.1-11
Mean Daily Flows for the San Antonio River at Goliad, Texas, USGS Gage 08188500

Day of Month	Mean of daily mean values for each day of record in, cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	528	552	639	615	976	1,080	1,110	465	1,240	912	891	516
2	524	533	554	676	1,010	1,120	982	413	1,310	1,080	873	486
3	527	563	502	682	1,070	1,150	915	412	1,140	1,030	832	521
4	492	610	489	670	1,120	1,170	813	420	903	754	780	511
5	484	728	494	629	1,050	1,370	808	428	726	534	809	527
6	506	860	546	673	1,050	1,450	953	452	641	492	915	529
7	509	898	580	703	1,030	1,350	1,180	469	648	577	1,060	562
8	494	894	623	695	978	1,330	1,430	524	781	655	1,090	550
9	489	823	616	649	970	1,310	1,820	584	863	649	834	533
10	471	708	597	626	930	1,250	1,750	540	940	552	567	496
11	479	621	556	687	894	1,050	1,380	459	1,110	687	574	491
12	523	596	531	656	1,040	1,120	1,050	482	1,290	816	568	491
13	577	599	504	591	1,020	1,250	906	481	1,260	768	572	496
14	604	580	606	576	967	1,400	853	409	1,270	748	598	533
15	583	570	685	548	1,120	1,300	692	375	1,060	706	588	515
16	563	597	800	563	1,250	1,220	663	357	808	742	600	506
17	510	662	792	644	1,160	1,170	703	393	752	904	558	545
18	499	639	636	752	1,140	1,110	715	452	783	1,020	561	608
19	528	605	666	877	1,160	967	734	474	756	1,030	690	566
20	645	566	638	837	1,220	972	765	565	849	871	730	547
21	708	572	638	854	983	965	800	557	861	1,180	783	651
22	701	678	616	909	885	1,090	789	584	963	1,480	804	656
23	764	767	662	936	998	1,090	779	580	2,210	1,310	701	647
24	867	810	545	1,040	1,020	897	810	511	1,710	1,040	703	781
25	834	852	516	1,170	1,010	839	807	410	1,160	972	887	900
26	776	906	528	1,130	1,060	877	753	405	959	962	941	913
27	691	906	501	1,060	1,090	1,010	656	445	858	1,100	926	813
28	655	797	475	1,070	1,030	1,130	628	516	786	1,120	852	663
29	684	661	530	1,040	1,070	1,190	604	483	759	1,060	660	563
30	676		582	1,080	1,080	1,230	597	540	823	918	581	503
31	637		615		1,060		566	844		829		507

Table 2.3.1-12
Mean Daily Flows for Coleto Creek near Victoria, Texas, USGS Gage 08177500

Day of Month	Mean of daily mean values for each day of record in, cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	14	79	36	44	65	46	51	7.8	768	4.6	231	4.5
2	21	87	37	272	127	40	431	8	189	4.4	68	106
3	5.9	78	21	598	219	79	277	7.4	101	4.4	33	73
4	9.4	205	16	1,060	118	180	233	7.4	123	4.5	141	28
5	10	106	5.8	847	124	311	313	13	105	9.3	367	15
6	23	25	96	296	710	66	254	6.7	74	146	146	27
7	6.8	12	131	125	93	164	71	11	57	105	84	19
8	39	7.4	46	53	58	59	38	4.2	37	16	13	34
9	38	13	32	19	77	54	44	12	62	12	13	29
10	11	40	23	88	135	72	21	6.5	54	17	19	35
11	31	159	11	175	46	391	6.6	4.9	395	98	17	51
12	39	25	323	116	78	609	7.8	5.8	332	173	14	92
13	104	20	147	95	67	439	7.5	5.8	72	528	218	53
14	49	12	459	52	526	374	7.5	4.4	43	50	548	54
15	11	61	313	16	267	66	116	5.4	118	10	199	45
16	51	83	246	6.2	131	37	531	19	274	14	222	29
17	129	17	318	296	185	62	590	7.5	188	87	70	17
18	69	11	156	373	371	51	79	4.1	108	974	193	19
19	28	44	84	22	87	91	39	4	104	1,130	227	25
20	22	48	118	47	83	537	70	3.9	98	295	175	7
21	17	78	97	25	113	333	66	3.8	66	170	712	30
22	16	151	26	24	22	1,030	19	3.9	24	65	283	573
23	8	104	139	23	164	178	6.1	4	5.2	179	152	132
24	56	191	94	21	183	74	5.4	4.6	4.8	188	114	38
25	24	469	23	39	122	76	61	3.9	4.5	299	44	37
26	40	474	105	241	52	298	119	4.4	4.3	97	20	11
27	248	228	33	110	44	172	51	8	6.2	51	16	24
28	183	92	20	13	39	72	17	4.7	4.6	15	5.2	19
29	47	14	12	7.3	106	110	5.8	9.5	4.6	24	4.9	9.9
30	26		29	19	116	98	13	9.4	4.6	5.7	7.3	8.6
31	11		223		71		27	524		601		33

Table 2.3.1-13
Maximum of the Daily Mean Flows for the Guadalupe River at Victoria, Texas, USGS Gage 08176500

Day of Month	Max. of daily mean values for each day of record in, cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	14,500	23,500	21,300	8,660	22,800	15,300	22,300	8,080	22,300	22,600	15,800	13,000
2	10,500	10,600	16,900	10,300	30,800	20,200	39,800	7,270	77,600	10,900	24,000	10,100
3	9,510	7,430	17,900	12,700	49,700	17,000	129,000	7,680	86,900	14,300	36,200	9,340
4	9,150	10,500	10,500	22,500	30,600	14,300	122,000	8,210	61,400	16,700	27,100	9,290
5	9,130	14,100	7,540	21,300	25,400	20,000	75,200	8,390	35,300	8,920	17,400	9,490
6	9,290	17,500	10,500	19,000	26,400	61,800	44,400	8,580	14,500	4,580	16,900	9,370
7	9,590	34,100	14,600	14,500	30,200	80,700	30,000	8,190	7,280	5,050	22,700	10,900
8	9,980	45,100	27,600	15,800	30,000	66,100	26,600	7,820	8,040	7,570	48,800	13,600
9	9,630	33,300	30,300	16,300	24,400	47,200	42,800	7,580	8,010	9,040	48,700	18,200
10	8,790	23,200	20,900	10,300	18,500	31,500	67,800	7,400	8,960	9,980	30,900	19,800
11	8,670	15,600	9,860	11,000	24,100	30,500	59,400	7,300	9,140	6,760	11,600	12,500
12	10,400	10,400	7,600	14,000	24,600	29,200	42,900	7,200	16,200	17,000	6,280	8,640
13	10,400	9,550	8,270	15,900	20,600	21,100	29,000	7,070	18,500	20,700	13,600	11,600
14	11,200	10,900	12,800	11,500	21,400	35,800	20,300	6,970	25,500	22,500	21,200	14,100
15	9,850	12,200	17,500	10,200	44,900	37,800	14,400	6,900	18,000	23,900	21,700	11,500
16	11,500	10,000	20,500	10,800	52,200	35,800	15,600	7,050	25,300	24,900	20,500	12,100
17	12,000	9,170	26,400	14,600	35,400	31,900	19,100	7,120	23,700	26,000	22,900	12,000
18	7,810	10,700	15,200	20,600	23,900	26,600	13,300	7,270	12,100	20,800	25,200	11,900
19	8,460	11,300	12,300	18,200	17,700	27,100	11,100	7,730	7,100	33,200	20,300	12,400
20	9,940	13,300	11,400	19,900	21,300	36,200	11,800	7,840	8,940	307,000	13,500	15,300
21	11,000	14,700	13,300	20,600	22,000	28,300	12,000	7,810	34,500	235,000	25,000	15,900
22	15,500	12,600	12,100	20,200	17,300	48,000	10,000	7,380	35,400	115,000	31,400	14,400
23	17,600	17,800	10,200	36,000	21,100	43,600	11,500	7,190	41,400	75,400	30,500	17,200
24	26,100	17,800	8,000	50,100	24,700	27,500	15,500	7,060	51,200	52,900	29,200	21,000
25	41,000	29,800	8,450	32,000	15,400	14,300	20,300	6,950	42,500	34,200	64,500	52,700
26	30,400	54,000	7,900	19,900	13,700	15,600	28,200	6,880	28,300	25,600	90,400	54,600
27	19,900	41,400	7,980	15,600	14,600	15,700	27,400	6,820	20,600	22,000	67,900	38,200
28	14,200	36,600	7,890	16,700	22,000	13,500	20,500	6,880	18,800	19,000	45,800	26,700
29	15,000	32,500	8,190	21,800	29,000	15,400	18,900	6,980	22,000	22,400	24,900	20,800
30	18,000		8,710	24,400	25,000	21,400	16,800	8,340	26,300	19,500	15,200	18,800
31	24,200		8,980		21,200		11,200	10,100		16,800		18,200

Table 2.3.1-14
Maximum of the Daily Mean Flows for the San Antonio River at Goliad, Texas, USGS Gage 08188500

Day of Month	Max. of daily mean values for each day of record in, cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2,280	5,590	7,230	4,730	15,000	13,000	10,200	8,260	23,600	17,000	7,180	3,530
2	2,110	3,500	4,720	7,100	10,200	10,100	11,300	4,890	26,500	27,800	7,430	3,240
3	1,910	4,220	3,000	7,030	9,380	9,270	8,800	4,150	22,700	25,500	5,850	3,790
4	1,800	7,510	2,790	8,740	9,200	12,200	9,320	3,680	16,800	14,900	5,900	3,210
5	1,870	10,300	2,770	5,530	11,900	18,400	11,400	3,620	14,100	7,160	8,010	3,030
6	2,450	12,600	5,380	7,130	13,200	27,400	15,600	2,930	11,100	3,070	10,900	3,540
7	2,780	14,600	9,220	7,250	10,000	32,800	26,000	3,640	10,700	5,030	14,200	3,810
8	2,340	16,900	12,000	6,690	9,420	32,000	40,100	4,730	14,000	7,130	16,600	3,720
9	2,030	16,100	12,700	6,360	9,740	29,000	62,000	5,680	12,800	6,420	10,500	2,300
10	1,490	12,700	11,400	3,760	9,220	26,300	60,800	5,080	13,100	3,830	3,730	2,960
11	2,580	9,100	8,630	5,280	7,980	23,900	46,300	2,910	23,200	5,480	2,880	2,880
12	5,250	6,660	6,150	4,110	9,130	21,100	35,100	4,260	28,600	11,900	3,770	3,620
13	6,170	5,400	4,900	3,760	9,650	19,700	25,000	5,510	24,000	11,900	4,980	4,290
14	5,120	4,640	5,840	4,070	11,000	24,300	16,500	2,920	23,400	7,820	4,540	5,670
15	6,620	4,170	12,000	3,330	12,500	25,900	11,100	1,750	15,800	7,310	6,190	3,750
16	4,800	4,470	16,600	4,060	12,700	24,000	11,700	1,800	6,130	7,490	4,900	2,710
17	1,800	6,160	15,000	6,530	11,600	22,200	13,000	4,110	5,180	14,900	3,700	5,170
18	1,620	6,160	4,360	9,480	9,640	20,600	14,800	8,190	5,780	19,000	4,210	7,130
19	2,120	5,240	4,150	11,800	15,100	16,500	13,500	9,410	7,680	13,200	7,640	3,170
20	4,690	3,350	3,550	11,200	20,300	13,200	11,100	11,600	7,070	10,900	10,400	4,210
21	7,020	2,720	5,470	11,800	12,000	12,500	9,290	14,700	11,200	34,100	13,300	8,170
22	9,030	5,570	6,280	8,610	9,660	12,400	11,000	19,100	28,800	55,800	14,700	8,660
23	14,900	9,780	10,200	11,300	10,400	10,300	13,100	20,200	121,000	43,300	11,000	11,100
24	24,900	12,400	2,290	14,800	10,500	7,660	14,700	15,000	84,200	29,500	9,140	16,400
25	22,200	15,500	2,550	15,200	11,000	7,730	14,800	6,530	42,900	17,000	12,400	25,100
26	17,700	14,300	2,520	10,700	13,200	9,860	14,200	4,380	25,300	11,000	19,500	25,800
27	12,200	13,900	2,470	12,300	12,900	11,800	12,800	3,800	17,100	13,700	22,600	18,300
28	7,030	11,400	2,370	13,800	10,200	12,600	13,300	9,070	12,300	17,100	16,500	13,000
29	10,100	5,860	2,500	11,400	9,610	13,300	14,700	6,460	8,710	16,900	6,520	8,640
30	11,700		2,720	14,400	11,300	15,600	15,400	6,580	10,300	10,500	4,010	3,450
31	10,400		5,360		13,200		14,100	12,700		7,500		2,570

Table 2.3.1-15
Maximum of the Daily Mean Flows for Coleto Creek near Victoria, Texas, USGS Gage 08177500

Day of Month	Max. of daily mean values for each day of record in, cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	127	1,890	343	930	841	282	1,160	95	15,300	19	6,000	15
2	300	1,300	262	6,560	2,320	340	10,600	101	4,430	19	729	2,590
3	18	1,450	261	15,200	4,910	1,330	6,430	92	1,810	19	425	1,270
4	115	5,050	120	27,500	2,470	2,460	3,740	91	2,560	19	3,470	624
5	135	2,330	19	15,300	2,720	4,710	7,070	156	2,460	83	8,550	111
6	280	290	2,350	2,720	14,500	1,260	5,730	70	1,750	3,400	1,930	457
7	42	94	2,180	1,750	1,960	2,510	1,110	172	1,330	2,370	1,240	343
8	554	60	776	505	569	616	363	7.6	857	287	160	511
9	600	141	303	166	1,430	814	617	212	1,560	150	154	377
10	112	696	373	1,860	2,370	1,180	344	42	1,350	189	161	527
11	665	3,710	99	2,900	778	8,430	26	21	9,240	1,440	210	820
12	343	201	4,670	2,280	1,510	9,000	75	51	8,220	4,190	147	1,490
13	1,310	188	1,540	1,320	918	6,790	68	52	1,520	13,400	5,690	1,030
14	722	161	6,960	770	9,390	4,750	67	20	375	1,190	14,500	1,330
15	150	1,000	3,420	228	3,020	1,130	2,640	42	1,260	161	4,380	625
16	692	1,310	1,750	17	2,290	716	6,720	406	5,380	174	5,180	507
17	2,220	266	6,350	7,780	3,100	1,250	10,400	102	3,600	2,210	853	296
18	626	182	3,330	9,780	4,740	372	850	13	2,180	14,700	2,870	217
19	325	1,040	1,660	377	1,140	1,770	404	9	2,300	16,600	4,960	341
20	240	685	1,570	1,000	1,220	13,900	1,220	8.3	1,800	6,890	4,080	75
21	151	1,270	2,350	490	2,330	7,090	1,500	7.1	1,540	3,160	18,600	408
22	221	1,900	454	315	215	23,200	365	7	395	508	6,990	10,600
23	58	1,370	2,750	430	3,510	3,040	34	11	24	3,100	3,620	1,870
24	623	2,910	2,070	352	2,580	635	20	28	25	4,300	2,580	720
25	235	6,410	178	538	1,660	560	1,520	9.8	21	7,260	876	398
26	697	6,210	2,150	3,530	735	3,290	3,090	24	20	1,240	366	105
27	6,420	2,920	235	1,800	407	2,710	1,270	123	56	456	282	340
28	3,040	1,280	151	146	331	959	340	29	20	135	16	148
29	654	59	85	35	1,990	2,130	41	155	20	333	16	81
30	176		152	132	1,740	1,190	234	85	20	14	79	87
31	142		5,690		918		608	11,400		15,800		553

Table 2.3.1-16
Minimum of the Daily Mean Flows for the Guadalupe River at Victoria, Texas, USGS Gage 08176500

Day of Month	Min. of daily mean values for each day of record in, cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	127	132	181	113	103	71	47	41	92	22	46	50
2	121	119	188	168	138	71	47	43	81	22	44	50
3	128	147	161	148	106	68	47	44	68	23	46	53
4	119	231	181	127	95	64	47	43	68	24	95	48
5	118	171	181	111	98	59	46	37	66	23	95	46
6	118	126	181	106	106	62	44	29	66	24	100	46
7	116	113	188	111	116	62	44	35	61	30	79	48
8	132	126	174	102	128	61	43	40	66	32	66	48
9	119	111	162	95	106	62	40	37	61	30	54	56
10	113	142	165	94	95	62	40	36	61	25	47	58
11	103	132	174	90	84	66	50	30	66	25	43	53
12	118	116	119	182	79	62	50	25	74	22	48	47
13	108	133	145	210	84	62	76	30	69	20	47	54
14	105	121	134	154	84	59	90	36	58	25	44	52
15	103	239	157	116	90	56	76	37	48	49	54	56
16	116	239	161	94	174	53	71	35	44	54	59	56
17	105	248	181	87	188	56	56	30	41	29	54	50
18	97	231	122	87	328	48	47	25	44	95	56	105
19	150	181	164	82	286	56	40	17	44	91	58	168
20	113	168	154	82	254	56	43	14	44	91	50	144
21	105	208	160	82	188	53	47	25	44	95	43	76
22	121	194	164	79	138	52	41	30	37	95	41	174
23	134	248	160	79	103	58	37	29	36	98	41	174
24	106	231	158	90	87	73	44	29	37	97	48	130
25	110	181	142	81	90	68	47	28	37	94	44	106
26	128	194	158	162	84	61	52	32	35	84	41	188
27	105	208	119	160	89	58	58	52	30	73	39	201
28	113	181	151	188	79	54	53	53	24	64	43	188
29	108	231	168	155	79	50	44	53	19	58	46	181
30	130		134	138	78	47	37	52	19	53	41	165
31	174		113		71		37	87		50		161

Table 2.3.1-17
Minimum of the Daily Mean Flows for the San Antonio River at Goliad, USGS Gage 08188500

Day of Month	Min. of daily mean values for each day of record in, cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	81	103	78	63	57	28	6.8	25	37	62	62	76
2	81	102	76	60	57	49	12	23	47	70	66	78
3	81	105	84	58	56	44	19	21	48	44	63	78
4	88	103	84	53	51	23	21	16	48	48	58	78
5	87	108	94	66	45	23	21	18	48	89	62	78
6	84	103	89	78	41	20	20	22	48	72	62	78
7	81	103	78	75	40	14	21	15	46	69	65	78
8	84	86	75	69	40	14	21	16	48	68	63	78
9	92	86	80	69	43	16	25	21	48	56	66	78
10	89	99	76	103	44	24	23	19	47	49	70	74
11	83	97	76	105	59	20	20	16	47	47	78	76
12	83	94	81	89	55	7.2	26	17	54	46	78	65
13	86	102	83	76	56	5	55	18	49	46	78	53
14	84	112	78	78	52	2.1	65	19	46	63	78	52
15	91	108	84	72	66	5	63	16	60	62	78	55
16	89	94	95	69	90	3.4	66	16	65	74	72	65
17	84	84	92	68	90	2.3	51	18	65	67	66	69
18	86	84	89	62	81	9.8	42	20	86	61	66	79
19	94	94	86	62	71	24	34	21	74	61	78	82
20	87	95	78	55	86	35	22	27	74	55	78	84
21	84	89	86	55	93	56	19	24	63	61	76	87
22	107	89	92	59	86	46	27	22	55	61	76	86
23	97	83	105	57	76	56	35	43	62	61	75	82
24	97	87	94	60	63	58	23	37	59	62	75	86
25	97	89	84	63	59	60	23	43	52	60	76	89
26	94	92	86	63	58	43	27	43	48	60	69	92
27	97	84	84	71	54	28	32	37	46	59	70	91
28	108	84	83	65	83	22	25	44	39	65	78	89
29	102	87	76	60	62	16	25	37	39	62	75	92
30	92		78	56	32	8.2	39	37	51	56	76	88
31	103		76		28		34	20		59		83

Table 2.3.1-18
Minimum of the Daily Mean Flows for Coleto Creek near Victoria, Texas, USGS Gage 08177500

Day of Month	Min. of daily mean values for each day of record in, cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.9	0.2	2.4	2	2.2	0.17	0	0	0.71	0.58	1.7	0.71
2	1.9	0.2	2.2	2.1	1.2	0.13	0.02	0	0.79	0.57	1.8	1.5
3	2	0.18	0	2	1.1	0.09	0.02	0	1	0.56	1.8	1.7
4	1.5	0.19	0	1.9	1.1	0.06	0.01	0	1	0.53	2.1	1.7
5	0.8	2.2	0	2	1.9	0.05	0	0	0.98	0.51	2.2	1.4
6	0.72	2	0	1.9	0	0.04	0	0	0.66	0.51	1.9	1
7	0.68	1.8	0	1.9	0	0.03	0	0	0.66	1.6	2	0.92
8	0.7	1.9	0	2	1.3	0.44	0	0	0.66	0.67	1.8	1.6
9	0.71	1.8	2.1	2	2.3	0.07	0	0.01	0.65	0.52	1.7	1.6
10	0.7	1.8	2.1	2	2	0.03	0	0.01	0.66	0.47	1.6	1.6
11	0.69	1.8	2.1	2	2	0.03	0	0.02	1.2	0.43	1.5	1.5
12	2	2	2	1.8	2	0.02	0	0.02	1.2	0.41	1.4	1.5
13	2	2	1.9	1.7	2	0.02	0	0.02	1.3	0.41	1.4	1.5
14	2	1.9	1.9	1.8	2	0.02	0	0.02	1.3	0.42	1.4	1.5
15	1.9	1.9	1.8	1.8	1.6	0.02	0	0.03	1.5	0.4	1.4	1.8
16	0.43	1.9	1.9	1.7	0.89	0.02	0.17	0.03	1.4	0.39	1.5	1.9
17	0.27	1.9	1.9	1.6	0.66	0.01	0.02	0.03	1.3	0.39	1.5	1.1
18	0.65	1.9	2	1.5	0.64	0.01	0.01	0.03	1.4	0.38	1.6	1.8
19	0.6	1.9	2	1.5	0.55	0	0	0.03	1.3	0.41	1.5	2
20	1.9	1.9	2.1	1.3	0.47	0	0	0.05	1.3	0.45	1.5	0.58
21	1.7	1.9	2.2	1.3	0.41	0	0	0.07	1.4	0.41	1.4	1.2
22	0.32	1.6	2.1	1.3	0.37	0.01	0	0.09	1.3	0.43	1.3	0.75
23	0.19	1.6	2.1	1.2	0.35	0	0	0.11	1.3	1.5	1.3	0.72
24	0.2	1.8	2	1.2	0.33	0	0	0.14	1.2	1.5	1.5	1.9
25	0.2	1.9	2.1	1	0.31	0	0	0.17	0.96	1.5	1.1	2
26	0.19	1.9	2.2	0.95	0.29	0.01	0	0.2	0.75	1.5	0.83	2.1
27	0.17	1.8	2.3	1	0.27	0.01	0.01	0.23	0.67	1.5	0.71	1.2
28	0.18	1.9	2.2	0.95	0.24	0	0.01	0.32	0.65	1.4	0.71	0.93
29	0.18	2.2	2.1	1.1	0.2	0	0	0.36	0.62	1.5	0.77	0.7
30	0.16		1.9	2.5	0.17	0	0	0.73	0.6	1.6	0.69	0.74
31	0.19		2		0.2		0	0.71		1.6		0.63

Table 2.3.1-19
Guadalupe River Peak Discharge Frequency at Confluence with Coleto Creek

Flooding Source And Location	Drainage Area (square miles)	Peak Discharges (cfs)			
		10-Year	50-Year	100-Year	500-Year
Guadalupe River at confluence of Coleto Creek	5200	48,000	99,000	129,000	219,000

Source: FEMA 1998

Table 2.3.1-20
Suspended Sediment Concentrations for the Guadalupe River at Victoria, Texas
USGS Gage 08176500

Date	Concentration (mg/l)	Date	Concentration (mg/l)	Date	Concentration (mg/l)	Date	Concentration (mg/l)
1/8/1973	34	6/24/1976	56	10/2/1979	79	5/8/1985	144
2/14/1973	52	7/21/1976	129	11/6/1979	83	7/10/1985	192
3/12/1973	67	8/19/1976	67	12/12/1979	65	10/10/1985	64
4/17/1973	709	9/23/1976	52	1/17/1980	77	1/16/1986	46
6/25/1973	281	10/21/1976	319	2/12/1980	63	4/23/1986	110
7/26/1973	272	11/19/1976	79	3/11/1980	51	9/3/1986	41
8/29/1973	94	12/16/1976	205	4/8/1980	53	10/23/1986	114
9/25/1973	66	1/13/1977	55	5/6/1980	75	2/11/1987	52
10/24/1973	137	2/17/1977	90	6/11/1980	99	6/23/1987	331
11/13/1973	128	3/17/1977	66	7/9/1980	63	8/19/1987	135
12/11/1973	38	4/14/1977	81	8/7/1980	72	10/14/1987	55
1/15/1974	310	5/12/1977	221	9/10/1980	1210	3/1/1988	75
2/20/1974	32	6/9/1977	77	10/15/1980	54	6/29/1988	72
3/19/1974	40	7/14/1977	57	11/13/1980	32	8/10/1988	153
4/23/1974	35	8/18/1977	86	12/9/1980	16	11/9/1988	15
5/21/1974	88	9/15/1977	110	1/7/1981	35	3/8/1989	21
6/25/1974	52	10/20/1977	90	2/4/1981	45	6/15/1989	96
7/23/1974	48	11/10/1977	270	3/5/1981	59	8/16/1989	37
8/28/1974	31	12/8/1977	62	4/9/1981	134	10/17/1989	45
9/24/1974	89	1/26/1978	30	5/15/1981	102	3/6/1990	49
10/23/1974	26	2/16/1978	39	6/22/1981	255	5/24/1990	15
11/14/1974	123	3/16/1978	28	7/17/1981	193	9/5/1990	34
12/11/1974	574	4/24/1978	431	8/21/1981	146	10/30/1990	20
1/30/1975	22	5/22/1978	13	9/18/1981	135	3/6/1991	44
2/20/1975	379	6/12/1978	205	11/19/1981	112	5/21/1991	85
3/27/1975	67	7/17/1978	42	2/10/1982	57	9/5/1991	75
4/23/1975	170	8/22/1978	295	3/30/1982	96	10/23/1991	33
5/22/1975	602	9/26/1978	352	5/3/1982	55	2/12/1992	311
6/18/1975	168	10/17/1978	32	7/26/1982	103	4/7/1992	241
7/17/1975	498	11/7/1978	187	9/1/1982	74	8/28/1992	90
8/20/1975	40	12/20/1978	21	10/14/1982	78	10/15/1992	108
9/18/1975	19	1/16/1979	350	1/12/1983	33	3/9/1993	69
10/23/1975	18	2/21/1979	78	4/12/1983	89	5/3/1993	84
11/20/1975	24	3/20/1979	73	8/23/1983	64	8/20/1993	59
12/10/1975	11	4/10/1979	162	10/12/1983	21	11/15/1993	88
1/22/1976	9	5/9/1979	223	1/17/1984	26	3/25/1994	60
2/26/1976	25	6/5/1979	195	4/11/1984	73	5/17/1994	409
3/25/1976	29	7/12/1979	141	7/11/1984	62	8/25/1994	35
4/29/1976	327	7/31/1979	299	10/17/1984	608		
5/27/1976	317	8/29/1979	64	1/23/1985	147		

Table 2.3.1-21
Suspended Sediment Concentrations for the San Antonio River at Goliad, Texas
USGS Gage 08188500

Date	Concentration (mg/l)	Date	Concentration (mg/l)	Date	Concentration (mg/l)	Date	Concentration (mg/l)
10/24/1974	102	3/15/1978	78	4/10/1981	81	12/14/1987	87
11/14/1974	145	4/25/1978	2450	5/14/1981	186	3/1/1988	62
12/12/1974	885	5/23/1978	295	6/23/1981	262	4/12/1988	103
1/30/1975	111	6/28/1978	87	7/16/1981	380	6/28/1988	104
2/21/1975	250	7/19/1978	84	8/20/1981	179	8/9/1988	89
3/27/1975	160	8/23/1978	181	9/18/1981	361	11/8/1988	63
4/24/1975	138	9/28/1978	265	11/16/1981	149	1/26/1989	145
5/22/1975	231	10/18/1978	243	3/29/1982	80	3/7/1989	71
6/18/1975	322	11/8/1978	2350	5/3/1982	51	5/10/1989	146
7/17/1975	187	12/19/1978	46	7/26/1982	104	6/13/1989	66
8/21/1975	95	1/17/1979	358	8/31/1982	85	8/15/1989	135
9/18/1975	700	2/22/1979	125	10/13/1982	1460	10/17/1989	93
10/22/1975	92	3/21/1979	1380	1/10/1983	57	3/6/1990	486
11/20/1975	71	4/10/1979	260	2/22/1983	142	5/23/1990	5
12/10/1975	54	5/8/1979	100	4/11/1983	138	7/11/1990	80
1/21/1976	67	5/9/1979	390	7/11/1983	176	9/4/1990	90
2/25/1976	78	6/6/1979	706	10/11/1983	66	10/29/1990	78
3/24/1976	398	6/6/1979	77	1/16/1984	105	1/31/1991	141
4/28/1976	493	7/11/1979	124	2/28/1984	63	3/6/1991	83
5/26/1976	475	7/30/1979	106	4/9/1984	83	5/21/1991	184
6/23/1976	137	8/1/1979	442	7/9/1984	78	7/9/1991	540
7/21/1976	417	8/28/1979	148	8/21/1984	186	9/5/1991	425
8/18/1976	152	8/28/1979	68	10/17/1984	1840	10/23/1991	88
9/22/1976	740	10/3/1979	67	1/22/1985	189	12/18/1991	384
10/20/1976	701	11/5/1979	57	3/11/1985	70	2/12/1992	580
11/18/1976	163	12/5/1979	54	5/7/1985	86	4/8/1992	487
12/15/1976	564	1/15/1980	66	7/8/1985	647	6/11/1992	523
1/12/1977	145	2/13/1980	55	8/12/1985	138	8/29/1992	151
2/16/1977	226	3/10/1980	15	10/9/1985	98	10/15/1992	69
3/16/1977	122	4/9/1980	113	1/14/1986	56	1/11/1993	87
4/13/1977	169	5/5/1980	459	2/25/1986	38	3/9/1993	87
5/11/1977	355	6/9/1980	110	4/23/1986	66	5/3/1993	235
6/8/1977	276	7/9/1980	70	7/16/1986	208	7/12/1993	1520
7/13/1977	109	8/5/1980	101	9/3/1986	121	8/18/1993	248
8/17/1977	100	9/9/1980	905	10/21/1986	234	11/15/1993	86
9/14/1977	112	10/14/1980	50	12/8/1986	47	1/18/1994	98
10/19/1977	65	11/12/1980	38	2/10/1987	201	3/24/1994	205
11/9/1977	1240	12/10/1980	66	4/14/1987	89	5/16/1994	685
12/8/1977	61	1/8/1981	60	6/23/1987	793	7/12/1994	76
1/25/1978	67	2/2/1981	79	8/18/1987	125	8/25/1994	68
2/16/1978	130	3/3/1981	69	10/13/1987	85		

2.3.1.2 Groundwater

Regional and local groundwater resources that could be affected by the construction and operation of VCS are described below. The regional and site-specific data on the physical and hydrologic characterization of these groundwater resources are summarized in order to provide the basic data for an evaluation of impacts on the aquifers of the area.

The VCS site covers an area of approximately 11,500 acres and is located on the coastal plain of southeastern Texas in Victoria County, south of the city of Victoria, Texas. The approximately 4900-acre VCS cooling basin is the predominant feature of the VCS site. The basin is fully enclosed with a compacted earth embankment and encompasses most of the southern and central portion of the site. The VCS power block area is located on the northern portion of the site, adjacent to the northern embankment of the cooling basin.

Note that all references to elevations given in this subsection are to North American Vertical Datum of 1988 (NAVD 88), unless otherwise specified.

2.3.1.2.1 Description and Onsite Use

This subsection contains a description of the regional and local physiography and geomorphology, groundwater aquifers, geologic formations, and groundwater sources and sinks. Regional and onsite uses of groundwater are described in Subsection 2.3.2.2, including groundwater production and groundwater flow requirements of the VCS site.

2.3.1.2.1.1 Physiography and Geomorphology

The VCS site is located in Victoria County, Texas, approximately 21 miles north of San Antonio Bay. The closest community is McFaddin, which is located approximately 4 miles from the power block area and approximately 1 mile southwest of the VCS site boundary (Figure 2.3.1.2-1). The closest city is Victoria, located approximately 13 miles north of the VCS site.

The VCS site and surrounding region are situated in the Coastal Prairies sub-province of the Gulf Coastal Plains physiographic province. The Coastal Prairies sub-province forms a broad band of nearly flat prairies along the Texas Gulf Coast (Figure 2.3.1.2-2). Ground surface elevation varies from approximately 0 feet along the coast to approximately 300 feet along the western boundary of the sub-province (Bureau of Economic Geology 1996).

Victoria County is located within the gently rolling plains of South Texas. The ground surface elevation of the plains in Victoria County varies from approximately 100 feet in the moderately dissected upland in the west to approximately 0 feet in the east at the Gulf of Mexico. Regional surface slopes vary from approximately 0 percent to 8 percent, with more pronounced slopes near surface water bodies (Uddameri 2008a). The VCS site is located on a relatively flat plain west of the Guadalupe River valley, downstream (south) of the city of Victoria, Texas. The topographic features of the approximately 11,500 acre VCS site shown in Figure 2.3.1.2-3 are as follows:

- Gently sloping plains cover most of the VCS site. The plains exhibit approximately 20 feet of natural relief in the 10-mile distance between the northwestern and southeastern property boundaries. Ground surface elevation ranges from approximately 85 feet on the northwest side of the VCS site to approximately 65 feet on the southeast side of the VCS site, except where the site slopes down to the Guadalupe River along its eastern boundary. The planned post-construction ground surface elevation for the power block buildings on the northwest side of the VCS site is approximately 95 feet.

- A 50- to 65-foot escarpment is located to the northeast of the VCS cooling basin and separates Linn Lake to the east from the higher elevations of the VCS site. Linn Lake is at an elevation of approximately 15 feet and flows into the Guadalupe River near the southeastern site boundary.

- A gully associated with Kuy Creek is located to the southwest of the VCS cooling basin. Kuy Creek is generally classified as a perennial stream. However, field observations made during the site subsurface investigation indicate that the upper reaches of Kuy Creek adjacent to the VCS cooling basin are ephemeral. The emergency spillway for the VCS cooling basin is to Kuy Creek.

- A gully associated with Dry Kuy Creek, an ephemeral stream, is located at the south-southeastern boundary of the VCS site and extends to the northwest, into the site area to be enclosed by the VCS cooling basin.

- There are several unnamed ephemeral streams located throughout the site. Most are tributaries to Dry Kuy Creek; the others flow to Linn Lake to the east or Kuy Creek to the southwest. Dry Kuy Creek flows southeast into Kuy Creek, which drains into the Guadalupe River. The Guadalupe River flows southeasterly, and is intersected by the San Antonio River southeast of the site boundaries.

- The drainage pattern in the vicinity of the VCS site is generally dendritic, with the local tributaries draining either to the Guadalupe or San Antonio rivers and then to San Antonio Bay.

- Additional landforms present at the VCS site include fluvial terraces, river paleochannels, point bars, natural levees, backswamp deposits, relict barrier islands/dunes, and younger alluvial and man-made (fill) deposits. These landforms are consistent with the geomorphology of the Beaumont Formation.

2.3.1.2.1.2 Regional Groundwater Aquifers

The VCS site is located within the Coastal Prairies sub-province characterized by deltaic sands and muds. The VCS site is underlain by a thick wedge of southeasterly dipping sedimentary deposits of Oligocene through Holocene age. The site overlies what has been referred to as the "Coastal Lowland Aquifer System". This aquifer system contains numerous local aquifers in a thick sequence of mostly unconsolidated Coastal Plain sediments of alternating and interfingering beds of clay, silt, sand, and gravel. The sediments reach thicknesses of thousands of feet and contain groundwater that ranges from fresh to saline. The majority of groundwater usage is for municipal, industrial, and irrigation needs (Ryder 1996).

The lithology of the aquifer system is generally sand, silt, and clay and reflects three depositional environments: continental (alluvial plain), transitional (delta, lagoon, and beach), and marine (continental shelf). The depositional basin thickens toward the Gulf of Mexico, resulting in a wedge-shaped configuration of hydrogeologic units. Numerous oscillations of ancient shorelines resulted in a complex, overlapping mixture of sand, silt, and clay (Ryder 1996).

As part of the U.S. Geological Survey's (USGS) Regional Aquifer-System Analysis program, the aquifer system was subdivided into five permeable zones and two confining units. The term "Gulf Coast Aquifer" is generally used in Texas to describe the composite of the sands, silts, and clays of the Coastal Lowland Aquifer System as shown in Figure 2.3.1.2-4 (TWDB 2006a).

Figure 2.3.1.2-5 compares the Gulf Coast Aquifer and the Coastal Lowlands Aquifer System terminologies. Hydrogeologic cross sections of the Coastal Lowlands Aquifer System and the Gulf Coast Aquifer are shown in Figures 2.3.1.2-6 and 2.3.1.2-7, respectively (Ryder 1996 and Baker 1979). The Gulf Coast Aquifer nomenclature will be used to describe the hydrogeologic units at the VCS site.

The Gulf Coast Aquifer is subdivided into four major hydrogeologic units based on sedimentary formations and hydraulic properties. These include, from deepest to shallowest:

- The Catahoula Confining System, which includes the Frio Formation, Anahuac Formation, and the Catahoula Tuff or Sandstone (Chowdhury et al. 2006).

- The Jasper Aquifer, which consists of the Oakville Sandstone and the Fleming Formation. The upper part of the Fleming Formation forms the Burkeville confining system (Chowdhury et al. 2006).
- The Evangeline Aquifer, which consists of the Goliad Sand (Chowdhury et al. 2006).
- The Chicot Aquifer, which consists of the Willis Formation, Lissie Formation (undifferentiated Bentley and Montgomery formations), Beaumont Formation, and surficial alluvial deposits (Chowdhury et al. 2006).

The base of the Gulf Coast Aquifer is identified as either its contact with the top of the Eocene/ Oligocene Vicksburg-Jackson Confining Unit or the approximate depth where the concentration of total dissolved solids in groundwater exceeds 10,000 milligrams per liter (mg/L). The base of the aquifer varies from approximately elevation 300 feet near the updip limit to approximately elevation -6000 feet midway between the updip limit and the coastline (Ryder 1996).

The Gulf Coast Aquifer is recharged by the infiltration of precipitation that falls on topographically high aquifer outcrop areas in the northern and western portion of the province. Discharge occurs by evapotranspiration, loss of water to streams and rivers as base flow, upward leakage to shallow aquifers in low lying coastal areas or in the Gulf of Mexico, and pumping (Ryder 1996).

Groundwater in the Gulf Coast Aquifer is generally under confined conditions, except for shallow zones in outcrop areas. In the shallow zones, the specific yield for sandy deposits generally ranges from 10 percent to 30 percent. For confined aquifers, the storage coefficient is estimated to range from 1×10^{-4} to 1×10^{-3} (Ryder 1996).

The productivity of the aquifer system is directly related to the thickness of the sands in the aquifer system that contain freshwater. The thickness of the aggregated sand within the aquifer ranges from 0 feet at the updip limit of the aquifer system to as much as 2000 feet in the east. Estimated values of transmissivity are reported to range from approximately 5000 to 35,000 square feet/day (37,000 to 261,800 gallons per day/foot, or gpd/foot) (Ryder 1996).

Groundwater quality in the Gulf Coast Aquifer in the vicinity of Victoria County is generally characterized as good, northeast of the San Antonio River, but declines to the southwest due to increased chloride concentrations and saltwater intrusion near the coast (Chowdhury et al. 2006). The Gulf Coast Aquifer has not been declared a sole-source aquifer by the U.S. EPA in Texas. A sole-source aquifer is defined as the sole or principal source of drinking water that supplies 50 percent or more of drinking water for an area, with no reasonably available alternative source should the aquifer become contaminated. Figure 2.3.1.2-8 shows the location of sole-source aquifers in EPA Region 6, which encompasses the VCS site. The nearest Texas sole-source aquifer is the Edwards I and II Aquifer system, which is located approximately 150 miles northwest of the VCS site (U.S. EPA 2008a).

The identified sole-source aquifers are beyond the boundaries of the local and regional hydrogeologic systems associated with the VCS site. Therefore, the VCS site is not expected to impact any of the sole-source aquifers.

2.3.1.2.1.3 Local Hydrogeology

Victoria County covers an area of approximately 890 square miles and is bounded by Jackson County to the east, DeWitt County to the north, Goliad County to the west, and Calhoun and Refugio Counties to the south. Much of the land use in Victoria County is agriculture (26 percent rangeland and 42 percent cropland and pasture), forest (approximately 27 percent), or urban development (3.5 percent). The remaining few percent of land use is mixed use or surface water. Surface water covers only a small portion of the land surface in Victoria County (0.01 percent bays and estuaries, 0.13 percent streams and canals, and 0.21 percent reservoirs and lakes). The lack of surface water resources in the county highlights the importance of groundwater for stock watering, irrigation, and water supply (Uddameri 2008a).

Groundwater usage in Victoria County is under the jurisdiction of the Victoria County Groundwater Conservation District (VCGCD). The estimated groundwater usage in Victoria County in 1997 was approximately 27,500 acre-feet per year (24.5 million gpd). Groundwater demand has subsequently decreased because the city of Victoria shifted to using surface water for most of its needs in 2001. Current groundwater usage is estimated to be approximately 20,000 acre-feet per year (17.8 million gpd). The estimated surface water usage in Victoria County in 1997 was approximately 29,000 acre-feet per year (25.9 million gpd), with the largest user group being manufacturing (Uddameri 2008a).

The Guadalupe and San Antonio rivers, Linn Lake, San Antonio Bay, the Victoria Barge Canal, Coleto Creek, and Coleto Creek Reservoir are the major surface water bodies in Victoria County. Many ephemeral streams are also present in Victoria County, with stream flow largely influenced by precipitation. Victoria County is situated in a humid, subtropical climate characterized by mild winters and hot summers and is subject to tropical disturbances from the Gulf of Mexico. Therefore, rainfall in Victoria County tends to exhibit spatial and temporal variability (Uddameri 2008a).

A water balance was performed for Victoria County using the average annual precipitation, which was approximately 39 inches from 1951 to 1980. The corresponding average annual runoff was approximately 7 inches. The remaining 32 inches of precipitation evaporated, was transpired by plants, or percolated into the subsurface to recharge the shallow aquifers (Ryder 1996).

The surficial soils in Victoria County tend to limit recharge because they are composed of low-permeability silt and clay intermingled with sand. Recharge in Victoria County is estimated to range from 10,000 to 30,000 acre-feet per year (8.9 to 26.8 million gpd). The northwestern portions of Victoria County exhibit more porous soils and receive higher precipitation, making these areas more suitable for recharge to the shallow aquifers in the vicinity of the VCS site, located in southern Victoria County (Uddameri 2008a).

The principal aquifers in Victoria County are the Chicot and Evangeline Aquifers. As shown in Figure 2.3.1.2-7, the shallower Chicot Aquifer extends to an elevation of approximately –300 feet and the deeper Evangeline Aquifer extends to an elevation of approximately –1000 feet, respectively, in the vicinity of the VCS site. Regional groundwater flow is generally to the southeast from the recharge areas in the northwestern parts of Victoria County toward the Gulf of Mexico (Figure 2.3.1.2-9). Groundwater flow is described in more detail in Subsection 2.3.1.2.2.2.

The Goliad Sand of the Evangeline Aquifer and the Willis Formation, Lissie Formation, Beaumont Formation, and Holocene alluvium of the Chicot Aquifer are the primary stratigraphic units at the VCS site and surrounding area. The following sections describe the pertinent details of these geologic units.

2.3.1.2.1.3.1 Goliad Sand

The Pliocene Goliad Sand consists of whitish- to pinkish-gray, coarse-grained sediments, including cobbles, clay balls, and wood fragments at the base of the formation. The upper part of the Goliad Sand consists of finer-grained sands cemented together with caliche. The sands are interbedded with grayish clays, which are locally marly. The presence of caliche, gravel, and irregular bedding are indicative of a high-energy fluvial depositional environment in the early Pliocene, followed by semi-arid periods later in the Pliocene. The top of the Goliad Sand forms the hydrogeologic boundary between the Evangeline and Chicot Aquifers (Chowdhury and Turco 2006).

2.3.1.2.1.3.2 Willis Formation

The Pleistocene Willis Formation consists of reddish, gravelly, unfossiliferous coarse sand. Sediments of the Willis Formation are fluvial and deltaic deposits in coarsening-upward sequences, indicative of delta-front facies (Chowdhury and Turco 2006).

2.3.1.2.1.3.3 Lissie Formation

The Pleistocene Lissie Formation consists of reddish, orange, and gray, fine- to coarse-grained, cross-bedded sands. The sediments of the Lissie Formation represent sand, silt, and mud deposited on flood plains or in river deltas. The undifferentiated Lissie Formation is considered equivalent in age to the Bentley and Montgomery formations. However, the heterogeneity of the sediments, discontinuity of the beds, and the general absence of index fossils and diagnostic electrical log signatures make correlation of the lithologic units difficult. The undifferentiated Lissie Formation and the Bentley Formation are generally considered the base of the Pleistocene, while the Montgomery Formation is occasionally included in the younger Beaumont Formation (Chowdhury and Turco 2006).

2.3.1.2.1.3.4 Beaumont Formation

The Pleistocene Beaumont Formation consists of poorly bedded, marly, reddish-brown clay interbedded with lenses of sand. Sediments of the Beaumont Formation represent natural levees and deltas deposited largely by rivers and, to a lesser extent, water from shallow-marine and lagoonal bays and embayments. The clays of the Beaumont Formation retard any significant infiltration of rainwater (Chowdhury and Turco 2006).

A total of 11 sand layers and 9 clay layers were identified at the VCS site based on the results of the geotechnical investigation described in detail in Subsection 2.5.4 of the Site Safety Analysis Report (SSAR). The interbedded sands and clays found at the VCS site are considered to be consistent with the Beaumont Formation.

2.3.1.2.1.3.5 Holocene Alluvium

The Holocene alluvium consists of fluvial basin and flood plain deposits. The fluvial basin deposits consist of terrace gravels, buried sand deposits, and point bar deposits with grain sizes ranging from clay to gravel. The flat-lying floodplain deposits consist of sand and gravel in the lower part and silt and clay in the upper part. Holocene alluvium occurs in a relatively narrow band surrounding the rivers. The alluvial deposits are typically coarser-grained than the materials found in the Beaumont Formation. Because the alluvial materials are deposited in a channel incised into the Beaumont Formation, it is likely that the alluvium is in contact with the shallow aquifer units in the Beaumont Formation.

The Holocene alluvium only occurs locally, and cannot be correlated on a regional scale. It is, therefore, typically included in the Chicot Aquifer. The Holocene alluvium exhibits the largest outcrop area of the stratigraphic units in the Texas Gulf Coast and provides a direct hydraulic connection between surface water and groundwater in some cases (Chowdhury and Turco 2006).

2.3.1.2.1.4 Site Specific Hydrogeology

A subsurface investigation was conducted at the VCS site between October 2007 and February 2008 to evaluate soil and groundwater conditions to depths of approximately 600 feet below ground surface (bgs). Subsurface information was collected from more than 200 geotechnical borings, geologic/geophysical borings, cone penetrometer tests (CPTs), shallow test pits, groundwater observation and test wells, and borehole permeameter tests. A supplemental geotechnical subsurface field investigation was conducted in late 2008 within the vicinity of the power block area.

A detailed description of the geotechnical investigation, including the location of these borings and CPTs, boring logs, and soil testing data is provided in SSAR Subsection 2.5.4. A summary of the groundwater field investigation is discussed in this subsection.

- Groundwater observation wells: Twenty-seven groundwater observation well pairs (or 54 individual observation wells) were installed throughout the site. These wells were completed to depths ranging from approximately 45 to 155 feet bgs and were installed to provide an adequate distribution for determining groundwater flow directions and hydraulic gradients beneath the site. Well pairs were selected to determine vertical gradients between the aquifer subunits.

- Slug tests: Field hydraulic conductivity tests (slug tests) were conducted in each of the 54 observation well. The results of the slug tests are discussed in Subsection 2.3.1.2.2.4.1.

- Aquifer pumping tests: Two aquifer pumping test well clusters, each consisting of one test well (pumping well) and four water level observation wells, were installed. A shallow test well and a deep test well were installed to a depths of approximately 80 feet and 180 feet bgs, respectively. Aquifer pumping tests were conducted at each location. The aquifer pumping tests are discussed in Subsection 2.3.1.2.2.4.1.

- Borehole permeameter tests: Borehole permeameter tests were conducted at 16 borehole locations within the footprint of the VCS cooling basin. Permeameter tests were conducted at depths of 5 and 10 feet bgs in each borehole. The permeameter tests are discussed in Subsection 2.3.1.2.2.4.2.

Well installations began in October 2007 and were completed in February 2008. Figure 2.3.1.2-10 shows the locations of observation wells used to identify and characterize the aquifers at the VCS site. Table 2.3.1.2-1 presents the construction information for the observation wells. The groundwater observation wells at the VCS site are named in four series, which represent the location and screen intervals of the observation wells and are as follows:

- "OW" identifies groundwater observation wells. "TW" identifies aquifer pumping tests wells.
    - OW-00 series wells represent the first set of exploratory borings and observation wells installed at the VCS site. With the exception of OW-08U/L through OW-10U/L, the well pairs are located in the VCS cooling basin footprint.

- ▪ OW-2100 series wells, with the exception of OW-2185U/L, are located in the western VCS power block area.
- ▪ OW-2200 series wells are located in the eastern VCS power block area.
- ▪ OW-2300 series wells identify wells located outside of the power block area. With the exception of OW-2301U/L, OW-2307U/L, OW-2324U/L, and OW-2348U/L, the well pairs are located in the vicinity of the VCS cooling basin area.

- A "U" suffix in the observation well name indicates the shallower well of the well pair. The observation well is screened in either the Upper Shallow or Lower Shallow aquifer.
- An "L" suffix in the observation well name indicates the deeper well of the well pair. The observation well is screened in either the Lower Shallow or Deep aquifer.

A geotechnical interpretation of the subsurface conditions encountered across the VCS site was developed from the geotechnical properties described in SSAR Subsection 2.5.4. The series of cross sections presented in SSAR Subsection 2.5.4 illustrate the substrata of the power block area and across the cooling basin.

Three aquifer subsystems were identified at the VCS site based on the subsurface investigation. These include:

- The "Shallow aquifer," consisting of sand layers occurring from existing ground surface to a depth of approximately 120 feet bgs. The Shallow aquifer is further subdivided into the "Upper Shallow aquifer" (from approximately 50 to 80 feet bgs) and the "Lower Shallow aquifer" (from approximately 90 to 120 feet bgs). The Upper Shallow and Lower Shallow aquifers are interpreted as components of the Chicot Aquifer.
- The "Deep aquifer," consisting of sand layers occurring from approximately 130 to 280 feet bgs. The Deep aquifer is also interpreted as a component of the Chicot Aquifer.
- The Evangeline Aquifer, consisting of sand layers at depths greater than 500 feet bgs. Observation wells were not installed into the Evangeline Aquifer because the groundwater investigation at the VCS site was focused on shallow groundwater conditions that may have an impact or be impacted by construction and operation of the VCS.The primary source of water for the VCS is surface water from the cooling basin. Groundwater will be used as described in Subsection 2.3.2. The source of groundwater will be the Evangeline Aquifer. Published reports and data for the Evangeline Aquifer were used to evaluate aquifer properties, VCS production well requirements, and aquifer impacts (well locations, pumping rates, and area of influence of the production wells).

A summary of the well identification and the hydrogeologic units where the well is screened is presented in Table 2.3.1.2-2.

A conceptual hydrostratigraphic model was developed from the geotechnical cross sections to describe the shallow portion of the Chicot Aquifer at the site. This model subdivided the Chicot Aquifer into three units: a confined Deep aquifer and Lower Shallow aquifer, and a partially confined Upper Shallow aquifer. The Upper Shallow, Lower Shallow, and Deep aquifer designations are informal and are based primarily on the hydrogeologic conditions encountered during the subsurface site investigation and the resulting screen intervals of the observation wells. The sand layers at the site were also subdivided into geotechnical units based on soil properties described in SSAR Subsection 2.5.4. The following list relates the geotechnical sand units to the hydrogeological units:

Geotechnical Sand Unit	Hydrogeological Unit
Sand 1	Unsaturated sand zone
Sand 2	Upper Shallow aquifer
Sand 4	Lower Shallow aquifer
Sand 5, 6, and 8	Deep aquifer

Additionally, as discussed in Subsection 2.3.1.2.3.1, the conceptual site model developed and incorporated into a groundwater flow model consists of eleven sand and clay layers chosen to represent the aquifer units.

The top of the Deep aquifer is generally comprised of Sand 5 and/or Sand 6 strata. These strata are typically between 10 and 50 feet thick at the site. However, the top of the Deep aquifer may also include Sand 8 where the intervening confining Clay 7 is absent and Sand 8 is in direct contact with Sand 6. The entire Deep aquifer is considered to include all the strata from Sand 5 down to a depth of about 280 feet, where the top of the Goliad Sand, which separates the Chicot and Evangeline aquifers, is encountered.

Confining the top of the Deep aquifer is Clay 5-T, which at the site varies in thickness from about 5 to 30 feet and is absent at other locations. Above this unit is the Lower Shallow aquifer, which consists of the approximately 5 to 50-foot thick Sand 4. In places, such as at OW-09L and OW-2319U/L, the sand strata that comprise the Deep aquifer can directly contact with Sand 4 and effectively merge to form one aquifer. This is illustrated by the similar water levels between OW-2319U and OW-2319L.

The Lower Shallow aquifer is confined at the top by Clay 3, which ranges in thickness from less than 5 feet to about 50 feet and is absent at several locations at the site. One well (OW-04U) may be screened within a less permeable section of the Upper Shallow aquifer or may be absent at this location. Overlying Clay 3 is the Upper Shallow aquifer, which consists of Sand 2. Sand 2 is about five to 35 feet thick and is absent at some locations. In many areas Sand 2 and Sand 4 are in direct contact because the intervening Clay 3 is absent. In these areas (e.g., OW-03U/L) the Upper Shallow aquifer and the Lower Shallow aquifer are hydraulically connected, and groundwater would flow through these two sand strata as if they comprise one aquifer. At OW-03U/L, where the Shallow aquifers merge, the Upper Shallow aquifer well is typically dry, which indicates unconfined conditions in the Shallow aquifer system prevail at this location.

Above Sand 2 is Clay 1-B, which confines the Upper Shallow aquifer in most places. Above the Upper Shallow aquifer is the vadose zone, which is comprised of Sand 1 and Clay 1-T, with Clay 1-T exposed at the surface. However, in a few areas, Sand 1 is exposed where Clay 1-T is absent or eroded toward the Guadalupe River terrace. The Sand 1 stratum appears to pinch out north and northwest of the power block area to at least the northern site boundary. The vadose zone is generally about 30 to 40 feet thick at the site.

Monthly water level monitoring began in October 2007 with the installation of the first set of wells and continued through February 2009 to complete one year of monthly water level measurements for the complete set of wells installed at VCS. Quarterly water level monitoring was conducted in 62 of the 64 wells installed (excluding the two pumping test wells) through October 2010.

The groundwater level measurements collected from the VCS wells between October 2007 and October 2010 are discussed in the following subsections.

2.3.1.2.1.5 Groundwater Sources and Sinks

The natural regional flow pattern in the Chicot and Evangeline Aquifers is from recharge areas, where the sand layers outcrop at the surface, to discharge areas, which are either at the Gulf of Mexico or the Guadalupe River valley alluvium (for the Chicot Aquifer). The outcrop areas for the Chicot Aquifer sands are considered to be northern Victoria County and those areas north and west of the county. Groundwater within the Upper and Lower Shallow aquifer sands would discharge as seeps or base flow to local streams and rivers or migrate vertically to Deep aquifer. Groundwater within the Deep aquifer would discharge as base flow to the more predominant river valleys such as the Guadalupe River valley or to the Gulf of Mexico.

The outcrop areas for the Evangeline Aquifer are considered to be in areas north and west of Victoria County (Figures 2.3.1.2-4, 2.3.1.2-6, and 2.3.1.2-7). In the outcrop areas, precipitation falling on the ground surface can infiltrate directly into the sands and recharge the aquifer. Superimposed on this generalized flow pattern is the influence of heavy pumping within the aquifer. Concentrated pumping areas can alter or reverse the regional flow pattern. A further description of groundwater flow patterns is presented in Subsection 2.3.1.2.2.

The Holocene alluvium receives recharge from infiltration of precipitation and groundwater flow from the Shallow aquifer sands in the Beaumont Formation. In the vicinity of the site area, flow paths in the alluvium are considered to be short due to the limited surface area. Discharge from the Holocene alluvium contributes to the base flow of the main rivers in the area.

The predominant surface water feature at the VCS site will be the approximately 4900-acre VCS cooling basin. As shown in Figure 2.3.1.2-3, this surface water body encompasses the majority of the southern and western portions of the site. The design pool level of the approximately 4900-acre cooling basin is elevation 90.5 feet, imposing a maximum hydraulic head of up to 25 feet above the existing ground surface in the southeastern portion of the site. The planned bottom of the VCS cooling basin is at an elevation of 69.0 feet. The capacity of the VCS cooling basin at the normal operating level will be approximately 103,600 acre-feet.

The VCS cooling basin will experience seepage through the impoundment floor to the subsurface, through the embankment, and through the spillway. The cooling basin will be fully enclosed by a compacted earth embankment dam. The embankment dam will be constructed of compacted, low permeability, clay fill that will reduce seepage from the cooling basin. Seepage from the cooling basin through the embankment dam will be intercepted, in part, by drainage ditches around the outside of the embankment dam that will discharge to surface water at various locations.

Seepage from the VCS cooling basin to the subsurface is predicted to be approximately 4000 gpm (3930 gpm), based on the results of the groundwater modeling described in Subsection 2.3.1.2.3.

2.3.1.2.1.5.1 Site-Specific Groundwater Recharge

Groundwater flow at the VCS in the Chicot Aquifer is generally to the east towards the Guadalupe River valley as described in Subsection 2.3.1.2.1.5. The Beaumont Formation crops out over much of the VCS site and receives minor to insignificant recharge from infiltration of precipitation. The Holocene alluvium, which crops out along Linn Lake and the San Antonio and Guadalupe Rivers, receives recharge from infiltration of precipitation and groundwater flow from the Chicot Aquifer.

The construction and operation of the cooling basin at the VCS site will result in the removal of approximately 4900 acres of surface drainage area west of Linn Lake. The reduced drainage area will decrease surface recharge to both the Beaumont Formation and the alluvium. However, unmitigated seepage from the basin will increase groundwater contributions to Kuy and Dry Kuy Creeks and downgradient seeps by more than two orders of magnitude above preconstruction seepage amounts. Seepage from the VCS cooling basin into the subsurface is described in greater detail in Subsection 2.3.1.2.3.2.1.

2.3.1.2.1.5.2 Site-Specific Groundwater Discharge

The primary areas for groundwater discharge at the site are where creek and river channels have been incised into the underlying saturated zone. These areas include the Kuy Creek channel on the south side of the site and in the Guadalupe River valley to the east. Groundwater discharge provides base flow to Kuy Creek and the Linn Lake/Black Bayou surface water system. However, during dry periods, the groundwater level may drop below the bottom of these channels eliminating the base flow component.

Filling of the cooling basin will increase recharge to the underlying shallow aquifer as the result of seepage from the cooling basin to the subsurface environment. Seepage from the cooling basin is predicted to alter the groundwater flow direction in the site area. The groundwater level is predicted to rise beneath the basin to saturate previously unsaturated shallow sand layers. Seepage from the cooling basin to the groundwater system is predicted to increase groundwater contribution (groundwater discharge as base flow) to Kuy Creek, Dry Kuy Creek, and the surface seeps to the north and east of the VCS site. Seepage from the VCS cooling basin enters the subsurface and is discharged to the local surface water features as described in more detail in Subsection 2.3.1.2.3.

2.3.1.2.2 Groundwater Sources

This subsection contains a description of the historic groundwater levels; groundwater flow direction and gradients; seasonal and long-term variations of the aquifers; horizontal and vertical permeability and total and effective porosity of the geologic formations beneath the site; reversibility of groundwater flow; the effects of water use on gradients and groundwater levels beneath the site; and groundwater recharge areas. This information has been organized into five subcategories: (1) a summary of historical groundwater use, (2) groundwater flow directions, (3) temporal groundwater trends, (4) aquifer properties, and (5) hydrogeochemical characteristics.

2.3.1.2.2.1 Historical Groundwater Use

A brief summary of regional and local historical groundwater use in the vicinity of the VCS site is provided in this subsection. A detailed historical, current, and projected groundwater use discussion is provided in Subsection 2.3.2.2.

Historically, groundwater pumping in the Gulf Coast Aquifer system was relatively small and constant from 1900 until the late 1930s. Pumping rates increased sharply between 1940 and 1960, and increased relatively slowly through the mid 1980s. Groundwater withdrawals were primarily from the east-central area of the aquifer system, centered mostly in the Houston area of Harris County. Groundwater withdrawal was primarily for public supply and agriculture. (Ryder 1996).

Currently, groundwater use data for Victoria County is available from the EPA, the Texas Water Development Board (TWDB), and the VCGCD. The EPA monitors drinking water supply systems throughout the country and maintains the results in the Safe Drinking Water Information System (SDWIS) (U.S. EPA 2009). The TWDB is legislatively directed to plan for, and financially assist in, the development and management of the water resources of Texas. As a result, the TWDB conducts an annual survey of groundwater and surface water use by municipal and industrial entities so it can maintain accurate information concerning the current use of water in the state. The survey is based on water user-submitted information and may include estimated values. The survey does not include single-family, domestic well groundwater use (TWDB 2009a).

The TWDB maintains the information gathered during the annual survey in a statewide database called the Water Information Integration and Dissemination (WIID) system. As of May 2009, TWDB groundwater and surface water use data for Victoria County are available for 1974 through 2004 (TWDB 2009b). Water use data for Victoria County for 2005 and 2006 are also presented. Based on the TWDB data, the predominant water use categories in Victoria County in 2004 were manufacturing and municipal, followed by irrigation, mining, steam electric, and livestock. Most of the water used in the livestock, manufacturing, and steam electric categories in 2004 was obtained from surface water sources, while the majority of the water used in the irrigation, mining, and municipal categories in 2004 was obtained from groundwater (TWDB 2009b).

The TWDB also prepares estimates of future water use as part of water supply planning in addition to conducting the annual water use survey. This is facilitated through coordination with 16 planning regions throughout the state. Victoria County is a member of the South Central Texas Region (TWDB 2006b).

The population of the South Central Texas region was estimated to be 2.0 million in 2000 and is projected to increase to 4.3 million by 2060 (TWDB 2006b). Future development of the water resources in Victoria County is projected to be primarily around the city of Victoria (Uddameri 2008b). Victoria County was projected to experience a net increase in withdrawal of 3 percent, or 1 million gpd, with pumping rates increasing from 29 to 30 million gpd by 2030 (Ryder 1996). However, as described in Subsection 2.3.1.2.1.3, groundwater demand in Victoria County has decreased since 2000, when the city of Victoria shifted to using surface water for most of its needs.

The VCGCD implemented a District Management Plan for adoption in October 2008 and was approved by TWDB in December 2008 (VCGCD 2008a). The mission of the management plan is to develop sound water conservation and management strategies within Victoria County to conserve, protect, and prevent waste of groundwater resources. A spectrum of groundwater development alternatives were evaluated by the VCGCD. Available groundwater within the district was estimated to range from 25,000 to 45,000 acre-feet per year. For planning purposes, the available groundwater was established at 35,000 acre-feet per year. Historical groundwater use in Victoria County was as high as 40,000 acre-feet per year in the early 1980s, decreasing to about 15,500 acre-feet per year in 2004. The average groundwater use between 2000 and 2004 was approximately 20,200 acre-feet per year (VCGCD 2008a).

The total water demand for 2010 through 2020 is predicted to be nearly 63,000 acre-feet per year and will be met by conjunctive use of both surface water and groundwater resources. There are no unmet water needs projected for Victoria County until 2040. The predicted water shortages from 2040 to 2060 are projected to be small (VCGCD 2008a). The district is in the process of establishing monitoring and management programs, and additional studies to protect the water resources of the county. In October of 2008, the VCGCD adopted rules for groundwater use, which became effective in December 2008 (VCGCD 2008b). These rules included registration of groundwater wells, permitting for new well installations and use, production well pumping limits and minimum well spacing, transfer of groundwater out of the district, enforcement, and other measures.

The groundwater needs for VCS are projected to be approximately 1053 gpm (peak demand) and approximately 464 gpm during normal plant operations. The temporary water supply required for construction activities is estimated to be approximately 580 gpm and is expected to last approximately 4 to 5 years.

It is expected that three onsite groundwater production wells will be installed to meet groundwater demands to support construction and operation. The onsite production wells will be located in the Evangeline Aquifer. It is expected that two wells would be in operation with a third acting as a backup. The wells would be screened in the Evangeline Aquifer at depths ranging between approximately 450 to 1000 feet bgs. Preliminary well locations would be to the east, west, and north of the power block area at spacing greater than 6500 feet to minimize aquifer drawdown beneath the power block area. The exact number, depths, locations, and pumping rates of the onsite production wells are preliminary and will be determined during the detailed design of the VCS site, in accordance with the VCGCD rules in effect at the time.

2.3.1.2.2.2 Groundwater Flow Directions

Limited historical groundwater level data exist for the site proper because it is a greenfield site; however, TWDB does maintain several observation wells close to the site to measure water levels in the Chicot Aquifer. Regionally, groundwater flow in the Chicot Aquifer is generally southeast toward the Gulf of Mexico as shown in Figure 2.3.1.2-11, which is a regional potentiometric surface map of the Chicot Aquifer for 1999. The limited number of data points in the site area obscures any localized impacts from rivers in the site area. Figure 2.3.1.2-12 presents the steady-state simulated groundwater level elevations in the Chicot Aquifer using the calibrated Central Gulf Coast Groundwater Availability Model (GAM) (Chowdhury et al. 2004). This map shows the influence of the

Guadalupe and San Antonio Rivers on localized flow conditions adjacent to the site, where a west to east component of flow is overlain on the regional flow pattern.

Regional groundwater flow in the Evangeline Aquifer is also generally to the south and east toward the Gulf of Mexico, based on groundwater level data collected by the TWDB between 2001 and 2005 (Chowdhury et al. 2006). As depicted in Figure 2.3.1.2-9, localized pumping has caused a decline in water level in some parts of the Gulf Coast Aquifer, such as Harris and Kleberg counties. The pumping has created large cones of depression in these pumping areas, which divert groundwater flow from the Gulf of Mexico to the pumping centers.

As described in Subsection 2.3.1.2.1.4, groundwater observation well pairs were installed at 27 locations (54 individual wells) to investigate groundwater flow directions and horizontal and vertical hydraulic gradients at the VCS site. In addition, the four pumping test observation wells for each of the two test well locations (additional eight wells) were added to the observation well network resulting in 62 groundwater level monitoring wells.

Monthly groundwater level measurements were collected from the newly installed observation wells beginning in October 2007, when the first wells were installed. By February 2008, all of the site investigation wells had been installed and the first complete set of groundwater levels was collected. Monthly groundwater level measurements were collected through February 2009. Approximately quarterly groundwater level measurements were collected thereafter, until October 2010.

For the first three months of data collection, only the OW-01U/L through OW-10U/L well pairs were installed, for a total of 20 observation wells. By February 2008, an additional 42 observation wells (17 well pairs and two sets of 4 observation wells associated with the aquifer pumping test wells). The two aquifer pumping test wells were not incorporated into the groundwater monitoring program. Water level measurements from October 2007 through October 2010 are presented on Table 2.3.1.2-3. (Anomalous or suspect water level measurements due to instrument malfunction, operator error, or typographical errors are indicated in the table).

Groundwater level measurements collected from the observation wells at the VCS site in February, May, August, and November 2008; February, May, and August 2009; and March and October 2010 were used to develop potentiometric surface maps for the Upper Shallow, Lower Shallow, and Deep aquifers (Figure 2.3.1.2-13). These potentiometric surface maps show that groundwater flow direction at the VCS site in the three aquifers is generally to the east toward the Guadalupe River valley.

The potentiometric surface maps are used to estimate horizontal hydraulic gradients at the site. For each map, horizontal hydraulic gradients are calculated by drawing a flow line on the potentiometric surface map and determining the head loss (h) over the horizontal projection of the flow path length (L) to determine the horizontal hydraulic gradient (i_h or h/L).

The Upper Shallow aquifer potentiometric map surfaces indicate a hydraulic gradient of between 0.002 and 0.003 feet/foot. The Lower Shallow aquifer potentiometric map surfaces indicate a hydraulic gradient of between 0.001 and 0.002 feet/foot. The Deep aquifer potentiometric map surfaces indicate a hydraulic gradient of between 0.001 and 0.002 feet/foot.

