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2.4.12 Groundwater

This subsection contains a description of the hydrogeologic conditions present at and in the vicinity of the VCS site.

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

The VCS site covers an area of approximately 11,500 acres and is located on the coastal plain of southeastern Texas in Victoria County, south of the city of Victoria, Texas. The VCS cooling basin, an approximately 4900-acre water impoundment, is the predominant feature of the VCS site. The basin is fully enclosed with a compacted earth embankment (see Subsections 2.5.4 and 2.5.5) and encompasses most of the southern and central portion of the site. The VCS power block area is located on the northern portion of the site, adjacent to the northern embankment of the cooling basin.

Regional and local surface water features are described in Subsection 2.4.1, a geologic overview is presented in Subsection 2.5.1, and a geotechnical description for plant construction is presented in Subsection 2.5.4.

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

2.4.12.1 Description and Onsite Use

This subsection contains a description of the regional and local physiography and geomorphology, groundwater aquifers, geologic formations, and groundwater sources and sinks. Onsite uses of groundwater are also described, including groundwater production wells and groundwater requirements of the VCS site.

2.4.12.1.1 Physiography and Geomorphology

The VCS site is located in Victoria County, Texas, approximately 21 miles north of San Antonio Bay. The closest community is McFaddin, which is located approximately 4 miles from the power block area and approximately 1 mile southwest of the VCS site boundary (see Figure 2.4.12-1). The closest city is Victoria, located approximately 13 miles north of the VCS site.

The VCS site and surrounding region are situated in the Coastal Prairies sub-province of the Gulf Coastal Plains physiographic province. The Coastal Prairies sub-province forms a broad band of nearly flat prairies along the Texas Gulf Coast (see Figure 2.4.12-2). Ground surface elevation varies from approximately 0 feet along the coast to approximately elevation 300 feet along the western boundary of the sub-province (Reference 2.4.12-1).

Victoria County is located within the gently rolling plains of South Texas. The ground surface elevation of the plains in Victoria County varies from approximately elevation 100 feet in the moderately dissected upland in the west to approximately elevation 0 feet in the east at the Gulf of Mexico. Regional surface slopes vary from approximately 0 percent to 8 percent, with more pronounced slopes near surface water bodies (Reference 2.4.12-2). The VCS site is located on a relatively flat plain west of the Guadalupe River valley, downstream (south) of the city of Victoria, Texas. The topographic features of the approximately 11,500-acre VCS site shown in Figure 2.4.12-3 are as follows:

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

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

- A gully associated with Kuy Creek is located to the southwest of the VCS cooling basin. As described in Subsection 2.4.1, Kuy Creek is generally classified as a perennial stream. However, field observations made during the site subsurface investigation indicate that the upper reaches of Kuy Creek adjacent to the VCS cooling basin are ephemeral. The emergency spillway for the VCS cooling basin is to Kuy Creek (see Subsection 2.4.8).

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

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

- The drainage pattern in the vicinity of the VCS site is generally dendritic, with the local tributaries draining either to the Guadalupe or San Antonio rivers and then to San Antonio Bay.
- As described in Subsection 2.5.1, additional landforms present at the VCS site include fluvial terraces, river paleochannels, point bars, natural levees, backswamp deposits, relict barrier islands/dunes, and younger alluvial and man-made (fill) deposits. These landforms are consistent with the geomorphology of the Beaumont Formation.

Regional and local surface water features, and a detailed geologic description are presented in Subsections 2.4.1 and 2.5.1, respectively.

2.4.12.1.2 Regional Groundwater Aquifers

The hydrogeologic materials underlying the Coastal Prairies sub-province consist of deltaic sands and muds (Reference 2.4.12-1). The VCS site is underlain by a thick wedge of southeasterly dipping sedimentary deposits of Oligocene through Holocene age. The site overlies what has been referred to as the “Coastal Lowland Aquifer System” (Reference 2.4.12-3). This aquifer system contains numerous local aquifers in a thick sequence of mostly unconsolidated Coastal Plain sediments of alternating and interfingering beds of clay, silt, sand, and gravel. The sediments reach thicknesses of thousands of feet and contain groundwater that ranges from fresh to saline. The majority of groundwater usage is for municipal, industrial, and irrigation needs (Reference 2.4.12-3).

The lithology of the aquifer system is generally sand, silt, and clay and reflects three depositional environments: continental (alluvial plain), transitional (delta, lagoon, and beach), and marine (continental shelf). The depositional basin thickens toward the Gulf of Mexico, resulting in a wedge-shaped configuration of hydrogeologic units. Numerous oscillations of ancient shorelines resulted in a complex, overlapping mixture of sand, silt, and clay (Reference 2.4.12-3).

As part of the U.S. Geological Survey’s (USGS) Regional Aquifer-System Analysis program, the aquifer system was subdivided into five permeable zones and two confining units. The term “Gulf Coast Aquifer” is generally used in Texas to describe the composite of the sands, silts, and clays of the Coastal Lowland Aquifer System as shown in Figure 2.4.12-4 (Reference 2.4.12-4).

Figure 2.4.12-5 compares the Gulf Coast Aquifer and the Coastal Lowlands Aquifer System terminologies (Reference 2.4.12-3). Hydrogeologic cross sections of the Coastal Lowlands Aquifer System and the Gulf Coast Aquifer are shown in Figure 2.4.12-6 (Reference 2.4.12-3) and Figure 2.4.12-7 (Reference 2.4.12-5), respectively. The Gulf Coast Aquifer nomenclature will be used to describe the hydrogeologic units at the VCS site.

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

- The Catahoula Confining System, which includes the Frio Formation, Anahuac Formation, and the Catahoula Tuff or Sandstone (Reference 2.4.12-6).
- The Jasper Aquifer, which consists of the Oakville Sandstone and the Fleming Formation. The upper part of the Fleming Formation forms the Burkeville confining system (Reference 2.4.12-6).
- The Evangeline Aquifer, which consists of the Goliad Sand (Reference 2.4.12-6).
- The Chicot Aquifer, which consists of the Willis Formation, Lissie Formation (undifferentiated Bentley and Montgomery formations), Beaumont Formation, and surficial alluvial deposits (Reference 2.4.12-6).

