2.3 Water

This section describes the hydrology, water use, and water quality characteristics of the STP site and surrounding region that could affect or be affected by the construction and operation of two Advanced Boiling Water Reactor (ABWR) units, which will be referred to as STP 3 & 4. The potential water-related impacts of construction and operation are discussed in Chapters 4 and 5, respectively.

The STP site is located in Matagorda County, Texas, near the west bank of the Colorado River, opposite river mile 14.6. It is approximately 12 miles south-southwest of Bay City, Texas, and 8 miles north-northwest of Matagorda, Texas (Figure 2.3.1-1). The surface elevation of the site ranges from approximately 32 to 34 ft above mean sea level (MSL) at the north boundary to between 15 ft and 20 ft MSL at the south end. The existing grade at the location for STP 3 & 4 is approximately 30 ft MSL and the finish plant grade in the STP 3 & 4 power block area is anticipated to be between 32 ft and 36.6 ft MSL.

2.3.1 Hydrology

This section describes 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 STP 3 & 4. The site-specific and regional data on the physical and hydrologic characteristics of these water resources are summarized in the following sections.

2.3.1.1 Surface Water

2.3.1.1.1 The Colorado River Basin

The Colorado River Basin extends across the middle of Texas, from the southeastern portion of New Mexico to Matagorda Bay at the Gulf of Mexico. The total drainage area of the Colorado River is 42,318 mi^2, of which 11,403 mi^2 are considered non-contributory to the river's water supply (Reference 2.3.1-1). The Lower Colorado River Basin is the part of the river system from Lake O.H. Ivie to the Gulf Coast (Figure 2.3.1-2) and comprises approximately 22,682 mi^2 of drainage area (Reference 2.3.1-2). The Upper Colorado River Basin has a drainage area of approximately 19,636 mi^2. There are six major tributaries with drainage areas greater than 900 mi^2 that contribute to the Colorado River: Beals Creek and the Concho River in the Upper Colorado River Basin and the San Saba, Llano, Pedernales Rivers and Pecan Bayou in the Lower Colorado River Basin. These major tributaries, and approximately 90% of the entire contributing drainage for the river, occur upstream of Mansfield Dam near Austin. Downstream of Austin, there are only two tributaries with drainage areas greater than 200 mi^2, Barton Creek and Onion Creek in Travis County (Reference 2.3.1-1). Table 2.3.1-1 summarizes the drainage areas of major freshwater streams in the Colorado River Basin.

The Colorado River Basin lies in the warm-temperate/subtropical zone, and its subtropical climate is typified by dry winters and humid summers. Spring and fall are both wet seasons in this region with rainfall peaks in May and September. The spring rains are produced by convective thunderstorms, which result in high intensity, short duration precipitation events with rapid runoff. The fall rains are primarily governed by tropical storms and hurricanes that originate in the Caribbean Sea or the Gulf of Mexico. These rains pose flooding risks to the Gulf Coast from Louisiana to Mexico. The spatial rainfall distribution in this region varies from an annual amount of 44 inches at the coast to 24 inches in the northwestern portion of the region (Reference 2.3.1-1). The Colorado River Basin is located in a semi-arid region, and its hydrologic characteristics are closely linked to the weather in this area, which has been described as a “continuous drought periodically interrupted by floods” (Reference 2.3.1-3).

Stream flow gauging data collected in the Colorado River since the early 1900s show that there has been a major drought in almost every decade of the twentieth century, with severe droughts occurring every 20 to 40 years. Major droughts in the basin cause stock ponds and small reservoirs to go dry and large reservoirs, such as Lake Travis, to significantly drop their storage levels, to as much as one third of their storage capacity. 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, when 94% of the counties in the state were declared disaster areas (Reference 2.3.1-1).

A drought cycle is often followed by one or more flooding events. Due to very limited vegetative cover, rocky terrain, and steep channels, runoff in the Upper Colorado River Basin is high and rapid, producing fast moving and high-peak floods. The terrain in the Lower Colorado River Basin is flatter with greater vegetative cover and wider floodplains, which reduces the velocity of floods. The Hill Country watershed of the Lower Colorado River has been characterized as “Flash Flood Alley,” meaning that the Lower Colorado River Basin is one of the regions that are most prone to flash flood damage. The susceptibility to flash flooding occurs because the thin soils and steep slopes in the Upper Colorado River Basin promote rapid runoff from the watershed during heavy rain events. Also, the large drainage area of the Hill Country watershed can contribute runoff from hundreds of miles away, transforming heavy rains into flood waters with destructive potential. More than 80 floods have been recorded in this region since the mid-1800s. During these events, water levels exceed the river flood stage and inundate dry lands. The most intense localized flash flood in the Lower Colorado region in recent history occurred in May 1981 in Austin (Reference 2.3.1-1).

Major reservoirs in the Colorado River Basin are summarized in Table 2.3.1-2 (Reference 2.3.1-4 sorted in order of descending storage capacity. The locations of some major dams are shown in Figure 2.3.1-3. Because of the high risk of flooding in the Lower Colorado River Basin, a system of dams and reservoirs has been developed along the river primarily to manage floodwaters, and to conserve and convey water supplies. The Lower Colorado River Authority (LCRA) operates six dams on the Lower Colorado River: Buchanan, Roy Inks, Alvin Wirtz, Max Starcke, Mansfield, and Tom Miller (Figure 2.3.1-4). These dams form the six Highland Lakes; Buchanan, Inks, LBJ, Marble Falls, Travis, and Austin (Reference 2.3.1-5).

Approximately 28 miles upstream from Austin is Mansfield Dam, which forms Lake Travis, the largest reservoir on the Colorado River. Mansfield Dam is the most downstream existing major control structure on the Colorado River. With the completion of the Simon Freese Dam in 1989, normal flows and flood flows in the Colorado River upstream of Mansfield Dam are regulated by a total of 27 major reservoirs, which includes Lake Travis, with Mansfield Dam providing most of the floodwater storage capacity and precludes short-duration flow fluctuation downstream.

The storage capacities of the remaining upstream reservoirs are relatively small compared to Lake Travis and Lake Buchanan formed by the Buchanan Dam, and are of lesser importance to flood control. Tom Miller Dam at Austin, downstream of Lake Travis, impounds a portion of the Colorado River known as Lake Austin, but because of the small storage capacity of its reservoir, it affords no major control of flood flows.

Lake Travis and Lake Buchanan also serve as water supply reservoirs. With a combined capacity of approximately 4.2 million acre-feet, they store water for communities, industry, and aquatic life along the river, and they supply irrigation water for the agricultural industry near the Gulf Coast.

The Lower Colorado River near the STP site has a relatively shallow gradient and broad floodplain. The average gradient of the river downstream of Austin varies from 1.0 ft/mile to 2.1 ft/mile. The main channel of the Colorado River has the capacity to contain flows ranging from a 6-year to a 21-year return interval from Austin to the Gulf of Mexico. Thus, in any given year there is a 5 to 16% chance that river flows will encroach upon the floodplains. The Lower Colorado River floodplain below Columbus varies from 4 to 8 miles in width with side slopes averaging between 0.009% and 0.028%. In this area, no discernible valley exists, and the floodwaters can spill over beyond the basin divide causing interbasin spillage. As mentioned above, the susceptibility of the Lower Colorado River area to the flash flooding results from regional weather patterns and its geographic proximity to the Gulf of Mexico, which induces very high intensity rainfalls frequently in the summer. Historically, the most severe floods often occurred in May to September as a result of high rainfall intensities (Reference 2.3.1-3), and the area of floodplain extends correspondingly. As the dry season approaches, some floodplains will shrink or even dry up completely.

Table 2.3.1-3 presents pertinent data for seven U.S. Geological Survey (USGS) maintained stream-flow gauge stations downstream of the Mansfield Dam, including location, drainage area, mean, maximum, and minimum average annual flow for the period of record. The locations of these gauges are shown on Figure 2.3.1-5 (Reference 2.3.1-6). The Bay City streamflow gauging station (Gauge 08162500) is the nearest to the STP site, being located approximately 16 miles upstream of the STP site, approximately 2.8 miles west of Bay City, at river mile 32.5 on the Colorado River. Records of water elevation at this station have been collected since the gauge was installed in April 1948. Based on the historical data for the water years 1948 to 2004, the maximum annual average stream flow at this station is 14,270 cubic feet per second (cfs), the minimum annual average flow is 375 cfs, and the mean annual average flow is approximately 2628 cfs.

In order to facilitate the evaluation of the water supply characteristics at the STP site, a number of flow data statistics are presented for the Colorado River at Bay City. Table

2.3.1-4 presents the mean daily flow rate for each day of the May 1948 to September 2006 period of record (Reference 2.3.1-7). Table 2.3.1-5 presents the mean monthly flow rate for the same period of record (Reference 2.3.1-7). Table 2.3.1-6 gives the minimum daily flow and Table 2.3.1-7 gives the maximum daily flow for each month of the period of record.

Table 2.3.1-8 presents the flood frequency distribution for the Colorado River at Wharton for regulated conditions estimated in Reference 2.3.1-8, Chapter 4: “The basis for the regulated peak discharge frequency curves are the regulated daily flows for the period of record generated by a reservoir system regulation model that takes into account the current system of reservoirs, conservation pool demands and the flood control regulation rules” (Reference 2.3.1-9, Chapter 2, page 1).

Table 2.3.1-9 presents the minimum daily flow at Bay City for the years 1948 to 2006. Table 2.3.1-10 presents the 7-day minimum flow for the same period based on data from Reference 2.3.1-10. The minimum 7-day flow for the period 1948 to 2006 is approximately 0.5 cfs. The minimum daily and minimum 7-day low flows for the years 1948-2006 are also shown in Figure 2.3.1-6. Plotting the low flow data using the Weibull plotting position formula on normal distribution paper and fitting a straight line through the data, the 7-day low flow with a 10-year return period was estimated to be 4.3 cfs.

2.3.1.1.2 Local Hydrologic Features

A major feature of the site is the Main Cooling Reservoir (MCR), which is formed by a 12.4-mile-long earthfill embankment constructed above the natural ground surface. The MCR was developed solely for the industrial use of dissipating heat from STP units as an engineered cooling pond. The MCR has a surface area of 7000 acres with a normal maximum operating level of El. 49 ft MSL (Reference 2.3.1-9). The MCR makeup water is withdrawn from the Colorado River adjacent to the site, and provides reservoir storage to account for dry periods during the year. A smaller separate cooling pond, referred to as the Essential Cooling Pond (ECP), serves as the Ultimate Heat Sink (UHS) for STP 1 & 2. The surface area of the ECP is 46 acres.

The MCR was originally sized for four nuclear units similar in size to the existing two units. Therefore, there will be no significant changes to the existing MCR due to the construction of new units, except the addition, on the north dike, of the STP 3 & 4 Circulating Water (CW) pump intake and the STP 3 & 4 outfall west of the existing STP 1 & 2 outfall. To maintain sufficient MCR water inventory to offset evaporation, seepage and blowdown, STP is entitled to divert 55% of the river flow in excess of 300 cfs at the Reservoir Makeup Pumping Facility (RMPF) as MCR makeup, with the annual flow diversion in any given year limited to 102,000 acre-ft (Reference 2.3.1-11). In the event of a repeat of the Lower Colorado River’s Drought of Record (DOR) from 1947 to 1957, the LCRA would be required, by contract, to make available an additional 40,000 acre-ft per year of firm water. This firm water will be made available, without restriction on river flow, for MCR makeup when the water level in MCR is below 35 ft MSL. These arrangements are expected to be adequate to maintain sufficient water in the MCR for continuous operation of all four units. This assessment is also supported by the water management plan for the Lower Colorado River (Reference 2.3.1-12).

A significant hydrologic feature near the STP site is Little Robbins Slough. It is an intermittent stream located 9 miles northwest of Matagorda in southwestern Matagorda County and runs south for 6.5 miles to the point where it joins Robbins Slough, a brackish marsh, which meanders for four more miles to the Gulf Intracoastal Waterway (GIWW). During the construction of the MCR for STP 1 & 2, the water course of Little Robbins Slough within the boundary of the STP site was relocated to a channel on the west side of the west embankment of the reservoir, and rejoined its natural course approximately one mile east of the southwest corner of the MCR.

The Design-Basis Flood (DBF) for STP 3 & 4 is based on the potential breach of the dike containing the MCR. The DBF elevation is 40.0 ft MSL.

2.3.1.1.2.1 Seepage from the MCR

As discussed above, the existing 7000-acre MCR would provide cooling water for STP 3 & 4. The maximum operating level elevation of the MCR is 49 ft above MSL, imposing a hydraulic head of up to 20 ft above the reservoir floor. The capacity of the MCR at this elevation is approximately 202,600 acre-ft. The MCR embankment dike and associated features are designed to lower the hydraulic gradient across the embankment to the extent that the potentiometric levels of the soil layers in the site area stay below the ground surface. This is accomplished through the use of low permeability clay (compacted fill), relief wells, and sand drainage blankets. The relief well system consists of 770 wells that have been installed in the Upper Shallow Aquifer at the toe of the embankment around the reservoir to relieve excess hydrostatic pressure.

The purposes of MCR seepage controls provided by the relief wells are as follows (Reference 2.3.1-9):

- To minimize seepage through the embankment section and prevent detrimental discharge on downstream slopes.
- To minimize underseepage beneath the embankment and control its exit in order to prevent detrimental uplift and discharge at the downstream toe.
- To limit the maximum piezometric level at the relief well line to El. 27.0 MSL opposite the power block structures.

The 7000-acre MCR is unlined, allowing seepage of water from the MCR through the reservoir floor. This seepage acts as a local recharge source to the Shallow Aquifer at the site. During the design stage, total seepage from the MCR, based on a maximum operating water level of 49 feet above MSL, was estimated to be 3530 gpm, or approximately 5700 acre-ft/yr (Reference 2.3.1-9). Seepage discharge from the MCR has two flow paths: (a) part of the seepage is collected by the relief well system, which is installed in the sands of the Upper Shallow Aquifer, and is then discharged to surface waters; and (b) part of the seepage bypasses the relief wells and continues in the Upper Shallow Aquifer in a southeasterly direction to the Colorado River.

Approximately 68%, or 3850 acre-ft/yr, of the total expected MCR seepage would be discharged through the relief wells (Reference 2.3.1-9) and into surface waters. The distribution of relief well surface water discharge results in approximately 28% being returned to the Colorado River, 53% to Little Robbins Slough, 18% to the East Fork of Little Robbins Slough and <1% being returned to the West Branch of the Colorado River (Reference 2.3.1-42). These discharges were originally authorized under NPDES Permit No. TX0064947, and currently are authorized under TPDES Permit No. WQ0001908000.

2.3.1.1.3 Adjacent Drainage Basins

To the west of the Lower Colorado River Basin is the Colorado-Lavaca River Basin, shown on Figure 2.3.1-7. This basin includes the Tres Palacios River, which is not tributary to either of those rivers. The Colorado-Lavaca River Basin drains into Tres Palacios Bay, northwest of Matagorda Bay. In the event of inter-basin spillage, flood waters from the Colorado River Basin flow into Caney Creek near Wharton, as in the case of the 1913 flood, into the San Bernard Coastal Basin on the east edge of the Colorado River Basin, or into the Colorado-Lavaca River Basin to the west.

2.3.1.1.4 Wetlands

The STP site is located in the mid-coast region of the Gulf-Atlantic Coastal Flats, which are characterized by large bay and estuary systems supplied by freshwater inflow from rivers and covered with extensive coastal prairies inland (Figure 2.3.1-8, Reference 2.3.1-13). A study conducted by the Texas General Land Office determined that wetlands and aquatic habitats on Matagorda Island, Matagorda Peninsula, and Colorado River delta are dominated by estuarine emergent wetlands (salt and brackish marshes), which represent 67% of the vegetated wetland and aquatic classes in this area (Reference 2.3.1-14). Among other mapped classes, seagrass beds are most abundant, followed by tidal flats, Gulf beaches, palustrine marshes, and mangroves.

Wetlands in the vicinity of the STP site are mainly associated with the Colorado River and its tributaries. Wetlands within a 6 mile radius of the site are delineated on Figure 2.3.1-9. Wetland inventory data was provided by the U.S. Fish and Wildlife Service (Reference 2.3.1-15). Freshwater emergent wetlands have been identified as the predominant class in this region, encompassing an area of approximately 262 acres in a 6-mile radius from the STP site. Other wetland types found in this region include freshwater forested/shrub wetland and freshwater pond, which cover areas of 13 acres and 1 acre, respectively in the same radius from the site (See Section 2.4). Because wetlands near the site are primarily classified as freshwater types, the area of wetlands covered by water generally reduces in the dry season and expands in the wet season.

2.3.1.1.5 Erosion and Sedimentation

Most of the sediment data for the Colorado River have been collected from two USGS daily suspended sediment stations; one near San Saba at river mile 474.3 and the other at the eastern edge of Columbus at river mile 135.1. Because the Columbus gauging station is the closest to the STP site, its sediment records were examined to characterize the suspended sediment loads for the Colorado River. Figure 2.3.1-10 shows in histogram form the annual sediment load based on data collected at this station from March 1957 to September 1973 (Reference 2.3.1-16). Each bar of the histogram is divided into the suspended load discharged in 1% of the year (3.65 days), 10% of the year (36.5 days), and the rest of the year. These frequencies are generated by ranking the sediment load for each day of the year. The data summarized in Figure 2.3.1-10 indicate that the annual sediment load at the Columbus gauging station has declined over time. This decline is likely associated with the creation of impoundments over the same period, which serve as sediment traps in the Colorado River Basin. The data also indicate that major fractions (80-90%) of the total sediment load in individual years are produced by infrequent large storms.

No bed load sediment transport measurements have been reported for any reach of the Colorado River and cannot be easily estimated as a fraction of the suspended load because the portion of sediment that moves as bed load varies widely between rivers and on the same river over time (Reference 2.3.1-17). However, to get an order of magnitude estimate, the globally averaged ratio of suspended load to bed load sediment flux for rivers of 9:1, reported in Reference 2.3.1-18 can be used.

2.3.1.1.6 Shore Regions

The STP site is located 10.5 miles inland from Matagorda Bay and 16.9 miles inland from the Gulf of Mexico. It is approximately 75 miles from the Continental Shelf. The shoreline of Matagorda Peninsula along the Gulf of Mexico changes constantly, retreating landward or advancing seaward as the result of a combination of hydrologic and meteorological processes, climatic factors as well as engineering activities.

Matagorda Peninsula is a classic microtidal, wave-dominated coast with a mean diurnal tide range of approximately 2.1 ft. An evaluation of 20 years of data shows that the mean significant wave height near the Colorado River entrance is approximately 3.3 ft, with a variation of 1.3 ft during the year (Reference 2.3.1-19). This shore region is also greatly affected by waves generated by tropical storms and hurricanes.

The hydrologic features of the shore region are also altered by a series of engineering interventions. After the removal of a log jam on the Colorado River in 1929, a channel was dredged across the Matagorda Peninsula to allow the river to directly discharge to the Gulf of Mexico in 1936. In the 1990s, the U.S. Army Corps of Engineers (USACE) constructed jetties on each side of the river entrance and dredged an entrance channel. In 1993, USACE constructed a diversion channel that directs the flow of the Colorado River into East Matagorda Bay. The former river channel is now a navigation channel connected to the GIWW.

Studies conducted recently to calculate the average annual rate of shoreline changes show that the shoreline segment of Matagorda Peninsula 1.6 miles southwest of the Colorado River is retreating at a rate of 1.6 to 6.4 ft/yr (Reference 2.3.1-19). Up north toward the mouth of the Colorado River, the shoreline displays long-term advance, which is related to the sediment supplies from the river, sand bypassing across the entrance jetties, and wave sheltering by the jetties (Reference 2.3.1-19). The shoreline northeast of the Colorado River is relatively stable and shows slight long-term advance in an area 8 miles to the northeast of the river mouth (Reference 2.3.1-19).

2.3.1.1.7 Hydrologic Characteristics of the Intake Structure Area

STP 3 & 4 will use the MCR for normal plant cooling. The Colorado River is the source of water to make up water losses in the MCR due to evaporation and seepage. For this purpose, STP 3 & 4 will use the existing RMPF on the Colorado River.

Makeup water demands are described in Section 3.3, while the RMPF is discussed in Section 3.4. Based on the dimensions of the RMPF, the total length of the intake is 406 ft, and the depth below normal water surface elevation in front of the intake is 10 ft. The Figure 2.3.1-11 shows a cross section of the Colorado River channel near the RMPF. As can be seen in the figure, the bottom of the river channel is at elevation approximately -14 ft NAVD88. NAVD 88, North America Vertical Datum 88, is the new vertical (elevation) reference system adopted in North America. It is adjusted based on field work prior to 1929 as well as surveys as recent as 1988. Based on the makeup demands described in Section 3.3 and dimensions of the intake presented in Section 3.4, the average water velocity in front of the intake for maximum flow conditions (1200 cfs) would be approximately 0.3 ft/s considering a cross section of approximately 4060 ft^2.

2.3.1.2 Groundwater Resources

The regional and site-specific data on the physical and hydrologic characteristics of the groundwater resources are summarized in this section to provide the basic data for an evaluation of impacts on the aquifers of the area.

The STP site covers an area of approximately 12,220 acres and is located on the coastal plain of southeastern Texas in Matagorda County (Reference 2.3.1-9). The STP site lies approximately 10 mi north of Matagorda Bay. Nearby communities include Palacios, approximately 10 mi to the southwest, and Bay City, approximately 12 mi to the northeast (Figure 2.3.1-12). The closest major metropolitan center is Houston, approximately 90 mi to the northeast.