The vertical hydraulic gradient (i_v) is calculated by dividing the difference in hydraulic head between adjacent upper and lower observation wells by the length of the vertical flow path. The vertical flow path length is assumed to be from the midpoint elevation of the upper observation well screen to the midpoint elevation of the lower observation well screen. Table 2.3.1.2-4 presents the calculated vertical hydraulic gradients.

Measurement data collected from the observation well pairs generally indicate a downward flow between the Upper Shallow, Lower Shallow, and Deep aquifer zones in the Chicot Aquifer. The downward vertical hydraulic gradients at the VCS site range from less than 0.01 to approximately 0.28 feet/foot. Those well pairs indicating upward flow are described as follows:

- Well pairs exhibiting an upward vertical gradient (OW-10U/L, OW-2320U/L, and OW-2350U/L). Excluding anomalous measurements, the upward vertical hydraulic gradient exhibited by these well pairs ranged up to -0.07 feet/foot. Well pair OW-2352U/L consistently shows a subtle, nearly imperceptible upward hydraulic gradient. The August 2009 readings at OW-10U/L indicate a weak downward hydraulic gradient (0.01 foot per foot) at OW-10U/L.

- Well pairs exhibiting occasional to infrequent upward vertical gradients (OW-05U/L, OW-07U/L, OW-09U/L, OW-2321U/L, OW-2348U/L, and OW-2359U1/L1). Some of the readings show a subtle, nearly imperceptible upward hydraulic gradient.

- Well pairs exhibiting an upward gradient only in months where suspect measurements were made (OW-02U/L, OW-06U/L, and OW-2319U/L). Ignoring the suspect readings, these well pairs all show a downward vertical hydraulic gradient.

The well pairs exhibiting upward vertical hydraulic gradients are, in general, located in the eastern half of the site. However, other well pairs in the eastern half of the site exhibit a downward hydraulic gradient, suggesting that the aquifer is heterogeneous.

Construction dewatering, operation of the proposed onsite production wells, and the operation of the cooling basin have the potential to alter or reverse the local flow patterns at the VCS site. Post-construction groundwater flow patterns were simulated through the development of a site groundwater computer model (Subsection 2.3.1.2.3.1).

2.3.1.2.2.3 Temporal Groundwater Trends

As depicted in Figure 2.3.1.2-14, groundwater levels in Victoria County were on the decline from the 1950s to 2000, until the city of Victoria switched to surface water for much of its needs (Uddameri 2008a). Data obtained from the TWDB for three observation wells (well numbers 7924702, 7932602, and 8017502; (TWDB 2009a) located near the VCS site were selected to prepare the regional hydrographs shown on Figure 2.3.1.2-14. Water level data from these wells through approximately 2006 were used in the temporal groundwater analysis based on their proximity to the VCS site.

Well 8017502 is located approximately 6.3 miles northeast of the proposed VCS power block area and is screened in the Goliad Sand of the Evangeline Aquifer to a depth of 1026 feet below ground surface. Historical water level data from this well indicate that between 1958 and 2000 a decrease in groundwater level occurred. Since 2001, the groundwater level has recovered and has surpassed the 1958 level. This coincides with the city of Victoria switching to surface water for much of its needs.

Well number 7932602 is located approximately 5.5 miles northeast of the proposed VCS power block area and is screened in the Lissie Formation of the Chicot Aquifer to a depth of 595 feet below ground surface (TWDB 2009a). As with well 8017502, historical water level data from this well indicates that between 1958 and 2000, a decrease in groundwater level occurred. Since 2001, the groundwater level has recovered and has also surpassed the 1958 level.

Well 7924702 is located approximately 6 miles northwest of the proposed VCS power block area and is screened in the Chicot Aquifer to a depth of 180 feet below ground surface (TWDB 2009a). This well exhibits a generally decreasing water level over the period of record for the well. Groundwater level data are not available from this well from 1998 to 2003. Therefore, the relationship, if any, of the decrease in groundwater level in this well to the city of Victoria switching to surface water for its needs in 2001 is unclear.

Figure 2.3.1.2-15 presents hydrographs for the observation wells installed at the VCS site. Review of the data suggests that there are a few suspect water level readings that deviate from the general water level trend in some wells. These suspect readings may result from misreading of the water level device or from conditions in the well that can produce false readings when using an electric water level measuring device, such as water condensate droplets on the interior wall of the well casing. Excluding the suspect water level measurements, the following trends are apparent for the three monitoring intervals:

- Upper Shallow aquifer: Readings generally show an overall rise in water level elevations of up to 2 feet between October 2007 and January 2008. Between January 2008 and November 2009, the wells in this zone generally show a downward trend of up to approximately 6 feet across the site. From November 2009 to October 2010 readings showed a rise in water levels of up to approximately 3 feet.

- Lower Shallow aquifer: Water levels typically show minor fluctuations of less than 1 foot between October 2007 and January 2008. Between January 2008 and November 2009, the wells in this zone show a general downward trend, with some wells exhibiting stable water levels with minor fluctuations during the fall and winter months of late 2008 into early 2009. Water levels show an overall rise between November 2009 and October 2010 of up to approximately 2.5 feet.

  Wells OW-2324U and OW-2348U stand out as exceptions to these general trends. These wells are screened in the Lower Shallow aquifer and are located in the eastern part of the site near the floodplain of the Guadalupe River and Linn Lake. Groundwater in this area is believed to be influenced by surface water conditions. Some water level fluctuations in wells OW-2324U and OW-2348U (particularly those between September 2008 and May 2009) appear to be related to fluctuations in the stage of the Guadalupe River based on river stage data recorded at USGS Gage 08177520 on the Guadalupe River near Bloomington, Texas (USGS 2011).

  Linn Lake is an oxbow lake on the west side of the Guadalupe River valley. The lake is a former meander that has been cut off from the main channel of the Guadalupe River. The Bloomington, Texas 7.5-minute USGS topographic map (USGS 1995) shows the river to be approximately 1000 feet from the lake at their closest point, and both to be at approximately the same elevation. No water level measurements for Linn Lake are available. However, because of the geomorphology of Linn Lake and its proximity to the river, it is likely that the lake and river are hydraulically connected and that the stage in the lake trends similarly to the stage of the nearby river.

- Deep aquifer: During the winter of 2007, water level readings show small variations of less than 1 foot in this zone. Beginning in 2008, and ending in November 2009, there is an overall downward trend in the water level elevation data, with the exception of a few wells showing a flattening of the hydrograph curve during the fall and winter months of late 2008 and into early 2009. From November 2009 to October 2010, water levels rose up to 2.5 feet. Water levels in wells OW-2324L and OW-2348L, screened in the Deep aquifer and also located near Linn Lake and the Guadalupe River, follow similar trends to those observed in wells OW-2324U and OW-2348U screened in the Lower Shallow aquifer. Some of the water level fluctuations in OW-2324L and OW-2348L also appear to be related to fluctuations in the stage of the Guadalupe River based on river stage data recorded at USGS Gage 08177520 for the Guadalupe River near Bloomington, Texas (USGS 2011).

In general, the difference in groundwater levels between wells screened in the Upper Shallow, Lower Shallow and Deep aquifers is greater in the well pairs located on the western side of the site than in well pairs on the eastern side of the site. This condition appears to be related to transition from an upland area of net groundwater recharge to a lowland area within a river valley where groundwater discharge predominates.

Figure 2.3.1.2-7 is a regional hydrogeologic cross-section through the Gulf Coast aquifer system. The figure shows that the outcrop area of the Chicot aquifer extends inland from the VCS site to approximately the southeastern DeWitt County line, where the ground surface elevation is approximately 150 feet. Precipitation falling on the outcrop area recharges groundwater in the Chicot aquifer. The higher ground surface elevation inland near DeWitt County induces a regional hydraulic gradient within the aquifer toward the southeast and the Gulf of Mexico, where the ground surface elevation is nominally 0 feet.

Figure 2.3.1.2-11 shows that in 1999 a southeastern regional hydraulic gradient was observed in the Chicot aquifer near the VCS site. Figure 2.3.1.2-12 shows groundwater elevations in the Chicot aquifer simulated by the Groundwater Availability Model (GAM) developed by the Texas Water Development Board (Chowdhury et al. 2004). This figure shows a similar regional hydraulic gradient toward the southeast.

Figure 2.3.1.2-12 shows, in the area of the VCS site, the 50-foot equipotential line to be diverted locally near the San Antonio and Guadalupe rivers. That diversion occurs because groundwater from higher elevations in the Chicot aquifer drains down-gradient toward and discharges to the rivers. The surface elevation within the power block area of the VCS site is about 80 feet. At observation well pair OW-2348, near the eastern boundary of the VCS site and the Guadalupe River valley, the surface elevation is approximately 50 feet (Table 2.3.1.2-1). Within the floodplain of the river and near Linn Lake the surface elevation is approximately 15 feet (USGS 1995).

In the upland areas of the Chicot aquifer, and potentially the northern and western parts of the VCS site, groundwater recharge prevails. Vertical hydraulic gradients are predominantly downward in areas of groundwater recharge and upward in areas of groundwater discharge (Fetter 1988). Table 2.3.1.2-4 presents the observed vertical hydraulic gradients in the northern and western parts of the VCS site, which are consistently downward.

In the eastern part of the site, near the floodplain of the Guadalupe River, the observed vertical hydraulic gradients tend to be upward or only weakly downward. This condition in the eastern part of the site suggests transition from an area of groundwater recharge to one of groundwater discharge. None of the VCS observation well pairs are located within the floodplain near the Guadalupe river channel or Linn Lake. Stronger upward vertical hydraulic gradients are likely to exist there, indicating groundwater discharge to the Guadalupe River Valley hydraulic system.

The groundwater potentiometric head of the Upper Shallow aquifer beneath the VCS site power block area ranges between approximately elevation 31 and 49 feet (Table 2.3.1.2-3). Post-construction changes to the hydrogeologic regime were evaluated using a groundwater computer model. The results are described in Subsection 2.3.1.2.3.2.

2.3.1.2.2.4 Aquifer Properties

The properties of the aquifers at the VCS site are divided into hydrogeologically and geotechnically derived parameters and are described in detail in Subsection 2.3.1.2.2.4.1 and 2.3.1.2.2.4.2. The hydrogeologically derived aquifer parameters include transmissivity, storativity, and hydraulic conductivity. The geotechnically derived aquifer parameters include bulk density, porosity, and permeability (hydraulic conductivity) from grain size and in situ Guelph permeameter tests.

2.3.1.2.2.4.1 Hydrogeological Parameters

Hydrogeologic field tests conducted at the VCS site included well slug tests and aquifer pumping tests. Slug tests were conducted in each of the site observation wells with the exception of OW-10U which had insufficient water in the well for testing.

Aquifer pumping tests were conducted at the VCS site in February 2008 at test well clusters TW-2320 (Upper Shallow aquifer) and TW-2359 (Deep aquifer). Each test consisted of a test pumping well and four adjacent observation wells. Nearby observation well pairs installed to monitor site groundwater levels were also monitored during the tests. The information obtained during the testing was used to evaluate the transmissivity and storativity of the aquifers.

- Transmissivity is defined as the rate at which a fluid of a specified density and viscosity is transmitted through a unit width of an aquifer or confining bed under a unit hydraulic gradient. Transmissivity is a function of the properties of the fluid, the porous medium, and the thickness of the porous medium (Fetter 1988).

- Storativity (storage coefficient) is defined as the volume of water released from or taken into storage per unit surface area of the aquifer per unit change in head (Fetter 1988).

- Hydraulic conductivity is defined as the coefficient of proportionality that describes flow per unit time under a unit hydraulic gradient through a unit area of a porous medium and is a function of the properties of the fluid and the porous medium. Hydraulic conductivity can be calculated by dividing the transmissivity by the saturated aquifer thickness (Fetter 1988).

Slug Test Analysis

Hydraulic conductivity can be determined from the slug test method, which evaluates the aquifer response to an instantaneous change in water level in the test well. A disadvantage of the slug test method is that it measures hydraulic conductivity only in the immediate vicinity of the test well. However, because the slug test requires minimal equipment and can be performed rapidly, slug tests can be performed in many wells, allowing a determination of spatial variability in hydraulic conductivity.

Slug tests were conducted in 53 of the 54 observation wells at the VCS site. (Observation well OW-10U had insufficient water in the well for testing.) Slug test results are summarized in Table 2.3.1.2-5. The minimum, maximum and geometric mean hydraulic conductivity values from the slug tests analyses presented in Table 2.3.1.2-5. for the Upper Shallow, Lower Shallow, and Deep aquifer zones at the VCS site are as follows:

Hydraulic Conductivity Based on Slug Tests

Aquifer Zone	Minimum (ft/day)	Maximum (ft/day)	Geometric Mean (ft/day)
Upper Shallow	0.06	56.79	12.29
Lower Shallow	0.02	163.5	24.76
Deep	0.67	142.7	9.80

Notes:
1. Minimum value = lowest value of the mean test results.
2. Maximum value = highest value of the mean test results.
3. Geometric mean = geometric mean of the average value for the analytical method results per well.

The data presented in Table 2.3.1.2-5 suggest variations in the materials tested, indicative of heterogeneous conditions. The slug test results for the Upper Shallow, Lower Shallow, and Deep aquifer zones were contoured to evaluate spatial trends Figure 2.3.1.2-16. For consistency, the hydraulic conductivities calculated from the rising head slug tests, Bouwer-Rice analytical method (Table 2.3.1.2-5) were used.

The Upper Shallow aquifer contour map indicates a discontinuous zone of increased hydraulic conductivity trending north to south from OW-07U to OW-2304U. The Lower Shallow aquifer contour map indicates an area of increased hydraulic conductivity trending northwest to southeast parallel to Linn Lake between OW-2307L and OW-2348U. An isolated area of increased hydraulic conductivity is also present in the Lower Shallow aquifer zone in the vicinity of OW-2320U. The Deep aquifer zone exhibits a general increase in hydraulic conductivity from west to east across the VCS site and does not appear to have any particular zones of increased hydraulic conductivity. The hydraulic conductivity trends in the Lower Shallow and Deep aquifers are generally consistent with coarsening and thickening of alluvial deposits in the direction of the Guadalupe River valley. The contour maps also show the locations of the aquifer pumping tests in the Upper Shallow and Deep aquifers, although the hydraulic conductivity values from the aquifer pumping tests were not used in the contouring.

Pumping Test Analysis

Aquifer pumping tests were conducted at the VCS site in February 2008 at test well clusters TW-2320 (Upper Shallow aquifer) and TW-2359 (Deep aquifer) as shown in Figure 2.3.1.2-10. Each test consisted of a test well and four adjacent observation wells. Nearby observation well pairs installed to monitor site groundwater levels were also monitored during the tests. The information obtained during the testing was used to evaluate the transmissivity and storativity of the aquifers. Test results and analysis are presented in Part 5 of this ESPA. The results of the February 2008 pumping tests, including additional analysis performed since 2008 are summarized in Table 2.3.1.2-6.

The Upper Shallow aquifer pumping test was conducted in the vicinity of observation test well cluster OW-2320, which is located in the approximate center of the cooling basin area. The test well cluster consisted of test well TW-2320U (pumping well) and four observation wells (OW-2320U1 through OW-2320U4), located at distances of approximately 15 to 50 feet from the test well as shown on Figure 2.3.1.2-17. Pressure transducers equipped with data loggers were used to measure water level drawdown and recovery in the test well and the observation wells. The pressure transducer in observation well OW-2320U4 apparently malfunctioned during the test and did not provide usable data.

TW-2320U was pumped at a rate of approximately 3.2 gpm for 48 hours. Based on the results presented in Table 2.3.1.2-6, a transmissivity of approximately 312.2 feet^2/day, a storage coefficient of approximately 3.3 x 10^{-3}, and a hydraulic conductivity of approximately 8.2 feet/day (using a saturated thickness of 38 feet) are estimated for the Upper Shallow aquifer at this location.

A distance drawdown analysis of the data was performed to compare with the single well test data analysis at times of 300 and 3000 seconds after pumping began. At 300 seconds, transmissivity of approximately 1474 square feet per day, hydraulic conductivity of 39 feet per day, and a storage coefficient of approximately 5 x 10^{-4} were estimated for the Upper Shallow aquifer. At 3000 seconds, transmissivity of approximately 738.7 square feet per day, hydraulic conductivity of 19 feet per day, and a storage coefficient of 4 x 10^{-4} were estimated for the aquifer zone at this location. The distance drawdown analysis suggests a higher hydraulic conductivity than that of the single well test analysis.

The Deep aquifer pumping test was located near the northeastern corner of the cooling basin between observation well clusters OW-06, OW-07, and OW-10. The test well cluster consisted of test well TW-2359L and four observation wells (OW-2359L1 through OW-2359L3 screened in the Deep aquifer and OW-2359U1 screened in Lower Shallow aquifer) as shown on Figure 2.3.1.2-18. TW-2359L was pumped at a rate of approximately 21 gpm for 24 hours. The transducer at OW-2359L1 failed during the test resulting in no useable data for this observation point. Based on the results presented in Table 2.3.1.2-6, a transmissivity of approximately 2507.3 $feet^2$/day, a storage coefficient of approximately 4.1 x 10^{-4}, and a hydraulic conductivity of approximately 47.3 feet/day (using a saturated thickness of 53 feet) were estimated for the aquifer zone at this location.

A distance drawdown analysis of the Deep aquifer test data was also performed to compare with the single well test data analysis. This analysis yields an estimated transmissivity of 3157.7 square feet per day after 300 seconds and 2508.2 square feet per day after 3000 seconds of pumping. The corresponding hydraulic conductivity varies between 60 feet per day and 47 feet per day, respectively (assuming a saturated thickness of 53 ft). The distance drawdown analysis after 3000 seconds of pumping yielded virtually the same estimates of transmissivity and hydraulic conductivity in the Deep aquifer as the single well test analysis.

The site-specific hydraulic conductivity and transmissivity values obtained from the pumping tests are, in general, consistent with regional values for the Chicot Aquifer (Young et al. 2006). The Upper Shallow aquifer hydraulic conductivity values of approximately 8 feet/day from the single well test analysis and 39 feet per day from the distance drawdown test analysis plot approximately on the 20 feet/day slug test contour in Figure 2.3.1.2-16, indicating reasonable agreement between the test methods. The Deep aquifer hydraulic conductivity values of approximately 47 feet/day from the single well test analysis and 60 feet per day from the distance drawdown test analysis plots between the 10 and 20 feet/day slug test contours, indicating approximately a 3 to 4 times difference between the test methods. It should be noted that the aquifer pumping test wells were open to a thicker sequence of sands than the slug test wells.

2.3.1.2.2.4.2 Geotechnical Parameters

The geotechnical component of the subsurface investigation program at the VCS site included the collection of soil samples for field and laboratory determination of soil properties. These tests are described below. Additional details are provided in SSAR Subsection 2.5.4. Geotechnical tests of hydrogeologic interest include:

- Geotechnical laboratory derived hydrogeologic parameters from disturbed geotechnical samples include bulk density, porosity, and permeability (hydraulic conductivity) from grain size.
- Geotechnical laboratory derived hydrogeologic parameters from undisturbed geotechnical samples include hydraulic conductivity.
- In situ hydraulic conductivity values from Guelph borehole permeameter field tests.

Porosity and Bulk Density Properties

The geotechnical investigation component of the subsurface investigation program at the VCS site included the collection of soil samples for laboratory determination of soil properties. A summary of the hydrogeologic properties from geotechnical tests is presented in Table 2.3.1.2-7.

Bulk density (γ_m) values for the various subsurface units are determined from the dry density (γ_d) and water content (ω) measurements using the following formula (U.S. ACOE 2004):

$$\gamma_m = \gamma_d \times (1 + \omega / 100)$$

Porosity is defined as the percentage of rock or soil that is void of material. Porosity was calculated as a function of void ratio for individual soil samples using the relationship (U.S. ACOE 2004):

$$n = \frac{e}{1 + e}$$

The effective porosity was determined as a function of the average total porosity and median grain size (d_{50}) using Figure 2.3.1.2-19 which is adapted from Davis and DeWiest (1966). For the silty sand that comprises the aquifers (d_{50} equal about 0.1 mm), the ratio of effective porosity to total porosity is 30 percent (effective porosity from the specific yield curve on Figure 2.3.1.2-19) divided by 37 percent (average total porosity), or 0.8. For the clay comprising the intervening confining layers (d_{50} equal about 0.001 mm), the ratio is 8 percent (from the specific yield curve on Figure 2.3.1.2-19) divided by 40 percent (average total porosity for clays) or 0.2. It should be noted that applying this relationship to clays is different than applying it to sand. Differences in clay mineralogy may result in differences in the electrostatic forces binding water molecules to the clay particles, thus introducing variability in the specific retention of the clay. Clays also may contain discontinuities resulting from cyclic wetting and drying (mud cracks) or as a result of post-depositional deformation (fractures). These factors could result in the overestimation or underestimation of the effective porosity of a clay.

Table 2.3.1.2-7 summarizes the total and effective porosities for each sample. The results of the geotechnical laboratory derived hydrogeologic parameters from disturbed geotechnical samples are summarized on Table 2.3.1.2-8, which provides the maximum, minimum, and mean values for each unit.

Hydraulic Conductivity for Sands Derived from Grain Size Analysis

The hydraulic conductivity of sands can be estimated using the Hazen approximation (Fetter 1988) and selected geotechnical laboratory data from Table 2.3.1.2-7.

$$K = C \times (D_{10})^2$$

where:

K = hydraulic conductivity (cm/sec)

D_{10} = the effective grain size (cm)

C = coefficient from the following table:
very fine sand, poorly sorted: 40–80
fine sand, with appreciable fines: 40–80
medium sand, well sorted: 80–120
coarse sand, poorly sorted: 80–120
coarse sand, well sorted, clean: 120–150

The effective grain size D_{10} is defined as the grain-size diameter at which 10 percent by weight of the soil particles are finer and 90 percent are coarser. The formula is valid for D_{10} between 0.1 and 3 mm with a coefficient of uniformity less than 5 (Kresic 1997). For the soils at the VCS site, a C value of 40 is used to represent fine sand with appreciable fines. A summary of the results of the grain size permeability analyses is presented in Table 2.3.1.2-9. Due to the restrictions on the D_{10} size (between 0.1 and 3 mm), the tests are biased toward the more permeable zones in each sand layer. The test results indicate a narrow range of hydraulic conductivity for all the sand zones tested.

The grain size data can also be used to qualitatively asses the hydraulic conductivity of the sand layers. Figure 2.3.1.2-20 shows ternary diagrams for the grain size data from each of the sand layers identified beneath the site. The ternary plots indicate that the unsaturated sand zone (geotechnical Sand 1) and the Upper Shallow aquifer (geotechnical Sand 2) have more fines than the underlying sand layers suggesting that these sands have a lower hydraulic conductivity than the Lower Shallow aquifer and the Deep aquifer.

Hydraulic Conductivity for Clayey Layers Derived from Laboratory Analysis

The vertical hydraulic conductivities of the clayey layers between the sand layers were determined using laboratory hydraulic conductivity measurements of undisturbed soil samples. The laboratory tests are performed using a triaxial cell permeameter with confining pressure. The results of these tests are shown on Table 2.3.1.2-10. The hydraulic conductivity range measured by the test is from a minimum of 2.5 x 10^{-9} cm/sec (7.1 x 10^{-6} feet/day) to a maximum of 8.3 x 10^{-6} cm/sec (2.4 x 10^{-2} feet/day). All the listed analyses were performed on materials classified as high plasticity clay.

Hydraulic Conductivity from Guelph Borehole Permeameter In Situ Field Tests

The Guelph permeameter is a constant-head borehole permeameter designed for in situ use in the field. The borehole permeameter tests were conducted at 16 locations within and adjacent to the VCS cooling basin at depths of 5 and 10 feet below preconstruction ground surface for a total of 32 tests. Only 18 of the tests are above the method detection limit. The results of the borehole permeameter tests are summarized in Table 2.3.1.2-11. Based on visual classification of the soils made during borehole preparation, the test results were subdivided into tests performed in sandy material and tests performed in clay. The field saturated hydraulic conductivity in sandy materials ranged from 1.44 x 10^{-6} cm/sec (0.0041 feet/day) to 9.70 x 10^{-4} cm/sec (2.75 feet/day), while the tests in clay ranged from 6.94 x 10^{-8} cm/sec (0.0002 feet/day) to 2.40 x 10^{-5} cm/sec (0.0680 feet/day).

The results of the borehole permeameter tests are contoured, including the tests below the method detection limit, as shown on Figure 2.3.1.2-21. The results in both the shallow (5 feet below ground surface) and deep test zones (10 feet below ground surface) show a higher hydraulic conductivity zone near the center of the cooling basin with lower hydraulic conductivity near the outer margin of the cooling basin. The following table relates the range of test results to the elevation of the test zone:

Elevation of Test	SP-SC		CH or SC	
	cm/sec	feet/day	cm/sec	feet/day
50–60	9.70 x 10^{-4}	2.75	5.37 x 10^{-7}–2.40 x 10^{-5}	0.0015–0.0680
60–70	1.44 x 10^{-6}–4.00 x 10^{-5}	0.0041–0.1134	1.38 x 10^{-6}–4.20 x 10^{-4}	0.0053–1.1907
70–80	None	None	6.94 x 10^{-8}–4.73 x 10^{-6}	0.0002–0.0134

SC — sandy clay
CH — high plasticity clay
SP-SC — poorly graded sand with clay

2.3.1.2.2.4.3 Summary of Aquifer Properties

Based on the results of geotechnical and hydrogeological testing the hydraulic conductivity values derived from grain size analysis, aquifer pumping tests, and slug tests at the VCS site (included in Part 5 of the ESPA) are considered to be in agreement and within the range of hydraulic conductivity values reported for the region (Young et al. 2006). Results of statistical analysis indicate that the slug tests produce the greatest range of hydraulic conductivity. Following is a summary of hydraulic conductivity ranges determined by different methods:

- Chicot Aquifer regional horizontal hydraulic conductivity values (from the technical literature): 8.5 to 170 feet/day
- VCS horizontal hydraulic conductivity pumping test results: 8 to 60 feet/day
- VCS slug test horizontal hydraulic conductivity results: 0.02 to 164 feet/day
- VCS grain size analysis horizontal hydraulic conductivity (sand): 11 to 30 feet/day
- VCS Guelph permeameter test vertical hydraulic conductivity results: less than 3 feet/day

The lower range in the slug test, grain size analysis, and the Guelph permeameter values are up to three orders of magnitude lower than the regional and VCS pumping test values. This may be due to the fact that the regional values are based on the probability of water wells being located in the most permeable sands, while the wells at VCS have short screen lengths and are, located in the more permeable material within the borehole drilled, regardless of whether or not the material is suitable for water production.

As discussed in Subsection 2.3.1.2.1.4, the VCS site is underlain by unconsolidated and discontinuous interbedded layers of sand and clay of the Chicot aquifer that dip toward the Gulf of Mexico. The Chicot aquifer at the site is divided informally into the Upper Shallow, Lower Shallow, and Deep aquifers.

2.3.1.2.2.5 Hydrogeochemical Characteristics

Regional hydrogeochemical data available for observation wells within 7.5 miles of the VCS site were obtained from TWDB (2009a) and are presented in Table 2.3.1.2-12. The analytical data were compared to EPA Primary and Secondary Drinking Water Standards (U.S. EPA 2008b) and exceedances are identified on the table. The principal exceedances were for total dissolved solids and chloride (Secondary Drinking Water Standards). The data indicate that the highest concentrations of total dissolved solids and chlorides are generally present in the Lissie Formation of the Chicot Aquifer.

The VCS site-specific hydrogeochemical data are presented in Table 2.3.1.2-13 and include 20 samples from the Chicot Aquifer. The analytical data were compared to EPA Primary and Secondary Drinking Water Standards and the exceedances are identified in the table. The principal exceedances at the VCS site were total dissolved solids and chloride. The data indicate that total dissolved solids exceedances are present in the Upper Shallow, Lower Shallow, and Deep aquifers at the VCS site. Chloride exceedances are present primarily in the Deep aquifer but are also locally present in the Upper Shallow and Lower Shallow aquifers.

Variations in chemical composition can be used to define hydrochemical facies in the groundwater system. The hydrochemical facies are classified by the dominant cations and anions in a groundwater sample. These facies may be shown graphically on a trilinear diagram (Fetter 1988). A trilinear diagram showing the regional and VCS site-specific geochemical data is presented on Figure 2.3.1.2-22. As depicted in Figure 2.3.1.2-22, the hydrochemical facies of the Chicot Aquifer consists predominantly of calcium chloride in the Deep aquifer, and bicarbonate to chloride anionic range with no dominant cation type in the Upper and Lower Shallow aquifers. The hydrochemical facies of the Evangeline Aquifer is dominated by the sodium cation, with a range of anions from bicarbonate to chloride.

The San Antonio River at McFaddin does not exhibit a dominant cation or anion facies. However, the Guadalupe River at Victoria exhibits a calcium-bicarbonate hydrochemical facies. The difference in facies between the two rivers may be attributed to the proximity of the sampling location on the Guadalupe River to the water treatment facility in Victoria.

Comparison of historical and more recent regional hydrogeochemical data presented in Table 2.3.1.2-12 indicates a general temporal consistency in groundwater chemistry for the individual aquifers present in the site area. This suggests that long-term variations in groundwater chemistry are not likely to occur at the VCS site.

2.3.1.2.3 Subsurface Groundwater Pathways

This section presents the development of a groundwater computer flow model that was used to represent the subsurface groundwater pathways at the VCS site.

2.3.1.2.3.1 Groundwater Flow Model

A numerical groundwater flow model was developed to assist with interpretation of the subsurface hydrogeologic conditions and to simulate post-construction groundwater conditions. Modeling efforts began while the subsurface site investigation was being conducted to provide preliminary estimates of the cooling basin seepage rate, the predicted groundwater elevation in the power block, and expected post-construction groundwater flow paths using preliminary data evaluation and assumptions. The groundwater model was refined as subsurface data interpretation and evaluation were completed. The conclusions of the final groundwater modeling effort are presented in this subsection.

A three-dimensional, eleven layer VCS groundwater flow model was developed to evaluate potential impacts on the groundwater flow system from the construction and operation of the cooling basin. Four specific areas of impact were assessed:

- Seepage rate from the cooling basin into the site groundwater system
- Post-construction groundwater level in the power block area
- Impacts on plant construction dewatering
- Postulated, post construction groundwater accidental release pathway

The groundwater flow model is executed under the Visual MODFLOW Version 4.3 environment developed by Schlumberger Water Services (Schlumberger Water Services 2008). The program consists of a series of pre- and post-processors that feed information to various numerical groundwater flow models developed by others. The groundwater flow model selected for the VCS utilizes a three-dimensional finite-difference groundwater flow model known as MODFLOW-2000 (Harbaugh et al. 2000). A subsidiary program known as MODPATH (Pollock 1999) is used to perform particle tracking to identify the groundwater flow paths and estimate travel time from the power block area to the nearest site boundary.

A detailed description of the construction, calibration, and results of the model are included in SSAR Appendix 2.4.12-C. The area of the model domain is presented in Figure 2.3.1.2-23.

2.3.1.2.3.1.1 Site Conceptual Model

Prior to development of a numerical groundwater model, a conceptual model of the Victoria County Station (VCS) site and surrounding area was developed. The conceptual model is the overall qualitative understanding of how the local and regional topography, climate, geomorphology, stratigraphy, groundwater use patterns, hydrology and boundary conditions affect groundwater flow in the aquifer.

The topography for the groundwater model for the VCS site was established using the U.S. Geological Survey 1999 National Elevation Dataset. This dataset references surface elevations to the NAVD88 vertical datum. Climatic parameters of average rainfall and evapotranspiration were determined from records of the Victoria County Groundwater Conservation District (TWDB 2006a) and the Texas A & M University System Texas ET Network. The regional stratigraphy and geomorphology were established from publications of the TWDB (TWDB 2006a, Chowdhury and Turco 2006, Chowdhury et al. 2004, and Young et al. 2006), the Texas Department of Water Resources (Baker 1979) and the U.S. Geological Survey (Ryder 1996). The stratigraphy at the VCS site was determined by drilling and testing more than 200 geotechnical borings, monitoring wells and cone penetrometer tests in the Chicot aquifer. Groundwater use patterns were established with information available from the U.S. Environmental Protection Agency (U.S. EPA 2009) and TWDB (TWDB 2009a, TWDB 2009b, and TWDB 2006a). Hydrology and boundary conditions were determined from publications of the Texas Department of Water Resources (Baker 1979) and the TWDB (Chowdhury and Turco 2006, Chowdhury et al. 2004, and Young et al. 2006).

The conceptual model of the VCS site includes interbedded sand and clay layers based on the site geotechnical boring logs, geophysical logs, monitoring well data and cone penetrometer test results included in Part 5 of the ESP application. Groundwater levels measured in a total of 62 observation wells at the VCS site at different times during 2008 and 2009 were used to develop potentiometric surface maps for the Upper Shallow, Lower Shallow, and Deep aquifer zones established for the Chicot aquifer based on the geotechnical borings. The bottom of the model domain was set at an elevation of -260 ft, which is the approximate bottom elevation of "Sand 10" at the Powerblock area. The bottom elevation of the "Sand 10" layer was based on the average S-wave velocity profile in SSAR 2.5.4 (Figures 2.5.4-A-71 and 2.5.4-A-72). Based on the potentiometric surface maps the groundwater flow direction at the site is generally to the east toward the Guadalupe River. The site-specific potentiometric surface maps show groundwater trends similar to the regional groundwater flow to the southeast, as measured by the TWDB (Chowdhury et al. 2006) and modeled by the TWDB Groundwater Availability Model (GAM) of the Central Gulf Coast Aquifer System (Chowdhury et al. 2004).

The domain of the GAM model includes the VCS site in Victoria County, Texas. The GAM model is a regional numerical model with four (4) layers and the Chicot aquifer is included as one continuous single layer within the model. In contrast, the site-specific VCS model subdivides the upper Chicot aquifer into various sands and clay units based on the site geotechnical boring logs and test results. Similar subdivision of the upper Chicot aquifer into a series of interbedded sand and clay layers was done for a site-specific groundwater model in Port Arthur, Texas (Haug et al. 1990).

To represent the regional flow at the VCS site, a general head boundary (GHB) was assigned to the cells at the north, east and west perimeters of the groundwater model domain in each of the saturated sand layers. The application of the GHB is to "represent heads in a model that are influenced by a large surface water body outside the model domain with a known water elevation.

The purpose of using this boundary condition is to avoid unnecessarily extending the model domain outward to meet the element influencing the head in the model. As a result, the General Head boundary condition is usually assigned along the outside edges of the model domain" (Schlumberger Water Services 2008). The inclusion of a GHB for cells to the north and west in the VCS model was not related to the presence of a large surface water body, but rather to dictate that groundwater flow within the vicinity of the site is consistent with observed aquifer flow patterns without unnecessarily extending the model. The GHB to the east represents the effect of the Guadalupe River.

Rivers in the VCS model domain such as the San Antonio River, Coleto Creek, Victoria Barge Canal and Guadalupe River were assigned the river package boundary of MODFLOW. The river package boundary models the groundwater and surface water interaction within the aquifer via a seepage layer separating the surface water body from the groundwater system. Small creeks were assigned as drain package boundaries to allow the groundwater model to represent groundwater discharge from the aquifer to the creeks. The drain package is designed to remove groundwater from the aquifer at a rate proportional to the difference between the head in the aquifer and some fixed head or elevation. The drain package assumes the drain has no effect if the head in the aquifer falls below the fixed head of the drain. A constant head boundary was assigned to Linn Lake to represent a steady-state water elevation in the lake and to provide a continuous source of water to the layers below.

The magnitudes of recharge and evapotranspiration assigned to the VCS groundwater model were similar to those assigned to the GAM model. The GAM model included boundary conditions similar to those assigned in the VCS site groundwater model, including GHBs, river package boundaries, drain package boundaries and constant head boundaries. Thus, based on site-specific geotechnical boring logs and test results and a conceptual hydrogeologic understanding of the VCS site it can be deduced that the VCS site groundwater model has the same framework as that of the regional TWDB GAM model and another site-specific groundwater model in the Chicot aquifer (Haug et al. 1990).

2.3.1.2.3.1.2 Groundwater Model Development

Hydrogeologic information for the VCS site was obtained primarily from the site subsurface investigation program and regional publications and databases to develop a stratigraphic model of the Chicot Aquifer within the area of the VCS site. Regional groundwater data and VCS site groundwater level measurements were used as calibration targets for the groundwater model.

The Chicot Aquifer is subdivided into three saturated sandy zones: the Upper Shallow aquifer, the Lower Shallow aquifer, and the Deep aquifer. Additionally, a sand layer designated Sand 1 exists above the saturated zone beneath the cooling basin. These sand units are separated by less permeable layers of clayey materials.

Eleven model layers were chosen to represent the component of the Chicot Aquifer. These layers correspond to geotechnical layers and hydrogeologic units identified by the subsurface investigations as follows: Sand 1 (unsaturated) corresponds to model layer 2; Sand 2 (the Upper Shallow aquifer) corresponds to model layer 4; and Sand 4 (the Lower Shallow aquifer) corresponds to model layer 6. Sand 5, Clay 5-bottom and Sand 6 (collectively the Deep aquifer) correspond to model layers 8, 9, and 10. Model layers 1, 3, 5, and 7 correspond to the inter-fingering clay layers between these aquifer units. The bottom model layer (layer 11) is comprised of Clay 7, Sand 8, Clay 9, and Sand 10. The geotechnical layers are further described in SSAR Subsection 2.5.4.

2.3.1.2.3.1.2.1 Description of Hydro-lithologic Units

The various hydro-lithologic units included in the VCS conceptual model were defined based on the results of a detailed subsurface investigation at the VCS site. The initial subsurface investigation included obtaining samples and data from over 150 soil borings, 27 pairs of observation wells and 2 well clusters each containing a test well and 4 nearby observation wells. The investigation was conducted within and around the power block area and in the area of the cooling basin. Sixty-five cone penetration tests (CPTs), geophysical logging, and laboratory testing were also performed for the subsurface investigation. A supplemental investigation included drilling an additional 94 borings and performing 12 additional CPTs as well as geophysical logging and laboratory testing. Soil samples were collected from the soil borings using standard penetration test (SPT) procedures and were visually examined and logged in the field by a geologist or geotechnical engineer. The number of hammer blows required to advance the soil sampler for each SPT was recorded. Soil index tests to determine grain-size distribution were completed on a total of 706 soil samples. The data produced by these investigative activities is provided in Part 5 of the ESP application.

The soil sample descriptions, sampler blow counts, soil index test results, cone penetrometer measurements, borehole geophysical logs, observations of soil cuttings, rate of loss of drilling fluid to the formation, rig behavior, and rate of advancement as drilling proceeded were all used to determine the depths in each boring at which changes in soil type occurred. Based on these depths and the surveyed elevations of ground surface at each soil boring and cone penetrometer sounding, a series of geotechnical cross-sections was constructed to provide an interpretation of the stratigraphy underlying the site. These cross-sections are provided in SSAR Subsection 2.5.4.

In addition, driller's logs obtained from the Texas Water Development Board of 72 water wells in the vicinity of the VCS site were used to assist in interpretation of the stratigraphy near the site. The elevations of the bottom of each soil layer noted in these well logs were correlated with those from onsite soil borings and cone penetrometer soundings to extend several cross-sections offsite and construct additional regional cross-sections that extend across the domain of the VCS numerical model. The locations of these cross-sections are shown on Figure 2.3.1.2-24a.

The cross-sections provide a conceptual model of the stratigraphy beneath the VCS site and its vicinity. This stratigraphic conceptual model provides the basis for interpolating elevations of the bottom of each soil stratum. The interpolated strata elevations were used to prepare contour maps representing the bottom of each layer in the numerical model. Where strata are absent, the bottom elevation of the corresponding model layer was arbitrarily set to 1 foot below the bottom elevation of the overlying layer. The hydraulic properties of this layer were set to the properties of the underlying layer. Contour maps were prepared by kriging the elevation data and contouring them using contouring and 3D surface-mapping software. Contouring accuracy was verified by manually contouring the data and comparing the results to the maps generated by the contouring and 3D surface-mapping software.

Based on the analyses described above, the stratigraphy of the site and its vicinity is interpreted to be comprised of a sequence of discontinuous and interbedded strata consisting primarily of sand and clay. In many cases, the vertical transition from one stratum to the next is gradational and open to interpretation, as is the continuity of strata from one soil boring to the next. As discussed in SSAR Subsection 2.5.1.1.1.3, the depositional environment within which the local soils accumulated is interpreted to be that of coalescing fluvial deltas containing a complex overlapping series of braided stream, levee, lagoon, and overbank flood deposits. Sediments deposited in this environment would typically vary in grain size, sorting, and hydraulic properties both horizontally and vertically. These variations would occur because of changes over time in the locations of stream meanders and distributaries related to the changing position of the Gulf of Mexico shoreline and the energy available for transporting sediments related to changes in stream flow.

The hydro-lithologic units simulated by the VCS numerical model were defined based on the following investigations and findings. Pairs of observation wells were drilled at 27 locations across the VCS site. The wells in each pair were completed with 10-foot long screens, each in different sand strata. Hydrogeologic cross-sections BB-BB' and HH-HH' (Figures 2.3.1.2-28 and 2.3.1.2-29, respectively) show the approximate elevations of well screens within the various sand strata at a total of six observation well pairs. These cross-sections also show the potentiometric head measured in each observation well on February 18, 2008, and the inferred direction of the vertical groundwater gradient, based on differing heads in the sand strata within which each well screen is completed.

Figure 2.3.1.2-15 contains several hydrographs, each showing a time series of the potentiometric heads in an observation well pair, including those well pairs shown on cross-sections BB-BB' and HH-HH'. The hydrographs demonstrate a generally consistent vertical potentiometric gradient between the upper and lower screen zones in each well pair. The difference in potentiometric head between the sand strata in Figures 2.3.1.2-28 and 2.3.1.2-29 in which the well screens are completed provides evidence that the sands are to some extent hydraulically isolated from each other by the intervening strata comprised predominantly of silt and clay. These finer-grained strata are interpreted to be confining layers acting as aquitards, while the sand strata are interpreted to be aquifers.

This finding forms the basis for subdividing the Chicot Aquifer at the VCS site into the Upper Shallow, Lower Shallow, and Deep aquifer zones. These aquifer zones are represented in the VCS numerical model by Sand 2 (model layer 4), Sand 4 (model layer 6), and Sands 5 and 6 (model layers 8 and 10), respectively. Estimates of the hydraulic properties of the aquitards and aquifers are discussed in Subsection 2.3.1.2.2.4.

Figure 2.3.1.2-13 provides a series of potentiometric surface maps for the Upper Shallow, Lower Shallow, and Deep aquifer zones at approximately quarterly intervals. Comparison of the maps showing potentiometric surfaces of the three aquifer zones on the same date reveals significant differences in the horizontal hydraulic gradients, particularly with respect to the Upper Shallow and Lower Shallow aquifer zones. Further, as indicated by the hydrographs in Figure 2.3.1.2-15, the potentiometric surface maps show that on the same date and at the same location on the VCS site, the elevation of the head in each aquifer differs significantly, especially between the Upper Shallow and Lower Shallow aquifer zones. These differences provide additional evidence that the sand strata interpreted on the hydrogeologic cross-sections in Figures 2.3.1.2-28 and 2.3.1.2-29 behave as discrete aquifer zones that can appropriately be divided into the Upper Shallow, Lower Shallow, and Deep aquifers.

The following additional lines of evidence support subdivision of the Chicot Aquifer at the VCS site:

- The results of slug tests and pumping tests (Tables 2.3.1.2-5 and 2.3.1.2-6, respectively) show that the hydraulic conductivities of the Upper Shallow, Lower Shallow, and Deep aquifer zones differ significantly.

- During the 24-hour pumping test completed in the Deep aquifer, groundwater levels were monitored in a nearby observation well completed in the Lower Shallow aquifer. The results of that testing, provided in Part 5 of the ESP application, indicate that there was no water-level response in the Lower Shallow aquifer, and therefore, the Lower Shallow and Deep aquifers are hydraulically isolated in the area of the test.

- Other investigators, including Haug et al. (1990). have also subdivided the upper Chicot Aquifer in their numerical groundwater model of an area of Port Arthur, Texas.

2.3.1.2.3.1.2.2 Discussion of the Influence of Windows in Confining Units

The confining units of most interest throughout the VCS site are Clay 1-top (model layer 1 in the VCS numerical model), Clay 1-bottom (model layer 3), Clay 3 (model layer 5), and Clay 5-top (model layer 7). A geotechnical description of these clay layers is presented in SSAR Subsection 2.5.4. The incorporation of site stratigraphy into the numerical groundwater model is further discussed in SSAR Appendix 2.4.12-C. Table 2.3.1.2-16 summarizes the locations on the VCS site where one or more of the confining units are absent.

Clay 1-top was identified at all sample locations within the power block area, based on a summary of the bottom elevations of each stratum identified in the 73 soil borings and 28 cone penetrometer soundings completed in the power block area. The apparently continuous coverage of Clay 1-top throughout the power block area suggests relatively uniform hydraulic properties of the shallow soils in the area of the power block.

The summary of strata bottom elevations in the power block area indicates that Clay 1-bottom is absent at three locations in the eastern part of the power block, potentially providing a window that places Sand 1 (model layer 2) in contact with Sand 2 (model layer 4). The power block area will be excavated to allow construction of foundations. The depth of the foundation excavation will be determined based on the reactor design chosen for the site.

In the groundwater numerical model, the deepest foundation in the eastern part of the power block is set at elevation -35 feet, which is approximately the bottom elevation of Sand 4 (model layer 6) in this area (SSAR Figures 2.5.4-9 and 2.5.4-10). Therefore, the foundation excavation will completely remove Clay 1-top, Sand 1, Clay 1-bottom, Sand 2, Clay 3, and Sand 4 (and the three windows between Sand 1 and Sand 2) in the modeled eastern part of the power block area. Although Subsection 2.3.1.2.3.2.2, states that excavation for the building foundations in the power block area could extend to elevation -15 feet, the groundwater numerical model represents a more conservative scenario with respect to groundwater travel time because it would result in placement of relatively high permeability structural fill across the entire thickness of Sand 4 and a correspondingly shorter travel time for a hypothetical release of radionuclides flowing through Sand 4 to their down-gradient discharge point.

The foundations will be surrounded with structural fill with hydraulic conductivity greater than that of the native soils. Therefore, the fill will provide a hydraulic connection between Sand 1, Sand 2, and Sand 4 in the power block area. The effect of this hydraulic connection has been evaluated with the VCS numerical groundwater flow model by a particle-tracking analysis (Subsection 2.3.1.2.3.2). This analysis simulates the flow paths and travel times for transport of liquid effluents postulated to be released from the basement of radwaste buildings in the power block. The particle tracking analysis (Subsection 2.3.1.2.3.2.3) indicates that the postulated release will travel vertically downward within the structural fill until encountering Clay 5-top (model layer 7) and then travel laterally to the east-southeast within the overlying Sand 4 where it eventually discharges into Linn Lake, the Guadalupe River, or the Victoria Barge Canal. The travel time to reach the closest VCS site boundary in this direction is discussed in SSAR Appendix 2.4.12-C.

Figure 2.3.1.2-30 shows 16 sample locations where Clay 1-top (model layer 1) is absent, based on a summary of the bottom elevations of each stratum identified in the 53 soil borings and 27 cone penetrometer soundings completed in the cooling basin area. Eleven of the locations where Clay 1-top is absent are east of the cooling basin. In this area, ground surface elevations are generally lower than those within the footprint of the basin (SSAR Tables 2.5.4-37 and 2.5.4-41). Unnamed streams draining eastward into the Guadalupe River Valley have eroded the shallow soils and completely removed Clay 1-top in some areas east of the cooling basin. In these areas, the underlying Sand 1 is exposed at the ground surface. Near the escarpment at the west side of the river valley the channels of the unnamed streams are incised into Sand 1. The incised channels were denoted as drains in the VCS numerical model to remove excess groundwater that may seep into the channels under high water table conditions. Pre- and post-construction model runs (SSAR Appendix 2.4.12-C) indicate that the combined discharge from the seeps will increase from 0 (pre-construction) to 310 gallons per minute when the cooling basin is filled.

Of the 16 locations where Clay 1-top is absent, five locations are within the footprint of the cooling basin. These five locations are widely distributed over the central portion of the approximately 4,900-acre cooling basin, and the absence of this unit is inferred based on widely spaced discrete sample locations. It can be noted that permeameter testing completed in the vicinity of those five locations where Clay 1-top was absent in samples collected from soil borings indicates that the permeability of the shallow soil is generally less than that assumed for Clay 1-top (layer 1) in the VCS numerical groundwater model (Table 2.3.1.2-11). This finding suggests that in its current pre-construction condition, the permeability of the shallow soil within the footprint of the cooling basin is not greater than that of Clay 1-top.

While excavation of the surficial soils to construct the cooling basin and embankment dam will partially or completely remove Clay 1-top in some areas, silt and clay are expected to accumulate on the floor of the basin when it is filled, due to re-distribution of fine-grained sediments by currents and wave action and importation of fine-grained sediments in makeup water from the Guadalupe River. These sediments will form a layer of relatively low permeability that will limit post-construction seepage through the bottom of the cooling basin and into Sand 1. A sensitivity analysis of the cooling basin seepage rate in the VCS numerical groundwater model demonstrated that a 10-fold increase in the hydraulic conductivity of Clay 1-top results in only a 2-percent increase in the seepage rate (SSAR Appendix 2.4.12-C).

Figure 2.3.1.2-31 shows Clay 1-bottom (model layer 3) to be absent at three locations in the vicinity of the cooling basin, providing a window that places Sand 1 (model layer 2) in contact with Sand 2 (model layer 4). Each of these three locations is outside of the basin footprint; two (B-2346 and B-2348) are near the southwest corner of Linn Lake, and the third (C-2328) is near the southwest corner of the basin. Sand 1 is unsaturated at each of these locations under pre-construction conditions but will become saturated when the cooling basin is filled because of seepage through the bottom of the basin into Sand 1 (SSAR Appendix 2.4.12-C).

With the cooling basin full, the modeled hydraulic head of 90.5 feet in the basin will induce a downward vertical gradient through Clay 1-top into Sand 1 and through Clay 1-bottom into Sand 2 and result in saturation of Sand 1, including the area near the basin embankment dam. The VCS numerical model predicts that post-construction groundwater discharge to Linn Lake (east of the cooling basin) will approximately double relative to pre-construction flow (SSAR Appendix 2.4.12-C).

Clay 3 (model layer 5) is absent at eight locations east of the cooling basin as shown in Figure 2.3.1.2-32, creating areas where Sand 2 (the Upper Shallow aquifer) is in contact with Sand 4 (the Lower Shallow aquifer). The Upper and Lower Shallow aquifers merge into one relatively continuous sand unit in these areas. The eight locations where Clay 3 is absent are located at the western edge of the Guadalupe River Valley. This valley is the principal drainage feature toward which shallow groundwater flows in the region of the VCS site (Figure 2.3.1.2-12). On this basis, it is reasonable to infer that an upward vertical gradient and groundwater flow from Sand 4 to Sand 2 exists within the valley. It is likely that this condition will not be affected significantly by construction of VCS.

Clay 5-top (model layer 7) is shown in Figure 2.3.1.2-33 to be absent at four locations in the area of the cooling basin. The location at the northeast corner of the basin (Boring B-09) is within the down-gradient flow path of a postulated release of radioactive effluent from the basement of a radwaste building in the power block area (SSAR Appendix 2.4.12-C). A particle-tracking analysis of that release determined that the effluent would flow vertically downward within the structural fill surrounding the building foundation until encountering Clay 5-top. The effluent would then flow laterally down-gradient toward the east-southeast within the overlying Sand 4. The absence of Clay 5-top at Boring B-09 places Sand 4 in contact with Sand 5 at this location and may allow the released effluent to disperse into Sand 5. This condition is depicted on the cross-section in SSAR Appendix 2.4.12-C.

Groundwater in both Sand 4 and Sand 5 eventually discharges within the Guadalupe River valley to Linn Lake, the Guadalupe River, and the Victoria Barge Canal. The data in Table 2.3.1.2-4 show that the vertical groundwater gradient at observation well pair OW-2348U/L near Linn Lake is slightly upward, indicating a discharging condition from the Deep aquifer (Sand 5) to the Lower Shallow aquifer (Sand 4). Conversely, at well pair OW-2319U/L near the western side of the cooling basin, the data in Table 2.3.1.2-4 show the vertical groundwater gradient to be slightly downward from Sand 4 to Sand 5, indicating a recharge condition. Neither of these relationships is likely to be affected significantly by construction of VCS.

The explicit method of using a model layer to represent a confining layer was selected for the VCS numerical model. A single value of hydraulic conductivity was selected to represent each sand geotechnical unit. Hydraulic conductivity values were adjusted to match the observed heads as part of model calibration. Other properties used to support model development include recharge rate, evapotranspiration, and effective porosity.

Model development included a preconstruction site elevation at the power block area of approximately 80 feet. The finished plant grade in the power block area is assumed to be elevation 95 feet. The surface elevation on the Guadalupe River floodplain is approximately 15 feet. Local wells are assumed to have average pumping rates of less than 10 gpm, and are considered to have minimal impact on groundwater levels outside of the immediate area of the well.

The VCS cooling basin bottom is approximated at elevation 69 feet. The water level for the cooling basin is assumed to be at elevation 90.5 feet. The cooling basin dikes were not considered in the seepage analysis due to their small size in relation to the cooling basin area. The hydraulic conductivity of the fill material used in plant construction is assumed to be that of a clean sand and gravel.

The primary zones of interest for VCS cooling basin seepage and excavation dewatering are Sand 1 and the Upper Shallow aquifer because these are the uppermost layers through which much of the groundwater flow will occur. The primary zones of concern for VCS cooling basin seepage and excavation dewatering are the Sand 1 and the Upper Shallow aquifer. Sand 1 is unsaturated in the preconstruction groundwater flow system.

2.3.1.2.3.1.2.3 Comparison of Site Specific Hydraulic Conductivities to Published Scientific Literature

The value of vertical hydraulic conductivity of the clay in model layer 1 is based on the results of borehole permeameter tests in layer 1 (the uppermost clay layer) from Table 2.3.1.2-11. The vertical hydraulic conductivity of the remaining clay layers in the model is based on laboratory permeability testing of undisturbed soil samples from the shallow (layers 3 and 5) and deep (layer 9) confining layers (Table 2.3.1.2-10). The horizontal hydraulic conductivity of each clay layer in the model is assumed to be ten times the corresponding vertical hydraulic conductivity (Walton 1984).

The value of horizontal hydraulic conductivity of the sand in model layer 4 is based on the results of a 48-hour pumping test of this layer and optimized through model calibrations. Similarly, the horizontal hydraulic conductivity of the sand in model layer 8 is based on the results of a 24-hour pumping test of this layer and adjusted during model calibration. The horizontal hydraulic conductivity of the sands in model layers 6 and 10 is assumed to be the same as that determined by the pumping test of layer 8 because the grain size distribution of samples from layers 6, 8 and 10 are similar

(Figure 2.3.1.2-20). The vertical hydraulic conductivity of each sand layer in the model is assumed to be one-third of the corresponding horizontal hydraulic conductivity (Walton 1984).

Values for the hydraulic conductivity of sand and clay layers in the VCS groundwater model were compared to values published in the scientific literature for the Chicot aquifer. Young et al. (2006) provides a range of hydraulic conductivity values determined from qualifying pumping tests in the Chicot aquifer. The range of horizontal hydraulic conductivity values reported in Young et al. (2006) for the Chicot aquifer varies between 13 feet/day and 154 feet/day. The values of horizontal hydraulic conductivity assigned to the "sand units" of the Chicot aquifer in the VCS groundwater model range from 68 feet/day to 103 feet/day and are within the range reported in Young et al. (2006).

Bravo et al. (1996) describes a groundwater model that simulates the hydrological conditions of the Chicot and Evangeline aquifers that underlie the Houston area. The Chicot and Evangeline are the same aquifers that extend to the VCS site. The horizontal hydraulic conductivity of the highly permeable zones of the Chicot aquifer in the Houston area is reported to be 170 feet/day (Table 2 of Bravo et al. 1996). The vertical hydraulic conductivity of the permeable unit of the Chicot aquifer reported in Table 2 of Bravo et al. (1996) is 0.01 feet/day. However, in the groundwater model described in Bravo et al. (1996), both the Chicot and Evangeline aquifers are modeled as isotropic, with the horizontal and vertical hydraulic conductivities equal to 170 feet/day.

Cleveland et al. (1992) reports that the vertical hydraulic conductivity of the clay units of the Chicot aquifer in the Houston area ranges between 4.63×10^{-4} meters/day (1.52×10^{-3} feet/day) and 0.73×10^{-5} meters/day (2.4×10^{-5} feet/day). Except for Clay 1-Top (6×10^{-2} feet/day), the vertical hydraulic conductivity assigned to the clay layers in the VCS groundwater model is 7×10^{-5} feet/day. This value is within the range reported in Cleveland et al. (1992).

Haug et al. (1990) provides estimates of the horizontal and vertical hydraulic conductivities of the various sand and clay units of the Upper Chicot aquifer used in a groundwater model of the Port Arthur, Texas area. The vertical extent of that model is the "Sand 2" hydrostratigraphic unit of the Upper Chicot aquifer, which seems to correspond to Sand 2 in the VCS groundwater model.

Table 1 of Haug et al. (1990) lists a horizontal hydraulic conductivity for the surficial clay unit at the Port Arthur site of 1×10^{-9} meters/second (2.8×10^{-4} feet/day). For the "Sand 1" unit at the Port Arthur site (which seems to correspond to Sand 1 at the VCS site) the values for horizontal hydraulic conductivity range between 3×10^{-5} meters/second (8.5 feet/day) and 4×10^{-5} meters/second (11.3 feet/day). For the Middle clay unit at the Port Arthur site (which seems to correspond to Clay 2 at the VCS site) the horizontal hydraulic conductivity is listed as 2×10^{-5} meters/second (5.7 feet/day) and for the "Sand 2" unit (which seems to correspond to Sand 2 at the VCS site) the value is 1×10^{-4} meters/second (28.3 feet/day). The anisotropy ratio of horizontal to vertical hydraulic conductivity for both the sand units and the clay units at the Port Arthur site is modeled as 10:1 (Haug et al. 1990).

The horizontal hydraulic conductivity values reported in Young et al. (2006) for the sand layers in the Chicot aquifer bound the values used in the VCS site groundwater model. The anisotropy ratio of horizontal to vertical hydraulic conductivity of 3:1 assigned to the sand layers in the VCS groundwater model falls within the reported range for the Chicot aquifer of 10:1 at the Port Arthur site (Haug et al. 1990) and 1:1 in the Houston area (Bravo et al. 1996).

The anisotropy ratio of horizontal to vertical hydraulic conductivity of 10:1 used in the VCS groundwater model for the clay layers of the Chicot aquifer agrees with that reported in Haug et al. 1990 for the clay layers of the Chicot aquifer at the Port Arthur site. The vertical hydraulic conductivity values for the clay layers in the VCS groundwater model are nominally within the range reported in Cleveland et al. 1992 for the Chicot aquifer in the Houston area.

The values of hydraulic conductivity for the sand and clay units of the Chicot aquifer represented in the VCS groundwater model are based on the results of site-specific pumping tests, grain size analysis and laboratory permeameter tests. These values and the anisotropy ratio of horizontal to vertical hydraulic conductivity assigned in the VCS groundwater model are within the range of the values published in the scientific literature.

2.3.1.2.3.1.3 Numerical Model

The model area was established to take advantage of natural boundary conditions in the site area. The Guadalupe and San Antonio Rivers, the Victoria Barge Canal, and Coleto Creek form physical boundaries along the north, east, west, and south perimeters of the model domain. Groundwater flow directions are interpreted as generally west to east across the VCS site, based on the regional potentiometric surface in the Chicot Aquifer. Preconstruction groundwater discharge is interpreted to occur on the west side of the Guadalupe River valley into Linn Lake and a series of sloughs that flow eastward along the west side of the valley.

The model grid consists of 189 columns, 193 rows, and 11 layers. Grid spacing ranges from 500 feet at the edges to 250 feet in the power block area. Figure 2.3.1.2-23 is a plan view of model domain showing the grid and calibration wells.

As stated in Subsection 2.3.1.2.3.1.2.1, hydrogeologic cross-sections and structure contour maps were developed from the subsurface data obtained from the VCS site subsurface investigation and from regional driller's log databases. These cross-sections and contour maps were used as the basis for the hydrogeologic layers developed for the numerical groundwater model. The locations of the cross-sections are shown in Figure 2.3.1.2-24a. Figures 2.3.1.2-24b and 2.3.1.2-24c present orthogonal hydrogeologic cross-sections E-E' and G-G'.

Cross-section E-E' is oriented approximately east-west and passes through the central part of the cooling basin. Cross-section G-G' is oriented approximately north-south and passes through the power block area and the western portion of the cooling basin. These cross-sections show the hydro-lithologic units labeled consistent with site nomenclature and the conceptual model of the stratigraphy beneath the VCS area. The hydro-lithologic units were interpreted from logs of geotechnical borings drilled on the VCS site, drillers' logs of water wells drilled in the region of the site, and results of other onsite investigative activities.

Cross-sections E-E' and G-G' both show the stratigraphy at soil boring B-2310 but with slightly different interpretations because of differing perspective due to different orientations of the cross-sections. The stratigraphic interpretation in E-E' is incorporated in the layering of the VCS numerical model because it provides better characterization of layering within the Deep aquifer, based on soil boring information.

Tables 2.3.1.2-1 and 2.3.1.2-3 show construction details and monthly groundwater levels for the observation wells, respectively. Potentiometric levels measured on February 18, 2008, in each of the observation wells in the cross-sections and the direction of the vertical groundwater gradient are also shown. The potentiometric levels shown in the regional water wells were measured as each was drilled during the period between 2003 and 2009.

Figures 2.3.1.2-24d and 2.3.1.2-24e are orthogonal cross-sections showing the modeled hydrostratigraphy along row 110 and column 92, respectively, of the VCS numerical groundwater model grid. As shown in Figure 2.3.1.2-24a, the locations of the cross-sections in Figures 2.3.1.2-24d and 2.3.1.2-24e approximate the locations of the two hydrostratigraphic cross-sections in Figures 2.3.1.2-24b and 2.3.1.2-24c. Comparison of the figures confirms that the hydro-lithologic units of the conceptual model closely match those of the groundwater numerical model. The numerical model cross-sections do not precisely mirror the conceptual model cross-sections because the sets of east-west sections and north-south sections are not constructed on the same vertical plane.

A layer type is defined for each layer in the model. The layer type represents the hydrogeologic conditions anticipated for each layer. For the VCS model, two layer types are used. Type 0 confined (where the transmissivity and storage coefficient are constant throughout the simulation) and type 3 confined/unconfined (with variable storage coefficient and transmissivity). Layer type 3 was assigned to all the layers in the pre-construction model to represent the variable conditions in these layers. Layer type 0 was applied to model layers 4 through 11 in the post-construction model simulations representing the relatively constant confined conditions present in these layers. The MODFLOW default method for assigning inter-block transmissivity using the harmonic mean is used for all layers.

The solver used in the model is the algebraic multigrid (SAMG) solver. The configuration of the model requires the use of the re-wetting function to saturate unsaturated cells in the model.

2.3.1.2.3.1.4 Boundary Conditions

The recharge boundary condition was assigned to the uppermost active model cell. Two zones of recharge were used for preconstruction conditions to represent areas overlain by clay or sandy deposits. The values of recharge in each zone were adjusted during calibration.

The evapotranspiration (ET) boundary condition was a single zone. An extinction depth of 5 feet was used to represent the maximum root penetration depth. It should be noted that Visual MODFLOW stops ET if the groundwater level is below the extinction depth or below the bottom of layer 1.

A constant head boundary was assigned to represent Linn Lake in the model. The lake is represented by an elevation head of 10 feet.

A general head boundary was assigned along the west central and northwestern edge of the model to represent regional inflow of groundwater in the Upper Shallow aquifer (layer 4), the Lower Shallow aquifer (layer 6), and the Deep aquifer (layer 8 and layer 10).

Drain boundaries were assigned in layer 1 and layer 2 along Kuy and Dry Kuy Creeks, other unnamed creeks and streams adjacent to the VCS site, and on the Guadalupe River Valley slope to the east of the proposed cooling basin to simulate seepage areas. Drain boundaries were assigned in layer 3 along Kuy Creek from its confluence with Dry Kuy Creek to its confluence with the Guadalupe River to simulate seepage in this area.

River boundaries were assigned in selected layers for the Guadalupe River, San Antonio River, Coleto Creek, Black Bayou, and the Victoria Barge Canal.

The surface water elevations in the canal, rivers, creeks and seeps were determined from published literature values, U.S. Geological Survey (USGS) topographic maps, and from site observations. Three types of model boundary conditions (river, drain and constant head) were assigned to the surface water features, as shown in Table 2.4.12-C-6 in SSAR Appendix 2.4.12-C.

The elevations of the drains simulating Kuy Creek, Dry Kuy Creek, the primary unnamed creeks and the Guadalupe River Valley seeps were estimated from USGS topographic maps (USGS 1995 and USGS 1962a, 1962b, and 1962c) and interpretation of site stratigraphy in the area of the drainage features. The drain elevations were assigned using a Visual MODFLOW formula ($BOT + 1.0), which places the drain elevation 1 foot above the bottom of the cell that represents the creek or seep.

A river boundary condition was assigned to the Victoria Barge Canal, Guadalupe River, Coleto Creek, San Antonio River, and Black Bayou to represent the groundwater and surface water interactions. The Victoria Barge Canal was assigned a stage elevation of 0 ft and a channel bottom elevation of approximately -12 ft based on VEDC (2009).

The mean stage in the Guadalupe River was estimated using data from USGS stream gages 08176500, 08177520 and 08188800 at Victoria, Bloomington and Tivoli, Texas, respectively (USGS 2009). The elevation of the Guadalupe River channel bottom was derived from channel profiles developed from bathymetric survey data. A linear gradient was assumed in order to assign river stage and bottom elevations in the numerical model. At the north end of the model domain a stage elevation of 20 ft and bottom elevation of 10 ft were estimated. At the southeast corner of the model domain a stage elevation of 5 ft and a bottom elevation of -10 ft were estimated. These bottom elevation estimates were extrapolated from bathymetric survey data for a reach of the river located between the upstream and downstream model boundaries, in conjunction with the topography at the river in these areas.

The stage of the Coleto Creek was estimated using the mean stage at the Coleto Creek Reservoir (USGS gage 08177400) and USGS gage 08177500 located on the Coleto Creek near Victoria, Texas (USGS 2009). The stage was linearly interpolated from an estimated 72 ft downstream of the Coleto Creek Reservoir at the western boundary of the VCS model domain to a stage elevation of 19 ft at the confluence of the Coleto Creek with the Guadalupe River. The bottom elevation of the river at the western boundary of the model domain (67 ft) was estimated based on a regional cross section developed for the model. A bottom elevation of 14 ft at the confluence of the creek with the Guadalupe River was estimated based on extrapolated bathymetric survey data for the Guadalupe River.

The stage of the San Antonio River was based on linear interpolation of the mean stage at USGS gage 08188570 near McFadden, Texas (USGS 2009). A stage elevation of 62 ft was estimated for the San Antonio River at the western boundary of the VCS model domain. The stage elevation was estimated to be approximately 5 feet below the average ground surface elevation within the local river valley, as determined from the National Elevation Dataset and the Lott Lake USGS topographic quadrangle map (USGS 1999 and USGS 1962a, respectively). The bottom elevation at this location was estimated assuming a river depth of approximately 20 feet. These values were then linearly interpolated to a stage elevation of 5 ft and a bottom elevation of -10 ft at the confluence with the Guadalupe River.

Linn Lake was assigned a constant head elevation of 10 ft, based on the estimated stage of the Guadalupe River to the east of Linn Lake.

2.3.1.2.3.1.5 Model Calibration

Model calibration involved adjustment of uncertain input parameters to obtain the best match between observed and simulated groundwater levels and the lowest water balance error. The input parameters with the most uncertainty are the recharge rate, because this value is based on regional observations rather than site-specific measurements, and hydraulic conductivity. The model was calibrated by systematically varying these parameters over a plausible range to determine the values that yielded the best model fit to the observed potentiometric head data.

The model calibration process was accomplished in two stages. The first stage involved adjusting the recharge and hydraulic conductivity to obtain the best match between simulated and observed heads. Review of the stratigraphic model within the Guadalupe River Valley suggests that the clay layers (model layers 7 and 9) may have been eroded and replaced with more permeable valley fill deposits. Using the hydraulic conductivity of the underlying sand, the areas of layers 7 and 9 were revised from the original conceptual model within the Guadalupe River Valley, from south of the confluence with Coleto Creek to the southern edge of the model. This allowed the Deep aquifer to be hydraulically connected with the overlying river and constant head boundaries in layer 6 (Lower Shallow aquifer). This first stage of calibration produced very good agreement between simulated and observed heads in layers 6, 8, and 10 (or the Lower Shallow and Deep aquifers); however layer 4 heads (Upper Shallow aquifer) did not meet the calibration criteria.

The second stage of calibration focused on layer 4 using an automated calibration program called PEST (Parameter ESTimation). This program is part of the Visual MODFLOW program package. The PEST program adjusts model parameters until the fit between model output (head) and field observations is optimized. For the VCS groundwater model, the program was constrained to vary only the hydraulic conductivity values for the Upper Shallow aquifer sand in layer 4. The resulting hydraulic conductivity value was used in the model to finalize the calibration. This stage of the calibration process was performed in lieu of a calibration sensitivity analysis.