The base of the Gulf Coast Aquifer is identified as either its contact with the top of the Eocene/Oligocene Vicksburg-Jackson Confining Unit or the approximate depth where the concentration of total dissolved solids in groundwater exceeds 10,000 milligrams per liter (mg/L). The base of the aquifer varies from approximately elevation 300 feet near the updip limit to approximately elevation –6000 feet midway between the updip limit and the coastline (Reference 2.4.12-3).

The Gulf Coast Aquifer is recharged by the infiltration of precipitation that falls on topographically high aquifer outcrop areas in the northern and western portion of the province. Discharge occurs by evapotranspiration, loss of water to streams and rivers as base flow, upward leakage to shallow aquifers in low lying coastal areas or in the Gulf of Mexico, and pumping (Reference 2.4.12-3).

Groundwater in the Gulf Coast Aquifer is generally under confined conditions, except for shallow zones in outcrop areas. In the shallow zones, the specific yield for sandy deposits generally ranges from 10 percent to 30 percent. For confined aquifers, the storage coefficient is estimated to range from 1×10^{-4} to 1×10^{-3} (Reference 2.4.12-3).

The productivity of the aquifer system is directly related to the thickness of the sands in the aquifer system that contain freshwater. The thickness of the aggregated sand within the aquifer ranges from 0 feet at the updip limit of the aquifer system to as much as 2000 feet in the east. Estimated values of transmissivity are reported to range from approximately 5000 to 35,000 square feet per day (37,000 to 261,800 gallons per day per foot, or gpd/foot) (Reference 2.4.12-3).

Groundwater quality in the Gulf Coast Aquifer in the vicinity of Victoria County is generally characterized as good northeast of the San Antonio River but declines to the southwest due to increased chloride concentrations and saltwater intrusion near the coast (Reference 2.4.12-6). The

Gulf Coast Aquifer has not been declared a sole-source aquifer by the U.S. EPA in Texas (Reference 2.4.12-7). A sole-source aquifer is defined as the sole or principal source of drinking water that supplies 50 percent or more of drinking water for an area, with no reasonably available alternative source should the aquifer become contaminated. Figure 2.4.12-8 shows the location of sole-source aquifers in EPA Region 6, which encompasses the VCS site. The nearest Texas sole-source aquifer is the Edwards I and II aquifer system, which is located approximately 150 miles northwest of the VCS site (Reference 2.4.12-7).

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

2.4.12.1.3 Local Hydrogeology

Victoria County covers an area of approximately 890 square miles and is bounded by Jackson County to the east, DeWitt County to the north, Goliad County to the west, and Calhoun and Refugio Counties to the south. Much of the land use in Victoria County is agriculture (26 percent rangeland and 42 percent cropland and pasture), forest (approximately 27 percent) or urban development (3.5 percent). The remaining few percent of land use is mixed use or surface water. Surface water covers only a small portion of the land surface in Victoria County (0.01 percent bays and estuaries, 0.13 percent streams and canals, and 0.21 percent reservoirs and lakes). The lack of surface water resources in the county highlights the importance of groundwater for stock watering, irrigation, and water supply (Reference 2.4.12-2).

Groundwater usage in Victoria County is under the jurisdiction of the Victoria County Groundwater Conservation District (VCGCD). The estimated groundwater usage in Victoria County in 1997 was approximately 27,500 acre-feet per year (24.5 million gpd). Groundwater demand has subsequently decreased because the city of Victoria shifted to using surface water for most of its needs in 2001. Current groundwater usage is estimated to be approximately 20,000 acre-feet per year (17.8 million gallons per day). The estimated surface water usage in Victoria County in 1997 was approximately 29,000 acre-feet per year (25.9 million gallons per day), with the largest user group being manufacturing (Reference 2.4.12-2).

The Guadalupe and San Antonio rivers, Linn Lake, San Antonio Bay, the Victoria Barge Canal, Coleto Creek, and Coleto Creek Reservoir are the major surface water bodies in Victoria County. Many ephemeral streams are also present in Victoria County, with stream flow largely influenced by precipitation. Victoria County is situated in a humid, subtropical climate characterized by mild winters and hot summers and is subject to tropical disturbances from the Gulf of Mexico. Therefore, rainfall in Victoria County tends to exhibit spatial and temporal variability (Reference 2.4.12-2).

A water balance in Victoria County was performed using the average annual precipitation in Victoria County from 1951 to 1980, which was approximately 39 inches. The corresponding average annual runoff was approximately 7 inches. The remaining 32 inches of precipitation evaporated, was transpired by plants, or percolated into the subsurface to recharge the shallow aquifers (Reference 2.4.12-3). Subsection 2.3.2.2.6 indicates the long-term average precipitation in the site area is between approximately 38.6 and 40.8 inches per year.

The surficial soils in Victoria County tend to limit recharge because they are composed of low-permeability silt and clay intermingled with sand. Recharge in Victoria County is estimated to range from 10,000 to 30,000 acre-feet per year (8.9 to 26.8 million gallons per day). The northwestern portions of Victoria County exhibit more porous soils and receive higher precipitation, making these areas more suitable for recharge to the shallow aquifers in the vicinity of the VCS site, located in southern Victoria County (Reference 2.4.12-2).

The principal aquifers in Victoria County are the Chicot and Evangeline aquifers. As shown in Figure 2.4.12-7, the shallower Chicot Aquifer extends to an elevation of approximately –300 feet and the deeper Evangeline Aquifer extends to an elevation of approximately –1000 feet, respectively, in the vicinity of the VCS site. Regional groundwater flow is generally to the southeast from the recharge areas in the northwestern parts of Victoria County toward the Gulf of Mexico (see Figure 2.4.12-9). Groundwater flow is described in more detail in Subsection 2.4.12.2.2.