The 7000-acre MCR is the predominant feature at the STP site, as shown in Figure 2.3.1-13. The MCR is fully enclosed with a compacted earth embankment and encompasses most of the southern and central portions of the site. The existing STP 1 & 2 facilities are located just outside of the MCR northern embankment. Further north of the embankment and to the northwest of STP 1 & 2 is the proposed area for STP 3 & 4.

The STP site, in general, has less than 15 ft of natural relief in the 4.5 mi distance from the northern to southern boundary. The northern section is at an elevation of approximately 30 ft MSL. The southeastern section is at an elevation of approximately 15 ft above MSL. The Colorado River flows along the southeastern site boundary.

There are also several unnamed drainages in the site boundaries, one of which feeds Kelly Lake.

2.3.1.2.1 Hydrogeologic Setting

The STP site lies in the Gulf Coastal Plains physiographic province in the Coastal Prairies sub-province, which extends as a broad band parallel to the Texas Gulf Coast, as shown in Figure 2.3.1-14 (Reference 2.3.1-20). The Coastal Prairies sub-province is characterized by relatively flat topography with land elevation ranging from sea level along the coast to 300 ft above sea level along the northern and western boundaries. The geologic materials underlying the Coastal Prairies sub-province consist of deltaic deposits.

The STP site is underlain by a thick wedge of southeasterly dipping, sedimentary deposits of Holocene through Oligocene age. The site overlies what has been referred to as the Coastal Lowlands Aquifer System (Figure 2.3.1-15). 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. Large amounts of groundwater are withdrawn from the aquifer system for municipal, industrial, and irrigation needs (Reference 2.3.1-21).

The lithology of the aquifer system reflects three depositional environments: continental (alluvial plain), transitional (delta, lagoon, and beach), and marine (continental shelf). The depositional basin thickens towards 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 (Reference 2.3.1-21).

As part of the USGS Regional Aquifer-System Analysis (RASA) program, the Coastal Lowlands 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 Coastal Lowlands Aquifer System. A comparison of the USGS aquifer system nomenclature to that used in Texas is shown in Figure 2.3.1-16. A cross-sectional representation is shown in Figure 2.3.1-17 (Reference 2.3.1-21).

The Texas nomenclature is used to describe the Gulf Coast Aquifer beneath the site. The hydrogeologic units commonly used to describe the aquifer system (from shallow to deep) are as follows (Figure 2.3.1-16):

- Chicot Aquifer
- Evangeline Aquifer
- Burkeville Confining Unit
- Jasper Aquifer
- Catahoula Confining Unit (restricted to where present in the Jasper Aquifer)

- Vicksburg-Jackson Confining Unit

The base of the Gulf Coast Aquifer is identified as either its contact with the top of the Vicksburg-Jackson Confining Unit or the approximate depth where groundwater has a total dissolved solids concentration of more than 10,000 milligrams per liter (mg/l). The aquifer system is recharged by the infiltration of precipitation that falls on 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 to the Gulf of Mexico, and pumping.

With the exception of the shallow zones in the vicinity of the outcrops, the water in the Gulf Coast Aquifer is under confined conditions. In the shallow zones, the specific yield for sandy deposits generally ranges between 10 and 30%. For the confined aquifer, the storage coefficient is estimated to range between 1×10^{-4} and 1×10^{-3}. The productivity of the aquifer system is directly related to the thickness of the sands in the aquifer system that contain freshwater. The aggregated sand thickness ranges from 0 ft at the up dip limit of the aquifer system to as much as 2000 ft in the east. Estimated values of transmissivity are reported to range from 5000 ft^2/day to nearly 35,000 ft^2/day (Reference 2.3.1-21).

The hydrogeologic conceptual model presented herein was developed from multiple conceptual hydrogeologic models that vary in scale and hydrostratigraphic framework. Consideration of the scale and framework were not mutual exclusive, but were intertwined during a series of steps designed to develop a tenable site hydrogeologic conceptual model. Four steps were involved in the development of the scale-dependent conceptual models, and include:

- A regional "desktop" study based on published state, federal and other sources;
- A review of documentation addressing STP Units 1 & 2;
- A site-specific geotechnical, geologic, and hydrogeologic field study conducted for proposed Units 3 & 4; and
- An evaluation of site-specific data in conjunction with regional and local information.

The first step of site model conceptualization involved formulating an understanding of the hydrogeologic conditions in Southern Texas and Matagorda County by reviewing regional geologic and hydrogeologic information available from the USGS and Texas. Research indicates that the USGS and the State of Texas developed separate regional hydrogeologic conceptual models to describe the Coastal Lowlands Aquifer System, with the Texas model being the more widely used. Although nomenclature between the two conceptual models varies significantly, the frameworks are largely comparable (Table 2.3.1-16).

The second step involved a review of documentation addressing local hydrogeologic conditions, such as the STP Units 1 & 2 UFSAR and the Annual Environmental

Operating Report, to resolve the temporal and localized unknowns. Incorporating the conceptual site model with regional concepts, the Chicot aquifer was subdivided into two distinct confined aquifers - the "Deep Aquifer" and the "Shallow Aquifer".

During the third step, a site-specific subsurface site investigation (SI) was implemented at the proposed Units 3 & 4 site area, concentrated within the STP northern site boundaries and the proposed Units 3 & 4 facility footprint.

The fourth step involved evaluation of the SI field data with the regional and local STP information. This included evaluation of:

- regional & local groundwater movement;
- vertical gradients between the aquifers;
- site-specific slug test results and local and regional pumping test results; and
- natural and manmade (i.e., MCR) impacts on water levels in the Shallow Aquifer.

From this effort, site-specific data was integrated with existing STP Units 1 & 2 information and regional information to formulate the conceptual site model described in the following section.

2.3.1.2.2 Regional Hydrogeologic Conceptual Model

The STP site is located over the Gulf Coast Aquifer System, as shown on Figure 2.3.1-18 (Reference 2.3.1-22). The boundary of the regional area surrounding the STP site is defined as the extent of Matagorda County. The principal aquifer used in Matagorda County is the Chicot Aquifer, which extends to a depth of greater than 1000 ft in the vicinity of the STP site, as shown on Figure 2.3.1-19. The Chicot Aquifer is the shallowest aquifer in the Gulf Coast Aquifer System, and it is comprised of Holocene alluvium in river valleys and the Pleistocene age Beaumont, Montgomery, and Bentley Formations, and the Willis Sand (Reference 2.3.1-23). Groundwater flow beneath Matagorda County is, in general, southeasterly from the recharge areas north and west of the county, to the Gulf of Mexico. Numerous river systems and creeks flow south and southeasterly through Matagorda County. River channel incisions can act as localized areas of recharge and discharge for the underlying aquifer system resulting in localized hydraulic sources and sinks.

The Chicot Aquifer geologic units used for groundwater supply in Matagorda County are the Beaumont Formation and the more localized Holocene alluvium that is associated with the Colorado River floodplain. The following sections describe the pertinent details of these units.

2.3.1.2.2.1 Beaumont Formation

The Beaumont Formation consists of fine-grained mixtures of sand, silt, and clay deposited in alluvial and deltaic environments. In the upper portion of the Beaumont Formation, sands occur as sinuous bodies, representing laterally discontinuous channel deposits, while the clays and silts tend to be more laterally continuous, representing their deposition as natural levees and flood deposits. The deeper portion of the unit, or the Deep Aquifer, is greater than 250 ft below ground surface in the vicinity of the STP site and has thicker and more continuous sands. This portion of the Beaumont Formation is the primary groundwater production zone for most of Matagorda County. Well yields in this interval are typically between 500 and 1500 gallons per minute (gpm), with yields of up to 3500 gpm reported (Reference 2.3.1-24). Groundwater occurs in this zone under confined conditions.

2.3.1.2.2.2 Holocene Alluvium

Holocene alluvium of the Colorado River floodplain occurs in a relatively narrow band that parallels the river. The alluvial deposits are typically coarser-grained than the materials found in the Beaumont Formation. The alluvium consists of silt, clay, fine- to coarse-grained sand, and gravel along with wood debris and logs (Reference 2.3.1-24). Because the alluvial materials are deposited in a channel incised into the Beaumont Formation, it is likely that the alluvium is in contact with shallow aquifer units in the Beaumont Formation.

The thickness of the alluvium influences the amount of groundwater that can be withdrawn for use. In the vicinity of the STP site, the alluvium is considered too thin to be a significant source of groundwater.

2.3.1.2.3 Local and Site Specific Hydrogeologic Conceptual Model

The Beaumont Formation in the Chicot Aquifer (and to the lesser extent, the Holocene alluvium associated with the Colorado River floodplain) is the principal water-bearing unit used for groundwater supply in the vicinity of STP. The following sections describe the local and site specific characteristics of these water-bearing units, including groundwater sources and sinks. Discussions include groundwater flow directions and hydraulic gradients, temporal groundwater trends, aquifer properties, and hydrogeochemical characteristics.

2.3.1.2.3.1 Local Hydrogeologic Conditions

The local hydrogeologic system is identified as the STP site area and includes areas of groundwater-surface water interactions within a few miles of the site. In this area, the Chicot Aquifer is divided into two aquifer units, the Shallow Aquifer and the Deep Aquifer. The base of the Shallow Aquifer is approximately 90 to 150 ft below ground surface. The Shallow Aquifer has limited production capability, and it is used for livestock watering and occasional domestic use. Potentiometric heads are generally within 15 ft of ground surface. The Deep Aquifer is the primary groundwater production zone and lies below depths of 250 to 300 ft. A zone of predominately clay materials, usually greater than 150 ft thick, separates the Shallow and Deep Aquifers (Reference 2.3.1-9).

Recharge to the Shallow Aquifer is considered to be within a few miles north of the STP site. Discharge is to the Colorado River alluvial material east of the site. Recharge to the Deep Aquifer is further north in Wharton County, where the aquifer outcrops. Discharge from the Deep Aquifer is to Matagorda Bay and the Colorado River estuary, approximately 5 mi southeast of the STP site. Shallow Aquifer groundwater quality is generally inferior to that of the Deep Aquifer.

The Shallow Aquifer has been subdivided into Upper and Lower zones. Both zones respond to pumping as confined or semi-confined aquifers with somewhat different potentiometric heads. The Upper Shallow Aquifer is comprised of interbedded sand layers to depths of approximately 50 ft below ground surface. The Lower Shallow Aquifer consists of interbedded sand layers between depths of approximately 50 to 150 ft below ground surface.

Aquifer pumping tests performed in the Shallow Aquifer at the site in support of STP 1 & 2 indicate well yields from 10 to 300 gpm. These tests also indicate a variable degree of hydraulic connection between the Upper Shallow Aquifer and Lower Shallow Aquifer (Reference 2.3.1-9).

2.3.1.2.3.2 Site Specific Hydrogeologic Conditions

The STP 3 & 4 geotechnical and hydrogeological investigation provided information to depths of 600 ft below ground surface. Subsurface information was collected from more than 150 geotechnical borings and cone penetrometer tests (CPTs). A detailed description of the geotechnical subsurface investigation, including the locations of these borings and CPTs is provided in COLA Part 2.

Twenty-eight (28) groundwater observation wells were installed in the vicinity of STP 3 & 4 and completed in the Upper and Lower Shallow Aquifer between October and December 2006. An additional 26 wells were installed in July and August 2008 along the north perimeter of the MCR and the site boundary, and around Kelly Lake. The wells were located to supplement the existing STP site piezometer network in order to provide (a) an adequate distribution for determining groundwater flow directions and (b) hydraulic gradients in the vicinity of STP 3 & 4. Well pairs were installed at all but two locations to determine vertical hydraulic gradients. Field hydraulic conductivity tests (slug tests) were conducted in each observation well. Monthly water level measurements from the first 28 STP 3 & 4 groundwater observation wells were collected from December 2006 through December 2007. Measurements were conducted quarterly during 2008. The September and December 2008 quarterly measurement events are included from all 54 observation wells. Figure 2.3.1-20 shows the locations of observation wells and piezometers at the STP site.

The subsurface data collected in 2006, 2007 and 2008 as part of the STP 3 & 4 subsurface investigation confirmed the aquifer conditions described for STP 1 & 2. The top of the upper sand layer in the Upper Shallow Aquifer is encountered at approximately depth of about 15 to 30 ft below ground surface. The groundwater potentiometric level is approximately 5 to 10 ft below ground surface. The unit is comprised of sand and silty sand, approximately 15 to 20 ft thick.

Multiple sandy units separated by silts and clays define the Lower Shallow Aquifer. The groundwater potentiometric level for these sands intervals is approximately 10 to 15 ft below ground surface in the vicinity of STP 3 & 4.

2.3.1.2.3.3 Groundwater Sources and Sinks

The natural regional flow pattern in the Beaumont Formation (Chicot Aquifer) is from recharge areas, where the sand layers outcrop at the surface, to discharge areas, which are either at the Gulf of Mexico or to the Colorado River Valley alluvium. The outcrop areas for the Beaumont Formation sands are in northern Matagorda County (Shallow Aquifer) and Wharton County (Deep Aquifer), to the north of Matagorda County. In the outcrop areas, precipitation falling on the ground surface can infiltrate directly into the sands and recharge the aquifer. Groundwater flow, in general, is towards the Gulf of Mexico. Superimposed on this generalized flow pattern is the influence of heavy pumping in the aquifer. Concentrated pumping areas can either alter or reverse the regional flow patterns.

The Holocene alluvium receives recharge from infiltration of precipitation and groundwater flow from the Shallow Aquifer in the Beaumont Formation. In the site area, flow paths in the alluvium are short due to the limited surface area. Discharge from the Holocene alluvium contributes to the base flow of the Colorado River. During certain times of the year the only sources of water to the Colorado River below Bay City are irrigation tail water releases and base flow created by seepage from the Holocene alluvium. Because there are no flow-gauging stations downstream of Bay City, the amount of base flow contributed by seepage is not known (Reference 2.3.1-24).

Groundwater from five production wells is currently used to support STP 1 & 2 plant operations. Water use from these wells includes: makeup water for the ECP, makeup of demineralized water, the potable and sanitary water system, and the plant fire protection system (Reference 2.3.1-25). The groundwater is pumped from the Deep Aquifer. Groundwater is projected to be the main source of makeup water for the STP 3 & 4 UHS, condensate makeup, radwaste and fire protection systems and the source of potable water for STP 3 & 4. The water level within the MCR will remain within the original design levels and therefore, large changes with the MCR seepage rate are not expected. Regional groundwater use trends and future plant groundwater demand projections are discussed in Subsection 2.3.1.2.4.

2.3.1.2.3.4 Groundwater Flow Directions and Subsurface Pathways

A regional potentiometric surface map for the Deep Aquifer in Matagorda County in 1967 is presented on Figure 2.3.1-21 (Reference 2.3.1-24). Figure 2.3.1-22 presents a potentiometric surface map for the Gulf Coast Aquifer from data collected between 2001 and 2005 (Reference 2.3.1-26). Comparison of the figures suggests that the regional flow direction of northwest to southeast is represented on both figures with localized flow disturbances caused by pumping. Comparison of the figures also suggests that groundwater elevations have increased in some parts of Matagorda County. In 1967, groundwater elevations above mean sea level were primarily located in the northern portion of the county. In the 2001-2005 potentiometric surface map, groundwater elevations in both the northern and central portions of the county were above mean sea level. The hydraulic gradient in the STP site area is 0.0006 ft/ft for the 1967 potentiometric surface map and 0.0002 ft/ft for the 2001 to 2005 map. Regional potentiometric surface maps are not available for the Shallow Aquifer, due primarily to limited regional use of this aquifer.

The STP piezometer network, site groundwater level measurements from November 1, 2005 and May 1, 2006 were used to develop potentiometric surface maps for the Upper and Lower Shallow Aquifer Figure 2.3.1-23 and the Deep Aquifer Figure 2.3.1-24. The Upper Shallow Aquifer groundwater flow direction in the vicinity of STP 3 & 4 is generally toward the southeast. There is also an apparent southerly flow direction along the west side of the MCR. This southerly flow direction may be a result of seepage from the MCR or the operation of the relief wells adjacent to the MCR dike. The groundwater flow direction in the vicinity of STP 3 & 4 in the Lower Shallow Aquifer is generally easterly. The Lower Shallow Aquifer flow direction turns southeasterly near the eastern edge of the STP site. Both the Upper and Lower Shallow Aquifer flow directions are consistent with flow toward the Holocene alluvium in the Colorado River floodplain. The groundwater flow directions and gradients are based on the water levels recorded in the observation wells and do not represent localized gradients between the eastern wells and the river. Localized conditions in the vicinity of the Colorado River could vary based on the flow and elevation of the river stage.

The potentiometric maps for the Deep Aquifer show the influence of onsite groundwater production, with most of the onsite groundwater flows toward the production wells. The onsite Deep Aquifer potentiometric surface suggests a reversal of the regional flow direction in the southern portion of the map, where flow is north towards the site pumping wells, rather than toward the southeast.

The potentiometric surface maps were used to estimate hydraulic gradients at the site. A flow line originating in the area of STP 3 & 4 was drawn on each map. The hydraulic gradient along these flow lines is estimated by dividing the head change along the flow line by the length of the flow line. The Upper Shallow Aquifer potentiometric surfaces indicate a hydraulic gradient of approximately 0.001 ft/ft. The Lower Shallow Aquifer potentiometric surface maps indicate a hydraulic gradient of approximately 0.0004 ft/ft. The Deep Aquifer has a hydraulic gradient between 0.0008 and 0.002 ft/ft. The hydraulic gradient in the Deep Aquifer adjacent to STP 3 & 4 appears to be influenced primarily by changes in pumping at Production Well 6 (Figures 2.3.1-20 and -24).

Monthly and quarterly groundwater level measurements have been collected from the Shallow Aquifer observation wells for the STP 3 & 4 subsurface investigation. The measurements are presented in Table 2.3.1-11. Well construction information is provided in Table 2.3.1-12. The measurements were used to prepare the potentiometric maps for February, April, June, September, and December of 2007, and March, June, September, and December 2008 (Figure 2.3.1-25). These maps indicate flow directions toward the southeast and southwest. The Upper Shallow Aquifer potentiometric surface map also shows seepage influence from the south, presumably from the MCR, and from the north, presumably from an irrigation water supply channel, the duck pond/marsh, or another source located to the north of Observation Well OW-954U. The potentiometric surface maps indicate hydraulic gradients of approximately 0.0007 ft/ft to 0.002 ft/ft for the southeast flow component and 0.0005 ft/ft to 0.0008 ft/ft for the southwest flow component in the Upper Shallow Aquifer. The Lower Shallow Aquifer hydraulic gradient is approximately 0.0004 ft/ft to 0.0007 ft/ft.

As part of the subsurface investigation program, well pairs screened in the Upper and Lower zones of the Shallow Aquifer were installed. These well pairs were used to estimate the vertical hydraulic gradient in the Shallow Aquifer. The vertical flow path length is assumed to be from the midpoint elevation of the Upper zone observation well screen to the midpoint elevation of the Lower zone observation well screen. Figure 2.3.1-26 shows a generalized hydrogeologic section through the STP 3 & 4 area. This figure shows the relationship between the Upper and Lower Shallow Aquifer zones and the interconnection of sand layers in the Lower Shallow Aquifer zone. The head difference over the vertical flow path is the difference in water level elevations between the two paired wells. The hydraulic gradient is estimated by dividing the head difference by the length of the flow path. Table 2.3.1-13 presents the estimated vertical hydraulic gradients. All well pairs except observation well pair OW-959 U/L and OW-961 U/L during September 2008 indicate a downward flow potential between the Upper and Lower zones in the Shallow Aquifer. The estimated vertical hydraulic gradients range from approximately 0.02 ft/ft at well pair 0W-961U/L on December 15, 2008 to 0.29 ft/ft at well pair OW-929U/L on January 30, 2007 in a downward direction. The two upward gradients recorded on September 22, 2008 at well pair OW-959 U/L (0.004), located north of Kelly Lake, and OW-961 U/L (0.007), located south of Kelly Lake, were very slight compared to the range of documented downward vertical gradients at the site. This appears to have been a temporary, perhaps seasonal or weather-related occurrence, considering a downward gradient was recorded at these two locations in the next quarter. A third well pair (OW-960 U/L), located immediately west of Kelly Lake, exhibited no upward gradient during either the September 2008 or the December 2008 groundwater level measurement events.

2.3.1.2.3.5 Temporal Groundwater Trends and Variations

The Texas Water Development Board (TWDB) has been collecting groundwater level data in Matagorda County since the 1940s (Reference 2.3.1-27). Two observation wells near the STP site were selected to prepare the regional hydrographs shown on Figure 2.3.1-27. These wells monitor two different intervals in the Deep Aquifer. Well 8015402 monitors the heavy pumping interval approximately 300 ft below ground surface. This well indicates that between 1957 and the early 1990s a significant drop in groundwater level occurred. Since the early 1990s, the groundwater level has been recovering and has nearly returned to the 1957 level. The second well, Well 8015301, monitors the deeper zone of the Deep Aquifer, corresponding to the production zone in the STP onsite wells. This well shows generally stable water levels over the period of record. Due to the limited groundwater development potential in the Shallow Aquifer, regional temporal measurements of water levels have not been collected.

Groundwater levels are monitored in the historical site observation wells (piezometers) as part of STP 1 & 2 operations. Selected observation wells in proximity to STP 3 & 4 were used to prepare hydrographs of the Shallow and Deep Aquifers, as shown in Figure 2.3.1-28. The monitoring data set selected extends from March 1995 through May 2006. Upper Shallow Aquifer Wells 603B and 601 are located to the west and east, respectively, of STP 3 & 4, and well 602A, which is located immediately north of STP 3. Well 603B shows some seasonal variability, on the order of 1 to 2 ft, while Well 601 shows little seasonal variability. Well 602A shows some seasonal variability, with a peak groundwater elevation over the period of record of 25.8 ft MSL and with a long term variability of approximately 4 ft. Lower Shallow Aquifer wells 603A and 601A are located to the west and east, respectively, of STP 3 & 4. These wells show some seasonal variability, with an overall decreasing trend in groundwater elevation. The elevation difference between the two wells suggests that they may be screened in different sand units in the Lower zone.