2.3.1.2.3.2 Post-Construction Model Simulations

The predictive simulations performed with the calibrated groundwater flow model include estimation of cooling basin seepage, the amount of water removed during power block dewatering, and simulation of a post-construction accidental release of radioactive liquid effluent to groundwater. The following adjustments were made to the preconstruction model for the post-construction conditions:

- Surface elevations within the power block area were set to an elevation of 95 feet and within the cooling basin, the surface elevations were set to elevation 69 feet. Areas within the cooling basin where layer 1 was 1 foot in thickness (surficial clay absent as a result of excavation or erosion) were assigned a hydraulic conductivity of the underlying sand;

- Permeable backfill and inactive model cells were added to the power block area to represent backfill around buildings and the building locations, respectively;

2.3.1.2.3.2.1 Cooling Basin Seepage

Cooling basin seepage was simulated using the river boundary condition to represent the basin. The river stage for the boundary was set at an elevation of 90.5 feet with the riverbed bottom at an elevation of 69 feet. The riverbed conductance is based on a 2-foot thick sediment layer with a vertical hydraulic conductivity values equivalent to sand (34 feet/day) and a channel width equal to the model cell.

In addition to the cooling basin, the post-construction power block area conditions were also simulated. Postulated buildings within the area were based on a generic ABWR layout and are represented by inactive model cells, which were surrounded by cells with permeable backfill. The power block backfill is assumed to be approximately 5 times more permeable than the natural sand units, however mitigating surface features such as finish grading to assure overland flow rather than ponding, storm drains to conduct surface drainage, and vegetation control are assumed to reduce the amount of infiltration through the backfill.

Cooling basin seepage was evaluated by looking at the flow budget in subareas of the model domain. The simulation results indicate an estimated 3930 gpm seepage rate from the cooling basin. The primary impacts of the cooling basin seepage appear to be restricted to the adjacent creeks and seeps. There appears to be minimal impact on Black Bayou, Linn Lake and the Guadalupe River. Kuy Creek, Dry Kuy Creek, and the downgradient seeps show more than two orders of magnitude increase in base flow (contribution from groundwater). Table 2.3.1.2-14 provides pre- and post-construction cooling basin seepage estimates.

Another impact of cooling basin seepage would be to raise groundwater levels beneath the power block area. Figure 2.3.1.2-25 presents a simulated potentiometric surface map in model layer 2 (geotechnical Sand 1) in the power block area. The map indicates that groundwater levels are predicted to rise after filling the cooling basin. However, the permeable backfill around the power block buildings provides a pathway for vertical flow to bypass the underlying clay layers and enter the more permeable sands of the Lower Shallow aquifer. The predicted groundwater elevation in the power block area is 85 feet. Figure 2.3.1.2-26 presents the simulated potentiometric surface surrounding the cooling basin in layer 2. The design of the cooling basin may include additional structures (such as drainage ditches, sand drains, and relief wells) if lowering of the groundwater table is required at areas adjacent to the cooling basin.

A sensitivity analysis was performed on uncertain parameters associated with cooling basin seepage. The two primary uncertainties are the conductance of the cooling basin river boundary and the vertical hydraulic conductivity of the natural material underlying the cooling basin.

The vertical hydraulic conductivity of the sediment was assumed to be 34 feet/day for the base case, which represents a relatively clean sand. A more likely sediment composition would be that of a silty sand (due to sedimentation and chemical precipitation in the bottom of the operated basin), with a hydraulic conductivity approximately an order of magnitude lower (3.4 feet/day). The first sensitivity case uses this lower hydraulic conductivity to estimate seepage from the cooling basin.

A second sensitivity case involves uncertainty regarding the hydraulic conductivity of the clay in model layer 1. Exposure to repeated wetting and drying cycles could result in a higher hydraulic conductivity of the surficial materials. An order of magnitude increase in vertical hydraulic conductivity (0.6 feet/day) of the clay in layer 1 is assumed for the second sensitivity case.

Sensitivity case 1 appears to be sensitive to a change in the vertical hydraulic conductivity of sediment on the bottom of the cooling basin. An order of magnitude reduction in the vertical hydraulic conductivity of the sediment results in an approximately 14.5 percent reduction in the seepage rate from the cooling basin. Sensitivity case 2 appears to be insensitive to a change in the vertical hydraulic conductivity of the surficial clay layer. An order of magnitude increase in the vertical hydraulic conductivity of the clay results in only an approximately 2 percent increase in seepage from the cooling basin. The value selected for the hydraulic conductivity of the layer 1 clay in the base case represents the maximum value from the Guelph Permeameter testing and therefore would provide an upper bound for the hydraulic conductivity in the clay.

2.3.1.2.3.2.2 Power Block Construction Dewatering Effects

Construction dewatering will be required when constructing the plant because the excavations for the deeper building foundations will extend to an estimated elevation of –15 feet, which is in the Lower Shallow aquifer (model layer 6). The Lower Shallow aquifer is assumed to be dewatered to the approximate bottom of the aquifer at an elevation or approximately –20 feet. Two dewatering scenarios were considered:

- Preconstruction groundwater conditions (cooling basin empty) with dewatering the entire power block area.
- Postconstruction groundwater conditions (cooling basin full) with dewatering the entire power block area.

These scenarios were evaluated because the scheduling of the construction activities is still in the planning stage. All scenarios were simulated by assigning constant head boundaries representing the excavation in model layers 4 and 6, and in the post-construction scenario, model layer 2 also.

Dewatering pumping (flow) rates ranged from approximately 990 to 1840 gpm. The finalization of the excavation and the dewatering scheme (areal extent, depth, and construction schedule) will be evaluated once a reactor vendor has been selected, during the COL application stage.

2.3.1.2.3.2.3 Simulation of Accidental Release Pathway

The groundwater flow system downgradient of the power block area was evaluated to identify potential exposure points from an accidental release of radionuclides to groundwater. The release is postulated to occur below the basement of a radwaste building in the backfill present in model layer 4 (Upper Shallow aquifer). The release was simulated by placing particles in the power block backfill. The movement of these particles was calculated using MODPATH, which is a companion program to MODFLOW, that uses its output to perform the particle tracking. Four particle release scenarios are considered:

- No pumping.
- With a hypothetical domestic well pumping on the north site boundary (approximately 4500 feet from the release).
- With a hypothetical domestic well pumping on the west site boundary (approximately 3800 feet from the release).
- With a hypothetical domestic well pumping on the east site boundary (approximately 11,000 feet from the release).

The hypothetical domestic wells are screened to fully penetrate model layer 6 (Lower Shallow aquifer), which is the uppermost aquifer used for water supply in the site area. For the northern well, the screened interval was from an elevation of –4 to –20 feet, and for the western well, the screened interval was from an elevation of –4 to –31 feet, and for the eastern well, the screen interval was from an elevation of 8 to –31 feet. The hypothetical wells were pumped at simulated rate of 50 gpm, which is considered the maximum practical pumping rate for the Lower Shallow aquifer within the site vicinity.

Table 2.3.1.2-15 presents a summary of the travel times from the release point to the exposure point at the property boundary as derived from the particle tracking. The results of the particle tracking indicate a travel time of approximately 41,000 days (110 years) to eastern site boundary. Modeling results indicates that when the particles are released into the fill they migrate down through the fill into model layer 6 (Lower Shallow aquifer) and then travel laterally toward the east or vertically to model layer 8 (Deep aquifer). None of the hypothetical pumping scenarios result in capture of particles by the pumping wells. The primary influence of the offsite pumping is to locally divert the particle tracks toward the north prior to the particle continuing to the eastern site boundary. Figure 2.3.1.2-27 presents the particle track pathways for Scenario 1 (without pumping).

2.3.1.2.3.3 Groundwater Modeling Summary and Conclusions

A three-dimensional eleven layer groundwater flow model was developed and calibrated to evaluate groundwater level and flow changes associated with the operation of a cooling basin at the VCS site, with dewatering of site excavations, and to assess post-construction, groundwater flow paths. Specific findings of the modeling effort include:

- The groundwater levels in the power block area are predicted to be about elevation 85 feet or about ten feet below the final plant grade of elevation 95 feet.
- Filling the cooling basin to an elevation 90.5 feet is predicted to raise groundwater levels beneath the site to a point where the currently unsaturated sand layer referred to as the Sand 1 geotechnical unit becomes saturated.
- Seepage from the cooling basin is predicted to increase groundwater contributions (base flow) to Kuy and Dry Kuy Creeks and seeps to the north and east of the VCS site. Seepage from the cooling basin is estimated to be approximately 3930 gpm.
- Seepage from the cooling basin is also predicted to alter the groundwater flow directions in the site area, particularly in the power block area.
- Construction dewatering scenarios were simulated with the cooling basin empty and full with an estimated range of pumping rates between 990 (empty) and 1840 gpm (full).
- Particle tracking suggests that the closest receptor for an accidental release to groundwater from postulated radwaste buildings would be the eastern property boundary for the VCS site with a travel time of approximately 41,000 days (110 years) to the eastern site boundary.

Additional description of the model results is presented in Section 5.2.

As mentioned in Subsection 2.3.1.2.3.1, an earlier numerical groundwater flow model was developed as the subsurface information was being interpreted. The model consisted of seven model layers and the model boundaries were closer to the VCS site than that used for the final modeling effort. The predominant difference between the final model and the earlier model is that the earlier model was developed with the following:

- Each subsurface model layer had a fixed thickness in the model domain.
- The top 50 feet of the subsurface (layer 1) was treated as sand. Model layer 2 was interpreted to be a 20 foot clay layer separating model layer 1 from model layer 3 (Upper Shallow aquifer). The remaining modeling layers were intervening clay layers separated by aquifer sand layers (the Lower Shallow aquifer and the Deep aquifer).
- The eastern edge of the model domain terminated at the edge of the western edge of the Guadalupe River valley flood plain.

Post-construction simulations utilizing this earlier modeling configuration are summarized as follows:

- The groundwater level in the power block area was predicted to be at an elevation of about 85 feet, which is the same predicted groundwater level obtained from the most recent model.
- Seepage from the cooling basin was estimated to be approximately 5700 gpm. The seepage from the cooling basin was predicted to increase groundwater contributions to the Guadalupe and San Antonio River valleys, and Kuy and Dry Kuy creeks by as much as 15 times the pre-construction amounts.
- Dewatering rates were less than 1000 gpm.
- Particle tracks from the power block area suggested a northeasterly groundwater flow direction.

The results of the final modeling effort have been incorporated into the ESP unless otherwise stated.

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Table 2.3.1.2-1 (Sheet 1 of 3)
Observation Well Construction Details

Well Number[a]	Hydrogeologic Unit	Northing (ft)[b]	Easting (ft)[b]	Top of Casing Elevation (ft NAVD 88)[b]	Top of Concrete Pad (ft NAVD 88)[b]	Well Diameter (in)	Well Depth (ft bgs)	Top of Screen (ft bgs)[c]	Bottom of Screen (ft bgs) [c]	Top of Screen (ft NAVD 88)[c]	Bottom of Screen (ft NAVD 88)[c]	Top of Filter Pack (ft bgs)	Bottom of Filter Pack (ft bgs)
OW-01L	Lower Shallow	13404252.1	2606686.52	73.74	72.22	2	111	100	110	-27.78	-37.78	96	113
OW-01U	Upper Shallow	13404253.6	2606666.85	73.65	72.16	2	61	50	60	22.16	12.16	47	63
OW-02L	Lower Shallow	13411520.5	2607869.3	76.53	75.07	2	109	98	108	-22.93	-32.93	94	112
OW-02U	Upper Shallow	13411502.4	2607862.19	76.74	75.25	2	64	53	63	22.25	12.25	50	66
OW-03L	Lower Shallow	13414918.7	2609286.61	76.67	75.21	2	98	87	97	-11.79	-21.79	84.1	100
OW-03U	Upper Shallow	13414934.5	2609294.86	77.05	75.6	2	54	43	53	32.6	22.6	40	56
OW-04L	Lower Shallow	13414268.7	2607440.23	80.67	79.13	2	111	100	110	-20.87	-30.87	96	113
OW-04U	Upper Shallow	13414280.5	2607428.57	81.08	79.61	2	86	75	85	4.61	-5.39	71	88
OW-05L	Deep	13414774.2	2605813.28	79.9	78.26	2	131	120	130	-41.74	-51.74	116.3	135
OW-05U	Upper Shallow	13414770.2	2605832.08	79.55	78.07	2	57	46	56	32.07	22.07	43	60
OW-06L	Lower Shallow	13415889.6	2604964.9	81.55	79.49	2	96	85	95	-5.51	-15.51	80.5	99
OW-06U	Upper Shallow	13415875.6	2604966.94	80.77	79.46	2	64	53	63	26.46	16.46	50	66
OW-07L	Deep	13418420.5	2606531.28	79.04	77.47	4	124	113	123	-35.53	-45.53	110	127
OW-07U	Upper Shallow	13418421.4	2606542.01	79.02	77.32	2	64	53	63	24.32	14.32	50.2	66
OW-08L	Deep	13415818.9	2598942.49	84.07	82.56	4	138	127	137	-44.44	-54.44	124	140
OW-08U	Lower Shallow	13415801.2	2598934.58	83.88	82.38	2	101	90	100	-7.62	-17.62	86	103
OW-09L	Deep	13414937.4	2604893.58	80	77.86	2	121	110	120	-32.14	-42.14	106	125
OW-09U	Upper Shallow	13414956.1	2604894.51	79.24	77.91	2	61	50	60	27.91	17.91	47	61
OW-10L	Deep	13418486.4	2604760.99	79.88	78.07	2	138	127	137	-48.93	-58.93	123	141
0W-10U	Upper Shallow	13418474.4	2604768.43	79.53	78.09	2	59	48	58	30.09	20.09	45	62
OW-2150L	Deep	13412552.9	2599585.12	82.45	80.87	2	151.55	140	150	-59.13	-69.13	136	152
OW-2150U	Upper Shallow	13412568.1	2599582.77	82.78	80.91	2	66.15	55	65	25.91	15.91	51	67
OW-2169L	Lower Shallow	13412356.7	2599930.2	81.72	80.04	2	101	90	100	-9.96	-19.96	86	102
OW-2169U	Upper Shallow	13412343.8	2599945.85	81.77	80.11	2	66	55	65	25.11	15.11	51	67
OW-2181L	Lower Shallow	13412138.4	2600071.96	81.32	79.88	2	101	90	100	-10.12	-20.12	86	102
OW-2181U	Upper Shallow	13412147.4	2600052.86	81.31	80.01	2	51	40	50	40.01	30.01	36	52
OW-2185L	Lower Shallow	13412314.5	2600815.69	81.36	79.76	2	101	90	100	-10.24	-20.24	86	102
OW-2185U	Upper Shallow	13412328.1	2600801.11	81.45	79.89	2	76	65	75	14.89	4.89	61	77
OW-2253L	Deep	13413591.6	2600474.37	82.66	81.17	2	146	135	145	-53.83	-63.83	131	147

Table 2.3.1.2-1 (Sheet 2 of 3)
Observation Well Construction Details

Well Number[a]	Hydrogeologic Unit	Northing (ft)[b]	Easting (ft)[b]	Top of Casing Elevation (ft NAVD 88)[b]	Top of Concrete Pad (ft NAVD 88)[b]	Well Diameter (in)	Well Depth (ft bgs)	Top of Screen (ft bgs)[c]	Bottom of Screen (ft bgs)[c]	Top of Screen (ft NAVD 88)[c]	Bottom of Screen (ft NAVD 88)[c]	Top of Filter Pack (ft bgs)	Bottom of Filter Pack (ft bgs)
OW-2253U	Upper Shallow	13413584.8	2600494.74	82.82	81.18	2	66	55	65	26.18	16.18	51	67
OW-2269L	Deep	13413123.3	2600574.23	82.55	80.89	2	141.15	130	140	-49.11	-59.11	126	143
OW-2269U	Lower Shallow	13413110.1	2600589.08	82.43	80.75	2	91.15	80	90	0.75	-9.25	76	92
OW-2284L	Lower Shallow	13413063.7	2600939.04	82.74	80.98	2	111.06	100	110	-19.02	-29.02	96	112
OW-2284U	Upper Shallow	13413055.1	2600956.6	82.62	80.97	2	76.07	65	75	15.97	5.97	61	77
OW-2301L	Deep	13414429.8	2596268.29	83.19	81.89	2	141	130	140	-48.11	-58.11	126	142
OW-2301U	Upper Shallow	13414430.1	2596288.46	83.27	81.77	2	61	50	60	31.77	21.77	46	62
OW-2302L	Deep	13407382.1	2598388.94	81.95	80.46	2	151	140	150	-59.54	-69.54	136	152
OW-2302U	Lower Shallow	13407361.5	2598388.47	81.99	80.52	2	96	85	95	-4.48	-14.48	81	97
OW-2304L	Lower Shallow	13396528.1	2608678.06	69.73	68.88	2	96	85	95	-16.12	-26.12	81	97
OW-2304U	Upper Shallow	13396542.4	2608679.35	70.1	68.8	2	51	40	50	28.8	18.8	36	52
OW-2307L	Lower Shallow	13420879.1	2603152.12	78.56	76.91	2	111	100	110	-23.09	-33.09	95	112
OW-2307U	Upper Shallow	13420896.7	2603164.23	78.59	77.07	2	66	55	65	22.07	12.07	50	67
OW-2319L	Deep	13403611.3	2603051.83	76.05	74.68	2	156	145	155	-70.32	-80.32	141	157
OW-2319U	Lower Shallow	13403590.4	2603046.21	75.97	74.33	2	96	85	95	-10.67	-20.67	81	97
OW-2320L	Deep	13407580.9	2606834.36	73.19	71.76	2	151	140	150	-68.24	-78.24	136	152
OW-2320U	Lower Shallow	13407569.5	2606849.7	73.5	71.8	2	111	100	110	-28.2	-38.2	96	112
OW-2321L	Deep	13410955.5	2610027.59	73.54	71.99	2	151	140	150	-68.01	-78.01	136	152
OW-2321U	Lower Shallow	13410943.6	2610040.96	73.27	71.79	2	111	100	110	-28.21	-38.21	96	112
OW-2324L	Deep	13416300.5	2612217	26.27	24.85	2	126	115	125	-90.15	-100.15	110	127
OW-2324U	Lower Shallow	13416316.5	2612203.23	26.17	24.67	2	46	35	45	-10.33	-20.33	31	47
OW-2348L	Deep	13409617.8	2621644.36	52.7	51.21	2	145	134	144	-82.79	-92.79	130	146
OW-2348U	Lower Shallow	13409636.3	2621660.58	52.12	50.56	2	81	70	80	-19.44	-29.44	66	82
OW-2352L	Lower Shallow	13402468.5	2617518.54	64.6	63.33	2	91	80	90	-16.67	-26.67	76	92
OW-2352U	Upper Shallow	13402470.6	2617538.69	64.47	63.17	2	56	45	55	18.17	8.17	41	57
TW-2320U[d]	Upper Shallow	13407428.6	2607105.51	72.72	71.5	6	82	55	80	16.5	-8.5	50	82
OW-2320U1	Upper Shallow	13407445.7	2607080.05	72.9	71.36	2	81	60	80	11.36	-8.64	55	82
OW-2320U2	Upper Shallow	13407436.8	2607093.25	72.92	71.36	2	81	60	80	11.36	-8.64	55	82
OW-2320U3	Upper Shallow	13407448.2	2607121.37	72.84	71.36	2	81	60	80	11.36	-8.64	55	82
OW-2320U4	Upper Shallow	13407466.5	2607138.42	72.91	71.42	2	81	60	80	11.42	-8.58	55	82

Table 2.3.1.2-1 (Sheet 3 of 3)
Observation Well Construction Details

Well Number[(a)]	Hydrogeologic Unit	Northing (ft)[(b)]	Easting (ft)[(b)]	Top of Casing Elevation (ft NAVD 88)[(b)]	Top of Concrete Pad (ft NAVD 88)[(b)]	Well Diameter (in)	Well Depth (ft bgs)	Top of Screen (ft bgs)[(c)]	Bottom of Screen (ft bgs)[(c)]	Top of Screen (ft NAVD 88)[(c)]	Bottom of Screen (ft NAVD 88)[(c)]	Top of Filter Pack (ft bgs)	Bottom of Filter Pack (ft bgs)
TW-2359L[(d)]	Deep	13417241.4	2605450.48	79.88	77.69	6	182	150	180	-72.31	-102.31	145	182
OW-2359L1	Deep	13417263.7	2605470.56	79.36	78.08	2	176	155	175	-76.92	-96.92	151	177
OW-2359L2	Deep	13417259.8	2605433.37	78.93	77.56	2	176	155	175	-77.44	-97.44	150	177
OW-2359L3	Deep	13417278.6	2605416.18	78.83	77.26	2	176	155	175	-77.74	-97.74	151	177
OW-2359U1	Lower Shallow	13417252.6	2605460.64	79.29	77.66	2	96	85	95	-7.34	-17.34	80	97

(a) "L" suffix wells are the lower well in well pair, installed in Lower Shallow or Deep aquifer zones. "U" suffix wells are the upper well in well pairs, installed in Upper Shallow or Lower Shallow aquifer zones.
(b) Coordinates based on the North American Datum of 1983 (NAD 83) and elevations based on North American Vertical Datum of 1988 (NAVD 88).
(c) Observation well screens are 0.020 in slot width.
(d) Well screen interval contains a 5 ft casing blank at 65 to 70 ft bgs.

Abbreviations:
bgs = below ground surface
ft = feet
in = inches
OW = Observation Well
TW = Aquifer Test Well

Table 2.3.1.2-2
Groundwater Observation and Test Wells Monitoring the Chicot Aquifer

Upper Shallow	Lower Shallow	Deep
OW-01U	OW-01L	—
OW-02U	OW-02L	—
OW-03U	OW-03L	—
OW-04U	OW-04L	—
OW-05U	—	OW-05L
OW-06U	OW-06L	—
OW-07U	—	OW-07L
—	OW-08U	OW-08L
OW-09U	—	OW-09L
OW-10U	—	OW-10L
OW-2150U	—	OW-2150L
OW-2169U	OW-2169L	—
OW-2181U	OW-2181L	—
OW-2185U	OW-2185L	—
OW-2253U	—	OW-2253L
—	OW-2269U	OW-2269L
OW-2284U	OW-2284L	—
OW-2301U	—	OW-2301L
—	OW-2302U	OW-2302L
OW-2304U	OW-2304L	—
OW-2307U	OW-2307L	—
—	OW-2319U	OW-2319L
—	OW-2320U	OW-2320L
—	OW-2321U	OW-2321L
—	OW-2324U	OW-2324L
—	OW-2348U	OW-2348L
OW-2352U	OW-2352L	—
TW-2320U	—	—
OW-2320-U1	—	—
OW-2320-U2	—	—
OW-2320-U3	—	—
OW-2320-U4	—	—
—	—	—
—	—	TW-2359L
—	OW-2359-U1	OW-2359-L1
—	—	OW-2359-L2
—	—	OW-2359-L3

Table 2.3.1.2-3 (Sheet 1 of 3)
VCS Monthly Groundwater Level Measurements

Well No.	Ref. Elev. (NAVD88)	Hydro-geologic Unit	25-Oct-07			17-Nov-07			18-Dec-07			30-Jan-08			18-Feb-08			31-Mar-08			26-Apr-08			23-May-08		
			Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)	Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)	Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)	Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)	Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)	Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)	Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)	Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)
OW-01L	73.74	Lower	12:28	42.39	31.35	9:37	42.39	31.35	16:33	42.51	31.23	9:16	42.77	30.97	10:20	42.94	30.80	10:51	42.99	30.75	14:12	42.41	31.33	12:31	43.32	30.42
OW-01U	73.65	Upper	12:33	41.46	32.19	9:34	41.45	32.20	16:30	41.56	32.09	9:14	41.97	31.68	10:19	42.19	31.46	10:50	42.18	31.47	14:11	41.91	31.74	12:28	42.52	31.13
OW-02L	76.53	Lower	12:16	51.36	25.17	9:26	51.21	25.32	16:20	51.12	25.41	9:30	51.21	25.32	10:48	51.31	25.22	10:29	51.32	25.21	12:54	50.81	25.72	11:37	51.66	24.87
OW-02U	76.74	Upper	12:19	51.49	25.25	9:29	51.35	25.39	16:22	51.19	25.55	9:28	51.25	25.49	10:46	51.35	25.39	10:28	51.29	25.45	12:56	51.46	25.28	11:30	51.58	25.16
OW-03L	76.67	Lower	12:02	55.63	21.04	9:15	55.73	20.94	16:13	55.88	20.79	9:39	56.17	20.50	10:55	56.31	20.36	10:20	56.47	20.20	12:46	56.69	19.98	11:19	56.84	19.83
OW-03U	77.05	Upper	12:06	55.96	21.09	9:18	55.04	22.01	16:16	DRY	NA	9:40	DRY	NA	10:53	DRY	NA	10:19	DRY	NA	12:48	DRY	NA	11:23	DRY	NA
OW-04L	80.67	Lower	11:55	56.69	23.98	9:07	56.61	24.06	16:09	56.54	24.13	9:49	56.75	23.92	11:02	56.91	23.76	10:10	56.98	23.69	12:41	57.22	23.45	11:10	57.39	23.28
OW-04U	81.08	Upper	11:49	56.15	24.93	9:04	56.02	25.06	16:07	56.06	25.02	9:47	56.20	24.88	11:00	56.32	24.76	10:09	56.44	24.64	12:39	56.70	24.38	11:12	56.87	24.21
OW-05L	79.90	Deep	11:37	53.17	26.73	8:57	53.02	26.88	16:03	52.97	26.93	9:58	53.05	26.85	11:08	53.21	26.69	10:04	53.25	26.65	12:34	53.52	26.38	11:04	53.71	26.19
OW-05U	79.55	Upper	11:44	52.71	26.84	9:00	52.48	27.07	16:02	52.31	27.24	9:56	52.33	27.22	11:06	52.45	27.10	10:03	52.50	27.05	12:36	52.75	26.80	11:02	52.88	26.67
OW-06L	81.55	Lower	11:12	54.46	27.09	8:47	54.25	27.30	15:50	53.86	27.69	10:15	54.22	27.33	11:23	54.34	27.21	9:55	54.41	27.14	12:21	54.22	27.33	10:48	54.82	26.73
OW-06U	80.77	Upper	11:18	53.59	27.18	8:49	53.38	27.39	15:51	53.20	27.57	10:12	53.23	27.54	11:22	53.35	27.42	9:53	53.43	27.34	12:23	53.66	27.11	10:45	53.84	26.93
OW-07L	79.04	Deep	11:00	57.78	21.26	8:39	57.88	21.16	15:40	57.99	21.05	10:25	58.17	20.87	11:50	58.33	20.71	9:20	58.41	20.63	11:44	58.68	20.36	10:17	58.88	20.16
OW-07U	79.02	Upper	11:04	58.02	21.00	8:42	57.99	21.03	15:42	55.98	23.04	10:24	58.17	20.85	11:48	58.30	20.72	9:18	58.39	20.63	11:42	58.55	20.47	10:14	58.66	20.36
OW-08L	84.07	Deep	10:00	49.75	34.32	8:17	49.98	34.09	15:23	50.1	33.97	11:07	50.08	33.99	12:40	50.16	33.91	8:55	50.30	33.77	9:56	50.69	33.38	9:00	51.02	33.05
OW-08U	83.88	Lower	10:03	46.26	37.62	8:21	46.24	37.64	15:26	46.36	37.52	11:05	46.49	37.39	12:38	46.64	37.24	8:53	46.79	37.09	9:54	46.98	36.90	8:55	47.25	36.63
OW-09L	80.00	Deep	11:26	52.19	27.81	8:53	51.91	28.09	15:56	51.82	28.18	10:06	51.97	28.03	11:14	52.13	27.87	9:59	52.10	27.90	12:29	46.74	33.26	10:55	52.58	27.42
OW-09U	79.24	Upper	11:32	51.77	27.47	8:51	51.37	27.87	15:55	50.83	28.41	10:04	51.31	27.93	11:13	51.46	27.78	9:58	51.32	27.92	12:28	51.71	27.53	10:52	51.77	27.47
OW-10L	79.88	Deep	10:45	54.52	25.36	8:31	54.76	25.12	15:35	54.81	25.07	10:35	54.80	25.08	12:16	54.98	24.90	9:13	55.15	24.73	11:33	53.61	26.27	9:36	56.00	23.88
OW-10U	79.53	Upper	10:50	57.24	22.29	8:34	57.04	22.49	15:37	56.92	22.61	10:33	57.00	22.53	12:14	57.04	22.49	9:11	56.83	22.70	11:35	56.91	22.62	9:32	56.90	22.63
OW-2150L	82.45	Deep	-	-	-	-	-	-	-	-	-	13:46	48.01	34.44	13:27	47.90	34.55	8:15	47.87	34.58	10:40	48.11	34.34	18:09	48.29	34.16
OW-2150U	82.78	Upper	-	-	-	-	-	-	-	-	-	13:43	36.49	46.29	13:26	36.70	46.08	8:13	36.51	46.27	10:38	36.73	46.05	18:07	36.93	45.85
OW-2169L	81.72	Lower	-	-	-	-	-	-	-	-	-	13:52	44.58	37.14	14:42	44.76	36.96	8:24	44.91	36.81	10:44	45.15	36.57	18:15	45.40	36.32
OW-2169U	81.77	Upper	-	-	-	-	-	-	-	-	-	13:54	38.29	43.48	14:40	38.59	43.18	8:20	38.40	43.37	10:46	38.71	43.06	18:17	38.82	42.95
OW-2181L	81.32	Lower	-	-	-	-	-	-	-	-	-	14:00	44.87	36.45	14:04	44.74	36.58	8:29	44.78	36.54	10:51	44.86	36.46	18:23	44.91	36.41
OW-2181U	81.31	Upper	-	-	-	-	-	-	-	-	-	13:58	38.07	43.24	13:51	38.46	42.85	8:27	38.27	43.04	10:50	38.60	42.71	18:21	38.67	42.64
OW-2185L	81.36	Lower	-	-	-	-	-	-	-	-	-	14:17	45.54	35.82	14:16	45.72	35.64	8:37	45.88	35.48	11:02	46.13	35.23	18:34	46.38	34.98
OW-2185U	81.45	Upper	-	-	-	-	-	-	-	-	-	14:15	41.64	39.81	14:15	41.76	39.69	8:35	41.77	39.68	10:59	41.96	39.49	18:30	42.19	39.26
OW-2253L	82.82	Deep	-	-	-	-	-	-	-	-	-	13:09	49.23	33.59	14:48	49.39	33.43	7:43	49.52	33.30	10:29	49.82	33.00	17:56	50.10	32.72
OW-2253U	82.66	Upper	-	-	-	-	-	-	-	-	-	13:11	34.35	48.31	14:49	34.82	47.84	7:41	34.48	48.18	10:27	34.65	48.01	17:58	35.68	46.98
OW-2269L	82.55	Deep	-	-	-	-	-	-	-	-	-	13:21	48.87	33.68	15:03	48.99	33.56	7:53	49.12	33.43	10:16	49.42	33.13	17:47	49.70	32.85
OW-2269U	82.43	Lower	-	-	-	-	-	-	-	-	-	13:18	46.70	35.73	15:00	46.88	35.55	7:50	47.02	35.41	10:12	47.25	35.18	17:50	47.55	34.88
OW-2284L	82.74	Lower	-	-	-	-	-	-	-	-	-	13:28	47.40	35.34	15:09	47.58	35.16	8:03	47.73	35.01	10:06	47.96	34.78	17:34	48.32	34.42
OW-2284U	82.62	Upper	-	-	-	-	-	-	-	-	-	13:25	38.13	44.49	15:07	38.32	44.30	8:01	38.18	44.44	10:08	38.21	44.41	17:38	38.62	44.00
OW-2301L	83.19	Deep	-	-	-	-	-	-	-	-	-	-	-	-	7:39	44.84	38.35	7:16	44.97	38.22	9:19	45.23	37.96	17:21	45.51	37.68
OW-2301U	83.27	Upper	-	-	-	-	-	-	-	-	-	-	-	-	7:37	33.03	50.24	7:14	32.75	50.52	9:15	33.07	50.20	17:18	33.27	50.00
OW-2302L	81.95	Deep	-	-	-	-	-	-	-	-	-	-	-	-	7:54	44.94	37.01	7:27	45.02	36.93	9:37	45.27	36.68	8:31	45.48	36.47
OW-2302U	81.99	Lower	-	-	-	-	-	-	-	-	-	-	-	-	7:53	43.10	38.89	7:26	43.22	38.77	9:39	43.49	38.50	8:37	43.70	38.29
OW-2304L	69.73	Lower	-	-	-	-	-	-	-	-	-	-	-	-	8:33	42.26	27.47	11:01	42.31	27.42	16:04	42.41	27.32	15:58	42.84	26.89
OW-2304U	70.10	Upper	-	-	-	-	-	-	-	-	-	-	-	-	8:31	33.96	36.14	11:10	34.17	35.93	16:05	34.37	35.73	16:00	34.57	35.53
OW-2307L	78.56	Lower	-	-	-	-	-	-	-	-	-	10:47	51.54	27.02	12:31	51.75	26.81	9:05	51.92	26.64	11:26	52.35	26.21	9:25	52.53	26.03
OW-2307U	78.59	Upper	-	-	-	-	-	-	-	-	-	10:44	45.77	32.82	12:29	45.91	32.68	9:03	46.09	32.50	11:23	46.32	32.27	9:20	46.45	32.14
OW-2319L	76.05	Deep	-	-	-	-	-	-	-	-	-	9:00	42.37	33.68	8:13	41.54	34.51	11:01	42.31	33.74	14:22	37.44	38.61	12:42	42.71	33.34
OW-2319U	75.97	Lower	-	-	-	-	-	-	-	-	-	9:01	40.62	35.35	8:11	40.74	35.23	11:00	40.84	35.13	14:25	41.02	34.95	12:49	41.23	34.74
OW-2320L	73.19	Deep	-	-	-	-	-	-	-	-	-	8:10	43.02	30.17	10:28	43.14	30.05	10:35	43.24	29.95	13:54	43.51	29.68	16:20	43.68	29.51
OW-2320U	73.50	Lower	-	-	-	-	-	-	-	-	-	8:09	44.59	28.91	10:27	44.69	28.81	10:34	44.70	28.80	13:52	44.86	28.64	16:17	45.02	28.48
OW-2320U1	72.90	Upper	-	-	-	-	-	-	-	-	-	8:03	43.52	29.38	10:33	43.65	29.25	10:45	43.62	29.28	13:57	43.79	29.11	12:08	43.90	29.00
OW-2320U2	72.92	Upper	-	-	-	-	-	-	-	-	-	8:04	43.53	29.39	10:35	43.69	29.23	10:44	43.65	29.27	14:00	43.80	29.12	12:11	43.93	28.99
OW-2320U3	72.84	Upper	-	-	-	-	-	-	-	-	-	8:00	43.58	29.26	10:37	43.72	29.12	10:42	43.69	29.15	14:02	42.89	29.95	12:14	43.97	28.87
OW-2320U4	72.91	Upper	-	-	-	-	-	-	-	-	-	8:01	43.79	29.12	10:39	43.91	29.00	10:41	43.89	29.02	14:05	40.87	32.04	12:21	44.19	28.72
OW-2321L	73.54	Deep	-	-	-	-	-	-	-	-	-	-	-	-	9:58	51.68	21.86	12:17	51.79	21.75	13:31	52.02	21.52	11:57	52.28	21.26
OW-2321U	73.27	Lower	-	-	-	-	-	-	-	-	-	-	-	-	9:56	51.70	21.57	12:16	51.70	21.57	13:29	51.86	21.41	11:55	52.01	21.26
OW-2324L	26.27	Deep	-	-	-	-	-	-	-	-	-	-	-	-	12:03	11.79	14.48	9:29	11.99	14.28	11:52	12.13	14.14	10:03	13.08	13.19
OW-2324U	26.17	Lower	-	-	-	-	-	-	-	-	-	-	-	-	12:02	11.28	14.89	9:28	11.38	14.79	11:53	11.54	14.63	9:58	12.44	13.73
OW-2348L	52.70	Deep	-	-	-	-	-	-	-	-	-	-	-	-	9:31	39.53	13.17	11:55	39.73	12.97	15:04	39.31	13.39	13:24	40.66	12.04
OW-2348U	52.12	Lower	-	-	-	-	-	-	-	-	-	-	-	-	9:29	39.06	13.06	11:54	39.17	12.95	14:55	39.12	13.00	13:32	40.07	12.05
OW-2352L	64.60	Lower	-	-	-	-	-	-	-	-	-	-	-	-	9:03	45.17	19.43	11:39	45.09	19.51	15:30	45.19	19.41	13:56	45.21	19.39
OW-2352U	64.47	Upper	-	-	-	-	-	-	-	-	-	-	-	-	9:02	45.09	19.38	11:38	45.00	19.47	15:32	45.08	19.39	13:54	45.13	19.34
OW-2359L1	79.36	Deep	-	-	-	-	-	-	-	-	-	-	-	-	11:42	54.54	24.82	9:44	54.72	24.64	12:11	53.72	25.64	16:49	55.52	23.84
OW-2359L2	78.93	Deep	-	-	-	-	-	-	-	-	-	-	-	-	11:38	54.12	24.81	9:46	54.30	24.63	12:07	52.40	26.53	16:59	55.12	23.81
OW-2359L3	78.83	Deep	-	-	-	-	-	-	-	-	-	-	-	-	11:36	53.89	24.94	9:47	54.05	24.78	12:05	52.12	26.71	16:56	54.89	23.94
OW-2359U1	79.29	Lower	-	-	-	-	-	-	-	-	-	-	-	-	11:40	55.01	24.28	9:45	55.09	24.20	12:09	55.29	24.00	16:47	55.45	23.84

Table 2.3.1.2-3 (Sheet 2 of 3)
VCS Monthly Groundwater Level Measurements

			17-Jun-08			15-Jul-08			11-Aug-08			24-Sep-08			22-Oct-08			12-Nov-08			16-Dec-08			13-Jan-09		
Well No.	Ref. Elev. (NAVD88)	Hydro-geologic Unit	Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)	Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)	Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)	Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)	Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)	Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)	Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)	Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)
OW-01L	73.74	Lower	11:24	43.57	30.17	11:14	43.67	30.07	14:25	43.85	29.89	11:15	44.14	29.60	13:08	44.26	29.48	15:18	44.34	29.40	11:46	44.59	29.15	12:46	44.74	29.00
OW-01U	73.65	Upper	11:20	42.72	30.93	11:11	42.86	30.79	14:23	42.99	30.66	11:18	43.33	30.32	13:07	43.40	30.25	15:20	43.54	30.11	11:45	43.75	29.90	12:45	43.93	29.72
OW-02L	76.53	Lower	10:26	51.87	24.66	10:11	52.00	24.53	13:30	52.16	24.37	11:05	52.49	24.04	12:22	52.64	23.89	14:41	52.78	23.75	11:16	53.06	23.47	12:04	53.26	23.27
OW-02U	76.74	Upper	10:24	51.80	24.94	10:13	51.94	24.80	13:32	52.05	24.69	11:07	52.40	24.34	12:21	52.48	24.26	14:39	52.62	24.12	11:14	52.90	23.84	12:03	53.12	23.62
OW-03L	76.67	Lower	10:17	57.11	19.56	10:05	57.42	19.25	13:21	57.76	18.91	10:57	58.26	18.41	12:15	58.52	18.15	14:33	58.75	17.92	11:08	59.01	17.66	11:54	59.43	17.24
OW-03U	77.05	Upper	10:19	DRY	NA	10:07	DRY	NA	13:24	DRY	NA	10:59	DRY	NA	12:17	DRY	NA	14:35	DRY	NA	11:10	DRY	NA	11:53	DRY	NA
OW-04L	80.67	Lower	10:06	57.57	23.10	9:55	57.78	22.89	13:12	58.01	22.66	10:50	58.43	22.24	12:08	58.63	22.04	14:24	58.81	21.86	11:03	59.12	21.55	11:46	59.35	21.32
OW-04U	81.08	Upper	10:08	57.03	24.05	9:58	57.22	23.86	13:15	57.47	23.61	10:53	57.83	23.25	12:10	58.02	23.06	14:22	58.20	22.88	11:05	58.52	22.56	11:45	58.74	22.34
OW-05L	79.90	Deep	10:06	53.93	25.97	9:43	54.11	25.79	13:07	54.31	25.59	10:42	54.64	25.26	12:05	54.79	25.11	14:17	54.93	24.97	10:59	55.23	24.67	11:39	55.45	24.45
OW-05U	79.55	Upper	10:03	53.06	26.49	9:45	53.21	26.34	13:04	53.36	26.19	10:39	53.71	25.84	12:04	53.83	25.72	14:19	53.98	25.57	10:58	54.29	25.26	11:38	54.51	25.04
OW-06L	81.55	Lower	9:55	55.02	26.53	9:25	55.19	26.36	12:52	55.38	26.17	10:27	55.71	25.84	11:52	55.85	25.70	14:08	55.98	25.57	10:46	56.27	25.28	11:26	56.50	25.05
OW-06U	80.77	Upper	9:53	54.02	26.75	9:23	54.20	26.57	12:54	54.36	26.41	10:29	54.71	26.06	11:54	54.84	25.93	14:06	54.97	25.80	10:47	55.26	25.51	11:27	55.49	25.28
OW-07L	79.04	Deep	9:17	59.14	19.90	8:59	59.41	19.63	12:07	59.75	19.29	9:40	59.97	19.07	11:31	60.21	18.83	13:31	60.29	18.75	10:06	60.37	18.67	10:51	60.44	18.60
OW-07U	79.02	Upper	9:13	58.81	20.21	8:57	59.00	20.02	12:04	59.21	19.81	9:37	59.58	19.44	11:33	59.78	19.24	13:33	59.91	19.11	10:04	60.16	18.86	10:52	60.30	18.72
OW-08L	84.07	Deep	8:46	51.39	32.68	8:08	51.56	32.51	10:07	52.03	32.04	9:02	52.16	31.91	11:08	52.33	31.74	8:32	52.34	31.73	8:58	52.56	31.51	10:26	52.63	31.44
OW-08U	83.88	Lower	8:43	47.60	36.28	8:10	47.79	36.09	10:05	48.17	35.71	9:05	48.38	35.50	11:09	48.54	35.34	8:35	48.62	35.26	8:59	48.90	34.98	10:27	49.03	34.85
OW-09L	80.00	Deep	9:59	52.75	27.25	9:30	52.91	27.09	13:00	53.11	26.89	10:35	53.41	26.59	11:58	53.51	26.49	14:12	53.68	26.32	10:55	54.02	25.98	11:32	54.27	25.73
OW-09U	79.24	Upper	9:57	51.93	27.31	9:33	52.07	27.17	12:58	52.02	27.22	10:33	52.53	26.71	11:56	52.59	26.65	14:14	52.76	26.48	10:53	53.13	26.11	11:31	53.43	25.81
OW-10L	79.88	Deep	9:05	56.54	23.34	8:48	56.84	23.04	11:54	57.34	22.54	9:28	57.35	22.53	11:27	57.56	22.32	13:25	57.52	22.36	9:58	57.51	22.37	10:44	57.42	22.46
OW-10U	79.53	Upper	9:07	56.95	22.58	8:50	57.01	22.52	11:58	57.09	22.44	9:25	57.29	22.24	11:26	57.29	22.24	13:27	57.36	22.17	9:56	57.53	22.00	10:43	57.75	21.78
OW-2150L	82.45	Deep	15:18	48.61	33.84	13:33	48.85	33.60	10:54	49.21	33.24	12:52	49.46	32.99	10:06	49.71	32.74	15:52	49.84	32.61	12:17	49.95	32.50	9:11	50.00	32.45
OW-2150U	82.78	Upper	15:16	37.17	45.61	13:30	37.43	45.35	10:52	37.66	45.12	12:54	38.00	44.78	10:04	38.12	44.66	15:50	38.38	44.40	12:18	38.58	44.20	9:10	38.81	43.97
OW-2169L	81.72	Lower	15:25	45.72	36.00	13:36	45.91	35.81	11:00	46.23	35.49	12:59	46.49	35.23	9:55	46.65	35.07	15:56	46.72	35.00	12:22	47.01	34.71	9:20	47.13	34.59
OW-2169U	81.77	Upper	15:29	39.19	42.58	13:38	39.38	42.39	11:01	39.62	42.15	13:01	39.99	41.78	9:57	40.08	41.69	15:59	40.15	41.62	12:23	40.55	41.22	9:19	40.82	40.95
OW-2181L	81.32	Lower	15:33	45.06	36.26	13:43	45.20	36.12	11:09	45.41	35.91	13:07	45.68	35.64	10:13	45.86	35.46	16:04	46.03	35.29	12:32	46.23	35.09	9:28	46.36	34.96
OW-2181U	81.31	Upper	15:30	39.05	42.26	13:41	39.23	42.08	11:07	39.48	41.83	13:05	39.85	41.46	10:12	39.91	41.40	16:07	39.98	41.33	12:30	40.41	40.90	9:27	40.70	40.61
OW-2185L	81.36	Lower	15:55	46.69	34.67	17:35	46.87	34.49	11:18	47.18	34.18	15:30	47.45	33.91	10:58	47.61	33.75	9:00	47.69	33.67	9:31	47.99	33.37	10:15	48.12	33.24
OW-2185U	81.45	Upper	15:57	42.54	38.91	17:37	42.73	38.72	11:16	43.01	38.44	15:34	43.32	38.13	10:57	43.47	37.98	9:02	43.53	37.92	9:33	43.87	37.58	10:16	44.03	37.42
OW-2253L	82.82	Deep	16:08	50.51	32.31	14:08	50.70	32.12	10:40	51.08	31.74	14:38	51.24	31.58	9:02	51.43	31.39	9:56	51.44	31.38	9:09	51.65	31.17	10:00	51.71	31.11
OW-2253U	82.66	Upper	16:10	36.14	46.52	14:10	36.59	46.07	10:43	37.01	45.65	14:41	37.61	45.05	9:03	37.95	44.71	9:58	38.24	44.42	9:11	38.67	43.99	9:59	39.05	43.61
OW-2269L	82.55	Deep	15:43	50.07	32.48	13:56	50.26	32.29	10:34	50.64	31.91	8:41	50.81	31.74	9:34	51.00	31.55	10:21	51.00	31.55	9:17	51.21	31.34	9:50	51.28	31.27
OW-2269U	82.43	Lower	15:40	47.84	34.59	13:54	48.03	34.40	10:33	48.37	34.06	8:46	48.62	33.81	9:38	48.78	33.65	10:23	48.86	33.57	9:15	49.16	33.27	9:51	49.28	33.15
OW-2284L	82.74	Lower	15:50	48.55	34.19	14:00	48.75	33.99	10:24	49.05	33.69	8:31	49.32	33.42	9:28	49.48	33.26	8:48	49.57	33.17	9:24	49.88	32.86	9:41	50.00	32.74
OW-2284U	82.62	Upper	15:52	38.94	43.68	14:02	39.26	43.36	10:29	39.55	43.07	8:27	39.98	42.64	9:25	40.22	42.40	8:46	40.44	42.18	9:22	40.77	41.85	9:40	41.05	41.57
OW-2301L	83.19	Deep	8:31	45.88	37.31	8:02	46.05	37.14	9:35	46.45	36.74	8:47	46.60	36.59	8:40	46.77	36.42	17:25	46.75	36.44	8:48	47.00	36.19	8:55	47.11	36.08
OW-2301U	83.27	Upper	8:34	33.60	49.67	7:59	33.74	49.53	9:39	33.89	49.38	8:52	34.08	49.19	8:37	34.11	49.16	17:28	34.24	49.03	8:47	34.48	48.79	8:54	34.67	48.60
OW-2302L	81.95	Deep	11:44	45.88	36.07	11:39	45.97	35.98	9:52	46.31	35.64	12:32	46.51	35.44	16:01	46.65	35.30	15:40	46.68	35.27	12:06	46.96	34.99	13:09	47.08	34.87
OW-2302U	81.99	Lower	11:46	44.12	37.87	11:42	44.23	37.76	9:54	44.57	37.42	12:34	44.79	37.20	16:03	44.96	37.03	15:42	45.02	36.97	12:05	45.29	36.70	13:08	45.42	36.57
OW-2304L	69.73	Lower	13:29	42.94	26.79	14:35	43.12	26.61	16:01	43.45	26.28	9:37	43.65	26.08	15:36	43.79	25.94	16:29	43.82	25.91	14:26	44.04	25.69	14:16	44.15	25.58
OW-2304U	70.10	Upper	13:31	34.84	35.26	14:37	35.16	34.94	15:59	35.50	34.60	9:41	36.00	34.10	15:34	36.30	33.80	16:32	36.52	33.58	14:28	36.81	33.29	14:15	37.03	33.07
OW-2307L	78.56	Lower	8:55	53.46	25.10	8:17	53.89	24.67	11:45	54.46	24.10	9:19	54.50	24.06	11:21	54.83	23.73	10:36	54.87	23.69	9:49	54.87	23.69	10:36	54.89	23.67
OW-2307U	78.59	Upper	8:57	46.59	32.00	8:15	46.73	31.86	11:43	46.92	31.67	9:15	47.21	31.38	11:20	47.37	31.22	10:38	47.52	31.07	9:47	47.79	30.80	10:35	48.02	30.57
OW-2319L	76.05	Deep	12:02	43.19	32.86	11:20	43.17	32.88	14:35	43.47	32.58	12:13	43.71	32.34	15:49	43.82	32.23	15:25	43.87	32.18	11:52	44.15	31.90	12:56	44.29	31.76
OW-2319U	75.97	Lower	12:04	41.63	34.34	11:23	41.67	34.30	14:37	41.94	34.03	12:15	42.20	33.77	15:50	42.33	33.64	15:27	42.40	33.57	11:54	42.67	33.30	12:55	42.79	33.18
OW-2320L	73.19	Deep	10:41	44.07	29.12	10:44	44.14	29.05	14:04	44.42	28.77	11:34	44.67	28.52	12:45	44.81	28.38	15:01	44.84	28.35	11:39	45.11	28.08	12:28	45.22	27.97
OW-2320U	73.50	Lower	10:44	45.24	28.26	10:40	45.38	28.12	14:01	45.54	27.96	11:36	45.84	27.66	12:47	45.96	27.54	15:03	46.07	27.43	11:40	46.31	27.19	12:27	46.47	27.03
OW-2320U1	72.90	Upper	10:35	44.09	28.81	10:53	44.23	28.67	14:11	44.36	28.54	11:27	44.66	28.24	12:56	44.78	28.12	15:08	44.89	28.01	11:34	45.10	27.80	12:38	45.24	27.66
OW-2320U2	72.92	Upper	10:33	44.10	28.82	10:50	44.24	28.68	14:13	44.38	28.54	11:29	44.67	28.25	12:54	44.77	28.15	15:06	44.91	28.01	11:35	45.10	27.82	12:39	45.25	27.67
OW-2320U3	72.84	Upper	10:37	44.15	28.69	10:56	44.29	28.55	14:16	44.42	28.42	11:23	44.72	28.12	12:59	44.83	28.01	15:13	44.96	27.88	11:33	45.15	27.69	12:40	45.30	27.54
OW-2320U4	72.91	Upper	10:39	44.35	28.56	10:58	44.49	28.42	14:17	44.62	28.29	11:25	44.92	27.99	12:58	45.04	27.87	15:11	45.14	27.77	11:32	45.35	27.56	12:41	45.49	27.42
OW-2321L	73.54	Deep	11:06	52.68	20.86	10:21	52.91	20.63	13:47	53.28	20.26	11:57	53.55	19.99	12:34	53.76	19.78	14:52	53.84	19.70	11:24	54.01	19.53	12:14	54.07	19.47
OW-2321U	73.27	Lower	11:04	52.17	21.10	10:25	52.31	20.96	13:50	52.48	20.79	11:59	52.82	20.45	12:35	52.99	20.28	14:50	53.14	20.13	11:22	53.41	19.86	12:13	53.62	19.65
OW-2324L	26.27	Deep	9:28	13.84	12.43	8:27	14.29	11.98	12:22	14.91	11.36	9:54	14.86	11.41	15:16	15.07	11.20	13:40	14.93	11.34	10:16	14.37	11.90	11:04	14.14	12.13
OW-2324U	26.17	Lower	9:25	13.26	12.91	8:30	13.69	12.48	12:24	14.38	11.79	9:57	14.19	11.98	15:15	14.45	11.72	13:42	14.14	12.03	10:18	13.74	12.43	11:03	13.71	12.46
OW-2348L	52.70	Deep	14:15	41.20	11.50	15:00	41.61	11.09	15:27	42.16	10.54	10:11	42.23	10.47	13:35	42.49	10.21	16:47	42.45	10.25	14:51	42.40	10.30	14:36	42.35	10.35
OW-2348U	52.12	Lower	14:18	40.63	11.49	15:03	41.15	10.97	15:28	41.75	10.37	10:14	41.81	10.31	13:37	42.11	10.01	16:50	42.00	10.12	14:53	41.85	10.27	14:35	43.76	8.36
OW-2352L	64.60	Lower	13:55	45.36	19.24	15:23	45.47	19.13	15:04	45.56	19.04	12:25	45.74	18.86	13:58	45.79	18.81	17:05	45.89	18.71	15:15	45.98	18.62	14:58	46.06	18.54
OW-2352U	64.47	Upper	13:57	45.27	19.20	15:21	45.38	19.09	15:02	45.47	19.00	12:22	45.66	18.81	13:59	45.70	18.77	17:02	45.81	18.66	15:12	45.88	18.59	14:57	45.96	18.51
OW-2359L1	79.36	Deep	9:50	56.02	23.34	9:10	56.33	23.03	12:38	56.82	22.54	10:06	56.85	22.51	11:42	57.08	22.28	13:56	57.04	22.32	10:35	57.08	22.28	11:15	57.01	22.35
OW-2359L2	78.93	Deep	9:41	55.61	23.32	9:08	55.91	23.02	12:42	56.41	22.52	10:21	56.44	22.49	11:45	56.66	22.27	14:02	56.62	22.31	10:41	56.66	22.27	11:17	56.60	22.33
OW-2359L3	78.83	Deep	9:44	55.37	23.46	9:06	55.67	23.16	12:44	56.18	22.65	10:19	56.20	22.63	11:44	56.42	22.41	14:00	56.38	22.45	10:39	56.42	22.41	11:18	56.34	22.49
OW-2359U1	79.29	Lower	9:47	55.67	23.62	9:13	55.87	23.42	12:40	56.07	23.22	10:15	56.42	22.87	11:40	56.60	22.69	13:58	56.43	22.86	10:37	56.98	22.31	11:16	57.16	22.13

Table 2.3.1.2-3 (Sheet 3 of 3)
VCS Monthly Groundwater Level Measurements

Well No.	Ref. Elev. (NAVD88)	Hydro-geologic Unit	18-Feb-09			19-May-09			25-Aug-09			19-Nov-09			17-Mar-10			8-Jun-10			18-Oct-10		
			Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)	Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)	Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)	Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)	Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)	Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)	Time	Depth to Water (ftbtc)	Elevation of Water (NAVD88)
OW-01L	73.74	Lower	11:42	44.86	28.88	11:00	45.32	28.42	10:26	45.96	27.78	13:22	46.24	27.50	12:46	46.02	27.72	11:43	45.90	27.84	15:57	44.93	28.81
OW-01U	73.65	Upper	11:44	44.03	29.62	10:59	44.56	29.09	10:25	45.15	28.50	13:24	45.49	28.16	12:44	45.35	28.30	11:42	45.23	28.42	15:55	44.14	29.51
OW-02L	76.53	Lower	10:54	53.41	23.12	10:28	53.95	22.58	10:04	54.53	22.00	12:40	54.91	21.62	11:56	54.87	21.66	11:10	54.65	21.88	16:27	53.99	22.54
OW-02U	76.74	Upper	10:56	53.22	23.52	10:30	53.79	22.95	10:03	54.33	22.41	12:42	54.70	22.04	11:55	54.90	21.84	11:08	54.69	22.05	16:25	54.16	22.58
OW-03L	76.67	Lower	10:48	59.25	17.42	10:19	59.54	17.13	9:59	60.44	16.23	12:32	60.26	16.41	11:49	58.98	17.69	11:04	58.73	17.94	16:31	58.12	18.55
OW-03U	77.05	Upper	10:46	DRY	NA	10:20	DRY	NA	9:58	DRY	NA	12:31	DRY	NA	11:47	DRY	NA	11:05	DRY	NA	16:33	DRY	NA
OW-04L	80.67	Lower	10:39	59.50	21.17	10:13	59.97	20.70	9:52	60.67	20.00	12:25	60.94	19.73	11:42	60.46	20.21	10:58	60.22	20.45	16:52	Damaged	NA
OW-04U	81.08	Upper	10:37	58.91	22.17	10:14	59.45	21.63	9:51	60.09	20.99	12:23	60.46	20.62	11:40	60.20	20.88	10:56	59.95	21.13	16:50	59.15	21.93
OW-05L	79.90	Deep	10:29	55.47	24.43	10:10	56.04	23.86	9:47	56.74	23.16	12:18	56.95	22.95	11:34	56.82	23.08	10:50	56.62	23.28	16:56	55.95	23.95
OW-05U	79.55	Upper	10:31	54.64	24.91	10:08	55.22	24.33	9:46	55.83	23.72	12:20	56.25	23.30	11:32	56.48	23.07	10:52	56.28	23.27	16:58	55.62	23.93
OW-06L	81.55	Lower	10:18	56.58	24.97	9:58	57.10	24.45	9:37	57.75	23.80	12:11	58.12	23.43	11:22	58.07	23.48	10:43	57.88	23.67	15:11	57.36	24.19
OW-06U	80.77	Upper	10:15	55.59	25.18	10:00	56.12	24.65	9:38	56.74	24.03	12:09	57.13	23.64	11:19	57.21	23.56	10:42	57.04	23.73	15:14	56.52	24.25
OW-07L	79.04	Deep	9:51	60.45	18.59	9:40	60.83	18.21	8:57	61.95	17.09	11:32	61.41	17.63	10:34	60.45	18.59	10:02	60.32	18.72	17:48	59.97	19.07
OW-07U	79.02	Upper	9:53	60.39	18.63	9:39	60.63	18.39	8:56	61.34	17.68	11:33	61.55	17.47	10:36	60.82	18.20	10:04	60.59	18.43	17:51	60.36	18.66
OW-08L	84.07	Deep	8:32	52.66	31.41	7:56	53.17	30.90	8:34	54.14	29.93	9:05	53.76	30.31	9:25	52.38	31.69	9:09	52.28	31.79	13:19	51.46	32.61
OW-08U	83.88	Lower	8:33	49.11	34.77	7:58	49.71	34.17	8:33	50.46	33.42	9:03	50.66	33.22	9:28	49.65	34.23	9:07	49.38	34.50	13:17	48.48	35.40
OW-09L	80.00	Deep	10:22	54.25	25.75	10:04	54.85	25.15	9:42	55.49	24.51	12:14	55.83	24.17	11:28	55.89	24.11	10:47	55.70	24.30	17:05	55.04	24.96
OW-09U	79.24	Upper	10:24	53.36	25.88	10:03	53.99	25.25	9:41	54.56	24.68	12:15	54.95	24.29	11:26	55.29	23.95	10:48	55.12	24.12	17:03	54.50	24.74
OW-10L	79.88	Deep	9:30	57.38	22.50	9:07	58.07	21.81	8:51	59.52	20.36	11:25	58.17	21.71	10:25	56.64	23.24	9:38	56.64	23.24	18:30	56.38	23.50
OW-10U	79.53	Upper	9:32	57.65	21.88	9:08	57.92	21.61	8:49	58.19	21.34	11:26	58.43	21.10	10:27	58.70	20.83	9:40	58.72	20.81	18:32	58.37	21.16
OW-2150L	82.45	Deep	12:18	50.09	32.36	11:30	50.44	32.01	11:03	51.30	31.15	9:42	51.34	31.11	13:19	50.10	32.35	12:46	49.94	32.51	14:41	49.02	33.43
OW-2150U	82.78	Upper	12:16	38.87	43.91	11:28	39.80	42.98	11:02	40.76	42.02	9:44	41.21	41.57	13:17	40.35	42.43	12:48	40.18	42.60	14:43	38.43	44.35
OW-2169L	81.72	Lower	12:22	47.23	34.49	11:35	47.84	33.88	11:09	48.57	33.15	9:50	48.78	32.94	13:25	47.98	33.74	12:35	47.74	33.98	14:48	46.56	35.16
OW-2169U	81.77	Upper	12:23	40.76	41.01	11:37	41.68	40.09	11:08	42.56	39.21	9:52	42.93	38.84	13:23	42.22	39.55	12:38	42.06	39.71	14:50	40.47	41.30
OW-2181L	81.32	Lower	12:28	46.54	34.78	11:42	46.90	34.42	11:11	47.53	33.79	9:56	47.99	33.33	13:32	47.89	33.43	12:54	47.69	33.63	15:01	47.11	34.21
OW-2181U	81.31	Upper	12:27	40.57	40.74	11:40	41.50	39.81	11:13	42.33	38.98	9:54	42.68	38.63	13:34	42.08	39.23	12:53	39.93	41.38	14:59	40.43	40.88
OW-2185L	81.36	Lower	9:07	48.22	33.14	8:49	48.79	32.57	8:21	49.54	31.82	11:06	49.73	31.63	10:04	49.05	32.31	8:32	48.84	32.52	14:19	47.70	33.66
OW-2185U	81.45	Upper	9:08	44.12	37.33	8:48	44.81	36.64	8:19	45.59	35.86	11:08	45.89	35.56	10:02	45.40	36.05	8:35	45.23	36.22	14:21	43.98	37.47
OW-2253L	82.82	Deep	8:43	51.76	31.06	8:06	52.27	30.55	7:54	53.20	29.62	9:16	52.86	29.96	9:34	51.69	31.13	8:55	51.55	31.27	13:55	50.68	32.14
OW-2253U	82.66	Upper	8:45	39.34	43.32	8:07	40.32	42.34	7:52	41.27	41.39	9:14	41.94	40.72	9:36	38.94	43.72	8:57	38.57	44.09	13:53	35.22	47.44
OW-2269L	82.55	Deep	8:49	51.31	31.24	8:27	51.85	30.70	8:02	52.77	29.78	10:45	52.45	30.10	9:43	51.30	31.25	8:50	51.17	31.38	13:46	50.27	32.28
OW-2269U	82.43	Lower	8:51	49.38	33.05	8:28	49.97	32.46	7:59	50.72	31.71	10:42	50.92	31.51	9:41	50.23	32.20	8:48	50.01	32.42	13:44	48.91	33.52
OW-2284L	82.74	Lower	8:57	50.10	32.64	8:39	50.67	32.07	8:10	51.42	31.32	10:28	51.63	31.11	9:50	51.00	31.74	8:45	50.74	32.00	13:33	49.70	33.04
OW-2284U	82.62	Upper	8:55	41.19	41.43	8:37	42.06	40.56	8:08	43.02	39.60	10:32	43.61	39.01	9:53	43.09	39.53	8:43	43.00	39.62	13:31	41.32	41.30
OW-2301L	83.19	Deep	8:23	47.19	36.00	7:48	47.68	35.51	7:40	48.50	34.69	8:53	48.36	34.83	9:14	47.11	36.08	8:05	46.90	36.29	13:03	45.83	37.36
OW-2301U	83.27	Upper	8:25	34.63	48.64	7:50	35.15	48.12	7:39	35.61	47.66	8:55	35.54	47.73	9:17	34.71	48.56	8:03	34.42	48.85	13:05	32.22	51.05
OW-2302L	81.95	Deep	12:04	47.14	34.81	11:17	47.62	34.33	10:49	48.39	33.56	14:02	48.38	33.57	13:07	47.35	34.60	12:17	47.18	34.77	15:24	46.07	35.88
OW-2302U	81.99	Lower	12:05	45.51	36.48	11:18	46.04	35.95	10:50	46.82	35.17	14:04	46.90	35.09	13:08	45.73	36.26	12:19	45.51	36.48	15:26	44.00	37.99
OW-2304L	69.73	Lower	13:46	44.20	25.53	12:59	44.66	25.07	12:42	45.41	24.32	14:20	45.51	24.22	13:56	44.65	25.08	14:07	44.60	25.13	8:16	43.12	26.61
OW-2304U	70.10	Upper	13:48	37.28	32.82	13:02	37.99	32.11	12:40	39.14	30.96	14:19	39.70	30.40	13:54	39.12	30.98	14:05	39.06	31.04	8:18	38.15	31.95
OW-2307L	78.56	Lower	9:21	54.90	23.66	9:03	55.82	22.74	8:44	57.32	21.24	11:20	56.39	22.17	10:18	53.05	25.51	9:30	52.91	25.65	10:56	52.42	26.14
OW-2307U	78.59	Upper	9:23	48.18	30.41	9:01	48.81	29.78	8:43	49.54	29.05	11:18	50.10	28.49	10:16	49.98	28.61	9:32	49.79	28.80	10:58	49.52	29.07
OW-2319L	76.05	Deep	11:53	44.43	31.62	11:06	44.84	31.21	10:31	45.57	30.48	13:52	45.69	30.36	12:54	45.01	31.04	12:01	44.90	31.15	15:44	43.97	32.08
OW-2319U	75.97	Lower	11:50	42.86	33.11	11:07	43.34	32.63	10:33	44.06	31.91	13:54	44.20	31.77	12:53	43.53	32.44	12:00	43.39	32.58	15:46	42.33	33.64
OW-2320L	73.19	Deep	11:25	45.29	27.90	10:46	45.71	27.48	10:11	46.47	26.72	13:06	46.41	26.78	12:27	45.71	27.48	11:18	45.57	27.62	16:16	44.16	29.03
OW-2320U	73.50	Lower	11:24	46.57	26.93	10:48	47.09	26.41	10:12	47.71	25.79	13:04	48.05	25.45	12:25	48.01	25.49	11:17	47.89	25.61	16:18	47.15	26.35
OW-2320U1	72.90	Upper	11:35	45.36	27.54	10:51	45.88	27.02	10:16	46.49	26.41	13:11	46.88	26.02	12:31	46.92	25.98	11:26	46.84	26.06	16:06	46.11	26.79
OW-2320U2	72.92	Upper	11:33	45.36	27.56	10:50	45.89	27.03	10:17	46.51	26.41	13:13	46.89	26.03	12:32	46.93	25.99	11:28	46.87	26.05	16:07	46.13	26.79
OW-2320U3	72.84	Upper	11:29	45.41	27.43	10:54	45.94	26.90	10:19	46.55	26.29	13:14	46.92	25.92	12:35	46.95	25.89	11:24	46.89	25.95	16:10	46.15	26.69
OW-2320U4	72.91	Upper	11:31	45.61	27.30	10:53	46.14	26.77	10:20	46.74	26.17	13:16	47.10	25.81	12:37	47.15	25.76	11:22	47.08	25.83	16:09	46.35	26.56
OW-2321L	73.54	Deep	11:10	54.11	19.43	10:36	54.31	19.23	11:40	55.40	18.14	12:54	54.63	18.91	12:14	53.60	19.94	13:48	53.49	20.05	9:52	53.10	20.44
OW-2321U	73.27	Lower	11:12	53.78	19.49	10:38	54.25	19.02	11:39	54.77	18.50	12:56	55.08	18.19	12:12	54.63	18.64	13:46	54.52	18.75	9:50	54.04	19.23
OW-2324L	26.27	Deep	9:43	13.99	12.28	9:26	13.87	12.40	9:07	16.66	9.61	11:46	12.78	13.49	10:55	11.87	14.40	9:52	11.74	14.53	10:28	12.36	13.91
OW-2324U	26.17	Lower	9:41	13.47	12.70	9:24	13.64	12.53	9:09	16.10	10.07	11:42	12.71	13.46	10:52	11.62	14.55	9:51	11.60	14.57	10:30	11.96	14.21
OW-2348L	52.70	Deep	14:10	42.29	10.41	13:19	41.25	11.45	12:06	43.68	9.02	15:00	40.09	12.61	14:16	39.19	13.51	14:28	39.06	13.64	9:28	39.90	12.80
OW-2348U	52.12	Lower	14:14	41.71	10.41	13:21	40.56	11.56	12:08	43.34	8.78	14:57	39.56	12.56	14:17	38.34	13.78	14:27	38.25	13.87	9:30	38.97	13.15
OW-2352L	64.60	Lower	14:54	46.16	18.44	13:39	46.48	18.12	12:23	46.88	17.72	15:42	47.17	17.43	15:23	47.04	17.56	14:45	47.02	17.58	9:02	46.62	17.98
OW-2352U	64.47	Upper	14:52	46.06	18.41	13:35	46.38	18.09	12:21	46.79	17.68	15:40	47.09	17.38	15:24	46.97	17.50	14:43	46.94	17.53	9:00	46.56	17.91
OW-2359L1	79.36	Deep	10:07	56.97	22.39	9:50	57.59	21.77	9:24	58.97	20.39	11:57	57.72	21.64	11:12	56.31	23.05	10:24	56.28	23.08	17:31	55.93	23.43
OW-2359L2	78.93	Deep	9:59	56.55	22.38	9:53	57.16	21.77	9:21	58.55	20.38	12:01	57.30	21.63	11:05	55.89	23.04	10:26	55.85	23.08	17:34	55.50	23.43
OW-2359L3	78.83	Deep	10:01	56.31	22.52	9:51	56.92	21.91	9:20	58.31	20.52	12:03	57.07	21.76	11:07	55.63	23.20	10:34	55.61	23.22	17:36	55.26	23.57
OW-2359U1	79.29	Lower	10:09	57.24	22.05	9:48	57.66	21.63	9:22	58.37	20.92	11:59	58.61	20.68	11:10	58.13	21.16	10:36	57.93	21.36	17:33	57.54	21.75

Purple-shaded areas indicate an anomaly or suspect reading
Yellow-shaded areas indicate water level collected on a different date
September 2008 water levels were collected on 9/25/08.
October 2010 water levels were collected on 10/19/10.