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

2.4.12.1.3.1 Goliad Sand

The Pliocene Goliad Sand consists of whitish- to pinkish-gray, coarse-grained sediments, including cobbles, clay balls, and wood fragments at the base of the formation. The upper part of the Goliad Sand consists of finer-grained sands cemented together with caliche. The sands are interbedded with grayish clays, which are locally marly. The presence of caliche, gravel, and irregular bedding are indicative of a high-energy fluvial depositional environment in the early Pliocene, followed by semi-arid periods later in the Pliocene. The top of the Goliad Sand forms the hydrogeologic boundary between the Evangeline and Chicot aquifers (Reference 2.4.12-8).

2.4.12.1.3.2 Willis Formation

The Pleistocene Willis Formation consists of reddish, gravelly, unfossiliferous coarse sand. Sediments of the Willis Formation are fluvial and deltaic deposits in coarsening-upward sequences, indicative of delta-front facies (Reference 2.4.12-8).

2.4.12.1.3.3 Lissie Formation

The Pleistocene Lissie Formation consists of reddish, orange, and gray, fine- to coarse-grained, cross-bedded sands. The sediments of the Lissie Formation represent sand, silt, and mud deposited on flood plains or in river deltas. The undifferentiated Lissie Formation is considered equivalent in age to the Bentley and Montgomery formations. However, the heterogeneity of the sediments, discontinuity of the beds, and the general absence of index fossils and diagnostic electrical log signatures make correlation of the lithologic units difficult. The undifferentiated Lissie Formation and the Bentley Formation are generally considered the base of the Pleistocene, while the Montgomery Formation is occasionally included in the younger Beaumont Formation (Reference 2.4.12-8).

2.4.12.1.3.4 Beaumont Formation

The Pleistocene Beaumont Formation consists of poorly bedded, marly, reddish-brown clay interbedded with lenses of sand. Sediments of the Beaumont Formation represent natural levees and deltas deposited largely by rivers and, to a lesser extent, water from shallow-marine and lagoonal bays and embayments. The clays of the Beaumont Formation retard any significant infiltration of rainwater (Reference 2.4.12-8).

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

2.4.12.1.3.5 Holocene Alluvium

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

The Holocene alluvium only occurs locally and cannot be correlated on a regional scale. It is, therefore, typically included in the Chicot Aquifer. The Holocene alluvium exhibits the largest outcrop area of the stratigraphic units in the Texas Gulf Coast and provides a direct hydraulic connection between surface water and groundwater in some cases (Reference 2.4.12-8).

2.4.12.1.4 Site Specific Hydrogeology

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

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

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

- Slug tests: Field hydraulic conductivity tests (slug tests) were conducted in each of the 54 observation wells. The results of the slug tests are discussed in Subsection 2.4.12.2.4.1.

- Aquifer pumping tests: Two aquifer pumping test well clusters, each consisting of one test well (pumping well) and four water level observation wells, were installed. A shallow test well and a deep test well were installed to a depths of approximately 80 feet and 180 feet bgs, respectively. Aquifer pumping tests were conducted at each location. The aquifer pumping tests are discussed in Subsection 2.4.12.2.4.1.

- Borehole permeameter tests: Borehole permeameter tests were conducted at 16 borehole locations within the footprint of the VCS cooling basin. Permeameter tests were conducted at depths of 5 and 10 feet bgs in each borehole. The permeameter tests are discussed in Subsection 2.4.12.2.4.2.

Well installations began in October 2007 and were completed in February 2008. Figure 2.4.12-10 shows the locations of observation wells used to identify and characterize the aquifers at the VCS site. Table 2.4.12-1 presents the construction information for the observation wells. The groundwater observation wells at the VCS site are named in four series, which represent the location and screen intervals of the observation wells and are as follows:

- “OW” identifies groundwater observation wells. “TW” identifies aquifer pumping tests wells.
    - OW-00 series wells represent the first set of exploratory borings and observation wells installed at the VCS site. With the exception of OW-08U/L through OW-10U/L, the well pairs are located in the VCS cooling basin footprint.
    - OW-2100 series wells, with the exception of OW-2185U/L, are located in the western VCS power block facility area.
    - OW-2200 series wells are located in the eastern VCS power block facility area.
    - OW-2300 series wells identify wells located outside of the power block area. With the exception of OW-2301U/L, OW-2307U/L, OW-2324U/L, and OW-2348U/L, the well pairs are located in the vicinity of the VCS cooling basin area.
- A “U” suffix in the observation well name indicates the shallower well of the well pair. The observation well is screened in either the Upper Shallow or Lower Shallow aquifer.
- An “L” suffix in the observation well name indicates the deeper well of the well pair. The observation well is screened in either the Lower Shallow or Deep aquifer.

A geotechnical interpretation of the subsurface conditions encountered across the VCS site was developed from the geotechnical properties described in Subsection 2.5.4. The series of cross sections presented in Subsection 2.5.4, as shown in Figures 2.5.4-5, 2.5.4-6, 2.5.4-9, and 2.5.4-10, illustrate the substrata of the power block area, and the cross sections shown in Figures 2.5.4-14 through 2.5.4-20 illustrate the substrata across the cooling basin.

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

- The “Shallow aquifer,” consisting of sand layers occurring from existing ground surface to a depth of approximately 120 feet bgs. The Shallow aquifer is further subdivided into the “Upper Shallow aquifer” (from approximately 50 to 80 feet bgs) and the “Lower Shallow aquifer” (from approximately 90 to 120 feet bgs). The Upper Shallow and Lower Shallow aquifers are interpreted as components of the Chicot Aquifer.
- The “Deep aquifer,” consisting of sand layers occurring from approximately 130 to 280 feet bgs. The Deep aquifer is also interpreted as a component of the Chicot Aquifer.
- The Evangeline Aquifer, consisting of sand layers at depths greater than 500 feet bgs. Observation wells were not installed into the Evangeline Aquifer because the groundwater investigation at the VCS site was focused on shallow groundwater conditions that may have

an impact or be impacted by construction and operation of the VCS. The primary source of water for the VCS is surface water from the cooling basin. Groundwater will be used as described in Subsection 2.4.12.1.6. The source of groundwater will be the Evangeline Aquifer. Published reports and data for the Evangeline Aquifer were used to evaluate aquifer properties, VCS production well requirements, and aquifer impacts (well locations and flow rates, and area of influence).