Deep Aquifer wells 613 and 605 are located to the southwest and north, respectively, of STP 3 & 4. These wells show a notable increase in water level elevation between 1996 and 1998. Water levels in Well 613 show a slight declining trend between 2004 and 2006. Well 613 is located in the influence of STP Production Well 6.

The first 28 Shallow Aquifer observation wells installed as part of the STP 3 & 4 subsurface investigation program have been used for water level measurements since December of 2006, and the 13 additional well pairs installed in July and August 2008 were monitored during the third and fourth quarters of 2008. Three well series designations represent the following location areas:

- OW-300 series wells are located in the proposed STP 3 facility area
- OW-400 series wells are located in the proposed STP 4 facility area
- OW-900 series wells include all of the wells located outside of the power block areas

An “L” suffix on the well number indicates a Lower Shallow Aquifer well and a “U” suffix indicates an Upper Shallow Aquifer well.

Figure 2.3.1-29 presents the hydrographs for these wells (December 2006 through December 2008). The temporal variation is approximately 6 ft for the Upper Shallow Aquifer and approximately 4 ft for the Lower Shallow Aquifer wells. These hydrographs suggest short-term temporal variations in the Upper Shallow Aquifer on the order of 1 to 2 ft. The Upper Shallow Aquifer wells show consistently higher groundwater elevations than the adjacent Lower Shallow Aquifer wells. In the power block areas, groundwater is approximately 5 ft below ground surface. An anomalously high reading was obtained from observation wells OW-408U and OW-420U during August 2007. The water level in both aquifers across the power block area during this time exhibited similar trends with the exception of these two data points.

2.3.1.2.3.6 Hydrogeologic Properties

The hydraulic properties of the aquifer materials at the STP site were evaluated using both field methods and laboratory analysis. Field parameters include transmissivity and storage coefficient measurements from historical aquifer pumping tests and hydraulic conductivity values determined from both historical aquifer pumping tests and the slug tests performed in December 2006 and in July and August of 2008 as part of the STP 3 & 4 subsurface investigation.

The geotechnical parameters derived from laboratory testing include bulk density (or dry unit weight), porosity, effective porosity, and permeability from grain size. Regional and site-specific hydrogeochemical data is also presented.

Vadose Zone

Between 1951 and 1980, the average annual precipitation in the general area of STP was approximately 42 inches, and the corresponding average annual runoff was estimated as about 12 inches (Reference 2.3.1-21). The difference of approximately 30 inches is either evaporated, consumed by plants, or percolates into the vadose zone to recharge the shallow aquifers. Much of the water is returned to the atmosphere by evapotranspiration (Reference 2.3.1-21).

The vadose zone is considered to be relatively thin and limited at the site. The first saturated sand zone is encountered at a depth of approximately 20 ft below ground surface, and is classified as part of the Upper Shallow Aquifer. The aquifer zone exhibits semi-confined to confined conditions. The potentiometric head is under pressure, rising to within 5 ft to 10 ft of ground surface as measured in the onsite observation wells. The soils overlying the sand are generally described as clay.

From the geotechnical data listed in COLA Part 2, measured natural moisture contents from samples collected to a depth of 20 ft ranged from approximately 5% to 29%. The majority of the values ranged between 15% and 25%. Dry unit weights for the materials sampled ranged from approximately 92 pounds per cubic foot (pcf) to 115 pcf. Wet densities when measured, ranged from approximately 97 pcf to 133 pcf.

Aquifer Properties

Regional aquifer properties have been collected by the TWDB (Reference 2.3.1-24). Data for the area in proximity to the STP site is presented on Table 2.3.1-14. Deep Aquifer transmissivity ranges from 10,500 to 195,300 gpd/ft (with one outlying value of 399,000 gpd/ft) and storage coefficient ranges from 4.6×10^{-5} to 1.4×10^{-3}. Although several of the wells on the table have screened intervals that encompass the depth interval associated with the Shallow Aquifer at the STP site, the screened intervals also extend into the Deep Aquifer, thus the test results cannot be applied to the Shallow Aquifer. Historical aquifer pumping tests have been performed on the STP site at three of the Deep Aquifer production wells and four test wells in the Shallow Aquifer in support of STP 1 & 2. The results of these tests are summarized on Table 2.3.1-15. Transmissivity ranges from 1100 to 50,000 gpd/ft and the storage coefficient ranges from 2.2×10^{-4} to 1.7×10^{-3}.

Additionally, five short duration aquifer pumping tests (with 6 to 8 hour pumping period) were conducted in the Upper Shallow Aquifer in five MCR relief wells during the construction and filling of the MCR. These tests, due to their short duration and the boundary influences of MCR filling, were not presented or used in the groundwater evaluations because they do not provide representative properties of the Upper Shallow Aquifer.

Figure 2.3.1-30 presents a graphical comparison of regional and site-specific measurements using box and whisker plots. The box and whisker plot, also known as a boxplot, is a graphical representation of the data based on dividing the data set into quartiles. The data range of the solid portion of the box encompasses 50% of the data and the data range of each "whisker" contains 25% of the data. The ends of the "whiskers" represent the minimum and maximum values in the data set. Examination of the transmissivity plot indicates that the regional and STP Deep Aquifer values fall in the same data range, while the STP Shallow Aquifer data range falls below the regional range. This is caused by two Upper Shallow Aquifer tests that have transmissivity values of 1100 and 12,500 gpd/ft. The plot for storage coefficient indicates that the regional, STP Deep Aquifer, and STP Shallow Aquifer fall in the same data range. The Shallow Aquifer values fall in the upper portion of the regional range of data. This may be a result of aquitard leakage influencing the Shallow Aquifer tests.

Hydraulic conductivity can be determined from aquifer pumping tests by dividing the transmissivity by the saturated thickness. There is uncertainty associated with this method because assumptions are made regarding the amount of permeable material present in the screened interval of the test well. The pumping wells have screened intervals ranging from 16 ft to 819 ft in length, and the saturated thickness is apportioned across this screened interval (possibly underestimating the hydraulic conductivity for the more permeable sands units in the well screen intervals). Hydraulic conductivity values from the aquifer pumping tests are included in Tables 2.3.1-14 and 2.3.1-15.

Hydraulic conductivity can also be determined by the slug test method. This method measures the water level response in the test well to an instantaneous change in water level in the well. A disadvantage of this method is that it measures hydraulic conductivity only in the immediate vicinity of the test well. Generally, slug test results provide reasonable low-end values of the hydraulic conductivity of a given system. 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. Table 2.3.1-16 presents a summary of slug tests performed in observation wells installed as part of the STP 3 & 4 subsurface investigation. The test results indicate a range of hydraulic conductivity from 7 to 1,316 gpd/ft^2.

The slug test results for the Upper and Lower zones of the Shallow Aquifer were contoured, as shown on Figure 2.3.1-31, to delineate spatial trends. The Upper Shallow Aquifer contour map indicates the area of highest measured hydraulic conductivity in the vicinity of STP 3. The surrounding measurements suggest these characteristics are localized to this area. The Lower Shallow Aquifer map indicates areas of higher hydraulic conductivity at and southeast of STP 3 & 4 and an isolated area south of Kelly Lake at observation well OW-961. This area corresponds to the area of higher groundwater elevation identified on the February 22, 2007 potentiometric surface map for the Lower Shallow Aquifer, as previously shown on Figure 2.3.1-25.

Box and whisker plots comparing hydraulic conductivity from regional aquifer pumping tests, STP site aquifer pumping tests, STP site slug tests, and grain size data are shown on Figure 2.3.1-32. The grain size derived hydraulic conductivity is discussed in the next section. The plots indicate that regional aquifer pumping tests have the greatest range of hydraulic conductivity; however, the geometric means for the STP site aquifer pumping test derived hydraulic conductivity values and the slug test results are not significantly different (337 gpd/ft^2 versus 126 gpd/ft^2).

Geotechnical Properties

The geotechnical investigation component of the STP 3 & 4 subsurface investigation program included the collection of soil samples for laboratory determination of soil properties. These tests are discussed in FSAR Section 2.5S. A summary of the test results are presented in Table 2.3.1-17. The results have been arranged to reflect the properties of the various hydrogeologic units present at the site. Basic soil properties were used to estimate the hydrogeologic properties of the materials such as porosity, effective porosity, and permeability. Bulk density values were measured by the laboratory, thus no further processing of the data was necessary.

Porosity is determined from a conversion of the void ratio to porosity. The effective porosity (or specific yield) is some fraction of porosity. In general terms, the effective porosity of sands or gravels approximates porosity, while the effective porosity of silts and clays is much less than their porosity. Figure 2.3.1-33 (from Reference 2.3.1-28) shows the relationship between porosity, specific yield, and specific retention for various median grain sizes and sorting conditions. Interpolating from this graph for median grain sizes in the Shallow Aquifer, and using the curve for average material, suggest that the specific yield is approximately 80% of the porosity of the Shallow Aquifer.

Permeability or hydraulic conductivity of sands can be estimated using the D10 grain size using the Hazen formula (Reference 2.3.1-29). This formula is based on empirical studies for the design of sand filters for drinking water. The formula was developed for use in well-sorted sand, and application to poorer-sorted materials would result in over-prediction of permeability. Figure 2.3.1-32 included the grain size derived hydraulic conductivity with aquifer pumping test and slug test derived hydraulic conductivity. Comparison of the box plots suggests that the grain size derived hydraulic conductivity is within the range of the slug test hydraulic conductivity values but, is below that of the regional and STP aquifer pumping test values. Comparison of the geometric means indicates the grain size derived hydraulic conductivity is below the geometric means determined from the other cited sources of hydraulic conductivity.

The hydraulic conductivity of the clay materials was measured in the STP 1 & 2 subsurface investigation (Reference 2.3.1-9). Table 2.3.1-18 summarizes the results of these tests. The geometric mean hydraulic conductivity of the clay samples is 0.004 gpd/ft^2 (1.72×10^{-7} cm/s). The clay samples were collected to a maximum depth of 39 ft below ground surface. The uniform depositional history and effects of consolidation and loading on clay hydraulic conductivity suggest that it would be a conservative assumption to apply these hydraulic conductivity values to deeper clays at the site.

Hydrogeochemical Characteristics

Regional hydrogeochemical data were obtained from Reference 2.3.1-24 and are presented in Table 2.3.1-19. The data set includes 10 wells in the Deep Aquifer and seven wells in the Shallow Aquifer. The analytical data was compared to EPA Primary and Secondary Drinking Water Standards (Reference 2.3.1-30), and exceedances are identified on the table. The principal exceedances were for total dissolved solids and chloride (Secondary Drinking Water Standards). Examination of data suggests that the highest concentrations of total dissolved solids and chlorides are present in the Shallow Aquifer.

STP site-specific hydrogeochemical data are presented in Table 2.3.1-20, which includes seven samples from the Deep Aquifer and 23 samples from the Shallow Aquifer. The analytical data were also compared to EPA Primary and Secondary Drinking Water Standards and the exceedances are identified on the table. The principal exceedances were for total dissolved solids and chloride with the highest concentrations present in the Shallow Aquifer.

The hydrogeochemical data can also be used as an indicator of flow patterns in the groundwater system. 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 the groundwater sample. These facies can be shown graphically on a trilinear diagram (Reference 2.3.1-31). A trilinear diagram showing the regional and STP site-specific data is presented in Figure 2.3.1-34. The predominant groundwater type for the Deep Aquifer regional groundwater data is a sodium bicarbonate type, while for the Shallow Aquifer regional data the groundwater type varies from a sodium bicarbonate type to a sodium chloride type. The predominant STP site-specific groundwater type in the Deep Aquifer is sodium bicarbonate, in the Upper Shallow Aquifer is sodium chloride, and in the Lower Shallow Aquifer is sodium bicarbonate. An exception to the Lower Shallow Aquifer hydrochemical facies pattern is observed at observation wells OW-332L and OW-930L, where the water type is sodium chloride. This facies change may indicate the proximity of a zone of vertical interconnection between the Upper and Lower Shallow Aquifers. This observation would be consistent with the findings of aquifer pumping test WW-4 that indicated a localized hydraulic connection between the Upper and Lower Shallow Aquifers (Reference 2.3.1-32). The conclusion that this is a localized connection is based on the absence of a hydraulic connection at the other three aquifer pumping test sites. The source of this interconnection may be either a natural feature, such as an incised channel or scour feature, or a man-made feature, such as an excavation backfilled with pervious material or a leaking well seal. The manmade sources of interconnection are less probable because the depth to the Lower Shallow Aquifer is on the order of 60 ft below ground surface, which would be below most site excavations, and leaky well seals also typically exhibit elevated pH associated with the impacts of cement grout, which is not observed at either of the wells.

Hydrogeologic Conceptual Model

Figure 2.3.1-35 presents a simplified hydrostratigraphic section of the site. The units presented on the section were used as a framework to relate measured or estimated properties to the groundwater system. A summary of important properties related to groundwater flow and transport is presented on Table 2.3.1-21. The values for bulk density, total porosity, and effective porosity for the Deep Aquifer were taken from tests performed in the Lower Shallow Aquifer. The similarity of depositional environments and the observed grain size distributions suggest that an assumption of equivalence between the units is reasonable.

To assign representative values, the properties were divided into spatially and temporally variable data. Spatially variable data includes unit thickness, hydraulic conductivity, bulk density, porosity, and effective porosity. Representative values for the spatially variable data were assigned either an arithmetic mean (unit thickness, bulk density, porosity, and effective porosity) or a geometric mean (hydraulic conductivity) of the referenced data set. Temporally variable data are the hydraulic gradient measurements, and the maximum value from each data set are assigned as the representative value.

2.3.1.2.4 Groundwater Users and Historical Trends

Groundwater use is discussed in Subsection 2.3.2.2. A summary is provided in the following sections to assist with the description of the hydrogeologic conceptual model used in the groundwater flow and transport evaluation presented in Subsection 2.3.1.2.5. The databases referenced in this section are periodically updated by the identified source agency. The information used in this evaluation was accessed through the source agency web pages in March 2007.

2.3.1.2.4.1 Sole Source Aquifers

The Gulf Coast Aquifer has not been declared a Sole Source Aquifer (SSA) by the U.S. Environmental Protection Agency (EPA) (Reference 2.3.1-33). A SSA is a source of drinking water for an area that supplies 50% or more of the drinking water with no reasonably available alternative source should the aquifer become contaminated. Figure 2.3.1-36 shows the location of SSAs in EPA Region VI, which includes Texas. The nearest SSA in Texas is the Edwards I and II Aquifer System, which is located approximately 150 mi northwest of the STP site. Based on a southeasterly groundwater flow direction beneath Matagorda County toward the Gulf of Mexico, and the distances to the identified SSAs, the construction and operation of STP 3 & 4 will not impact any SSAs. The identified SSAs are upgradient and beyond the boundaries of the local and regional hydrogeologic systems associated with the STP site.

2.3.1.2.4.2 Regional Groundwater Trends

Groundwater pumpage 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 then increased relatively slowly through the mid 1980s. By the mid 1980s, withdrawals were primarily from the east and central area of the aquifer system. This included the Houston area; but some of the greatest pumpage was associated with rice irrigation centered in Jackson, Wharton, and portions of adjacent counties including Matagorda (Reference 2.3.1-21).

Problems associated with groundwater pumpage, such as land subsidence, saltwater encroachment, stream base-flow depletion, and larger pumping lifts, have caused pumpage to be curtailed in some areas. As a result, TWDB began making projections of future groundwater use. For the 10 counties that withdrew the largest amount of water from the Gulf Coast Aquifer System during 1985, state officials projected a large decline in pumping from six counties, including Matagorda County, through 2030. Matagorda County was expected to experience a net decrease of 48% or 15 million gallons per day (mgd), with pumping rates decreasing from 31 mgd to approximately 16 mgd (Reference 2.3.1-21). These water use projections undergo revisions and updating as technical and socioeconomic factors change and are further discussed in Subsection 2.3.2.2.

The EPA monitors drinking water supply systems throughout the country and displays the results on their Safe Drinking Water Information System (SDWIS) website (Reference 2.3.1-34). Figure 2.3.1-37 shows the locations of the SDWIS water supply systems in Matagorda County as of March 2007. A total of 40 systems were identified in Matagorda County by SDWIS, with seven systems serving greater than 1000 people, 18 systems serving greater than 100 to less than 1000 people, and 15 systems serving less than or equal to 100 people. The closest SDWIS water supply systems are the onsite water supply (Water system ID TX1610051) and the Nuclear Training Facility water supply (Water system ID TX1610103). The nearest non-site related SDWIS water supply system is the Selkirk Water System, which is located across the Colorado River from the STP, approximately 4 mi to the southeast.

Regional groundwater use in the site area is controlled by the TWDB and in Matagorda County by the Coastal Plains Groundwater Conservation District (CPGCD). The TWDB maintains a statewide database of wells called the Water Information Integration and Dissemination (WIID) system. This database includes water wells and oil and gas production wells (Reference 2.3.1-35). The CPGCD, in conjunction with the Coastal Bend Groundwater Conservation District (Wharton County), also maintains a database of water wells (Reference 2.3.1-36).

Information from the TWDB database was used to prepare Figure 2.3.1-38, which shows well locations in Matagorda County as of March 2007. The database includes water wells, and oil and gas wells. The search area for wells was limited to Matagorda County because pumping effects in the Deep Aquifer and flow information in the Shallow Aquifer suggest that groundwater use and groundwater impacts from accidents at STP would be limited to this area. The figure presents a total of 838 water wells in Matagorda County. It should be noted that the TWDB database (Driller’s Report database) includes 18 wells identified as being in other counties, but the well coordinates plot in Matagorda County. It is not known whether these entries have erroneous county names or location coordinates.

Figure 2.3.1-39 presents the water well information from the CPGCD as of March 2007. The database includes 1989 water wells in Matagorda County. The larger number of wells in this database is a result of including single-family domestic wells.

The TWDB conducts water use surveys throughout the state (Reference 2.3.1-37). The surveys are based on information submitted by the water user and may include estimated values. These surveys do not include single-family domestic well groundwater use. The TWDB also prepares estimates of future water use as part of water supply planning (Reference 2.3.1-38). These estimates contain uncertainties associated with population growth projections, assumptions about climatic conditions (drought or wet years), and schedules for implementation of water conservation measures. The results of these studies and projections are discussed in Subsection 2.3.2.2 and FSAR Subsection 2.4S.12.

2.3.1.2.4.3 Plant Groundwater Use

Both surface water and groundwater are used on the site to support STP 1 & 2 plant operations. The groundwater is pumped from the Deep Aquifer using five production wells (Production Wells 5 through 8 and the Nuclear Training Facility [NTF] well), as shown on Figure 2.3.1-20. No sustained pumping is permitted within 4000 ft of the STP 1 & 2 plant area in order to minimize the potential for subsidence resulting from lowering of the Deep Aquifer potentiometric head. The exception is the NTF well, which was installed to provide fire protection water to the NTF. Potable water for the NTF is supplied by Production Well 8.

Based on the results of an operating plant (Units 3 and 4) water balance calculation (Reference 2.3.1-42) and a site groundwater use calculation (Reference 2.3.1-43), STPNOC has determined that the STP site groundwater operating permit limit provides adequate groundwater supply for water uses required for the operation of STP Units 1 and 2 and the construction, initial testing, and operation of STP Units 3 and 4. The permit allows groundwater withdrawals from the five site production wells discussed above up to a limit of 9000 acre-feet over the permit term of approximately 3 years. For discussion purposes, this permit limit may be described herein as “approximately 3000 acre-feet/year,” recognizing that groundwater withdrawal in a single year may exceed 3000 acre-feet provided that total withdrawals over the permit term do not exceed 9000 acre-feet. As a point of reference, if the permit limit were exactly 3000 acre-feet/year (which is not necessarily the case due to slight variances in the permit term with each permit renewal), the equivalent “normalized” withdrawal rate assuming continuous pumping every minute of every day of each year would be approximately 1860 gpm.

Historical groundwater withdrawal rates associated with operation of Units 1 and 2 are provided in Table 2.3.1-22 and Table 2.3.2-18. This data shows that from 2001 through 2006, annual groundwater use for operation of STP Units 1 and 2 averaged approximately 798 gpm (approximately 1288 acre-feet/year). A small but not insignificant portion of this amount has been diverted to the Main Cooling Reservoir (MCR) as a result of manual operation of the groundwater well pump and header system. With the installation of appropriate automated groundwater well pump and header system controls, this diverted groundwater would be available for use by Units 3 and 4. However, as documented in the site groundwater use calculation (Reference 2.3.1-43), it has been determined that even if this water were not available to Units 3 and 4, the existing STP site groundwater operating permit limit provides adequate groundwater supply for water uses required for the operation of STP Units 1 and 2 and the construction, initial testing, and operation of STP Units 3 and 4.

Water uses projected for the operation of STP Units 3 and 4 are derived from system design data as well as from operational water use data for specific systems for which such data is available (Reference 2.3.1-42). Conservative water use projections for simultaneous operation of both STP Units 3 and 4 are summarized in Table 2.3.2-19 and Table 3.3-1, and include a total estimated normalized groundwater demand of approximately 975 gpm (approximately 1574 acre-feet/year), and approximately 3434 gpm for maximum short-term steady-state conditions.