Abbreviations:
NAVD88 = North American Vertical Datum 1988
fbtc = feet below top of casing
NA = Not Applicable

Table 2.3.1.2-4 (Sheet 1 of 14)
Vertical Hydraulic Gradient Calculations

Well Pair	Date	Upper Zone Top of screen (NAVD88)	Upper Zone Bottom of screen (NAVD88)	Upper Zone Midpoint (NAVD88)	Upper Zone Elevation of Water (NAVD88)	Lower Zone Top of screen (NAVD88)	Lower Zone Bottom of screen (NAVD88)	Lower Zone Midpoint (NAVD88)	Lower Zone Elevation of Water (NAVD88)	Δx	Δh	i_v
OW-01U/L (Upper Shallow/Lower Shallow)	25-Oct-07	22.16	12.16	17.16	32.19	-27.78	-37.78	-32.78	31.35	49.94	0.84	0.02
	17-Nov-07	22.16	12.16	17.16	32.20	-27.78	-37.78	-32.78	31.35	49.94	0.85	0.02
	18-Dec-07	22.16	12.16	17.16	32.09	-27.78	-37.78	-32.78	31.23	49.94	0.86	0.02
	30-Jan-08	22.16	12.16	17.16	31.68	-27.78	-37.78	-32.78	30.97	49.94	0.71	0.01
	18-Feb-08	22.16	12.16	17.16	31.46	-27.78	-37.78	-32.78	30.80	49.94	0.66	0.01
	31-Mar-08	22.16	12.16	17.16	31.47	-27.78	-37.78	-32.78	30.75	49.94	0.72	0.01
	26-Apr-08	22.16	12.16	17.16	31.74	-27.78	-37.78	-32.78	31.33	49.94	0.41	0.01
	23-May-08	22.16	12.16	17.16	31.13	-27.78	-37.78	-32.78	30.42	49.94	0.71	0.01
	17-Jun-08	22.16	12.16	17.16	30.93	-27.78	-37.78	-32.78	30.17	49.94	0.76	0.02
	15-Jul-08	22.16	12.16	17.16	30.79	-27.78	-37.78	-32.78	30.07	49.94	0.72	0.01
	11-Aug-08	22.16	12.16	17.16	30.66	-27.78	-37.78	-32.78	29.89	49.94	0.77	0.02
	24-Sep-08	22.16	12.16	17.16	30.32	-27.78	-37.78	-32.78	29.60	49.94	0.72	0.01
	22-Oct-08	22.16	12.16	17.16	30.25	-27.78	-37.78	-32.78	29.48	49.94	0.77	0.02
	12-Nov-08	22.16	12.16	17.16	30.11	-27.78	-37.78	-32.78	29.40	49.94	0.71	0.01
	16-Dec-08	22.16	12.16	17.16	29.90	-27.78	-37.78	-32.78	29.15	49.94	0.75	0.02
	13-Jan-09	22.16	12.16	17.16	29.72	-27.78	-37.78	-32.78	29.00	49.94	0.72	0.01
	18-Feb-09	22.16	12.16	17.16	29.62	-27.78	-37.78	-32.78	28.88	49.94	0.74	0.01
	19-May-09	22.16	12.16	17.16	29.09	-27.78	-37.78	-32.78	28.42	49.94	0.67	0.01
	25-Aug-09	22.16	12.16	17.16	28.50	-27.78	-37.78	-32.78	27.78	49.94	0.72	0.01
	19-Nov-09	22.16	12.16	17.16	28.16	-27.78	-37.78	-32.78	27.50	49.94	0.66	0.01
	17-Mar-10	22.16	12.16	17.16	28.30	-27.78	-37.78	-32.78	27.72	49.94	0.58	0.01
	8-Jun-10	22.16	12.16	17.16	28.42	-27.78	-37.78	-32.78	27.84	49.94	0.58	0.01
	18-Oct-10	22.16	12.16	17.16	29.51	-27.78	-37.78	-32.78	28.81	49.94	0.70	0.01
OW-02U/L (Upper Shallow/Lower Shallow)	25-Oct-07	22.25	12.25	17.25	25.25	-22.93	-32.93	-27.93	25.17	45.18	0.08	0.00
	17-Nov-07	22.25	12.25	17.25	25.39	-22.93	-32.93	-27.93	25.32	45.18	0.07	0.00
	18-Dec-07	22.25	12.25	17.25	25.55	-22.93	-32.93	-27.93	25.41	45.18	0.14	0.00
	30-Jan-08	22.25	12.25	17.25	25.49	-22.93	-32.93	-27.93	25.32	45.18	0.17	0.00
	18-Feb-08	22.25	12.25	17.25	25.39	-22.93	-32.93	-27.93	25.22	45.18	0.17	0.00
	31-Mar-08	22.25	12.25	17.25	25.45	-22.93	-32.93	-27.93	25.21	45.18	0.24	0.01
	26-Apr-08	22.25	12.25	17.25	25.28	-22.93	-32.93	-27.93	25.72	45.18	-0.44	-0.01
	23-May-08	22.25	12.25	17.25	25.16	-22.93	-32.93	-27.93	24.87	45.18	0.29	0.01
	17-Jun-08	22.25	12.25	17.25	24.94	-22.93	-32.93	-27.93	24.66	45.18	0.28	0.01
	15-Jul-08	22.25	12.25	17.25	24.80	-22.93	-32.93	-27.93	24.53	45.18	0.27	0.01
	11-Aug-08	22.25	12.25	17.25	24.69	-22.93	-32.93	-27.93	24.37	45.18	0.32	0.01
	24-Sep-08	22.25	12.25	17.25	24.34	-22.93	-32.93	-27.93	24.04	45.18	0.30	0.01
	22-Oct-08	22.25	12.25	17.25	24.26	-22.93	-32.93	-27.93	23.89	45.18	0.37	0.01
	12-Nov-08	22.25	12.25	17.25	24.12	-22.93	-32.93	-27.93	23.75	45.18	0.37	0.01
	16-Dec-08	22.25	12.25	17.25	23.84	-22.93	-32.93	-27.93	23.47	45.18	0.37	0.01
	13-Jan-09	22.25	12.25	17.25	23.62	-22.93	-32.93	-27.93	23.27	45.18	0.35	0.01
	18-Feb-09	22.25	12.25	17.25	23.52	-22.93	-32.93	-27.93	23.12	45.18	0.40	0.01
	19-May-09	22.25	12.25	17.25	22.95	-22.93	-32.93	-27.93	22.58	45.18	0.37	0.01
	25-Aug-09	22.25	12.25	17.25	22.41	-22.93	-32.93	-27.93	22.00	45.18	0.41	0.01
	19-Nov-09	22.25	12.25	17.25	22.04	-22.93	-32.93	-27.93	21.62	45.18	0.42	0.01
	17-Mar-10	22.25	12.25	17.25	21.84	-22.93	-32.93	-27.93	21.66	45.18	0.18	0.00
	8-Jun-10	22.25	12.25	17.25	22.05	-22.93	-32.93	-27.93	21.88	45.18	0.17	0.00
	18-Oct-10	22.25	12.25	17.25	22.58	-22.93	-32.93	-27.93	22.54	45.18	0.04	0.00

Table 2.3.1.2-4 (Sheet 2 of 14)
Vertical Hydraulic Gradient Calculations

		Upper Zone				Lower Zone						
Well Pair	Date	Top of screen (NAVD88)	Bottom of screen (NAVD88)	Midpoint (NAVD88)	Elevation of Water (NAVD88)	Top of screen (NAVD88)	Bottom of screen (NAVD88)	Midpoint (NAVD88)	Elevation of Water (NAVD88)	Δx	Δh	i_v
OW-03U/L (Upper Shallow/Lower Shallow)	25-Oct-07	32.60	22.60	27.60	21.09	-11.79	-21.79	-16.79	21.04	44.39	0.05	0.00
	17-Nov-07	32.60	22.60	27.60	22.01	-11.79	-21.79	-16.79	20.94	44.39	1.07	0.02
	18-Dec-07	32.60	22.60	27.60	DRY	-11.79	-21.79	-16.79	20.79	44.39	NA	NA
	30-Jan-08	32.60	22.60	27.60	DRY	-11.79	-21.79	-16.79	20.50	44.39	NA	NA
	18-Feb-08	32.60	22.60	27.60	DRY	-11.79	-21.79	-16.79	20.36	44.39	NA	NA
	31-Mar-08	32.60	22.60	27.60	DRY	-11.79	-21.79	-16.79	20.20	44.39	NA	NA
	26-Apr-08	32.60	22.60	27.60	DRY	-11.79	-21.79	-16.79	19.98	44.39	NA	NA
	23-May-08	32.60	22.60	27.60	DRY	-11.79	-21.79	-16.79	19.83	44.39	NA	NA
	17-Jun-08	32.60	22.60	27.60	DRY	-11.79	-21.79	-16.79	19.56	44.39	NA	NA
	15-Jul-08	32.60	22.60	27.60	DRY	-11.79	-21.79	-16.79	19.25	44.39	NA	NA
	11-Aug-08	32.60	22.60	27.60	DRY	-11.79	-21.79	-16.79	18.91	44.39	NA	NA
	24-Sep-08	32.60	22.60	27.60	DRY	-11.79	-21.79	-16.79	18.41	44.39	NA	NA
	22-Oct-08	32.60	22.60	27.60	DRY	-11.79	-21.79	-16.79	18.15	44.39	NA	NA
	12-Nov-08	32.60	22.60	27.60	DRY	-11.79	-21.79	-16.79	17.92	44.39	NA	NA
	16-Dec-08	32.60	22.60	27.60	DRY	-11.79	-21.79	-16.79	17.66	44.39	NA	NA
	13-Jan-09	32.60	22.60	27.60	DRY	-11.79	-21.79	-16.79	17.24	44.39	NA	NA
	18-Feb-09	32.60	22.60	27.60	DRY	-11.79	-21.79	-16.79	17.42	44.39	NA	NA
	19-May-09	32.60	22.60	27.60	DRY	-11.79	-21.79	-16.79	17.13	44.39	NA	NA
	25-Aug-09	32.60	22.60	27.60	DRY	-11.79	-21.79	-16.79	16.23	44.39	NA	NA
	19-Nov-09	32.60	22.60	27.60	DRY	-11.79	-21.79	-16.79	16.41	44.39	NA	NA
	17-Mar-10	32.60	22.60	27.60	DRY	-11.79	-21.79	-16.79	17.69	44.39	NA	NA
	8-Jun-10	32.60	22.60	27.60	DRY	-11.79	-21.79	-16.79	17.94	44.39	NA	NA
	18-Oct-10	32.60	22.60	27.60	DRY	-11.79	-21.79	-16.79	18.55	44.39	NA	NA
OW-04U/L (Upper Shallow/Lower Shallow)	25-Oct-07	4.61	-5.39	-0.39	24.93	-20.87	-30.87	-25.87	23.98	25.48	0.95	0.04
	17-Nov-07	4.61	-5.39	-0.39	25.06	-20.87	-30.87	-25.87	24.06	25.48	1.00	0.04
	18-Dec-07	4.61	-5.39	-0.39	25.02	-20.87	-30.87	-25.87	24.13	25.48	0.89	0.03
	30-Jan-08	4.61	-5.39	-0.39	24.88	-20.87	-30.87	-25.87	23.92	25.48	0.96	0.04
	18-Feb-08	4.61	-5.39	-0.39	24.76	-20.87	-30.87	-25.87	23.76	25.48	1.00	0.04
	31-Mar-08	4.61	-5.39	-0.39	24.64	-20.87	-30.87	-25.87	23.69	25.48	0.95	0.04
	26-Apr-08	4.61	-5.39	-0.39	24.38	-20.87	-30.87	-25.87	23.45	25.48	0.93	0.04
	23-May-08	4.61	-5.39	-0.39	24.21	-20.87	-30.87	-25.87	23.28	25.48	0.93	0.04
	17-Jun-08	4.61	-5.39	-0.39	24.05	-20.87	-30.87	-25.87	23.10	25.48	0.95	0.04
	15-Jul-08	4.61	-5.39	-0.39	23.86	-20.87	-30.87	-25.87	22.89	25.48	0.97	0.04
	11-Aug-08	4.61	-5.39	-0.39	23.61	-20.87	-30.87	-25.87	22.66	25.48	0.95	0.04
	24-Sep-08	4.61	-5.39	-0.39	23.25	-20.87	-30.87	-25.87	22.24	25.48	1.01	0.04
	22-Oct-08	4.61	-5.39	-0.39	23.06	-20.87	-30.87	-25.87	22.04	25.48	1.02	0.04
	12-Nov-08	4.61	-5.39	-0.39	22.88	-20.87	-30.87	-25.87	21.86	25.48	1.02	0.04
	16-Dec-08	4.61	-5.39	-0.39	22.56	-20.87	-30.87	-25.87	21.55	25.48	1.01	0.04
	13-Jan-09	4.61	-5.39	-0.39	22.34	-20.87	-30.87	-25.87	21.32	25.48	1.02	0.04
	18-Feb-09	4.61	-5.39	-0.39	22.17	-20.87	-30.87	-25.87	21.17	25.48	1.00	0.04
	19-May-09	4.61	-5.39	-0.39	21.63	-20.87	-30.87	-25.87	20.70	25.48	0.93	0.04
	25-Aug-09	4.61	-5.39	-0.39	20.99	-20.87	-30.87	-25.87	20.00	25.48	0.99	0.04
	19-Nov-09	4.61	-5.39	-0.39	20.62	-20.87	-30.87	-25.87	19.73	25.48	0.89	0.03
	17-Mar-10	4.61	-5.39	-0.39	20.88	-20.87	-30.87	-25.87	20.21	25.48	0.67	0.03
	8-Jun-10	4.61	-5.39	-0.39	21.13	-20.87	-30.87	-25.87	20.45	25.48	0.68	0.03
	18-Oct-10	4.61	-5.39	-0.39	21.93	-20.87	-30.87	-25.87	Damaged	25.48	NA	NA

Table 2.3.1.2-4 (Sheet 3 of 14)
Vertical Hydraulic Gradient Calculations

Well Pair	Date	Upper Zone				Lower Zone				Δx	Δh	i_v
		Top of screen (NAVD88)	Bottom of screen (NAVD88)	Midpoint (NAVD88)	Elevation of Water (NAVD88)	Top of screen (NAVD88)	Bottom of screen (NAVD88)	Midpoint (NAVD88)	Elevation of Water (NAVD88)			
OW-05U/L (Upper Shallow/Deep)	25-Oct-07	32.07	22.07	27.07	26.84	-41.74	-51.74	-46.74	26.73	73.81	0.11	0.00
	17-Nov-07	32.07	22.07	27.07	27.07	-41.74	-51.74	-46.74	26.88	73.81	0.19	0.00
	18-Dec-07	32.07	22.07	27.07	27.24	-41.74	-51.74	-46.74	26.93	73.81	0.31	0.00
	30-Jan-08	32.07	22.07	27.07	27.22	-41.74	-51.74	-46.74	26.85	73.81	0.37	0.01
	18-Feb-08	32.07	22.07	27.07	27.10	-41.74	-51.74	-46.74	26.69	73.81	0.41	0.01
	31-Mar-08	32.07	22.07	27.07	27.05	-41.74	-51.74	-46.74	26.65	73.81	0.40	0.01
	26-Apr-08	32.07	22.07	27.07	26.80	-41.74	-51.74	-46.74	26.38	73.81	0.42	0.01
	23-May-08	32.07	22.07	27.07	26.67	-41.74	-51.74	-46.74	26.19	73.81	0.48	0.01
	17-Jun-08	32.07	22.07	27.07	26.49	-41.74	-51.74	-46.74	25.97	73.81	0.52	0.01
	15-Jul-08	32.07	22.07	27.07	26.34	-41.74	-51.74	-46.74	25.79	73.81	0.55	0.01
	11-Aug-08	32.07	22.07	27.07	26.19	-41.74	-51.74	-46.74	25.59	73.81	0.60	0.01
	24-Sep-08	32.07	22.07	27.07	25.84	-41.74	-51.74	-46.74	25.26	73.81	0.58	0.01
	22-Oct-08	32.07	22.07	27.07	25.72	-41.74	-51.74	-46.74	25.11	73.81	0.61	0.01
	12-Nov-08	32.07	22.07	27.07	25.57	-41.74	-51.74	-46.74	24.97	73.81	0.60	0.01
	16-Dec-08	32.07	22.07	27.07	25.26	-41.74	-51.74	-46.74	24.67	73.81	0.59	0.01
	13-Jan-09	32.07	22.07	27.07	25.04	-41.74	-51.74	-46.74	24.45	73.81	0.59	0.01
	18-Feb-09	32.07	22.07	27.07	24.91	-41.74	-51.74	-46.74	24.43	73.81	0.48	0.01
	19-May-09	32.07	22.07	27.07	24.33	-41.74	-51.74	-46.74	23.86	73.81	0.47	0.01
	25-Aug-09	32.07	22.07	27.07	23.72	-41.74	-51.74	-46.74	23.16	73.81	0.56	0.01
	19-Nov-09	32.07	22.07	27.07	23.30	-41.74	-51.74	-46.74	22.95	73.81	0.35	0.00
	17-Mar-10	32.07	22.07	27.07	23.07	-41.74	-51.74	-46.74	23.08	73.81	-0.01	0.00
	8-Jun-10	32.07	22.07	27.07	23.27	-41.74	-51.74	-46.74	23.28	73.81	-0.01	0.00
	18-Oct-10	32.07	22.07	27.07	23.93	-41.74	-51.74	-46.74	23.95	73.81	-0.02	0.00
OW-06U/L (Upper Shallow/Lower Shallow)	25-Oct-07	26.46	16.46	21.46	27.18	-5.51	-15.51	-10.51	27.09	31.97	0.09	0.00
	17-Nov-07	26.46	16.46	21.46	27.39	-5.51	-15.51	-10.51	27.30	31.97	0.09	0.00
	18-Dec-07	26.46	16.46	21.46	27.57	-5.51	-15.51	-10.51	27.69	31.97	-0.12	0.00
	30-Jan-08	26.46	16.46	21.46	27.54	-5.51	-15.51	-10.51	27.33	31.97	0.21	0.01
	18-Feb-08	26.46	16.46	21.46	27.42	-5.51	-15.51	-10.51	27.21	31.97	0.21	0.01
	31-Mar-08	26.46	16.46	21.46	27.34	-5.51	-15.51	-10.51	27.14	31.97	0.20	0.01
	26-Apr-08	26.46	16.46	21.46	27.11	-5.51	-15.51	-10.51	27.33	31.97	-0.22	-0.01
	23-May-08	26.46	16.46	21.46	26.93	-5.51	-15.51	-10.51	26.73	31.97	0.20	0.01
	17-Jun-08	26.46	16.46	21.46	26.75	-5.51	-15.51	-10.51	26.53	31.97	0.22	0.01
	15-Jul-08	26.46	16.46	21.46	26.57	-5.51	-15.51	-10.51	26.36	31.97	0.21	0.01
	11-Aug-08	26.46	16.46	21.46	26.41	-5.51	-15.51	-10.51	26.17	31.97	0.24	0.01
	24-Sep-08	26.46	16.46	21.46	26.06	-5.51	-15.51	-10.51	25.84	31.97	0.22	0.01
	22-Oct-08	26.46	16.46	21.46	25.93	-5.51	-15.51	-10.51	25.70	31.97	0.23	0.01
	12-Nov-08	26.46	16.46	21.46	25.80	-5.51	-15.51	-10.51	25.57	31.97	0.23	0.01
	16-Dec-08	26.46	16.46	21.46	25.51	-5.51	-15.51	-10.51	25.28	31.97	0.23	0.01
	13-Jan-09	26.46	16.46	21.46	25.28	-5.51	-15.51	-10.51	25.05	31.97	0.23	0.01
	18-Feb-09	26.46	16.46	21.46	25.18	-5.51	-15.51	-10.51	24.97	31.97	0.21	0.01
	19-May-09	26.46	16.46	21.46	24.65	-5.51	-15.51	-10.51	24.45	31.97	0.20	0.01
	25-Aug-09	26.46	16.46	21.46	24.03	-5.51	-15.51	-10.51	23.80	31.97	0.23	0.01
	19-Nov-09	26.46	16.46	21.46	23.64	-5.51	-15.51	-10.51	23.43	31.97	0.21	0.01
	17-Mar-10	26.46	16.46	21.46	23.56	-5.51	-15.51	-10.51	23.48	31.97	0.08	0.00
	8-Jun-10	26.46	16.46	21.46	23.73	-5.51	-15.51	-10.51	23.67	31.97	0.06	0.00
	18-Oct-10	26.46	16.46	21.46	24.25	-5.51	-15.51	-10.51	24.19	31.97	0.06	0.00

Table 2.3.1.2-4 (Sheet 4 of 14)
Vertical Hydraulic Gradient Calculations

		Upper Zone				Lower Zone						
Well Pair	Date	Top of screen (NAVD88)	Bottom of screen (NAVD88)	Midpoint (NAVD88)	Elevation of Water (NAVD88)	Top of screen (NAVD88)	Bottom of screen (NAVD88)	Midpoint (NAVD88)	Elevation of Water (NAVD88)	Δx	Δh	i_v
OW-07U/L (Upper Shallow/Deep)	25-Oct-07	24.32	14.32	19.32	21.00	-35.53	-45.53	-40.53	21.26	59.85	-0.26	0.00
	17-Nov-07	24.32	14.32	19.32	21.03	-35.53	-45.53	-40.53	21.16	59.85	-0.13	0.00
	18-Dec-07	24.32	14.32	19.32	23.04	-35.53	-45.53	-40.53	21.05	59.85	1.99	0.03
	30-Jan-08	24.32	14.32	19.32	20.85	-35.53	-45.53	-40.53	20.87	59.85	-0.02	0.00
	18-Feb-08	24.32	14.32	19.32	20.72	-35.53	-45.53	-40.53	20.71	59.85	0.01	0.00
	31-Mar-08	24.32	14.32	19.32	20.63	-35.53	-45.53	-40.53	20.63	59.85	0.00	0.00
	26-Apr-08	24.32	14.32	19.32	20.47	-35.53	-45.53	-40.53	20.36	59.85	0.11	0.00
	23-May-08	24.32	14.32	19.32	20.36	-35.53	-45.53	-40.53	20.16	59.85	0.20	0.00
	17-Jun-08	24.32	14.32	19.32	20.21	-35.53	-45.53	-40.53	19.90	59.85	0.31	0.01
	15-Jul-08	24.32	14.32	19.32	20.02	-35.53	-45.53	-40.53	19.63	59.85	0.39	0.01
	11-Aug-08	24.32	14.32	19.32	19.81	-35.53	-45.53	-40.53	19.29	59.85	0.52	0.01
	24-Sep-08	24.32	14.32	19.32	19.44	-35.53	-45.53	-40.53	19.07	59.85	0.37	0.01
	22-Oct-08	24.32	14.32	19.32	19.24	-35.53	-45.53	-40.53	18.83	59.85	0.41	0.01
	12-Nov-08	24.32	14.32	19.32	19.11	-35.53	-45.53	-40.53	18.75	59.85	0.36	0.01
	16-Dec-08	24.32	14.32	19.32	18.86	-35.53	-45.53	-40.53	18.67	59.85	0.19	0.00
	13-Jan-09	24.32	14.32	19.32	18.72	-35.53	-45.53	-40.53	18.60	59.85	0.12	0.00
	18-Feb-09	24.32	14.32	19.32	18.63	-35.53	-45.53	-40.53	18.59	59.85	0.04	0.00
	19-May-09	24.32	14.32	19.32	18.39	-35.53	-45.53	-40.53	18.21	59.85	0.18	0.00
	25-Aug-09	24.32	14.32	19.32	17.68	-35.53	-45.53	-40.53	17.09	59.85	0.59	0.01
	19-Nov-09	24.32	14.32	19.32	17.47	-35.53	-45.53	-40.53	17.63	59.85	-0.16	0.00
	17-Mar-10	24.32	14.32	19.32	18.20	-35.53	-45.53	-40.53	18.59	59.85	-0.39	-0.01
	8-Jun-10	24.32	14.32	19.32	18.43	-35.53	-45.53	-40.53	18.72	59.85	-0.29	0.00
	18-Oct-10	24.32	14.32	19.32	18.66	-35.53	-45.53	-40.53	19.07	59.85	-0.41	-0.01
OW-08U/L (Lower Shallow/Deep)	25-Oct-07	-7.62	-17.62	-12.62	37.62	-44.44	-54.44	-49.44	34.32	36.82	3.30	0.09
	17-Nov-07	-7.62	-17.62	-12.62	37.64	-44.44	-54.44	-49.44	34.09	36.82	3.55	0.10
	18-Dec-07	-7.62	-17.62	-12.62	37.52	-44.44	-54.44	-49.44	33.97	36.82	3.55	0.10
	30-Jan-08	-7.62	-17.62	-12.62	37.39	-44.44	-54.44	-49.44	33.99	36.82	3.40	0.09
	18-Feb-08	-7.62	-17.62	-12.62	37.24	-44.44	-54.44	-49.44	33.91	36.82	3.33	0.09
	31-Mar-08	-7.62	-17.62	-12.62	37.09	-44.44	-54.44	-49.44	33.77	36.82	3.32	0.09
	26-Apr-08	-7.62	-17.62	-12.62	36.90	-44.44	-54.44	-49.44	33.38	36.82	3.52	0.10
	23-May-08	-7.62	-17.62	-12.62	36.63	-44.44	-54.44	-49.44	33.05	36.82	3.58	0.10
	17-Jun-08	-7.62	-17.62	-12.62	36.28	-44.44	-54.44	-49.44	32.68	36.82	3.60	0.10
	15-Jul-08	-7.62	-17.62	-12.62	36.09	-44.44	-54.44	-49.44	32.51	36.82	3.58	0.10
	11-Aug-08	-7.62	-17.62	-12.62	35.71	-44.44	-54.44	-49.44	32.04	36.82	3.67	0.10
	24-Sep-08	-7.62	-17.62	-12.62	35.50	-44.44	-54.44	-49.44	31.91	36.82	3.59	0.10
	22-Oct-08	-7.62	-17.62	-12.62	35.34	-44.44	-54.44	-49.44	31.74	36.82	3.60	0.10
	12-Nov-08	-7.62	-17.62	-12.62	35.26	-44.44	-54.44	-49.44	31.73	36.82	3.53	0.10
	16-Dec-08	-7.62	-17.62	-12.62	34.98	-44.44	-54.44	-49.44	31.51	36.82	3.47	0.09
	13-Jan-09	-7.62	-17.62	-12.62	34.85	-44.44	-54.44	-49.44	31.44	36.82	3.41	0.09
	18-Feb-09	-7.62	-17.62	-12.62	34.77	-44.44	-54.44	-49.44	31.41	36.82	3.36	0.09
	19-May-09	-7.62	-17.62	-12.62	34.17	-44.44	-54.44	-49.44	30.90	36.82	3.27	0.09
	25-Aug-09	-7.62	-17.62	-12.62	33.42	-44.44	-54.44	-49.44	29.93	36.82	3.49	0.09
	19-Nov-09	-7.62	-17.62	-12.62	33.22	-44.44	-54.44	-49.44	30.31	36.82	2.91	0.08
	17-Mar-10	-7.62	-17.62	-12.62	34.23	-44.44	-54.44	-49.44	31.69	36.82	2.54	0.07
	8-Jun-10	-7.62	-17.62	-12.62	34.50	-44.44	-54.44	-49.44	31.79	36.82	2.71	0.07
	18-Oct-10	-7.62	-17.62	-12.62	35.40	-44.44	-54.44	-49.44	32.61	36.82	2.79	0.08

Table 2.3.1.2-4 (Sheet 5 of 14)
Vertical Hydraulic Gradient Calculations

		Upper Zone				Lower Zone						
Well Pair	Date	Top of screen (NAVD88)	Bottom of screen (NAVD88)	Midpoint (NAVD88)	Elevation of Water (NAVD88)	Top of screen (NAVD88)	Bottom of screen (NAVD88)	Midpoint (NAVD88)	Elevation of Water (NAVD88)	Δx	Δh	i_v
OW-09U/L (Upper Shallow/Deep)	25-Oct-07	27.91	17.91	22.91	27.47	-32.14	-42.14	-37.14	27.81	60.05	-0.34	-0.01
	17-Nov-07	27.91	17.91	22.91	27.87	-32.14	-42.14	-37.14	28.09	60.05	-0.22	0.00
	18-Dec-07	27.91	17.91	22.91	28.41	-32.14	-42.14	-37.14	28.18	60.05	0.23	0.00
	30-Jan-08	27.91	17.91	22.91	27.93	-32.14	-42.14	-37.14	28.03	60.05	-0.10	0.00
	18-Feb-08	27.91	17.91	22.91	27.78	-32.14	-42.14	-37.14	27.87	60.05	-0.09	0.00
	31-Mar-08	27.91	17.91	22.91	27.92	-32.14	-42.14	-37.14	27.90	60.05	0.02	0.00
	26-Apr-08	27.91	17.91	22.91	27.53	-32.14	-42.14	-37.14	33.26	60.05	-5.73	-0.10
	23-May-08	27.91	17.91	22.91	27.47	-32.14	-42.14	-37.14	27.42	60.05	0.05	0.00
	17-Jun-08	27.91	17.91	22.91	27.31	-32.14	-42.14	-37.14	27.25	60.05	0.06	0.00
	15-Jul-08	27.91	17.91	22.91	27.17	-32.14	-42.14	-37.14	27.09	60.05	0.08	0.00
	11-Aug-08	27.91	17.91	22.91	27.22	-32.14	-42.14	-37.14	26.89	60.05	0.33	0.01
	24-Sep-08	27.91	17.91	22.91	26.71	-32.14	-42.14	-37.14	26.59	60.05	0.12	0.00
	22-Oct-08	27.91	17.91	22.91	26.65	-32.14	-42.14	-37.14	26.49	60.05	0.16	0.00
	12-Nov-08	27.91	17.91	22.91	26.48	-32.14	-42.14	-37.14	26.32	60.05	0.16	0.00
	16-Dec-08	27.91	17.91	22.91	26.11	-32.14	-42.14	-37.14	25.98	60.05	0.13	0.00
	13-Jan-09	27.91	17.91	22.91	25.81	-32.14	-42.14	-37.14	25.73	60.05	0.08	0.00
	18-Feb-09	27.91	17.91	22.91	25.88	-32.14	-42.14	-37.14	25.75	60.05	0.13	0.00
	19-May-09	27.91	17.91	22.91	25.25	-32.14	-42.14	-37.14	25.15	60.05	0.10	0.00
	25-Aug-09	27.91	17.91	22.91	24.68	-32.14	-42.14	-37.14	24.51	60.05	0.17	0.00
	19-Nov-09	27.91	17.91	22.91	24.29	-32.14	-42.14	-37.14	24.17	60.05	0.12	0.00
	17-Mar-10	27.91	17.91	22.91	23.95	-32.14	-42.14	-37.14	24.11	60.05	-0.16	0.00
	8-Jun-10	27.91	17.91	22.91	24.12	-32.14	-42.14	-37.14	24.30	60.05	-0.18	0.00
	18-Oct-10	27.91	17.91	22.91	24.74	-32.14	-42.14	-37.14	24.96	60.05	-0.22	0.00
OW-10U/L (Upper Shallow/Deep)	25-Oct-07	30.09	20.09	25.09	22.29	-48.93	-58.93	-53.93	25.36	79.02	-3.07	-0.04
	17-Nov-07	30.09	20.09	25.09	22.49	-48.93	-58.93	-53.93	25.12	79.02	-2.63	-0.03
	18-Dec-07	30.09	20.09	25.09	22.61	-48.93	-58.93	-53.93	25.07	79.02	-2.46	-0.03
	30-Jan-08	30.09	20.09	25.09	22.53	-48.93	-58.93	-53.93	25.08	79.02	-2.55	-0.03
	18-Feb-08	30.09	20.09	25.09	22.49	-48.93	-58.93	-53.93	24.90	79.02	-2.41	-0.03
	31-Mar-08	30.09	20.09	25.09	22.70	-48.93	-58.93	-53.93	24.73	79.02	-2.03	-0.03
	26-Apr-08	30.09	20.09	25.09	22.62	-48.93	-58.93	-53.93	26.27	79.02	-3.65	-0.05
	23-May-08	30.09	20.09	25.09	22.63	-48.93	-58.93	-53.93	23.88	79.02	-1.25	-0.02
	17-Jun-08	30.09	20.09	25.09	22.58	-48.93	-58.93	-53.93	23.34	79.02	-0.76	-0.01
	15-Jul-08	30.09	20.09	25.09	22.52	-48.93	-58.93	-53.93	23.04	79.02	-0.52	-0.01
	11-Aug-08	30.09	20.09	25.09	22.44	-48.93	-58.93	-53.93	22.54	79.02	-0.10	0.00
	24-Sep-08	30.09	20.09	25.09	22.24	-48.93	-58.93	-53.93	22.53	79.02	-0.29	0.00
	22-Oct-08	30.09	20.09	25.09	22.24	-48.93	-58.93	-53.93	22.32	79.02	-0.08	0.00
	12-Nov-08	30.09	20.09	25.09	22.17	-48.93	-58.93	-53.93	22.36	79.02	-0.19	0.00
	16-Dec-08	30.09	20.09	25.09	22.00	-48.93	-58.93	-53.93	22.37	79.02	-0.37	0.00
	13-Jan-09	30.09	20.09	25.09	21.78	-48.93	-58.93	-53.93	22.46	79.02	-0.68	-0.01
	18-Feb-09	30.09	20.09	25.09	21.88	-48.93	-58.93	-53.93	22.50	79.02	-0.62	-0.01
	19-May-09	30.09	20.09	25.09	21.61	-48.93	-58.93	-53.93	21.81	79.02	-0.20	0.00
	25-Aug-09	30.09	20.09	25.09	21.34	-48.93	-58.93	-53.93	20.36	79.02	0.98	0.01
	19-Nov-09	30.09	20.09	25.09	21.10	-48.93	-58.93	-53.93	21.71	79.02	-0.61	-0.01
	17-Mar-10	30.09	20.09	25.09	20.83	-48.93	-58.93	-53.93	23.24	79.02	-2.41	-0.03
	8-Jun-10	30.09	20.09	25.09	20.81	-48.93	-58.93	-53.93	23.24	79.02	-2.43	-0.03
	18-Oct-10	30.09	20.09	25.09	21.16	-48.93	-58.93	-53.93	23.50	79.02	-2.34	-0.03

Table 2.3.1.2-4 (Sheet 6 of 14)
Vertical Hydraulic Gradient Calculations

Well Pair	Date	Upper Zone				Lower Zone				Δx	Δh	i_v
		Top of screen (NAVD88)	Bottom of screen (NAVD88)	Midpoint (NAVD88)	Elevation of Water (NAVD88)	Top of screen (NAVD88)	Bottom of screen (NAVD88)	Midpoint (NAVD88)	Elevation of Water (NAVD88)			
OW-2150U/L (Upper Shallow/Deep)	30-Jan-08	25.91	15.91	20.91	46.29	-59.13	-69.13	-64.13	34.44	85.04	11.85	0.14
	18-Feb-08	25.91	15.91	20.91	46.08	-59.13	-69.13	-64.13	34.55	85.04	11.53	0.14
	31-Mar-08	25.91	15.91	20.91	46.27	-59.13	-69.13	-64.13	34.58	85.04	11.69	0.14
	26-Apr-08	25.91	15.91	20.91	46.05	-59.13	-69.13	-64.13	34.34	85.04	11.71	0.14
	23-May-08	25.91	15.91	20.91	45.85	-59.13	-69.13	-64.13	34.16	85.04	11.69	0.14
	17-Jun-08	25.91	15.91	20.91	45.61	-59.13	-69.13	-64.13	33.84	85.04	11.77	0.14
	15-Jul-08	25.91	15.91	20.91	45.35	-59.13	-69.13	-64.13	33.60	85.04	11.75	0.14
	11-Aug-08	25.91	15.91	20.91	45.12	-59.13	-69.13	-64.13	33.24	85.04	11.88	0.14
	24-Sep-08	25.91	15.91	20.91	44.78	-59.13	-69.13	-64.13	32.99	85.04	11.79	0.14
	22-Oct-08	25.91	15.91	20.91	44.66	-59.13	-69.13	-64.13	32.74	85.04	11.92	0.14
	12-Nov-08	25.91	15.91	20.91	44.40	-59.13	-69.13	-64.13	32.61	85.04	11.79	0.14
	16-Dec-08	25.91	15.91	20.91	44.20	-59.13	-69.13	-64.13	32.50	85.04	11.70	0.14
	13-Jan-09	25.91	15.91	20.91	43.97	-59.13	-69.13	-64.13	32.45	85.04	11.52	0.14
	18-Feb-09	25.91	15.91	20.91	43.91	-59.13	-69.13	-64.13	32.36	85.04	11.55	0.14
	19-May-09	25.91	15.91	20.91	42.98	-59.13	-69.13	-64.13	32.01	85.04	10.97	0.13
	25-Aug-09	25.91	15.91	20.91	42.02	-59.13	-69.13	-64.13	31.15	85.04	10.87	0.13
	19-Nov-09	25.91	15.91	20.91	41.57	-59.13	-69.13	-64.13	31.11	85.04	10.46	0.12
	17-Mar-10	25.91	15.91	20.91	42.43	-59.13	-69.13	-64.13	32.35	85.04	10.08	0.12
	8-Jun-10	25.91	15.91	20.91	42.60	-59.13	-69.13	-64.13	32.51	85.04	10.09	0.12
	18-Oct-10	25.91	15.91	20.91	44.35	-59.13	-69.13	-64.13	33.43	85.04	10.92	0.13
OW-2169U/L (Upper Shallow/Lower Shallow)	30-Jan-08	25.11	15.11	20.11	43.48	-9.96	-19.96	-14.96	37.14	35.07	6.34	0.18
	18-Feb-08	25.11	15.11	20.11	43.18	-9.96	-19.96	-14.96	36.96	35.07	6.22	0.18
	31-Mar-08	25.11	15.11	20.11	43.37	-9.96	-19.96	-14.96	36.81	35.07	6.56	0.19
	26-Apr-08	25.11	15.11	20.11	43.06	-9.96	-19.96	-14.96	36.57	35.07	6.49	0.19
	23-May-08	25.11	15.11	20.11	42.95	-9.96	-19.96	-14.96	36.32	35.07	6.63	0.19
	17-Jun-08	25.11	15.11	20.11	42.58	-9.96	-19.96	-14.96	36.00	35.07	6.58	0.19
	15-Jul-08	25.11	15.11	20.11	42.39	-9.96	-19.96	-14.96	35.81	35.07	6.58	0.19
	11-Aug-08	25.11	15.11	20.11	42.15	-9.96	-19.96	-14.96	35.49	35.07	6.66	0.19
	24-Sep-08	25.11	15.11	20.11	41.78	-9.96	-19.96	-14.96	35.23	35.07	6.55	0.19
	22-Oct-08	25.11	15.11	20.11	41.69	-9.96	-19.96	-14.96	35.07	35.07	6.62	0.19
	12-Nov-08	25.11	15.11	20.11	41.62	-9.96	-19.96	-14.96	35.00	35.07	6.62	0.19
	16-Dec-08	25.11	15.11	20.11	41.22	-9.96	-19.96	-14.96	34.71	35.07	6.51	0.19
	13-Jan-09	25.11	15.11	20.11	40.95	-9.96	-19.96	-14.96	34.59	35.07	6.36	0.18
	18-Feb-09	25.11	15.11	20.11	41.01	-9.96	-19.96	-14.96	34.49	35.07	6.52	0.19
	19-May-09	25.11	15.11	20.11	40.09	-9.96	-19.96	-14.96	33.88	35.07	6.21	0.18
	25-Aug-09	25.11	15.11	20.11	39.21	-9.96	-19.96	-14.96	33.15	35.07	6.06	0.17
	19-Nov-09	25.11	15.11	20.11	38.84	-9.96	-19.96	-14.96	32.94	35.07	5.90	0.17
	17-Mar-10	25.11	15.11	20.11	39.55	-9.96	-19.96	-14.96	33.74	35.07	5.81	0.17
	8-Jun-10	25.11	15.11	20.11	39.71	-9.96	-19.96	-14.96	33.98	35.07	5.73	0.16
	18-Oct-10	25.11	15.11	20.11	41.30	-9.96	-19.96	-14.96	35.16	35.07	6.14	0.18

Table 2.3.1.2-4 (Sheet 7 of 14)
Vertical Hydraulic Gradient Calculations

		Upper Zone				Lower Zone						
Well Pair	Date	Top of screen (NAVD88)	Bottom of screen (NAVD88)	Midpoint (NAVD88)	Elevation of Water (NAVD88)	Top of screen (NAVD88)	Bottom of screen (NAVD88)	Midpoint (NAVD88)	Elevation of Water (NAVD88)	Δx	Δh	i_v
OW-2181U/L (Upper Shallow/Lower Shallow)	30-Jan-08	40.01	30.01	35.01	43.24	-10.12	-20.12	-15.12	36.45	50.13	6.79	0.14
	18-Feb-08	40.01	30.01	35.01	42.85	-10.12	-20.12	-15.12	36.58	50.13	6.27	0.13
	31-Mar-08	40.01	30.01	35.01	43.04	-10.12	-20.12	-15.12	36.54	50.13	6.50	0.13
	26-Apr-08	40.01	30.01	35.01	42.71	-10.12	-20.12	-15.12	36.46	50.13	6.25	0.12
	23-May-08	40.01	30.01	35.01	42.64	-10.12	-20.12	-15.12	36.41	50.13	6.23	0.12
	17-Jun-08	40.01	30.01	35.01	42.26	-10.12	-20.12	-15.12	36.26	50.13	6.00	0.12
	15-Jul-08	40.01	30.01	35.01	42.08	-10.12	-20.12	-15.12	36.12	50.13	5.96	0.12
	11-Aug-08	40.01	30.01	35.01	41.83	-10.12	-20.12	-15.12	35.91	50.13	5.92	0.12
	24-Sep-08	40.01	30.01	35.01	41.46	-10.12	-20.12	-15.12	35.64	50.13	5.82	0.12
	22-Oct-08	40.01	30.01	35.01	41.40	-10.12	-20.12	-15.12	35.46	50.13	5.94	0.12
	12-Nov-08	40.01	30.01	35.01	41.33	-10.12	-20.12	-15.12	35.29	50.13	6.04	0.12
	16-Dec-08	40.01	30.01	35.01	40.90	-10.12	-20.12	-15.12	35.09	50.13	5.81	0.12
	13-Jan-09	40.01	30.01	35.01	40.61	-10.12	-20.12	-15.12	34.96	50.13	5.65	0.11
	18-Feb-09	40.01	30.01	35.01	40.74	-10.12	-20.12	-15.12	34.78	50.13	5.96	0.12
	19-May-09	40.01	30.01	35.01	39.81	-10.12	-20.12	-15.12	34.42	50.13	5.39	0.11
	25-Aug-09	40.01	30.01	35.01	38.98	-10.12	-20.12	-15.12	33.79	50.13	5.19	0.10
	19-Nov-09	40.01	30.01	35.01	38.63	-10.12	-20.12	-15.12	33.33	50.13	5.30	0.11
	17-Mar-10	40.01	30.01	35.01	39.23	-10.12	-20.12	-15.12	33.43	50.13	5.80	0.12
	8-Jun-10	40.01	30.01	35.01	41.38	-10.12	-20.12	-15.12	33.63	50.13	7.75	0.15
	18-Oct-10	40.01	30.01	35.01	40.88	-10.12	-20.12	-15.12	34.21	50.13	6.67	0.13
OW-2185U/L (Upper Shallow/Lower Shallow)	30-Jan-08	14.89	4.89	9.89	39.81	-10.24	-20.24	-15.24	35.82	25.13	3.99	0.16
	18-Feb-08	14.89	4.89	9.89	39.69	-10.24	-20.24	-15.24	35.64	25.13	4.05	0.16
	31-Mar-08	14.89	4.89	9.89	39.68	-10.24	-20.24	-15.24	35.48	25.13	4.20	0.17
	26-Apr-08	14.89	4.89	9.89	39.49	-10.24	-20.24	-15.24	35.23	25.13	4.26	0.17
	23-May-08	14.89	4.89	9.89	39.26	-10.24	-20.24	-15.24	34.98	25.13	4.28	0.17
	17-Jun-08	14.89	4.89	9.89	38.91	-10.24	-20.24	-15.24	34.67	25.13	4.24	0.17
	15-Jul-08	14.89	4.89	9.89	38.72	-10.24	-20.24	-15.24	34.49	25.13	4.23	0.17
	11-Aug-08	14.89	4.89	9.89	38.44	-10.24	-20.24	-15.24	34.18	25.13	4.26	0.17
	24-Sep-08	14.89	4.89	9.89	38.13	-10.24	-20.24	-15.24	33.91	25.13	4.22	0.17
	22-Oct-08	14.89	4.89	9.89	37.98	-10.24	-20.24	-15.24	33.75	25.13	4.23	0.17
	12-Nov-08	14.89	4.89	9.89	37.92	-10.24	-20.24	-15.24	33.67	25.13	4.25	0.17
	16-Dec-08	14.89	4.89	9.89	37.58	-10.24	-20.24	-15.24	33.37	25.13	4.21	0.17
	13-Jan-09	14.89	4.89	9.89	37.42	-10.24	-20.24	-15.24	33.24	25.13	4.18	0.17
	18-Feb-09	14.89	4.89	9.89	37.33	-10.24	-20.24	-15.24	33.14	25.13	4.19	0.17
	19-May-09	14.89	4.89	9.89	36.64	-10.24	-20.24	-15.24	32.57	25.13	4.07	0.16
	25-Aug-09	14.89	4.89	9.89	35.86	-10.24	-20.24	-15.24	31.82	25.13	4.04	0.16
	19-Nov-09	14.89	4.89	9.89	35.56	-10.24	-20.24	-15.24	31.63	25.13	3.93	0.16
	17-Mar-10	14.89	4.89	9.89	36.05	-10.24	-20.24	-15.24	32.31	25.13	3.74	0.15
	8-Jun-10	14.89	4.89	9.89	36.22	-10.24	-20.24	-15.24	32.52	25.13	3.70	0.15
	18-Oct-10	14.89	4.89	9.89	37.47	-10.24	-20.24	-15.24	33.66	25.13	3.81	0.15

Table 2.3.1.2-4 (Sheet 8 of 14)
Vertical Hydraulic Gradient Calculations

Well Pair	Date	Upper Zone Top of screen (NAVD88)	Upper Zone Bottom of screen (NAVD88)	Upper Zone Midpoint (NAVD88)	Upper Zone Elevation of Water (NAVD88)	Lower Zone Top of screen (NAVD88)	Lower Zone Bottom of screen (NAVD88)	Lower Zone Midpoint (NAVD88)	Lower Zone Elevation of Water (NAVD88)	Δx	Δh	i_v
OW-2253U/L (Upper Shallow/Deep)	30-Jan-08	26.18	16.18	21.18	48.31	-53.83	-63.83	-58.83	33.59	80.01	14.72	0.18
	18-Feb-08	26.18	16.18	21.18	47.84	-53.83	-63.83	-58.83	33.43	80.01	14.41	0.18
	31-Mar-08	26.18	16.18	21.18	48.18	-53.83	-63.83	-58.83	33.30	80.01	14.88	0.19
	26-Apr-08	26.18	16.18	21.18	48.01	-53.83	-63.83	-58.83	33.00	80.01	15.01	0.19
	23-May-08	26.18	16.18	21.18	46.98	-53.83	-63.83	-58.83	32.72	80.01	14.26	0.18
	17-Jun-08	26.18	16.18	21.18	46.52	-53.83	-63.83	-58.83	32.31	80.01	14.21	0.18
	15-Jul-08	26.18	16.18	21.18	46.07	-53.83	-63.83	-58.83	32.12	80.01	13.95	0.17
	11-Aug-08	26.18	16.18	21.18	45.65	-53.83	-63.83	-58.83	31.74	80.01	13.91	0.17
	24-Sep-08	26.18	16.18	21.18	45.05	-53.83	-63.83	-58.83	31.58	80.01	13.47	0.17
	22-Oct-08	26.18	16.18	21.18	44.71	-53.83	-63.83	-58.83	31.39	80.01	13.32	0.17
	12-Nov-08	26.18	16.18	21.18	44.42	-53.83	-63.83	-58.83	31.38	80.01	13.04	0.16
	16-Dec-08	26.18	16.18	21.18	43.99	-53.83	-63.83	-58.83	31.17	80.01	12.82	0.16
	13-Jan-09	26.18	16.18	21.18	43.61	-53.83	-63.83	-58.83	31.11	80.01	12.50	0.16
	18-Feb-09	26.18	16.18	21.18	43.32	-53.83	-63.83	-58.83	31.06	80.01	12.26	0.15
	19-May-09	26.18	16.18	21.18	42.34	-53.83	-63.83	-58.83	30.55	80.01	11.79	0.15
	25-Aug-09	26.18	16.18	21.18	41.39	-53.83	-63.83	-58.83	29.62	80.01	11.77	0.15
	19-Nov-09	26.18	16.18	21.18	40.72	-53.83	-63.83	-58.83	29.96	80.01	10.76	0.13
	17-Mar-10	26.18	16.18	21.18	43.72	-53.83	-63.83	-58.83	31.13	80.01	12.59	0.16
	8-Jun-10	26.18	16.18	21.18	44.09	-53.83	-63.83	-58.83	31.27	80.01	12.82	0.16
	18-Oct-10	26.18	16.18	21.18	47.44	-53.83	-63.83	-58.83	32.14	80.01	15.30	0.19
OW-2269U/L (Lower Shallow/Deep)	30-Jan-08	0.75	-9.25	-4.25	35.73	-49.11	-59.11	-54.11	33.68	49.86	2.05	0.04
	18-Feb-08	0.75	-9.25	-4.25	35.55	-49.11	-59.11	-54.11	33.56	49.86	1.99	0.04
	31-Mar-08	0.75	-9.25	-4.25	35.41	-49.11	-59.11	-54.11	33.43	49.86	1.98	0.04
	26-Apr-08	0.75	-9.25	-4.25	35.18	-49.11	-59.11	-54.11	33.13	49.86	2.05	0.04
	23-May-08	0.75	-9.25	-4.25	34.88	-49.11	-59.11	-54.11	32.85	49.86	2.03	0.04
	17-Jun-08	0.75	-9.25	-4.25	34.59	-49.11	-59.11	-54.11	32.48	49.86	2.11	0.04
	15-Jul-08	0.75	-9.25	-4.25	34.40	-49.11	-59.11	-54.11	32.29	49.86	2.11	0.04
	11-Aug-08	0.75	-9.25	-4.25	34.06	-49.11	-59.11	-54.11	31.91	49.86	2.15	0.04
	25-Sep-08	0.75	-9.25	-4.25	33.81	-49.11	-59.11	-54.11	31.74	49.86	2.07	0.04
	22-Oct-08	0.75	-9.25	-4.25	33.65	-49.11	-59.11	-54.11	31.55	49.86	2.10	0.04
	12-Nov-08	0.75	-9.25	-4.25	33.57	-49.11	-59.11	-54.11	31.55	49.86	2.02	0.04
	16-Dec-08	0.75	-9.25	-4.25	33.27	-49.11	-59.11	-54.11	31.34	49.86	1.93	0.04
	13-Jan-09	0.75	-9.25	-4.25	33.15	-49.11	-59.11	-54.11	31.27	49.86	1.88	0.04
	18-Feb-09	0.75	-9.25	-4.25	33.05	-49.11	-59.11	-54.11	31.24	49.86	1.81	0.04
	19-May-09	0.75	-9.25	-4.25	32.46	-49.11	-59.11	-54.11	30.70	49.86	1.76	0.04
	25-Aug-09	0.75	-9.25	-4.25	31.71	-49.11	-59.11	-54.11	29.78	49.86	1.93	0.04
	19-Nov-09	0.75	-9.25	-4.25	31.51	-49.11	-59.11	-54.11	30.10	49.86	1.41	0.03
	17-Mar-10	0.75	-9.25	-4.25	32.20	-49.11	-59.11	-54.11	31.25	49.86	0.95	0.02
	8-Jun-10	0.75	-9.25	-4.25	32.42	-49.11	-59.11	-54.11	31.38	49.86	1.04	0.02
	18-Oct-10	0.75	-9.25	-4.25	33.52	-49.11	-59.11	-54.11	32.28	49.86	1.24	0.02

Table 2.3.1.2-4 (Sheet 9 of 14)
Vertical Hydraulic Gradient Calculations

Well Pair	Date	Upper Zone: Top of screen (NAVD88)	Upper Zone: Bottom of screen (NAVD88)	Upper Zone: Midpoint (NAVD88)	Upper Zone: Elevation of Water (NAVD88)	Lower Zone: Top of screen (NAVD88)	Lower Zone: Bottom of screen (NAVD88)	Lower Zone: Midpoint (NAVD88)	Lower Zone: Elevation of Water (NAVD88)	Δx	Δh	i_v
OW-2284U/L (Upper Shallow/Lower Shallow)	30-Jan-08	15.97	5.97	10.97	44.49	-19.02	-29.02	-24.02	35.34	34.99	9.15	0.26
	18-Feb-08	15.97	5.97	10.97	44.30	-19.02	-29.02	-24.02	35.16	34.99	9.14	0.26
	31-Mar-08	15.97	5.97	10.97	44.44	-19.02	-29.02	-24.02	35.01	34.99	9.43	0.27
	26-Apr-08	15.97	5.97	10.97	44.41	-19.02	-29.02	-24.02	34.78	34.99	9.63	0.28
	23-May-08	15.97	5.97	10.97	44.00	-19.02	-29.02	-24.02	34.42	34.99	9.58	0.27
	17-Jun-08	15.97	5.97	10.97	43.68	-19.02	-29.02	-24.02	34.19	34.99	9.49	0.27
	15-Jul-08	15.97	5.97	10.97	43.36	-19.02	-29.02	-24.02	33.99	34.99	9.37	0.27
	11-Aug-08	15.97	5.97	10.97	43.07	-19.02	-29.02	-24.02	33.69	34.99	9.38	0.27
	25-Sep-08	15.97	5.97	10.97	42.64	-19.02	-29.02	-24.02	33.42	34.99	9.22	0.26
	22-Oct-08	15.97	5.97	10.97	42.40	-19.02	-29.02	-24.02	33.26	34.99	9.14	0.26
	12-Nov-08	15.97	5.97	10.97	42.18	-19.02	-29.02	-24.02	33.17	34.99	9.01	0.26
	16-Dec-08	15.97	5.97	10.97	41.85	-19.02	-29.02	-24.02	32.86	34.99	8.99	0.26
	13-Jan-09	15.97	5.97	10.97	41.57	-19.02	-29.02	-24.02	32.74	34.99	8.83	0.25
	18-Feb-09	15.97	5.97	10.97	41.43	-19.02	-29.02	-24.02	32.64	34.99	8.79	0.25
	19-May-09	15.97	5.97	10.97	40.56	-19.02	-29.02	-24.02	32.07	34.99	8.49	0.24
	25-Aug-09	15.97	5.97	10.97	39.60	-19.02	-29.02	-24.02	31.32	34.99	8.28	0.24
	19-Nov-09	15.97	5.97	10.97	39.01	-19.02	-29.02	-24.02	31.11	34.99	7.90	0.23
	17-Mar-10	15.97	5.97	10.97	39.53	-19.02	-29.02	-24.02	31.74	34.99	7.79	0.22
	8-Jun-10	15.97	5.97	10.97	39.62	-19.02	-29.02	-24.02	32.00	34.99	7.62	0.22
	18-Oct-10	15.97	5.97	10.97	41.30	-19.02	-29.02	-24.02	33.04	34.99	8.26	0.24
OW-2301U/L (Upper Shallow/Deep)	18-Feb-08	31.77	21.77	26.77	50.24	-48.11	-58.11	-53.11	38.35	79.88	11.89	0.15
	31-Mar-08	31.77	21.77	26.77	50.52	-48.11	-58.11	-53.11	38.22	79.88	12.30	0.15
	26-Apr-08	31.77	21.77	26.77	50.20	-48.11	-58.11	-53.11	37.96	79.88	12.24	0.15
	23-May-08	31.77	21.77	26.77	50.00	-48.11	-58.11	-53.11	37.68	79.88	12.32	0.15
	17-Jun-08	31.77	21.77	26.77	49.67	-48.11	-58.11	-53.11	37.31	79.88	12.36	0.15
	15-Jul-08	31.77	21.77	26.77	49.53	-48.11	-58.11	-53.11	37.14	79.88	12.39	0.16
	11-Aug-08	31.77	21.77	26.77	49.38	-48.11	-58.11	-53.11	36.74	79.88	12.64	0.16
	24-Sep-08	31.77	21.77	26.77	49.19	-48.11	-58.11	-53.11	36.59	79.88	12.60	0.16
	22-Oct-08	31.77	21.77	26.77	49.16	-48.11	-58.11	-53.11	36.42	79.88	12.74	0.16
	12-Nov-08	31.77	21.77	26.77	49.03	-48.11	-58.11	-53.11	36.44	79.88	12.59	0.16
	16-Dec-08	31.77	21.77	26.77	48.79	-48.11	-58.11	-53.11	36.19	79.88	12.60	0.16
	13-Jan-09	31.77	21.77	26.77	48.60	-48.11	-58.11	-53.11	36.08	79.88	12.52	0.16
	18-Feb-09	31.77	21.77	26.77	48.64	-48.11	-58.11	-53.11	36.00	79.88	12.64	0.16
	19-May-09	31.77	21.77	26.77	48.12	-48.11	-58.11	-53.11	35.51	79.88	12.61	0.16
	25-Aug-09	31.77	21.77	26.77	47.66	-48.11	-58.11	-53.11	34.69	79.88	12.97	0.16
	19-Nov-09	31.77	21.77	26.77	47.73	-48.11	-58.11	-53.11	34.83	79.88	12.90	0.16
	17-Mar-10	31.77	21.77	26.77	48.56	-48.11	-58.11	-53.11	36.08	79.88	12.48	0.16
	8-Jun-10	31.77	21.77	26.77	48.85	-48.11	-58.11	-53.11	36.29	79.88	12.56	0.16
	18-Oct-10	31.77	21.77	26.77	51.05	-48.11	-58.11	-53.11	37.36	79.88	13.69	0.17

Table 2.3.1.2-4 (Sheet 10 of 14)
Vertical Hydraulic Gradient Calculations

Well Pair	Date	Upper Zone				Lower Zone				Δx	Δh	i_v
		Top of screen (NAVD88)	Bottom of screen (NAVD88)	Midpoint (NAVD88)	Elevation of Water (NAVD88)	Top of screen (NAVD88)	Bottom of screen (NAVD88)	Midpoint (NAVD88)	Elevation of Water (NAVD88)			
OW-2302U/L (Lower Shallow/Deep)	18-Feb-08	-4.48	-14.48	-9.48	38.89	-59.54	-69.54	-64.54	37.01	55.06	1.88	0.03
	31-Mar-08	-4.48	-14.48	-9.48	38.77	-59.54	-69.54	-64.54	36.93	55.06	1.84	0.03
	26-Apr-08	-4.48	-14.48	-9.48	38.50	-59.54	-69.54	-64.54	36.68	55.06	1.82	0.03
	23-May-08	-4.48	-14.48	-9.48	38.29	-59.54	-69.54	-64.54	36.47	55.06	1.82	0.03
	17-Jun-08	-4.48	-14.48	-9.48	37.87	-59.54	-69.54	-64.54	36.07	55.06	1.80	0.03
	15-Jul-08	-4.48	-14.48	-9.48	37.76	-59.54	-69.54	-64.54	35.98	55.06	1.78	0.03
	11-Aug-08	-4.48	-14.48	-9.48	37.42	-59.54	-69.54	-64.54	35.64	55.06	1.78	0.03
	24-Sep-08	-4.48	-14.48	-9.48	37.20	-59.54	-69.54	-64.54	35.44	55.06	1.76	0.03
	22-Oct-08	-4.48	-14.48	-9.48	37.03	-59.54	-69.54	-64.54	35.30	55.06	1.73	0.03
	12-Nov-08	-4.48	-14.48	-9.48	36.97	-59.54	-69.54	-64.54	35.27	55.06	1.70	0.03
	16-Dec-08	-4.48	-14.48	-9.48	36.70	-59.54	-69.54	-64.54	34.99	55.06	1.71	0.03
	13-Jan-09	-4.48	-14.48	-9.48	36.57	-59.54	-69.54	-64.54	34.87	55.06	1.70	0.03
	18-Feb-09	-4.48	-14.48	-9.48	36.48	-59.54	-69.54	-64.54	34.81	55.06	1.67	0.03
	19-May-09	-4.48	-14.48	-9.48	35.95	-59.54	-69.54	-64.54	34.33	55.06	1.62	0.03
	25-Aug-09	-4.48	-14.48	-9.48	35.17	-59.54	-69.54	-64.54	33.56	55.06	1.61	0.03
	19-Nov-09	-4.48	-14.48	-9.48	35.09	-59.54	-69.54	-64.54	33.57	55.06	1.52	0.03
	17-Mar-10	-4.48	-14.48	-9.48	36.26	-59.54	-69.54	-64.54	34.60	55.06	1.66	0.03
	8-Jun-10	-4.48	-14.48	-9.48	36.48	-59.54	-69.54	-64.54	34.77	55.06	1.71	0.03
	18-Oct-10	-4.48	-14.48	-9.48	37.99	-59.54	-69.54	-64.54	35.88	55.06	2.11	0.04
OW-2304U/L (Upper Shallow/Lower Shallow)	18-Feb-08	28.80	18.80	23.80	36.14	-16.12	-26.12	-21.12	27.47	44.92	8.67	0.19
	31-Mar-08	28.80	18.80	23.80	35.93	-16.12	-26.12	-21.12	27.42	44.92	8.51	0.19
	26-Apr-08	28.80	18.80	23.80	35.73	-16.12	-26.12	-21.12	27.32	44.92	8.41	0.19
	23-May-08	28.80	18.80	23.80	35.53	-16.12	-26.12	-21.12	26.89	44.92	8.64	0.19
	17-Jun-08	28.80	18.80	23.80	35.26	-16.12	-26.12	-21.12	26.79	44.92	8.47	0.19
	15-Jul-08	28.80	18.80	23.80	34.94	-16.12	-26.12	-21.12	26.61	44.92	8.33	0.19
	11-Aug-08	28.80	18.80	23.80	34.60	-16.12	-26.12	-21.12	26.28	44.92	8.32	0.19
	24-Sep-08	28.80	18.80	23.80	34.10	-16.12	-26.12	-21.12	26.08	44.92	8.02	0.18
	22-Oct-08	28.80	18.80	23.80	33.80	-16.12	-26.12	-21.12	25.94	44.92	7.86	0.17
	12-Nov-08	28.80	18.80	23.80	33.58	-16.12	-26.12	-21.12	25.91	44.92	7.67	0.17
	16-Dec-08	28.80	18.80	23.80	33.29	-16.12	-26.12	-21.12	25.69	44.92	7.60	0.17
	13-Jan-09	28.80	18.80	23.80	33.07	-16.12	-26.12	-21.12	25.58	44.92	7.49	0.17
	18-Feb-09	28.80	18.80	23.80	32.82	-16.12	-26.12	-21.12	25.53	44.92	7.29	0.16
	19-May-09	28.80	18.80	23.80	32.11	-16.12	-26.12	-21.12	25.07	44.92	7.04	0.16
	25-Aug-09	28.80	18.80	23.80	30.96	-16.12	-26.12	-21.12	24.32	44.92	6.64	0.15
	19-Nov-09	28.80	18.80	23.80	30.40	-16.12	-26.12	-21.12	24.22	44.92	6.18	0.14
	17-Mar-10	28.80	18.80	23.80	30.98	-16.12	-26.12	-21.12	25.08	44.92	5.90	0.13
	8-Jun-10	28.80	18.80	23.80	31.04	-16.12	-26.12	-21.12	25.13	44.92	5.91	0.13
	18-Oct-10	28.80	18.80	23.80	31.95	-16.12	-26.12	-21.12	26.61	44.92	5.34	0.12

Table 2.3.1.2-4 (Sheet 11 of 14)
Vertical Hydraulic Gradient Calculations

Well Pair	Date	Upper Zone Top of screen (NAVD88)	Upper Zone Bottom of screen (NAVD88)	Upper Zone Midpoint (NAVD88)	Upper Zone Elevation of Water (NAVD88)	Lower Zone Top of screen (NAVD88)	Lower Zone Bottom of screen (NAVD88)	Lower Zone Midpoint (NAVD88)	Lower Zone Elevation of Water (NAVD88)	Δx	Δh	i_v
OW-2307U/L (Upper Shallow/Lower Shallow)	30-Jan-08	22.07	12.07	17.07	32.82	-23.09	-33.09	-28.09	27.02	45.16	5.80	0.13
	18-Feb-08	22.07	12.07	17.07	32.68	-23.09	-33.09	-28.09	26.81	45.16	5.87	0.13
	31-Mar-08	22.07	12.07	17.07	32.50	-23.09	-33.09	-28.09	26.64	45.16	5.86	0.13
	26-Apr-08	22.07	12.07	17.07	32.27	-23.09	-33.09	-28.09	26.21	45.16	6.06	0.13
	23-May-08	22.07	12.07	17.07	32.14	-23.09	-33.09	-28.09	26.03	45.16	6.11	0.14
	17-Jun-08	22.07	12.07	17.07	32.00	-23.09	-33.09	-28.09	25.10	45.16	6.90	0.15
	15-Jul-08	22.07	12.07	17.07	31.86	-23.09	-33.09	-28.09	24.67	45.16	7.19	0.16
	11-Aug-08	22.07	12.07	17.07	31.67	-23.09	-33.09	-28.09	24.10	45.16	7.57	0.17
	24-Sep-08	22.07	12.07	17.07	31.38	-23.09	-33.09	-28.09	24.06	45.16	7.32	0.16
	22-Oct-08	22.07	12.07	17.07	31.22	-23.09	-33.09	-28.09	23.73	45.16	7.49	0.17
	12-Nov-08	22.07	12.07	17.07	31.07	-23.09	-33.09	-28.09	23.69	45.16	7.38	0.16
	16-Dec-08	22.07	12.07	17.07	30.80	-23.09	-33.09	-28.09	23.69	45.16	7.11	0.16
	13-Jan-09	22.07	12.07	17.07	30.57	-23.09	-33.09	-28.09	23.67	45.16	6.90	0.15
	18-Feb-09	22.07	12.07	17.07	30.41	-23.09	-33.09	-28.09	23.66	45.16	6.75	0.15
	19-May-09	22.07	12.07	17.07	29.78	-23.09	-33.09	-28.09	22.74	45.16	7.04	0.16
	25-Aug-09	22.07	12.07	17.07	29.05	-23.09	-33.09	-28.09	21.24	45.16	7.81	0.17
	19-Nov-09	22.07	12.07	17.07	28.49	-23.09	-33.09	-28.09	22.17	45.16	6.32	0.14
	17-Mar-10	22.07	12.07	17.07	28.61	-23.09	-33.09	-28.09	25.51	45.16	3.10	0.07
	8-Jun-10	22.07	12.07	17.07	28.80	-23.09	-33.09	-28.09	25.65	45.16	3.15	0.07
	18-Oct-10	22.07	12.07	17.07	29.07	-23.09	-33.09	-28.09	26.14	45.16	2.93	0.06
OW-2319U/L(Lower Shallow/Deep)	30-Jan-08	-10.67	-20.67	-15.67	35.35	-70.32	-80.32	-75.32	33.68	59.65	1.67	0.03
	18-Feb-08	-10.67	-20.67	-15.67	35.23	-70.32	-80.32	-75.32	34.51	59.65	0.72	0.01
	31-Mar-08	-10.67	-20.67	-15.67	35.13	-70.32	-80.32	-75.32	33.74	59.65	1.39	0.02
	26-Apr-08	-10.67	-20.67	-15.67	34.95	-70.32	-80.32	-75.32	38.61	59.65	-3.66	-0.06
	23-May-08	-10.67	-20.67	-15.67	34.74	-70.32	-80.32	-75.32	33.34	59.65	1.40	0.02
	17-Jun-08	-10.67	-20.67	-15.67	34.34	-70.32	-80.32	-75.32	32.86	59.65	1.48	0.02
	15-Jul-08	-10.67	-20.67	-15.67	34.30	-70.32	-80.32	-75.32	32.88	59.65	1.42	0.02
	11-Aug-08	-10.67	-20.67	-15.67	34.03	-70.32	-80.32	-75.32	32.58	59.65	1.45	0.02
	24-Sep-08	-10.67	-20.67	-15.67	33.77	-70.32	-80.32	-75.32	32.34	59.65	1.43	0.02
	22-Oct-08	-10.67	-20.67	-15.67	33.64	-70.32	-80.32	-75.32	32.23	59.65	1.41	0.02
	12-Nov-08	-10.67	-20.67	-15.67	33.57	-70.32	-80.32	-75.32	32.18	59.65	1.39	0.02
	16-Dec-08	-10.67	-20.67	-15.67	33.30	-70.32	-80.32	-75.32	31.90	59.65	1.40	0.02
	13-Jan-09	-10.67	-20.67	-15.67	33.18	-70.32	-80.32	-75.32	31.76	59.65	1.42	0.02
	18-Feb-09	-10.67	-20.67	-15.67	33.11	-70.32	-80.32	-75.32	31.62	59.65	1.49	0.02
	19-May-09	-10.67	-20.67	-15.67	32.63	-70.32	-80.32	-75.32	31.21	59.65	1.42	0.02
	25-Aug-09	-10.67	-20.67	-15.67	31.91	-70.32	-80.32	-75.32	30.48	59.65	1.43	0.02
	19-Nov-09	-10.67	-20.67	-15.67	31.77	-70.32	-80.32	-75.32	30.36	59.65	1.41	0.02
	17-Mar-10	-10.67	-20.67	-15.67	32.44	-70.32	-80.32	-75.32	31.04	59.65	1.40	0.02
	8-Jun-10	-10.67	-20.67	-15.67	32.58	-70.32	-80.32	-75.32	31.15	59.65	1.43	0.02
	18-Oct-10	-10.67	-20.67	-15.67	33.64	-70.32	-80.32	-75.32	32.08	59.65	1.56	0.03