A summary of the well identification and the hydrogeologic units where the well is screened is presented in Table 2.4.12-2.

A conceptual hydrostratigraphic model was developed from the geotechnical cross sections to describe the shallow portion of the Chicot Aquifer at the site. This model subdivided the Chicot Aquifer into three units: a confined Deep aquifer and Lower Shallow aquifer, and a partially confined Upper Shallow aquifer. The Upper Shallow, Lower Shallow, and Deep aquifer designations are informal and are based primarily on the hydrogeologic conditions encountered during the subsurface site investigation and the resulting screen intervals of the observation wells. The sand layers at the site were also subdivided into geotechnical units based on soil properties described in Subsection 2.5.4. Figure 2.5.4-5 in Subsection 2.5.4 is a typical cross section showing the geotechnical units. The following list relates the geotechnical sand units to the hydrogeological units:

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

Additionally, as discussed in Subsection 2.4.12.3.1, the conceptual site model developed and incorporated into a groundwater flow model consists of eleven sand and clay layers chosen to represent the aquifer units.

The top of the Deep aquifer is comprised of Sand 5 and/or Sand 6 strata. These strata are typically between 10 and 50 feet thick at the site. However, in areas such as that depicted in Cross Section E (see Figure 2.5.4-14), the top of the Deep aquifer may also include Sand 8 because the intervening confining Clay 7 is absent and Sand 8 is in direct contact with Sand 6. However, the entire Deep aquifer is considered to include all the strata from Sand 5 down to a depth of approximately 280 feet, where the top of the Goliad Sand, which separates the Chicot and Evangeline aquifers, is encountered.

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

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

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

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

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

2.4.12.1.5 Groundwater Sources and Sinks

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

The outcrop areas for the Evangeline Aquifer are considered to be in areas north and west of Victoria County (see Figures 2.4.12-4, 2.4.12-6, and 2.4.12-7). In the outcrop areas, precipitation falling on the ground surface can infiltrate directly into the sands and recharge the aquifer. Superimposed on this generalized flow pattern is the influence of heavy pumping within the aquifer. Concentrated pumping areas can alter or reverse the regional flow pattern. A further description of regional groundwater use and flow patterns is presented in Subsection 2.4.12.2.

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

The predominant surface water feature at the VCS site will be the approximately 4900-acre VCS cooling basin. As shown in Figure 2.4.12-3, this surface water body encompasses the majority of the southern and western portions of the site. The design pool level of the approximately 4900-acre cooling basin is elevation 90.5 feet, imposing a maximum hydraulic head of up to 25 feet above the existing ground surface in the southeastern portion of the site. The planned bottom of the VCS cooling basin is at an elevation of 69.0 feet. The capacity of the VCS cooling basin at the normal operating level will be approximately 103,600 acre-feet.

The VCS cooling basin will experience seepage through the impoundment floor to the subsurface, through the embankment, and through spillways. The cooling basin will be fully enclosed by a compacted earth embankment dam. The embankment dam will be constructed of compacted, low permeability, clay fill that will reduce seepage from the cooling basin. Seepage from the cooling basin through the embankment dam will be intercepted, in part, by drainage ditches around the outside of the embankment dam that will discharge to surface water at various locations (see Subsections 2.5.4 and 2.5.5).

Seepage from the VCS cooling basin to the subsurface is predicted to be approximately 4000 gpm (3930 gpm), based on the results of the groundwater modeling described in Subsection 2.4.12.3.

2.4.12.1.5.1 Site-Specific Groundwater Recharge

Groundwater flow at the VCS site in the Chicot Aquifer is generally to the east towards the Guadalupe River valley as described in Subsection 2.4.12.2.2. The Beaumont Formation crops out over much of the VCS site and receives recharge from infiltration of precipitation. The Holocene alluvium, which crops out along Linn Lake and the San Antonio and Guadalupe Rivers, receives recharge from infiltration of precipitation and groundwater flow from the Chicot Aquifer. Discharge from these formations contributes to the base flow of the Guadalupe River, Colleto Creek, and Linn Lake.

The construction and operation of the cooling basin at the VCS site will result in the removal of approximately 4900 acres of surface drainage area west of Linn Lake. The reduced drainage area will decrease surface recharge to both the Beaumont Formation and the alluvium. However, unmitigated seepage from the basin will increase groundwater contributions to Kuy and Dry Kuy Creeks and downgradient seeps by more than two orders of magnitude above preconstruction seepage amounts. Seepage discharge from the VCS cooling basin into the subsurface is described in greater detail in Subsection 2.4.12.3.

2.4.12.1.5.2 Site-Specific Groundwater Discharge

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

Filling of the cooling basin will increase recharge to the underlying shallow aquifer as the result of seepage from the cooling basin to the subsurface environment. Seepage from the cooling basin is predicted to alter the groundwater flow direction in the site area. The groundwater level is predicted to rise beneath the basin to saturate previously unsaturated shallow sand layers. Seepage from the cooling basin to the groundwater system is predicted to increase groundwater contribution (groundwater discharge as base flow) to Kuy Creek, Dry Kuy Creek, and the surface seeps to the north and east of the VCS site. Seepage from the VCS cooling basin enters the subsurface and is discharged to the local surface water features as described in more detail in Subsection 2.4.12.3.