Water uses for the construction (including concrete production) and initial testing of STP Units 3 and 4 were estimated for each month during the construction period through the commencement of unit operation (Reference 2.3.1-43). As documented in the site groundwater use calculation (Reference 2.3.1-43), monthly construction water uses are projected to range from a normalized rate of approximately 10 gpm to approximately 228 gpm. Similarly, monthly water uses associated with initial testing of STP Units 3 and 4 are projected to range from a normalized rate of approximately 47 gpm to approximately 491 gpm.

When evaluating whether the total site groundwater demand can be satisfied by the available groundwater supply, the groundwater use values quantified above cannot simply be added since the timing and duration of the use must be considered. For example, water uses associated with construction and initial testing of STP Unit 4 will “overlap” with those for operation of Units 1, 2, and 3. Thus, the site groundwater use calculation (Reference 2.3.1-43) considers the schedule projected for each use, and evaluates the total site groundwater usage at each point in time from the commencement of STP Units 3 and 4 construction until both Units 3 and 4 are in operation (i.e., Units 1, 2, 3 and 4 are operating simultaneously). With consideration for the need to maintain water storage capacity to provide for peak site water demands, this evaluation confirms that total site groundwater demand remains below the existing site groundwater permit limit during construction, initial testing, and operation of STP Units 3 and 4.

The design groundwater withdrawal capacity associated with the five (5) site production wells covered by the existing site groundwater operating permit is described in Table 2.3.2-17. Of the total 1950 gpm design capacity indicated in the table, not more than approximately 1650 gpm is considered to be available based on operating experience and the fact that use of the NTF pump is limited to providing fire protection water for the NTF. Therefore, STPNOC intends to install at least one additional site groundwater well with a design capacity of 500 gpm. As documented in the site groundwater use calculation (Reference 2.3.1-43), this additional capacity will allow for sufficient groundwater withdrawal to meet water uses required for: (1) operation of STP Units 1 and 2 and the construction, initial testing, and operation of STP Units 3 and 4; and (2) potential temporary capacity reduction as a result of equipment failure/unavailability. Any additional wells would be properly permitted under applicable Coastal Plains Groundwater Conservation District (CPGCD) and TECQ requirements, and would not involve a request for an increase in the permit limit.

As with the existing five (5) site production wells, any new well(s) would be installed to depths within the deep portion of the Chicot Aquifer. The potential impacts to the local groundwater aquifer system as the result of the construction, initial testing, and operation of STP Units 3 and 4 are discussed in Section 4.2 and Section 5.2.

2.3.1.2.5 Groundwater Flow and Transport

The likelihood of an accidental liquid effluent release to groundwater is remote due to multiple levels of protection in the liquid radwaste system. The radwaste building system components are designed to prevent environmental releases, and include a stainless steel lined compartment to contain tank spillage and specially constructed building components surrounding the tanks to capture and prevent releases from the Radwaste Building. These design components would mitigate any potential release from the building tanks to the subsurface environment. Discussion of sorption and radioactive decay effects on offsite exposure is presented in COLA Part 2. Provided in the next section is a brief description of the potential groundwater pathways in the highly unlike event that a release could occur.

2.3.1.2.5.1 Groundwater Pathway

The Shallow Aquifer would be the most likely hydrogeologic unit to be impacted by an accidental liquid effluent release on site. The Upper Shallow Aquifer has a predominant flow direction from the proposed STP 3 & 4 power block toward the southeast. A minor transient southwest flow component from STP 4 toward Little Robbins Slough has also been identified in the Upper Shallow Aquifer. A similar southwest flow component was not identified for the Lower Shallow Aquifer. Examination of Figure 2.3.1-40 (Reference 2.3.1-39) indicates that a potential Upper Shallow Aquifer groundwater discharge area would be the unnamed surface water tributary, located to the east of the STP 1 & 2 ECP, which flows into Kelly Lake, approximately 7300 ft from STP 3. Although Kelly Lake is a plausible pathway exposure point, it is approximately 3,500 feet further from STP 3 than the unnamed tributary exposure point, which renders it a less conservative analysis than the unnamed tributary exposure point. A second possible discharge area for both the Upper and Lower Shallow Aquifer is at Well 2004120846, which is an 80 ft deep livestock well located east of the site boundary, approximately 9000 ft from STP 3. A third possible discharge area for both Shallow Aquifer zones would be the Colorado River, approximately 17,800 ft to the southeast of STP 3. A fourth possible discharge area for the Upper Shallow aquifer is Little Robbins Slough at the west site boundary, approximately 6,000 feet southwest of STP 4. This exposure point accounts for the transient southwest component of flow from STP 4 in the Upper Shallow Aquifer.

Over much of the site, the Lower Shallow Aquifer is isolated from the Upper Shallow Aquifer by a less permeable confining layer. However, aquifer pumping test data and hydrogeochemical data suggest that leakage through the less permeable confining layer separating these to aquifer zones is occurring. Additionally, excavations for the foundations of some of the deeper structures are projected to depths associated with the Lower Shallow Aquifer. A consistent downward vertical hydraulic gradient exists between the Upper and Lower Shallow Aquifer, which would provide the driving force for movement of groundwater from the Upper to the Lower Shallow Aquifer

An effluent release scenario would be a direct effluent release into the surrounding excavation backfill material. The downward hydraulic head between the Upper and Lower Shallow Aquifer zones would result in vertical migration downward through the backfill to the Lower Shallow Aquifer. The Lower Shallow Aquifer has an east to southeast flow direction. Due to the depth to the top of the aquifer, and the downward vertical hydraulic gradient in the Lower Shallow Aquifer, it is unlikely that discharge would occur into the unnamed tributary to the east of the STP 1 & 2 ECP. Likely discharge points are Well 2004120846 as discussed above or the Colorado River alluvium, where the river channel has incised into the Lower Shallow Aquifer, approximately 17,800 ft from STP 3 & 4.

The Deep Aquifer is the least likely hydrogeologic unit to be impacted by an accidental liquid effluent release. A release of contaminants would follow the path of least resistance, which is the permeable sand layers within the Shallow Aquifer. The Deep Aquifer is separated from the Shallow Aquifer by a 100 to 150 ft thick clay and silt layer with low permeability. Surface maps for the Deep Aquifer indicate that groundwater flow beneath the site is moving toward the site production wells, thus precluding the potential for offsite migration. These factors suggest that there is no credible offsite release pathway for the Deep Aquifer.

2.3.1.2.5.2 Advective Transport

Advective transport assumes that an accidental liquid effluent release travels at the same velocity as groundwater flow. The groundwater flow velocity or average linear velocity is estimated from Reference 2.3.1-29:

$$v = \frac{Ki}{n_e}$$

where:

v = average linear velocity (ft/day)

K = hydraulic conductivity (ft/day)

i = hydraulic gradient (ft/ft)

n_e = effective porosity (decimal)

The travel time from the effluent source to the receptor would be:

$$T = \frac{D}{v}$$

where:

T = travel time (day)

D = distance from source to receptor (ft)

v = average linear groundwater velocity (ft/day)

Table 2.3.1-23 presents average linear velocity and travel time estimates for the Shallow Aquifer using representative properties from Table 2.3.1-21. The average linear velocity in the Upper Shallow Aquifer is estimated to be 0.13 ft/day and in the Lower Shallow Aquifer to be 0.16 ft/day. In the Upper Shallow Aquifer, the estimated average travel time to the unnamed tributary or the hypothetical well at the east site boundary is about 154 years, to Well 2004120846 about 190 years, and to the Colorado River about 375 years. In the Lower Shallow Aquifer, the estimated average travel time to the hypothetical well at the east site boundary is about 125 years, to Well 2004120846 is about 154 years, and to the Colorado River is about 305 years. Table 2.3.1-23 also includes groundwater velocity and travel time ranges for a southwest transport pathway in the Upper Shallow Aquifer from Unit 4 to the west property boundary. The average linear velocity and estimated average travel time for this pathway is estimated to be 0.05 ft/d and about 330 years, respectively. Bounding average linear velocities and travel times based on the calculated range for hydraulic conductivities, hydraulic gradients, and effective porosities are also presented in Table 2.3.1-23.

2.3.1.2.6 Monitoring and Safeguards

Groundwater level monitoring in the STP 3 & 4 area is currently being implemented through the use of the groundwater observation wells installed in 2006 and through the periodic review of water levels from selected historical wells in the vicinity of the site.

Some of the existing STP 3 & 4 area observation wells will be taken out of service prior to construction activities due to anticipated earth moving and construction requirements. Prior to commencing construction activities, the observation well monitoring network will be evaluated in order to determine groundwater data gaps and needs created by the abandonment of existing wells. These data needs will be met by the installation of additional observation wells, if required. As part of the detailed engineering for STP 3 & 4, the groundwater monitoring program described in Section 6 and Subsection 2.4S.12.4 of the FSAR will be evaluated to determine if modification of the existing program is required to adequately monitor plant effects on the groundwater.

Construction activities at STP 3 & 4 should not adversely affect the local or regional groundwater systems. The Shallow Aquifer will be temporarily impacted during construction dewatering activities. The Deep Aquifer is not expected to be impacted by construction activities. Construction and water related impacts are discussed in Sections 4.2 and 6.3.

During excavation and construction of STP 3 & 4, the hydrostatic loading on the excavation and structures will be controlled by a temporary construction dewatering system which includes the installation of a slurry wall around the perimeter of the entire excavation. Typical dewatering systems for this type of cut and fill excavation would consist of a combination of perimeter dewatering wells and open pumping from sumps in the excavation. The perimeter dewatering wells would control lateral inflow and assist in removing water stored in the excavation. The open pumping system would control precipitation runoff, assist in water storage removal, and the removal of any inflow to the excavation.

Excavations for the construction of STP 3 & 4 are preliminarily planned to depths of at least 94 ft below nominal post-construction site grade (approximately 34 ft MSL). The reactor building bottom of foundation is expected to be placed at a depth of approximately 84 ft below existing grade, with the control building at a depth of approximately 76 ft, the UHS basins and pump houses at 30 ft and 62 ft (respectively), and the turbine building at the lowest stepped depth of approximately 60 ft. Perimeter construction dewatering will be required to a depth of at least 35 ft with deeper excavation dewatering to a depth of at least 100 ft. The excavation design includes the addition of a slurry wall. The wall is located outside the foundation and excavation areas, at least 30 feet from the top edge of the excavation, and is continuous around the perimeter. The low permeability wall will hydraulically isolate the excavation inside the wall and allow the excavation to be dewatered, minimizing the effect on the groundwater outside the wall. Details are in Section 2.5S.4.5.2 of the FSAR.

The hydrogeologic conditions encountered beneath the STP 3 & 4 area are, in general, similar to that beneath STP 1 & 2. The initial dewatering rate is estimated to be 6700 gpm and is expected to decline due to the slurry wall. The range in pumping rates is dependent on the hydraulic conductivity used in the analysis. Since the excavation required for the construction of STP 3 & 4 is estimated to be deeper than that for STP 1 & 2, the flow rates estimated for STP 3 & 4 are considered to be within reason in comparison to actual flow rates measured at STP 1 & 2 which were between 1300 and 2900 gpm. The slurry wall will reduce the amount of water to be removed. The slurry wall is a permanent featureas opposed to other typed of cut off walls which are temporary. Some dewatering would still be required to remove storage, precipitation runoff, and vertical inflow. Methods to mitigate the potential for subsidence to existing structures include cut-off walls, injection wells, and infiltration trenches. The entire dewatering system consists of a combination of deepwells, recharge wells, jet eductors, sand drains, wellpoints, pumps, standby pumps, sumps, sump pumps, trenches, and necessary appurtenances capable of achieving the design requirements to dewater or to depressurize the major water-bearing strata.

The ground surface elevation within the power block areas prior to construction is approximately 29 ft to 32 ft MSL. The post construction grade will range from approximately 32 ft to 36.6 ft MSL. Floor grade for the main building facilities is expected to be at approximately 35 ft MSL. Based on the water level elevations collected to date, the groundwater depth in the power block area for both units is below the maximum groundwater level of 61 cm (2 ft) below ground surface as specified in ABWR DCD Tier 2, Table 2.0-1 (Reference 2.3.1-40). Based on this observation, a permanent dewatering system is not a design feature for the STP 3 & 4 facilities.

Post-construction groundwater conditions are anticipated to have some localized changes resulting from excavation, backfilling, and placements of buildings. However, based on observations of STP 1 & 2 post-construction groundwater conditions, the effects would be minimal and may include localized communication between the Upper and Lower Shallow Aquifers and an increased cone of depression in the Deep Aquifer resulting from increased groundwater use for STP 3 & 4.

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Table 2.3.1-1 Major Freshwater Streams in the Colorado River Basin

Stream Name	County	Drainage Area (sq. miles)
Beals Creek	Mitchell County	9,802 [1]
Concho River	Concho County	6,574 [2]
San Saba River	San Baba County	3,046 [3]
Llano River	Llano County	4,197 [4]
Pedernales River	Blanco County	901
Pecan Bayou	Mills County	2,073
Barton Creek	Travis County	215
Onion Creek	Travis County	321

Data in the Table are taken from Reference 2.3.1-6

Notes:

[1] Of the drainage area, about 7,814 mi^2 is probably not contributing.

[2] Of the drainage area, about 1,131 mi^2 is probably not contributing.

[3] Of the drainage area, about 7 mi^2 is probably not contributing.

[4] Of the drainage area, about 5 mi^2 is probably not contributing.

Table 2.3.1-2 Major Dams in the Colorado River Basin

	Dam Name	NID ID	River	Maximum Height	Maximum Storage	Drainage Area	Surface Area	Year Completed	Dam Type	Dam Purposes	Hazard	County	Owner Type	Owner Name	Longitude	Latitude
				ft	acre-ft	sq mi	acre								degrees	degrees
1	Mansfield Dam (Marshall Ford Dam)	TX01087	Colorado River	278	3,223,000	38,130	18,929	1942	REPGER	IH	H	Travis	L	Lower Colorado River Authority	-97.9067	30.3917
2	Twin Buttes	TX00022	Middle And South Concho Rivers	134	1,087,530	2,472	32,660	1962	RE	ICR	H	Tom Green	F	DOI BR	-100.5333	31.3767
3	Buchanan Dam	TX00989	Colorado River	146	982,000	50.1	23,060	1937	PGRE	IH	H	Burnet	L	Lower Colorado River Authority	-98.4183	30.7517
4	Robert Lee Dam	TX03517	Colorado River	140	810,000	4,140	18,000	1969	RE	R	H	Coke	L	Colorado River Municipal Water District	-100.515	31.895
5	OC Fisher Dam (San Angelo Dam)	TX00012	Concho River	128	696,300	1,511	3,854	1952	RE	R	H	Tom Green	F	Corps Of Engineers SWF	-100.4833	31.4667
6	Simon Freese Dam (Stacy Dam)	TX06386	Colorado River	148	540,340	18.4	19,149	1989	RECN	R	H	Coleman	L	Colorado River Municipal Water District	-99.6683	31.4967
7	Lake Brownwood Dam	TX02789	Pecan Bayou	120	448,200	2.4	7,300	1933	RE	R	H	Brown	L	Brown County WID No 1	-99.0017	31.8383
8	Lake J B Thomas Dam (Colorado River Dam)	TX04138	Colorado River	105	360,000	3,524	7,820	1952	RE	R	H	Scurry	L	Colorado River Municipal Water District	-101.135	32.5833
9	Alvin Wirtz Dam	TX00986	Colorado River	118	227,000	37.8	6,375	1951	RE	HR	H	Burnet	L	Lower Colorado River Authority	-98.3383	30.555

Table 2.3.1-2 Major Dams in the Colorado River Basin (Continued)

	Dam Name	NID ID	River	Maximum Height ft	Maximum Storage acre-ft	Drainage Area sq mi	Surface Area acre	Year Completed	Dam Type	Dam Purposes	Hazard	County	Owner Type	Owner Name	Longitude degrees	Latitude degrees
10	Brady Dam	TX01659	Brady Creek	104	212,400	513	2,020	1963	RE	R	H	McCulloch	L	City Of Brady	-99.3917	31.14
11	Natural Dam Salt Lake [1]	TX06028	Sulphur Springs Draw	47	207,265	556	3,710	1989	RE	CP	H	Howard	L	Colorado River Municipal Water District	-101.625	32.2183
12	Coleman Dam	TX02152	Jim Ned Creek	92	91,680	299	1,886	1966	RE	R	H	Coleman	L	City Of Coleman	-99.465	32.03
13	Champion Creek Dam	TX01691	Champion Creek	120	90,200	164	1,560	1959	RE	R	L	Mitchell	U	TU Electric	-100.86	32.2817
14	Cedar Creek Dam	TX04380	Cedar Creek	106	88,628	6.3	2,400	1977	RE	C	H	Fayette	L	Lower Colorado River Authority	-96.7367	29.915
15	Oak Creek Dam	TX03516	Oak Creek	95	79,336	244	2,375	1950	RE	C	H	Coke	L	City Of Sweetwater	-100.2667	32.04
16	Tom Miller Dam	TX01086	Colorado River	85	73,100	26,124	1,830	1939	CNPG	HR	H	Travis	L	City Of Austin	-97.7867	30.295
17	Colorado City Dam (Morgan Creek Dam)	TX01693	Morgan Creek	85	70,700	322	1,610	1949	RE	R	L	Mitchell	U	TU Electric	-100.9167	32.3183
18	Roy Inks Dam	TX00988	Colorado River	96	63,500	32,076	803	1938	PG	HR	H	Burnet	L	Lower Colorado River Authority	-98.385	30.73
19	Mitchell County Dam [1]	TX06420	Beals Creek	70	50,241	15.3	1,603	1991	REOT	T	S	Mitchell	L	Colorado River Municipal Water District	-101.105	32.24
20	Hords Creek Dam	TX00006	Hords Creek	91	49,290	48	510	1948	RE	R	H	Coleman	F	Corps Of Engineers SWF	-99.5667	31.85

Table 2.3.1-2 Major Dams in the Colorado River Basin (Continued)

	Dam Name	NID ID	River	Maximum Height	Maximum Storage	Drainage Area	Surface Area	Year Completed	Dam Type	Dam Purposes	Hazard	County	Owner Type	Owner Name	Longitude	Latitude
				ft	acre-ft	sq mi	acre								degrees	degrees
21	Decker Creek Dam	TX01089	Decker Creek	83	45,200	9.3	1,269	1967	RE	R	H	Travis	L	City Of Austin	-97.5967	30.285
22	Nasworthy Dam	TX03139	South Concho River	47	42,500	3,833	-	1930	RE	R	H	Tom Green	L	City Of San Angelo	-100.4783	31.3883
23	Ballinger Municipal Lake Dam (Lake Moonen Dam)	TX05952	Valley Creek	76	34,353	-	560	1985	RE	R	H	Runnels	L	City of Ballinger	-100.0433	31.73
24	Elm Creek Dam	TX05776	Elm Creek	57	33,500	65.5	643	1983	RE	R	H	Runnels	L	City of Winters	-99.8683	31.9383
25	Sulphur Springs Draw Dam [1]	TX06482	Sulphur Springs Draw	33	20,692	258	970	1993	RE	T	S	Martin	L	Colorado River Municipal Water District	-101.7486	32.3217
26	Bastrop Dam	TX02718	Spicer Creek	80	16,962	8.7	244	1964	RE	R	H	Bastrop	L	Lower Colorado River Authority	-97.2917	30.155
27	Upper Pecan Bayou WS SCS Site 17 Dam (Lake Clyde Dam)	TX02940	North Prong Pecan Bayou	63	16,550	38	449	1970	RE	C	S	Callahan	L	Callahan Divide SWCD	-99.47	32.3133
28	Brady Creek WS SCS Site 17 Dam	TX01677	South Brady Creek	50	13,511	28.8	76	1962	RE	C	L	McCulloch	L	McCulloch SWCD	-99.5967	31.1467
29	Brady Creek WS SCS Site 28 Dam	TX01626	Fitzgerald Creek	42	13,042	21.88	67	1957	RE	C	L	Concho	L	Concho SWCD	-99.88	31.1486

Table 2.3.1-2 Major Dams in the Colorado River Basin (Continued)

	Dam Name	NID ID	River	Maximum Height	Maximum Storage	Drainage Area	Surface Area	Year Completed	Dam Type	Dam Purposes	Hazard	County	Owner Type	Owner Name	Longitude	Latitude
				ft	acre-ft	sq mi	acre								degrees	degrees
30	Brady Creek WS SCS Site 31 Dam	TX01625	Brady Creek	50	11,155	22.5	-	1958	RE	C	L	Concho	L	Concho SWCD	-99.975	31.1683
31	Old Lake Winters City Dam	TX03245	Elm Creek	41	10,032	-	-	1945	RE	C	H	Runnels	L	City of Winters	-99.8733	31.9517

Table 2.3.1-2 Major Dams in the Colorado River Basin (Continued)

Notes:

Dam Type (in the order of importance)
RE - Earth
ER - Rockfill
PG - Gravity
CB - Buttress
VA - Arch
MV - Multi-Arch
CN - Concrete
MS - Masonry
ST - Stone
TC - Timber Crib
OT - Other

Dam Purpose
I - Irrigation
H - Hydroelectric
C - Flood Control and Storm Water Management
N - Navigation
S - Water Supply
R - Recreation
P - Fire Protection, Stock, Or Small Farm Pond
F - Fish and Wildlife Pond
D - Debris Control
T - Tailings
O - Other

Owner Type
F - Federal
S - State
L - Local Government
U - Public Utility
P - Private

Downstream Hazard Potential		
Potential hazard to the downstream area resulting from failure or misoperation of the dam or facilities:		
L - Low	S - Significant	H - High
Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property	Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environment damage, disruption of lifeline facilities, or impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure	Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.
Hazard Potential Classification	**Loss of Human Life**	**Economic, Environmental, Lifeline Losses**
Low	None expected	Low and generally limited to owner
Significant	None expected	Yes
High	Probable. One or more expected	Yes (but not necessary)

Data in this table are taken from Reference 2.3.1-4 except for those noted.