Table 2.3.1.2-4 (Sheet 12 of 14)
Vertical Hydraulic Gradient Calculations

		Upper Zone				Lower Zone						
Well Pair	Date	Top of screen (NAVD88)	Bottom of screen (NAVD88)	Midpoint (NAVD88)	Elevation of Water (NAVD88)	Top of screen (NAVD88)	Bottom of screen (NAVD88)	Midpoint (NAVD88)	Elevation of Water (NAVD88)	Δx	Δh	i_v
OW-2320U/L (Lower Shallow/Deep)	30-Jan-08	-28.20	-38.20	-33.20	28.91	-68.24	-78.24	-73.24	30.17	40.04	-1.26	-0.03
	18-Feb-08	-28.20	-38.20	-33.20	28.81	-68.24	-78.24	-73.24	30.05	40.04	-1.24	-0.03
	31-Mar-08	-28.20	-38.20	-33.20	28.80	-68.24	-78.24	-73.24	29.95	40.04	-1.15	-0.03
	26-Apr-08	-28.20	-38.20	-33.20	28.64	-68.24	-78.24	-73.24	29.68	40.04	-1.04	-0.03
	23-May-08	-28.20	-38.20	-33.20	28.48	-68.24	-78.24	-73.24	29.51	40.04	-1.03	-0.03
	17-Jun-08	-28.20	-38.20	-33.20	28.62	-68.24	-78.24	-73.24	29.12	40.04	-0.50	-0.01
	15-Jul-08	-28.20	-38.20	-33.20	28.12	-68.24	-78.24	-73.24	29.05	40.04	-0.93	-0.02
	11-Aug-08	-28.20	-38.20	-33.20	27.96	-68.24	-78.24	-73.24	28.77	40.04	-0.81	-0.02
	24-Sep-08	-28.20	-38.20	-33.20	27.66	-68.24	-78.24	-73.24	28.52	40.04	-0.86	-0.02
	22-Oct-08	-28.20	-38.20	-33.20	27.54	-68.24	-78.24	-73.24	28.38	40.04	-0.84	-0.02
	12-Nov-08	-28.20	-38.20	-33.20	27.43	-68.24	-78.24	-73.24	28.35	40.04	-0.92	-0.02
	16-Dec-08	-28.20	-38.20	-33.20	27.19	-68.24	-78.24	-73.24	28.08	40.04	-0.89	-0.02
	13-Jan-09	-28.20	-38.20	-33.20	27.03	-68.24	-78.24	-73.24	27.97	40.04	-0.94	-0.02
	18-Feb-09	-28.20	-38.20	-33.20	26.93	-68.24	-78.24	-73.24	27.90	40.04	-0.97	-0.02
	19-May-09	-28.20	-38.20	-33.20	26.41	-68.24	-78.24	-73.24	27.48	40.04	-1.07	-0.03
	25-Aug-09	-28.20	-38.20	-33.20	25.79	-68.24	-78.24	-73.24	26.72	40.04	-0.93	-0.02
	19-Nov-09	-28.20	-38.20	-33.20	25.45	-68.24	-78.24	-73.24	26.78	40.04	-1.33	-0.03
	17-Mar-10	-28.20	-38.20	-33.20	25.49	-68.24	-78.24	-73.24	27.48	40.04	-1.99	-0.05
	8-Jun-10	-28.20	-38.20	-33.20	25.61	-68.24	-78.24	-73.24	27.62	40.04	-2.01	-0.05
	18-Oct-10	-28.20	-38.20	-33.20	26.35	-68.24	-78.24	-73.24	29.03	40.04	-2.68	-0.07
OW-2321U/L (Lower Shallow/Deep)	18-Feb-08	-28.21	-38.21	-33.21	21.57	-68.01	-78.01	-73.01	21.86	39.80	-0.29	-0.01
	31-Mar-08	-28.21	-38.21	-33.21	21.57	-68.01	-78.01	-73.01	21.75	39.80	-0.18	0.00
	26-Apr-08	-28.21	-38.21	-33.21	21.41	-68.01	-78.01	-73.01	21.52	39.80	-0.11	0.00
	23-May-08	-28.21	-38.21	-33.21	21.26	-68.01	-78.01	-73.01	21.26	39.80	0.00	0.00
	17-Jun-08	-28.21	-38.21	-33.21	21.10	-68.01	-78.01	-73.01	20.86	39.80	0.24	0.01
	15-Jul-08	-28.21	-38.21	-33.21	20.96	-68.01	-78.01	-73.01	20.63	39.80	0.33	0.01
	11-Aug-08	-28.21	-38.21	-33.21	20.79	-68.01	-78.01	-73.01	20.26	39.80	0.53	0.01
	24-Sep-08	-28.21	-38.21	-33.21	20.45	-68.01	-78.01	-73.01	19.99	39.80	0.46	0.01
	22-Oct-08	-28.21	-38.21	-33.21	20.28	-68.01	-78.01	-73.01	19.78	39.80	0.50	0.01
	12-Nov-08	-28.21	-38.21	-33.21	20.13	-68.01	-78.01	-73.01	19.70	39.80	0.43	0.01
	16-Dec-08	-28.21	-38.21	-33.21	19.86	-68.01	-78.01	-73.01	19.53	39.80	0.33	0.01
	13-Jan-09	-28.21	-38.21	-33.21	19.65	-68.01	-78.01	-73.01	19.47	39.80	0.18	0.00
	18-Feb-09	-28.21	-38.21	-33.21	19.49	-68.01	-78.01	-73.01	19.43	39.80	0.06	0.00
	19-May-09	-28.21	-38.21	-33.21	19.02	-68.01	-78.01	-73.01	19.23	39.80	-0.21	-0.01
	25-Aug-09	-28.21	-38.21	-33.21	18.50	-68.01	-78.01	-73.01	18.14	39.80	0.36	0.01
	19-Nov-09	-28.21	-38.21	-33.21	18.19	-68.01	-78.01	-73.01	18.91	39.80	-0.72	-0.02
	17-Mar-10	-28.21	-38.21	-33.21	18.64	-68.01	-78.01	-73.01	19.94	39.80	-1.30	-0.03
	8-Jun-10	-28.21	-38.21	-33.21	18.75	-68.01	-78.01	-73.01	20.05	39.80	-1.30	-0.03
	18-Oct-10	-28.21	-38.21	-33.21	19.23	-68.01	-78.01	-73.01	20.44	39.80	-1.21	-0.03

Table 2.3.1.2-4 (Sheet 13 of 14)
Vertical Hydraulic Gradient Calculations

Well Pair	Date	Upper Zone				Lower Zone				Δx	Δh	i_v
		Top of screen (NAVD88)	Bottom of screen (NAVD88)	Midpoint (NAVD88)	Elevation of Water (NAVD88)	Top of screen (NAVD88)	Bottom of screen (NAVD88)	Midpoint (NAVD88)	Elevation of Water (NAVD88)			
OW-2324U/L (Lower Shallow/Deep)	18-Feb-08	-10.33	-20.33	-15.33	14.89	-90.15	-100.15	-95.15	14.48	79.82	0.41	0.01
	31-Mar-08	-10.33	-20.33	-15.33	14.79	-90.15	-100.15	-95.15	14.28	79.82	0.51	0.01
	26-Apr-08	-10.33	-20.33	-15.33	14.63	-90.15	-100.15	-95.15	14.14	79.82	0.49	0.01
	23-May-08	-10.33	-20.33	-15.33	13.73	-90.15	-100.15	-95.15	13.19	79.82	0.54	0.01
	17-Jun-08	-10.33	-20.33	-15.33	12.91	-90.15	-100.15	-95.15	12.43	79.82	0.48	0.01
	15-Jul-08	-10.33	-20.33	-15.33	12.48	-90.15	-100.15	-95.15	11.98	79.82	0.50	0.01
	11-Aug-08	-10.33	-20.33	-15.33	11.79	-90.15	-100.15	-95.15	11.36	79.82	0.43	0.01
	24-Sep-08	-10.33	-20.33	-15.33	11.98	-90.15	-100.15	-95.15	11.41	79.82	0.57	0.01
	22-Oct-08	-10.33	-20.33	-15.33	11.72	-90.15	-100.15	-95.15	11.20	79.82	0.52	0.01
	12-Nov-08	-10.33	-20.33	-15.33	12.03	-90.15	-100.15	-95.15	11.34	79.82	0.69	0.01
	16-Dec-08	-10.33	-20.33	-15.33	12.43	-90.15	-100.15	-95.15	11.90	79.82	0.53	0.01
	13-Jan-09	-10.33	-20.33	-15.33	12.46	-90.15	-100.15	-95.15	12.13	79.82	0.33	0.00
	18-Feb-09	-10.33	-20.33	-15.33	12.70	-90.15	-100.15	-95.15	12.28	79.82	0.42	0.01
	19-May-09	-10.33	-20.33	-15.33	12.53	-90.15	-100.15	-95.15	12.40	79.82	0.13	0.00
	25-Aug-09	-10.33	-20.33	-15.33	10.07	-90.15	-100.15	-95.15	9.61	79.82	0.46	0.01
	19-Nov-09	-10.33	-20.33	-15.33	13.46	-90.15	-100.15	-95.15	13.49	79.82	-0.03	0.00
	17-Mar-10	-10.33	-20.33	-15.33	14.55	-90.15	-100.15	-95.15	14.40	79.82	0.15	0.00
	8-Jun-10	-10.33	-20.33	-15.33	14.57	-90.15	-100.15	-95.15	14.53	79.82	0.04	0.00
	18-Oct-10	-10.33	-20.33	-15.33	14.21	-90.15	-100.15	-95.15	13.91	79.82	0.30	0.00
OW-2348U/L (Lower Shallow/Deep)	18-Feb-08	-19.44	-29.44	-24.44	13.06	-82.79	-92.79	-87.79	13.17	63.35	-0.11	0.00
	31-Mar-08	-19.44	-29.44	-24.44	12.95	-82.79	-92.79	-87.79	12.97	63.35	-0.02	0.00
	26-Apr-08	-19.44	-29.44	-24.44	13.00	-82.79	-92.79	-87.79	13.39	63.35	-0.39	-0.01
	23-May-08	-19.44	-29.44	-24.44	12.05	-82.79	-92.79	-87.79	12.04	63.35	0.01	0.00
	17-Jun-08	-19.44	-29.44	-24.44	11.49	-82.79	-92.79	-87.79	11.50	63.35	-0.01	0.00
	15-Jul-08	-19.44	-29.44	-24.44	10.97	-82.79	-92.79	-87.79	11.09	63.35	-0.12	0.00
	11-Aug-08	-19.44	-29.44	-24.44	10.37	-82.79	-92.79	-87.79	10.54	63.35	-0.17	0.00
	25-Sep-08	-19.44	-29.44	-24.44	10.31	-82.79	-92.79	-87.79	10.47	63.35	-0.16	0.00
	22-Oct-08	-19.44	-29.44	-24.44	10.01	-82.79	-92.79	-87.79	10.21	63.35	-0.20	0.00
	12-Nov-08	-19.44	-29.44	-24.44	10.12	-82.79	-92.79	-87.79	10.25	63.35	-0.13	0.00
	16-Dec-08	-19.44	-29.44	-24.44	10.27	-82.79	-92.79	-87.79	10.30	63.35	-0.03	0.00
	13-Jan-09	-19.44	-29.44	-24.44	8.36	-82.79	-92.79	-87.79	10.35	63.35	-1.99	-0.03
	18-Feb-09	-19.44	-29.44	-24.44	10.41	-82.79	-92.79	-87.79	10.41	63.35	0.00	0.00
	19-May-09	-19.44	-29.44	-24.44	11.56	-82.79	-92.79	-87.79	11.45	63.35	0.11	0.00
	25-Aug-09	-19.44	-29.44	-24.44	8.78	-82.79	-92.79	-87.79	9.02	63.35	-0.24	0.00
	19-Nov-09	-19.44	-29.44	-24.44	12.56	-82.79	-92.79	-87.79	12.61	63.35	-0.05	0.00
	17-Mar-10	-19.44	-29.44	-24.44	13.78	-82.79	-92.79	-87.79	13.51	63.35	0.27	0.00
	8-Jun-10	-19.44	-29.44	-24.44	13.87	-82.79	-92.79	-87.79	13.64	63.35	0.23	0.00
	18-Oct-10	-19.44	-29.44	-24.44	13.15	-82.79	-92.79	-87.79	12.80	63.35	0.35	0.01

Table 2.3.1.2-4 (Sheet 14 of 14)
Vertical Hydraulic Gradient Calculations

		Upper Zone				Lower Zone						
Well Pair	Date	Top of screen (NAVD88)	Bottom of screen (NAVD88)	Midpoint (NAVD88)	Elevation of Water (NAVD88)	Top of screen (NAVD88)	Bottom of screen (NAVD88)	Midpoint (NAVD88)	Elevation of Water (NAVD88)	Δx	Δh	i_v
W-2352U/L (Upper Shallow/Lower Shallow)	18-Feb-08	18.17	8.17	13.17	19.38	-16.67	-26.67	-21.67	19.43	34.84	-0.05	0.00
	31-Mar-08	18.17	8.17	13.17	19.47	-16.67	-26.67	-21.67	19.51	34.84	-0.04	0.00
	26-Apr-08	18.17	8.17	13.17	19.39	-16.67	-26.67	-21.67	19.41	34.84	-0.02	0.00
	23-May-08	18.17	8.17	13.17	19.34	-16.67	-26.67	-21.67	19.39	34.84	-0.05	0.00
	17-Jun-08	18.17	8.17	13.17	19.20	-16.67	-26.67	-21.67	19.24	34.84	-0.04	0.00
	15-Jul-08	18.17	8.17	13.17	19.09	-16.67	-26.67	-21.67	19.13	34.84	-0.04	0.00
	11-Aug-08	18.17	8.17	13.17	19.00	-16.67	-26.67	-21.67	19.04	34.84	-0.04	0.00
	25-Sep-08	18.17	8.17	13.17	18.81	-16.67	-26.67	-21.67	18.86	34.84	-0.05	0.00
	22-Oct-08	18.17	8.17	13.17	18.77	-16.67	-26.67	-21.67	18.81	34.84	-0.04	0.00
	12-Nov-08	18.17	8.17	13.17	18.66	-16.67	-26.67	-21.67	18.71	34.84	-0.05	0.00
	16-Dec-08	18.17	8.17	13.17	18.59	-16.67	-26.67	-21.67	18.62	34.84	-0.03	0.00
	13-Jan-09	18.17	8.17	13.17	18.51	-16.67	-26.67	-21.67	18.54	34.84	-0.03	0.00
	18-Feb-09	18.17	8.17	13.17	18.41	-16.67	-26.67	-21.67	18.44	34.84	-0.03	0.00
	19-May-09	18.17	8.17	13.17	18.09	-16.67	-26.67	-21.67	18.12	34.84	-0.03	0.00
	25-Aug-09	18.17	8.17	13.17	17.68	-16.67	-26.67	-21.67	17.72	34.84	-0.04	0.00
	19-Nov-09	18.17	8.17	13.17	17.38	-16.67	-26.67	-21.67	17.43	34.84	-0.05	0.00
	17-Mar-10	18.17	8.17	13.17	17.50	-16.67	-26.67	-21.67	17.56	34.84	-0.06	0.00
	8-Jun-10	18.17	8.17	13.17	17.53	-16.67	-26.67	-21.67	17.58	34.84	-0.05	0.00
	18-Oct-10	18.17	8.17	13.17	17.91	-16.67	-26.67	-21.67	17.98	34.84	-0.07	0.00
OW-2359U1/L1 (Upper Shallow/Deep)	18-Feb-08	-7.34	-17.34	-12.34	24.28	-76.92	-96.92	-86.92	24.82	74.58	-0.54	-0.01
	31-Mar-08	-7.34	-17.34	-12.34	24.20	-76.92	-96.92	-86.92	24.64	74.58	-0.44	-0.01
	26-Apr-08	-7.34	-17.34	-12.34	24.00	-76.92	-96.92	-86.92	25.64	74.58	-1.64	-0.02
	23-May-08	-7.34	-17.34	-12.34	23.84	-76.92	-96.92	-86.92	23.84	74.58	0.00	0.00
	17-Jun-08	-7.34	-17.34	-12.34	23.62	-76.92	-96.92	-86.92	23.34	74.58	0.28	0.00
	15-Jul-08	-7.34	-17.34	-12.34	23.42	-76.92	-96.92	-86.92	23.03	74.58	0.39	0.01
	11-Aug-08	-7.34	-17.34	-12.34	23.22	-76.92	-96.92	-86.92	22.54	74.58	0.68	0.01
	24-Sep-08	-7.34	-17.34	-12.34	22.87	-76.92	-96.92	-86.92	22.51	74.58	0.36	0.00
	22-Oct-08	-7.34	-17.34	-12.34	22.69	-76.92	-96.92	-86.92	22.28	74.58	0.41	0.01
	12-Nov-08	-7.34	-17.34	-12.34	22.86	-76.92	-96.92	-86.92	22.32	74.58	0.54	0.01
	16-Dec-08	-7.34	-17.34	-12.34	22.31	-76.92	-96.92	-86.92	22.28	74.58	0.03	0.00
	13-Jan-09	-7.34	-17.34	-12.34	22.13	-76.92	-96.92	-86.92	22.35	74.58	-0.22	0.00
	18-Feb-09	-7.34	-17.34	-12.34	22.05	-76.92	-96.92	-86.92	22.39	74.58	-0.34	0.00
	19-May-09	-7.34	-17.34	-12.34	21.63	-76.92	-96.92	-86.92	21.77	74.58	-0.14	0.00
	25-Aug-09	-7.34	-17.34	-12.34	20.92	-76.92	-96.92	-86.92	20.39	74.58	0.53	0.01
	19-Nov-09	-7.34	-17.34	-12.34	20.68	-76.92	-96.92	-86.92	21.64	74.58	-0.96	-0.01
	17-Mar-10	-7.34	-17.34	-12.34	21.16	-76.92	-96.92	-86.92	23.05	74.58	-1.89	-0.03
	8-Jun-10	-7.34	-17.34	-12.34	21.36	-76.92	-96.92	-86.92	23.08	74.58	-1.72	-0.02
	18-Oct-10	-7.34	-17.34	-12.34	21.75	-76.92	-96.92	-86.92	23.43	74.58	-1.68	-0.02

Notes: All Screen elevations are in ft NAVD 88.
Purple shaded areas indicate an anomaly or suspect measurement.
Blue shaded areas: Wells OW-2253U/L were field mislabeled. Shaded areas indicate data corrected to reflect the true well identities.
A positive i_v represents a downward hydraulic gradient.
A negative i_v represents an upwards hydraulic gradient.

Table 2.3.1.2-5 (Sheet 1 of 4)
VCS Site Slug Test Results

Observation Well	Surface Elevation (NAVD 88)	Depth (ft)	Geologic Unit	Saturated Thickness (ft)	Hydraulic Conductivity in ft/d					Notes
					Falling		Rising		Arithmetic Mean	
					Bouwer-Rice	Butler	Bouwer-Rice	Butler		
OW-01U	71.46	63	Upper	10	13.97	20.70	37.10	31.69	25.87	
OW-02U	74.68	66	Upper	10	4.46	11.45	12.62	23.37	12.98	
OW-03U	74.89	56	Upper	NA	NA	NA	NA	NA	NA	Dry
OW-04U	78.97	88.13	Upper	3.5	3.34	3.49	1.91	1.81	2.64	
OW-05U	77.56	59.28	Upper	10	NA	NA	26.79	31.06	28.93	Missing Falling Head data
OW-06U	78.98	65.98	Upper	7	10.63	17.70	23.25	23.08	18.67	
OW-07U	77.39	66.13	Upper	10	NA	NA	26.43	87.14	56.79	Missing Falling Head data
OW-09U	77.36	62.85	Upper	10	28.71	33.84	26.18	23.02	27.94	
OW-10U	77.69	60.1	Upper	NA	NA	NA	NA	NA	NA	Insufficient water for testing
OW-2150U	80.44	67.05	Upper	9.1	0.05	0.08	2.46	4.46	1.76	
OW-2150U	80.44	67.05	Upper	9.1	0.05	0.07	NA	NA	0.06	Duplicate Test
OW-2150 Average	80.44	67.05	Upper	9.1	0.05	0.08	2.46	4.46	0.91	Well Average
OW-2169U	79.47	68.7	Upper	10	14.50	30.15	28.44	30.87	25.99	
OW-2181U	79.24	53.02	Upper	10	4.08	13.53	8.95	12.82	9.85	
OW-2185U	79.48	78.24	Upper	4.5	9.92	15.15	10.79	13.86	12.43	
OW-2253U	80.86	68.25	Upper	8.5	10.80	11.58	12.48	15.36	12.56	
OW-2284U	80.42	78.45	Upper	5	0.85	0.95	1.37	1.82	1.25	
OW-2284U	80.42	78.45	Upper	5	0.58	3.04	NA	NA	1.81	Duplicate Test
OW-2284U Average	80.42	78.45	Upper	5	0.72	2.00	1.37	1.82	1.53	Well Average
OW-2301U	81.23	63	Upper	7	12.29	20.62	14.24	21.46	17.15	

Table 2.3.1.2-5 (Sheet 2 of 4)
VCS Site Slug Test Results

Observation Well	Surface Elevation (NAVD 88)	Depth (ft)	Geologic Unit	Saturated Thickness (ft)	Hydraulic Conductivity in ft/d					Notes
					Falling		Rising		Arithmetic Mean	
					Bouwer-Rice	Butler	Bouwer-Rice	Butler		
OW-2304U	68.33	54.33	Upper	10	60.44	61.99	35.62	53.45	52.88	
OW-2307U	76.75	68.11	Upper	10	9.64	10.33	7.13	14.67	10.44	
OW-2352U	62.91	58.6	Upper	10	3.78	5.03	11.53	12.79	8.28	
OW-01L	71.46	112.95	Lower	10	43.26	73.30	48.94	49.32	53.71	
OW-01L	71.46	112.95	Lower	10	33.55	25.72	45.98	59.56	41.20	Duplicate Test
OW-01L Average	71.46	112.95	Lower	10	38.41	49.51	47.46	54.44	47.45	Well Average
OW-02L	74.68	109.13	Lower	10	23.26	24.84	20.46	36.29	26.21	
OW-03L	74.89	100	Lower	10	83.66	94.77	120.80	120.80	105.01	
OW-03L	74.89	100	Lower	0	80.62	96.53	NA	NA	88.58	Duplicate Test
OW-03L Average	74.89	100	Lower	10	82.14	95.65	120.80	120.80	96.79	Well Average
OW-04L	78.97	113.49	Lower	10	4.18	8.40	7.39	11.66	7.91	
OW-06L	78.98	98.62	Lower	10	87.21	88.25	31.36	29.45	59.07	
OW-08U	81.71	103.03	Lower	10	24.67	39.35	82.12	69.06	53.80	
OW-2169L	79.47	103.2	Lower	10	1.07	1.32	36.16	36.52	18.77	
OW-2181L	79.24	99.2	Lower	5.2	0.01	0.03	0.01	0.03	0.02	Multiple sat. thicknesses
OW-2185L	79.48	102.96	Lower	10	6.17	8.10	19.40	27.27	15.24	
OW-2269U	80.45	93.35	Lower	9.6	0.79	1.13	2.49	3.41	1.96	
OW-2269U	80.45	93.35	Lower	9.6	1.56	2.25	NA	NA	1.91	Duplicate Test
OW-2269U Average	80.45	93.35	Lower	9.6	1.18	1.69	2.49	3.41	1.93	Well Average
OW-2284L	80.42	113.4	Lower	10	26.23	38.88	23.94	35.84	31.22	
OW-2304L	68.33	98.44	Lower	5	16.58	115.20	55.97	60.49	62.06	

**Table 2.3.1.2-5 (Sheet 3 of 4)
VCS Site Slug Test Results**

Observation Well	Surface Elevation (NAVD 88)	Depth (ft)	Geologic Unit	Saturated Thickness (ft)	Hydraulic Conductivity in ft/d					Notes
					Falling		Rising		Arithmetic Mean	
					Bouwer-Rice	Butler	Bouwer-Rice	Butler		
OW-2307L	76.75	113.27	Lower	10	10.65	19.05	43.17	63.09	33.99	
OW-2319U	74.16	98.15	Lower	7	37.72	58.38	69.49	75.61	60.30	
OW-2320U	71.46	113.35	Lower	10	77.06	82.09	110.20	152.50	105.46	
OW-2321U	71.62	113.17	Lower	10	12.55	18.51	13.45	18.42	15.73	
OW-2324U	24.47	47.98	Lower	8	169.10	233.90	78.51	134.50	154.00	
OW-2324U	24.47	47.98	Lower	8	147.30	226.00	130.40	150.30	163.50	Duplicate Test
OW-2324U Average	24.47	47.98	Lower	8	158.20	229.95	104.46	142.40	158.75	Well Average
OW-2348U	50.63	83.09	Lower	10	95.58	121.50	140.70	167.20	131.25	
OW-2348U	50.63	83.09	Lower	10	135.60	185.00	128.90	158.50	152.00	Duplicate Test
OW-2348U Average	50.63	83.09	Lower	10	115.59	153.25	134.80	162.85	141.62	Well Average
OW-2352L	62.91	84.9	Lower	10	27.26	37.82	42.33	38.63	36.51	
OW-05L	77.56	133.28	Deep	10	8.62	12.78	9.04	8.34	9.70	
OW-07L	77.39	126.3	Deep	7	11.55	8.15	12.09	13.05	11.21	
OW-08L	81.71	135.6	Deep	10	0.63	0.69	0.88	0.87	0.77	
OW-09L	77.36	122.43	Deep	9	0.90	1.16	0.91	0.99	0.99	
OW-09L	77.36	122.43	Deep	9	NA	NA	5.36	7.94	6.65	Duplicate Test
OW-09L Average	77.36	122.43	Deep	9	0.90	1.16	3.14	4.47	3.82	Well Average
OW-10L	77.69	140.66	Deep	10	9.82	12.90	14.94	14.89	13.14	
OW-2150L	80.44	153.71	Deep	1.5	2.46	4.10	8.67	16.44	7.92	
OW-2253L	80.86	148.35	Deep	10	101.40	105.20	77.25	87.90	92.94	
OW-2253L	80.86	148.35	Deep	10	99.76	115.20	NA	NA	107.48	Duplicate Test
OW-2253L	80.86	148.35	Deep	10	137.60	147.80	NA	NA	142.70	Triplicate test

Table 2.3.1.2-5 (Sheet 4 of 4)
VCS Site Slug Test Results

Observation Well	Surface Elevation (NAVD 88)	Depth (ft)	Geologic Unit	Saturated Thickness (ft)	Hydraulic Conductivity in ft/d					Notes
					Falling		Rising		Arithmetic Mean	
					Bouwer-Rice	Butler	Bouwer-Rice	Butler		
OW-2253L Average	80.86	148.35	Deep	10	112.92	122.73	77.25	87.90	114.37	Well Average
OW-2269L	80.45	138.52	Deep	9.6	0.63	1.26	1.17	1.50	1.14	
OW-2301L	81.23	143.15	Deep	10	26.18	38.14	30.29	42.90	34.38	
OW-2302L	80.32	153.5	Deep	3	0.97	1.17	9.16	9.96	9.56	
OW-2319L	74.16	156.8	Deep	10	0.78	0.71	0.60	0.60	0.67	
OW-2320L	71.46	153.55	Deep	5	10.62	13.74	12.76	17.09	13.55	
OW-2321L	71.62	153.06	Deep	10	2.40	3.21	17.81	21.56	11.25	
OW-2324L	24.47	128.17	Deep	10	77.00	85.12	48.21	52.80	65.78	
OW-2348L	50.63	148.32	Deep	10	86.08	86.70	41.74	62.03	69.14	
OW-2348L	50.63	148.32	Deep	10	50.94	49.39	36.72	37.56	43.65	Duplicate Test
OW-2348L Average	50.63	148.32	Deep	10	68.51	68.05	39.23	49.80	56.40	Well Average

Geometric Mean:	Upper	12.29
	Lower	24.76
	Deep	9.60
Minimum:	Upper	0.06
	Lower	0.02
	Deep	0.67
Maximum:	Upper	56.79
	Lower	163.5
	Deep	142.7

Highlighted rows indicate multiple tests on the same well with the arithmetic mean (average) determined for all tests on the well.
Data source: Site Geotechnical Subsurface Investigation, SSAR Reference 2.5.4-2

Table 2.3.1.2-6 (Sheet 1 of 2)
Summary of Aquifer Pumping Test Results

TW-2320U Aquifer Pumping Test

48 hour test

Observation Well	Saturated Thickness (ft)	Theis Method		Cooper-Jacob Method		Neumann Method		Vertical/ Horizontal Hydraulic Conductivity (unitless)
		Transmissivity (ft^2/d)	Storage Coefficient (unitless)	Transmissivity (ft^2/d)	Storage Coefficient (unitless)	Transmissivity (ft^2/d)	Storage Coefficient (unitless)	
OW-2320U1	38	295	1.89×10^{-3}	371	1.40×10^{-3}	295	1.98×10^{-3}	0.16
OW-2320U2	38	248	6.10×10^{-3}	310	4.42×10^{-3}	248	6.07×10^{-3}	0.14
OW-2320U3	38	276	2.94×10^{-3}	361	2.23×10^{-3}	276	2.94×10^{-3}	0.17
Combination/ Drawdown	38	370	2.85×10^{-3}	378	2.36×10^{-3}	283	5.75×10^{-3}	0.15
Combination/ Recovery	38	340	—	—	—	—	—	—
mean		306	3.45×10^{-3}	355	2.59×10^{-3}	275.5	4.19×10^{-3}	0.16
Hydraulic Conductivity (ft/d)		8.0	—	9.3	—	7.2	—	—

Mean of Transmissivity (Theis, Cooper-Jacobs, and Neumann Methods): 312.2 ft^2/d
Mean of Hydraulic Conductivity (Theis, Cooper-Jacobs, and Neumann Methods): 8.2 ft/d
Mean of Storage Coefficient (Theis, Cooper-Jacobs, and Neumann Methods): 3.3×10^{-3}

Table 2.3.1.2-6 (Sheet 2 of 2)
Summary of Aquifer Pumping Test Results

TW-2359L Aquifer Pumping Test

24 hour test

Observation Well	Saturated Thickness (ft)	Theis Method Transmissivity (ft^2/d)	Theis Method Storage Coefficient (unitless)	Cooper-Jacob Method Transmissivity (ft^2/d)	Cooper-Jacob Method Storage Coefficient (unitless)	Hantush-Jacob Method Transmissivity (ft^2/d)	Hantush-Jacob Method Storage Coefficient (unitless)	Vertical/ Horizontal Hydraulic Conductivity (unitless)
OW-2359L2	53	2526	7.33×10^{-5}	2546	6.43×10^{-5}	2455	1.59×10^{-3}	0.0073
OW-2359L3	53	2502	7.64×10^{-5}	2509	7.48×10^{-5}	2527	7.33×10^{-4}	0.0055
Combination/ Drawdown	53	2508	7.35×10^{-5}	2495	7.36×10^{-5}	2551	1.04×10^{-3}	0.0014
Combination/ Recovery	54	2440	—	—	—	—	—	—
mean		2494	7.44×10^{-5}	2517	7.09×10^{-5}	2511	1.12×10^{-3}	0.0047
Hydraulic Conductivity (ft/d)		47.0	—	47.5	—	47.4	—	—

Mean of Transmissivity (Theis, Cooper-Jacobs, and Hantush-Jacob Methods): 2507.3 ft^2/d
Mean of Hydraulic Conductivity (Theis, Cooper-Jacobs, and Hantush-Jacob Methods): 47.3 ft/d
Mean of Storage Coefficient (Theis, Cooper-Jacobs, and Hantush-Jacob Methods): 4.1×10^{-4}

Notes:
ft^2/d = square feet per day
ft/d = feet per day

Table 2.3.1.2-7 (Sheet 1 of 6)
Hydrogeologic Properties from Geotechnical Tests

Boring No.	Sample No.	Sample Depth (ftbgs)	USCS Symbol	Geotechnical Unit	Hydrogeologic Unit	Dry Unit Weight (γ_d) (pcf)	Void Ratio (e)	Specific Gravity (G_s)	Moisture Content (ω) (%)	Porosity[(a)] (n) (%)	Effective Porosity[(b)] (n_e) (%)	Bulk Density[(c)] (γ_m) (pcf)	Bulk Density (γ_m) (g/cm^3)
B-2174UD	UD 1	10-11.7	CL	Clay 1 Top	Shallow Confining layer	109.4	0.53	—	19.5	34.6	6.9	130.7	2.09
B-2182UD	UD-1	10-11.7	CL	Clay 1 Top	Shallow Confining layer	113.0	0.53	2.76	14.0	34.5	6.9	128.8	2.06
B-2269UD	UD-1	10-12	CL	Clay 1 Top	Shallow Confining layer	109.7	—	2.67	17.8	—	—	129.2	2.07
B-2269UD	UD-1	10-12	CL	Clay 1 Top	Shallow Confining layer	114.4	0.46	2.67	17.6	31.3	6.3	134.5	2.15
B-2269UD	UD-2	13-15	CH	Clay 1 Top	Shallow Confining layer	104.9	0.58	2.66	23.0	36.8	7.4	129.0	2.06
B-2274UD	UD-1	10.2-11.9	CL	Clay 1 Top	Shallow Confining layer	113.8	—	2.75	16.4	—	—	132.5	2.12
B-2274UD	UD-1	10.2-11.9	CL	Clay 1 Top	Shallow Confining layer	109.2	0.57	2.75	19.3	36.4	7.3	130.3	2.08
B-2304UD	UD 2	11-13.3	ML	Clay 1 Top	Shallow Confining layer	98.6	0.74	2.74	11.9	42.4	8.5	110.3	1.77
B-2321UD	UD 3	10.0-11.7	CH	Clay 1 Top	Shallow Confining layer	111.9	—	2.71	16.4	—	—	130.2	2.08
B-2321UD	UD 3	10.0-11.7	CH	Clay 1 Top	Shallow Confining layer	110.3	—	—	18.8	—	—	131.0	2.10
B-2321UD	UD 5	17.0-18.7	CL	Clay 1 Top	Shallow Confining layer	100.2	—	—	18.8	—	—	119.1	1.90
B-2321UD	UD-1	5.2	CL	Clay 1 Top	Shallow Confining layer	102.4	—	2.71	17.4	—	—	120.3	1.92
B-2321UD	UD-3	11.35	CH	Clay 1 Top	Shallow Confining layer	106.6	—	2.71	15.4	—	—	122.9	1.97
B-2321UD	UD-4	15.15	CH	Clay 1 Top	Shallow Confining layer	102.0	—	2.72	21.8	—	—	124.3	1.99
B-2321UD	UD-5	18.7	CL	Clay 1 Top	Shallow Confining layer	97.0	—	2.72	19.5	—	—	115.9	1.85
B-2352UD	1	3.5-5.2	CL	Clay 1 Top	Shallow Confining layer	111.5	—	2.7	17.3	—	—	130.7	2.09
B-2352UD	3	11.5-13.2	CL	Clay 1 Top	Shallow Confining layer	108.8	—	2.71	18.4	—	—	128.8	2.06
B-2352UD	UD 1	3.5-5.2	CL	Clay 1 Top	Shallow Confining layer	110.8	0.52	2.70	18.3	34.3	6.9	131.1	2.10
B-2352UD	UD 3	11.5-13.2	CL	Clay 1 Top	Shallow Confining layer	108.7	0.56	2.71	18.6	35.7	7.1	128.9	2.06
B-2269UD	UD-3	30-32	CL	Sand 1	Sand 1	110.7	—	2.66	15.4	—	—	127.7	2.04
B-2269UD	UD-3	30-32	CL	Sand 1	Sand 1	116.6	0.42	2.66	15.8	29.7	23.7	135.0	2.16
B-2269UD	UD-4	33-34.8	CL	Sand 1	Sand 1	116.7	0.47	2.74	15.0	31.9	25.5	134.2	2.15
B-2302UD	UD 3	13.5-16.0	SM	Sand 1	Sand 1	103.3	—	—	17.4	—	—	121.3	1.94
B-2319UD	2	5.5-7.5	SC	Sand 1	Sand 1	116.2	—	2.73	13.7	—	—	132.1	2.11
B-2319UD	UD 2	5.5-7.5	SC	Sand 1	Sand 1	117.1	0.46	2.73	13.7	31.3	25.0	133.1	2.13
B-2319UD	UD 3	11.0-13.0	SM	Sand 1	Sand 1	102.8	—	2.72	8.7	—	—	111.7	1.79
B-2174UD	UD 2	30-31.7	CH	Clay 1 Bottom	Shallow Confining layer	100.5	0.71	—	24.0	41.5	8.3	124.6	1.99
B-2182UD	UD-5	33-34.7	CH	Clay 1 Bottom	Shallow Confining layer	97.2	0.78	2.77	29.6	43.8	8.8	126.0	2.02

Table 2.3.1.2-7 (Sheet 2 of 6)
Hydrogeologic Properties from Geotechnical Tests

Boring No.	Sample No.	Sample Depth (ftbgs)	USCS Symbol	Geotechnical Unit	Hydrogeologic Unit	Dry Unit Weight (γ_d) (pcf)	Void Ratio (e)	Specific Gravity (G_s)	Moisture Content (ω) (%)	Porosity[(a)] (n) (%)	Effective Porosity[(b)] (n_e) (%)	Bulk Density[(c)] (γ_m) (pcf)	Bulk Density (γ_m) (g/cm^3)
B-2269UD	UD-5	50-51.7	CH	Clay 1 Bottom	Shallow Confining layer	103.0	0.64	2.70	21.8	38.9	—	125.5	2.01
B-2319UD	UD 4	25.0-27.0	CH	Clay 1 Bottom	Shallow Confining layer	106.5	—	2.72	20.7	—	—	128.5	2.06
B-2319UD	UD 4	25.0-27.0	CH	Clay 1 Bottom	Shallow Confining layer	105.3	—	—	21.4	—	7.8	127.8	2.05
B-2319UD	UD-4	26.65	CH	Clay 1 Bottom	Shallow Confining layer	103.0	0.64	2.70	21.8	38.9	—	125.5	2.01
B-2321UD	7	38.5-40.2	CH	Clay 1 Bottom	Shallow Confining layer	106.5	—	2.72	20.7	—	—	128.5	2.06
B-2321UD	UD 6	28.5-30.2	CH	Clay 1 Bottom	Shallow Confining layer	105.3	—	—	21.4	—	7.8	127.8	2.05
B-2321UD	UD 7	38.5-40.2	CH	Clay 1 Bottom	Shallow Confining layer	109.1	—	2.72	19.2	—	—	130.1	2.08
B-2321UD	UD 7	38.5-40.2	CH	Clay 1 Bottom	Shallow Confining layer	101.9	—	2.78	21.3	—	—	123.6	1.98
B-2321UD	UD-6	30.2	CH	Clay 1 Bottom	Shallow Confining layer	96.4	—	2.72	25.5	—	—	121.0	1.94
B-2321UD	UD-8	49.75	CH	Clay 1 Bottom	Shallow Confining layer	102.8	—	2.78	21.0	—	—	124.4	1.99
B-2352UD	5	24.0-25.7	CH	Clay 1 Bottom	Shallow Confining layer	106.6	0.63	2.78	14.8	38.6	—	122.4	1.96
B-2352UD	UD 5	24-25.7	CH	Clay 1 Bottom	Shallow Confining layer	96.1	—	2.72	23.9	—	—	119.1	1.91
B-2359UD	3	30.8-32.8	CH	Clay 1 Bottom	Shallow Confining layer	92.2	—	2.72	28.5	—	7.7	118.4	1.89
B-2359UD	UD 5	40.0-41.7	CH	Clay 1 Bottom	Shallow Confining layer	94.4	—	2.67	28.0	—	—	120.8	1.93
B-2359UD	UD-4	36.45	CH	Clay 1 Bottom	Shallow Confining layer	100.7	0.66	2.67	22.7	39.6	—	123.6	1.98
B-2359UD	UD-5	41.15	CH	Clay 1 Bottom	Shallow Confining layer	108.96	—	2.71	18.4	—	—	129.0	2.06
B-2302UD	UD 7	59.0-60.2	SC-SM	Sand 2	Upper Shallow Aquifer	106.4	—	—	20.1	—	—	127.8	2.04
B-2302UD	UD 9	63.5-66	SP-SM	Sand 2	Upper Shallow Aquifer	103.0	0.63	2.68	21.1	38.7	30.9	124.7	2.00
B-2319UD	UD 5	35.0-37.0	ML	Sand 2	Upper Shallow Aquifer	106.2	—	2.72	18.8	—	—	126.2	2.02
B-2359UD	UD 7	55.0-56.7	ML	Sand 2	Upper Shallow Aquifer	108.4	0.53	2.65	14.3	34.6	27.6	123.9	1.98
B-2174UD	UD 3	75-76.7	CL	Clay 3	Lower Confining layer	117.1	0.47	—	15.8	32.0	6.40	135.6	2.17
B-2182UD	UD-7	65-66.7	SC	Clay 3	Lower Confining layer	95.4	—	2.74	20.9	—	—	115.3	1.85
B-2182UD	UD-7	65-66.7	SC	Clay 3	Lower Confining layer	93.3	0.84	2.74	25.0	45.5	9.10	116.7	1.87
B-2269UD	UD-7	70-71.7	CH	Clay 3	Lower Confining layer	84.4	—	2.72	36.6	—	—	115.2	1.84
B-2269UD	UD-7	70-71.7	CH	Clay 3	Lower Confining layer	95.5	0.78	2.72	28.3	43.7	8.75	122.5	1.96
B-2269UD	UD-8	73-74.7	CH	Clay 3	Lower Confining layer	100.6	0.66	2.67	22.4	39.6	7.92	123.1	1.97
B-2274UD	UD-4	67-68.7	CH	Clay 3	Lower Confining layer	89.24	—	2.76	32.6	—	—	118.3	1.89
B-2274UD	UD-4	67-68.7	CH	Clay 3	Lower Confining layer	93.6	0.84	2.76	28.1	45.7	9.14	119.9	1.92
B-2302UD	11	69.5-71.5	CH	Clay 3	Lower Confining layer	96.8	—	2.74	24.2	—	—	120.2	1.92

Table 2.3.1.2-7 (Sheet 3 of 6)
Hydrogeologic Properties from Geotechnical Tests

Boring No.	Sample No.	Sample Depth (ftbgs)	USCS Symbol	Geotechnical Unit	Hydrogeologic Unit	Dry Unit Weight (γ_d) (pcf)	Void Ratio (e)	Specific Gravity (G_s)	Moisture Content (ω) (%)	Porosity[a] (n) (%)	Effective Porosity[b] (n_e) (%)	Bulk Density[c] (γ_m) (pcf)	Bulk Density (γ_m) (g/cm^3)
B-2302UD	UD 10	66.0-68.5	CH	Clay 3	Lower Confining layer	103.7	—	—	22.5	—	—	127.0	2.03
B-2304UD	7	73.5-75.5	MH	Clay 3	Lower Confining layer	92.6	—	2.78	29.8	—	8.2	119.7	1.91
B-2304UD	UD 7	73.5-75.5	MH	Clay 3	Lower Confining layer	92.3	0.9	2.78	27.6	46.8	—	122.8	1.97
B-2304UD	UD 8	83.5-85.5	CH	Clay 3	Lower Confining layer	90.8	—	—	30.9	—	—	120.2	1.92
B-2304UD	UD-8	85.3	CH	Clay 3	Lower Confining layer	90.8	—	2.71	29.6	—	9.4	117.8	1.88
B-2319UD	8	75-77	SP-SM	Clay 3	Lower Confining layer	96.6	—	2.73	25.3	—	—	118.9	1.90
B-2319UD	UD 6	55.0-57.0	ML	Clay 3	Lower Confining layer	91.9	—	2.71	30.7	—	—	117.7	1.88
B-2319UD	UD 7	65.0-67.0	CL	Clay 3	Lower Confining layer	103.4	—	—	20.1	—	—	121.0	1.94
B-2319UD	UD 8	75.0-77.0	SP-SM	Clay 3	Lower Confining layer	98.7	0.73	2.73	24.6	42.1	—	120.1	1.92
B-2319UD	UD-7	66.6	CL	Clay 3	Lower Confining layer	103.2	—	2.66	18.8	—	—	124.2	1.99
B-2321UD	UD 9	58.5-61.0	CL	Clay 3	Lower Confining layer	106.6	—	—	20.0	—	8.4	123.0	1.97
B-2321UD	UD-10	65.05	CL	Clay 3	Lower Confining layer	116.5	—	2.67	13.7	—	—	122.6	1.96
B-2321UD	UD-9	59.45	CL	Clay 3	Lower Confining layer	104.0	—	2.68	19.3	—	—	127.9	2.05
B-2352UD	UD 8	68.0-69.4	SM	Clay 3	Lower Confining layer	107.3	0.56	2.68	14.4	35.9	—	132.4	2.12
B-2359UD	UD 10	70.0-71.7	CH	Clay 3	Lower Confining layer	114.1	—	—	16.6	—	—	124.0	1.98
B-2359UD	UD-10	71.6	CH	Clay 3	Lower Confining layer	110.7	—	2.72	16.8	—	7.2	122.8	1.96
B-2174UD	UD 4	90-90.9	CL	Sand 4	Lower Shallow Aquifer	118.1	0.44	—	15.6	30.7	24.6	133.0	2.13
B-2182UD	UD 12B	95-97.5	SP-SM	Sand 4	Lower Shallow Aquifer	103.5	0.64	2.72	17.7	39.0	31.2	129.3	2.07
B-2182UD	UD-11	90.5-93	CL	Sand 4	Lower Shallow Aquifer	114.3	—	2.77	15.8	—	—	136.5	2.18
B-2182UD	UD-11	90.5-93.0	CL	Sand 4	Lower Shallow Aquifer	125.6	0.38	2.77	12.3	27.3	21.9	121.8	1.95
B-2182UD	UD-12T	95-97.5	CL	Sand 4	Lower Shallow Aquifer	117.4	—	2.73	15.4	—	—	132.3	2.12
B-2302UD	UD 14	108.5-111	SM	Sand 4	Lower Shallow Aquifer	110.2	0.54	2.71	17.8	34.9	27.9	141.0	2.26
B-2302UD	UD-16	122.2	CH	Sand 4	Lower Shallow Aquifer	97.6	—	2.72	25.5	—	—	135.5	2.17
B-2319UD	UD 10	95.0-97.0	SP	Sand 4	Lower Shallow Aquifer	103.2	—	2.72	11.2	—	—	129.8	2.08
B-2321UD	UD 12	93.0-95.7	SP-SM	Sand 4	Lower Shallow Aquifer	101.2	0.66	2.69	22.7	39.8	31.8	122.5	1.96
B-2321UD	UD 12	93.0-95.7	SP-SM	Sand 4	Lower Shallow Aquifer	101.9	—	2.69	21.3	—	—	114.8	1.84
B-2359UD	11	77.0-78.7	SC-SM	Sand 4	Lower Shallow Aquifer	106.2	—	2.72	19.4	—	—	124.2	1.99
B-2359UD	UD 11	77.0-78.7	SC-SM	Sand 4	Lower Shallow Aquifer	101.9	0.67	2.72	19.9	40.0	32.0	123.6	1.98
B-2359UD	UD 14	88.5-90.5	ML	Sand 4	Lower Shallow Aquifer	96.6	0.78	2.74	25.3	43.8	35.1	121.0	1.94

Table 2.3.1.2-7 (Sheet 4 of 6)
Hydrogeologic Properties from Geotechnical Tests

Boring No.	Sample No.	Sample Depth (ftbgs)	USCS Symbol	Geotechnical Unit	Hydrogeologic Unit	Dry Unit Weight (γ_d) (pcf)	Void Ratio (e)	Specific Gravity (G_s)	Moisture Content (ω) (%)	Porosity[a] (n) (%)	Effective Porosity[b] (n_e) (%)	Bulk Density[c] (γ_m) (pcf)	Bulk Density (γ_m) (g/cm^3)
B-2359UD	UD-12	80.25	SC	Sand 4	Lower Shallow Aquifer	107.2	—	2.66	18.2	—	—	126.7	2.03
B-2182UD	UD-13	120-121.7	SC	Clay 5 Top	Deep Confining layer	111.0	0.52	2.71	18.7	34.3	6.9	131.8	2.11
B-2182UD	UD-13	120-121.7	SC	Clay 5 Top	Deep Confining layer	104.6	—	2.71	20.4	—	—	125.9	2.02
B-2302UD	UD-19	147	CL	Clay 5 Top	Deep Confining layer	—	—	2.69	21.5	—	10.0	116.6	1.87
B-2304UD	UD 11	111.0-113.0	CH	Clay 5 Top	Deep Confining layer	103.6	—	—	22.7	—	6.2	135.1	2.16
B-2304UD	UD 13	121.0-123.0	CH	Clay 5 Top	Deep Confining layer	110.0	—	—	21.0	—	—	—	—
B-2304UD	9	98.5-101	CH	Clay 5 Top	Deep Confining layer	99.8	—	2.74	25.8	—	—	127.1	2.03
B-2304UD	UD 9	98.5-101.0	CH	Clay 5 Top	Deep Confining layer	101.5	0.69	2.74	22.8	40.7	—	133.1	2.13
B-2304UD	UD-11	112.9	CH	Clay 5 Top	Deep Confining layer	103.6	—	2.71	21.7	—	—	125.5	2.01
B-2304UD	UD-13	122.95	CH	Clay 5 Top	Deep Confining layer	108.0	—	2.71	18.6	—	8.1	124.6	1.99
B-2321UD	14	128.5-130	CH	Clay 5 Top	Deep Confining layer	96.8	—	2.75	25.5	—	—	126.0	2.02
B-2321UD	UD 14	128.5-130.3	CH	Clay 5 Top	Deep Confining layer	97.0	—	2.75	25.0	—	—	128.1	2.05
B-2321UD	UD 15	130.5-132.5	CH	Clay 5 Top	Deep Confining layer	106.8	—	—	20.3	—	—	121.5	1.94
B-2321UD	UD-15	132.5	CH	Clay 5 Top	Deep Confining layer	102.2	—	2.71	21.0	—	—	121.3	1.94
B-2359UD	18	112-113.1	SC	Clay 5 Top	Deep Confining layer	92.4	—	2.77	25.5	—	—	128.5	2.06
B-2359UD	UD 17	110-111.7	SM	Clay 5 Top	Deep Confining layer	106.9	0.58	2.71	17.4	36.8	—	123.6	1.98
B-2359UD	UD 19	114.0-116.6	SM	Clay 5 Top	Deep Confining layer	105.7	0.60	2.70	17.3	37.4	—	116.0	1.86
B-2304UD	UD 15	141.0-143.5	SP-SM	Sand 5	Deep Confining layer	99.2	0.69	2.68	17.9	40.8	7.4	125.5	2.01
B-2182UD	UD-15	145-147.5	ML	Clay 5 Bottom	Deep Confining layer	95.4	—	2.70	26.8	—	7.5	124.0	1.98
B-2182UD	UD-15	145-147.5	ML	Clay 5 Bottom	Deep Confining layer	102.5	0.65	2.70	25.3	39.2	8.2	116.9	1.87
B-2269UD	UD-11	150-151.7	CH	Clay 5 Bottom	Deep Confining layer	103.7	—	2.70	21.8	—	—	121.0	1.94
B-2269UD	UD-11	150-151.7	CH	Clay 5 Bottom	Deep Confining layer	105.0	0.60	2.70	21.8	37.7	7.8	128.4	2.05
B-2359UD	UD-20	121.25	CH	Clay 5 Bottom	Deep Confining layer	85.9	—	2.72	34.0	—	—	126.3	2.02
B-2174UD	UD 8	145-147	SM	Sand 6	Deep Aquifer	101.0	0.66	2.68	17.5	39.8	31.8	127.9	2.05
B-2174UD	UD 10	183-185	SM	Sand 6	Deep Aquifer	109.8	0.55	2.72	15.7	35.5	28.4	115.1	1.84
B-2182UD	UD 16	180-182.5	SM	Sand 6	Deep Aquifer	107.0	0.57	2.68	15.1	36.3	29.0	118.7	1.90
B-2269UD	UD 16	280-281.2	SC	Sand 6	Deep Aquifer	107.5	0.56	2.69	18.6	35.9	28.8	127.0	2.03
B-2182UD	UD-17	215-217.5	CL	Clay 7	Deep Aquifer	101.7	—	2.72	22.8	—	—	123.2	1.97
B-2174UD	UD 15	265-267	SC	Sand 8	Deep Aquifer	108.6	0.52	2.65	19.3	34.2	27.4	127.5	2.04

Table 2.3.1.2-7 (Sheet 5 of 6)
Hydrogeologic Properties from Geotechnical Tests

Boring No.	Sample No.	Sample Depth (ftbgs)	USCS Symbol	Geotechnical Unit	Hydrogeologic Unit	Dry Unit Weight (γ_d) (pcf)	Void Ratio (e)	Specific Gravity (G_s)	Moisture Content (ω) (%)	Porosity[a] (n) (%)	Effective Porosity[b] (n_e) (%)	Bulk Density[c] (γ_m) (pcf)	Bulk Density (γ_m) (g/cm^3)
B-2274UD	UD 12	221.1-223.6	SC	Sand 8	Deep Aquifer	114.7	0.45	2.66	10.6	31.0	24.8	126.9	2.03
B-2274UD	UD 13	240-242.5	CL	Sand 8	Deep Aquifer	114.1	0.48	—	15.6	32.4	26.0	131.9	2.11
B-2274UD	UD-13	240-242.5	CL	Sand 8	Deep Aquifer	112.9	—	2.70	17.1	—	—	132.2	2.12
B-2182UD	UD-25	303-304.2	CH	Clay 9	Deep Bottom Confining layer	91.3	—	2.79	26.5	—	—	115.5	1.85
B-2182UD	UD-26	320-321.5	CL	Clay 9	Deep Bottom Confining layer	115.5	—	2.73	14.9	—	9.0	119.8	1.92
B-2182UD	UD-28	330-332	CH	Clay 9	Deep Bottom Confining layer	97.3	0.76	2.74	28.0	43.1	6.6	132.2	2.12
B-2182UD	UD-29	333-334.7	CH	Clay 9	Deep Bottom Confining layer	96.9	—	2.72	24.7	—	—	132.7	2.12
B-2182UD	UD-30	340-341.1	CL	Clay 9	Deep Bottom Confining layer	116.9	—	2.73	15.5	—	8.6	124.6	1.99
B-2182UD	UD-30	340-341.1	CL	Clay 9	Deep Bottom Confining layer	117.6	0.45	2.73	15.0	31.1	—	120.8	1.93
B-2182UD	UD-31	343-344	CL	Clay 9	Deep Bottom Confining layer	115.9	0.48	2.74	15.8	32.2	—	135.1	2.16
B-2274UD	UD-16	300-301.8	CH	Clay 9	Deep Bottom Confining layer	90.9	—	2.76	26.8	—	6.2	135.2	2.16
B-2274UD	UD-16	300-301.8	CH	Clay 9	Deep Bottom Confining layer	95.4	0.81	2.76	25.0	44.7	6.4	134.2	2.15
B-2274UD	UD-17	320-322.5	MH	Clay 9	Deep Bottom Confining layer	99.2	0.71	2.72	24.3	41.6	—	115.2	1.84
B-2274UD	UD 18	330.1-332.6	SM	Sand 10	Deep Bottom Confining layer	110.6	0.54	2.71	14.0	35.1	8.9	119.2	1.91
B-2274UD	UD 19	350.1-352.6	SM	Sand 10	Deep Bottom Confining layer	104.7	0.60	2.69	20.5	37.5	8.3	123.3	1.97
B-2182UD	UD-33	380-381.7	CH	Clay 11	Deep Bottom Confining layer	84.9	—	2.78	33.8	—	7.0	126.1	2.02
B-2182UD	UD-33	380-381.7	CH	Clay 11	Deep Bottom Confining layer	86.6	1.00	2.78	32.2	50.0	7.5	126.2	2.02
B-2182UD	UD-37	400-402.5	CL	Clay 11	Deep Bottom Confining layer	91.4	—	2.76	29.3	—	—	113.6	1.82
B-2182UD	UD-37	400-402.5	CL	Clay 11	Deep Bottom Confining layer	103.1	0.67	2.76	23.6	40.1	10.0	114.4	1.83
B-2269UD	UD-18	375-376.6	CL	Clay 11	Deep Bottom Confining layer	104.1	0.67	2.78	22.3	40.0	—	118.1	1.89
B-2269UD	UD-20	400-402.1	CH	Clay 11	Deep Bottom Confining layer	85.7	—	2.77	32.9	—	8.0	127.4	2.04
B-2269UD	UD-20	400-402.1	CH	Clay 11	Deep Bottom Confining layer	102.7	0.69	2.77	24.1	40.7	8.0	127.3	2.04
B-2274UD	UD-20	380-381.8	MH	Clay 11	Deep Bottom Confining layer	86.0	—	2.76	34.9	—	—	113.8	1.82
B-2274UD	UD-20	380-381.8	MH	Clay 11	Deep Bottom Confining layer	89.6	0.92	2.76	31.0	48.0	8.1	127.5	2.04
B-2274UD	UD-21	390-391.8	CH	Clay 11	Deep Bottom Confining layer	83.6	—	2.75	36.7	—	—	116.0	1.86
B-2274UD	UD-22	400-401.3	CH	Clay 11	Deep Bottom Confining layer	98.2	—	2.72	26.3	—	9.6	117.4	1.88
B-2274UD	UD-22	400-401.3	CH	Clay 11	Deep Bottom Confining layer	96.7	0.76	2.72	25.6	43.1	—	114.3	1.83
B-2174UDR	UD-26	445-446	CH	Clay 13	Deep Bottom Confining layer	96.2	—	2.78	27.6	—	—	124.0	1.98
B-2174UDR	UD-26	445-446	CH	Clay 13	Deep Bottom Confining layer	98.7	0.76	2.78	26.2	43.2	8.6	121.5	1.94

Table 2.3.1.2-7 (Sheet 6 of 6)
Hydrogeologic Properties from Geotechnical Tests

Boring No.	Sample No.	Sample Depth (ftbgs)	USCS Symbol	Geotechnical Unit	Hydrogeologic Unit	Dry Unit Weight (γ_d) (pcf)	Void Ratio (e)	Specific Gravity (G_s)	Moisture Content (ω) (%)	Porosity[(a)] (n) (%)	Effective Porosity[(b)] (n_e) (%)	Bulk Density[(c)] (γ_m) (pcf)	Bulk Density (γ_m) (g/cm^3)
B-2174UDR	UD-27	490-492.5	CH	Clay 13	Deep Bottom Confining layer	109.6	—	2.73	20.2	—	—	122.8	1.96
B-2274UD	UD-26	580-582.5	CL	Clay 17	Deep Bottom Confining layer	111.0	—	2.70	17.8	—	—	130.8	2.09

(a) $n = \frac{e}{1+e} \times 100$ (U.S. ACOE, 2004)

(b) Effective Porosity (ne) for sands = n × 0.8 and the Effective Porosity for clays = n × 0.2

(c) $\gamma_m = \gamma_d \times (1 + \omega / 100)$ (U.S. ACOE, 2004)

Abbreviations:

ftbgs = feet below ground surface

USCS = Unified Soil Classification System

pcf = pounds per cubic foot

Data Source: Site Geotechnical Subsurface Investigation, SSAR Reference 2.5.4-1 and Reference 2.5.4-2.

Table 2.3.1.2-8
Summary Statistics for Hydrogeologic Properties from Geotechnical Tests

Hydrogeologic Unit	Number of Tests	Total Porosity (%)			Effective Porosity(%)			Bulk Density (pcf)			Bulk Density (g/cm^3)		
		Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean
Shallow Confining Layer	39	31.3	43.8	37.6	6.3	8.8	7.5	110.3	134.5	125.7	1.77	2.15	2.01
Sand 1	7	29.7	31.9	31.0	23.7	25.5	24.8	111.7	135.0	127.9	1.79	2.16	2.05
Upper Shallow Aquifer	4	34.6	38.6	36.6	27.6	30.9	29.3	123.9	127.8	125.6	1.98	2.04	2.01
Lower Confining Layer	27	32.0	46.8	41.4	6.4	9.4	8.3	115.2	135.6	122.6	1.84	2.17	1.96
Lower Shallow Aquifer	14	27.3	43.8	36.5	21.9	35.1	29.2	114.8	141.0	127.1	1.84	2.26	2.03
Deep Confining Layer	24	31.1	50.0	38.7	6.2	10.0	7.7	115.1	135.1	124.8	1.84	2.16	2.00
Deep Aquifer	9	31.0	39.8	35.0	24.8	31.8	28.0	118.7	132.2	126.9	1.90	2.12	2.03
Deep Bottom Confining Layer	30	31.1	50.0	40.5	6.2	10.0	8.1	113.6	135.2	123.5	1.82	2.16	1.98

Abbreviations:
pcf = pounds per cubic foot
g/cm^3 = grams per cubic centimeter

Table 2.3.1.2-9
Grain-Size Derived Hydraulic Conductivity

Boring	Sample Interval	Geologic Unit	D_{10} (mm)	D_{10} (cm)	C_u	K (cm/sec)	K (ft/day)
B-2319	13.5-15	Sand 1	0.1287	0.01287	1.85	6.63E-03	18.8
B-2359	19.8-21.3	Sand 1	0.1039	0.01039	1.73	4.32E-03	12.2
B-2359	24.8-26.3	Sand 1	0.1327	0.01327	1.67	7.04E-03	20.0
B-2304A	38.5-40	Upper	0.1018	0.01018	1.76	4.15E-03	11.8
B-2320UD	63.5-66	Upper	0.10	0.01	2.08	4.00E-03	11.3
B-2320	75-76.5	Upper	0.1090	0.0109	2.37	4.75E-03	13.5
B-2321	78.5-80	Upper	0.1295	0.01295	1.70	6.71E-03	19.0
B-2174UD	95-96.4	Lower	0.1425	0.01425	2.37	8.12E-03	23.0
B-2265	98.5-98.9	Lower	0.1620	0.0162	1.73	1.05E-02	29.8
B-2304	88.5-90	Lower	0.1283	0.01283	2.15	6.58E-03	18.7
B-2319	90-91.5	Lower	0.1151	0.01151	2.48	5.30E-03	15.0
B-2319UD	95-97	Lower	0.13	0.013	2.02	6.76E-03	19.2
B-2319	100-101.5	Lower	0.1434	0.01434	2.91	8.23E-03	23.3
B-2321UD	93-95.7	Lower	0.13	0.013	2.12	6.76E-03	19.2
B-2352	73.5-75	Lower	0.1050	0.0105	4.00	4.41E-03	12.5
B-2359	94.8-96.3	Lower	0.1527	0.01527	2.36	9.33E-03	26.4
B-2160	168.5-170	Deep	0.1134	0.01134	4.60	5.14E-03	14.6
B-2170R	153.5-155	Deep	0.1094	0.01094	2.12	4.79E-03	13.6
B-2304UD	141-143.5	Deep	0.11	0.011	1.87	4.84E-03	13.7

Geologic Unit	Minimum	Maximum	Geometric Mean
Sand 1	12.2	20	16.6
Upper	11.3	19	13.6
Lower	12.5	29.8	20.1
Deep	13.6	14.6	13.9

Table 2.3.1.2-10
Laboratory Hydraulic Conductivity Test

Boring No.	Sample No.	Sample Depth	USCS Symbol	Geologic Unit	Confining Stress (psi)	Hydraulic Conductivity (cm/s)	Hydraulic Conductivity (ft/d)
B-2319UD	UD-4	25.0–27.0	CH	Shallow Confining Layer	20.0	3.4×10^{-9}	9.6×10^{-6}
B-2421UD	UD-3	10.0–11.7	CH	Shallow Confining Layer	10.0	8.3×10^{-6}	2.4×10^{-2}
B-2321UD	UD-6	28.5–30.2	CH	Shallow Confining Layer	25.0	1.8×10^{-8}	5.1×10^{-5}
B-2321UD	UD-7	38.5–40.2	CH	Shallow Confining Layer	35.0	8.4×10^{-9}	2.4×10^{-5}
B-2321UD	UD-14	128.5–130.3	CH	Deep Confining Layer	75.0	2.5×10^{-9}	7.1×10^{-6}
					Minimum	2.5×10^{-9}	7.1×10^{-6}
					Maximum	8.3×10^{-6}	2.4×10^{-2}
					Geometric Mean	2×10^{-8}	7×10^{-5}

Data Source: Site Geotechnical Subsurface Investigation, SSAR Reference 2.5.4-1
USCS = Unified Soil Classification System (CH = high plasticity clay)

Table 2.3.1.2-11 (Sheet 1 of 2)
VCS Cooling Basin Permeability Values from Borehole Permeameter Tests

Borehole Number	Northing (NAD 83 TXSC)	Easting (NAD 83 TXSC)	Surface Elevation (NAVD 88)	Material Type USCS	Test Elevation (NAVD 88)	Saturated Permeability (cm/s)	Saturated Permeability (ft/d)
B-2309P-U	13405492.3	2600435.2	76.25	SC	71.25	1.0×10^{-8}	3.0×10^{-5}
B-2309P-L	13405491.6	2600445.1	76.13	SP-SC	66.13	1.44×10^{-6}	0.0041
B-2311P-U	13407705.7	2602287.6	75.71	SC	70.71	6.94×10^{-8}	0.0002
B-2311P-L	13407703	2602296.9	75.33	CH	65.33	1.0×10^{-8}	3.0×10^{-5}
B-2312P-U	13410699.8	2604161.2	75.46	SC	70.46	1.76×10^{-7}	0.0005
B-2312P-L	13410694.3	2604153.2	75.5	SP-SC	65.5	4.00×10^{-5}	0.1134
B-2313P-U	13412117.4	2605610.9	77.88	SC	72.88	1.0×10^{-8}	3.0×10^{-5}
B-2313P-L	13412115.6	2605606.1	77.97	SC	67.97	2.67×10^{-6}	0.0076
B-2314P-U	13413938	2607776.5	75.48	CH	70.48	4.73×10^{-6}	0.0134
B-2314P-L	13413940.7	2607782.6	75.42	CH	65.42	1.0×10^{-8}	3.0×10^{-5}
B-2325P-U	13401288.3	2603699.2	73.79	SP-SC	68.79	1.71×10^{-6}	0.0049
B-2325P-L	13401292.3	2603696.5	73.85	SC	63.85	4.20×10^{-4}	1.1907
B-2326P-U	13403069.2	2605616.5	70.97	SC	65.97	1.0×10^{-8}	3.0×10^{-5}
B-2326P-L	13403074.7	2605620.4	70.76	SC	60.76	1.44×10^{-6}	0.0041
B-2327P-U	13404711.4	2607393.8	71.24	SC	66.24	1.0×10^{-8}	3.0×10^{-5}
B-2327P-L	13404712.2	2607384	70.81	SC	60.81	1.60×10^{-5}	0.0454
B-2328P-U	13406233.3	2609021.3	68.13	SC	63.13	1.60×10^{-5}	0.0454
B-2328P-L	13406222.9	2609021.2	68.42	SP-SC	58.42	9.70×10^{-4}	2.7500
B-2329P-U	13407878	2610791.9	68.07	SC	63.07	1.0×10^{-8}	3.0×10^{-5}
B-2329P-L	13407871.4	2610784.7	68.06	SC	58.06	1.0×10^{-8}	3.0×10^{-5}
B-2330P-U	13410096.3	2613184	67.89	CH	62.89	1.88×10^{-6}	0.0053
B-2330P-L	13410088.7	2613185	68.18	SC	58.18	5.37×10^{-7}	0.0015
B-2339P-U	13399916.5	2608670.1	68.75	CH	63.75	1.99×10^{-6}	0.00564
B-2339P-L	13399911.2	2608674.7	68.63	CH	58.63	2.40×10^{-5}	0.06804

Table 2.3.1.2-11 (Sheet 2 of 2)
VCS Cooling Basin Permeability Values from Borehole Permeameter Tests

Borehole Number	Northing (NAD 83 TXSC)	Easting (NAD 83 TXSC)	Surface Elevation (NAVD 88)	Material Type USCS	Test Elevation (NAVD 88)	Saturated Permeability (cm/s)	Saturated Permeability (ft/d)
B-2341P-U	13401608.5	2610954.3	65.22	CH	60.22	2.70×10^{-6}	0.0077
B-2341P-L	13401608.5	2610954.3	65.22	SC	55.22	1.08×10^{-5}	0.0306
B-2342P-U	13402788.9	2612523.3	67.61	CH	62.61	1.0×10^{-8}	3.0×10^{-5}
B-2342P-L	13402761	2612526.3	67.34	CH	57.34	1.0×10^{-8}	3.0×10^{-5}
B-2343P-U	13404159.4	2614386.7	64.62	CH	59.62	1.0×10^{-8}	3.0×10^{-5}
B-2343P-L	13404159.4	2614395.9	64.95	CH	54.95	1.0×10^{-8}	3.0×10^{-5}
B-2345P-U	13405835.3	2616662.5	67.91	CH	62.91	1.0×10^{-8}	3.0×10^{-5}
B-2345P-L	13405831.4	2616657.3	67.79	CH	57.79	1.0×10^{-8}	3.0×10^{-5}

Summary Statistics				
	Sand (SP-SC)		Clay (CH or SC)	
	cm/sec	ft/d	cm/sec	ft/d
Count	4	4	14	14
Minimum	1.44×10^{-6}	0.0041	6.94×10^{-8}	0.0002
Maximum	9.70×10^{-4}	2.75	2.40×10^{-5}	0.06804
Geometric Mean	1.8×10^{-5}	0.05	3.45×10^{-6}	0.0098

USCS is the Unified Soil Classification System:

SC - sandy clay
CH - high plasticity clay
SP-SC - poorly graded sand with clay

Shaded values indicate a permeability below the method detection limit and are interpreted as 1.0×10^{-8} cm/s or 3.0×10^{-5} feet/day; values not used in summary statistics.