2.4.12.1.6 Onsite Use of Groundwater

Groundwater and the VCS raw water makeup system are the sources of water for operations at the VCS site. Groundwater is not a safety-related source of water for the VCS site. Groundwater will supply the demineralized water system, the potable and sanitary water system, and fire protection system. Operation of the VCS site is estimated to require a typical groundwater consumption of approximately 464 gpm. The peak groundwater consumption (i.e., during plant outage) for the VCS site is expected to be approximately 1053 gpm. The temporary water supply required for construction activities is estimated to be approximately 580 gpm and is expected to last approximately four to five years. It is expected that three onsite groundwater production wells will be installed to meet groundwater demands to support construction and operation. The onsite production wells will be located in the Evangeline Aquifer. It is expected that two wells would be in operation with a third acting as a backup. The wells would be screened in the Evangeline Aquifer at depths ranging between approximately 450 to 1000 feet bgs. Preliminary well locations would be to the east, west, and north of the power block area at spacing greater than 6500 feet to minimize aquifer drawdown beneath the power block area. The exact number, depths, locations, and pumping rates of the onsite production wells are preliminary and will be determined during the detailed design of the VCS site.

2.4.12.2 Groundwater Sources

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

2.4.12.2.1 Historical and Projected Groundwater Use

Historical, current, and projected groundwater use in the vicinity of the VCS site is evaluated using information obtained from the EPA, the Texas Water Development Board (TWDB), the VCGCD, and a well canvass conducted in the vicinity of the VCS site on April 1 and 2, 2008.

2.4.12.2.1.1 Historical Groundwater Use

Groundwater pumping in the Gulf Coast Aquifer system was relatively small and constant from 1900 until the late 1930s. Pumping rates increased sharply between 1940 and 1960, when approximately 800 million gallons per day were withdrawn from the aquifer system. Groundwater pumping in the aquifer system increased relatively slowly through the mid 1980s. By 1985, 1090 million gpd were withdrawn from the aquifer system. Groundwater withdrawals were primarily from the east-central area of the aquifer system, centered mostly in the Houston area of Harris County. Approximately 476 million gallons per day were withdrawn for public supply and 447 million gallons per day were withdrawn for agriculture. Much of the pumping for agricultural use was associated with rice irrigation centered in Jackson, Wharton, and portions of adjacent counties (Reference 2.4.12-3).

Problems associated with groundwater pumping, such as land subsidence, saltwater encroachment, stream base-flow depletion, and larger pumping lifts have caused pumping to be curtailed in some areas. The TWDB made projections of groundwater use to 2030 (Reference 2.4.12-3). For the ten 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 (Colorado, Harris, Jackson, Jasper, Matagorda, and Wharton) and an increase in pumping from four of the counties (Brazoria, Fort Bend, Victoria, and Waller).

Victoria County was projected to experience a net increase in withdrawal of 3 percent, or 1 million gallons per day, with pumping rates increasing from 29 to 30 million gallons per day by 2030 (Reference 2.4.12-3). However, as described in Subsection 2.4.12.1.3, groundwater demand in Victoria County has decreased since 2001, when the city of Victoria shifted to using surface water for most of its needs. Current groundwater usage is estimated to be less than approximately 20,000 acre-feet per year, or 18 million gallons per day (Reference 2.4.12-2).

2.4.12.2.1.2 Current Groundwater Use

Current groundwater use data for Victoria County is available from the EPA, the TWDB, and the VCGCD. The EPA monitors drinking water supply systems throughout the country and maintains the results in the Safe Drinking Water Information System (SDWIS) (Reference 2.4.12-9). Table 2.4.12-3 presents a listing of SDWIS water supply systems in Victoria County as of May 2009. Figure 2.4.12-11 shows the locations of these SDWIS water supply systems. Thirty-three systems are identified in Victoria County, with four systems serving greater than 1000 people, twenty-three systems serving from 100 to 1000 people, and six systems serving less than 100 people. The closest SDWIS water supply systems are the Victoria County WCID 1 (Water system ID TX2350001) and the Invista SARL—Victoria System (Water system ID TX2350014), which are located approximately 5.5 miles northeast of the power block area at the VCS site, across the Guadalupe River, and the Spiritual Renewal Center (water system ID TX2350057), which is located approximately 5 miles southwest of the VCS power block area.

Groundwater use in the state and the county are controlled by the TWDB and the VCGCD, respectively. The VCGCD implemented a District Management Plan for adoption in October 2008 and was approved by TWDB in December 2008 (Reference 2.4.12-25). The mission of the plan is to develop sound water conservation and management strategies designed to conserve, preserve, protect, and prevent waste of groundwater resources within Victoria County. A spectrum of groundwater development alternatives were evaluated by VCGCD. Based on the evaluation, available groundwater within the district was estimated to range between 25,000 and 45,000 acre-feet per year. For planning purposes, the available groundwater was established at 35,000 acre-feet per year. Groundwater use in Victoria County was as high as approximately 40,000 acre-feet per year in the early 1980s, decreasing to about 15,500 acre-feet per year in 2004. The average groundwater use between 2000 and 2004 was approximately 20,200 acre-feet per year.

The total water demand for 2010 through 2020 was estimated by VCGCD to average nearly 63,000 acre-feet per year and would be met by conjunctive use of both surface water and groundwater resources. It was also estimated that there would be no unmet water needs projected for Victoria County through 2040 based on the current projected estimates for county water needs. Water shortages are projected to be small through 2060 (Reference 2.4.12-25). The district is in the process of establishing monitoring and management programs, and additional studies to protect the water resources of the county. In October of 2008, VCGCD adopted rules for groundwater use in the county which became effective in December 2008 (Reference 2.4.12-26). These rules included registration of groundwater wells, permitting for new well installations and use, production well limits and spacing, transfer of groundwater out of the district, enforcement, and other measures.