[1] Dam data are provided by Texas Commission on Environmental Quality (TCEQ)

Table 2.3.1-3 Stream-flow Gauging Data Downstream of Mansfield Dam

Gauge No.	Gauge Name	Location (river mile)	Longitude	Latitude	County	Drainage Area (square mile) [1]	Period of Record From Year	Years of Record [2]	Historical Annual Flow Rate (cfs)		
									Maximum	Minimum	Mean
08158000	Austin	290.3	97.694	30.244	Travis	39,009	1898	106	7,535	590	2,168
08159200	Bastrop	236.6	97.319	30.104	Bastrop	39,979	1960	44	9,073	828	2,227
08159500	Smithville	212.1	97.161	30.013	Bastrop	40,371	1930	74	6,780	794	2,654
08160400	LaGrange	177	96.904	29.912	Fayette	40,874	1988	16	9,913	930	2,662
08161000	Columbus	135.1	96.537	29.706	Colorado	41,640	1916	88	10,810	653	3,100
08162000	Wharton	66.6	96.104	29.309	Wharton	42,003	1939	65	11,120	615	2,740
08162500	Bay City	32.5	96.012	28.974	Matagorda	42,240	1948	56	14,270	375	2,628

Data in this table is taken from Reference 2.3.1-6

NOTES:

[1] All drainage areas include 11,403 square miles of probably noncontributing area

[2] All gauges listed in the table are currently active, and "years of record" is counted from the beginning year up to the water year of 2004

Table 2.3.1-4 Mean Daily Flows on the Colorado River near Bay City, Texas (Period of Data: 1948 to 2006)

Day of month	Daily mean values (cfs)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2,780	1,830	3,340	2,240	3,850	3,940	2,560	976	1,660	1,110	3,120	2,360
2	2,830	1,980	3,240	2,090	3,700	4,060	2,500	950	1,840	1,050	3,470	2,300
3	2,660	2,120	3,060	2,180	2,940	4,390	2,340	962	1,800	1,030	2,900	2,500
4	2,460	2,290	2,940	2,390	3,110	4,920	2,220	972	1,340	967	2,550	2,340
5	2,250	2,730	3,010	2,640	3,450	4,820	2,120	981	1,160	1,020	2,500	2,370
6	2,160	3,280	3,050	2,680	3,500	4,270	2,200	947	1,210	1,070	2,790	2,370
7	2,300	3,540	3,110	2,620	3,530	4,380	2,160	900	1,380	1,180	2,890	2,220
8	2,440	3,390	3,170	2,660	3,110	4,550	2,160	877	1,350	1,530	2,680	2,190
9	2,540	3,420	3,120	2,640	3,050	4,600	2,170	834	1,240	1,610	2,280	2,020
10	2,600	3,190	2,880	2,640	2,700	4,190	2,190	856	1,230	1,780	2,130	1,890
11	2,680	2,890	2,690	2,770	2,880	3,720	2,330	847	1,630	1,880	2,220	2,040
12	2,760	3,300	2,710	2,740	3,150	3,970	2,660	834	2,070	2,160	2,180	2,300
13	2,890	3,530	2,740	2,700	3,520	4,990	2,620	816	2,390	2,260	2,370	2,550
14	2,850	3,260	2,750	2,580	3,770	5,610	2,150	750	2,680	2,580	2,880	2,450
15	2,540	3,150	2,870	2,380	3,750	5,710	2,040	750	3,110	2,920	2,990	2,210
16	2,250	3,210	3,110	2,590	4,030	5,370	2,240	790	2,570	2,860	2,750	2,220
17	2,100	3,300	3,170	2,690	4,290	4,560	2,140	768	1,890	2,910	2,530	2,450
18	2,200	3,350	3,120	3,110	4,160	4,450	1,900	741	1,530	3,430	2,300	2,610
19	2,380	3,020	3,120	3,290	4,440	4,530	1,730	760	1,790	4,610	2,350	2,730
20	2,770	2,700	2,910	3,080	4,440	4,440	1,680	693	2,130	4,680	2,680	2,260
21	3,280	2,580	2,670	3,210	3,980	4,380	1,590	689	2,110	4,150	2,610	2,060
22	3,340	3,340	2,710	3,140	3,610	4,070	1,460	692	2,140	3,720	2,620	2,200

Table 2.3.1-4 Mean Daily Flows on the Colorado River near Bay City, Texas (Period of Data: 1948 to 2006) (Continued)

Day of month	Daily mean values (cfs)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
23	3,240	3,990	2,550	3,100	4,040	3,430	1,360	707	2,240	3,440	2,890	2,380
24	2,980	4,280	2,790	2,790	4,000	3,310	1,330	726	1,930	3,760	3,110	2,760
25	2,850	4,540	2,920	2,410	4,020	3,590	1,280	732	1,550	3,420	3,320	3,240
26	2,470	4,500	2,920	2,400	3,680	4,600	1,390	755	1,370	3,040	3,640	3,270
27	2,370	4,260	2,450	3,010	3,490	4,430	1,370	745	1,560	2,890	3,910	3,050
28	2,330	3,740	2,230	3,130	3,680	3,490	1,260	734	1,550	2,270	3,690	2,790
29	2,220	3,540	2,290	2,940	3,930	2,910	1,130	793	1,170	2,190	2,620	2,720
30	2,060		2,460	3,080	3,870	2,610	1,050	924	1,010	2,120	2,500	2,570
31	1,910		2,420		3,760		1,010	1,370		2,550		2,640

Source: Reference 2.3.1-7

Table 2.3.1-5 Mean Monthly Flows on the Colorado River near Bay City, Texas (Period of Data: 1948 to 2006)

Year	Monthly mean flows (cfs)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1948	-	-	-	-	1,009	325.9	599.4	637.1	928.4	875.3	894.5	794.5
1949	942.8	2,850	2,093	6,018	1,457	889.4	935.8	525.5	1,115	4,507	1,635	2,530.
1950	1,908	3,713	1,167	2,626	1,476	3,532	815.5	341.3	1,357	691.7	680.1	788.2
1951	841.0	1,045	528.8	294.5	446.3	1,489	71.4	298.9	1,289	634.7	439.5	405.8
1952	344.0	449.6	344.7	979.2	1,830.	453.7	503.1	235.5	763.3	389.8	622.1	1,940.
1953	1,374	1,612	714.1	458.0	4,924	177.9	619.1	897.6	1,508	1,315	883.9	1,625
1954	784.4	402.8	260.3	383.7	676.1	221.9	193.2	545.4	474.1	453.2	378.5	362.0
1955	485.3	1,646	295.9	436.0	1,418	2,640.	1,511	1,541.	1,073	2,508	1,793	898.4
1956	496.9	993.9	388.0	472.4	886.3	814.6	164.2	367.2	313.6	285.9	225.5	296.8
1957	249.2	347.6	2,037	5,027	27,750	24,560	4,058	1,757	4,975	12,820	8,559	6,173
1958	6,146	9,910.	7,537	5,050.	5,611	3,544	3,412	2,080.	3,804	2,330.	2,609	1,035
1959	1,231	3,675	1,348	7,564	2,926	1,500.	844.0	2,506	2,575	10,410	6,010.	4,408
1960	4,205	4,954	3,693	3,829	5,898	8,909	2,566	1,949	1,113	4,944	7,059	3,708
1961	4,849	8,289	4,682	3,672	1,877	8,613	7,675	2,876	11,160	1,736	4,713	3,580.
1962	2,672	1,058	699.6	562.4	341.2	1,183	582.5	274.5	888.3	813.0	680.9	1,358
1963	979.0	1,637	577.1	387.3	355.5	384.2	635.8	313.0	393.0	351.7	317.8	342.5
1964	257.5	482.2	800.0	125.0	226.8	504.6	115.3	114.1	878.1	765.9	694.6	572.8
1965	2,233	4,850.	773.8	367.6	6,250.	6,364	1,369	189.0	447.1	1,018	3,464	4,101
1966	1,890.	1,966	1,556	2,154	6,532	1,129	427.9	583.0	93.9	588.1	850.6	296.7
1967	269.8	246.4	257.4	323.6	452.6	294.4	1.00	311.4	2,675	1,101	1,329	676.5
1968	8,228	6,700.	5,908	6,859	10,130	12,050	3,375	739.0	1,907	764.0	626.7	2,456
1969	879.2	4,002	3,773	4,274	5,566	901.8	371.3	200.0	326.2	1,480.	3,614	2,680.

Table 2.3.1-5 Mean Monthly Flows on the Colorado River near Bay City, Texas (Period of Data: 1948 to 2006) (Continued)

Year	Monthly mean flows (cfs)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1970	2,800.	3,238	7,371	5,460.	6,987	4,276	2,139	887.9	1,341	3,801	703.1	458.5
1971	592.2	342.5	282.7	559.0	533.4	155.5	280.6	795.3	2,592	1,684	3,462	4,883
1972	1,907	1,530.	747.9	353.2	4,537	850.6	923.9	310.7	425.5	766.7	889.2	498.3
1973	1,727	2,727	3,638	5,810.	2,428	8,229	877.9	1,431	2,916	8,905	2,676	2,460.
1974	6,414	1,898	1,231	908.8	2,437	817.0	571.1	1,088	7,521	4,549	13,470	5,084
1975	3,441	7,820.	3,765	2,708	13,140	10,050	4,447	1,388	787.6	908.6	26.3	1,009
1976	679.8	462.7	528.5	3,941	3,922	2,255	4,164	1,275	1,303	2,507	2,814	7,003
1977	2,169	5,394	1,754	13,410	7,448	3,135	910.2	489.1	935.1	536.7	826.1	536.3
1978	1,007	1,169	400.5	809.7	328.8	1,006	673.5	451.7	2,733	545.0	1,222	770.1
1979	4,633	3,838	2,045	3,806	6,679	6,579	1,905	877.2	3,956	594.3	484.3	540.7
1980	1,708	1,013	739.8	939.9	3,121	444.6	634.9	349.4	625.2	787.4	723.5	885.8
1981	974.1	732.4	2,285	1,457	1,952	16,580	4,606	839.6	4,463	2,223	7,674	1,617
1982	1,052	1,472	1,206	1,474	7,430.	1,147	1,853	876.2	729.8	658.6	1,019	760.9
1983	869.9	3,082	3,599	783.2	2,818	869.9	1,770.	902.8	2,444	1,523	881.7	641.5
1984	949.0	520.1	284.0	232.3	869.0	459.3	589.9	405.4	520.7	4,810.	1,272	1,261
1985	1,979	2,052	3,955	2,652	953.3	1,799	986.7	408.8	550.5	1,408	4,370.	2,738
1986	1,710.	1,208	918.3	419.4	2,804	4,216	924.6	688.3	1,375	4,545	5,594	10,260
1987	6,866	5,326	6,758	2,751	2,261	30,360	5,321	1,646	2,025	1,658	1,510.	1,241
1988	896.2	572.6	2,327	650.3	501.8	637.1	464.5	750.1	427.5	606.8	385.0	382.7
1989	1,446	1,009	691.5	655.7	1,730	1,064	553.3	495.6	270.0	253.7	377.8	292.5
1990	301.7	632.6	505.1	1,009	1,391	290.4	656.8	259.5	547.7	368.6	423.4	321.4
1991	6,215	2,923	1,402	6,727	2,353	855.2	1,412	644.6	1,101	711.8	665.5	16,200

Table 2.3.1-5 Mean Monthly Flows on the Colorado River near Bay City, Texas (Period of Data: 1948 to 2006) (Continued)

Year	Monthly mean flows (cfs)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1992	25,780	42,200	25,780	12,620	20,920	23,050	2,216	988.2	1,223	1,031	2,147	2,314
1993	4,205	3,464	5,037	5,061	6,483	7,369	1,062	824.7	766.5	1,209	1,034	732.4
1994	616.8	878.5	759.8	702.6	2,440.	1,706	339.1	1,121	738.4	10,040	1,698	3,667
1995	3,368	929.7	3,987	3,173	1,449	9,092	1,294	739.5	654.9	585.8	884.1	1,653
1996	615.2	538.2	358.5	404.2	276.4	2,177	467.5	1,025	2,548	563.6	787.2	912.3
1997	2,164	2,570.	13,680	10,230	7,736	14,140	14,240	1,114	1,774	5,248	1,461	2,175
1998	2,078	5,535	7,130.	3,469	752.4	366.6	419.1	656.2	3,662	16,110	12,830	4,822
1999	2,533	1,221	2,603	1,391	1,224	1,957	1,212	430.6	425.9	712.8	444.6	437.7
2000	497.8	422.7	375.6	764.6	1,379	1,141	368.0	276.8	310.1	752.3	4,818	1,875
2001	3,794	2,983	5,009	2,529	1,707	394.8	321.7	846.8	4,622	2,255	4,325	5,888
2002	2,066	986.1	738.0	1,670.	586.5	547.5	12,820	2,044	3,221	5,244	9,011	6,110.
2003	4,029	7,271	4,822	1,401	554.6	1,103	2,025	786.5	1,603	917.4	1,171	744.2
2004	1,520.	2,472	1,232	1,972	3,660.	10,710	4,053	926.9	802.8	1,822	19,720	9,539
2005	3,317	5,745	7,733	3,005	1,457	1,069	1,364	547.2	873.8	918.1	605.0	548.1
2006	493.1	476.6	505.0	592.2	649.5	960.2	1,349	372.4	636.4	-	-	-

Table 2.3.1-5 Mean Monthly Flows on the Colorado River near Bay City, Texas (Period of Data: 1948 to 2006) (Continued)

Year	Monthly mean flows (cfs)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum Monthly Discharge	25,780	42,200	25,780	13,410	27,750	30,360	14,240	2,876	11,160	16,110	19,720	16,200
Minimum Monthly Discharge	249.2	246.4	257.4	125	226.8	155.5	1	114.1	93.9	253.7	225.5	292.5
Average Monthly Discharge	2,560	3,230	2,860	2,730	3,660	4,280	1,880	835	1,750	2,460	2,780	2,450

Source: Reference 2.3.1-7

Table 2.3.1-6 Monthly Minimum Flows on the Colorado River near Bay City, Texas (Period of Data: 1948 to 2006)

Year	Monthly minimum flows (cfs)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1948					44	16	154	221	394	600	655	630
1949	655	865	1,420	560	81	88	305	162	340	610	1,150	1,120
1950	1,120	1,120	810	460	586	635	137	157	568	508	498	530
1951	610	605	298	7	8	0	0	0	521	386	400	350
1952	322	302	229	151	1	0	143	50	90	242	290	660
1953	630	930	226	0	386	11	48	2	256	346	431	440
1954	467	350	92	2	190	28	43	208	238	318	342	318
1955	368	350	53	23	1	386	550	740	526	1,080	1,020	530
1956	404	440	60	53	15	205	0	12	114	156	128	92
1957	219	231	305	455	7,430	5,780	2,260	925	1,710	2,130	6,180	4,400
1958	4,110	2,400	6,540	3,660	3,000	2,520	1,400	1,670	1,600	1,600	1,300	710
1959	805	1,460	900	850	1,300	562	510	1,080	1,920	2,760	3,840	3,160
1960	2,280	2,200	2,130	2,840	1,850	1,090	1,360	1,270	500	1,170	2,350	1,700
1961	1,670	1,390	3,920	2,590	1,200	800	3,110	2,350	2,270	1,200	1,140	2,700
1962	1,570	785	225	50	5	416	201	107	342	466	449	650
1963	550	449	26	14	12	22	76	12	12	52	253	247
1964	5	256	10	3	2	2	3	1	1	2	3	238
1965	255	722	227	24	12	4,240	92	16	16	510	1,070	1,070
1966	1,100	710	432	60	2,060	300	10	3	2	72	282	258
1967	190	8	2	1	1	1	1	0	1	221	304	490
1968	476	6,010	3,850	5,100	4,500	3,900	1,050	258	205	182	428	781
1969	569	520	1,440	365	1,640	234	1	0	0	0	2,810	1,520

Table 2.3.1-6 Monthly Minimum Flows on the Colorado River near Bay City, Texas (Period of Data: 1948 to 2006) (Continued)

Year	Monthly minimum flows (cfs)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1970	2,020	1,390	4,440	3,560	350	1,670	504	84	406	72	410	370
1971	380	280	2	5	3	1	5	6	239	40	2,150	1,670
1972	626	645	10	2	9	6	96	3	8	332	529	300
1973	400	1,100	1,100	1,020	1,490	415	100	500	31	265	1,520	1,210
1974	2,300	1,060	262	150	15	41	86	10	1,720	2,510	6,290	1,540
1975	1,470	1,540	1,020	1,560	2,930	4,850	1,740	500	128	284	557	490
1976	477	234	111	330	415	829	752	699	618	807	832	1,540
1977	1,480	1,770	1,040	1,460	4,690	803	537	309	174	294	388	369
1978	388	479	161	240	166	222	348	227	597	363	365	459
1979	1,170	1,110	521	1,190	500	847	613	624	379	393	413	385
1980	356	357	299	352	451	351	345	1	66	467	476	573
1981	535	534	370	675	15	1,370	1,220	406	593	586	2,060	1,010
1982	635	597	807	474	728	737	791	356	314	424	372	439
1983	379	433	310	38	156	265	303	70	159	40	443	480
1984	521	373	70	45	3	15	225	9	17	271	685	610
1985	982	690	873	1,500	178	260	307	87	142	236	600	1,150
1986	1,100	708	85	48	494	1,440	501	340	337	502	3,630	2,390
1987	4,090	1,950	4,460	380	583	8,370	2,580	610	1,420	1,230	797	644
1988	576	526	509	7	81	24	168	478	129	260	290	283
1989	357	558	125	157	48	33	148	60	77	36	261	198
1990	230	238	85	265	137	37	226	119	68	61	253	180
1991	392	1,100	468	783	415	431	568	72	559	441	439	486

Table 2.3.1-6 Monthly Minimum Flows on the Colorado River near Bay City, Texas (Period of Data: 1948 to 2006) (Continued)

Year	Monthly minimum flows (cfs)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1992	13,000	17,000	5,530	5,040	1,980	2,930	733	590	496	645	898	927
1993	1,470	1,940	1,670	2,200	1,940	39	175	215	349	533	684	520
1994	515	555	278	90	51	394	138	541	67	374	918	899
1995	1,460	795	1,070	617	147	551	203	370	265	99	506	460
1996	546	236	20	20	20	648	236	20	448	247	393	359
1997	188	533	6,180	3,210	4,570	3,610	1,770	470	503	869	821	753
1998	1,000	1,090	2,790	1,020	429	245	227	145	15	239	3,870	2,290
1999	1,490	943	743	690	478	488	340	253	118	484	349	333
2000	320	281	30	48	41	201	21	10	37	285	718	823
2001	2,010	1,160	2,300	755	503	48	95	178	589	578	472	1,930
2002	894	433	545	292	191	120	2,000	669	535	1,020	1,510	1,530
2003	1,790	1,300	2,160	869	115	631	578	249	593	262	206	398
2004	517	800	627	316	277	358	928	376	357	354	980	3,040
2005	2,250	3,090	4,030	1,350	632	660	670	180	391	591	372	460
2006	428	370	250	250	270	337	382	210	230	-	-	-
Average Minimum Monthly Flow	1,157	1,212	1,182	832	845	941	544	327	420	536	1,065	933

Source: Reference 2.3.1-7

Table 2.3.1-7 Monthly Maximum Flows on the Colorado River near Bay City, Texas (Period of Data: 1948 to 2006)

	Monthly maximum flows (cfs)											
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1948					6,060	1,220	1,280	1,420	2,060	1,740	1,540	1,280
1949	1,700	27,200	6,670	31,300	8,060	2,700	2,350	1,220	1,700	17,700	2,260	8,060
1950	4,780	10,600	1,580	10,400	5,320	23,100	2,880	578	6,060	930	1,080	1,340
1951	1,250	1,850	1,340	1,970	960	10,100	266	724	4,160	1,310	521	530
1952	377	930	545	5,400	18,700	2,600	2,250	595	1,280	762	4,120	7,540
1953	6,670	3,170	1,480	5,850	22,100	555	4,490	10,200	6,330	8,060	1,810	7,630
1954	1,930	462	359	1,050	2,810	1,120	413	1,890	960	790	436	404
1955	1,280	8,800	508	1,020	10,400	4,460	3,170	2,900	1,620	4,360	2,410	1,810
1956	845	3,380	575	1,150	2,050	1,220	449	1,080	600	431	308	1,000
1957	312	925	7,750	48,400	51,800	43,200	5,520	2,960	34,800	56,800	21,100	7,780
1958	12,500	52,200	11,000	6,660	22,600	8,510	5,940	2,440	19,100	5,040	5,590	2,060
1959	2,440	10,400	2,600	32,400	12,200	5,000	1,540	4,700	3,900	28,200	13,000	12,300
1960	8,520	9,640	4,300	10,000	37,900	68,400	6,710	3,160	1,850	31,600	42,200	11,400
1961	11,700	24,600	6,560	7,450	4,100	54,800	40,400	3,380	65,200	2,510	19,400	5,440
1962	5,120	1,740	1,250	3,020	1,990	4,520	2,380	740	3,600	1,940	1,500	2,970
1963	2,060	7,100	1,640	2,970	1,150	960	1,870	765	930	742	465	870
1964	1,450	1,300	2,620	617	958	5,740	612	571	6,600	4,160	1,870	2,990
1965	18,800	22,600	2,270	1,560	26,000	16,800	4,240	465	2,190	2,030	10,100	14,100
1966	2,670	4,240	6,800	7,960	13,800	3,070	800	1,810	495	1,450	1,360	355
1967	665	722	1,210	2,840	4,140	4,420	1	1,700	18,700	5,410	8,010	1,570
1968	39,600	8,440	8,080	20,700	30,000	48,500	6,820	1,130	8,880	2,040	3,560	13,700
1969	2,420	21,300	17,300	17,700	12,300	3,160	622	2,040	1,540	3,100	5,930	6,770