Table 2.3.1.2-12 (Sheet 1 of 2)
Regional Hydrogeochemical Data

Sample Location	Sample Date	Sample Depth (ft bgs)	Unit	pH (standard units)	Specific Conductance (μmhos/cm)	Total Dissolved Solids (mg/L)	Total Hardness (mg/L as $CaCO_3$)	Total Iron (mg/L)	Gross Alpha (pCi/L)	Gross Beta (pCi/L)	ORP (mV)	Temperature (°C)
National Primary DWS	**—**	**—**	**—**	—	—	—	—	—	**15**	—	—	—
National Secondary DWS	**—**	**—**	**—**	**6.5-8.5**	—	**500**	—	—	—	—	—	—
7924601	4/11/2001	40	Lissie	6.75	1646	**913**	401	1.36	1.8 ± 1.7	4.9 ± 2.6	NA	22.2
7924601	3/30/2005	40	Lissie	NA	2150	**1217**	501	2.09	2.1 ± 4.6	1.9 ± 4.2	NA	22.4
7924901	2/5/1959	90	Lissie	7.8	967	**560**	294	NA	NA	NA	NA	NA
7924901	6/28/1979	90	Lissie	8.2	987	**560**	306	NA	NA	NA	NA	NA
7924901	8/25/1983	90	Lissie	8.3	1072	**584**	286	NA	NA	NA	NA	NA
7924902	3/26/1997	125	Lissie	7.2	918	**531**	293	NA	NA	NA	57.5	22.8
7924902	4/11/2001	125	Lissie	6.91	1016	**572**	286	NA	2.6 ± 1.6	4.1 ± 2.7	NA	23.2
7924902	3/22/2005	125	Lissie	NA	994	**575**	292	NA	4.8 ± 3.2	10 ± 2	NA	23.2
7924904	2/4/1959	254	Chicot	7.2	2050	**1113**	597	NA	NA	NA	NA	NA
7932101	5/16/1969	250	Lissie	7.5	1848	**899**	541	NA	NA	NA	NA	NA
7932101	8/16/1975	250	Lissie	7.7	1823	**904**	529	NA	NA	NA	NA	NA
7932101	6/28/1979	250	Lissie	7.8	1573	**782**	399	NA	NA	NA	NA	NA
7932103	3/26/1997	142	Lissie	7.09	1750	**1088**	493	NA	NA	NA	52.2	23.3
7932103	4/11/2001	142	Lissie	6.77	1940	**1107**	451	NA	4.5 ± 2.7	6.3 ± 3.9	NA	23.2
7932403	4/20/1992	150	Chicot	6.51	1579	**936**	545	0.025	4.8 ± 2.2	9.6 ± 2.1	53.3	23.6
7932404	2/4/1959	100	Chicot	7.4	1430	**753**	429	NA	NA	NA	NA	NA
7932602	4/28/1959	595	Lissie	7.9	1940	**1064**	57	NA	NA	NA	NA	NA
7932602	4/14/1971	595	Lissie	7.6	2058	**1040**	56	NA	NA	NA	NA	NA
8017501	8/25/1983	1026	Goliad	**8.6**	1430	**733**	44	NA	NA	NA	NA	NA
8017503	5/31/1949	1062	Evangeline	7.8	NA	**718**	120	NA	<4.0	4.6 ± 2.6	-165.3	28.3
8017503	4/22/1992	1062	Evangeline	7.63	1265	**725**	126	NA	NA	NA	NA	NA
8017504	5/12/1949	1059	Evangeline	7.7	NA	**700**	126	NA	NA	NA	NA	NA
8017506	7/30/1965	420	Evangeline	7.81	1050	**591**	131	0.02	NA	NA	NA	NA
8017511	5/12/1949	1130	Evangeline	7.7	NA	**700**	126	NA	NA	NA	NA	NA
8017902	1/29/1959	500	Gulf Coast	7.5	1640	**898**	164	NA	NA	NA	NA	NA
8017904	7/22/1981	1001	Gulf Coast	8.5	1591	**832**	132	NA	NA	NA	NA	NA
8017904	8/25/1983	1001	Gulf Coast	8.2	1584	**827**	129	NA	NA	NA	NA	NA
8017905	6/4/1981	1010	Evangeline	7.93	1240	**843**	132	NA	NA	NA	NA	NA
8017905	4/22/1992	1010	Evangeline	7.69	1489	**856**	115	0.138	<4	6.3 ± 2.9	-219.4	29.7
8017905	3/26/1997	1010	Evangeline	7.56	1403	**823**	113	0.098	NA	NA	-98	29.3
8017905	3/29/2005	1010	Evangeline	NA	1538	**830**	117	0.135	7.4 ± 4.7	6.4 ± 2.7	NA	29.3
San Antonio River (USGS 08188570)	12/19/2006	0	—	8.1	1310	**740**	350	NA	NA	NA	NA	20
Guadalupe River (USGS 08176500)	3/25/1994	0	—	8.1	579	339	240	0.008	NA	NA	NA	22.5

Table 2.3.1.2-12 (Sheet 2 of 2)
Regional Hydrogeochemical Data

Sample Location	Sample Date	Sample Depth (ft bgs)	Unit	Silica (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Bicarbonate (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Fluoride (mg/L)	Nitrate (mg/L)
National Primary DWS	—	—	—	—	—	—	—	—	—	—	—	**4.0**	**10**
National Secondary DWS	—	—	—	—	—	—	—	—	—	**250**	**250**	**2.0**	—
7924601	4/11/2001	40	Lissie	34.4	127	20.4	169	2.77	489.36	**260**	58.4	0.31	<0.09
7924601	3/30/2005	40	Lissie	36.6	153	28.5	235	2.84	510.1	**424**	84.5	0.52	<0.09
7924901	2/5/1959	90	Lissie	30	100	11	94	NA	387	111	22	0.5	2
7924901	6/28/1979	90	Lissie	45	103	12	79	NA	353.9	115	24	0.3	8
7924901	8/25/1983	90	Lissie	44	95	12	94	3	362.44	128	25	0.4	5.01
7924902	3/26/1997	125	Lissie	19.7	96.5	12.6	92.7	3.25	356.34	102	19.8	0.26	9.3
7924902	4/11/2001	125	Lissie	42.4	94.4	12.3	87.4	2.89	346.58	125	22.5	0.38	**14.3**
7924902	3/22/2005	125	Lissie	46	96.3	12.3	92	3.19	346.57	120	21.1	0.56	**13.11**
7924904	2/4/1959	254	Chicot	31	185	33	177	NA	280	**488**	61	0.3	0.8
7932101	5/16/1969	250	Lissie	33	171	28	113	NA	303.87	**347**	58	<0.1	<0.4
7932101	8/16/1975	250	Lissie	32	186	16	120	NA	302.65	**351**	50	0.1	<0.4
7932101	6/28/1979	250	Lissie	33	150	6	122	6	244.07	**285**	59	0.2	1
7932103	3/26/1997	142	Lissie	20.5	158	23.9	224	6.44	353.9	**371**	108	<0.02	1.77
7932103	4/11/2001	142	Lissie	36.7	144	22.1	206	5.57	346.58	**390**	129	0.29	2.16
7932403	4/20/1992	150	Chicot	34	170	29	120	8.2	273.36	**376**	63	0.22	NA
7932404	2/4/1959	100	Chicot	34	131	25	106	NA	297	**252**	59	0.3	<0.4
7932602	4/28/1959	595	Lissie	15	12	6.6	404	2.8	362.1	**435**	8.6	0.7	2
7932602	4/14/1971	595	Lissie	15	11.4	6.9	384	NA	358.78	**437**	8.65	0.5	<0.4
8017501	8/25/1983	1026	Goliad	9	9.6	5.1	276	2	339.26	250	2	0.6	<0.1
8017503	5/31/1949	1062	Evangeline	8.4	25	14	247	NA	427	195	19	NA	NA
8017503	4/22/1992	1062	Evangeline	19	25	15	233	4.4	406.38	211	16	0.5	NA
8017504	5/12/1949	1059	Evangeline	13	26	15	233	NA	422	183	23	NA	NA
8017506	7/30/1965	420	Evangeline	18	33	12	185	NA	388	152	1	NA	NA
8017511	5/12/1949	1130	Evangeline	13	26	15	233	NA	422	183	23	NA	NA
8017902	1/29/1959	500	Gulf Coast	20	38	17	281	3.3	312.09	**348**	36	1	<0.4
8017904	7/22/1981	1001	Gulf Coast	31	40	8	258	4	356.34	234	70	0.4	<0.04
8017904	8/25/1983	1001	Gulf Coast	22	27	15	261	4	378.31	242	70	0.4	<0.1
8017905	6/4/1981	1010	Evangeline	12	30	14	279	NA	347.01	**266**	64	0.2	0.1
8017905	4/22/1992	1010	Evangeline	21	24	13	279	5.3	352.68	**275**	63	0.48	NA
8017905	3/26/1997	1010	Evangeline	12.5	22.1	13.6	291	4.2	356.34	244	58.1	0.32	<0.44
8017905	3/29/2005	1010	Evangeline	22.7	22.7	23.8	273	3.56	355.12	**264**	51.7	0.69	<0.09
San Antonio River (USGS 08188570)	12/19/2006	0	—	15.3	103	21.4	116	11.8	283	159	118	0.72	**10.9**
Guadalupe River (USGS 08176500)	3/25/1994	0	—	10	68	16	32	2.6	262	42	34	0.3	<0.010

Source: U.S. EPA, 2008b
Abbreviations:
— = Not Applicable
DWS = Drinking Water Standard
NA = Not Analyzed
Bold values exceed National Primary or Secondary DWS (U.S. EPA, 2008b)

Table 2.3.1.2-13 (Sheet 1 of 2)
VCS Site Hydrogeochemical Data

Sample Location	Sample Date	Sample Elevation (ft NAVD 88)(a)	Unit(b)	pH (standard units)	Specific Conductance (μmhos/cm)	Total Dissolved Solids (mg/L)	Total Hardness (mg/L as CaCO3)	Total Fe (mg/L)	Gross Alpha (pCi/L)	Gross Beta (pCi/L)	ORP (mV)	Temperature (°C)
National Primary DWS	—	—	—	—	—	—	—	—	**15**	—	—	—
National Secondary DWS	—	—	—	**6.5-8.5**	—	**500**	—	—	—	—	—	—
OW-2301 U	2/18/2008	28.27	Upper	7.20	921	**520**	—	<0.500	—	—	151.5	22.61
OW-2301 L	2/18/2008	–51.81	Deep	6.82	1162	**669**	—	<0.500	—	—	74.6	23.40
OW-2302 U	2/21/2008	–8.01	Lower	6.89	1019	**574**	—	<0.500	—	—	77.5	24.39
OW-2302 L	2/21/2008	–63.05	Deep	6.65	2066	**1,180**	—	18.3	—	—	211.7	23.37
OW-2304 U	2/21/2008	25.1	Upper	6.53	2043	**1,200**	—	0.14 B	—	—	81.2	22.43
OW-2304 L	2/21/2008	–20.27	Lower	6.73	1997	**1,160**	—	<0.500	—	—	119.3	23.05
OW-2307 U	2/20/2008	21.59	Upper	7.20	1106	**566**	—	0.564	—	—	56.8	23.10
OW-2307 L	2/20/2008	–26.44	Lower	6.91	1053	**466**	—	<0.500	—	—	152.2	23.17
OW-2319 U	2/21/2008	–14.03	Lower	6.95	1199	**665**	—	<0.500	—	—	81.2	22.84
OW-2319 L	2/21/2008	–73.95	Deep	6.71	2258	**1,340**	—	6.65	—	—	100.2	22.96
OW-2321 U	2/19/2008	–31.73	Lower	6.85	1687	**733**	—	<0.500	—	—	109.9	23.52
OW-2321 L	2/19/2008	–71.46	Deep	6.58	3819	**919**	—	3.78	—	—	97.7	23.90
OW-2324 U	2/20/2008	–13.83	Lower	6.83	1281	**586**	—	<0.500	—	—	110.9	22.14
OW-2324 L	2/20/2008	–93.73	Deep	6.68	2158	**1,090**	—	<0.500	—	—	59.8	22.82
OW-2348 U	2/19/2008	–22.88	Lower	6.82	2414	**1,110**	—	<0.500	—	—	164.3	22.67
OW-2348 L	2/19/2008	–86.3	Deep	6.60	4122	**1,050**	—	<0.500	—	—	42.1	23.19
OW-2352 U	2/19/2008	14.47	Upper	7.13	1515	**602**	—	0.14 B	—	—	180.7	22.45
OW-2352 L	2/19/2008	–20.4	Lower	6.79	3437	**788**	—	1.30	—	—	61.5	22.40
OW-2359 U1	2/20/2008	–10.71	Lower	6.87	1192	**554**	—	<0.500	—	—	27.3	23.29
OW-2359 L2	2/20/2008	–86.07	Deep	6.74	2031	**973**	—	<0.500	—	—	87.7	23.44

Table 2.3.1.2-13 (Sheet 2 of 2)
VCS Site Hydrogeochemical Data

Sample Location	Sample Date	Sample Elevation (ft NAVD 88)[a]	Unit[b]	Silica (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Bicarbonate (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Fluoride (mg/L)	Nitrate (mg/L)
National Primary DWS	—	—	—	—	—	—	—	—	—	—	—	**4.0**	**10**
National Secondary DWS	—	—	—	—	—	—	—	—	—	**250**	**250**	**2.0**	—
OW-2301 U	2/18/2008	28.27	Upper	58.4	77.4 N	8.66	130	3.86	333	73.5	35.4	0.66	0.68
OW-2301 L	2/18/2008	–51.81	Deep	36.0	114 N	14.6	122	5.13	300	155	62.5	0.26	0.36
OW-2302 U	2/21/2008	–8.01	Lower	39.6	91	12.4 E	119	4.55	339	110	26.1	0.44	0.73
OW-2302 L	2/21/2008	–63.05	Deep	155	265	30.8 E	167	9.69	308	**440**	125	0.23	0.56
OW-2304 U	2/21/2008	25.1	Upper	41.5	206	27.0 E	152	3.50	399	**441**	17.1	0.30	2.1
OW-2304 L	2/21/2008	–20.27	Lower	40.7	192	38.2 E	151	5.20	300	**436**	153	0.38	0.32
OW-2307 U	2/20/2008	21.59	Upper	48.4	44.9 N	7.04	163	3.34	490	59.9	18.9	1.0	0.36
OW-2307 L	2/20/2008	–26.44	Lower	41.5	83.9 N	12.0	100	4.97	298	100	25.4	0.40	1.4
OW-2319 U	2/21/2008	–14.03	Lower	40.2	73	12.4 E	147	4.10	378	163	41.1	0.53	0.63
OW-2319 L	2/21/2008	–73.95	Deep	92.7	229	35.7 E	189	7.58	310	**480**	198	0.26	0.43
OW-2321 U	2/19/2008	–31.73	Lower	41.9	111 N	18.4	133	4.61	300	220	65.3	0.41	0.50
OW-2321 L	2/19/2008	–71.46	Deep	66.3	166 N	27.1	128	6.59	279	**355**	59.6	0.28	0.52
OW-2324 U	2/20/2008	–13.83	Lower	38.3	111 N	15.6	100	3.61	289	160	58.3	0.29	0.67
OW-2324 L	2/20/2008	–93.73	Deep	33.6	196 N	33.6	138	6.74	249	**517**	86.0	0.22	0.54
OW-2348 U	2/19/2008	–22.88	Lower	35.5	159 N	30.4	166	4.38	252	**453**	106	0.37	0.57
OW-2348 L	2/19/2008	–86.3	Deep	34.0	175 N	33.3	111	5.42	252	**424**	93.3	0.27	0.41
OW-2352 U	2/19/2008	14.47	Upper	37.0	82.2 N	19.5	139	2.18	329	164	55.7	0.74	0.61
OW-2352 L	2/19/2008	–20.4	Lower	45.4	95.8 N	19.7	184	4.09	311	234	118	0.37	1.1
OW-2359 U1	2/20/2008	–10.71	Lower	37.9	93.1 N	13.4	111	3.85	309	148	45.6	0.44	0.71
OW-2359 L2	2/20/2008	–86.07	Deep	32.7	169 N	26.7	124	6.10	247	**415**	76.0	0.23	0.55

Abbreviations:

-- = Not Applicable

B = Estimated result. Result is less than the reporting limit.

DWS = Drinking Water Standard

E = Matrix interference

N = Spiked analyte recovery is outside stated control limits. Method performance confirmed using Laboratory Control Spike sample results.

NA = Not Analyzed

Bold values exceed National Primary or Secondary DWS (U.S. EPA, 2008b)

(a) Calculated from Table 2.3.1.2-1 by the following equation: (Top of screen - Bottom of Screen)/2

(b) Upper = Upper Shallow aquifer; Lower = Lower Shallow aquifer; and Deep = Deep aquifer

Table 2.3.1.2-14
Estimated Cooling Basin Seepage

Flow Component	Pre-Construction (gpm)	Post-Construction (gpm)	Change[(a)] (gpm)
Cooling Basin	0	3930	+3930
Evapotranspiration	(880)	(3770)	+2890
Kuy Creek	0	(220)	+220
Dry Kuy Creek	0	(460)	+460
Downgradient Drains	0	(310)	+310
Black Bayou and Linn Lake	(130)	(130)	0
Victoria Barge Canal	(16,240)	(16,520)	+280
Guadalupe River	7510	7510	0
San Antonio River	(940)	(1110)	+170

(RED) numbers indicate flow out of the model or base flow to creeks and rivers.
BLUE numbers indicate flow into the model — surface water inflow to groundwater.
Rates rounded to the nearest 10 gpm.
(a) "+" indicates an increase in flow from pre- to post-construction conditions and a "-" indicates a decrease.

Flow Mass Balance	Pre-Construction (%)	Post-Construction (%)
Overall Flow Discrepancy	0.04	0.15

Table 2.3.1.2-15
Summary of Particle Tracking Analysis

Scenario	Minimum Travel Time days (years)	Approximate Distance (ft)
1. No Pumping	41,000 (110)	14,000
2. Northern Domestic Well pumping 50 gpm	41,000 (110)	14,000
3. Western Domestic Well pumping 50 gpm	41,000 (110)	14,000
4. Eastern Domestic Well pumping 50 gpm	41,000 (110)	14,000

Travel time in days reported to the nearest 1000 days, travel time in years reported to the nearest 5 years, and distance reported to the nearest 500 feet.

Table 2.3.1.2-16
Summary of Locations Where Confining Layers are Absent

Confining Layer	Location
Clay 1 – Top	
	B-01
	B-03
	B-2306
	B-2315
	B-2322
	B-2324
	B-2332
	B-2334
	B-2336
	C-2305
	C-2307
	C-2308
	C-2309
	C-2311
	C-2311A
	C-2317
Clay 1 – Bottom	
	B-2346
	B-2348
	C-2328
Clay 3	
	B-2315
	B-2322
	B-2346
	B-2353
	B-2357
	C-2308
	C-2311
	C-2311A
Clay 5 – Top	
	B-09
	B-2319
	B-2348
	B-2352

2.3.2 Water Use

This subsection describes the groundwater and surface water uses that could affect or be affected by the construction and operation of the facility. Included are a description of the types of consumptive water uses; identification of their locations; and quantification of current and projected water demands, supplies and needs. A description of surface water returns upstream of the proposed VCS water intake location is provided in Subsection 2.3.3.2.7.

2.3.2.1 Water Resources Planning and Appropriation

2.3.2.1.1 Regional Surface and Groundwater Planning

Section 16.051 of the Texas Water Code (TWC) directs the Texas Water Development Board (TWDB) to prepare a comprehensive state water plan that provides for the development, management, and conservation of water resources and preparation for and response to drought conditions (TWDB Sep 2007). Under Senate Bill 1 (Texas Legislature, 75th Regular Session), enacted in 1997, the Regional Water Planning Groups (RWPGs) are required to plan for the future water needs under drought conditions. In 1998, the TWDB adopted rules for establishing 16 regional water planning areas and requiring that each RWPG prepare a regional water plan that would be assembled into the state water plan. Regional water plans are required to be updated every five years (TWDB Sep 2007).

The VCS site is located in the South Central Texas regional water planning area, initially designated by the TWDB as "Region L." As shown in Figure 2.3.2-1, Region L encompasses all or part of 21 counties. These 21 counties are included in whole or in part in the Rio Grande, Nueces, San Antonio, Guadalupe, and Lavaca River Basins and the Colorado-Lavaca, Lavaca-Guadalupe, and San Antonio-Nueces Coastal Basins. (TWDB Jan 2006)

One of the fundamental elements of the South Central Texas (Region L) water planning process is the quantification of surface and groundwater supplies reliably available during a repeat of the drought of record (1950-1957) and throughout the planning horizon. The 2006 South Central Texas (Region L) Regional Water Plan was adopted in September 2009 with an associated addendum to the 2007 State Water Plan in December 2009 and is the water plan currently in use for the region encompassing the VCS site. Accordingly, the 2006 plan provides the basis for analyzing water availability for VCS as well as potential water use impacts, in Chapters 4 and 5. As discussed in Subsection 2.3.2.3.5, the 2011 Region L Water Plan is currently under development and is expected to recognize the proposed VCS project (referred to as the “GBRA-Exelon Project”) as a recommended project. (TWDB Jan 2006 and TWDB Feb 2010)

Senate Bill 1 established a statewide comprehensive regional planning initiative and included amendments to Chapter 36 of the TWC. This chapter requires that groundwater conservation districts (GCDs) develop and implement a comprehensive management plan for groundwater resources within their jurisdiction, in coordination with the surface water management entities. TWC 36.108 requires each GCD to determine the desired future conditions of the managed water resources via a joint planning process with other GCDs within a groundwater management area. These determined conditions will be submitted to the TWDB who, in turn with the approval of the Texas Commission on Environmental Quality (TCEQ), will provide each managed area with the amount of managed available resources.

There are 15 GCDs in the South Central Texas Region. The Texas legislature created the Victoria County Groundwater Conservation District (VCGCD) in 2005 and their rules for protection and conservation of groundwater resources beneath the area of Victoria County were promulgated in December 2008. Registration is required for all new wells and all existing non-exempt wells.

Senate Bill 2 (Texas Legislature, 77th Regular Session), enacted in 2001, established the Texas Instream Flow Program, which is jointly administrated by the TCEQ, Texas Parks and Wildlife Department (TPWD), and TWDB. The purpose of the program is to perform scientific and engineering studies to determine flow conditions necessary for supporting a sound ecological environment in the river basins of Texas.

Senate Bill 3 (Texas Legislature, 80th Regular Session), passed in 2007, is a stakeholder-driven process to establish instream flow and freshwater inflow standards basin by basin. It directs the TCEQ to promulgate rules establishing flow standards starting in 2010. These new standards are to be reviewed once every 10 years for efficacy. In turn, the Bill authorizes the TCEQ to impose special conditions on new water rights in order to ensure sufficient in-stream flows and freshwater inflows to bays and estuaries are maintained. These restrictions are intended to promote the ecological soundness of the state's rivers, bay, and estuary systems.

2.3.2.1.2 Surface Water Resource Appropriation

Water in the rivers, streams, underflow, creeks, tides, lakes and bays in the State of Texas is considered state water. Its use (i.e., authorizations to divert, store and use) may be appropriated via the permitting process established in TWC Chapter 11, and Title 30, Texas Administrative Code Chapters 295 and 297 (and other applicable statutes and administrative rules). The permitting process is administrated by the TCEQ.

There are a number of types of appropriated water rights including:

- Perpetual rights, including certificates of adjudication and permits that have assigned priority dates
- Limited-term rights, including term permits and temporary permits

The TCEQ must take into consideration several factors during the appropriations permitting process:

- Water availability and its effect on other existing water rights holders, as well as requirements for in-stream flow and fresh water inflow to bays and estuaries (see Subsection 2.3.2.3.4)
- Consistency, pursuant to TWC Section 11.134(b)(3)(E), with the regional water plan
- Shortages or water use conflicts in the basin of origin (e.g., the Guadalupe-San Antonio River Basin)

2.3.2.2 Groundwater Use

As discussed in Subsection 2.3.1, the VCS site is located over the central portion of the Gulf Coast Aquifer System. The principal aquifer used in Victoria County for domestic and livestock wells is the Chicot Aquifer (TBWE Jan 1962), the shallowest aquifer in the Gulf Coast Aquifer System (TDWR Jul 1979). The primary source of groundwater for municipal and industrial use in Victoria County is the Evangeline Aquifer (TCEQ Oct 2007a), which underlies the Chicot Aquifer and is the most productive aquifer of the Gulf Coast System.

The Gulf Coast Aquifer has not been declared a sole source aquifer by the EPA (U.S. EPA Mar 2008). The nearest sole source aquifer in Texas is the Edwards Aquifer System, located approximately 100 miles north of the site. The Edwards Aquifer is hydraulically upgradient (TWDB Sep 2004, TWDB Feb 2006) and beyond the boundaries of the regional and local hydrogeologic systems associated with the site. Springs from the Edwards Aquifer are sources of tributary waters to the Guadalupe River and are discussed further in Subsection 2.3.2.3.

2.3.2.2.1 Regional Groundwater Use

Groundwater use as reported to the TWDB by each of the 13 counties within 50 miles of the site is summarized in Table 2.3.2-1. Groundwater from several major and minor aquifers is the primary source of drinking water for 6 of the 13 counties. Irrigation systems are the largest users (79.2 percent) of groundwater in the 50-mile region, followed by municipal water supply systems (13.1 percent), and manufacturing (3.7 percent). Smaller amounts of groundwater are used by steam electric power generation, mining, and livestock (TWDB 2007a).

Significant decreases in water levels in the eastern portion of the Gulf Coast Aquifer during the 1970s and 1980s prompted concern regarding the allocation of groundwater, causing a number of users, including municipalities, to revert to surface water as their primary source of water. New development, recent droughts, and the potential for saltwater intrusion have also heightened concerns about long-term groundwater availability in the Gulf Coast Aquifer System (TWDB Jan 2003). Aquifer declines of 200 to 300 feet have been measured in some areas of eastern and southeastern Harris and northern Galveston Counties. Other areas of significant water-level declines include the Kingsville area in Kleberg County and portions of Jefferson, Orange, and Wharton Counties. Some of the declines have resulted in compaction of dewatered clays and significant land surface subsidence. Subsidence is generally less than 0.5 foot over most of the Texas coast but has been as much as 9 feet in Harris and surrounding counties. Conversion to surface water use in many of the problem areas has reversed the declining trend (TWDB Nov 1995).

As discussed in Subsection 2.3.2.1, there are 15 GCDs in the South Central Texas Region. With the exception of Calhoun County, a GCD serves all or a portion of each county in the region. The responsibilities and authorities of these GCDs vary depending on their creating legislation and governing law, and some districts are not responsible for all aquifers within the geographic boundaries of the district.

Since the late 1990s, the TWDB has commissioned the development of mathematical groundwater availability models for the north, south, and central portions of the Gulf Coast Aquifer to predict how the aquifer might respond to increased pumping and drought. The groundwater availability models were developed with substantial stakeholder input. The goal is to provide reliable projections of groundwater availability to ensure adequate supplies or identify inadequate supplies over the current planning period.

2.3.2.2.2 Gulf Coast Aquifer Availability Projections

The regional water plan adopted by Region L in 2006 defines groundwater availability as the amount of groundwater available for use in the region as determined by analysis of aquifer recharge, existing groundwater demands, projected groundwater demands, limits of drawdown, and the annual groundwater availability calculations provided in each of the Region L GCD’s comprehensive water plans.

The projected groundwater supply available in Region L from the Gulf Coast Aquifer during a drought of record condition is 132,348 acre-feet per year throughout the 2010-through-2060 projection period (TWDB Jan 2006).

Available and allocated groundwater supply projections for Victoria, Calhoun, and Refugio Counties, as given in the 2006 South Central Regional Water Plan (TWDB Jan 2006), are provided in Tables 2.3.2-2, 2.3.2-3, and 2.3.2-4, respectively. Because neither Victoria County nor Calhoun County had a GCD when the 2006 plan was being prepared, the 2006 Region L Plan used earlier groundwater availability estimates developed by the TWDB for the 1997 state water plan and used in the 2001 Region L Plan. Refugio County does have an established GCD, so the groundwater availability numbers from their approved 2003 management plan were used for the 2006 Region L Plan. None of the groundwater availability projections for these three counties came from the Central

Gulf Coast groundwater availability modeling, because that groundwater availability modeling was not satisfactorily completed when the 2006 Region L Plan was in development.

Uddameri and Kuchanur (Aug 2006) developed a three-dimensional, county-scale, mathematical model to represent groundwater flow characteristics in Refugio County using the United States Geological Survey MODFLOW model. Simulation-optimization schemes estimate groundwater availability as a function of both science and policy choices and risk-preference of stakeholders involved. The stakeholder concerns were incorporated as constraints, which included prevention of saltwater intrusion in the aquifer, limiting the amount of allowable drawdown in the Chicot and Evangeline aquifers, and maintaining current flow gradients (especially near baseflow-dependent streams and rivers). For the conditions assumed, the results of the study indicated that approximately 39,968 acre-feet per year of groundwater could be extracted without violating the specified constraints. The groundwater availability results of the Uddameri and Kuchanur study for Refugio County are nearly identical to the Refugio County groundwater availability projections provided in the 2006 South Central Regional Water Plan (TWDB Jan 2006).

2.3.2.2.3 Local Groundwater Use

Reported permitted groundwater uses for Victoria County are included in Table 2.3.2-1. In 2004, groundwater pumping in Victoria County was 15,529 acre-feet per year. The largest consumer of groundwater that year was municipal water use, followed by irrigation (TWDB 2007a).

Groundwater in the vicinity of the site is primarily used for domestic and livestock purposes. A data query of the TWDB statewide well database on water wells located within 6 miles of the site (TWDB 2007b) is summarized in Table 2.3.2-5, and the locations of the wells are shown in Figure 2.3.2-2. A series of stock wells at the site and a domestic well located at the McCan Ranch house are not listed in the TWDB well database.

A Texas Commission on Environmental Quality (TCEQ) public water systems database query (TCEQ Oct 2007a) indicates that the nearest public water system (TX-2350014) is located more than 5 miles east of the site. It consists of three wells at an industrial facility (INVISTA, formerly DuPont) that produce from the Evangeline Aquifer. These wells have a total production capacity of approximately 3550 acre-feet per year and serve a population of 900 people (TCEQ 2008b). Table 2.3.2-6 summarizes the public water systems located within 10 miles of the site. The locations of the systems are shown on Figure 2.3.2-3.

The city of Victoria switched from a groundwater supply to a primarily surface water supply in September 2001, with groundwater as a backup during drought periods. The average daily consumption of surface water by the Victoria water system is approximately 11,100 acre-feet per year

(TCEQ 2008e). This implies an approximate decrease in groundwater use from the Evangeline aquifer of 11,100 acre-feet per year during non-drought periods.

As discussed in Subsection 2.3.2.1, the Texas legislature created the VCGCD in 2005. The district management plan was adopted by the VCGCD and the TWDB in October and December 2008, respectively.

At the time of adoption of the VCGCD District Management Plan, the 13 GCDs within the TWDB groundwater management area (GMA) had not completed their joint planning process to define the desired future condition of the aquifer. Thus, for the purposes of managing groundwater within the district, the VCGCD selected benchmark management conditions and applied them to the TWDB groundwater availability model (GAM) for the Gulf Coast Aquifer in Victoria County. Key criteria identified by the VCGCD to define the condition of the aquifer included drawdowns in the Chicot and Evangeline formations, stream-aquifer interactions, and cross-formational flows. A spectrum of groundwater development scenarios under wet, average, and dry recharge conditions were evaluated, resulting in an estimated range of available groundwater from 25,000 acre-feet per year to 45,000 acre-feet per year. For planning purposes, the district management plan established an estimated value of 35,000 acre-feet per year as the amount of groundwater that can be produced within the district and beneficially used (VCGD Oct 2008).

The groundwater availability of approximately 41,000 acre-feet per year estimated by the South Central Regional Water Planning Group as reported in the 2006 Region L Plan (TWDB, 2007) lies within the estimated range of the VCGCD estimate (VCGCD, Oct 2008). Note that the estimated groundwater availability is a function of both science, and policy. Selection of an appropriate value for management depends upon the risk-preferences of the decision makers.

The rules of VCGCD were adopted in December 2008 (VCGCD Dec 2008). Registration is required for all new wells drilled in the District and all existing non-exempt wells. An "exempt well" is a well that does not require an operating permit and is used for domestic purposes or for providing water for livestock, poultry or personal recreation use. An exempt well would be drilled, completed, or equipped so that it is incapable of producing more than 28,800 gallons of groundwater per day (20 gpm).

All existing wells within the district can be registered on a voluntary basis if the well does not require a permit. Wells constructed after adoption of the rules must have a valid drilling permit prior to drilling, pass a district inspection, and be registered and obtain an operation permit before operation.

By April 2009, a total of 40 drilling permit applications for exempt wells had been approved since the rules were adopted. One exempt well drilling permit application and 12 non-exempt well applications were under review, as of April 2009 (VCGCD Apr 2009).

2.3.2.3 Surface Water Use

Major hydrologic features in the region of the VCS site are shown on Figure 2.3.1-2**.** Permitted surface water users within counties located within 50-miles of the VCS site are indicated in Table 2.3.2-7. Permitted uses of surface water bodies include municipal water supply, manufacturing, steam electric, irrigation, mining, and livestock.

The Guadalupe River is a spring-fed river that rises in the western part of Kerr County and flows more than 430 river miles (TWDB Jan 2006). Both the Comal and San Marcos Rivers are fed by springs from the Edwards Aquifer, and these two rivers are major tributaries to the Guadalupe River (GBRA 2008). Edwards Aquifer water flows from Comal Springs in New Braunfels into the Comal River. Water from the Edwards Aquifer also flows from San Marcos Springs in San Marcos into the San Marcos River.

The Guadalupe River drains approximately 10,128 square miles above the Guadalupe-Blanco River Authority (GBRA) Saltwater Barrier, of which approximately 4180 square miles are in the San Antonio River Basin (TWDB Jan 2006). The Guadalupe River drains into the Guadalupe Bay and San Antonio Bay approximately 11 miles downstream of the GBRA Saltwater Barrier (SARA 2007). Although the Guadalupe and San Antonio River Basins have been delineated as separate river basins by the TWDB, the two rivers join prior to discharge into San Antonio Bay and they are hydrologically considered as one.

Major reservoirs in the Guadalupe River Basin include Canyon Reservoir and Coleto Creek Reservoir. Canyon Reservoir is a large water supply and flood control project located in Comal County on the mainstream of the Guadalupe River. It is owned and operated by the GBRA under certificate of adjudication 18-2074, as amended. Canyon Dam was completed in 1964, resulting in a total authorized impoundment of 740,900 acre-feet. At present, 386,200 acre-feet of this amount is considered the conservation storage capacity for water supply purposes (TNRCC Dec 1999). Conservation storage capacity is used for water supply during drought conditions. Uses of the reservoir include water supply for municipal, industrial, steam-electric power generation, irrigation, and hydroelectric power generation, as well as flood protection and recreation. Diversions from Canyon Reservoir are currently authorized up to 90,000 acre-feet per year, as shown in Table 2.3.2-8. Water supplies are managed by the GBRA and made available to customers in their 10-county district as well as in adjacent counties and river basins (TWDB Jan 2006).

Coleto Creek Reservoir is located approximately 11 miles northwest of the site in Goliad County. The reservoir is operated by the GBRA and is a cooling reservoir for steam-electric power generation. Sources of water include runoff from the Coleto Creek watershed and diversions from the Guadalupe River, backed by storage in Canyon Reservoir when needed. The reservoir supplies water for steam-electric power generation at Coleto Creek Power Station in Goliad County, and as shown in Table 2.3.2-8, it has a permitted consumptive use of 12,500 acre-feet per year. (TWDB Jan 2006).

The San Antonio River is approximately 240 miles long and drains approximately 4180 square miles (SARA 2007). The San Antonio River drains into the Guadalupe River upstream of the GBRA Saltwater Barrier.

Besides the lower Guadalupe River (which starts just below the northern boundary of Victoria County), the San Antonio River, and the Coleto Creek Reservoir, other notable surface water bodies located within 50 miles of the site in the lower Guadalupe River hydrologic system include the Victoria Barge Canal, Coleto Creek, Green Lake, Linn Lake, the GBRA Calhoun Canal System, and the San Antonio Bay (which is an embayment of the Gulf of Mexico).

The lower Guadalupe and San Antonio Rivers, Coleto Creek Reservoir, and Coleto Creek are used for recreational fishing and birding. Green Lake is a shallow lake (about 3 feet deep) that is privately owned with no public access. San Antonio Bay is used for commercial and recreational fishing, birding, and navigation. Linn Lake is a small, shallow cut-off meander of the lower Guadalupe River and is privately used for recreational purposes; its remote location limits access to the public. The man-made sea-level Victoria Barge Canal connects Victoria to the Gulf Intracoastal Waterway and transports barge traffic for the local industry (VEDC 2008). The GBRA Calhoun Canal System is a water delivery system that diverts water from the Guadalupe River for delivery to customers, including the Port Lavaca water treatment plant.

2.3.2.3.1 Drought Management and Preparation

As discussed in Subsection 2.3.1.1.1, there have been major droughts in the lower Guadalupe-San Antonio basin in almost every decade since stream gaging began in the 1930s. The most severe drought, referred to as the drought of record, occurred between 1950 and 1957 (TWDB Jan 2007c).

As discussed in Subsections 2.3.2.1.1 and 2.3.2.3.5, the South Central Texas (Region L) water planning process utilizes the Guadalupe-San Antonio Basin Water Availability Model (TNRCC Dec 1999), modified for regional planning purposes, to quantify water availability through a repeat of the drought of record and throughout the planning horizon. Because the water availability model was developed using hydrologic data from 1934-1989, an evaluation was performed to compare the regional droughts from 1990-2009 with the 1950s drought of record used in the water planning process. Lowest river flows during the drought of record occurred during the 3-year period from 1954-1956.

Historical flow records for the Guadalupe and San Antonio Rivers were used to compare the flow magnitudes for the drought of record with those from the 1990-2009 droughts (considering drought durations from 3 months up to 3 years). In making these comparisons, the effects of Canyon Reservoir on the historical Guadalupe River flows were eliminated by only considering the historical flows for the Spring Branch gage located immediately upstream of the reservoir and the historical incremental inflows into the Guadalupe River between the cities of New Braunfels and Victoria. These incremental inflows were derived by subtraction of the monthly gaged flows at the upstream location from the monthly gaged flows at downstream location, and as such, they reflect only inflows to the river and do not include the effects of Canyon Reservoir upstream. Incremental inflows to the San Antonio River also were analyzed as part of the drought assessment using historical monthly flow records for the gages at the cities of Falls City and Goliad. These gages, which are downstream of the City of San Antonio's major wastewater treatment plant discharge points, were selected to ensure that the effects of return flows from the City of San Antonio were consistently reflected in both gages. Since the VCS raw water makeup intake canal will be located just upstream of the GBRA Saltwater Barrier, below the confluence of the Guadalupe River and the San Antonio River, incremental inflows from both rivers were combined for some of the drought comparisons.

Table 2.3.2-15 presents the flow values for the 1950s drought and for the droughts from the 1990-2009 period, estimated as described above. Considering the consistently and significantly lower historical minimum river flow magnitudes associated with the 1950s drought relative to those that occurred since 1990, the hydrologic conditions reflected by the 1950s drought still are the more critical with regard to water availability planning in the lower Guadalupe-San Antonio Basin. Accordingly, the Guadalupe-San Antonio Basin Water Availability Model and the 1950s drought of record are considered to be appropriate for evaluating water availability for the proposed VCS during periods of drought. Under the requirements of Title 30 Texas Administrative Code Chapter 288, the requirements of TWC Section 11.1272, local public and private water suppliers and water districts are required by the TCEQ to adopt a Drought Contingency Plan that contains drought triggers and responses unique to each specific entity. These entities have the authority and responsibility to manage their particular water supply within the bounds created by applicable law.

Water supplies available from the Gulf Coast Aquifer are generally less subject to transient hydrologic drought conditions. If depletion in the Gulf Coast Aquifer were to occur at an unacceptable pace (typically measured over many years, rather than a few months), there would likely be sufficient time to amend groundwater district rules and/or develop alternative sources of supply.

Supplies from surface water sources as run-of-the-river water rights and reservoirs are determined on the basis of minimum year availability and firm yield, respectively. Hence, the current water supplies modeled in the regional water plan adopted by Region L in 2006 are considered dependable during drought (TWDB Jan 2006).

2.3.2.3.2 Local Surface Water Use

The discussion of local surface water use includes Victoria, Refugio, Calhoun, and Goliad counties. Victoria County is discussed because it is the proposed location of the plant; Refugio County is discussed because it is included downstream in the same hydrologic system of the site and is the location of the proposed site's water intake; and Calhoun County is discussed because it is the location of the alternate freshwater intake, evaluated in Section 9.4. Goliad County is discussed because it is the location of the Coleto Creek Reservoir, which lies within both Goliad and Victoria counties.

In addition to the associated major reservoirs, surface water rights have been issued by the TCEQ and predecessor agencies to individuals, cities, industries, water districts, and water authorities for diversion from flowing streams in the South Central Texas Region. Each right bears a priority date, diversion location, maximum diversion rate, and annual quantity of diversion. Some rights may include off-channel storage authorization, instream flow requirements, and various special conditions (such as a temporary water permit).

Tables 2.3.2-9 through 2.3.2-11 identify the surface water user, the body of water from which withdrawals are made, and the permitted maximum volume of surface water withdrawal, where available, for the Guadalupe-San Antonio River Basin. The locations of the surface water users are plotted on Figure 2.3.2-4 using latitude and longitude information provided by the TCEQ (2008a). Note that there were surface water users for livestock use only in Refugio County as reported in Table 2.3.2-7. As of April 2, 2009, there have been no additional permitted surface water users in Victoria, Calhoun, Goliad, and Refugio counties, other than those reported in Table 2.3.2-9 through 2.3.2-11 (TCEQ 2009a).

Downstream of the site, surface water is withdrawn by a number of industries and private users. However, the largest downstream surface water user is the GBRA. The GBRA Saltwater Barrier creates an impoundment that facilitates diversions under Certificate of Adjudication rights 18-5173 through 18-5178 and 18-3863 held either jointly or singularly by the GBRA and Union Carbide Corporation (UCC). Although UCC now operates as Dow Chemical Corporation, the water rights are held under the UCC name. These rights total 175,501 acre-feet per year and are authorized for municipal, industrial, and irrigation use, as shown in Table 2.3.2-12 (GBRA Nov 2007).

The maximum reported water use under GBRA/UCC rights at the GBRA Saltwater Barrier did not exceed 51,670 acre-feet per year from 2000 to 2006 (GBRA Nov 2007). Table 2.3.2-13 provides a record of GBRA-reported Calhoun (Main) Canal water use by water use category. The table also provides a list of the GBRA's industrial, municipal, and irrigation customers.

The TCEQ Pending Surface Water Rights Applications database has three pending applications in the lower Guadalupe River basin. The applicants are Coleto Creek Power, LP for Victoria/Goliad counties; San Marcos River Foundation for Refugio/Gonzales counties (in stream uses) (TCEQ Jan 2008); and GBRA junior water right permit for multiple counties adjacent to the Guadalupe River (water diversion/reservoir) (TCEQ 2009b).

2.3.2.3.3 Surface Water Availability Projections

Although the Guadalupe and San Antonio River Basins have been delineated as separate river basins by the TWDB, the two rivers join prior to discharge into the San Antonio Bay system, and the two watersheds are considered as one (the Guadalupe-San Antonio River Basin) when evaluating surface water supplies available under existing water rights. This arrangement is due, in part, to the large concentration of senior water rights below the confluence of the two rivers (TWDB Jan 2006).

Senior water right holders have priority when stream flows are low, as in periods of drought. This priority renders junior rights less reliable during droughts. The most junior water right holders may not be able to divert any water during severe droughts.

Surface water supplies for the Guadalupe and San Antonio River Basins have been quantified using the state's Guadalupe-San Antonio River Basin Water Availability Model prepared by HDR Engineering, Inc. (TNRCC Dec 1999). The Water Availability Model quantifies, through the period of record (1934–1989), the water availability associated with run-of-the-river water rights, calculates the firm yields associated with Canyon Reservoir, and simulates the reliability of authorized consumptive uses associated with steam-electric power generation.

The South Central Texas RWPG conducted a detailed analysis of the projected water demands for various water users including municipal, industrial, irrigation, livestock, mining, and domestic use in each of the counties that comprise Region L. The RWPG used the Guadalupe-San Antonio River Basin Water Availability Model (modified for regional planning purposes) to evaluate the projected surface water demands for Victoria and Calhoun Counties. The modelers followed a procedure that accounts for historical hydrologic conditions from 1934–1989, seniority (priority) of water rights, and other factors to calculate surface water availability and reliability.

Projected surface water demands, supplies, and needs (i.e., the difference between projected demands and available supplies) for Victoria and Calhoun Counties are summarized in Table 2.3.2-14. In that table, projected Calhoun County demands and projected Victoria County needs are compared against the GBRA/UCC water rights. The GBRA currently does not supply Victoria County with water from the GBRA/UCC water rights, but because of projected shortages of surface water for Victoria County industrial users, the GBRA will supply surface water to Victoria County starting in 2040 to offset the projected surface water shortages (GBRA Feb 2008). As shown in the table, after meeting the Calhoun County surface water demands and Victoria County surface water needs, a surplus of approximately 115,926 acre-feet per year remains in 2060 under the GBRA/UCC water rights.

2.3.2.3.4 Guadalupe Estuary Freshwater Inflows

In 1998, the TWDB and the Texas Parks and Wildlife Department (TPWD) prepared *Freshwater Inflow Recommendations for the Guadalupe Estuary of Texas* (TPWD Dec 1998), a coastal studies technical report "that summarizes studies which form the basis for TPWD's recommendations of target freshwater inflows needed to maintain the unique biological communities and ecosystems characteristic of a healthy Guadalupe Estuary." As part of determining the estuary's freshwater inflow needs, the TWDB and TPWD incorporated hydrographic surveys, hydrodynamic and salinity modeling, and verification of needs into the report. Modeling produced theoretical estimates of a minimum freshwater inflow pattern (termed MinQ) and a freshwater inflow pattern intended to maximize fisheries harvests (termed MaxH), given certain constraints.

Historical freshwater inflows to the estuary from 1941 to 1987 and available fisheries harvest data from 1959 to 1987 were used to develop functional relationships for seven selected species: blue crab, eastern oyster, red drum, black drum, spotted seatrout, brown shrimp, and white shrimp. The freshwater inflow-fisheries harvest relationships were then used in a mathematical optimization process to satisfy species harvest goals of maintaining 80 percent of mean historical harvest, more than 50 percent of the time, subject to various inflow and biomass ratio bounds (i.e., the "state methodology"). Simulations using the TPWD and TWDB model yielded MinQ and maximum inflow (termed MaxQ) patterns of 1.03 million acre-feet per year and 1.29 million acre-feet per year, respectively, with estimated monthly inflow needs ranging from 52,400 acre-feet (March, April, September, and October) to between 186,000 and 222,600 acre-feet (May). The freshwater inflow pattern to the Guadalupe Estuary for optimization of fisheries harvest (i.e., MaxH) was estimated to be approximately 1.15 million acre-feet per year.

The inflow to the Guadalupe Estuary, like most Texas Estuaries, is highly variable. The study reports that the average annual inflow to the Guadalupe Estuary during the 1941–1987 period was greater than 1.52 million acre-feet at least 50 percent of the years. Only 23 percent of these years had annual flows less than the 1.15 million acre feet target volume. Inflows below the simulated MinQ of 1.03 million acre-feet per year occurred less than 15 percent of the time (TPWD Dec 1998).

Recent TPWD studies have focused on evaluation of fisheries survey data (as compared to harvest data used in the 1998 study) from the TPWD Coastal Fisheries Resource Monitoring Database. Observed abundances of estuarine fishery species were empirically evaluated against freshwater inflow regimes proposed from the theoretical modeling. By comparing predicted results with observed fisheries survey data. TPWD staff recommended the pattern of optimal harvest inflows (totalling

1.15 million acre-feet per year) as the lowest target value to fulfill the biological needs of the Guadalupe Estuary System on a seasonal basis (TPWD Oct 2007).

Pursuant to passage of Senate Bill 3, a new process has been established for TCEQ to adopt appropriate environmental flow standards for each bay system that are adequate to support a sound ecological environment to the maximum extent reasonable considering other public interests and other relevant factors (TWC 11.1471[a][1]). Bay and basin advisory groups, stakeholder committees, and expert science teams will work with technical support from the TPWD, TWDB, and TCEQ over the next few years to develop recommendations regarding environmental flow standards which TCEQ must consider in rulemaking. Recommendations of the expert science teams shall be developed through a collaborative process designed to achieve consensus and must be based solely on the best science available (TWC 11.02362(m)). The TCEQ permitting decisions shall establish an amount of unappropriated water, if available, to be set aside to satisfy the Senate Bill 3 environmental flow standards to the maximum extent reasonable when considering human water needs. Although this process has been created to establish environmental flow standards and set-asides to be considered in evaluating applications for new water rights and amendments, the statute does not apply the environmental flow standards to existing water rights.

2.3.2.3.5 Water Availability for the Proposed VCS

The source of the plant's makeup water would be the Guadalupe River as described in Section 3.4. Long-term stream flow data is not available for the Guadalupe River at the location of the diversion into the Raw Water Makeup (RWMU) intake system, approximately 430 feet upstream of the GBRA Saltwater Barrier. However, two upstream USGS gaging stations (Victoria gage on the Guadalupe River and Goliad gage on the San Antonio River) have long-term stream flow records and were used to estimate (in combination with runoff estimated from the drainage area downstream of the gages) the stream flow at the RWMU system location. The results indicated that the annual mean flow in the Guadalupe River is 4341 cfs based on 10 years of flow data (1997 through 2006).

The required makeup water could be secured under existing water rights via contract with an existing water rights holder or obtaining ownership of existing water right(s). Alternatively, water could be withdrawn from the Guadalupe River under a new water right or via a combination of new and existing water rights.

<u>Existing Water Right(s)</u>

As an example, water rights totaling 175,501 acre-feet per year and authorized for municipal, industrial, and irrigation use are held either jointly or directly by the GBRA and Union Carbide Corporation (GBRA/UCC). The maximum reported water use under GBRA/UCC rights at the GBRA Saltwater Barrier did not exceed 51,670 acre-feet per year from 2000 to 2006, thereby leaving approximately 70 percent of the joint water rights available. As described in Section 2.3.2.3.3, approximately 115,926 acre-feet per year are projected to be available in 2060 under the GBRA/UCC water rights, excluding the proposed VCS water withdrawal, after Victoria County needs and Calhoun County demands have been satisfied.

In addition to the available portion of the GBRA/UCC rights, there are many water rights holders that do not divert the full amount of their authorized diversions. Because the available portions of these water rights in the Guadalupe-San Antonio (GSA) River Basin represent a potential source of surface water for the proposed VCS, these water rights are being evaluated by Exelon. In order to determine the amount of water that is potentially available, an analysis was performed using the water supply information derived from the outputs from the existing GSA Water Availability Model (WAM), previously developed by the TCEQ. Two scenarios were evaluated by comparing (i) the maximum authorized annual diversion amounts to the maximum diversion amounts reported in the 10 years prior to development of the GSA WAM, and (ii) the simulated average diversion quantities under the full utilization WAM run to the simulated average of actual diversion amounts. The total amount of unused diversion authority is about 52,000 acre-feet/year for Scenario (i) and 39,000 acre-feet per year for Scenario (ii). The latter scenario is considered to be a more conservative estimate of the available portions of water rights in the GSA basin, because many of the evaluated water rights are subject to streamflow availability.

New Surface Water Appropriations

For a new appropriation or an amendment to an existing water right, an applicant submits a request to the TCEQ regarding annual volume, rate and place of diversion, type of use and additional information as required. The TCEQ will analyze the request with respect to water availability, effect on other water right holders and the environment, and other considerations as authorized. Therefore, each new permit application is reviewed for technical requirements to evaluate its impact on other water rights, bays and estuaries, conservation, water availability, public welfare, etc. For a new permit to be granted, it implies that there would be water available at the permitted location and the amount and rate of withdrawals or diversions would not have a significant impact on water right holders downstream and the surrounding ecosystem.

2011 Region L Plan

The development of the 2011 South Central Texas Region (Region L) Water Plan has been ongoing since February 2006. The Initially Prepared Plan was approved during February 2010. The Initially Prepared Plan includes updated regional water demand projections for steam-electric power generation including those projected for the VCS Project. The Initially Prepared Plan also includes a recommended project to supply water to the VCS Project (i.e., the

"GBRA-Exelon Project"). Analysis conducted for the Regional Water Planning Group using the state's surface water availability model as modified for regional planning purposes, concludes that sufficient water is available to support plant and cooling basin operations for the VCS Project (TWDB Feb 2010). Exelon continues to work closely with GBRA to ensure that adequate water would be available for VCS at the COL stage.

2.3.2.4 References

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Table 2.3.2-1
Groundwater Use (Acre-Feet per Year) by County in 50-Mile Radius of VCS Site (2004)

County	Municipal	Manufacturing	Steam Electric	Irrigation	Mining	Livestock	Total
Aransas	308	76	0	0	81	4	469
Bee	2658	1	0	3458	15	69	6201
Calhoun	188	2081	30	0	12	195	2506
DeWitt	2357	414	0	96	40	112	3019
Goliad	659	0	98	1585	7	40	2389
Gonzales	2150	1332	0	1140	29	460	5111
Jackson	1439	39	0	44,599	72	205	46,354
Lavaca	2515	308	0	6009	1	227	9060
Matagorda	4955	4979	4656	32,196	131	362	47,279
Refugio	1002	0	0	527	6	62	1597
San Patricio	1449	3	0	8937	114	24	10,527
Victoria	9156	508	303	2966	2293	303	15,529
Wharton	5407	25	0	104,910	200	204	110,746
Total	34,243	9766	5087	206,423	3001	2267	260,787
Percent Use	13.1%	3.7%	2.0%	79.2%	1.2%	0.9%	100%

Source: TWDB 2007a

Table 2.3.2-2
Available and Allocated Groundwater Supplies (Acre-Feet per Year) in Victoria County, Texas (2000–2060)

Groundwater Supplies per Basin	2000	2010	2020	2030	2040	2050	2060
Available							
Guadalupe	18,669	18,669	18,669	18,669	18,669	18,669	18,669
Lavaca	271	271	271	271	271	271	271
Lavaca-Guadalupe	20,389	20,389	20,389	20,389	20,389	20,389	20,389
San Antonio	1800	1800	1800	1800	1800	1800	1800
Total Available	41,129	41,129	41,129	41,129	41,129	41,129	41,129
Allocated							
Guadalupe	16,467	17,330	17,687	17,924	18,174	18,441	18,642
Lavaca	9	9	9	9	9	9	9
Lavaca-Guadalupe	15,125	18,113	17,091	16,187	15,422	14,777	14,212
San Antonio	37	37	37	37	37	37	37
Total Allocated	31,638	35,489	34,824	34,157	33,642	33,264	32,900
Total Unallocated	9491	5640	6305	6972	7487	7865	8229

Source: TWDB Jan 2006
Note: Groundwater supply source is the Gulf Coast Aquifer.

Table 2.3.2-3
Available and Allocated Groundwater Supplies (Acre-Feet/Year) in Calhoun County, Texas (2000–2060)

	2000	2010	2020	2030	2040	2050	2060
Available							
Guadalupe Basin	42	42	42	42	42	42	42
Lavaca-Guadalupe Basin	1334	1334	1334	1334	1334	1334	1334
Colorado-Lavaca Basin	1467	1467	1467	1467	1467	1467	1467
San Antonio-Nueces Basin	97	97	97	97	97	97	97
Total Available	2940	2940	2940	2940	2940	2940	2940
Allocated							
Guadalupe Basin	14	16	17	18	18	19	19
Lavaca-Guadalupe Basin	840	841	842	842	842	842	842
Colorado-Lavaca Basin	1286	1286	1286	1286	1286	1286	1286
San Antonio-Nueces Basin	17	18	19	19	20	20	20
Total Allocated	2157	2161	2164	2165	2166	2167	2167
Total Unallocated	783	779	776	775	774	773	773

Source: TWDB Jan 2006
Note: Groundwater supply source is the Gulf Coast Aquifer.

Table 2.3.2-4
Available and Allocated Groundwater Supplies (Acre-Feet per Year) in Refugio County, Texas (2000–2060)

	2000	2010	2020	2030	2040	2050	2060
Available							
San Antonio Basin	1961	1961	1961	1961	1961	1961	1961
San Antonio-Nueces Basin	40,359	40,359	40,359	40,359	40,359	40,359	40,359
Total Available	42,320	42,320	42,320	42,320	42,320	42,320	42,320
Allocated							
San Antonio Basin	22	22	22	22	22	22	22
San Antonio-Nueces Basin	3820	3040	3041	3041	3041	3041	3041
Total Allocated	3842	3062	3063	3063	3063	3063	3063
Total Unallocated	38,479	39,259	39,258	39,258	39,258	39,258	39,258

Source: TWDB Jan 2006
Note: Groundwater supply source is the Gulf Coast Aquifer.

Table 2.3.2-5
TWDB Wells Located Within 6 Miles of the VCS Site

TWDB Well ID	Owner	Latitude	Longitude	Primary Use	Well Depth (feet)	Water Quality Data	Aquifer	Well Type
7924601	Pat Witte	284029	970018	Stock	40	Y	Chicot	Water
7924701	Rose Morris Estate	283803	970611	Domestic	84	N	Chicot	Water
7924801	Elmo Heller	283845	970430	Domestic	81	N	Chicot	Water
7924901	Pat Witte	283924	970202	Unused	90	Y	Chicot	Water
7924902	Pat Witte	283924	970203	Domestic	125	Y	Chicot	Water
7924903	Henry Witte	283948	970125	Stock	30	N	Chicot	Water
7924904	D.H. Braman	283759	970227	Domestic	254	Y	Chicot	Water
7932101	J.J. Murphy Estate	283554	970514	Unused	250	Y	Chicot	Water
7932102	J.J. Murphy	283533	970546	Unused	1475	N	L. Goliad	Water
7932103	Mary Murphy Greer	283554	970514	Domestic	142	Y	Chicot	Water
7932404	Gussie Smith	283354	970548	Domestic	100	Y	Chicot	Water
7932602	J.A. McFaddin Estate	283248	970020	Irrigation	595	Y	Chicot	Water
7932804	O'Connor Brothers	283231	970306	Stock	716	N	L. Goliad	Water
8025101	J.A. McFaddin Estate	283613	965813	Stock	888	N	Chicot	Water
8025102	J.A. McFaddin Estate	283631	965904	Stock	131	N	Chicot	Water
8025501	J.A. McFaddin Estate	283405	965701	Stock	700	N	Evangeline	Water

Source: TWDB 2007b

Table 2.3.2-6
TCEQ Public Water Supply Wells Located Within 10 Miles of the VCS Site

TCEQ PWS No.	State Well No.	System Name	Latitude	Longitude	Drill Date	Well Depth (feet)	Aquifer
TX-2350001	8017904	Victoria County WCID 1	28.64	96.90	1969	1001	Evangeline
TX-2350001	8017905	Victoria County WCID 1	28.65	96.90	1981	1010	Evangeline
TX-2350014	8017503	INVISTA S.A.R.L.—Victoria	28.68	96.95	1949	1062	Evangeline
TX-2350014	8017504	INVISTA S.A.R.L.—Victoria	28.68	96.95	1949	1059	Evangeline
TX-2350014	8017505	INVISTA S.A.R.L.—Victoria	28.68	96.95	1956	447	Evangeline
TX-2350036	7923301	Coleto Water Co.	28.72	97.14	1977	222	Evangeline
TX-2350044	N/A	Speedy Stop 46	28.70	97.05	1986	130	Chicot
TX-2350051	N/A	Victoria County Navigation District	28.70	96.95	2000	190	Chicot
TX-2350051	N/A	Victoria County Navigation District	28.69	96.95	2004	260	Chicot

Source: TCEQ Oct 2007a
NA = Not available
PWS = Public Water Supply
WCID = Water Control and Improvement District

Table 2.3.2-7
Surface Water Use (Acre-Feet per Year) by County in 50-Mile Radius of the VCS Site (2007)

County	Municipal	Manufacturing	Steam Electric	Irrigation	Mining	Livestock	Total
Aransas	2950	43	0	0	0	33	3026
Bee	3354	0	0	0	0	807	4161
Calhoun	2194	54,297	0	15,509	0	169	72,169
DeWitt	512	0	0	0	0	1813	2325
Goliad	0	0	2055	0	0	1100	3155
Gonzales	2289	162	0	360	0	4227	7038
Jackson	0	417	0	621	0	677	1715
Lavaca	3	0	0	591	0	2153	2747
Matagorda	0	9335	40,836	154,625	0	1140	205,936
Refugio	0	0	0	0	0	600	600
San Patricio	8190	14,453	0	223	57	403	23,326
Victoria	0	19,966	952	0	0	834	21,752
Wharton	0	0	0	211,126	437	1082	212,645
Total	19,492	98,673	43,843	383,055	494	15,038	560,595
Percent Use	3.5%	17.6%	8.0%	68.2%	0.09%	2.68%	100%

Source: TWDB 2007a

Table 2.3.2-8
List of major Guadalupe River Basin Reservoirs

Reservoir	Water Right Owner	Certificate of Adjudication Number	Authorized Diversion (ac-ft per yr)	Firm Yield (ac-ft per yr)	Purposes
Canyon Reservoir	GBRA	18-2074	90,000[(a)]	~90,000[(a)]	Municipal, industrial, steam-electric, hydropower, irrigation, flood protection
Coleto Creek Reservoir	Coleto Creek Power	18-5486	12,500[(b)]	>12,500[(c)]	Steam-electric power generation

(a) Subject to the hydrologic assumptions and operational procedures listed in Section 3.2.3.1 of the 2006 South Central Texas Regional Water Plan, estimates of Canyon Reservoir firm yield range from 88,232 acre-feet per year to 87,484 acre-feet per year in years 2000 and 2060, respectively.

(b) Includes rights to divert up to 20,000 acre-feet per year from the Guadalupe River to Coleto Creek Reservoir and to consume up to 12,500 acre-feet per year.

(c) The reservoir and supplemental authorized diversions from the Guadalupe River could support a firm yield in excess of the authorized consumptive use; however, operations of Coleto Creek Power steam- electric power generation facilities could be impaired.

Source: TWDB Jan 2006

Table 2.3.2-9 (Sheet 1 of 2)
Surface Water Users in Victoria County

Water Right Number	Type	Owner Name	Latitude	Longitude	River Basin	Stream Name	Amount in Ac-Ft per Yr	Use	Priority Date
3858	Cert of Adj	First Victoria Natl Bank Trust I	28.93	–97.15	Guadalupe	Guadalupe River	1000	Irrigation	6/27/1951
3859	Cert of Adj	South Texas Electric Coop Inc.	28.89	–97.14	Guadalupe	Guadalupe River	110,000	Industrial	2/18/1964
3860	Cert of Adj	City of Victoria	28.81	–97.03	Guadalupe	Guadalupe River	260	Municipal/ Domestic	8/15/1951
3860	Cert of Adj	City of Victoria	28.81	–97.03	Lavaca-Guadalupe	Guadalupe River	__	Municipal/ Domestic	8/15/1951
3860	Cert of Adj	City of Victoria	28.81	–97.03	Guadalupe	Guadalupe River	__	Storage	8/15/1951
3860	Cert of Adj	City of Victoria	28.81	–97.03	Lavaca-Guadalupe	Guadalupe River	__	Storage	8/15/1951
3861	Cert of Adj	E.I. Dupont De Nemours & Co	28.66	–96.96	Guadalupe	Guadalupe River	60,000	Industrial	8/16/1948
3862	Cert of Adj	Paradise Ranch Landowners Assn. Inc.	28.65	–96.96	Guadalupe	Guadalupe River	263	Irrigation	12/12/1951
3862	Cert of Adj	E.I. Dupont De Nemours & Co	28.65	–96.96	Guadalupe	Guadalupe River	137	Irrigation	12/12/1951
3863	Cert of Adj	Jess Womack II et al.	28.57	–96.91	Guadalupe	Guadalupe River	200	Irrigation	3/1/1951
3863	Cert of Adj	Guadalupe-Blanco River Authority	28.57	–96.91	Guadalupe	Guadalupe River	3000	Municipal/ Domestic	3/1/1951
3863	Cert of Adj	Guadalupe-Blanco River Authority	28.57	–96.91	Guadalupe	Guadalupe River	__	Industrial	3/1/1951
3863	Cert of Adj	Guadalupe-Blanco River Authority	28.57	–96.91	Guadalupe	Guadalupe River	__	Irrigation	3/1/1951
3895	Permit	Kate S O'Connor Trust	28.64	–96.96	Guadalupe	Guadalupe River	9676	Industrial	7/10/1978
4020	Permit	Nelson Pantel	28.92	–97.15	Guadalupe	Guadalupe River	100	Irrigation	1/21/1980
4062	Permit	Jay M. Easley et al.	28.88	–97.10	Guadalupe	Guadalupe River	90	Irrigation	7/14/1980
4182	Permit	William A. Kyle Jr. et al.	28.90	–97.14	Guadalupe	Guadalupe River	200	Irrigation	12/21/1981
4324	Permit	Spring Creek Development Co.	28.85	–97.01	Guadalupe	Spring Creek	__	Recreation	2/7/1983
4441	Permit	S.F. Ruschhaupt III	28.95	–97.16	Guadalupe	Guadalupe River	200	Irrigation	4/2/1984
5012	Permit	Joe D. Hawes	28.51	–96.92	Guadalupe	Elm Bayou	140	Irrigation	9/10/1985

Table 2.3.2-9 (Sheet 2 of 2)
Surface Water Users in Victoria County

Water Right Number	Type	Owner Name	Latitude	Longitude	River Basin	Stream Name	Amount in Ac-Ft per Yr	Use	Priority Date
5376	Permit	Heldenfels Brothers Inc.	28.84	–97.01	Guadalupe	Spring Creek	2	Industrial	8/16/1991
5424	Permit	Housing Authority of City of Victoria	28.87	–97.01	Guadalupe	Unnamed Trib. Spring Creek	—	Recreation	7/23/1992
5466	Permit	City of Victoria	28.81	–97.03	Guadalupe	Guadalupe River	20,000	Municipal/ Domestic	5/28/1993
5485	Cert of Adj	Victoria WLE LP	28.79	–97.01	Guadalupe	Guadalupe River	209,189	Industrial	8/15/1951
5486	Cert of Adj	Coleto Creek WLE LP	28.72	–97.17	Guadalupe	Guadalupe River	20,000	Industrial	1/7/1952
5486	Cert of Adj	Coleto Creek WLE LP	28.72	–97.17	Guadalupe	Guadalupe River & Coleto Creek	12,500	Industrial	1/10/1977
5489	Permit	Jess Womack II et al.	28.52	–96.92	Guadalupe	Cushman Bayou	750	Other	5/12/1994

Source: TCEQ Oct 2007b

Table 2.3.2-10 (Sheet 1 of 6)
Surface Water Users in Calhoun County

Water Right Number	Type	Owner Name	Latitude	Longitude	River Basin	Stream Name	Amount in Ac-Ft/Year	Use	Priority Date	Remarks
3746	Permit	Patrick H. Welder, Jr.	28.55	–96.83	Lavaca-Guadalupe	Victoria Barge Canal	1284.3	Irrigation	10/1/1979	None
3746	Permit	Standard Oil Chemical Co.	28.55	–96.83	Lavaca-Guadalupe	Victoria Barge Canal	715.7	Irrigation	10/1/1979	None
3864	Cert of Adj	Texas Parks & Wildlife Dept.	28.49	–96.81	Lavaca-Guadalupe	Hog Bayou	50	Irrigation	12/31/1955	Guadalupe Delta WMA
4276	Permit	Del & Gloria Williams	28.46	–96.83	Guadalupe	Guadalupe River	272	Industrial	6/25/1985	Crawfish Farm
5173	Cert of Adj	Guadalupe-Blanco River Authority	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	2500	Irrigation	2/3/1941	Amend. 5/21/04, 9/27/0, 5/1/2007: Stat Dist.
5173	Cert of Adj	Guadalupe-Blanco River Authority	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Industrial	8/12/1988	Amend. 5/21/04, 9/27/04, 5/1/2007: Stat Dist.
5173	Cert of Adj	Guadalupe-Blanco River Authority	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Irrigation	2/3/1941	Amend. 5/21/04, 9/27/04, 5/1/2007: Stat Dist.
5173	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Irrigation	2/3/1941	Part Owner with GBRA
5173	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Irrigation	2/3/1941	Part Owner of 2500 Ac-Ft with GBRA
5173	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Industrial	8/12/1988	Amend. 4/17/91. Part Owner with GBRA

Table 2.3.2-10 (Sheet 2 of 6)
Surface Water Users in Calhoun County

Water Right Number	Type	Owner Name	Latitude	Longitude	River Basin	Stream Name	Amount in Ac-Ft/Year	Use	Priority Date	Remarks
5174	Cert of Adj	Guadalupe-Blanco River Authority	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	1870	Irrigation	6/15/1944	Amend. 5/21/04, 9/27/04, 5/1/2007: Stat Dist.
5174	Cert of Adj	Guadalupe-Blanco River Authority	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Industrial	6/15/1944	Amend. 5/21/04, 9/27/04, 5/1/2007: Stat Dist.
5174	Cert of Adj	Guadalupe-Blanco River Authority	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Irrigation	6/15/1944	Amend. 5/21/04, 9/27/04, 5/1/2007: Stat Dist.
5174	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Irrigation	6/15/1944	Part Owner of 1870 Ac-Ft with GBRA
5174	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Irrigation	6/15/1944	Part Owner with GBRA
5174	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Industrial	6/15/1944	Amend. 4/17/91. Part Owner with GBRA
5175	Cert of Adj	Guadalupe-Blanco River Authority	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	940	Industrial	2/13/1951	Amend. 5/21/04, 9/27/04, 5/1/2007: Stat Dist.
5175	Cert of Adj	Guadalupe-Blanco River Authority	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Irrigation	2/13/1951	Amend. 5/21/04, 9/27/04, 5/1/2007: Stat Dist.