The TWDB is legislatively directed to plan for, and financially assist in, the development and management of the water resources of Texas. As a result, the TWDB conducts an annual survey of groundwater and surface water use by municipal and industrial entities so it can maintain accurate information concerning the current use of water in the state. Specifically, the TWDB seeks information pertaining to water that is self-supplied from groundwater sources (wells), surface water sources (lakes, rivers, and streams), or is purchased from a supplier (city, district, water supply corporation, private water company, or industry). The survey is based on water user-submitted information and may include estimated values. The survey does not include single-family, domestic well groundwater use (Reference 2.4.12-10).

The TWDB maintains the information gathered during the annual survey in a statewide database called the Water Information Integration and Dissemination (WIID) system. The WIID system is divided into water use categories (irrigation, livestock, manufacturing, mining, municipal, and steam electric) and water supply media (groundwater or surface water). The TWDB groundwater and surface water use data for Victoria County are available for 1974 through 2004 (see Table 2.4.12-4) (Reference 2.4.12-11). Draft water use data for Victoria County for 2005 and 2006 are also presented in Table 2.4.12-4. Final water use data from 2005 to present has not been released by the TWDB as of December 2007 and are, therefore, not included in this report. The VCGCD refers to the TWDB WIID and does not maintain its own database of water wells.

Information from the TWDB database was used to prepare Figure 2.4.12-12, which shows the locations of the known water wells within 5 miles of the VCS site, as of May 2009. Outputs from the TWDB WIID database for Victoria County are presented in map form on Plate I in Appendix 2.4.12-A and tabular form in Appendix 2.4.12-B.

Based on the TWDB data, the predominant water use categories in Victoria County in 2004 were manufacturing (54.9 percent) and municipal (24.6 percent), followed by irrigation (8.0 percent), mining (6.2 percent), steam electric (3.3 percent), and livestock (3.0 percent). Most of the water used in the livestock, manufacturing, and steam electric categories in 2004 was obtained from surface water sources, while the majority of the water used in the irrigation, mining, and municipal categories in 2004 was obtained from groundwater (Reference 2.4.12-11).

2.4.12.2.1.3 Projected Groundwater Use

The TWDB prepares estimates of future water use as part of water supply planning in addition to conducting the annual water use survey described in this subsection. This is facilitated through coordination with 16 planning regions throughout the state. Victoria County is a member of the South Central Texas Region, which includes all or part of 21 counties situated in the Rio Grande, Nueces, San Antonio, Guadalupe, Lavaca, and Colorado River Basins and the San Antonio-Nueces, Lavaca-Guadalupe, and Colorado Lavaca Coastal Basins (Reference 2.4.12-12).

The population of the South Central Texas region was estimated to be 2.0 million in 2000 and is projected to increase to 4.3 million by 2060. A water use increase associated with livestock (+1 percent), manufacturing (+79 percent), mining (+59 percent), municipal (+87 percent), and steam electric (+210 percent) is projected by 2060 as a result of this population increase. The combined water demand in the South Central Texas region for the irrigation, livestock, manufacturing, mining, municipal, and steam electric water use categories is projected to create a total water shortage of 417,000 acre-feet per year by 2060 (Reference 2.4.12-12). It should be noted that irrigation use in the South Central Texas Region is projected to decrease 21 percent by 2060 based on increased irrigation efficiency, economic factors, and reduced government programs affecting the profitability of irrigated agriculture (Reference 2.4.12-12).

Table 2.4.12-5 presents a summary of the projected water use through the year 2060 for Victoria County (Reference 2.4.12-12).

Future development of the water resources in Victoria County is projected to be primarily around the city of Victoria and in support of the VCS site (Reference 2.4.12-13). Preliminary estimates of groundwater availability in the vicinity of the VCS site were derived through a stakeholder workgroup, which included representatives of potential water marketers, water utilities, river authorities, navigation district, neighboring groundwater conservation districts, grass roots environmental and water advocacy groups, agricultural and ranching interests, and other concerned citizens. The workgroup evaluated a set of criteria to establish desired future conditions. These criteria included drawdown in the Chicot and Evangeline aquifers, stream flux, vertical exchange between aquifers, minimum saturated aquifer thickness, and groundwater gradients (Reference 2.4.12-13).

The workgroup proposed that the planning area be managed such that (1) the average drawdown in the unconfined portions of the Chicot and Evangeline aquifers be as small as possible and no more than 25 percent of their respective average aquifer thicknesses, (2) the average drawdown in confined portions of the Evangeline Aquifer be as small as possible and no more than 50 percent of the average aquifer thickness, and (3) to the extent possible, future groundwater development should ensure that fluxes between streams and aquifers, as well as exchanges between aquifers, be within the variability presumed to have been experienced between 1990 and 1999 (Reference 2.4.12-13).

Several water management strategies have been proposed to address potential water shortages in Victoria County and the South Central Texas region resulting from new development. These include water conservation, maximizing available resources, conjunctive use of groundwater and surface water, limiting depletion of storage in aquifers, and seawater desalinization. These water management strategies could produce new water supplies exceeding 738,000 acre-feet per year by 2060 (Reference 2.4.12-12). It should be noted that these estimates have uncertainties associated with population growth projections, assumptions about climatic conditions (drought or wet years), and schedules for implementation of water conservation measures.

The groundwater needs for VCS are projected to be approximately 1053 gpm (peak demand) and approximately 464 gpm during normal plant operations. Groundwater is to be withdrawn from the Evangeline Aquifer (see Subsection 2.4.12.1.6). As shown in Table 2.4.12-4, groundwater use within the county has decreased over time because the county has switched to surface water for much of its needs. The amount required for VCS would not result in a substantial change in the groundwater use trend shown in Table 2.4.12-4. (Reference 2.4.12-13)

2.4.12.2.2 Groundwater Flow Directions

Limited historical groundwater level data exist for the site proper because it is a greenfield site; however, the Texas Water Development Board (TWDB) does maintain several observation wells close to the site to measure water levels in the Chicot Aquifer. Regionally, groundwater flow in the Chicot Aquifer is generally southeast toward the Gulf of Mexico as shown in Figure 2.4.12-13, which is a regional potentiometric surface map of the Chicot Aquifer for 1999. The limited number of data points in the site area obscures any localized impacts from rivers in the site area. Figure 2.4.12-14 presents the steady-state simulated groundwater level elevations in the Chicot Aquifer using the calibrated Central Gulf Coast Groundwater Availability Model (GAM) (Reference 2.4.12-14). This map shows the influence of the Guadalupe and San Antonio Rivers on localized flow conditions adjacent to the site, where a west to east component of flow is overlain on the regional flow pattern.