Table 2.3.1-7 Monthly Maximum Flows on the Colorado River near Bay City, Texas (Period of Data: 1948 to 2006) (Continued)

	Monthly maximum flows (cfs)											
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1970	4,200	9,600	16,300	7,680	21,100	15,200	3,320	2,300	5,300	18,100	1,390	603
1971	1,950	450	610	1,810	1,550	633	733	3,510	13,900	4,820	4,930	12,100
1972	3,840	4,070	6,550	1,230	23,400	4,250	2,090	1,210	1,460	1,930	2,400	698
1973	7,000	6,360	19,100	33,200	4,900	57,000	2,720	2,740	11,400	31,700	6,700	4,320
1974	21,400	3,860	3,450	1,610	12,900	3,640	931	6,790	33,800	6,300	33,100	9,060
1975	5,320	17,600	6,280	6,770	47,000	31,800	9,610	4,620	1,530	1,610	2,550	6,800
1976	1,960	743	1,690	17,100	15,500	11,200	6,060	3,350	2,280	12,400	13,100	22,800
1977	4,280	20,000	2,860	49,100	19,400	4,760	1,670	784	3,380	884	2,320	797
1978	4,110	3,120	948	2,180	614	4,370	1,050	794	16,600	815	7,730	2,340
1979	13,000	17,200	10,600	16,000	21,800	36,500	6,330	2,790	24,800	869	648	1,620
1980	10,600	2,360	5,270	3,280	13,100	602	939	1,460	2,310	1,990	1,140	1,530
1981	1,760	1,140	4,500	5,220	7,990	41,600	12,600	5,020	35,900	4,690	43,500	3,400
1982	2,590	4,270	1,940	4,240	34,600	1,970	2,480	1,370	990	1,030	5,190	1,740
1983	3,790	11,600	19,000	2,480	21,400	2,510	9,670	3,380	18,100	9,430	3,360	1,580
1984	2,750	767	490	460	6,090	1,210	1,450	852	1,070	19,300	3,350	3,860
1985	5,620	11,900	8,810	6,790	2,560	7,730	3,230	688	1,000	4,400	21,100	12,500
1986	3,450	4,160	3,180	1,060	10,000	8,050	2,360	936	7,370	11,000	12,700	37,800
1987	11,100	23,500	20,900	6,640	7,060	50,300	8,000	3,530	3,030	2,320	4,880	5,490
1988	2,670	688	8,680	2,200	1,480	3,250	1,100	1,070	1,470	1,380	563	483
1989	6,140	3,450	2,710	2,170	6,990	4,470	1,190	1,290	576	577	817	516
1990	457	5,520	3,350	3,440	4,100	529	1,730	421	1,730	575	959	574
1991	20,200	13,700	2,560	21,600	6,540	2,640	5,060	2,810	2,620	912	1,220	66,700

Table 2.3.1-7 Monthly Maximum Flows on the Colorado River near Bay City, Texas (Period of Data: 1948 to 2006) (Continued)

	Monthly maximum flows (cfs)											
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1992	40,500	62,000	60,900	26,600	51,500	56,200	4,690	2,170	2,020	1,560	6,780	6,600
1993	11,500	10,500	10,100	15,800	26,200	36,500	2,670	1,470	1,530	4,010	4,550	1,050
1994	1,230	1,980	1,380	1,530	10,300	5,810	620	2,640	2,600	69,800	4,520	19,000
1995	13,300	1,410	22,100	12,400	5,720	37,300	5,540	1,530	1,660	1,170	2,310	10,400
1996	734	761	821	877	1,010	10,800	1,400	2,990	10,300	1,070	3,600	2,230
1997	15,200	7,590	35,400	19,700	12,700	27,300	27,600	1,790	10,200	30,600	6,640	5,220
1998	7,860	16,300	12,600	8,090	1,220	595	788	2,030	20,900	79,300	54,500	13,000
1999	4,970	2,080	7,100	4,240	2,750	9,210	2,730	738	774	1,030	574	537
2000	949	705	1,810	2,880	5,280	6,270	1,700	901	859	1,770	13,200	8,520
2001	7,490	4,630	13,300	6,180	5,190	1,230	940	16,100	22,300	11,000	24,700	19,600
2002	4,120	1,560	1,090	10,900	1,640	2,470	31,200	3,440	14,500	21,500	45,800	17,100
2003	10,300	44,500	11,300	2,190	879	2,720	7,980	1,800	6,880	4,520	9,400	2,070
2004	5,410	9,940	2,370	4,750	14,200	24,000	18,000	2,050	1,210	5,730	72,900	27,600
2005	5,940	17,200	12,600	5,370	4,260	2,230	4,370	971	1,880	1,800	1,380	715
2006	559	601	1,240	1,470	2,850	2,260	5,550	691	1,260			
Average Maximum Monthly Flow	6,816	9,817	7,419	9,304	12,393	14,123	5,002	2,364	8,170	9,534	9,881	7,635

Source: Reference 2.3.1-8

[1] Obtained from the Halff study (Reference 2.3.1-8, Chapter 4, Table VI-11)

Table 2.3.1-8 Flood Frequency Distribution for the Colorado River at Wharton

Flood Frequency	Discharge for Regulated Flow Conditions [1] (cfs)
2-Yr	27,000
5-Yr	48,000
10-Yr	63,000
25-Yr	88,000
50-Yr	100,000
100-Yr	116,000
500-Yr	n/a

Source: Reference 2.3.1-8

[1] Obtained from the Halff study (Reference 2.3.1-8, Chapter 4, Table VI-11)

Table 2.3.1-9 Historical Minimum Daily Flow Information for Bay City

Water Year	1-Day Minimum Flow (cfs)
1948	16
1949	81
1950	137
1951	0
1952	0
1953	0
1954	2.3
1955	1.4
1956	0
1957	92
1958	1400
1959	510
1960	500
1961	800
1962	4.9
1963	12
1964	1.3
1965	2.3
1966	2
1967	0.4
1968	205
1969	0.4
1970	0.4
1971	0.7
1972	2
1973	31
1974	10
1975	128
1976	111
1977	174
1978	161
1979	363
1980	0.9
1981	15
1982	314
1983	38
1984	3.1
1985	87
1986	48
1987	380
1988	6.8
1989	33
1990	36
1991	61
1992	439
1993	39
1994	51
1995	147
1996	20
1997	188
1998	15
1999	118
2000	9.5
2001	48
2002	120
2003	115
2004	206
2005	180
2006	210

Source: Reference 2.3.1-10

Table 2.3.1-10 Historical Minimum 7-Day Low Flow Information for Bay City

Water Year	7-Day Minimum Flow (cfs)
1948	61
1949	143
1950	177
1951	1
1952	2
1953	15
1954	58
1955	37
1956	13
1957	121
1958	1789
1959	684
1960	714
1961	890
1962	7
1963	13
1964	1.4
1965	17
1966	2
1967	0.5
1968	312
1969	0.5
1970	0.5
1971	1.3
1972	19
1973	366
1974	35
1975	348
1976	223
1977	297
1978	218
1979	374
1980	59
1981	243
1982	456
1983	127
1984	11
1985	205
1986	56
1987	598
1988	83
1989	41
1990	68
1991	90
1992	503
1993	348
1994	137
1995	200
1996	20
1997	286
1998	68
1999	210
2000	14
2001	110
2002	206
2003	214
2004	375
2005	288
2006	266

Source: Reference 2.3.1-10

Table 2.3.1-11 STP 3 & 4 Area Monthly Groundwater Levels

WELL ID	WELL DEPTH (ft bgs)	BOTTOM OF SCREEN (ft bgs)	REFERENCE POINT ELEVATION (ft MSL)	December 28, 2006		January 30, 2007		February 22, 2007		March 29, 2007		April 27, 2007		May 25, 2007		June 27, 2007	
				Depth to Water (ft)	Elevation (ft MSL)	Depth to Water (ft)	Elevation (ft MSL)	Depth to Water (ft)	Elevation (ft MSL)	Depth to Water (ft)	Elevation (ft MSL)	Depth to Water (ft)	Elevation (ft MSL)	Depth to Water (ft)	Elevation (ft MSL)	Depth to Water (ft)	Elevation (ft MSL)
Shallow Aquifer - Upper Zone																	
OW-308 U	47.1	48	31.80	7.78	24.02	6.46	25.34	7.46	24.34	7.41	24.39	7.17	24.63	7.07	24.73	7.72	24.08
OW-332 U	46.1	45	32.10	8.01	24.09	6.57	25.53	7.46	24.64	7.39	24.71	6.25	25.85	7.09	25.01	8.05	24.05
OW-348 U	39.1	38	32.28	8.09	24.19	6.52	25.76	7.71	24.57	7.66	24.62	7.34	24.94	7.25	25.03	7.95	24.33
OW-349 U	46.1	45	31.29	7.28	24.01	5.82	25.47	6.97	24.32	6.91	24.38	6.56	24.73	6.50	24.79	7.19	24.10
OW-408 U	43.1	42	33.57	9.71	23.86	8.30	25.27	9.13	24.44	9.08	24.49	8.95	24.62	8.94	24.63	9.47	24.10
OW-420 U	49.1	48	33.79	9.98	23.81	8.42	25.37	9.32	24.47	9.26	24.53	9.08	24.71	8.99	24.80	9.59	24.20
OW-438 U	41	40	32.18	8.45	23.73	6.55	25.63	7.21	24.97	7.14	25.04	7.17	25.01	7.00	25.18	7.97	24.21
OW-910 U	36.1	35	32.32	9.11	23.21	7.57	24.75	8.30	24.02	8.23	24.09	8.10	24.22	8.00	24.32	8.49	23.83
OW-928 U	39.6	38.5	31.69	8.18	23.51	6.21	25.48	6.85	24.84	6.72	24.97	6.69	25.00	6.59	25.10	7.33	24.36
OW-929 U	60.1	59	38.71	12.92	25.79	11.33	27.38	11.68	27.03	11.75	26.96	11.77	26.94	11.81	26.90	13.17	25.54
OW-930 U	36.1	35	27.33	7.92	19.41	5.79	21.54	7.05	20.28	6.98	20.35	6.45	20.88	7.31	20.02	7.97	19.36
OW-931 U	36	35	32.10	9.82	22.28	8.81	23.29	9.43	22.67	9.34	22.76	9.19	22.91	9.25	22.85	9.33	22.77
OW-932 U	39.6	38.5	32.83	8.52	24.31	7.03	25.80	8.04	24.79	7.96	24.87	7.77	25.06	7.68	25.15	8.27	24.56
OW-933 U	37.1	36	30.62	6.44	24.18	4.97	25.65	5.95	24.67	5.91	24.71	5.57	25.05	5.50	25.12	5.87	24.75
OW-934 U	41.1	40	30.39	10.22	20.17	9.54	20.85	10.04	20.35	10.08	20.31	9.91	20.48	10.00	20.39	10.36	20.03
Shallow Aquifer - Lower Zone																	
OW-308 L	97.1	96	31.78	16.08	15.70	15.08	16.70	14.91	16.87	14.67	17.11	14.21	17.57	14.32	17.46	14.30	17.48
OW-332 L [1]	103.2	102.1	31.85	15.22	16.63	-	-	-	-	-	-	-	-	-	-	-	-
OW-332 L(R) [1]	103.1	102	32.08	-	-	-	-	15.29	16.79	15.05	17.03	14.59	17.49	14.71	17.37	14.68	17.40
OW-348 L	79.1	78.2	31.86	16.16	15.70	15.08	16.78	14.94	16.92	14.71	17.15	14.29	17.57	14.40	17.46	14.36	17.50
OW-349 L	81.1	80	31.03	15.22	15.81	14.19	16.84	14.02	17.01	13.80	17.23	13.35	17.68	13.48	17.55	13.42	17.61
OW-408 L	81.3	80.2	33.76	18.05	15.71	17.05	16.71	16.86	16.90	16.64	17.12	16.20	17.56	16.32	17.44	16.28	17.48
OW-438 L	104.1	103	31.57	15.85	15.72	14.96	16.61	14.75	16.82	14.49	17.08	14.02	17.55	14.12	17.45	14.10	17.47
OW-910 L	92.1	91	32.48	16.62	15.86	16.22	16.26	15.77	16.71	15.59	16.89	15.27	17.21	15.22	17.26	15.13	17.35
OW-928 L	121.1	120	31.56	15.75	15.81	15.00	16.56	14.75	16.81	14.50	17.06	14.03	17.53	14.13	17.43	14.06	17.50
OW-929 L	98.1	97	38.63	23.47	15.16	22.41	16.22	22.26	16.37	22.00	16.63	21.51	17.12	21.70	16.93	21.67	16.96
OW-930 L	106.5	105	27.98	14.90	13.08	13.41	14.57	13.35	14.63	13.21	14.77	12.81	15.17	13.09	14.89	12.99	14.99
OW-932 L	79.6	78.5	32.79	17.23	15.56	16.01	16.78	15.90	16.89	15.73	17.06	15.35	17.44	15.48	17.31	15.38	17.41
OW-933 L	87.1	86	30.45	14.60	15.85	13.37	17.08	13.29	17.16	13.11	17.34	12.71	17.74	12.84	17.61	12.72	17.73
OW-934 L	100	99	30.94	17.07	13.87	15.83	15.11	15.73	15.21	15.51	15.43	15.09	15.85	15.33	15.61	15.23	15.71

[1] Observation well OW-332L was damaged in January of 2007. A replacement well, OW-332L(R) was installed and developed in February of 2007 prior to the February monthly water level measurements.

Table 2.3.1-12 Observation Well Construction Details

Well Number[2]	Northing (ft) [3]	Easting (ft) [3]	Well Pad Elevation (ft MSL) [3]	Reference Elevation (ft MSL) [3]	Borehole Diameter (in)	Well Depth (ft bgs)	Screen Interval Depth [4]		Screen Interval Elevation [4]		Filter Pack Interval Depth	
							Top (ft bgs)	Bottom (ft bgs)	Top (ft MSL)	Bottom (ft MSL)	Top (ft bgs)	Bottom (ft bgs)
OW-308L	363196.43	2943374.36	29.87	31.78	8	97.1	86.0	96.0	-56.13	-66.13	82.0	97.1
OW-308U	363195.64	2943354.04	29.88	31.80	8	47.1	36.0	46.0	-6.12	-16.12	32.0	47.1
OW-332L [1]	363739.87	2943610.91	30.24	31.85	8	103.2	92.1	102.1	-61.86	-71.86	88.0	103.2
OW-332L(R)	363729.36	2943608.74	30.01	32.08	8	103.1	92.0	102.0	-61.99	-71.99	87.0	103.1
OW-332U	363739.21	2943591.02	30.24	32.10	8	46.1	35.0	45.0	-4.76	-14.76	31.0	46.1
OW-348L	362685.92	2943014.48	30.08	31.86	8	79.1	68.2	78.2	-38.12	-48.12	64.0	79.1
OW-348U	362685.23	2942994.44	30.51	32.28	8	39.1	28.0	38.0	2.51	-7.49	24.0	39.1
OW-349L	362901.84	2943602.97	29.41	31.03	8	81.1	70.0	80.0	-40.59	-50.59	65.0	81.1
OW-349U	362902.40	2943582.28	29.40	31.29	8	46.1	35.0	45.0	-5.60	-15.60	31.0	46.1
OW-408L	363196.18	2942472.54	31.73	33.76	8	81.3	70.2	80.2	-38.47	-48.47	66.0	81.3
OW-408U	363194.01	2942456.01	31.50	33.57	8	43.1	32.0	42.0	-0.50	-10.50	28.0	43.1
OW-420U	362902.15	2942018.94	32.25	33.79	8	49.1	38.0	48.0	-5.75	-15.75	34.0	49.1
OW-438L	363790.77	2942045.09	30.11	31.57	8	104.1	93.0	103.0	-62.89	-72.89	89.0	104.1
OW-438U	363792.04	2942025.17	30.53	32.18	8	41.0	30.0	40.0	0.53	-9.47	26.0	41.0
OW-910L	363363.45	2941266.45	30.75	32.48	8	92.1	81.0	91.0	-50.25	-60.25	77.0	92.1
OW-910U	363362.02	2941246.57	30.69	32.32	8	36.1	25.0	35.0	5.69	-4.31	21.0	36.1
OW-928L	364932.30	2940376.21	29.81	31.56	8	121.1	110.0	120.0	-80.19	-90.19	106.0	121.1
OW-928U	364933.86	2940356.48	30.02	31.69	8	39.6	28.5	38.5	1.52	-8.48	24.5	39.6
OW-929L	364671.50	2945497.78	36.93	38.63	8	98.1	87.0	97.0	-50.07	-60.07	83.0	98.1
OW-929U	364672.34	2945477.58	36.91	38.71	8	60.1	49.0	59.0	-12.09	-22.09	45.0	60.1
OW-930L	360214.45	2949525.96	26.21	27.98	8	106.5	95.0	105.0	-68.79	-78.79	91.0	106.5
OW-930U	360209.72	2949506.58	25.62	27.33	8	36.1	25.0	35.0	0.62	-9.38	21.0	36.1
OW-931U	361979.42	2939520.36	30.53	32.10	7	36.0	25.0	35.0	5.53	-4.47	21.0	36.0
OW-932L	361899.37	2942115.90	31.09	32.79	8	79.6	68.5	78.5	-37.41	-47.41	64.5	79.6
OW-932U	361898.53	2942097.29	31.35	32.83	8	39.6	28.5	38.5	2.85	-7.15	24.5	39.6
OW-933L	361898.05	2943515.01	28.74	30.45	8	87.1	76.0	86.0	-47.26	-57.26	72.0	87.1
OW-933U	361897.65	2943494.66	28.87	30.62	8	37.1	26.0	36.0	2.87	-7.13	23.0	37.1
OW-934L	362082.08	2948254.12	29.04	30.94	7	100.0	89.0	99.0	-59.96	-69.96	85.0	100.0
OW-934U	362079.87	2948234.20	28.54	30.39	8	41.1	30.0	40.0	-1.46	-11.46	26.0	41.1

[1] Well was found to be collapsed. Drilled and installed replacement well OW-332L(R).

[2] "L" suffix wells installed in Lower Shallow Aquifer and "U" suffix wells installed in Upper Shallow Aquifer.

[3] Coordinates based on the North American Datum of 1927 (NAD27) and elevations based on National Geodetic Vertical Datum of 1929 (NGVD29). Water level depth measuring point is the top of PVC riser casing.

[4] Observation well screens are 2 in diameter, 0.020 in slot width, 10 ft in length.