Table 2.3.2-10 (Sheet 3 of 6)
Surface Water Users in Calhoun County

Water Right Number	Type	Owner Name	Latitude	Longitude	River Basin	Stream Name	Amount in Ac-Ft/Year	Use	Priority Date	Remarks
5175	Cert of Adj	Guadalupe-Blanco River Authority	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Mining	2/13/1951	Amend. 5/21/04, 9/27/04, 5/1/2007: Stat Dist.
5175	Cert of Adj	Guadalupe-Blanco River Authority	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Other (stockraising)	2/13/1951	Stockraising Amend. 4/91, 5/04, 9/04, 5/1/2007
5175	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Industrial	2/13/1951	Amend. 4/17/91. Part Owner with GBRA
5175	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Irrigation	2/13/1951	Amend. 4/17/91. Part Owner with GBRA
5175	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Mining	2/13/1951	Amend. 4/17/91. Part Owner with GBRA
5175	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Other	2/13/1951	Stockraising, Amend. 4/91, 5/2004, 9/27/2004
5176	Cert of Adj	Guadalupe-Blanco River Authority	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	9944	Municipal/ Domestic	6/21/1951	Amend. 5/21/04, 9/27/04, 5/1/2007: Stat Dist.
5176	Cert of Adj	Guadalupe-Blanco River Authority	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Industrial	6/21/1951	Amend. 4/91, 5/04, 9/04, 5/1/2007: Stat. District

Table 2.3.2-10 (Sheet 4 of 6)
Surface Water Users in Calhoun County

Water Right Number	Type	Owner Name	Latitude	Longitude	River Basin	Stream Name	Amount in Ac-Ft/Year	Use	Priority Date	Remarks
5176	Cert of Adj	Guadalupe-Blanco River Authority	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Irrigation	6/21/1951	Amend. 4/91, 5/04, 9/04, 5/1/2007: Stat District
5176	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Municipal/ Domestic	6/21/1951	Part Owner of 9944 Ac-Ft with GBRA
5176	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Industrial	6/21/1951	Part Owner of 9944 Ac-Ft with GBRA
5176	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Irrigation	6/21/1951	Part Owner of 9944 Ac-Ft with GBRA
5177	Cert of Adj	Guadalupe–Blanco River Authority	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	32,615	Municipal/ Domestic	1/3/1944	Amend. 4/91, 5/04, 9/04, 5/1/2007: Stat District
5177	Cert of Adj	Guadalupe-Blanco River Authority	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Industrial	1/3/1944	Amend. 4/91, 5/04, 9/04, 5/1/2007: Stat District
5177	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Municipal/ Domestic	1/3/1944	Part Owner of 3,2615 Ac-Ft with GBRA
5177	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Industrial	1/3/1944	Part Owner of 3,2615 Ac-Ft with GBRA

Table 2.3.2-10 (Sheet 5 of 6)
Surface Water Users in Calhoun County

Water Right Number	Type	Owner Name	Latitude	Longitude	River Basin	Stream Name	Amount in Ac-Ft/Year	Use	Priority Date	Remarks
5177	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Irrigation	1/3/1944	Part Owner of 3,2615 Ac-Ft with GBRA
5177	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	10,000	Municipal/ Domestic	1/3/1944	1,0000 Ac-Ft Uses 1,2,3: Union Carbide Only
5177	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Industrial	1/3/1944	1,0000 Ac-Ft Uses 1,2,3: Union Carbide Only
5177	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Irrigation	1/3/1944	1,0000 Ac-Ft Uses 1,2,3: Union Carbide Only
5177	Cert of Adj	Guadalupe-Blanco River Authority	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	8632	Industrial	1/26/1948	8632 Ac-Ft Uses 2 & 3. AM 1991, 2004, 5/1/2007
5177	Cert of Adj	Guadalupe-Blanco River Authority	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Irrigation	1/26/1948	8632 Ac-Ft Uses 2 & 3 AM 1991, 2004, 5/1/2007
5177	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Industrial	1/26/1948	Part Owner with GBRA, 8632 Ac-Ft Uses 2 & 3
5177	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Irrigation	1/26/1948	Part Owner with GBRA, 8632 Ac-Ft Uses 2 & 3

Table 2.3.2-10 (Sheet 6 of 6)
Surface Water Users in Calhoun County

Water Right Number	Type	Owner Name	Latitude	Longitude	River Basin	Stream Name	Amount in Ac-Ft/Year	Use	Priority Date	Remarks
5178	Cert of Adj	Guadalupe- Blanco River Authority	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	106,000	Municipal/ Domestic	5/5/1954	Amend. 4/91, 5/04, 9/04, 5/1/2007: Stat District
5178	Cert of Adj	Guadalupe-Blanco River Authority	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Industrial	5/5/1954	Amend. 4/91, 5/04, 9/04, 5/1/2007: Stat District
5178	Cert of Adj	Guadalupe-Blanco River Authority	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Irrigation	5/5/1954	Amend. 4/91, 5/04, 9/04, 5/1/2007: Stat District
5178	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Municipal/ Domestic	5/5/1954	Seadrift Plant Part Owner of 106,000 Ac-Ft with GBRA
5178	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Industrial	5/5/1954	Seadrift Plant Part Owner of 106,000 Ac-Ft with GBRA
5178	Cert of Adj	Union Carbide Chem. & Plastics	28.51	–96.89	Guadalupe	Guadalupe River: Mission Bay, Green Lake, Hog Bayou, Goff Bayou	—	Irrigation	5/5/1954	Part Owner of 106,000 Ac-Ft with GBRA
5484	Cert of Adj	Guadalupe-Blanco River Authority	28.51	–96.89	Guadalupe	Guadalupe River	—	Industrial	5/15/1964	& Co 196. In Accordance w/5173-517 8
5639	Cert of Adj	Terry M. Whitaker et al.	28.59	–96.77	Lavaca-Guadalupe	Coloma Creek	40	Irrigation	8/23/1999	SC

Source: TCEQ Oct 2007b

Table 2.3.2-11
Surface Water Users in Goliad County

Water Right Number	Type	Owner Name	Longitude	Latitude	River Basin	Stream Name	Amount in Acre-Feet per Year	Use	Priority Date	Remarks
2193	Cert of Adj	James M. Pettus et al.	–97.603798	28.692085	San Antonio	San Antonio River	284	Irrigation	12/31/1963	None
2194	Cert of Adj	Julia Gannt Newton et al.	–97.581062	28.686396	San Antonio	San Antonio River	1020	Irrigation	11/14/1947	None
2195	Cert of Adj	Kenneth B. Perkins	–97.571136	28.685186	San Antonio	San Antonio River	410	Irrigation	1/13/1956	None
2196	Cert of Adj	Coleto Cattle Company	–97.565994	28.680069	San Antonio	San Antonio River	336	Irrigation	11/30/1950	None
2197	Cert of Adj	James M. Pettus et al.	–97.52832	28.653498	San Antonio	San Antonio River	86	Irrigation	1/31/1967	None
2198	Cert of Adj	San Antonio River Authority	–97.507668	28.647745	San Antonio	San Antonio River	333	Irrigation	4/25/1950	No land; subject to amendment
2199	Cert of Adj	Sam Houston Clinton et al.	–97.491386	28.642643	San Antonio	San Antonio River	325	Irrigation	1/20/1949	None
3820	Permit	June Pettus	–97.52449	28.649004	San Antonio	San Antonio River	950	Irrigation	4/20/1981	Jointly owns 950 acre-feet to irrigate 380 acre-feet
3820	Permit	Mrs. Joe Cohn	–97.52449	28.649004	San Antonio	San Antonio River	—	Irrigation	4/20/1981	Jointly owns 950 acre-feet to irrigate 380 acre-feet
2195	Cert of Adj	Kenneth B. Perkins	–97.571136	28.685186	San Antonio	San Antonio River	410	Irrigation	1/13/1956	None
5079	Permit	John Brooke	–97.539726	28.66877	San Antonio	San Antonio River	114	Irrigation	7/28/1986	None
5220	Permit	Clarence F. Schendel et al.	–97.459122	28.648272	San Antonio	San Antonio River	330	Irrigation	2/27/1989	None
5313	Permit	Edwin Jacobson et al.	–97.610405	28.707199	San Antonio	San Antonio River	100	Irrigation	8/30/1990	Amended 4/11/97: 181.6 acre-feet off-channel imp.
5478	Permit	Patricia Pittman Light	–97.486397	28.642387	San Antonio	San Antonio River	300	Irrigation	1/14/1994	Off-channel reservoir

Source: TCEQ 2008a

Table 2.3.2-12
Summary of GBRA/UCC Water Rights in the Lower Guadalupe River Basin

Permit Number	Certificate of Adjudication	Priority Date	Authorized Use	Owner	Authorized Diversion Ac-Ft per Yr
1319	18-5173	2/3/1941	Irrigation/Industrial	GBRA/Union Carbide	2,500
1362	18-5174	6/15/1944	Irrigation/Industrial	GBRA/Union Carbide	1,870
1564	18-5175	2/13/1951	Irrigation/Industrial/ Mining/Livestock	GBRA/Union Carbide	940
1592	18-5176	6/21/1951	Irrigation/Industrial/ Municipal	GBRA/Union Carbide	9,944
1375	18-5177	1/3/1944	Industrial/Irrigation/ Municipal	GBRA/Union Carbide	32,615
1375	18-5177	1/3/1944	Irrigation/Industrial	GBRA/Union Carbide	8,632
1375	18-5177	1/3/1944	Irrigation/Industrial/ Municipal	Union Carbide	10,000
1614	18-5178	1/7/1952	Irrigation/Industrial/ Municipal	GBRA/Union Carbide	106,000
1562	18-3863	3/1/1951	Irrigation/Industrial/ Municipal	GBRA	3,000
2120	18-5484	5/15/1964	Diversion Dam & Salt Water Barrier	GBRA	N/A
Totals:					175,501

Source: Derived from TCEQ Oct 2007b

Table 2.3.2-13
GBRA Record of Reported Calhoun Canal Water Use and Availability

	2000	2001	2002	2003	2004	2005	2006	Average
GBRA/UCC (Calhoun Canal) Water Rights[(a)]	175,501	175,501	175,501	175,501	175,501	175,501	175,501	175,501
Industrial Customers Ineos Nitriles (formerly BP Chemicals) DOW Chemical Company (formerly Union Carbide Corp [UCC]) Seadrift Coke	26,637	26,047	21,919	20,482	19,370	20,254	22,264	22,425
Municipal Customers City of Port Lavaca Port O'Connor Municipal Utility District (MUD) GBRA Calhoun County Rural Water System	4754	3849	5837	10,398	4882	8482	6946	6450
Irrigation Customers Rice Farmers Aquaculture Farmers Waterfowl Enhancement	18,539	21,774	23,893	14,030	15,508	19,809	15,813	18,481
Total GBRA Calhoun Canal Water Used	49,930	51,670	51,649	44,910	39,760	48,545	45,023	47,355
Total Underutilized GBRA/UCC Water Rights	125,571	123,831	123,852	130,591	135,741	126,956	130,478	128,146

(a) For a detailed breakdown of the GBRA/UCC water rights, see Table 2.3.2-12.
Source: GBRA Nov 2007

Table 2.3.2-14
Projected Surface Water Demands, Supplies, and Needs for Victoria and Calhoun Counties (Acre-Feet per Year) (2000–2060)

	Actual 2000	2010	2020	2030	2040	2050	2060
GBRA/UCC (Calhoun Canal) Water Rights[a]	175,501	175,501	175,501	175,501	175,501	175,501	175,501
Calhoun County							
Total Calhoun County Water Demands[b]	49,930[c]	69,243	72,564	75,795	79,489	82,816	87,247
Less Calhoun Eastern Industrial Demands met by Lake Texana[b]	–20,128	–23,392	–25,644	–27,861	–30,086	–31,917	–34,238
Calhoun County Water Demands	29,802	45,851	46,920	47,934	49,403	50,899	53,009
Victoria County							
Victoria County Industrial Needs[b]	0	0	0	0	1008	3624	6566
Total Underutilized GBRA/UCC Water Rights	145,699	129,650	128,581	127,567	125,090	120,978	115,926

(a) For a detailed breakdown of the GBRA/UCC Surface Water Rights, see Table 2.3.2-12.

(b) Source of projected demands, Lake Texana supplies, and needs is the 2006 South Central Texas Region L Water Plan. In the Region L Water Plan, “needs” are projected shortages or projected demands not met by existing supplies. GBRA currently does not supply Victoria County with water from the GBRA/UCC (Calhoun County) water rights, but due to projected shortages in Victoria County, GBRA will supply water to Victoria County starting in 2040 to offset the projected water shortages.

(c) Total Calhoun County Water Demands for 2000 provided by GBRA Nov 2007 as shown in Table 2.3.2-13.

Source: HDR Feb 2008 except as noted

Table 2.3.2-15
Comparison of 1990–2009 Historical Droughts to the 1950s Drought of Record[(a)]

HISTORICAL PERIODS	MINIMUM CUMULATIVE FLOWS FOR INDICATED MONTHLY DURATIONS					
	3 Months	6 Months	12 Months	18 Months	24 Months	36 Months
	GUADALUPE RIVER FLOW AT SPRING BRANCH UPSTREAM OF CANYON RESERVOIR					
1950s Drought	66	1,830	7,171	14,661	38,986	61,483
1990 - 2009	2,515	13,947	33,217	60,925	128,566	453,186
	INCREMENTAL INFLOW INTO GUADALUPE RIVER FROM NEW BRAUNFELS TO VICTORIA					
1950s Drought	7,992	23,252	85,484	151,008	296,035	507,874
1990 - 2009	25,831	97,525	274,762	467,752	820,794	1,990,216
	INCREMENTAL INFLOW INTO SAN ANTONIO RIVER FROM FALLS CITY TO GOLIAD					
1950s Drought	-6,248 *	1,188	4,506	29,611	46,587	77,137
1990 - 2009	1,006	4,812	14,041	27,773	60,171	213,122
	COMBINED INCREMENTAL INFLOWS INTO GUADALUPE RIVER FROM NEW BRAUNFELS TO VICTORIA AND INTO SAN ANTONIO RIVER FROM FALLS CITY TO GOLIAD					
1950s Drought	1,744	32,739	89,990	195,199	358,984	597,159
1990 - 2009	32,836	103,686	288,803	543,840	971,890	2,225,148

* Negative incremental flows are likely the result of diversions and channel losses within the river reach that exceed the sum of river flows at the upstream end of the reach and natural inflows within the reach.

(a) Summary of minimum cumulative flows for different consecutive-month durations based on historical flows during the 1950s drought and the 1990-2009 period for key locations and reaches of the Guadalupe and San Antonio Rivers relevant to supplying water for VCS from a diversion point immediately upstream of the GBRA Saltwater Barrier.

2.3.3 Water Quality

This subsection considers the water quality of surface water bodies and groundwater aquifers that could affect plant water use and effluent discharge, or be affected by the construction or operation of the proposed plant to be built at the VCS site.

2.3.3.1 Groundwater

Groundwater quality in the Gulf Coast aquifer, consisting of the Chicot, Evangeline, and Jasper aquifers from youngest to oldest (TWDB Jan 2007), is generally good in the shallower portion of the aquifer. Groundwater containing less than 500 mg/L total dissolved solids (TDS) is usually encountered to a maximum depth of 3200 feet in the aquifer from the San Antonio River Basin northeastward. From the San Antonio River Basin southwestward, quality deterioration is evident in the form of increased chloride concentrations and saltwater encroachment along the coast (TWDB Jan 2006).

Groundwater from the Evangeline aquifer in areas south of Bee County, which is hydraulically downgradient of the site, has elevated concentrations of radioactivity relative to the rest of the aquifer system. Radioactivity generally increases from the northern part to the southern part of the Gulf Coast aquifer, occurs irregularly with depth, and shows no trend in composition. Radioactivity in the Texas Water Development Board (TWDB) Groundwater Database is mainly expressed as gross alpha and gross beta. Approximately 6.27 percent of 272 samples collected by the TWDB from the Evangeline Aquifer exceeded 15 pCi/L, the EPA maximum contaminant level (MCL) for alpha activity (not including radon or uranium). The gross alpha activity was reported in the 272 TWDB water samples at a maximum concentration of 208 picocuries per liter (pCi per L), a mean concentration of 6.05 pCi per L and a median concentration of 2.60 pCi per L. Nearly all the samples analyzed for beta activity were below the MCL.

The Texas Water Commission (TWC March 1989) reports, during a 1987 and 1988 study, anomalous radium concentrations of up to 65 pCi per L peaked at a depth of 585–1140 feet below the ground surface and were associated with wells near salt domes and/or streams. The study indicated that the proximity of salt domes and associated fault systems was an important predictor for the presence of radon and radium in the groundwater. Concentrations decreased as distance from the domes increased. It was concluded that radium and radon in the groundwater may have originated in the Catahoula Formation, a known source of uranium mineralization, and migrated upward into the shallower portion of the Gulf Coast aquifer. Avenues for migration may be located along flanks of piercement salt domes, along faults, and through permeable sediments deposited by streams. Alternatively, it was proposed that uranium could have migrated through the upper aquifer strata and concentrated in the reducing halo surrounding the domes (TWC Mar 1989).

Groundwater quality data for six of the TWDB wells located within 6 miles of the site (Figure 2.3.2-2) is summarized in Table 2.3.3-1**.** The data collected from the six wells includes a total of 12 samples collected between 1959 and 2005. The data indicates that chloride and total dissolved solids (TDS) concentrations in these wells exceed their EPA secondary maximum contaminant levels (SMCL). Nitrate concentrations in some of the groundwater samples are also in excess of the EPA MCL for nitrate (U.S. EPA 2008a).

In November 2007, groundwater samples were collected from eight groundwater wells at the site. The wells included two McCan Ranch livestock wells (i.e., Northwest Gate Well and Southwest Windmill Well) and six VCS site observation wells (i.e., OW-01 U/L, OW-03 L, OW-08 U/L, and OW-10 L), all of which are screened in the Chicot Aquifer. The depth of the livestock well referred to as the Southeast Windmill well is reportedly 135 feet deep (Banks Aug 2007), while the depth of the livestock well referred to as the Northwest Gate well is unknown. The VCS site observation wells that were included in the sampling program are screened at depths ranging from 56 feet to 142 feet below the ground surface.

In April 2008, a second groundwater sampling event was conducted for the same eight onsite wells sampled in November 2007, as well as one additional site observation well (i.e., OW-10 U) that was dry during the November sampling event. In addition, an offsite well (TWDB #7932602) screened in the deeper Evangeline Aquifer was sampled in March 2008.

The locations of the nine onsite and one offsite groundwater wells sampled in November 2007 and April 2008 are shown in Figure 2.3.3-1.

Each of the ten groundwater samples from the nine onsite wells and the offsite well was analyzed for the parameters selected from NRC guidance, as well as parameters used for permitting and plant design purposes. The parameter list for the nine onsite well samples and the offsite well sample is shown in Tables 2.3.3-2 and 2.3.3-3, respectively.

As shown in Table 2.3.3-1, the six TWDB wells located within 6 miles of the VCS site that have water quality data were analyzed for many of the same sample parameters as those in the November 2007 and April 2008 investigation (Table 2.3.3-2). The results from the recent (November 2007 and April 2008) groundwater investigation indicate that the general chemistry of groundwater at the site is within the ranges of concentrations seen in the TWDB wells from 1959 to 2005.

The April 2008 groundwater sampling results were compared to the analytical results of the November 2007 groundwater investigation to evaluate seasonal changes in groundwater quality of the nine onsite wells installed in the shallow Chicot Aquifer. Chloride concentrations increased in all the wells between the November and April sampling events. In November, the average chloride concentration in the wells was 173 milligrams per liter versus an average chloride concentration of

2098 mg per liter reported in April. Temperature, total hardness, alkalinity, sulfate, total silica, sodium, and total iron concentrations also increased in the water samples between the November and April sampling events. The increase in these groundwater quality parameters is most likely a reflection of the lower groundwater levels in April and resultant stagnant groundwater flow regime. Dissolved oxygen, pH, and conductivity remained relatively constant between the two sampling events, while TDS, barium, magnesium and total coliform concentrations decreased.

Most of the parameters for site groundwater were within the MCL or SMCL, with the following exceptions: chloride, aluminum, arsenic, barium, iron, lead, manganese, TDS, and Ra-228. The metals strontium and potassium were detected in shallow groundwater at the site during the November sampling event (the parameters were not included in the April sampling event). Analytical results for the nine onsite groundwater wells are summarized in Table 2.3.3-2.

Analytical results from the March 2008 sampling of the offsite well (TWDB #7932602) are summarized in Table 2.3.3-3. TDS and sodium were reported in the well at concentrations higher than the onsite well concentrations reported in November and April.

High chloride in groundwater has been mapped for all the major aquifers of Texas. Chloride leaches into the groundwater from sedimentary rocks, soils, and salt deposits. The metals aluminum, arsenic, barium, iron, lead, and manganese also occur naturally by leaching from aquifer materials into the groundwater. The high TDS concentrations in groundwater are a result of the high levels of metals and organics in the groundwater. Radium is also found naturally in groundwater in parts of Texas and was reported in two of the TWDB wells located within 6 miles of the site (included in gross alpha analysis in Table 2.3.3-1). Strontium and potassium are also detected in groundwater, but neither has associated drinking water standards (MCL or SMCL). Both strontium and potassium are naturally occurring in rock. In addition, potassium can be attributed to contamination from animal waste.

2.3.3.2 Surface Water

Surface water bodies of primary interest include: lower Guadalupe River, lower San Antonio River, Guadalupe-Blanco River Authority (GBRA) Calhoun Canal (which receives water diverted from an impoundment formed by the GBRA Saltwater Barrier), Victoria Barge Canal and Kuy Creek. These water bodies are important because the proposed VCS would withdraw makeup water through an intake structure assumed to be located on the west bank of the Guadalupe River approximately 0.6 miles southwest of the GBRA Saltwater Barrier and Diversion Dam; cooling basin blowdown would be discharged to the Guadalupe River upstream of the intake location; and an existing barge offload facility at the Port of Victoria Turning Basin located east of the site on the Victoria Barge Canal would be upgraded, as necessary, as part of the VCND transportation corridor project evaluated in Sections 4.7 and 5.11. Kuy Creek will intercept runoff from the site's cooling basin spillway during storms that exceed the 100-year rain event. The GBRA Calhoun Canal is considered as an alternate source of makeup water in Section 9.4. Coleto Creek is a major tributary to the Guadalupe River upstream of the proposed cooling basin blowdown location. The RWMU intake location is approximately 11 miles southeast of the VCS site, and three routes for the makeup water pipeline are evaluated as shown in Figure 2.2-5. Each of the routes would cross the San Antonio River and Elm Bayou.

The southern half of the site is bisected north to south by the ephemeral Dry Kuy Creek, which drains into the intermittent/ephemeral Kuy Creek south of the site**.** Other surface water bodies on the site include several unnamed intermittent or ephemeral tributaries to Kuy Creek (along the western section of the site), several unnamed intermittent or ephemeral tributaries to Linn Lake (along the eastern section of the site), four isolated wetlands ranging in size from approximately 5 to 40 acres, and more than two dozen small, isolated stock ponds.

One important goal of both the TCEQ and EPA, through the Clean Water Act, is maintaining the quality of surface waters to provide for the survival and propagation of a balanced, indigenous, aquatic flora and fauna community. The TCEQ established five subcategories of aquatic life (limited, intermediate, high, and exceptional aquatic life, and oyster waters). The aquatic life subcategories recognize the natural variability of aquatic community requirements and local environmental conditions. Biological data are considered to be a better indicator of water quality than chemical conditions. Therefore, if biological data shows a healthy, balanced community, the use is considered supported even if chemical parameters do not meet the applicable criteria. The criteria for “contact recreational use” are attained based on the frequency of E. coli and fecal coliform excursions. That is, the criteria are attained if E. coli do not exceed 126 organisms per 100 milliliters based upon the geometric mean of samples, with no single sample exceeding 394 per 100 milliliters, and fecal coliform organisms do not exceed 200 colonies per 100 milliliters based upon the geometric mean of samples, with no single sample exceeding 400 colonies per 100 milliliters (TCEQ 2000).

The TCEQ Surface Water Quality Segments located in the site’s hydrologic system are shown in Figure 2.3.3-2, and the designated uses of each segment are summarized in Table 2.3.3-4. The San Antonio River Segment 1901 and the San Antonio Bay/Hines Bay/Guadalupe Bay Segment 2462, Area 2462-02, are included on the 2008 Texas Water Quality Inventory and 303(d) List of Impaired Waters for high levels of bacteria (TCEQ 2008a).

Table 2.3.3-5 provides a list of 11 U.S. Geological Survey (USGS) and TCEQ surface water monitoring stations from which surface water quality data was collected. The locations of the monitoring stations are shown on Figure 2.3.3-3, and the water quality data is summarized in Tables 2.3.3-6 through 2.3.3-17.

In November 2007 and April 2008, surface water quality data were collected from a series of surface water bodies at and near the site as part of the site surface water characterization. The sample locations are shown in Figure 2.3.3-4**.** Each of the surface water samples was analyzed for a list of parameters that included those based on NRC guidance, as well as those used for permitting and plant design purposes. The water quality data are summarized in Table 2.3.3-18.

2.3.3.2.1 Guadalupe River

Water quality data for two USGS and five TCEQ surface water quality stations located on the lower Guadalupe River is summarized in Tables 2.3.3-6 through 2.3.3-13. Table 2.3.3-8 presents water quality data collected from the TCEQ Station 16579, which is located near the Invista-DuPont effluent discharge. TCEQ and GBRA discontinued collecting data at Station 16579 in 2008 because the integrity of the data was deemed suspect due to the station's proximity to the industrial outfall (GBRA Nov 2007).

Downgradient of the confluence with the San Marcos River, the Guadalupe River flows through an area occupied by a number of large poultry farms and cattle ranches. To date, there have been no problems in the main segment associated with these land uses, although the tributary Sandies Creek and Peach Creek watersheds have been listed as impaired (GBRA May 2006). In early assessments, there were concerns for nutrient enrichment and depressed oxygen in the tidal segment of the river; however, the tidal segment has been removed from the 2008 List of Impaired Waters for aquatic life use.

In November 2007 and April 2008, surface water samples (SW-01 and SW-05) were collected from the lower Guadalupe River as part of the Victoria County site surface water characterization. The locations of the river samples are shown in Figure 2.3.3-4, and the analytical data is summarized in Table 2.3.3-18.

Guadalupe River at Highway 59 (SW-05)

The November 2007 sampling event reported relatively high metal concentrations at SW-05, but the higher metals concentrations seen in November may be due to higher turbidity in the river, resulting from a rain event during the sampling period. The turbidity of the sample collected at SW-05 during the November sampling event was 482 nepthelometric turbidity units (NTUs) compared to the high historical (from 2004 to 2007) turbidity of 384 NTUs reported from TCEQ 12590.

The river flow during the April 2008 sampling event was near normal, and as a result turbidity was much less than that measured in November. Other water quality parameters, including color, phosphorous, total and fecal coliform, and iron also decreased.

Comparison of historical surface water quality data from monitoring stations USGS Station 08176500, TCEQ Station 12590, and TCEQ Station 12581 indicates that the general chemistry of the surface water collected from SW-05 in April shows little discernible variation from the historical data (GBRA Undated, USGS 2008, U.S. EPA 2008b).

Guadalupe River at the GBRA Saltwater Barrier (SW-01)

Historical water quality data collected from TCEQ Station 12578, which is located at the GBRA Saltwater Barrier, is summarized in Tables 2.3.3-6 and 2.3.3-7.

The general chemistry of the November 2007 and April 2008 samples collected at the saltwater barrier is typical of the historical general chemistry of the river at that location. Similar to SW-05, the November sampling data shows higher turbidity concentrations relative to the April data.

2.3.3.2.2 San Antonio River

Historical water quality data collected from TCEQ Station 12789 located on the lower San Antonio River are summarized in Table 2.3.3-14.

In the past, water quality in the San Antonio Basin has varied from very good in the upper basin to relatively poor in the lower basin, particularly during periods of low flow. Since 1987, advanced water treatment has been instituted at the three major San Antonio area water recycling plants. As a result, dissolved oxygen concentrations in the San Antonio River have been maintained well above the state of Texas stream standard of 5.0 mg per liter and aquatic life has been significantly enhanced. Of the 13 TCEQ water segments comprising the San Antonio Basin, all but two segments are rated as either high or excellent for aquatic life. Of the remaining two segments, Segment 1912 (Medio Creek) has a rating of impaired and Segment 1913 (Mid Cibolo Creek) has a rating of limited aquatic life (TCEQ 2000). As shown in Table 2.3.3-14, the lower San Antonio River is impaired for high levels of bacteria (TWDB Jan 2006).

The TCEQ completed a total maximum daily load (TMDL) study to determine the measures necessary to restore water quality in lower San Antonio River (LSAR) Segment 1901. The goal of the LSAR TMDL study was to determine the load of pollutants that the river can receive and still support its designated uses. The load was allocated to the source of pollution in the watershed. An implementation plan to reduce pollutant loads was then developed. The LSAR TMDL Report was completed and adopted by the TCEQ on August 20, 2008. EPA Region 6 approved the LSAR TMDL on October 20, 2008 (TCEQ Mar 2009).

2.3.3.2.3 GBRA Calhoun Canal (SW-06)

Water quality data collected from USGS Station 08188600, located on the GBRA Calhoun Canal near the GBRA Relift #1 Station is summarized in Table 2.3.3-15. The parameters measured and reported at the USGS monitoring station include primarily pesticides and herbicides, of which none were detected.

In November 2007 and April 2008, surface water samples were collected from sample location SW-06 (shown in Figure 2.3.3-4), which is located on the GBRA Calhoun Canal. The April water quality data collected at SW-06 indicated higher concentrations of many of the parameters such as TDS, hardness, total suspended solids (TSS), alkalinity, chloride, sulfate, sodium, iron, and magnesium than those reported during the November sampling event. However, turbidity concentrations decreased.

2.3.3.2.4 Victoria Barge Canal

Water quality data collected from TCEQ Station 12536 located on the Victoria Barge Canal is summarized in Table 2.3.3-16.

All water quality standards and uses are supported on the Victoria Barge Canal. Although the canal has high aquatic life use (Table 2.3.3-4), phosphorous and chlorophyll-a levels are occasionally elevated. At certain times during the year, the canal is very biologically productive and other parameters do not indicate water quality instability (TWDB Jan 2006).

2.3.3.2.5 Kuy Creek (SW-02)

In November 2007 and April 2008, surface water samples were collected at sample location SW-02, which is shown in Figure 2.3.3-4.

The April water quality data indicated higher TSS, chloride, and iron concentrations relative to the November data. However, turbidity, TDS, and magnesium concentration decreased from November to April. The creek had high total coliform concentrations during both sampling events that are assumed to result from cattle loitering in and around the creek.

Based on a review of surface water quality data from USGS and TCEQ monitoring stations located in the lower San Antonio and lower Guadalupe River basins, the general chemical and biological characteristics of the Kuy Creek water samples are typical for the area (GBRA Undated and Dec 2007, USGS 2008, U.S. EPA 2008b). However, chloride, sulfate, sodium, iron, and magnesium are relatively elevated in Kuy Creek and may be a result of the constituents leaching into the water from the alluvial sediments that comprise the creek channel.

2.3.3.2.6 Coleto Creek (SW-04)

Historical water quality data for TCEQ Station 12622 located on Coleto Creek is summarized in Table 2.3.3-17.

In November 2007 and April 2008, surface water samples were collected at SW-04 at the location shown in Figure 2.3.3-4. Based on a comparison of the data sets, there is no discernible variability between the two water quality data sets, with the exception of an increase in total iron concentrations in April. Based on a review of surface water quality data from the TCEQ monitoring stations in Coleto Creek and the lower Guadalupe River, the general chemical, physical and biological characteristics of the surface water samples are typical for the area (GBRA Dec 2007, U.S. EPA 2008b).

2.3.3.2.7 Factors Affecting Water Quality

Several upstream factors have the potential to affect water quality at the GBRA Saltwater Barrier impoundment. The potential sources of pollution include wastewater discharges from municipal treatment, industrial, and manufacturing facilities, as well as agricultural runoff.

Texas Pollutant Discharge Elimination System (TPDES) permitted discharges were identified within the lower Guadalupe River and lower San Antonio River basins located within Victoria, Refugio, and Goliad Counties. Table 2.3.3-19 provides a summary of permit numbers, facility information, flow rates, receiving streams, and distances to the VCS site.

There are seven permitted discharges that release effluent to the lower Guadalupe River basin below Victoria. The nearest to the GBRA Saltwater Barrier is the Invista facility, which is located approximately 5.5 miles northeast of the proposed VCS site. The facility is permitted to discharge 21.8 million gallons per day (mgd) into the Guadalupe River at a location on the opposite side of the river downstream from the proposed VCS discharge structure. According to files accessed on the EPA Envirofacts web site (U.S. EPA Feb 2008), the facility has had no TPDES violations in the past 5 years. The city of Victoria has two wastewater treatment plants that have combined permitted discharges of 12.1 mgd. There are four other non-major permitted discharges to the lower Guadalupe River that have no recorded discharge volumes.

There are two permitted discharges that release effluent to the lower San Antonio River. The city of Goliad wastewater treatment plant has a permitted discharge of 0.35 mgd. The second is a concrete plant with no recorded discharge volume. There are no TPDES permitted discharges to the lower Guadalupe River or the lower San Antonio River from Refugio County. Goliad County has two permitted discharges to the lower San Antonio River.

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Table 2.3.3-1
Summary of Groundwater Quality Data for TWDB Wells Located within 6 Miles of the VCS Site

State Well Number	7924601	7924601	7924901	7924901	7924901	7924902	7924902	7924902	7924904	7932404	7932602	7932602	Mean	Maximum
Date Sampled	4/11/01	3/30/05	2/5/59	6/28/79	8/25/83	3/26/97	4/11/01	3/22/05	2/4/59	2/4/59	4/28/59	4/14/71		
Parameter														
Temperature (°Celsius)	22	22	—	—	—	23	23	23	—	—	—	28	23.5	28
Silica (mg per L)	34.4	36.6	30	45	44	19.7	42.4	46	31	34	15	15	32.8	46
Calcium (mg per L)	127	153	100	103	95	96.5	94.4	96.3	185	131	12	11.4	100.4	185
Magnesium (mg per L)	20.4	28.5	11	12	12	12.6	12.3	12.3	33	25	6.6	6.9	16.1	33
Sodium (mg per L)	169	235	94	79	94	92.7	87.4	92	177	106	404	384	168	404
Potassium (mg per L)	2.77	2.84	—	—	3	3.25	2.89	3.19	—	—	2.8	—	2.96	3.25
Strontium (mg per L)	0.92	1.14	—	—	—	0.41	0.42	0.4	—	—	—	—	0.66	1.14
Carbonate (mg per L)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bicarbonate (mg per L)	489.36	510.1	387	353.9	362.44	356.34	346.58	346.57	280	297	362.1	358.78	370.9	510.1
Sulfate (mg per L)	58.4	84.5	22	24	25	19.8	22.5	21.1	61	59	8.6	8.65	34.5	84.5
Chloride (mg per L)	**260**	**424**	111	115	128	102	125	120	**488**	**252**	**435**	**437**	**250**	**488**
Fluoride (mg per L)	0.31	0.52	0.5	0.3	0.4	0.26	0.38	0.56	0.3	0.3	0.7	0.5	0.42	0.7
Nitrate (mg per L)	<0.09	<0.09	2	8	5.01	9.3	**14.3**	**13.11**	0.8	<0.4	2	<0.4	6.8	14.3
pH (standard)	6.75	—	7.8	8.2	8.3	7.2	6.91	—	7.2	7.4	7.9	7.6	7.5	8.3
Total Dissolved Solids (mg per L)	**913**	**1217**	**560**	**560**	**584**	**531**	**572**	**575**	**1113**	**753**	**1064**	**1040**	**790**	**1217**
Total Alkalinity (mg per L)	401	418	317.12	290	297	292	284	284	229.44	243.37	296.72	294	303.9	418
Total Hardness (mg per L)	401	501	294	306	286	293	286	292	597	429	57	56	317	597
Sodium (percent)	47	51	40	35	41	40	39	41	39	34	93	93	49	93
Specific Conductance (µmhos per cm)	1646	2150	967	987	1072	918	1016	994	2050	1430	1940	2058	1436	2150
Gross Alpha (pCi per L)	1.8 ± 1.7	2.1 ± 4.6	—	—	—	—	2.6 ± 1.6	4.8 ± 3.2	—	—	—	—	—	—
Gross Beta (pCi per L)	4.9 ± 2.6	1.9 ± 4.2	—	—	—	—	4.1 ± 2.7	10 ± 2	—	—	—	—	—	—

Source: TWDB 2007
See Table 2.3.2-5 for well depths and aquifer for which well is screened.
µmhos per cm = micro-mhos per centimeter
mg per L = milligrams per liter
pCi per L = pico Curies per liter
– Not available
Bold = Parameter concentration exceeds MCL or SMCL
MCL = Maximum Contaminant Level (U.S. EPA 2008a)
SMCL = Secondary Maximum Contaminant Level (U.S. EPA 2008a)

Table 2.3.3-2 (Sheet 1 of 7)
Summary of Exelon Victoria County Onsite Groundwater Analytical Results

Parameter	Analytical Method	MCL or *SMCL	OW-1U 11.29.07	OW-1U 04.15.08	OW-1L 11.29.07	OW-1L 04.15.08	OW-3L 11.29.07	OW-3L 04.15.07	OW-3L Duplicate 04.15.08	OW-8U 11.29.07	OW-8U 04.15.08
General Chemistry											
Temperature (°C)	Field Measurement	NE	22.55	20.8	22.61	23.51	22.43	24.23	24.23	21.10	24.33
pH (standard units)	Field Measurement	6.5 - 8.5*	7.53	7	7.57	7.6	7.53	7.4	7.4	7.55	7.4
Salinity (percent)	Field Measurement	NE	0.05	0.1	0.06	0.1	0.06	0.1	0.1	0.04	0
Total Suspended Solids (mg per L)	SM[2] 2540/USEPA 160.2	NE	13	371	21.7	0.67†	119	43.3	2.3	1120	7610
Total Dissolved Solids (mg per L)	SM 2540/USEPA 160.1	500*	**677**	**625**	**719**	**669**	**836**	**796**	**829**	**566**	**519**
Hardness, Total as $CaCO_3$ (mg per L)	USEPA 130.0	NE	340	610	314	336	330	380	372	408	352
Turbidity (NTU)	USEPA 180.1	0.3**	93.7	77.6	86.2	1.3	119	3.9	1.7	<0.75	82.5
Color, Apparent (Cobalt Units)	USEPA 110.2	15*	5	**25**	5	<5	5	<5	10	5	**20**
Odor (Threshold Odor Number)	USEPA 140.1	3*	<1	<1	<1	<1	<1	<1	<1	<1	<1
Specific Conductance (µmhos per cm)	USEPA 120.1	NE	1130	988	1210	1120	1360	1320	1310	902	831
Dissolved Oxygen (mg per L)	Field Measurement	NE	10.52	8.2	8.90	8.62	7.94	9.83	9.83	10.77	10.27
Biochemical Oxygen Demand (mg per L)	SM 5210/USEPA 405.1	NE	<1.0	<0.89	6.0	<0.89	<1.0	<0.89	<0.89	<2.0	<0.89
Chemical Oxygen Demand (mg per L)	SM 5220/USEPA 410	NE	<4.5	8.4†	22.5	<4.5	22.5	19†	16.3†	<4.5	34.9
Total Organic Carbon (mg per L)	USEPA 415.1	NE	<0.48	–	<0.30	–	<0.25	–	–	<0.43	–
Phosphorus, Total (mg per L)	SM 4500/USEPA 365	NE	0.038	0.55	0.031	<0.0040	0.15	<0.0090†	<0.013†	0.13	0.071
Phosphorus, Orthophosphate (mg per L)	SM 4500/USEPA 365.2	NE	0.036	0.014†	0.034	0.0040†	0.041	<0.0070†	<0.010†	0.084	0.010†
Nitrogen, Ammonia (mg per L)	SM 4500/USEPA 350.1	NE	<0.050	<0.10	<0.050	<0.10	<0.50	<0.10	<0.10	<0.050	<0.050
Nitrogen, Nitrite (mg per L)	SM 4500/USEPA 353.2	100	<0.011	<0.010	<0.011	<0.010	<0.015	<0.010	<0.010	0.053	<0.010
Nitrate-N (mg per L)	SM 4500	10	<1.0	0.77	<1.0	0.94	<1.0	0.55	0.61	<1.0	0.66
Nitrogen, Total Kjeldahl (mg per L)	USEPA 351.2	NE	0.29	–	<0.011	–	<0.20	–	–	–	–
Nitrogen, Organic (mg per L)	SM 4500-N	NE	0.29	<0.10	<0.011	<0.10	<0.20	<0.10	<0.10	<0.050	<0.050
Carbon Dioxide (mg per L)	SM4500 CO2 D	NE	51.55	67.8	53.55	37	64.1	34.8	20.7	93.97	47.3
Bicarbonate Alkalinity (mg per L)	SM2320	NE	257.75	324	267.74	280	272.78	340	320	364.73	412
Alkalinity, Total as $CaCO_3$ (mg per L)	SM 2320/USEPA 310	NE	258	324	268	280	273	340	320	365	412
Fluoride (mg per L)	USEPA 340.2	4	0.17	–	0.34	–	0.30	–	–	0.53	–

Table 2.3.3-2 (Sheet 2 of 7)
Summary of Exelon Victoria County Onsite Groundwater Analytical Results

Parameter	Analytical Method	MCL or *SMCL	OW-1U 11.29.07	OW-1U 04.15.08	OW-1L 11.29.07	OW-1L 04.15.08	OW-3L 11.29.07	OW-3L 04.15.07	OW-3L Duplicate 04.15.08	OW-8U 11.29.07	OW-8U 04.15.08
Chloride (mg per L)	SM 5220/USEPA 410	250*	69.8	**2100**	185	**3200**	147	**2180**	**3080**	11.6	**2180**
Chlorine Demand (mg per L)	HACH 10223	NE	1.58	NA	0.99	NA	3.21	–	–	2.63	–
Calcium (mg per L)	EPA 200.7	NE	114	222	119	115	124	118	121	159	119
Silica, Dissolved (mg per L)	USEPA 370.1	NE	32.6	–	34	–	33.6	–	–	29.7	–
Silica, Total (mg per L)	USEPA 6010B	NE	22.8	52.3	16.9	18.1	25.2	17.8	18.6	59.9	60.5
Silt Density Index	ASTM D4189	NE	0.28	–	IV	–	filter failed	–	–	IV	–
Sulfide (mg per L)	USEPA 376.1	NE	1.0	–	1.0	–	1.0	–	–	2.0	–
Sulfate (mg per L)	SM 4500/USEPA 375.3	250*	48.6	49.4	28.0	20.6	97.9	111	113	10.3	28
Sodium (mg per L)	USEPA 6010B	NE	135	106	103	131	171	172	178	116	115
Bacteria											
Total Coliform (CFUs per 100 mL)	SM 9223B/9221D	TCR	152	50	52	20	44	<10	<10	4200	1680
Fecal Coliform (CFUs per 100 mL)	SM 9222D	NE	<10	<10	<10	<10	<10	<10	<10	<10	<10
Fecal Streptococci (CFUs per 100 mL)	SM 9230C	NE	<10	<10	<10	<10	<10	<10	<10	<10	<10
Radionuclides (pCi per L)											
Potassium-40 (K-40)	USEPA 901.1	NE	-27.1	32.1	43.9	12.9	29.0	52.3	67.6	-22.6	14.4
Cesium-137 (Cs-137)	USEPA 901.1	NE	-0.891	0.629	-1.46	2.72	1.63	0.984	0.171	-0.38	1.54
Thallium-208 (Tl-208)	USEPA 901.1	NE	-1.23	0.14	-2.74	-2.22	-2.21	1.8	-3.77	1.48	8.34
Bismuth-212 (Bi-212)	USEPA 901.1	NE	-30.2	23.8	13.6	8.96	-13.3	28.5	8.77	0.01	50.2
Lead-212 (Pb-212)	USEPA 901.1	NE	-6.84	-1.18	-8.48	3.19	0.47	-1.08	0.01	-0.167	15.2
Bismuth-214 (Bi-214)	USEPA 901.1	NE	9.23	37.6	25.8	37.9	-0.93	27	22.3	13.4	37.7
Lead-214 (Pb-214)	USEPA 901.1	NE	5.21	48.9	17.7	38.9	14.1	35.3	23.2	15.0	29.9
Radium-226 (Ra-226)	USEPA 901.1	5.0	-10.7	-9.04	19.7	-3.14	-8.02	-14.4	-6.71	-11.0	7.08
Radium-228 (Ra-228)	USEPA 904.0	5.0	1.93	–	2.59	–	3.34	–	–	**5.68**	–
Tritium (H-3)	USEPA 906.0	NE	52.4	126	158	96	141	102	197	50.5	86.4
Metals (µg per L)											
Aluminum	USEPA 6010B	50 to 200*	488	–	290	–	2270	–	–	23,000	NA
Arsenic	USEPA 6010B	10	<2.7	6.6	<2.7	<2.8	<2.7	<2.7	3.1†	**12.2**	4.5†

Table 2.3.3-2 (Sheet 3 of 7)
Summary of Exelon Victoria County Onsite Groundwater Analytical Results

Parameter	Analytical Method	MCL or *SMCL	OW-1U 11.29.07	OW-1U 04.15.08	OW-1L 11.29.07	OW-1L 04.15.08	OW-3L 11.29.07	OW-3L 04.15.07	OW-3L Duplicate 04.15.08	OW-8U 11.29.07	OW-8U 04.15.08
Barium	USEPA 6010B	200	**261**	**428**	**382**	**204**	<108	81.3†	84.7†	**436**	**229**
Cadmium	USEPA 6010B	5	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8
Chromium	USEPA 6010B	100	<1.5	18	<1.5	<1.5	<2.6	<1.5	<1.5	19.8	2.3†
Cobalt	USEPA 6010B	NE	<9.6	–	<9.6	–	<9.6	–	–	<12.9	–
Copper	USEPA 6010B	1.0*	<5.9	–	<7.7	–	<7.9	–	–	<13.4	–
Iron (Dissolved)	USEPA 6010B	100*	<24	–	<24	–	<24	–	–	<24	–
Iron (Total)	USEPA 6010B	100*	**447**	**14,900**	**305**	55.8†	**1930**	68.9†	75.8†	**20,500**	**3,060**
Lead	USEPA 6010B	15	<2.8	12.4	<2.8	<2.8	3.4	<2.8	<2.8	19.0	6.9
Magnesium	USEPA 6010B	NE	18,900	20500	16,900	18600	17,800	16800	17300	17,300	12700
Manganese (Dissolved)	USEPA 6010B	50*	<12.8	–	6.6	–	<11.2	–	–	**270**	–
Manganese (Total)	USEPA 6010B	50*	<9.6	–	15.2	–	26.7	–	–	**541**	–
Mercury	USEPA 7470B	200	<0.094	<0.094	<0.094	<0.094	<0.094	<0.094	<0.094	<0.094	<0.094
Molybdenum	USEPA 6010B	NE	<1.2	–	<1.2	–	<1.2	–	–	<1.5	–
Nickel	USEPA 6010B	NE	<2.6	–	<2.6	–	<2.8	–	–	<15.0	–
Potassium	USEPA 7470B	NE	4800	–	3240	–	4990	–	–	7050	–
Selenium	USEPA 6010B	50	<2.3	–	<2.3	–	<3.8	–	–	<2.3	–
Silver	USEPA 6010B	100*	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1
Strontium	USEPA 6010B	NE	622	–	333	–	523	–	–	450	NA
Titanium	USEPA 6010B	NE	<4.1	–	<3.4	–	<15.0	–	–	67	NA
Vanadium	USEPA 6010B	NE	<9.6	–	<6.5	–	<12.1	–	–	51.5	NA
Zinc	USEPA 6010B	500*	<7.5	–	<7.5	–	<11.2	–	–	46.5	NA
Oil and Grease	USEPA 1664	NE	<1.4	–	<1.4	–	<1.4	–	–	<1.4	–

Table 2.3.3-2 (Sheet 4 of 7)
Summary of Exelon Victoria County Onsite Groundwater Analytical Results

Parameter	Analytical Method	MCL or *SMCL	OW-8L 11.29.07	OW-8L 04.15.08	OW-10U 04.15.08	OW-10L 11.29.07	OW-10L Duplicate 11.29.07	OW-10L 04.15.08	Northwest Gate Well 11.29.07	Northwest Gate Well 04.15.08	Southeast Windmill Well 11.29.07	Southeast Windmill Well 04.15.08	Mean	Maximum
General Chemistry														
Temperature (°C)	Field Measurement	NE	20.82	23.9	25.26	21.67	21.67	25.8	16.62	21.54	20.49	23.49	22.5	25.8
pH (standard units)	Field Measurement	6.5 - 8.5*	7.34	7.3	7.4	7.56	7.56	7.2	7.17	7.6	7.53	7.1	7.41	7.6
Salinity (percent)	Field Measurement	NE	0.04	0.1	0.1	0.06	0.06	0.1	0.07	0.1	0.09	0.1	0.1	0.1
Total Suspended Solids (mg per L)	SM[2] 2540/USEPA 160.2	NE	36.0	1850.0	2.7	<1.7	2.3	1.0†	8.7	2	<1.3	1.3†	590	7610
Total Dissolved Solids (mg per L)	SM 2540/USEPA 160.1	500*	**560**	**650**	**778**	**889**	**885**	**575**	**823**	**563**	**1290**	731	736	1290
Hardness, Total as $CaCO_3$ (mg per L)	USEPA 130.0	NE	292	850	270	232	424	480	268	150	500	590	395	850
Turbidity (NTU)	USEPA 180.1	0.3**	47.8	95.4	77.4	1.3	1.8	0.44†	46.2	5.9	<0.88	0.88†	39.2	119
Color, Apparent (Cobalt Units)	USEPA 110.2	15*	5	**20**	**20**	5	5	<5	10	**60**	5	<5	12	60
Odor (Threshold Odor Number)	USEPA 140.1	3*	**40**	<1	<1	<1	<1	<1	<1	<1	<1	<1	3.1	40
Specific Conductance (μmhos per cm)	USEPA 120.1	NE	805	1030	1230	1440	1440	1310	1410	1030	1880	1740	1236	1880
Dissolved Oxygen (mg per L)	Field Measurement	NE	8.18	10.12	10.51	5.17	5.17	8.55	10.97	7.46	9.35	8.6	8.89	10.97
Biochemical Oxygen Demand (mg per L)	SM 5210/USEPA 405.1	NE	<9.0	<0.89	<0.89	<1.0	<8.0	1.0†	6.0	<0.89	2.0	<0.89	<2.4	9
Chemical Oxygen Demand (mg per L)	SM 5220/USEPA 410	NE	57.1	5.7†	5.7†	<4.5	<4.5	29.6	25.0	<4.5	<4.5	<4.5	<14.9	57.1
Total Organic Carbon (mg per L)	USEPA 415.1	NE	19.8	–	–	<0.39	<0.40	–	<0.20	–	<0.12	–	<2.5	19.8
Phosphorus, Total (mg per L)	SM 4500/USEPA 365	NE	0.051	0.25	0.048	0.023	0.043	<0.0060†	<0.015	0.0030†	<0.017	0.0090†	<0.08	0.55
Phosphorus, Orthophosphate (mg per L)	SM 4500/USEPA 365.2	NE	0.029	0.0030†	0.02	<0.019	<0.019	<0.0040†	<0.011	<0.0030	<0.011	<0.0030	<0.02	0.084
Nitrogen, Ammonia (mg per L)	SM 4500/USEPA 350.1	NE	0.17	0.11	<0.10	<0.25	<0.50	<0.10	<0.50	<0.10	0.24	<0.10	<0.17	0.5
Nitrogen, Nitrite (mg per L)	SM 4500/USEPA 353.2	100	<0.034	<0.010	0.025	<0.011	<0.011	<0.010	<0.011	<0.010	<0.011	<0.010	<0.01	0.053
Nitrate-N (mg per L)	SM 4500	10	<1.0	<0.11	0.6	<1.0	<1.0	0.45	<1.0	<0.11	<1.0	0.31	<0.74	1
Nitrogen, Total Kjeldahl (mg per L)	USEPA 351.2	NE	–	–	–	<0.13	2.0	–	–	–	–	–	<0.53	2
Nitrogen, Organic (mg per L)	SM 4500-N	NE	0.17	0.11	<0.10	<0.25	<0.50	<0.10	<0.50	<0.10	0.24	<0.10	<0.17	0.5
Carbon Dioxide (mg per L)	SM4500 CO2 D	NE	63.82	58.5	54.2	57.35	46.1	62.8	643.39	9.5	18.12	61	81.3	643.4
Bicarbonate Alkalinity (mg per L)	SM2320	NE	304.72	344	420	286.73	264.7	300	377.96	316	92.71	248	305	420
Alkalinity, Total as $CaCO_3$ (mg per L)	SM 2320/USEPA 310	NE	305	344	420	287	265	300	378	316	92.8	248	305	420
Fluoride	USEPA 340.2	4	0.56	–	–	0.12	0.18	–	0.55	–	0.41	–	0.35	0.56

Table 2.3.3-2 (Sheet 5 of 7)
Summary of Exelon Victoria County Onsite Groundwater Analytical Results

Parameter	Analytical Method	MCL or *SMCL	OW-8L 11.29.07	OW-8L 04.15.08	OW-10U 04.15.08	OW-10L 11.29.07	OW-10L Duplicate 11.29.07	OW-10L 04.15.08	Northwest Gate Well 11.29.07	Northwest Gate Well 04.15.08	Southeast Windmill Well 11.29.07	Southeast Windmill Well 04.15.08	Mean	Maximum
Chloride (mg per L)	SM 5220/USEPA 410	250*	54	**2750**	**2680**	224	225	**1530**	175	**1300**	**462**	**1900**	**1287**	**3200**
Chlorine Demand (mg per L)	HACH 10223	NE	31.22	–	–	1.08	0.98	–	20.42	–	1.05	–	7	31.2
Calcium (mg per L)	EPA 200.7	NE	92.2	331.0	84.3	153	153	148	66.5	235	162	174	148	331
Silica, Dissolved (mg per L)	USEPA 370.1	NE	26.6	–	–	25.4	25.9	–	<0.015	–	28.6	–	26.3	34
Silica, Total (mg per L)	USEPA 6010B	NE	18.1	118	24.2	16.1	15.8	15.7	13.5	4.37	16.7	170	37.1	170
Silt Density Index	ASTM D4189	NE	IV	–	–	IV	IV	–	0.62	–	0.01	–	0.30	0.62
Sulfide (mg per L)	USEPA 376.1	NE	13	–	–	2.0	2.0	–	3.0	–	3.0	–	3	13
Sulfate (mg per L)	SM 4500/USEPA 375.3	250*	12.8	45.7	70	60.5	59.7	68.3	89.3	14.8	93.4	105	59	113
Sodium (mg per L)	USEPA 6010B	NE	66.7	124	219	127	124	116	214	185	176	177	145	219
Bacteria														
Total Coliform (CFUs per 100 mL)	SM 9223B/9221D	TCR	80,000	12,400	180	166	256	<10	<10	60	100	160	<5240	80,000
Fecal Coliform (CFUs per 100 mL)	SM 9222D	NE	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Fecal Streptococci (CFUs per 100 mL)	SM 9230C	NE	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Radionuclides (pCi per L)***														
Potassium-40 (K-40)	USEPA 901.1	NE	-32.3	73.6	52.3	4.4	-44.3	1.8	6.18	68.5	-45.0	15.3	15.9	73.6
Cesium-137 (Cs-137)	USEPA 901.1	NE	0.73	-3.93	0.317	-4.22	-1.26	-2.02	1.18	-0.912	-0.705	-1.01	-0.36	2.72
Thallium-208 (Tl-208)	USEPA 901.1	NE	0.129	1.56	0.156	-2.52	-0.161	1.03	-0.988	0.28	3.20	3.32	0.29	8.34
Bismuth-212 (Bi-212)	USEPA 901.1	NE	6.88	10.1	-22.3	-1.72	5.0	9.21	-2.8	-13.9	28.9	-8.92	5.3	50.2
Lead-212 (Pb-212)	USEPA 901.1	NE	-4.2	20.9	5.29	0.51	18.8	16.5	-1.13	-1.52	-3.25	-4.98	2.53	20.9
Bismuth-214 (Bi-214)	USEPA 901.1	NE	-1.77	48.7	36.3	24.5	4.38	36.9	26	57.9	20	30.6	26	57.9
Lead-214 (Pb-214)	USEPA 901.1	NE	7.80	40.5	15.3	3.78	3.66	32.7	29.9	61	10.2	37.7	24.8	61
Radium-226 (Ra-226)	USEPA 901.1	5.0	-3.48	-5.52	-0.267	1.96	-8.68	23.6	-0.866	**10**	4.56	12.1	-0.15	23.6
Radium-228 (Ra-228)	USEPA 904.0	5.0	4.71	–	–	3.76	4.37	–	0.905	–	4.56	–	3.54	5.68
Tritium (H-3)	USEPA 906.0	NE	79.8	33.3	72.5	79.8	82.5	74.6	105	183	117	207	108	207
Metals (µg per L)														
Aluminum	USEPA 6010B	50 to 200*	**871**	NA	NA	<86	**1180**	NA	<86	NA	<86	NA	<3151	23,000
Arsenic	USEPA 6010B	10	29.5	**67.7**	<2.7	<2.7	<2.7	<2.7	<2.7	3.8†	<2.7	4.7†	<8.5	67.7

Table 2.3.3-2 (Sheet 6 of 7)
Summary of Exelon Victoria County Onsite Groundwater Analytical Results

Parameter	Analytical Method	MCL or *SMCL	OW-8L 11.29.07	OW-8L 04.15.08	OW-10U 04.15.08	OW-10L 11.29.07	OW-10L Duplicate 11.29.07	OW-10L 04.15.08	Northwest Gate Well 11.29.07	Northwest Gate Well 04.15.08	Southeast Windmill Well 11.29.07	Southeast Windmill Well 04.15.08	Mean	Maximum
Barium	USEPA 6010B	200	**506**	**1280**	91.8†	**348**	**341**	**210**	<50	50.8†	<117	119†	280	1280
Cadmium	USEPA 6010B	5	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	1.8
Chromium	USEPA 6010B	100	<7.5	15.8	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	4.5	19.8
Cobalt	USEPA 6010B	NE	<9.6	–	–	<9.6	<9.6	–	<9.6	–	<9.6	–	<10.0	12.9
Copper	USEPA 6010B	1.0*	<9.3	–	–	<6.2	<7.2	–	<10.2	–	<20.2	–	<9.8	20.2
Iron (Dissolved)	USEPA 6010B	100*	<24	–	–	<24	<24	–	<24	–	<24	–	<24	24
Iron (Total)	USEPA 6010B	100*	**1260**	**19,200**	**480**	<24	<24	33.4†	**2260**	**2130**	<24	**372**	**<3534**	**20,500**
Lead	USEPA 6010B	15	<2.8	**15.3**	3.6	<2.8	<2.9	3.6	6.1	<2.8	4.9	4.8	<5.5	19
Magnesium	USEPA 6010B	NE	13,600	21100	13300	23,100	22,800	21100	27,900	21400	36,900	37700	20826	37,700
Manganese (Dissolved)	USEPA 6010B	50*	**793**	–	–	<7.8	<7.9	–	31.9	–	<14.2	–	128.4	793
Manganese (Total)	USEPA 6010B	50*	**823**	–	–	<8.8	<9.2	–	33.3	–	15.7	–	164.7	823
Mercury	USEPA 7470B	200	<0.094	<0.094	<0.094	<0.094	<0.094	<0.094	<0.094	<0.094	<0.094	<0.094	<0.094	<0.094
Molybdenum	USEPA 6010B	NE	<6.0	–	–	<1.2	<1.2	–	<8.4	–	<1.2	–	<2.6	8.4
Nickel	USEPA 6010B	NE	<3.3	–	–	<2.6	<2.6	–	<2.6	–	<2.6	–	<4.1	15
Potassium	USEPA 7470B	NE	8590	–	–	7380	7160	–	4550	–	5280	–	5893	8590
Selenium	USEPA 6010B	50	<2.3	–	–	<2.3	<2.6	–	<2.3	–	<2.8	–	<2.6	3.8
Silver	USEPA 6010B	100*	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1
Strontium	USEPA 6010B	NE	398	–	–	795	783	–	2140	–	1570	–	846	2140
Titanium	USEPA 6010B	NE	<5.0	–	–	<0.71	<1.7	–	<0.71	–	<0.71	–	<10.9	67
Vanadium	USEPA 6010B	NE	<5.2	–	–	<6.0	<6.2	–	<1.6	–	<9.4	–	<12	51.5
Zinc	USEPA 6010B	500*	<11.8	–	–	<17.1	21.6	–	**1310**	–	**814**	–	<250	1310
Oil and Grease	USEPA 1664	NE	<1.4	NA	NA	<1.4	<1.4	NA	<1.4	NA	<1.4	–	<1.4	<1.4

NE = Not established
SM = Standard Methods for Examination of Water and Waste Water, 19th Edition
NTU = Nepthelometric turbidity unit
μmhos = Micromhos per centimeter
CFU = Colony Forming Unit
TCR = Total Coliform Rule: No more than 5% of monthly samples may be positive for presence of coliforms
BOLD = Parameter concentration exceeds MCL or SMCL.
– = Parameter not analyzed
MCL = Maximum Contaminant Level (US EPA 2008a)
*SMCL = Secondary Maximum Contaminant Level (USEPA 2008a)

Table 2.3.3-2 (Sheet 7 of 7)
Summary of Exelon Victoria County Onsite Groundwater Analytical Results

*** = Radionuclide analyses usually required the subtraction of the instrument background counts from the sample counts. Even though both background and the sample values are positive, sometimes when the sample activity is low, variations in the two measurements can cause the sample value to be less than the background, resulting in a measured activity less than zero.
† = Parameter also detected in the laboratory method blank
> = Parameter detected at or below the method detection limit
IV = Insufficient volume of sample was provided by Accutest to their subcontract lab
OW-1U = Observation well screened in upper Chicot Aquifer
OW-1L = Observation well screened in lower Chicot Aquifer

**Table 2.3.3-3 (Sheet 1 of 3)
Summary of Exelon Victoria County Offsite TWDB Well #7932602
Groundwater Analytical Results (03/25/08)**

Parameter	Analytical Method	MCL or *SMCL	TWDB #7932602
General Chemistry			
Temperature (°C)	Field Measurement	NE	21.8
pH (standard units)	Field Measurement	6.5 - 8.5*	8.76
Salinity (percent)	Field Measurement	NE	0.1
Total Suspended Solids (mg per L)	SM 2540/EPA 160.2	NE	10
Total Dissolved Solids (mg per L)	SM 2540/EPA 160.1	500*	1120
Hardness, Total as $CaCO_3$ (mg per L)	EPA 130.0	NE	54
Turbidity (NTU)	EPA 180.1	0.3**	4.09
Color, Apparent (Cobalt Units)	EPA 110.2	15*	<5
Odor (Threshold Odor Number)	EPA 140.1	3*	<1
Specific Conductance (μmhos per cm)	EPA 120.1	NE	1820
Biochemical Oxygen Demand (mg per L)	SM 5210/EPA 405.1	NE	5.0†
Chemical Oxygen Demand (mg per L)	SM 5220/EPA 410	NE	12.5†
Total Organic Carbon (mg per L)	EPA 415.1	NE	49.5
Phosphorus, Total (mg per L)	SM 4500/EPA 365	NE	0.013†
Orthophosphate (mg per L)	SM 4500/EPA 365.2	NE	0.012†
Nitrogen, Ammonia (mg per L)	SM 4500/EPA 350.1	NE	<0.050
Nitrogen, Nitrite (mg per L)	SM 4500/EPA 353.2	100	<0.010
Nitrate-N (mg per L)	SM 4500	10	<0.11
Nitrogen, Total Kjeldahl (mg per L)	EPA 351.2	NE	0.20†
Carbon Dioxide (mg per L)	SM4500 CO2 D	NE	3.2†
Bicarbonate Alkalinity (mg per L)	SM 2320	NE	274
Alkalinity, Total as $CaCO_3$ (mg per L)	SM 2320/EPA 310	NE	274
Fluoride (mg per L)	EPA 340.2	4	0.34
Chloride (mg per L)	SM 5220/EPA 410	250*	1120
Chlorine Demand (mg per L)	HACH 10223	NE	0.68
Calcium (mg per L)	EPA 200.7	NE	11
Silica, Dissolved (mg per L)	EPA 370.1	NE	4.3
Silica, Total (mg per L)	EPA 6010B	NE	8.7
Silt Density Index	ASTM D4189	NE	0.26
Sulfide (mg per L)	EPA 376.1	NE	2
Sulfate (mg per L)	SM 4500/EPA 375.3	250*	4.1†
Sodium (mg per L)	EPA 6010B	NE	385
Cyanide, Total (mg per L)	EPA 335.4	0.2	<0.0050

Table 2.3.3-3 (Sheet 2 of 3)
Summary of Exelon Victoria County Offsite TWDB Well #7932602
Groundwater Analytical Results (03/25/08)

Parameter	Analytical Method	MCL or *SMCL	TWDB #7932602
Bacteria			
Sulfate Reducing Bacteria (units per L)	SM 9240C	NE	200
Iron Reducing Bacteria (units per mL)	SM 9240B	NE	9000
Bacteria Counts (Standard Units)	SM Sim Plate	NE	33
Total Coliform (CFUs per 100mL)	m-ColiBlue 24	TCR	***Positive
Fecal Coliform (CFUs per 100mL)	SM 9222D	NE	NA
Fecal Streptococci (CFUs per 100mL)	SM 9230C	NE	NA
Radionuclides (pCi per L)			
Potassium-40 (K-40)	EPA 901.1	NE	-9.1
Cesium-137 (Cs-137)	EPA 901.1	NE	1
Thallium-208 (Tl-208)	EPA 901.1	NE	-5.83
Bismuth-121 (Bi-212)	EPA 901.1	NE	-10.5
Lead-212 (Pb-212)	EPA 901.1	NE	2.79
Bismuth-214 (Bi-214)	EPA 901.1	NE	54.7
Lead-214 (Pb-214)	EPA 901.1	NE	74.6
Radium-226 (Ra-226)	EPA 903.1	5.0	0.341
Radium-228 (Ra-228)	EPA 901.1	5.0	**5.41**
Tritium (H-3)	EPA 906.0	NE	98.2
Metals (µg per L)			
Aluminum	EPA 6010B	50 to 200*	**838**
Antimony	EPA 6010B	6.0	<2.7
Arsenic	EPA 6010B	10	<2.7
Barium	EPA 6010B	200	**472**
Beryllium	EPA 6010B	4.0	<0.26
Boron	EPA 6010B	NE	408
Bromide	EPA 6010B	NE	3
Cadmium	EPA 6010B	5	<1.8
Chromium	EPA 6010B	100	<1.5
Cobalt	EPA 6010B	NE	<9.6
Copper	EPA 6010B	1.0*	<5.9
Iron (Dissolved)	EPA 6010B	100*	**345**
Iron (Total)	EPA 6010B	100*	**736**
Lead	EPA 6010B	15	<2.8
Magnesium	EPA 6010B	NE	6470
Manganese (Dissolved)	EPA 6010B	50*	<8.8
Manganese (Total)	EPA 6010B	50*	17.6
Mercury	EPA 7470B	200	<0.094
Molybdenum	EPA 6010B	NE	<1.2
Nickel	EPA 6010B	NE	<2.6

Table 2.3.3-3 (Sheet 3 of 3)
Summary of Exelon Victoria County Offsite TWDB Well #7932602
Groundwater Analytical Results (03/25/08)

Parameter	Analytical Method	MCL or *SMCL	TWDB #7932602
Metals (µg per L) (continued)			
Potassium	EPA 7470B	NE	2760†
Selenium	EPA 6010B	50	<2.3
Silver	EPA 6010B	100*	<1.1
Strontium	EPA 6010B	NE	1160
Thallium	EPA 6010B	0.5	3.8†
Vanadium	EPA 6010B	NE	1.7†
Zinc	EPA 6010B	500*	8.0†
Volatile Organic Compounds (VOCs) mg per L	EPA 8260B	Various	ND
Semi-Volatile Organic Compounds (SVOCs) mg per L	EPA 8270C	Various	ND
Pesticides & Herbicides (mg per L)	USEPA 8141/8151	Various	ND
PCBs (mg per L)	USEPA 8081	Various	ND
Oil and Grease (mg per L)	EPA 1664	NE	<1.4

TWDB = Texas Water Development Board

ND = Parameter Not Detected Above the Method Detection Limit

NE = not established

µg per L = micrograms per liter

mg per L = milligrams per liter

NTU = Nepthelometric turbidity unit

µmhos/cm = micromhos per centimeter

units per mL = units per milliliter

pCi per L = pico Curies per liter

PCBs = Polychlorinated biphenyls

CFU = Colony Forming Unit

TCR = Total Coliform Rule: No more than 5% of monthly samples may be positive for presence of coliforms

-9.1 = Radiochemical analyses usually require the subtraction of the instrument background counts from the sample counts. Even though both background and the sample values are positive, sometimes when the sample activity is low, variations in the two measurements can cause the sample value to be less than the background, resulting in a measured activity less than zero.