Regional groundwater flow in the Evangeline Aquifer is also generally to the south and east toward the Gulf of Mexico, based on groundwater level data collected by the TWDB between 2001 and 2005 (Reference 2.4.12-6). As depicted in Figure 2.4.12-9, localized pumping has caused a decline in water level in some parts of the Gulf Coast Aquifer, such as Harris and Kleberg counties. The pumping has created large cones of depression in these pumping areas, which divert groundwater flow from the Gulf of Mexico to the pumping centers.

As described in Subsection 2.4.12.1.4, groundwater observation well pairs were installed at 27 locations (54 individual wells) to investigate groundwater flow directions and horizontal and vertical hydraulic gradients at the VCS site. In addition, the four pumping test observation wells for each of the two test well locations (additional eight wells) were added to the observation well network resulting in 62 groundwater level monitoring wells.

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

For the first three months of data collection, only the OW-01U/L through OW-10U/L well pairs were installed, for a total of 20 observation wells. By February 2008, an additional 42 observation wells (17 well pairs and two sets of 4 observation wells associated with the aquifer pumping test wells) were installed. The two aquifer pumping test wells were not incorporated into the groundwater monitoring program. Water level measurements from October 2007 through October 2010 are presented on Table 2.4.12-6. (Anomalous or suspect water level measurements due to instrument malfunction, operator error, or transcription errors are indicated in the table).

Groundwater level measurements collected from the observation wells at the VCS site in February, May, August, and November 2008; February, May, and August 2009; and March and October 2010 were used to develop potentiometric surface maps for the Upper Shallow, Lower Shallow, and Deep aquifers (Figure 2.4.12-15). These potentiometric surface maps show that groundwater flow direction at the VCS site in the three aquifers is generally to the east toward the Guadalupe River valley.

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

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

The vertical hydraulic gradient (i_v) is calculated by dividing the difference in hydraulic head between adjacent upper and lower observation wells by the length of the vertical flow path. The vertical flow path length is assumed to be from the midpoint elevation of the upper observation well screen to the midpoint elevation of the lower observation well screen. Table 2.4.12-7 presents the calculated vertical hydraulic gradients.

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

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

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

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

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

Construction dewatering, operation of the proposed onsite production wells, and the operation of the cooling basin have the potential to alter or reverse the local flow patterns at the VCS site. Post-construction groundwater flow patterns were simulated through the development of a site groundwater computer model (see Subsection 2.4.12.3.1).

2.4.12.2.3 Temporal Groundwater Trends

As depicted in Figure 2.4.12-16, groundwater levels in Victoria County were on the decline from the 1950s to 2000, until the city of Victoria switched to surface water for much of its needs (Reference 2.4.12-2). Data obtained from the TWDB for three observation wells (well numbers 7924702, 7932602, and 8017502; (Reference 2.4.12-10) located near the VCS site were selected to prepare the regional hydrographs shown on Figure 2.4.12-16. Water level data from these wells through approximately 2006 were used in the temporal groundwater analysis based on their proximity to the VCS site.

Well 8017502 is located approximately 6.3 miles northeast of the power block area at the VCS site and is screened in the Goliad Sand of the Evangeline Aquifer to a depth of 1026 feet below ground surface. Historical water level data from this well indicates that between 1958 and 2000 a decrease in groundwater level occurred. Since 2000, the groundwater level has recovered and has surpassed the 1958 level.

Well number 7932602 is located approximately 5.5 miles northeast of the power block area at the VCS site and is screened in the Lissie Formation of the Chicot Aquifer to a depth of 595 feet below ground surface (Reference 2.4.12-10). As with well 8017502, historical water level data from this well indicates that between 1958 and 2000, a decrease in groundwater level occurred. Since 2000, the groundwater level has recovered and has also surpassed the 1958 level.

Well 7924702 is located approximately 6 miles northwest of the power block area at the VCS site and is screened in the Chicot Aquifer to a depth of 180 feet below ground surface (Reference 2.4.12-10). This well exhibits a generally decreasing water level over the period of record for the well. Groundwater level data are not available from this well from 1998 to 2003. Therefore, the relationship, if any, of the decrease in groundwater level in this well to the city of Victoria switching to surface water for its needs in 2001 is unclear.

Figure 2.4.12-17 presents hydrographs for the observation wells installed at the VCS site. Review of the data suggests that there are a few suspect water level readings that deviate from the general water level trend in some wells. These suspect readings may result from misreading of the water level device or from conditions in the well that can produce false readings when using an electric water level measuring device, such as water condensate droplets on the interior wall of the well casing. Excluding the suspect water level measurements, the following trends are apparent for the three monitoring intervals:

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

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

  Wells OW-2324U and OW-2348U stand out as exceptions to these general trends. These wells are screened in the Lower Shallow aquifer and are located in the eastern part of the site near the floodplain of the Guadalupe River and Linn Lake. Groundwater in this area is believed to be influenced by surface water conditions. Some water level fluctuations in wells OW-2324U and OW-2348U (particularly those between September 2008 and May 2009) appear to be related to fluctuations in the stage of the Guadalupe River based on river stage data recorded at USGS Gage 08177520 on the Guadalupe River near Bloomington, Texas (Reference 2.4.12-33).