Abbreviations: ft MSL = feet mean sea level, ft bgs = feet below ground surface, and in = inches

Table 2.3.1-13 Estimated Vertical Hydraulic Gradients in the STP 3 & 4 Area

Date	Well Pair	Upper Well Screen [1]					Lower Well Screen [1]					*dx* (ft)	Groundwater [2]		*dh* (ft)	*i* (ft/ft)
		Ground Elevation (ft MSL)	Top (ft bgs)	Bottom (ft bgs)	Midpoint (ft bgs)	Elevation (ft MSL)	Ground Elevation (ft MSL)	Top (ft bgs)	Bottom (ft bgs)	Midpoint (ft bgs)	Elevation (ft MSL)		Upper (ft MSL)	Lower (ft MSL)		
12/28/2006	OW-308 U/L	29.88	36	46	41	-11.12	29.87	86	96	91	-61.13	50.0	24.02	15.70	8.32	0.166
1/30/2007	OW-308 U/L	29.88	36	46	41	-11.12	29.87	86	96	91	-61.13	50.0	25.34	16.70	8.64	0.173
2/22/2007	OW-308 U/L	29.88	36	46	41	-11.12	29.87	86	96	91	-61.13	50.0	24.34	16.87	7.47	0.149
3/29/2007	OW-308 U/L	29.88	36	46	41	-11.12	29.87	86	96	91	-61.13	50.0	24.39	17.11	7.28	0.146
4/27/2007	OW-308 U/L	29.88	36	46	41	-11.12	29.87	86	96	91	-61.13	50.0	24.63	17.57	7.06	0.141
5/25/2007	OW-308 U/L	29.88	36	46	41	-11.12	29.87	86	96	91	-61.13	50.0	24.73	17.46	7.27	0.145
6/27/2007	OW-308 U/L	29.88	36	46	41	-11.12	29.87	86	96	91	-61.13	50.0	24.08	17.48	6.60	0.132
12/28/2006 [3]	OW-332 U/L	30.24	35	45	40	-9.76	30.24	92.1	102.1	97.1	-66.86	57.1	24.09	16.63	7.46	0.131
2/22/2007 [3]	OW-332 U/L(R)	30.24	35	45	40	-9.76	30.01	92	102	97	-66.99	57.2	24.64	16.79	7.85	0.137
3/29/2007 [3]	OW-332 U/L(R)	30.24	35	45	40	-9.76	30.01	92	102	97	-66.99	57.2	24.71	17.03	7.68	0.134
4/27/2007 [3]	OW-332 U/L(R)	30.24	35	45	40	-9.76	30.01	92	102	97	-66.99	57.2	25.85	17.49	8.36	0.146
5/25/2007 [3]	OW-332 U/L(R)	30.24	35	45	40	-9.76	30.01	92	102	97	-66.99	57.2	25.01	17.37	7.64	0.133
6/27/2007 [3]	OW-332 U/L(R)	30.24	35	45	40	-9.76	30.01	92	102	97	-66.99	57.2	24.05	17.40	6.65	0.116
12/28/2006	OW-348 U/L	30.51	28	38	33	-2.49	30.08	68.2	78.2	73.2	-43.12	40.6	24.19	15.70	8.49	0.209
1/30/2007	OW-348 U/L	30.51	28	38	33	-2.49	30.08	68.2	78.2	73.2	-43.12	40.6	25.76	16.78	8.98	0.221
2/22/2007	OW-348 U/L	30.51	28	38	33	-2.49	30.08	68.2	78.2	73.2	-43.12	40.6	24.57	16.92	7.65	0.188
3/29/2007	OW-348 U/L	30.51	28	38	33	-2.49	30.08	68.2	78.2	73.2	-43.12	40.6	24.62	17.15	7.47	0.184
4/27/2007	OW-348 U/L	30.51	28	38	33	-2.49	30.08	68.2	78.2	73.2	-43.12	40.6	24.94	17.57	7.37	0.181
5/25/2007	OW-348 U/L	30.51	28	38	33	-2.49	30.08	68.2	78.2	73.2	-43.12	40.6	25.03	17.46	7.57	0.186
6/27/2007	OW-348 U/L	30.51	28	38	33	-2.49	30.08	68.2	78.2	73.2	-43.12	40.6	24.33	17.50	6.83	0.168
12/28/2006	OW-349 U/L	29.40	35	45	40	-10.6	29.41	70	80	75	-45.59	35.0	24.01	15.81	8.20	0.234
1/30/2007	OW-349 U/L	29.40	35	45	40	-10.6	29.41	70	80	75	-45.59	35.0	25.47	16.84	8.63	0.247
2/22/2007	OW-349 U/L	29.40	35	45	40	-10.6	29.41	70	80	75	-45.59	35.0	24.32	17.01	7.31	0.209
3/29/2007	OW-349 U/L	29.40	35	45	40	-10.6	29.41	70	80	75	-45.59	35.0	24.38	17.23	7.15	0.204
4/27/2007	OW-349 U/L	29.40	35	45	40	-10.6	29.41	70	80	75	-45.59	35.0	24.73	17.68	7.05	0.201
5/25/2007	OW-349 U/L	29.40	35	45	40	-10.6	29.41	70	80	75	-45.59	35.0	24.79	17.55	7.24	0.207
6/27/2007	OW-349 U/L	29.40	35	45	40	-10.6	29.41	70	80	75	-45.59	35.0	24.10	17.61	6.49	0.185
12/28/2006	OW-408 U/L	31.50	32	42	37	-5.5	31.73	70.2	80.2	75.2	-43.47	38.0	23.86	15.71	8.15	0.215

Table 2.3.1-13 Estimated Vertical Hydraulic Gradients in the STP 3 & 4 Area (Continued)

Date	Well Pair	Upper Well Screen [1]					Lower Well Screen [1]					dx (ft)	Groundwater [2]		dh (ft)	i (ft/ft)
		Ground Elevation (ft MSL)	Top (ft bgs)	Bottom (ft bgs)	Midpoint (ft bgs)	Elevation (ft MSL)	Ground Elevation (ft MSL)	Top (ft bgs)	Bottom (ft bgs)	Midpoint (ft bgs)	Elevation (ft MSL)		Upper (ft MSL)	Lower (ft MSL)		
1/30/2007	OW-408 U/L	31.50	32	42	37	-5.5	31.73	70.2	80.2	75.2	-43.47	38.0	25.27	16.71	8.56	0.225
2/22/2007	OW-408 U/L	31.50	32	42	37	-5.5	31.73	70.2	80.2	75.2	-43.47	38.0	24.44	16.90	7.54	0.199
3/29/2007	OW-408 U/L	31.50	32	42	37	-5.5	31.73	70.2	80.2	75.2	-43.47	38.0	24.49	17.12	7.37	0.194
4/27/2007	OW-408 U/L	31.50	32	42	37	-5.5	31.73	70.2	80.2	75.2	-43.47	38.0	24.62	17.56	7.06	0.186
5/25/2007	OW-408 U/L	31.50	32	42	37	-5.5	31.73	70.2	80.2	75.2	-43.47	38.0	24.63	17.44	7.19	0.189
6/27/2007	OW-408 U/L	31.50	32	42	37	-5.5	31.73	70.2	80.2	75.2	-43.47	38.0	24.10	17.48	6.62	0.174
12/28/2006	OW-438 U/L	30.53	30	40	35	-4.47	30.11	93	103	98	-67.89	63.4	23.73	15.72	8.01	0.126
1/30/2007	OW-438 U/L	30.53	30	40	35	-4.47	30.11	93	103	98	-67.89	63.4	25.63	16.61	9.02	0.142
2/22/2007	OW-438 U/L	30.53	30	40	35	-4.47	30.11	93	103	98	-67.89	63.4	24.97	16.82	8.15	0.129
3/29/2007	OW-438 U/L	30.53	30	40	35	-4.47	30.11	93	103	98	-67.89	63.4	25.04	17.08	7.96	0.126
4/27/2007	OW-438 U/L	30.53	30	40	35	-4.47	30.11	93	103	98	-67.89	63.4	25.01	17.55	7.46	0.118
5/25/2007	OW-438 U/L	30.53	30	40	35	-4.47	30.11	93	103	98	-67.89	63.4	25.18	17.45	7.73	0.122
6/27/2007	OW-438 U/L	30.53	30	40	35	-4.47	30.11	93	103	98	-67.89	63.4	24.21	17.47	6.74	0.106
12/28/2006	OW-910 U/L	30.69	25	35	30	0.69	30.75	81	91	86	-55.25	55.9	23.21	15.86	7.35	0.131
1/30/2007	OW-910 U/L	30.69	25	35	30	0.69	30.75	81	91	86	-55.25	55.9	24.75	16.26	8.49	0.152
2/22/2007	OW-910 U/L	30.69	25	35	30	0.69	30.75	81	91	86	-55.25	55.9	24.02	16.71	7.31	0.131
3/29/2007	OW-910 U/L	30.69	25	35	30	0.69	30.75	81	91	86	-55.25	55.9	24.09	16.89	7.20	0.129
4/27/2007	OW-910 U/L	30.69	25	35	30	0.69	30.75	81	91	86	-55.25	55.9	24.22	17.21	7.01	0.125
5/25/2007	OW-910 U/L	30.69	25	35	30	0.69	30.75	81	91	86	-55.25	55.9	24.32	17.26	7.06	0.126
6/27/2007	OW-910 U/L	30.69	25	35	30	0.69	30.75	81	91	86	-55.25	55.9	23.83	17.35	6.48	0.116
12/28/2006	OW-928 U/L	30.02	28.5	38.5	33.5	-3.48	29.81	110	120	115	-85.19	81.7	23.51	15.81	7.70	0.094
1/30/2007	OW-928 U/L	30.02	28.5	38.5	33.5	-3.48	29.81	110	120	115	-85.19	81.7	25.48	16.56	8.92	0.109
2/22/2007	OW-928 U/L	30.02	28.5	38.5	33.5	-3.48	29.81	110	120	115	-85.19	81.7	24.84	16.81	8.03	0.098
3/29/2007	OW-928 U/L	30.02	28.5	38.5	33.5	-3.48	29.81	110	120	115	-85.19	81.7	24.97	17.06	7.91	0.097
4/27/2007	OW-928 U/L	30.02	28.5	38.5	33.5	-3.48	29.81	110	120	115	-85.19	81.7	25.00	17.53	7.47	0.091
5/25/2007	OW-928 U/L	30.02	28.5	38.5	33.5	-3.48	29.81	110	120	115	-85.19	81.7	25.10	17.43	7.67	0.094
6/27/2007	OW-928 U/L	30.02	28.5	38.5	33.5	-3.48	29.81	110	120	115	-85.19	81.7	24.36	17.50	6.86	0.084
12/28/2006	OW-929 U/L	36.91	49	59	54	-17.09	36.93	87	97	92	-55.07	38.0	25.79	15.16	10.63	0.280

Table 2.3.1-13 Estimated Vertical Hydraulic Gradients in the STP 3 & 4 Area (Continued)

Date	Well Pair	Upper Well Screen [1]					Lower Well Screen [1]					dx (ft)	Groundwater [2]		dh (ft)	i (ft/ft)
		Ground Elevation (ft MSL)	Top (ft bgs)	Bottom (ft bgs)	Midpoint (ft bgs)	Elevation (ft MSL)	Ground Elevation (ft MSL)	Top (ft bgs)	Bottom (ft bgs)	Midpoint (ft bgs)	Elevation (ft MSL)		Upper (ft MSL)	Lower (ft MSL)		
1/30/2007	OW-929 U/L	36.91	49	59	54	-17.09	36.93	87	97	92	-55.07	38.0	27.38	16.22	11.16	0.294
2/22/2007	OW-929 U/L	36.91	49	59	54	-17.09	36.93	87	97	92	-55.07	38.0	27.03	16.37	10.66	0.281
3/29/2007	OW-929 U/L	36.91	49	59	54	-17.09	36.93	87	97	92	-55.07	38.0	26.96	16.63	10.33	0.272
4/27/2007	OW-929 U/L	36.91	49	59	54	-17.09	36.93	87	97	92	-55.07	38.0	26.94	17.12	9.82	0.259
5/25/2007	OW-929 U/L	36.91	49	59	54	-17.09	36.93	87	97	92	-55.07	38.0	26.90	16.93	9.97	0.263
6/27/2007	OW-929 U/L	36.91	49	59	54	-17.09	36.93	87	97	92	-55.07	38.0	25.54	16.96	8.58	0.226
12/28/2006	OW-930 U/L	25.62	25	35	30	-4.38	26.21	95	105	100	-73.79	69.4	19.41	13.08	6.33	0.091
1/30/2007	OW-930 U/L	25.62	25	35	30	-4.38	26.21	95	105	100	-73.79	69.4	21.54	14.57	6.97	0.100
2/22/2007	OW-930 U/L	25.62	25	35	30	-4.38	26.21	95	105	100	-73.79	69.4	20.28	14.63	5.65	0.081
3/29/2007	OW-930 U/L	25.62	25	35	30	-4.38	26.21	95	105	100	-73.79	69.4	20.35	14.77	5.58	0.080
4/27/2007	OW-930 U/L	25.62	25	35	30	-4.38	26.21	95	105	100	-73.79	69.4	20.88	15.17	5.71	0.082
5/25/2007	OW-930 U/L	25.62	25	35	30	-4.38	26.21	95	105	100	-73.79	69.4	20.02	14.89	5.13	0.074
6/27/2007	OW-930 U/L	25.62	25	35	30	-4.38	26.21	95	105	100	-73.79	69.4	19.36	14.99	4.37	0.063
12/28/2006	OW-932 U/L	31.35	28.5	38.5	33.5	-2.15	31.09	68.5	78.5	73.5	-42.41	40.3	24.31	15.56	8.75	0.217
1/30/2007	OW-932 U/L	31.35	28.5	38.5	33.5	-2.15	31.09	68.5	78.5	73.5	-42.41	40.3	25.80	16.78	9.02	0.224
2/22/2007	OW-932 U/L	31.35	28.5	38.5	33.5	-2.15	31.09	68.5	78.5	73.5	-42.41	40.3	24.79	16.89	7.90	0.196
3/29/2007	OW-932 U/L	31.35	28.5	38.5	33.5	-2.15	31.09	68.5	78.5	73.5	-42.41	40.3	24.87	17.06	7.81	0.194
4/27/2007	OW-932 U/L	31.35	28.5	38.5	33.5	-2.15	31.09	68.5	78.5	73.5	-42.41	40.3	25.06	17.44	7.62	0.189
5/25/2007	OW-932 U/L	31.35	28.5	38.5	33.5	-2.15	31.09	68.5	78.5	73.5	-42.41	40.3	25.15	17.31	7.84	0.195
6/27/2007	OW-932 U/L	31.35	28.5	38.5	33.5	-2.15	31.09	68.5	78.5	73.5	-42.41	40.3	24.56	17.41	7.15	0.178
12/28/2006	OW-933 U/L	28.87	26	36	31	-2.13	28.74	76	86	81	-52.26	50.1	24.18	15.85	8.33	0.166
1/30/2007	OW-933 U/L	28.87	26	36	31	-2.13	28.74	76	86	81	-52.26	50.1	25.65	17.08	8.57	0.171
2/22/2007	OW-933 U/L	28.87	26	36	31	-2.13	28.74	76	86	81	-52.26	50.1	24.67	17.16	7.51	0.150
3/29/2007	OW-933 U/L	28.87	26	36	31	-2.13	28.74	76	86	81	-52.26	50.1	24.71	17.34	7.37	0.147
4/27/2007	OW-933 U/L	28.87	26	36	31	-2.13	28.74	76	86	81	-52.26	50.1	25.05	17.74	7.31	0.146
5/25/2007	OW-933 U/L	28.87	26	36	31	-2.13	28.74	76	86	81	-52.26	50.1	25.12	17.61	7.51	0.150
6/27/2007	OW-933 U/L	28.87	26	36	31	-2.13	28.74	76	86	81	-52.26	50.1	24.75	17.73	7.02	0.140
12/28/2006	OW-934 U/L	28.54	30	40	35	-6.46	29.04	89	99	94	-64.96	58.5	20.17	13.87	6.30	0.108

Table 2.3.1-13 Estimated Vertical Hydraulic Gradients in the STP 3 & 4 Area (Continued)

Date	Well Pair	Upper Well Screen [1]					Lower Well Screen [1]					*dx* (ft)	Groundwater [2]		*dh* (ft)	*i* (ft/ft)
		Ground Elevation (ft MSL)	Top (ft bgs)	Bottom (ft bgs)	Midpoint (ft bgs)	Elevation (ft MSL)	Ground Elevation (ft MSL)	Top (ft bgs)	Bottom (ft bgs)	Midpoint (ft bgs)	Elevation (ft MSL)		Upper (ft MSL)	Lower (ft MSL)		
1/30/2007	OW-934 U/L	28.54	30	40	35	-6.46	29.04	89	99	94	-64.96	58.5	20.85	15.11	5.74	0.098
2/22/2007	OW-934 U/L	28.54	30	40	35	-6.46	29.04	89	99	94	-64.96	58.5	20.35	15.21	5.14	0.088
3/29/2007	OW-934 U/L	28.54	30	40	35	-6.46	29.04	89	99	94	-64.96	58.5	20.31	15.43	4.88	0.083
4/27/2007	OW-934 U/L	28.54	30	40	35	-6.46	29.04	89	99	94	-64.96	58.5	20.48	15.85	4.63	0.079
5/25/2007	OW-934 U/L	28.54	30	40	35	-6.46	29.04	89	99	94	-64.96	58.5	20.39	15.61	4.78	0.082
6/27/2007	OW-934 U/L	28.54	30	40	35	-6.46	29.04	89	99	94	-64.96	58.5	20.03	15.71	4.32	0.074

[1] From Table 2.3.1-12

[2] From Table 2.3.1-11

[3] Observation well OW-332L was damaged in January of 2007, a replacement well, OW-332L(R) was installed and developed in February of 2007, prior to the February monthly water level measurement. Therefore, no data is available from January 30, 2007 for well OW-332 U/L.

ft MSL = feet mean sea levell = Hydraulic gradient (dh/dx) dh = Change in hydraulic head (ft) dx = Change in distance (ft)

ft bgs = feet below ground surface

Table 2.3.1-14 Regional Aquifer Properties from Aquifer Pumping Tests

Well Number	Test Date	Screened Interval (ft bgs)	Hydraulic Conductivity (gpd/ft^2)	Transmissivity (gpd/ft)	Storage Coefficient (unitless)	Yield (gpm)	Drawdown or Recovery (ft)	1-Hour Specific Capacity (gpm/ft)	Test Type
TA-65-49-901	3/8/1966	300-355	658	26,300	ND	91.5	10.1	9	Recovery
TA-65-57-702	3/14/1966	331-553	512	25,600	ND	252	36.1	7	Drawdown
TA-65-57-801	7/28/1955	150-530	812	160,000	ND	2,530	ND	ND	Recovery
TA-65-58-107	10/4/1966	75-202	ND	176,000	1.1 x 10^{-3}	NA	NA	NA	Observation well for TA-65-58-108 drawdown test
TA-65-58-108	10/4/1966	150-275	693	86,600	ND	2,378	40.7	58	Drawdown
TA-65-58-803	7/1/1966	91-215	3,950	399,000	ND	1,354	34.2	40	Drawdown
TA-66-63-802	5/25/1966	240-760	582	154,100	ND	2,692	55.9	48	Drawdown
TA-66-63-902	5/26/1966	unknown	753	82,800	9.1 x 10^{-4}	NA	NA	NA	Observation well for TA-66-63-903 drawdown test
TA-66-63-903	5/26/1966	63-240	ND	ND	ND	1,020	ND	ND	
TA-66-64-401	5/18/1966	317-1042	386	162,000	ND	3,417	61.6	55	Drawdown
TA-66-64-702	3/14/1966	unknown	223	64,600	ND	2,005	114	18	Recovery
TA-80-07-501	7/13/1955	220-820	403	120,000	ND	1,760	21.3	83	Recovery
TA-80-08-302	10/28/1966	530-630	355	35,500	ND	413	85	5	Recovery
TA-80-08-701	9/23/1966	300-600	212	19,700	ND	805	51.8	16	Recovery
TA-80-15-102	3/9/1967	506-634	458	45,800	ND	408	47.4	9	Recovery
TA-80-15-201	5/15/1955	353-878	420	107,000	ND	2,630	53	50	Drawdown, specific capacity calculated from recovery test
TA-80-15-301	6/10/1966	unknown	413	67,700	ND	1,026	49.3	21	Drawdown
TA-80-15-401	7/13/1955	225-1044	177	63,000	ND	2,000	47.4	42	Recovery
TA-80-15-502	9/19/1966	244-776	103	31,300	ND	2,020	ND	ND	Recovery
TA-80-16-301	3/10/1967	615-800	505	40,400	ND	158.4	31.6	5	Recovery
TA-80-23-101	7/19/1955	190-776	344	82,500	ND	1,560	34.1	46	Recovery
TA-80-23-301	7/19/1955	200-770	139	51,500	ND	1,535	50.5	30	Recovery
TA-80-23-402	3/17/1967	544-586	ND	44,800	ND	388.5	ND	ND	Recovery
TA-80-23-403	3/17/1967	542-578	ND	42,500	4.6 x 10^{-5}	NA	NA	NA	Observation well for TA-80-23-402 recovery test
TA-81-01-101	10/13/1955	565-760	489	68,500	ND	1,000	NA	NA	Recovery

Table 2.3.1-14 Regional Aquifer Properties from Aquifer Pumping Tests (Continued)

Well Number	Test Date	Screened Interval (ft bgs)	Hydraulic Conductivity (gpd/ft^2)	Transmissivity (gpd/ft)	Storage Coefficient (unitless)	Yield (gpm)	Drawdown or Recovery (ft)	1-Hour Specific Capacity (gpm/ft)	Test Type
TA-81-01-102	10/13/1955	777-1020	214	30,000	ND	915	50	18	Recovery
TA-81-01-601	3/13/1967	218-660	379	42,800	ND	1,290	45.8	28	Recovery
TA-81-01-802	7/18/1955	150-250	269	35,000	ND	1,075	73.2	15	Recovery
TA-81-09-401	3/24/1966	unknown	250	44,300	ND	1,182	83.3	14	Specific capacity calculated from drawdown, permeability and transmissivity from recovery
TA-81-09-504	7/19/1955	150-721	306	53,000	ND	2,000	52.4	38	Recovery
TA-81-09-904	3/16/1967	361-482	717	43,000	1.27×10^{-3}	NA	NA	NA	Observation well for TA-81-09-905 recovery test
TA-81-09-905	3/16/1967	364-491	454	29,500	ND	338	27.3	12	Recovery
TA-81-10-901	4/28/1966	280-296	ND	ND	ND	6.4	ND	ND	
TA-81-10-902	4/28/1966	unknown	ND	10,500	1.36×10^{-4}	NA	NA	NA	Observation well for TA-81-10-901 drawdown test
PP-80-06-101	7/8/1955	85-550	727	189,000	ND	1,485	ND	NA	Recovery
PP-80-06-102	9/9/1963	104-364	790	124,000	ND	1,690	29.9	57	Drawdown
PP-80-06-104	9/9/1963	50-215	ND	119,000	1.4×10^{-3}	NA	NA	NA	Observation well for PP-80-06-102 drawdown test
PP-80-06-703	7/8/1955	154-590	359	79,000	ND	1,450	36.1	40	Recovery
PP-80-06-704	8/21/1963	146-430	616	104,800	ND	1,500	19.6	77	Recovery
PP-80-22-501	9/5/1963	288-370	361	20,600	ND	540	33.2	16	Recovery
ZA-66-62-904	7/18/1955	162-573	382	102,000	ND	1,430	21	68	Recovery
ZA-66-63-504	3/15/1967	167-682	475	195,300	ND	2,508	37.7	67	Recovery
Geometric Mean			420	63,640	4.7×10^{-4}				

Source: Reference 2.3.1-24

Well County codes:

- TA = Matagorda County
- PP = Jackson County
- ZA = Wharton County

NA = Not applicable to test performed

ND = Not Determined

ft bgs = feet below ground surface
gpd/ft2 = gallons per day/square foot
gpd/ft = gallons per day/foot
gpm = gallons per minute
gpm/ft = gallons per minute/foot