BOLD = Parameter concentration exceeds MCL or SMCL.

– = Parameter not analyzed

MCL = Maximum Contaminant Level

*SMCL = Secondary Maximum Contaminant Level (U.S. EPA 2008a)

** = Performance standard; no more than 5% of monthly samples may exceed 0.3 NTU

***Positive = Sample exceeded the 30-hour hold time due to lab error so colony counts were not possible

† - Parameter Also Detected in the Laboratory Method Blank

Table 2.3.3-4
TCEQ Water Quality Segment Designated Uses

Segment Number[(a)]	Segment Name[(a)]	Uses[(b)]		
		Recreation	Aquatic Life	Water Supply
1701	Victoria Barge Canal	Non-contract recreation	High aquatic life use	NA
1801	Guadalupe River Tidal (from GBRA Salt Water Barrier to Guadalupe Bay)	Contact recreation	Exception aquatic life use	NA
1802	Guadalupe River Below San Antonio River (below San Antonio and Guadalupe River confluence to GBRA Salt Water Barrier)	Contact recreation	High aquatic life use	Public water supply
1803	Guadalupe River Below San Marcos River (below San Marcos River to San Antonio River)	Contact recreation	High aquatic life use	Public water supply
1807	Coleto Creek	Contact recreation	High aquatic life use	Public water supply
1901	Lower San Antonio River (from Farm Road 791 near Falls City in Karnes County to the Confluence with the Guadalupe River)	Non-contact recreation	High aquatic life use	NA
2462	San Antonio/Haynes Bay/Guadalupe Bay	Contact recreation	Exception aquatic life use/Oyster Waters	NA

(a) TCEQ 2008a
(b) TCEQ 2000
NA = Not applicable

Table 2.3.3-5
Summary of USGS and TCEQ Surface Water Monitoring Stations

Agency/Station No.	Water Body	Latitude	Longitude
TCEQ 12622	Coleto Creek At Highway 77	28.711	–97.034
TCEQ 12536	Victoria Barge Canal	28.518	–96.804
TCEQ 12577	Guadalupe River Tidal Hwy 35	28.478	–96.862
TCEQ 12578	Guadalupe River at GBRA Salt Water Barrier	28.506	–96.885
TCEQ 16579	Guadalupe River at DuPont	28.658	–96.963
TCEQ 12581	Guadalupe River 0.5 mile N of Hwy 175 bridge S. of Victoria	28.752	–97.008
TCEQ 12590	Guadalupe River at Farm Market Road 447	28.790	–97.010
TCEQ 12789	Lower San Antonio River at Highway 77	28.531	–97.043
USGS 08176500	Guadalupe River at Victoria	28.793	–97.013
USGS 08188600	GBRA Calhoun Canal Uplift #1 Station	28.510	–96.752
USGS 08188800	Guadalupe River at GBRA Salt Water Barrier	28.505	–96.884

Table 2.3.3-6
Summary of Guadalupe River at GBRA Saltwater Barrier (TCEQ Station 12578) Surface Water Metals Data (1999–2006)

Parameter (µg per L)	Nov-99	Jul-01	Sep-02	Jun-03	Aug-04	Mar-05	Mar-06
Aluminum	3	5.69	<2	5.43	20.7	17.1	8.23
Arsenic	3.26	2.53	2.92	1.42	2.69	2.07	2.01
Barium	118	72.2	—	86.4	—	—	—
Cadmium	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	4	<1	2.61	1.61	<1.0	<1.0	3.8
Copper	1.3	<1	1.42	1	0.87	1.03	0.892
Iron	191	<50	—	—	—	—	—
Lead	<0.05	<1.0	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese	—	1.26	2.5	3.31	6.1	—	—
Mercury	<0.006	2.07	0.0148	0.0027	0.00179	0.00374	0.00161
Nickel	2.3	3.05	2.62	3.52	0.87	2.41	2.94
Selenium	0.67	<4.0	0.68	0.514	0.46	0.375	0.711
Silver	<0.05	<1.0	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	1.4	1.9	1.21	0.75	1.23	1	0.952

Source: GBRA Undated
– = Data not available
< = parameter was detected at or below the method detection limit
µg per L = microgram per liter

Table 2.3.3-7
Summary of Guadalupe River at GBRA Saltwater Barrier (TCEQ Station 12578) Surface Water General Chemistry Data (2004–2007)

Parameter	1/3/2004	4/14/2004	7/15/2004	10/18/2004	1/11/2006	4/5/2005	7/7/2005	10/4/2005	1/4/2006	4/5/2006	7/12/2006	10/12/2006	1/9/2007	3/6/2007	6/12/2007	2004–2007 Minimum	2004–2007 Average	2004–2007 Maximum
Flow (cfs)	1390	3080	—	—	2890	2920	1460	1140	1330	1070	1550	575	1960	1030	2890	575	1791	3080
E. coli (org per 100 mL)	130	1312	32	276	86	67	11	36	81	47	70	43	920	43	25	11	211	1312
Suspended Solids (mg per L)	40.7	382	111	142	67.1	74.6	85.9	31.7	38.7	30.3	97.3	36	176	42.7	62.7	30.3	94.6	382
Turbidity (NTU)	24.5	284	86.3	113	52.4	62	29.3	24	31.3	52.9	71.9	34.2	221	11.3	46.7	11.3	76.3	284
pH (standard)	8.14	8.26	7.79	7.85	7.77	7.82	8.04	8.07	8.13	8.17	7.65	7.99	7.95	8.19	7.72	7.65	7.97	8.26
Temperature (C)	14.1	18.1	29.4	24.6	18.2	21.4	31.4	29.3	17.5	24.8	29.4	25.8	13.6	16.8	28.3	13.6	22.8	31.4
Dissolved Oxygen (mg per L)	10.2	7.27	5.18	7.4	8.89	8.83	6.3	7.41	9.8	8.57	5.1	7.18	9.45	10.4	8.68	5.10	8.04	10.40
Conductivity (μmhos per cm)	823	450	628	618	811	739	749	711	821	815	605	798	670	828	586	450	710	828
Total Phosphorous (mg per L)	0.21	0.27	0.38	0.44	0.23	0.14	0.21	0.25	0.37	0.09	0.38	0.38	0.71	0.49	0.16	0.09	0.31	0.71
Nitrate-N (mg per L)	1.8	1.11	0.64	0.83	2.36	1.68	1.42	2.32	4.05	4.05	1.34	3.16	3.84	2.68	1.2	0.64	2.17	4.05
Chloride (mg per L)	66.5	40.7	43.4	49.1	53.9	49	61.3	54.3	65.5	73	43.8	76.8	32	69.6	40.7	32	54.6	76.8
Sulfate (mg per L)	56.6	30.9	52.3	44.6	65.7	50.4	56.6	47.5	56.2	61.5	36.6	55.6	43.2	59.6	41.4	30.9	50.6	65.7
Total Hardness (mg per L)	297	229	281	267	317	314	294	293	320	261	196	242	290	280	244	196	275	320
Ammonia-N (mg per L)	—	0.11	—	0.08	—	0.04	—	0.04	—	0.03	—	<0.02	—	—	0.04	<0.02	0.06	0.11
Chlorophyll a (mg per m^3)	<5	<5	11.9	1.9	6.5	38.3	17.4	7.6	4.2	4.3	6.5	7.1	2.1	6.5	5.5	<5	9.2	38.3
Pheophytin (mg per m^3)	<3	9.8	<3	<3	<3	<3	4.6	3.3	<1	2.3	<1	1.6	<1	1.4	<1	<1	3.8	9.8

Source: GBRA 2008
cfs = cubic feet per second
mL = milliliters
mg per L = milligrams per liter
mg per m^3 = milligrams per cubic meter
NTU = Nepthelometric turbidity unit
– = parameter not analyzed
< = parameter detected at or below the method detection limit.
μmhos per cm = micromhos per centimeter

Table 2.3.3-8
Summary of Guadalupe River Near Dupont Invista (TCEQ Station 16579) Surface Water General Chemistry Data (2003–2006)

Parameter	2/24/2003	5/13/2003	7/15/2003	10/18/2003	2/17/2004	5/19/2004	8/10/2004	11/5/2004	2/7/2005	3/18/2005	7/7/2005	10/4/2005	2/2/2006	3/3/2006	6/7/2006	10/12/2006	2003–2006 Minimum	2003–2006 Average	2003–2006 Maximum
E. coli (org per 100mL)	2908	30	4	46	548	168	36	765	448	173	10	28	72	140	44	41	4	341.3	2908
Suspended Solids (mg per L)	194	67.4	39.6	24.8	54	94.3	48.7	216	87	75.9	79.5	37	9.3	38	35.7	5.3	5.3	69.2	216
Turbidity (NTU)	60	31	22.5	21.5	47.6	94.6	39.7	178	70.1	52.6	47.1	51	8.9	25.7	30.8	5.9	5.9	49.2	178
pH (standard)	7.98	7.74	8.3	8.2	8.15	7.93	8.26	7.75	7.75	7.92	8.08	8.02	8.35	8.21	8.2	7.63	7.63	8.03	8.35
Temperature (C)	14.6	28.3	32.5	24.3	13.1	25.5	31.5	20.7	13.1	17.9	32.1	29.4	19.5	22.2	30.5	29.6	13.1	24.1	32.5
Dissolved Oxygen (mg per L)	9.86	7.38	6.81	6.96	10.5	5.85	6.83	7.5	10.8	9.82	7.32	8.06	10.2	10.6	8.22	7.63	5.85	8.40	10.8
Conductivity (µmhos per cm)	335	727	739	601	500	347	697	373	483	609	555	541	1265	758	660	1024	335	638	1265
Total Phosphorous (mg per L)	0.54	0.18	0.16	0.15	0.16	0.25	0.19	0.7	0.21	0.16	0.24	0.11	0.33	0.17	0.3	0.35	0.11	0.26	0.7
Nitrate-N (mg per L)	0.44	1.83	0.67	0.37	0.59	0.64	0.19	0.63	1.08	1.14	0.85	1.02	12.2	2	0.18	11.2	0.18	2.19	12.2
Chloride (mg per L)	21.6	55.4	72.6	35	35.5	23.1	40.9	22.7	30.9	34.6	36.3	30.1	97	47	55.5	87.9	21.6	45.4	97
Sulfate (mg per L)	22.3	44.2	38.9	30.6	30	17.7	34.3	20.9	33.2	31.7	33.2	29.6	67	40.4	40.4	58.5	17.7	35.8	67
Total Hardness (mg per L)	199	288	223	261	208	148	256	234	220	276	256	276	296	254	185	242	148	239	296
Ammonia-N (mg per L)	0.12	0.06	0.04	<0.02	0.06	0.04	0.06	0.02	0.08	0.15	0.08	0.17	0.08	0.05	0.09	0.03	<0.02	0.08	0.17
Chlorophyll a (mg per m^3)	<1	<1	9.9	3.7	<5.0	<5.0	39.3	<1	<1	5.9	10.7	7.2	11.6	10.3	58.1	5.3	<1	16.2	58.1
Pheophytin (mg per m^3)	11.8	7.39	10.2	1.9	<3	<3	<3	<3	5.4	<3	3.7	2.1	5.2	3.2	7.7	2	1.9	5.5	11.8

Source: GBRA 2008
cfs = cubic feet per second
mL = Milliliters
mg per L = Milligrams per liter
mg per m^3 = milligrams per cubic meter
µmhos per cm = micromhos per centimeter
NTU = Nepthelometric turbidity unit
< = parameter detected at or below the method detection limit

Table 2.3.3-9
Summary of Guadalupe River at Highway 77 (TCEQ Station 12590) Surface Water General Chemistry Data (2004–2007)

Parameter	1/13/2004	4/14/2004	7/5/2004	10/18/2004	1/11/2005	3/2/2005	6/7/2005	12/7/2005	4/5/2006	8/10/2006	11/1/2006	1/19/2007	4/3/2007	2004–2007 Minimum	2004–2007 Average	2004–2007 Maximum
Flow (cfs)	870	7630	6070	2390	3230	4970	2030	757	684	325	483	844	12000	325	3252	12000
E. coli (org per 100mL)	55	804	46	291	62	520	13	50	60	62	59	1540	2300	13	450	2300
Suspended Solids (mg per L)	14.6	375	197	88.2	37.5	114	51.7	15.3	31	11	1437	79.5	948	11	261	1437
Turbidity (NTU)	9.94	140	147	73	27.1	47.3	38.3	15.2	28.3	10.2	12.8	69.9	384	9.94	77.2	384
pH	7.9	8.1	7.84	7.5	7.49	7.65	8.11	8.09	8.13	8.03	8.17	7.94	7.61	7.49	7.89	8.17
Temperature (°C)	14.7	18.6	28.7	24.4	18.4	17.1	29.8	14.5	25.3	30	22.1	13.2	22.4	13.2	21.5	30
Dissolved Oxygen (mg per L)	11.6	9.16	6.78	7.95	9.91	10.47	8.03	11.1	9.81	7.81	7.57	9.68	7.13	6.78	9.00	11.6
Conductivity (umhos per cm)	647	411	641	440	661	657	536	594	585	521	569	548	302	302	547	661
Total Phosphorous (mg per L)	0.13	0.19	0.34	0.25	0.1	0.16	0.1	<0.05	<0.05	<0.05	<0.05	0.38	0.29	<0.05	0.22	0.38
Nitrate-N (mg per L)	1.04	0.68	0.55	0.34	1.39	1.2	1.24	1.54	1.08	0.18	0.76	1.28	0.57	0.18	0.91	1.54
Chloride (mg per L)	34.4	20.4	17.9	28.4	33.1	41	24.2	33	34.8	36.2	32.5	36.2	9.1	9.1	29.3	41
Sulfate (mg per L)	32.1	22	21.4	21.9	38	47.9	29.3	32.6	32.4	31.5	30.5	26.6	12.3	12.3	29.1	47.9
Total Hardness (mg per L)	268	345	296	193	297	304	260	271	205	204	232	170	232	170	252	345
Ammonia-N (mg per L)	0.02	0.12	0.02	0.05	0.02	0.09	0.27	0.02	0.02	0.04	0.03	0.07	0.06	0.02	0.06	0.27
Chlorophyll a (mg per m^3)	<5	<5	<5	<1	3.3	2.3	7.8	3.1	2.5	4.9	2.6	1.1	<1	<1	3.5	7.8
Pheophytin (mg per m^3)	<3	9.2	<3	<3	<3	<3	<3	<1	1.9	<1	<1	<1	<1	<1	5.6	9.2

Source: GBRA 2008
cfs = cubic feet per second
mL = milliliters
mg per L = milligrams per liter
mg per m^3 = milligrams per cubic meter
NTU = Nepthelometric turbidity unit
µmhos per cm = micromhos per centimeter

Table 2.3.3-10 (Sheet 1 of 2)
Summary of Guadalupe River Tidal (TCEQ Station 12577) Surface Water Quality Data (2002–2007)

Parameter	1/17/2002	4/1/2002	6/25/2002	12/19/2002	4/7/2003	9/11/2003	12/10/2003	3/4/2004	5/26/2004	9/14/2004	12/21/2004	4/21/2005	6/16/2005	9/7/2005	12/1/2005	4/19/2006	7/11/2006	10/11/2006	1/25/2007	2002–2006 Minimum	2002–2006 Average	2002–2006 Maximum
Sample Depth Interval: 0.3 Feet																						
Temperature (°C)	14.8	22.2	29.7	17.8	22.4	28.9	15	19.4	27.3	28.3	14.7	23	30.8	29.6	16.8	27.5	30	26.9	8.9	8.9	22.8	30.8
Specific Conductance (µmhos per cm)	8062	787	770	579	800	748	773	632	613	659	636	786	648	671	714	795	460	800	445	445	1072	8062
Dissolved Oxygen (mg per L)	9.5	7.84	6.73	7.51	7.2	6.4	9.8	8.2	5.7	6.2	9.4	7.81	6.49	6.62	6.74	7.6	5.1	6.7	12.3	5.1	7.57	12.3
pH (Standard Units)	8.14	8.23	–	7.68	7.8	8.1	8.3	8.1	7.9	8.2	7.8	7.75	7.85	8	7.96	8.2	7.6	8.1	8.3	7.6	8.00	8.3
Salinity (parts per 1000)	0.42	0.41	0.4	0.3	–	1	1	0.32	1	1	1	0.41	0.33	0.35	0.37	1	2	2	–	0.3	0.78	2
Alkalinity, Total (As CaCO3)(mg per L)	231	232	215	180	246	220	236	204	181	230	248	271	209	220	230	222	156	194	154	154	214	271
Residue, Total Nonfiltrable (mg per L)	44	74	77	135	72	183	44	84	131	102	91	96	39	76	20	61	4	44	160	4	80.9	183
Nitrite/Nitrate (mg per L)	2.25	2.3	1.88	–	–	–	–	–	–	–	–	2.17	1.5	2.62	4.09	2.29	0.06	2.75	2	0.06	2.17	4.09
Nitrite Nitrogen, Total (mg per L)	–	–	–	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	–	–	–	–	–	–	–	–	0.05	0.05	0.05
Nitrate Nitrogen, Total (mg per L)	–	–	–	2	2.03	4.72	3.1	1.84	1.59	2.06	1.84	–	–	–	–	–	–	–	–	1.59	2.40	4.72
Nitrogen as Ammonia (mg per L)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.05	0.05	0.05	0.05	0.09	0.05	0.06	0.05	0.05	0.05	0.09	0.05	0.06	0.09
Nitrogen, KJELDAHL (mg per L)	0.44	0.59	0.59	0.92	0.59	1.15	0.73	0.62	0.82	0.5	0.38	0.51	0.81	0.62	0.4	0.68	0.5	0.58	0.91	0.38	0.65	1.15
Phosphorus, Total (mg per L)	0.2	0.16	0.26	0.29	0.16	0.44	0.2	0.19	0.3	0.23	0.19	0.22	0.23	0.32	0.42	0.32	0.06	0.46	0.42	0.06	0.27	0.46
Orthophosphate phosphorus, diss.(mg per L)	0.17	0.14	0.22	0.13	0.06	0.31	0.2	0.14	0.14	0.14	0.12	0.17	0.15	0.27	0.37	0.26	0.04	0.36	0.22	0.04	0.19	0.37
Total Organic Carbon	3	3	2	5	2	4	3	4	4	2	2	2	2	2	2	2	5	4	5	2	3.1	5
Sodium, Total (mg per L)	–	–	–	14	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	14	14	14
Chloride (mg per L)	51	63	70	53	67	143	74	62	50	49	47	64	56	63	64	135	125	84	29	29	71	143
Sulfate (mg per L)	48	51	54	55	63	67	59	48	43	44	54	60	48	54	56	93	26	59	29	26	53	93
Fluoride, Total (mg per L)	0.27	0.28	0.33	0.36	0.35	0.38	0.41	0.32	0.28	0.29	0.27	0.24	0.27	0.32	0.33	1.32	0.27	0.36	0.25	0.24	0.36	1.32
Residue, Total Filtrable (mg per L)	420	470	460	372	500	438	508	388	374	408	460	488	408	430	466	472	484	462	472	372	446	508
Chlorophyll-A (µg per L)	10	10	–	10	10	10	11.3	10	10	10	10	12.8	30.7	19.2	10	27.1	3	12.3	3	3	12.2	30.7
Pheophytyn-A (µg per L)	15.2	22.3	–	5	42.8	5	5	5	5.79	5.98	5	5	17.9	8.44	–	–	–	–	–	5	11.42	42.8

Table 2.3.3-10 (Sheet 2 of 2)
Summary of Guadalupe River Tidal (TCEQ Station 12577) Surface Water Quality Data (2002–2007)

Parameter	1/17/2002	4/1/2002	6/25/2002	12/19/2002	4/7/2003	9/11/2003	12/10/2003	3/4/2004	5/26/2004	9/14/2004	12/21/2004	4/21/2005	6/16/2005	9/7/2005	12/1/2005	4/19/2006	7/11/2006	10/11/2006	1/25/2007	2002–2006 Minimum	2002–2006 Average	2002–2006 Maximum
Fecal Coliform (# per 100 mL)	56	32	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	32	44.0	56
E. Coli, Colilert (mpn per 1000 mL)	–	–	–	–	–	–	–	–	–	–	–	–	–	25.6	–	5	3	61	722	3	163	722
Enterococci, Enterolert (mpn per 1000 mL)	41	41	10	52	41	–	–	31	10	51	10	10	10	–	6.1	–	–	–	–	6.1	26.1	52

Source: GBRA 2008
– = parameter not analyzed
per 100 mL = number of colony-forming units per 100 milliliters
MPN per 1000 mL = most probable number per 1000 milliliters

Table 2.3.3-11 (Sheet 1 of 2)
Summary of Guadalupe River at GBRA Saltwater Barrier (USGS Station 08188800) Water Quality Data (1980–1999)

Parameter	1/15/1980	8/5/1980	1/22/1985	8/20/1985	3/5/1990	7/24/1990	1/24/1995	8/23/1995	1/26/1999	8/24/1999	1980–1999 Minimum	1980–1999 Average	1980–1999 Maximum
Sample Depth Interval: 0.98 feet													
Temperature (°C)	15	30	7	28.6	18	28	13.5	30	19.5	—	7	21.1	30
Turbidity, Hach (Formazin Turb Unit)	26	36	140	—	—	—	—	—	—	—	26	67	140
Specific Conductance (µmhos per cm)	849	880	428	696	795	425	676	767	801	790	425	710	880
Oxygen, Dissolved (mg per L)	9.6	5.9	11.1	8.1	9.1	4.8	9.2	6.6	—	5.7	4.8	7.8	11.1
BOD, 5 day (mg per L)	1.8	1.4	3.1	1.9	2.2	2.4	1.5	3.7	—	—	1.4	2.3	3.7
Bicarbonate, Diss. Field as HCO_3, (mg per L)	290	270	—	—	—	—	—	—	—	—	270	280	290
Nitrogen (mg per L)	2.1	1.6	3.3	2.1	4.1	1.7	—	—	—	—	1.6	2.5	4.1
Ammonia (mg per L)	0.05	0.02	0.15	0.07	0.13	0.17	—	—	—	—	0.02	0.10	0.17
Nitrite (mg per L)	0.04	0.04	0.07	0.01	0.09	0.24	—	—	—	—	0.01	0.08	0.24
Nitrate (mg per L)	0.87	0.71	1.33	1.09	3.41	0.46	—	—	—	—	0.46	1.31	3.41
Nitrite & Nitrate (mg per L)	0.91	0.75	1.4	1.1	3.5	0.7				—	0.7	1.39	3.5
Phosphate, Ortho (mg per L)	—	—	—	—	—	—	0.675	0.613	—	—	0.613	0.644	0.675
Phosphorus (mg per L)	0.68	0.57	0.63	0.36	1.4	0.53	—	—	—	—	0.36	0.70	1.4
Hardness, Total as $CaCO_3$ (mg per L)	300	270	150	240	250	140	260	240	280	260	140	239	300
Calcium (mg per L)	89	77	45	69	72	44	76	68	83.3	75.6	44	69.9	89
Sodium (mg per L)	64	70	26	48	63	27	42	58	49.6	62.2	26	51.0	70
Potassium (mg per L)	3.7	4.7	3.5	3.9	5.1	7.7	3.8	4.2	2.99	4.32	2.99	4.39	7.7
Chloride (mg per L)	99	110	34	72	81	37	66	81	68.8	82	34	73.1	110
Sulfate (mg per L)	70	69	37	47	53	36	46	56	61.8	53.8	36	53.0	70
Silica (mg per L)	14	17	10	12	12	13	12	15	11.4	19	10	13.5	19
Arsenic (µg per L)	2	5	1	3	—	3	1	—	—	—	1	2.5	5
Barium (µg per L)	100	100	57	98	—	130	80	—	—	—	57	94	130
Copper (µg per L)	0	—	—	3	—	< 10	< 10	—	—	—	0	1.5	3

Table 2.3.3-11 (Sheet 2 of 2)
Summary of Guadalupe River at GBRA Saltwater Barrier (USGS Station 08188800) Water Quality Data (1980–1999)

Parameter	1/15/1980	8/5/1980	1/22/1985	8/20/1985	3/5/1990	7/24/1990	1/24/1995	8/23/1995	1/26/1999	8/24/1999	1980–1999 Minimum	1980–1999 Average	1980–1999 Maximum
Lead (µg per L)	—	—	< 1	< 1	—	< 10	< 100	—	—	—	<1	0	0
Manganese (µg per L)	—	—	—	9	—	9	2	—	—	—	2	6.7	9
Strontium (µg per L)	—	—	—	—	—	280	580		—	—	280	430	580

Source: USGS 2008
– = Parameter not analyzed
µg per L = micrograms per liter
< = parameter was detected at or below method detection limits

Table 2.3.3-12 (Sheet 1 of 2)
Summary of Guadalupe River at Victoria (USGS Station 08176500) Water Quality Data (1980–1999)

Parameter	1/17/1980	7/9/1980	1/23/1985	7/10/1985	3/6/1990	5/24/1990	3/25/1994	8/25/1994	12/13/1999	1980–1999 Minimum	1980–1999 Average	1980–1999 Maximum
Sample Depth Interval: 0.98 feet												
Temperature (°C)	16.5	31.5	7	28	18.5	28.5	22.5	29	18	7	22.2	31.5
Turbidity, Hach (Formazin Turb Unit)	4.9	17	74	95	23	56	14	6.2	—	4.9	36.3	95
Specific Conductance (µmhos per cm)	649	544	434	415	601	416	579	590	629	415	539	649
Oxygen, Dissolved (mg per L)	9.9	7.4	8.6	6.8	8.6	7.1	8.6	6.8	—	6.8	8.0	9.9
BOD, 5 day (mg per L)	1.3	2.8	1.1	1	0.8	0.8	0.6	2	—	0.6	1.3	2.8
Bicarbonate, Diss. Field as HCO_3, (mg per L)	280	240	—	—	—	—	—	—	—	240	260	280
Nitrogen (mg per L)	1.7	1.3	1.7	1.5	0.9	1.3		1	—	0.9	1.3	1.7
Ammonia (mg per L)	0.02	0.06	—	—	0.04	0.07	—	—	—	0.02	0.05	0.07
Nitrite (mg per L)	—	—	—	—	0.03	0.03	<0.010	<0.010	—	<0.010	0.03	0.03
Nitrate (mg per L)	—	—	—	—	0.67	0.97	—	—	—	0.67	0.82	0.97
Nitrite and Nitrate (mg per L)	0.91	0.67	0.76	0.55	0.7	1	1.1	0.7	—	0.55	0.80	1.1
Phosphate, Ortho (mg per L)		3.6	0.245	0.184	0.276	0.368	0.184	0.123	—	0.123	0.71	3.6
Phosphorus (mg per L)	0.09	0.06	0.18	0.23	0.12	0.21	0.09	0.05	—	0.05	0.13	0.23
Hardness, Total as $CaCO_3$ (mg per L)	250	220	200	170	230	180	240	200	—	170	211	250
Calcium (mg per L)	75	61	55	53	64	52	68	57	—	52	60	75
Sodium (mg per L)	30	26	19	14	37	15	32	34	—	14	25	37
Potassium (mg per L)	2.1	2.3	2.9	4.1	3.1	3.6	2.6	2.9	—	2.1	3.0	4.1
Chloride (mg per L)	47	37	25	17	38	18	42	44	—	17	33	47
Sulfate (mg per L)	34	28	28	23	28	20	34	31	—	20	28	34
Silica (mg per L)	10	15	11	14	8.7	11	10	14	—	8.7	11.7	15
Arsenic (µg per L)	—	—	1	3	2	2	—	—	—	1	2.0	3
Barium (µg per L)	—	—	59	68	64	120	66	75	—	59	75.3	120

Table 2.3.3-12 (Sheet 2 of 2)
Summary of Guadalupe River at Victoria (USGS Station 08176500) Water Quality Data (1980–1999)

Parameter	1/17/1980	7/9/1980	1/23/1985	7/10/1985	3/6/1990	5/24/1990	3/25/1994	8/25/1994	12/13/1999	1980–1999 Minimum	1980–1999 Average	1980–1999 Maximum
Copper (µg per L)	—	—	1	1	< 10	1	—	—	—	1	1	1
Manganese (µg per L)	—	—	< 1	2	2	1	4	5	—	<1	2.8	5
Strontium (µg per L)	—	—	420	350	530	350	520	470	—	350	440.0	530

Source: USGS 2008
– = Parameter not analyzed
< = parameter was detected at or below the method detection limit
µg per L = micrograms per liter

Table 2.3.3-13
Summary of Guadalupe River at Highway 59 (TCEQ Station 12581) Water Quality Data (1990–1994)

Parameter	4/16/1990	6/7/1990	10/11/1990	1/29/1991	4/17/1991	7/22/1991	11/13/1991	2/3/1992	4/28/1992	7/1/1992	10/5/1992	5/7/1993	11/9/1993	4/13/1994	1990–1994 Minimum	1990–1994 Average	1990–1994 Maximum
Sampling Depth Interval: 0.98 Feet																	
Temperature (°C)	24.4	30.1	19.6	13.3	22.7	29.8	17.1	15.3	23.1	29	23.7	22.9	15.7	22.1	13.3	22.1	30.1
Specific Conductance (µmhos per cm)	598	524	541	424	306	551	637	440	702	633	646	333	544	632	306	536	702
Oxygen, Dissolved (mg per L)	7.7	6.8	8.5	9.6	5.7	6.2	9.5	9.3	7.3	6.6	8.2	6.4	10.4	8.7	5.7	7.9	10.4
pH (Standard Units)	8.7	8.2	8.1	7.9	7.6	8.2	8.4	—	7.8	7.9	8.1	7.9	8.1	8.4	7.6	8.1	8.7
Alkalinity, Total ($CaCO_3$) (mg per L)	216	198	194	152	169	226	214	205	260	234	202	124	216	225	124	202	260
Residue, Total nonfiltrable (mg per L)	64	61	18	76	462	68	23	304	192	35	30	292	38	46	18	122	462
Nitrogen as Ammonia, Total (mg per L)	0.32	0.33	0.08	0.24	0.18	0.21	0.39	0.1	0.16	0.17	0.15	0.02	0.03	0.03	0.02	0.17	0.39
Nitrite Nitrogen, Total (mg per L)	0.06	—	—	0.08	0.26	—	0.05	0.06	0.07	< 0.01	0.05	0.05	0.03	< 0.01	<0.01	0.08	0.26
Nitrate Nitrogen, Total (mg per L)	1.02	0.44	—	1.36	0.73	0.54	0.78	0.53	1.45	1.09	1.09	0.58	0.1	1.43	0.1	0.86	1.45
Phosphorus, Total (mg per L)	0.56	0.26	0.25	0.29	0.72	0.3	0.25	0.38	0.16	0.2	0.32	0.28	0.13	0.26	0.13	0.31	0.72
Phosphorus, Diss. Orthopohosphate (mg per L)	0.49	0.17	0.21	0.29	0.44	0.26	0.24	0.23	0.12	0.12	0.28	0.18	0.11	0.22	0.11	0.24	0.49
Carbon, Total Organic (mg per L)	5	6	4	8	13	6	4	10	5	6	2	10	2	—	2	6.2	13
Chloride, Total (mg per L)	34	32	30	19	9	34	35	23	40	37	38	24	33	45	9	31	45
Sulfate, Total (mg per L)	26	27	20	< 1	< 1	17	31	28	32	32	32	27	32	34	<1	28	34
Fecal Coliform, membrane filter (# per 100 mLl)	17	< 17	—	< 17	—	—	< 16	—	373	140	40	—	20	53	<17	107	373
Chlorophyll-A (µg per L)	1.7	4	1.6	1.2	5.1	< 1	1	< 1	7.8	3.6	2.8	8.62	3.78	3.2	<1	3.70	8.62
Pheophytin-A (µg per L)	2.3	2	0	<1	2	8.5	5.3	0	< 1	3.9	< 1	0	0	< 1	0	2.4	8.5

Source: USEPA, 2008b
— = Parameter not analyzed
µg per L = micrograms per liter
mg per L = milligrams per liter
< = parameter detected at or below the method detection limit
per 100 mL = number of colony-forming units per 100 milliliters
µmhos per cm = micromhos per centimeter

Table 2.3.3-14
Summary of Lower San Antonio River at Highway 77 (TCEQ Station 12789) Water Quality Data (2003–2007)

Parameter	8/18/2003	12/17/2003	8/25/2004	12/8/2004	8/10/2005	12/21/2005	8/16/2006	12/20/2006	8/15/2007	2003–2007 Minimum	2003–2007 Average	2003–2007 Maximum
Flow rate, instantaneous (cfs)	512	505	511	2728	362	407	164	253	3260	164	966	3260
Temperature (°C)	30	13.3	29.8	18	30.6	12	30.4	20.7	29	12	23.8	30.6
pH (Standard Units)	8	8.1	8	8.1	8.2	8.2	8.3	8.1	8	8	8.1	8.3
Specific Conductance (µmhos per cm)	1206	1137	1080	777	1090	1100	1510	1220	805	777	1102	1510
Oxygen, Dissolved (mg per L)	6.8	10.5	7.2	8.9	8.6	11	7	8.6	6.7	6.7	8.4	11
Nitrogen, Total (Kjeldahl) (mg per L)	—	—	0.548	0.865	0.944	0.54	1.1	0.688	0.713	0.54	0.77	1.1
Ammonia (mg per L)	—	—	< 0.02	0.031	< 0.02	< 0.02	< 0.02	0.033	< 0.02	<0.02	0.032	0.033
Nitrite Nitrogen (mg per L)	—	—	< 0.02	< 0.02	0.021	< 0.02	0.042	< 0.02	< 0.02	<0.02	0.032	0.042
Nitrate Nitrogen (mg per L)	—	—	—	2.27	4.58	7.63	4.48	12.1	2.33	2.27	5.57	12.1
Carbon, Total Organic (mg per L)	—	—	2.18	3.18	3.51	2.9	3.37	2.88	2.79	2.18	2.97	3.51
Phosphorus (mg per L)	—	—	0.368	0.435	0.546	0.965	0.827	1.06	0.337	0.337	0.65	1.06
Chloride (mg per L)	—	—	108	62.1	126	130	206	164	54.4	54.4	121	206
Sulfate (mg per L)	—	—	107	69.2	105	106	171	115	66.3	66.3	105	171

Data downloaded from SARA, 2008
— = parameter not analyzed
cfs = cubic feet per second
mg per L = milligrams per liter
µmhos per cm = micromhos per centimeter
< = parameter detected at or below the method detection limit

Table 2.3.3-15 (Sheet 1 of 2)
Summary of GBRA Calhoun Canal Uplift Station #1 (USGS Station 08188600)
Water Quality Data (1995–2005)

Parameter (µg per L)	5/18/1995[a]	12/12/1996[b]	9/10/1997[b]	8/25/1998[b]	7/18/2000[b]	6/7/2005[b]
Trifluralin	–	< 0.05	< 0.05	< 0.05	< 0.05	<0.05
Propachlor	–	< 0.05	< 0.05	< 0.05	< 0.05	<0.05
Hexazinone	–	< 0.05	< 0.05	< 0.05	< 0.05	<0.05
Butachlor	–	< 0.05	< 0.05	< 0.05	< 0.05	<0.05
Carboxin	–	< 0.05	< 0.05	< 0.05	< 0.05	<0.05
Butylate	–	< 0.05	< 0.05	< 0.05	< 0.05	<0.05
Bromacil	–	< 0.05	< 0.05	0.14	< 0.02	0.12
Simatryn	–	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Cycloate	–	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Terbacil	–	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Diphenamid	–	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Vernolate	–	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Simazine	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.02
Prometryn	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Prometon	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
CEAT	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
CIAT	< 0.05	< 0.05	< 0.05	< 0.05	< 0.04	< 0.02
Cyanazine	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Ametryn	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Propazine	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Chlorpyrifos	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	–
Disulfoton	< 0.01	–	< 0.01	< 0.01	< 0.03	–
Phorate	< 0.01	< 0.10	< 0.1	< 0.1	<0.02	–
p,p'-Ethyl-DDD	< 0.1	< 0.1	< 0.1	< 0.1	–	–
Tribuphos	< 0.01	< 0.03	< 0.01	< 0.01	< 0.02	–
PCNs	< 0.1	< 0.1	< 0.1	< 0.1	–	–
Aldrin	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Lindane	< 0.010	< 0.010	< 0.010	< 0.010	< 0.012	< 0.014
Chlordane technical	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
p,p'-DDD	< 0.010	< 0.010	< 0.010	< 0.010	< 0.014	< 0.016
p,p'-DDE	< 0.010	< 0.010	< 0.010	< 0.010	< 0.016	< 0.014
p,p'-DDT	< 0.010	< 0.010	< 0.010	< 0.010	< 0.017	< 0.010
Dieldrin,	< 0.010	< 0.010	< 0.010	< 0.010	< 0.009	< 0.008
Alpha Endosulfan	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Endrin,	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ethion	< 0.01	< 0.03	< 0.01	< 0.01	< 0.01	–

Table 2.3.3-15 (Sheet 2 of 2)
Summary of GBRA Calhoun Canal Uplift Station #1 (USGS Station 08188600)
Water Quality Data (1995–2005)

Parameter (µg per L)	5/18/1995[a]	12/12/1996[b]	9/10/1997[b]	8/25/1998[b]	7/18/2000[b]	6/7/2005[b]
Toxaphene	< 1	< 1	< 1	< 1	< 1	< 1
Heptachlor	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Metolachlor	< 0.05	< 0.05	< 0.05	< 0.02	< 0.05	< 0.05
Helptachlorepoxide	< 0.006	< 0.007	< 0.008	< 0.009	< 0.009	<0.009

(a) USGS 2008
(b) URS Oct 2004
– = parameter not analyzed
µg per L = micrograms per liter
< = parameter detected at or below the method detection limit

Table 2.3.3-16
Summary of Victoria Barge Canal (TCEQ Station 12536) Water Quality Data (2004–2007)

Parameter	3/16/2004	5/26/2004	9/14/2004	12/21/2004	4/21/2005	6/16/2005	9/20/2005	12/1/2005	4/19/2006	7/11/2006	10/11/2006	1/25/2007	2004–2007 Minimum	2004–2007 Average	2004–2007 Maximum
Sampling Depth Interval: 0.3 Feet															
Temperature (°C)	26.867	27.9	28.8	15.9	24.4	31.9	31.4	19.02	27.5	31.4	28.6	9.9	9.9	25.3	31.86
Specific Conductance (µmhos per cm)	10,700	1050	2270	1810	1651	1896	6185	12,039	10,300	6220	5300	16,700	1050	6343	16700
Dissolved Oxygen (mg per L)	7.8	5.9	5.7	9.4	8.68	7.41	7.99	7.74	8.9	7.6	6.7	11.9	5.7	8.0	11.9
pH (Standard Units)	8.1	7.7	8.1	7.9	7.7	7.82	7.94	7.69	8.2	8	8	8.3	7.69	8.0	8.3
Salinity (parts per 1000)	6	1	2	1	0.88	1.01	3.42	6.89	5.8	3.4	2.9	9.8	0.88	3.7	9.8
Alkalinity, Total (As $CaCO_3$)(mg per L)	188	110	166	209	187	155	172	120	196	120	132	120	110	156	209
Residue, Total Nonfiltrable (mg per L)	16	55	38	28	25	4	52	55	56	33	19	59	4	36.7	59
Nitrite/Nitrate (mg per L)	—	—	—	—	0.33	0.04	0.11	0.37	1.4	0.1	0.16	1.02	0.04	0.44	1.4
Nitrite Nitrogen, Total (mg per L)	0.25	0.05	0.05	0.05	—	—	—	—	—	—	—	—	0.05	0.10	0.25
Nitrate Nitrogen, Total (mg per L)	1.04	0.19	0.22	0.2	—	—	—	—	—	—	—	—	0.19	0.41	1.04
Nitrogen as Ammonia (mg per L)	0.18	0.1	0.06	0.06	0.08	0.05	0.05	0.13	0.05	0.05	0.05	0.1	0.05	0.08	0.18
Nitrogen, KJELDAHL (mg per L)	0.78	1.01	0.81	0.58	0.9	0.82	1.14	1.04	1.37	1.06	0.67	0.85	0.58	0.92	1.37
Phosphorus, Total (mg per L)	0.06	0.2	0.14	0.19	0.19	0.16	0.09	0.16	0.22	0.16	0.17	0.25	0.06	0.17	0.25
Orthophosphate, diss. (mg per L)	0.3	0.18	0.06	0.08	0.18	0.11	0.05	0.12	0.16	0.08	0.12	0.11	0.05	0.13	0.3
Total Organic Carbon (mg per L)	2	8	6	5	7	5	4	3	3	7	6	3	2	4.9	8
Chloride (mg per L)	3270	234	526	435	373	454	1900	3860	3330	974	1450	5060	234	1822	5060
Sulfate (mg per L)	491	35	104	82	76	99	313	540	488	311	228	709	35	289	709
Fluoride, Total (mg per L)	0.41	0.23	0.3	0.26	0.17	0.28	0.4	0.43	0.49	0.5	0.25	0.5	0.17	0.35	0.5
Residue, Total Filtrable (mg per L)	6240	648	1200	1160	940	1120		7580	6300	3550	2910	9310	648	3723	9310
Chlorophyll-a (µg per L)	10	10	20	10	21.9	16	22.4	12.2	59.7	24.9	8.52	8.61	8.52	18.7	59.7
Pheophytyn-a (µg per L)	5	5	5	5	5	7.65	5	5	—	—	—	—	5	5.3	7.65
Enterococci, Enterolert (MPN per 100mL)	10	10	10	20	10	10	10	14.5	4	48	1	1250	1	116	1250

Source: GBRA, 2007a
— = Parameter not analyzed
µmhos per cm = micromhos per centimeter
mg per L = milligrams per liter
µg per L = micrograms per liter
MPN per 100 mL = most probable number per 100 milliliters

Table 2.3.3-17 (Sheet 1 of 2)
Summary of Coleto Creek at Highway 77 (TCEQ Station 12622) Water Quality Data (1994–1997)

Parameter	4/13/1994	10/25/1994	1/23/1995	4/18/1995	7/6/1995	10/24/1995	1/17/1996	4/15/1996	7/24/1996	10/29/1996	1/22/1997	4/22/1997	7/17/1997	12/16/1997	1990–1994 Minimum	1990–1994 Average	1990–1994 Maximum
Sampling Depth: 0.98 Feet																	
Temperature (°C)	25.3	24.6	15.91	23.7	30.66	24.65	19.23	24.31	33.58	—	15.97	25.71	33.68	15.74	15.74	24.1	33.68
Specific Conductance (μmhos per cm)	1002	878	678	929	881	1163	1053	1203	921	—	309	597	783	945	309	872	1203
Oxygen, Dissolved (mg per L)	10.2	4.8	8.29	7.12	6.89	8.95	8.64	9.39	9.09	—	6.65	8.8	7.8	9.75	4.8	8.18	10.2
pH (Standard Units)	8.1	7.3	7.79	7.93	8.23	8.24	8.02	8.28	8.83	—	8.92	7.9	8.38	8.37	7.3	8.18	8.92
Alkalinity, Total ($CaCO_3$) (mg per L)	247	146	180	222	174	210	243	—	130	153	76	154	186	—	76	177	247
Salinity (parts per 1000)	—	< 2	0.3	0.5	0.5	—	—	—	—	—	< 1	< 1	< 1	< 1	0.3	0.4	0.5
Residue, Total nonfiltrable (mg per L)	10	15	13	37	8	8	8	—	24	—	100	15	5	—	5	22.1	100
Nitrogen as Ammonia, Total (mg per L)	< 0.01	0.04	< 0.01	0.01	0.05	< 0.01	< 0.01	—	0.02	0.03	0.01	0.07	< 0.05	—	<0.01	0.03	0.07
Nitrite Nitrogen, Total (mg per L)	< 0.01	0.04	—	—	—	—	—	—	—	—	—	—	—	—	<0.01	0.04	0.04
Nitrate Nitrogen, Total (mg per L)	0.08	0.15	—	—	—	—	—	—	—	—	—	—	—	—	0.08	0.12	0.15
Nitrogen, KJELDAHL, Total (mg per L)	0.4	0.62	0.44	0.41	0.51	0.26	0.25	—	0.69	0.62	1.74	0.89	0.65	—	0.25	0.62	1.74
Nitrite & Nitrate, Total (mg per L)	—	—	0.03	0.03	< 0.01	0.01	< 0.1	—	< 0.1	< 0.1	0.44	< 0.1	< 0.1	—	<0.01	0.13	0.44
Phosphorus, Total (mg per L)	< 0.01	0.08	0.04	0.04	0.05	0.04	0.02	—	0.07	0.05	0.21	0.07	0.02	—	<0.01	0.06	0.21
Phosphorus, Diss. (mg per L)	< 0.01	0.06	0.01	0.02	0.02	0.04	—	—	—	—	0.21	—	—	—	<0.01	0.06	0.21
Phosphorus, Total (mg per L)	—	—	—	—	—	—	<0.1	—	< 0.1	< 0.2	—	< 0.06	< 0.06	—	<0.06	0	0
Carbon, Total Organic, (mg per L)	2	6	5	3	4	5	3	—	5	7	12	6	5	—	2	5.3	12
Chloride, Total (mg per L)	152	57	82	102	122	57	138	—	139	174	40	75	113	—	40	104	174
Sulfate, Total (mg per L)	27	13	18	23	28	33	30.1	—	35	32	< 1	12	17	—	< 1	24.4	35
Fecal Coliform (# per 100 mL)	673	107	33	7	20	< 7	20	73	73	—	1560	84	12.2	65	< 7	227	1560

Table 2.3.3-17 (Sheet 2 of 2)
Summary of Coleto Creek at Highway 77 (TCEQ Station 12622) Water Quality Data (1994–1997)

Parameter	4/13/1994	10/25/1994	1/23/1995	4/18/1995	7/6/1995	10/24/1995	1/17/1996	4/15/1996	7/24/1996	10/29/1996	1/22/1997	4/22/1997	7/17/1997	12/16/1997	1990–1994 Minimum	1990–1994 Average	1990–1994 Maximum
Chlorophyll-A (µg per L)	12.1	< 1	< 1	2.4	2.04	< 1	< 1	—	7.61	< 1	< 1	11.8	7.82	—	< 1	7.3	12.1
Pheophytin-A (µg per L)	0	13.6	6.09	< 1	2.04	10.2	< 1	—	< 1	0	< 1	12.2	< 1	—	0	6.3	13.6

Source: USEPA 2008b
— = parameter not analyzed
µg per L = micrograms per liter
mg per L = milligrams per liter
< = parameter detected at or below the method detection limit
per 100 ML = number of colony-forming units per 100 milliliters
µmhos per cm = micromhos per centimeter

Table 2.3.3-18 (Sheet 1 of 5)
VCS Site Surface Water Analytical Results

Parameter	Analytical Method	GBRA Uplift #1 Calhoun Canal	GBRA Uplift #1 Calhoun Canal SW-06	GBRA Salt Water Barrier SW-01	GBRA Salt Water Barrier SW-01	GBRA Salt Water Barrier Duplicate	Linn Lake SW-03	Linn Lake Duplicate	Kuy Creek SW-02	Kuy Creek SW-02	Coleto Creek at Hwy 77 SW-04	Coleto Creek at Hwy 77 SW-04	Guadalupe River at Hwy 59 SW-05	Guadalupe River at Hwy 59 SW-05
		11.27.07	4.16.08	11.27.07	4.16.08	4.16.08	11.27.07	11.27.07	11.28.07	4.16.08	11.28.07	4.16.08	11.28.07	4.16.08
General Chemistry														
Temperature (°C)	Field Measurement	13.82	24.73	14.07	23.44	23.44	13.85	13.85	17.14	19.33	19.18	21.63	15.14	20.66
pH (standard units)	Field Measurement	7.34	8.18	8.11	8.11	8.11	8.54	8.54	7.53	7.77	8.03	8.16	8.37	8.21
Salinity (percent)	Field Measurement	0.02	0	0.03	0	0	0.03	0.03	0.08	0.1	0.04	0	0.01	0
Total Suspended Solids (mg per L)	SM 2540/USEPA 160.2	21.3	47.3	31.0	89.5	89.3	20.0	21.0	2.0	63.6	4.0	3.3	40.0	79.3
Total Dissolved Solids (mg per L)	SM 2540/USEPA 160.1	323	509	398	530	523	987	336	1020	847	539	592	219	371
Hardness, Total as $CaCO_3$ (mg per L)	USEPA 130.2	200	300	260	320	320	220	226	486	464	258	284	144	264
Turbidity (NTU)	USEPA 180.1	91.3	23.5	197	8.4	9.9	88.2	60.5	16.5	7.9	2.1	2.2	482	7.5
Color, Apparent (Cobalt Units)	USEPA 110.2	40	15	25	10	10	25	25	35	25	5	10	240	10
Odor (Threshold Odor Number)	USEPA 140.1	2	<1	4	<1	<1	4	4	>1	<1	>1	<1	>1	<1
Conductivity (mS per cm)	Field Measurement	0.604	0.741	0.716	0.759	0.759	0.565	0.565	1.74	1.44	0.903	0.820	0.363	0.542
Dissolved Oxygen (mg per L)	Field Measurement	5.12	102.3	12.32	10.47	10.47	14.79	14.79	16.22	11.29	10.76	9.34	14.22	9.53
Biochemical Oxygen Demand (mg per L)	SM 5210/USEPA 405.1	2.0	<0.89	2.0	<0.89	<0.89	2.0	2.0	7.0	<0.89	2.0	<0.89	7.0	17
Chemical Oxygen Demand (mg per L)	SM 5220/USEPA 410	28.6	<4.5	<4.5	<4.5	5†	35.5	24.1	35.5	59.2	<14.9	15.3†	20.1	7.6†
Total Organic Carbon (mg per L)	USEPA 415.1	8.3	—	5.2	—	—	5.3	5.4	—	—	—	—	—	—
Phosphorus, Total (mg per L)	USEPA 365.2	0.11	0.099	0.27	0.27	0.27	0.11	0.12	0.040	0.094	0.038	0.003†	0.25	0.057
Orthophosphorus (mg per L)	USEPA 365.2	0.14	0.11	0.22	0.21	0.19	0.12	0.1	0.023	0.018†	<0.013	<0.003	0.29	1.6
Nitrogen, Ammonia (mg per L)	SM 4500/USEPA 350.1	0.10	<0.05	<0.050	<.010	<0.10	<0.050	<0.050	<0.1	0.13	<0.10	<0.10	0.28	0.21
Nitrogen, Nitrate (mg per L)	SM18 4500N03E/NO2B	0.50	1.60	2.4	2.6	2.6	0.89	0.91	—	<0.11	—	<0.11	—	0.86
Nitrogen, Nitrate, Nitrite (mg per L)	SM18 4500N03E	0.76	1.7	2.4	2.6	2.6	0.89	0.91	—	<0.10	—	<0.10	—	0.87

Table 2.3.3-18 (Sheet 2 of 5)
VCS Site Surface Water Analytical Results

Parameter	Analytical Method	GBRA Uplift #1 Calhoun Canal	GBRA Uplift #1 Calhoun Canal SW-06	GBRA Salt Water Barrier SW-01	GBRA Salt Water Barrier SW-01	GBRA Salt Water Barrier Duplicate	Linn Lake SW-03	Linn Lake Duplicate	Kuy Creek SW-02	Kuy Creek SW-02	Coleto Creek at Hwy 77 SW-04	Coleto Creek at Hwy 77 SW-04	Guadalupe River at Hwy 59 SW-05	Guadalupe River at Hwy 59 SW-05
		11.27.07	4.16.08	11.27.07	4.16.08	4.16.08	11.27.07	11.27.07	11.28.07	4.16.08	11.28.07	4.16.08	11.28.07	4.16.08
Nitrogen, Nitrite (mg per L)	USEPA 352.2	0.26	0.051	<0.24	0.019	0.02	<0.050	<0.026	<0.011	<0.10	<0.041	<0.10	<0.043	0.015
Nitrate, Nitrite (mg per L)	SM 4500/NO3	—	—	—	—	—	—	—	<1.0	—	<1.0	—	<1.0	—
Nitrogen, Total Kjeldahl (mg per L)	USEPA 351.2	0.80	—	0.88	—	—	0.56	0.58	<0.1	—	<0.1	—	0.72	—
Nitrogen, Organic (mg per L)	SM 4500-N	0.70	—	0.88	<.010	<0.10	0.56	0.58	<0.1	0.13	<0.1	<0.10	—	<0.10
Alkalinity, total as $CaCO_3$ (mg per L)	SM 2320/USEPA 310	168	268	223	232	316	205	200	440	392	261	252	119	224
Carbon Dioxide (mg per L)	SM4500 CO2 D	168	5.6	223	3.4†	3.5†	205	200	440	18.7	261	4.9†	119	4.7†
Bicarbonate Alkalinity (mg per L)	SM2320	167.42	268	221.31	232	316	202.65	198.04	438.01	392	258.63	252	118.44	224
Chloride (mg per L)	SM 5220/USEPA 325.3	48.8	77.5	48.3	73.5	74.5	31.2	31.7	196	204	98.2	124	21.3	24.8
Sulfide (mg per L)	USEPA 376.1	2.0	—	2.0	—	—	3.0	2.0	0.0	—	0.0	—	0.0	—
Sulfate (mg per L)	SM 4500/USEPA 375.3	12.8	66.77	11.9	63.4	69.1	<3.3	<5.4	81.1	15.6	10.3	22.6	10.3	33.3
Sodium (mg per L)	USEPA 6010B	36.6	58.7	44.9	58.7	59.1	25.5	25.4	155	107	69.9	82.4	17.5	30.4
MBAS as LAS (mg per L)	SM 5540C	<0.02	—	<0.02	—	—	—	—	—	—	—	—	—	—
Fluoride (mg per L)	USEPA 340.2	0.18	—	0.30	—	—	0.23	0.25	—	—	—	—	—	—
Calcium (mg per L)	USEPA 200.7	58.2	81.5	88.2	87.9	91.3	—	—	—	150	—	98.4	—	753
Silica (Dissolved) (mg per L)	USEPA 370.1	6.7	—	9.8	—	—	35.7	5.3	—	—	—	—	—	—
Silica (Total) (mg per L)	USEPA 6010B	10.9	11.1	14.2	10.6	11.2	—	—	—	10.3	—	13.4	—	71.5
Bacteria and Plankton														
Total Coliform (CFUs per 100 mL)	SM 9223B/9221D	6590	>2000	10,910	>2000	>2000	7820	6240	810	>2000	1900	900	10,000	>2000
Fecal Coliform (CFUs per 100 mL)	SM 9222D	—	10	—	90	210	—	—	40	250	40	20	140	10
Fecal Streptococci (CFUs per 100 mL)	SM 9230C	—	<10	—	50	100	—	—	10	20	2200	10	60	10

Table 2.3.3-18 (Sheet 3 of 5)
VCS Site Surface Water Analytical Results

Parameter	Analytical Method	GBRA Uplift #1 Calhoun Canal	GBRA Uplift #1 Calhoun Canal SW-06	GBRA Salt Water Barrier SW-01	GBRA Salt Water Barrier SW-01	GBRA Salt Water Barrier Duplicate	Linn Lake SW-03	Linn Lake Duplicate	Kuy Creek \SW-02	Kuy Creek SW-02	Coleto Creek at Hwy 77 SW-04	Coleto Creek at Hwy 77 SW-04	Guadalupe River at Hwy 59 SW-05	Guadalupe River at Hwy 59 SW-05
		11.27.07	4.16.08	11.27.07	4.16.08	4.16.08	11.27.07	11.27.07	11.28.07	4.16.08	11.28.07	4.16.08	11.28.07	4.16.08
Chlorophyll-a (mg per m^3)	SM 10200	<0.1	HT	<0.1	HT	HT	—	—	—	HT	—	HT	—	HT
Phytoplankton (cells per 5 ml)	Palmer-Maloney	4.33	600	0	2902	3854	—	—	—	632	—	2371	—	2239
Radionuclides (pCi per L)**														
Potassium-40 (K-40)	USEPA 901.1	39.2	-4.88	-9.67	81.3	20.1	-5.27	23.6	-35.9	31.6	-21.2	39.5	-22.6	29.8
Cesium-137 (Cs-137)	USEPA 901.1	1.04	-1.8	-1.75	0.85	-1.26	0.988	1.55	3.67	-4.17	1.98	1.07	-0.712	0.019
Thallium-208 (Tl-208)	USEPA 901.1	-1.96	9.61	-3.62	0.957	-1.14	2.74	-0.862	5.79	-6.02	-1.84	-1.73	1.04	1.87
Bismuth-212 (Bi-212)	USEPA 901.1	15.2	40.4	-32.2	18.6	-27.5	-6.93	1.49	17.2	-25.7	-19.4	-25.5	-6.24	-33.7
Lead-212 (Pb-212)	USEPA 901.1	-0.042	12	-5.05	3.87	-0.003	3.05	0.168	14.8	-0.813	0.991	3.33	2.26	3.93
Bismuth-214 (Bi-214)	USEPA 901.1	-2.74	88.3	1.64	36.2	30.6	15.9	19.3	17.6	2.23	-2.18	8.52	1.57	24.9
Lead-214 (Pb-214)	USEPA 901.1	-4.71	55.4	4.32	12.4	19.6	1.31	15.2	6.96	-0.348	-5.15	13	10.6	27.2
Radium-228 (Ra-228)	USEPA 901.1	6.04	-1.21	2.12	-7.65	-4.32	-0.915	-16.8	7.15	0.465	-3.9	-16.8	-3.47	-0.459
Radium-228 (Ra-228)	USEPA 904.0	0.250	—	0.956	—	—	70.7	0.556	1.69	—	0.752	—	76.6	—
Tritium (H-3)	USEPA 906.0	73.3	126	107	131	148	0.64	27.6	77.6	76	148	181	2.21	145
Metals (µg per L)														
Aluminum	USEPA 6010B	1240	—	4940	—	—	701	1760	<86	—	<86	—	3090	—
Antimony	USEPA 6010B	<2.7	—	<2.7	—	—	<2.7	<2.7	<2.7	—	<2.7	—	<2.7	—
Arsenic	USEPA 6010B	<3.4	<2.7	<2.9	<2.7	<2.7	<2.7	<2.7	<4.6	7.5	<3.7	10.1	<2.7	<2.7
Barium	USEPA 6010B	<79.2	109†	<99.3	92.6†	99.8†	<86.0	87.4	495	433	422	455	<71.5	82.3†
Beryllium	USEPA 6010B	<0.26	—	<0.26	—	—	<0.26	<0.26	<0.26	—	<0.26	—	<0.26	—
Boron	USEPA 6010B	<65.7	—	127	—	—	<64.1	<66.3	208	—	140	—	<62.2	—
Cadmium	USEPA 6010B	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8
Chromium	USEPA 6010B	<1.5	<1.5	<1.8	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.7	<1.5
Chromium +6	USEPA 7195	<0.0040	—	<0.0040	—	—	<0.0040	<0.0040	<0.0040	—	<0.0040	—	<0.0040	—

Table 2.3.3-18 (Sheet 4 of 5)
VCS Site Surface Water Analytical Results

Parameter	Analytical Method	GBRA Uplift #1 Calhoun Canal	GBRA Uplift #1 Calhoun Canal SW-06	GBRA Salt Water Barrier SW-01	GBRA Salt Water Barrier SW-01	GBRA Salt Water Barrier Duplicate	Linn Lake SW-03	Linn Lake Duplicate	Kuy Creek SW-02	Kuy Creek SW-02	Coleto Creek at Hwy 77 SW-04	Coleto Creek at Hwy 77 SW-04	Guadalupe River at Hwy 59 SW-05	Guadalupe River at Hwy 59 SW-05
		11.27.07	4.16.08	11.27.07	4.16.08	4.16.08	11.27.07	11.27.07	11.28.07	4.16.08	11.28.07	4.16.08	11.28.07	4.16.08
Cobalt	USEPA 6010B	<9.6	—	<9.6	—	—	<9.6	<9.6	<9.6	—	<9.6	—	<9.6	—
Copper	USEPA 6010B	<5.9	—	<5.9	—	—	<5.9	<5.9	<11.5	—	<18.3	—	<12.8	—
Iron (Dissolved)	USEPA 6010B	<24	—	<24	—	—	—	—	—	—	—	—	—	—
Iron (Total)	USEPA 6010B	800	1990	2800	1260	2010	434	1090	519	1250	<63.7	184	3080	865
Lead	USEPA 6010B	<2.8	3	<2.8	<2.8†	3.2	<2.8	<2.8	<2.8	<2.8	<2.8	4.9	4.4	<2.8
Magnesium	USEPA 6010B	13,600	18900	16,600	18900	19600	13,200	13,300	20,600	16300	9800	10600	8960	17900
Manganese (Total)	USEPA 6010B	50.2	—	58.8	—	—	43.8	45.8	920	—	62.5	—	60.5	—
Manganese (Dissolved)	USEPA 6010B	<4.1	—	<4.8	—	—	—	—	—	—	—	—	—	—
Mercury	USEPA 7470B	<0.094	<0.094	<0.094	<0.094	<0.094	<0.094	<0.094	<0.094	<0.094	<0.094	<0.094	<0.094	<0.094
Molybdenum	USEPA 6010B	<1.2	—	<1.4	—	—	<1.2	<1.2	<1.2	—	<1.2	—	<1.2	—
Nickel	USEPA 6010B	<2.6	—	<2.6	—	—	<2.6	<2.6	<4.7	—	<2.6	—	<3.7	—
Potassium	USEPA 7470B	6540	—	6720	—	—	4200	4360	7840	—	2660	—	6460	—
Selenium	USEPA 6010B	<2.3	—	<2.3	—	—	<2.3	<2.3	<2.3	—	<2.3	—	<2.3	—
Silver	USEPA 6010B	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1
Strontium	USEPA 6010B	362	—	576	—	—	406	404	576	—	288	—	231	—
Tin	USEPA 6010B	<3.2	—	<2.6	—	—	<2.4	<3.2	<1.9	—	<1.9	—	<1.9	—
Titanium	USEPA 6010B	9	—	45.4	—	—	<5.4	<14.0	<0.71	—	<0.71	—	21.1	—
Vanadium	USEPA 6010B	<5.1	—	<10.3	—	—	<4.7	<5.8	<0.04	—	<1.8	—	<7.0	—
Zinc	USEPA 6010B	<9.3	—	<15.6	—	—	<7.8	<9.8	<9.5	—	<12.9	—	20.2	—
Volatile Organic Compounds (VOCs) (mg per L)	USEPA 8260B	<0.0073	—	<0.0073	—	—	—	—	—	—	—	—	—	—

Table 2.3.3-18 (Sheet 5 of 5)
VCS Site Surface Water Analytical Results

Parameter	Analytical Method	GBRA Uplift #1 Calhoun Canal	GBRA Uplift #1 Calhoun Canal SW-06	GBRA Salt Water Barrier SW-01	GBRA Salt Water Barrier SW-01	GBRA Salt Water Barrier Duplicate	Linn Lake SW-03	Linn Lake Duplicate	Kuy Creek SW-02	Kuy Creek SW-02	Coleto Creek at Hwy 77 SW-04	Coleto Creek at Hwy 77 SW-04	Guadalupe River at Hwy 59 SW-05	Guadalupe River at Hwy 59 SW-05
		11.27.07	4.16.08	11.27.07	4.16.08	4.16.08	11.27.07	11.27.07	11.28.07	4.16.08	11.28.07	4.16.08	11.28.07	4.16.08
Semi-Volatile Compounds (SVOCs) (µg per L)	USEPA 8270C	<0.025	—	<0.025	—	—	—	—	—	—	—	—	—	—
Pesticides & Herbicides (mg per L)	EPA 8141/8151	<0.050	—	<0.050	—	—	—	—	—	—	—	—	—	—
Polychlorinated biphenyls (mg per L)	USEPA 8081A	<0.050	—	<0.050	—	—	—	—	—	—	—	—	—	—
Oil and Grease (mg per L)	USEPA 1664	<1.4	—	<1.4	—	—	—	—	—	—	—	—	—	—
Tributylin (nanograms per L)	Unger Method	16*	—	87*	—	—	—	—	—	—	—	—	—	—
Cyanide (Total) (mg per L)	USEPA 335.2	<0.0050	—	<0.0050	—	—	—	—	—	—	—	—	—	—
Asbestos (mg per L)	USEPA 100.1/100.2	ND	—	ND	—	—	—	—	—	—	—	—	—	—

NA = Not available due to equipment malfunction
mS per cm= milli-Siemens per centimeter
MBAS as LAS = Methylene blue active substances as standardized against Lineares Alkybenzosulfonate
mg per L = Micrograms per liter
µg per L = Micrograms per liter
CFU = Colony-Forming Units
HT = Sample exceeded holding time due to lab error and was therefore not analyzed
– = Parameter not analyzed
* = tributylin was detected at a concentration of 90 nanograms per liter in each of the three blanks as a result of lab contamination. Therefore, the three sample concentrations were "normalized" by using the standard method of simply subtracting the blank concentration from the samples' reported concentrations.
** = Radionuclide analyses usually required the subtraction of the instrument background counts from the sample counts. Even though both background and the sample values are positive, sometimes when the sample activity is low, variations in the two measurements can cause the sample value to be less than the background, resulting in a measured activity less than zero
† = Parameter also detected in the Laboratory Method Blank
< = parameter was detected at or below the method detection limit

Table 2.3.3-19
TPDES Sites in Lower Guadalupe and Lower San Antonio River Basins
(Victoria, Refugio, and Goliad Counties)

TPDES Permit Number	Permit Status	County	Facility Name	Receiving Stream	Permitted Flow (mgd)	Approximate Distance/ Direction to the VCS Site (mi)	Up Gradient/ Down Gradient with Respect to SWB
TXG110085	Active	Victoria	Alamo Concrete Products, LTD	Guadalupe River	NA	13-N	Up
TXG110086	Active	Victoria	Alamo Concrete Products, LTD	Guadalupe River	NA	20-N	Up
TX0003603	Active	Victoria	AEP Texas Central CO (CPL Victoria Power Station)	Guadalupe River	202	12-N	Up
TX0006050	Active	Victoria	Invista S.A.R.L.	Guadalupe River	21.8	5-NE	Up
TX0005118	Active	Victoria	South Texas Electric Cooperative	Guadalupe River	34.26	31-N	Up
TX0025186	Active	Victoria	Victoria Regional Wastewater Treatment Plant	Guadalupe River	9.6	9-N	Up
TX0025194	Active	Victoria	Victoria Willow Plant	Guadalupe River	2.5	12-N	Up
TX0022411	Active	Goliad	City of Goliad WWTP	San Antonio	0.35	24-W	Up
TXG110075	Active	Goliad	Goliad Plant No. 81 (Alamo Concrete Products, LTD)	San Antonio	NA	24-W	Up

Source: USEPA Feb 2008
SWB = GBRA Saltwater Barrier
NA = Data not available