Table 2.3.1-15 STP Aquifer Pumping Test Results Summary

Well	Screened Interval (ft bgs)	Aquifer	Test Start Date	Pumping Rate (gpm)	Pumping Duration (hrs)	Hydraulic Conductivity (gpd/ft^2)	Transmissivity (gpd/ft)	Storage Coefficient (unitless)
Production Well 5	290-670	Deep	1/27/1975	300/600	8/72	ND	50,000	2.2 x10^{-4} to 7.6 x 10^{-4}
Production Well 6	340-685	Deep	10/31/1977	320/614	8/72	ND	24,201	ND
Production Well 7	302-702	Deep	1/13/1978	316/614	8/72	ND	25,533	ND
WW-1	60-140	Lower Shallow	unknown	200/300	67/24	413	33,000	7.1 x 10^{-4}
WW-2	59-83	Lower Shallow	11/21/1973	140	120	605	13,000	4.5 x 10^{-4}
WW-2 (Long Term)	59-83	Lower Shallow	12/14/1973	140	288	651	14,000	ND
WW-3	20-43	Upper Shallow	11/28/1973	10	48	65	1,100	1.7 x 10^{-3}
WW-4	30-45	Upper Shallow	1/4/1974	50	46	735	12,500	7 x 10^{-4}
Geometric Mean All Tests						334	15,221	6.3 x 10^{-4}
Geometric Mean Lower Shallow Aquifer						509	21,107	5.6 x 10^{-4}
Geometric Mean Upper Shallow Aquifer						219	3,708	1.1 x 10^{-3}
Geometric Mean Deep Aquifer						ND	31,379	4.1 x 10^{-4}

Data Source: COLA Part 2 Subsection 2.4S.12.2.4.1

ND = Not Determined

Table 2.3.1-16 STP Slug Test Results

	Test Type						Arithmetic Mean of Tests		
	Rising Head Test Method			Falling Head Test Method					
Well	**Butler**	**KGS**	**B-R**	**Butler**	**KGS**	**B-R**	**ft/day**	**gpd/ft^2**	**cm/s**
OW-308L	64	67	65	72	73	56	66	495	2.33E-02
OW-308U	70	64	63	64	62	68	65	488	2.30E-02
OW-332L	53	54	P	49	49	55	52	389	1.83E-02
OW-332U	37	36	27	19	18	11	25	184	8.70E-03
OW-348L	58	46	44	76	61	39	54	404	1.90E-02
OW-348U	P	83	88	68	71	65	75	561	2.65E-02
OW-349L	63	51	35	43	40	52	47	354	1.67E-02
OW-349U	P	P	43	P	P	53	48	359	1.69E-02
OW-408L	P	72	P	70	68	50	65	486	2.29E-02
OW-408U	17	11	11	22	32	28	20	151	7.11E-03
OW-420U	P	33	45	ND	ND	ND	39	292	1.38E-02
OW-438L	17	27	10	15	28	14	18	138	6.53E-03
OW-438U	38	39	26	P	P	24	32	238	1.12E-02
OW-910L	3	0.3	0.6	2	0.9	0.5	1	9	4.29E-04
OW-910U	26	29	21	P	P	P	25	190	8.94E-03
OW-928L	19	11	7	P	24	21	16	123	5.79E-03
OW-928U	19	P	8	19	16	16	16	117	5.50E-03
OW-929L	56	54	29	59	P	59	51	384	1.81E-02
OW-929U	P	3	4	P	12	2	5	39	1.85E-03
OW-930L	40	37	27	24	15	19	27	202	9.52E-03
OW-930U	P	23	32	P	47	48	38	280	1.32E-02
OW-931U	34	23	20	P	P	49	32	236	1.11E-02
OW-932L	24	23	18	22	22	25	22	167	7.88E-03
OW-932U	21	13	14	P	16	22	17	129	6.07E-03
OW-933L	P	51	63	P	P	64	59	444	2.09E-02
OW-933U	P	10	3	8	5	3	6	43	2.05E-03
OW-934L	P	P	35	P	P	32	34	251	1.18E-02
OW-934U	P	32	33	49	P	40	38	288	1.36E-02
Geometric Mean all tests							27	205	9.66E-03
Geometric Mean Upper Shallow Aquifer							26	192	9.04E-03
Geometric Mean Lower Shallow Aquifer							30	221	1.04E-02

P = Poor curve match or questionable data

Test Methods:

KGS = Kansas Geological Survey

B-R = Bouwer and Rice

ND = No data – data not recovered from data logger

Table 2.3.1-17 Summary of STP Aquifer Properties from Laboratory Analyses

Hydrogeologic Unit	Parameter	Bulk Density	Porosity	Effective Porosity or Specific Yield	Grain Size Permeability
Upper Shallow Aquifer Confining Layer	Number of Tests	11	11	NA	NA
	Mean or Geometric mean	101 pcf	40%	NA	NA
	Range	96.4 – 114.9 pcf	31.8 – 42.8%	NA	NA
Upper Shallow Aquifer	Number of Tests	4	4	4	1
	Mean or Geometric mean	99 pcf	41%	33%	NA
	Range	97.2 – 100.2 pcf	39.5 – 41.7%	31.6 – 33.4%	4.11×10^{-3} cm/s
Lower Shallow Aquifer Confining Layer	Number of Tests	9	11	NA	NA
	Mean or Geometric mean	99 pcf	42%	NA	NA
	Range	87.3 – 107.7 pcf	36.1 – 47.2%	NA	NA
Lower Shallow Aquifer	Number of Tests	8	9	9	11
	Mean or Geometric mean	102 pcf	39%	31%	6.05×10^{-3} cm/s
	Range	94.5 – 120.0 pcf	28.8 – 43.9%	23.0 – 35.1%	4.60×10^{-3} – 1.02×10^{-2} cm/s
Deep Aquifer Confining Layer	Number of Tests	22	23	NA	NA
	Mean or Geometric mean	101 pcf	41%	NA	NA
	Range	82.1 – 111.4 pcf	33.4 – 51.8%	NA	NA
Deep Aquifer	Number of Tests	1	1	1	NA
	Mean or Geometric Mean	NA	NA	NA	NA
	Range	103.1	38.8%	31.0%	NA

NA-parameter not applicable or insufficient data to compute statistic

Table 2.3.1-18 Hydraulic Conductivity of Clay

Soil Boring/Sample	Depth (ft)	Hydraulic Conductivity (cm/s)	Hydraulic Conductivity (gpd/ft^2)
B-601 S2	3	3.6×10^{-7}	0.0076
B-241 T3	9	2.4×10^{-6}	0.051
B-242 T3	9	1.2×10^{-6}	0.025
B-601 T5	9	2.4×10^{-8}	0.00051
B-601 T9	29	2.6×10^{-8}	0.00055
B-400 T11	39	4.0×10^{-8}	0.00085
Geometric Mean		1.72×10^{-7}	0.0036

Source: Reference 2.3.1-9, Section 2.5.4.2.6.1

Table 2.3.1-19 Regional Hydrogeochemical Data

								Cations				Anions				
Well	Sample Date	Sample Depth (ft bgs)	pH (standard units)	Specific Conductance (µmhos/cm)	Total Dissolved Solids (mg/L)	Total Hardness (mg/L as CaCO3)	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)
TA-80-15-301	6/10/1966	570	7.7	1550	880	348	22	82	35	195	3	382	302	47	0.7	BDL
TA-80-15-502	9/2/1966	776	7.9	732	430	77	18	17	8	143	BDL	306	79	14	0.6	BDL
TA-80-15-901	12/2/1966	38	7.7	1840	1060	314	24	60	40	285	8	520	333	66	0.8	BDL
TA-80-15-902	12/2/1966	20	7.4	884	530	403	28	98	39	33	BDL	411	54	9	0.8	70
TA-80-16-101	6/12/1967	93	8.1	1200	710	295	25	65	32	160	3	489	153	33	0.8	BDL
TA-80-16-201	9/19/1966	100	7.6	746	437	216	20	53	20	87	BDL	349	73	11	0.7	BDL
TA-80-16-301	7/11/1964	823	8.0	720	570	46	10	11	5	150	ND	309	74	14	ND	ND
TA-80-16-302	7/31/1964	835	7.9	676	554	47	9	12	4	143	ND	312	62	14	ND	ND
TA-80-16-303	9/19/1966	98	7.8	1051	620	353	20	79	38	110	ND	530	111	3	0.6	BDL
TA-80-16-801	12/8/1966	130	7.5	1760	1000	355	22	73	42	245	ND	453	341	52	0.7	BDL
TA-80-23-301	7/19/1955	770	8.3	846	488	42	17	9.9	4.3	177	ND	344	94	11	ND	BDL
TA-80-23-302	6/12/1967	331	8.0	674	403	55	15	14	5	141	ND	334	51	12	0.7	BDL
TA-80-23-501	11/22/1966	68	7.5	2800	1570	730	25	191	62	297	6	375	760	41	0.4	BDL
TA-80-24-202	11/3/1966	411	8.0	811	475	36	10	7	5	182	2	367	79	9	1	BDL
TA-81-09-401	3/24/1966	360	7.8	1290	730	361	25	79	39	138	3	368	240	25	0.5	BDL
TA-81-09-504	7/19/1955	721	8.0	849	498	128	21	37	8.8	143	ND	366	90	11	ND	0.2
TA-81-09-802	9/30/1966	828	8.3	1600	910	18	15	5	1	367	BDL	550	253	BDL	3.1	BDL

BDL = Below analytical detection limit

ND = Not Determined

National Secondary Drinking Water Standard Exceeded (Reference 2.3.1-30)

National Primary Drinking Water Standard Exceeded (Reference 2.3.1-30)

Source: Reference 2.3.1-24

Table 2.3.1-20 STP Hydrogeochemical Data

Well	Sample Date	Sample Depth (ft bgs)	pH (standard units)	Specific Conductance (µmhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Alkalinity (mg/L as CaCO3)	Total Hardness (mg/L as CaCO3)	Silica (mg/L)	Cations						Anions				
										Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Iron (mg/L)	Manganese (mg/L)	Bicarbonate (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Fluoride (mg/L)	Nitrate (mg/L)
Shallow Aquifer at Prod. Well 5	12/17/1974	105	7.84	1480	ND	1095	390	324	18	74	34	211	ND	BDL	0.2	476	245	42	0.8	0.8
Prod. Well 5	1/29/1975	290-670	7.95	863	ND	642	284	37	14	10	3	176	1.3	BDL	BDL	346	87	11	0.9	ND
Prod. Well 5	1/30/1975	290-670	8.25	863	ND	623	286	38	13	10	3	177	1.3	BDL	BDL	320	87	12	0.9	ND
Prod. Well 5	1/31/1975	290-670	8.25	863	ND	626	284	37	13	10	3	176	1.3	BDL	BDL	317	87	11	0.9	ND
Prod. Well 5	12/16/1982	290-670	7.90	818	ND	648	289	42	14	10	4	ND	ND	BDL	0.13	353	79	10	ND	0.36
Prod. Well 6	12/7/1982	330-670	7.65	809	ND	635	298	49	15	12	5	ND	ND	BDL	BDL	364	69	14	ND	BDL
Prod. Well 7	2/9/1983	302-682	7.83	831	ND	628	288	38	13	10	3	168	1.4	BDL	BDL	351	74	8	0.8	0.3
Prod. Well 8	5/15/1991	449-552	8.20	ND	ND	256	197	89	ND	28.2	4.28	70.8	ND	0.06	BDL	216	33	12	0.37	0.3
WW-2	12/20/1973	59-83	7.7	1490	ND	1044	ND	320	ND	65	38	192	ND	ND	ND	464	242	42	ND	1
WW-3	11/30/1973	20-43	ND	4750	ND	2618	ND	672	ND	125	88	680	ND	ND	ND	458	1180	86	ND	1
WW-4	11/4/1974	30-45	ND	1610	ND	1103	ND	430	ND	118	33	191	ND	ND	ND	421	304	36	ND	BDL
Piezometer 115-A	12/21/1973	79	7.6	6100	ND	3316	ND	712	ND	130	95	920	ND	ND	ND	427	1610	134	ND	BDL
Piezometer 115-B	12/21/1973	40	7.5	4020	ND	2326	ND	688	ND	128	90	548	ND	ND	ND	458	1010	91	ND	1
Piezometer 415	12/14/1973	40	7.8	2050	ND	1315	ND	435	ND	93	49	265	ND	ND	ND	415	452	41	ND	BDL
Piezometer 417	12/14/1973	100	7.7	1930	ND	1257	ND	445	ND	104	45	238	ND	ND	ND	396	436	38	ND	BDL
OW-308L	12/30/2006	97.8	7.11	1240	23.1	661	347	ND	ND	62.7	34.2	149	5.47	ND	ND	423	199	24.4	0.8	0.136
OW-308U	12/30/2006	48.9	6.93	2348	23.7	1240	367	ND	ND	97.1	55.6	298	2.53	ND	ND	447	558	76.6	1.4	0.149
OW-332L	12/29/2006	104.6	7.07	1298	22.9	1020	351	ND	ND	98.3	53.5	208	2.98	ND	ND	428	439	43.9	0.77	0.52
OW-332U	12/29/2006	47.6	7.03	1582	22.7	870	383	ND	ND	70.2	35.9	213	BDL	ND	ND	467	240	104	1.4	0.39
OW-408L	12/30/2006	83.2	7.07	1242	23.4	650	349	ND	ND	66	32.5	145	1.97	ND	ND	426	195	21.6	0.97	0.05
OW-408U	12/30/2006	44.3	6.99	1764	23.4	913	385	ND	ND	74.5	38.6	240	1.64	ND	ND	469	344	29.5	1.1	0.053
OW-420U	12/30/2006	50.5	6.94	2114	22.9	1120	320	ND	ND	101	46.8	259	1.79	ND	ND	390	505	44.9	0.85	0.383
OW-928L	12/29/2006	124	6.99	1168	22.5	643	284	ND	ND	74	36.2	110	2.37	ND	ND	346	197	17.1	0.67	BDL
OW-928U	12/29/2006	41.1	6.82	2885	22.3	1560	296	ND	ND	156	51.6	315	2.03	ND	ND	361	815	132	0.75	BDL
OW-930L	12/28/2006	104.6	7.06	1506	22.3	726	360	ND	ND	65.5	34.7	200	2.66	ND	ND	439	260	28.2	0.83	BDL
OW-930U	12/28/2006	34.7	6.87	1152	22.4	623	358	ND	ND	95.6	31.5	89.7	BDL	ND	ND	436	175	16.8	0.66	0.16
OW-933L	12/29/2006	88.8	6.93	1936	23.5	713	392	ND	ND	63.4	33.6	149	2.93	ND	ND	478	197	25.6	0.77	0.069
OW-933U	12/29/2006	38.8	7.28	1658	24.2	908	367	ND	ND	39.2	25.8	273	1.9	ND	ND	447	294	70.9	2.1	BDL
OW-934L	12/31/2006	100.3	7.10	1359	22.6	731	380	ND	ND	62	35.4	185	2.3	ND	ND	463	189	24.5	0.78	BDL
OW-934U	12/31/2006	42.4	6.91	1891	22.7	1020	378	ND	ND	87.8	56.2	218	BDL	ND	ND	461	412	47.3	1.4	0.163

ND = parameter not measured

BDL = parameter below detection limit

🟩 National Secondary Drinking Water Standard Exceeded (Reference 2.3.1-30)

Table 2.3.1-21 Representative Properties of Hydrogeologic Units

Hydrogeologic Unit	Parameter	Bulk Density	Porosity	Effective Porosity or Specific Yield	Grain Size Permeability
Upper Shallow Aquifer Confining Layer	Number of Tests	11	11	NA	NA
	Mean or Geometric mean	101 pcf	40%	NA	NA
	Range	96.4 – 114.9 pcf	31.8 – 42.8%	NA	NA
Upper Shallow Aquifer	Number of Tests	4	4	4	1
	Mean or Geometric mean	99 pcf	41%	33%	NA
	Range	97.2 – 100.2 pcf	39.5 – 41.7%	31.6 – 33.4%	4.11 x 10^{-3} cm/s
Lower Shallow Aquifer Confining Layer	Number of Tests	9	11	NA	NA
	Mean or Geometric mean	99 pcf	42%	NA	NA
	Range	87.3 – 107.7 pcf	36.1 – 47.2%	NA	NA
Lower Shallow Aquifer	Number of Tests	8	9	9	11
	Mean or Geometric mean	102 pcf	39%	31%	6.05 x 10^{-3} cm/s
	Range	94.5 – 120.0 pcf	28.8 – 43.9%	23.0 – 35.1%	4.60 x 10^{-3} – 1.02 x 10^{-2} cm/s
Deep Aquifer Confining Layer	Number of Tests	22	23	NA	NA
	Mean or Geometric mean	101 pcf	41%	NA	NA
	Range	82.1 – 111.4 pcf	33.4 – 51.8%	NA	NA
Deep Aquifer	Number of Tests	1	1	1	NA
	Mean or Geometric Mean	NA	NA	NA	NA
	Range	103.1	38.8%	31.0%	NA

NA = Not applicable to test performed
Source: COLA Part 2 Subsection 2.4S.12

Table 2.3.1-22 STP Groundwater Withdrawals 1995-2006

Month	1995 (gallons)	1996 (gallons)	1997 (gallons)	1998 (gallons)	1999 (gallons)	2000 (gallons)	2001 (gallons)	2002 (gallons)	2003 (gallons)	2004 (gallons)	2005 (gallons)	2006 (gallons)
January	7,765,025	41,812,919	39,525,831	36,128,090	34,041,991	35,446,250	44,476,292	31,115,804	36,279,188	28,909,250	40,797,000	37,189,345
February	12,521,357	37,551,891	36,180,612	29,461,480	32,117,186	30,568,014	42,574,575	36,198,000	31,944,711	33,323,394	37,531,591	34,819,000
March	22,598,920	41,169,835	38,532,459	36,223,601	29,792,357	32,643,753	48,053,000	33,244,000	28,020,000	38,458,117	32,713,000	35,201,420
April	24,601,783	43,177,241	35,683,774	33,649,929	27,093,385	35,652,764	40,828,467	29,628,405	28,524,378	36,309,169	31,956,336	34,964,690
May	25,618,936	45,752,274	38,428,753	38,956,861	35,593,523	36,847,100	35,327,680	37,118,205	43,365,000	27,088,736	36,310,300	37,782,730
June	19,654,117	41,995,128	35,811,044	42,057,320	31,347,265	40,259,759	35,534,592	36,604,000	29,816,000	28,819,186	37,885,740	33,220,900
July	31,055,407	35,369,911	43,862,008	41,054,570	37,595,060	43,141,872	35,660,218	30,254,000	36,912,782	31,785,000	40,315,960	33,538,680
August	33,187,388	32,728,731	42,628,395	36,127,366	36,092,764	43,008,513	38,193,859	29,863,036	45,828,000	30,803,058	38,457,620	32,946,400
Sept.	24,719,646	33,787,725	37,324,840	34,910,719	36,325,308	40,309,148	31,716,791	33,151,000	39,865,019	41,838,634	31,230,060	36,836,000
October	25,744,319	42,742,696	34,426,989	38,050,780	30,770,476	38,460,958	37,052,232	25,675,791	37,863,296	31,538,000	36,540,206	29,407,550
November	22,606,096	38,944,140	35,413,702	32,764,920	36,391,863	31,657,842	30,886,310	33,875,759	37,353,000	28,499,573	34,429,744	38,474,080
December	21,338,258	39,694,275	33,674,338	34,950,153	36,841,789	29,493,213	33,436,651	34,751,855	30,409,159	41,168,000	24,196,105	39,554,770
Total (gallons)	271,411,252	474,726,766	451,492,745	434,335,789	404,002,967	437,489,186	453,740,667	391,479,855	426,180,533	398,540,117	422,363,662	423,935,565
Total (acre-feet)	833	1,457	1,386	1,333	1,240	1,343	1,392	1,201	1,308	1,223	1,296	1,301

Table 2.3.1-23 Estimated Average Linear Velocity and Travel Time

		Hydrogeologic Unit/Pathway				
	Property	**Upper Shallow Aquifer Discharge at tributary east of Plant**	**Upper Shallow Aquifer at Well 2004120846**	**Lower Shallow Aquifer at Well 2004120846**	**Upper Shallow Aquifer Discharge at Colorado River**	**Lower Shallow Aquifer Discharge at Colorado River**
Hydraulic Conductivity	**Representative Value (gpd/ft^2)**	192	192	543	192	543
	Range (gpd/ft^2)	39 - 561	39 - 561	410 - 651	39 - 561	410 - 651
	Representative Value (ft/day)	26	26	72	26	72
	Range (ft/day)	5 - 75	5 - 75	55 - 87	5 - 75	55 - 87
Hydraulic Gradient	**Representative Value (ft/ft)**	0.002	0.002	0.0004	0.002	0.0004
	Range (ft/ft)	0.001 - 0.002	0.001 - 0.002	0.0004	0.001 - 0.002	0.0004
Effective Porosity	**Representative Value (decimal)**	0.33	0.33	0.31	0.33	0.31
	Range (decimal)	0.316 - 0.334	0.316 - 0.334	0.23 - 0.351	0.316 - 0.334	0.23 - 0.351
Average Linear Velocity	**Representative Value (ft/day)**	0.2	0.2	0.09	0.2	0.09
	Range (ft/day)	0.03 – 0.5	0.03 – 0.5	0.06 - 0.2	0.03 – 0.5	0.06 - 0.2
Distance	**Distance to Receptor (ft)**	7,300	9,000	9,000	17,800	17,800
Travel Time	**Representative Value (day)**	36,500	45,000	100,000	89,000	197,800
	Range (day)	14,600 – 243,300	18,000 – 300,000	45,000 – 150,000	35,600 – 593,300	89,000 – 296,700