Linn Lake is an oxbow lake on the west side of the Guadalupe River valley. The lake is a former meander that has been cut off from the main channel of the Guadalupe River. The Bloomington, Texas 7.5-minute USGS topographic map (Reference 2.4.12-32) shows the river to be approximately 1,000 feet from the lake at their closest point, and both to be at approximately the same elevation. No water level measurements for Linn Lake are available. However, because of the geomorphology of Linn Lake and its proximity to the river, it is likely that the lake and river are hydraulically connected and that the stage in the lake trends similarly to the stage of the nearby river.

- Deep aquifer: During the winter of 2007, water level readings show small variations of less than 1 foot in this zone. Beginning in 2008, and ending in November 2009, there is an overall downward trend in the water level elevation data, with the exception of a few wells showing a flattening of the hydrograph curve during the fall and winter months of late 2008 and into early 2009. From November 2009 to October 2010, water levels rose up to 2.5 feet. Water levels in wells OW-2324L and OW-2348L, screened in the Deep aquifer and also located near Linn Lake and the Guadalupe River, follow similar trends to those observed in wells OW-2324U and OW-2348U screened in the Lower Shallow aquifer.Some water level fluctuations in wells OW-2324L and OW-2348L also appear to be related to fluctuations in the stage of the Guadalupe River based on river stage data recorded at USGS Gage 08177520 for the Guadalupe River near Bloomington, Texas (Reference 2.4.12-33).

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

Figure 2.4.12-7 is a regional hydrogeologic cross-section through the Gulf Coast aquifer system. The figure shows that the outcrop area of the Chicot aquifer extends inland from the VCS site to approximately the southeastern DeWitt County line, where the ground surface elevation is approximately 150 feet. Precipitation falling on the outcrop area recharges groundwater in the Chicot aquifer. The higher ground surface elevation inland near DeWitt County induces a regional hydraulic gradient within the aquifer toward the southeast and the Gulf of Mexico, where the ground surface elevation is nominally 0 feet.

Figure 2.4.12-13 shows that in 1999 a southeastern regional hydraulic gradient was observed in the Chicot aquifer near the VCS site. Figure 2.4.12-14 shows groundwater elevations in the Chicot aquifer simulated by the Groundwater Availability Model (GAM) developed by the Texas Water Development Board (Reference 2.4.12-14). This figure shows a similar regional hydraulic gradient toward the southeast.

Figure 2.4.12-14 shows, in the area of the VCS site, the 50-foot equipotential line to be diverted locally near the San Antonio and Guadalupe rivers. That diversion occurs because groundwater from higher elevations in the Chicot aquifer drains down-gradient toward and discharges to the rivers. The surface elevation within the power block area of the VCS site is about 80 feet (Table 2.5.4-36). At observation well pair OW-2348, near the eastern boundary of the VCS site and the Guadalupe River valley, the surface elevation is approximately 50 feet (Table 2.4.12-1). Within the floodplain of the river and near Linn Lake the surface elevation is approximately 15 feet (Reference 2.4.12-32).

In the upland areas of the Chicot aquifer, and potentially the northern and western parts of the VCS site, groundwater recharge prevails. Vertical hydraulic gradients are predominantly downward in areas of groundwater recharge and upward in areas of groundwater discharge (Reference 2.4.12-15). Table 2.4.12-7 presents the observed vertical hydraulic gradients in the northern and western parts of the VCS site, which are consistently downward.

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

The groundwater potentiometric head of the Upper Shallow aquifer beneath the VCS site power block area ranges between approximately elevation 31 and 49 feet (Table 2.4.12-6). Post-construction changes to the hydrogeologic regime were evaluated using a groundwater computer model. The results are described in Subsection 2.4.12.3.1.

2.4.12.2.4 Aquifer Properties

The properties of the aquifers at the VCS site are divided into hydrogeologically and geotechnically derived parameters and are described in detail in Subsections 2.4.12.2.4.1 and 2.4.12.2.4.2. The hydrogeologically derived aquifer parameters include transmissivity, storativity, and hydraulic conductivity. The geotechnically derived aquifer parameters include bulk density, porosity, and permeability (hydraulic conductivity) from grain size and in-situ Guelph permeameter tests.

2.4.12.2.4.1 Hydrogeological Parameters

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

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

Transmissivity is defined as the rate at which a fluid of a specified density and viscosity is transmitted through a unit width of an aquifer or confining bed under a unit hydraulic gradient. Transmissivity is a function of the properties of the fluid, the porous medium, and the thickness of the porous medium (Reference 2.4.12-15).

Storativity (storage coefficient) is defined as the volume of water released from or taken into storage per unit surface area of the aquifer per unit change in head (Reference 2.4.12-15).

Hydraulic conductivity is defined as the coefficient of proportionality that describes flow per unit time under a unit hydraulic gradient through a unit area of a porous medium and is a function of the properties of the fluid and the porous medium. Hydraulic conductivity can be calculated by dividing the transmissivity by the saturated aquifer thickness (Reference 2.4.12-15).

Slug Test Analysis

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

Slug tests were conducted in 53 of the 54 observation wells at the VCS site. (Observation well OW-10U had insufficient water in the well for testing.) Slug test results are summarized in Table 2.4.12-8. (Test results and analysis are presented in Reference 2.5.4-2). The minimum, maximum and geometric mean hydraulic conductivity values from the slug test analyses presented in Table 2.4.12-8 for the Upper Shallow, Lower Shallow, and Deep aquifer zones at the VCS site are as follows:

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

Notes:

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

The data presented in Table 2.4.12-8 suggest variations in the materials tested, indicative of heterogeneous conditions. The slug test results for the Upper Shallow, Lower Shallow, and Deep aquifer zones were contoured to evaluate spatial trends (Figure 2.4.12-18). For consistency, the hydraulic conductivities calculated from the rising head slug tests, Bouwer-Rice analytical method (Table 2.4.12-8) were used.

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

Pumping Test Analysis

Aquifer pumping tests were conducted at the VCS site in February 2008 at test well clusters TW-2320 (Upper Shallow aquifer) and TW-2359 (Deep aquifer) as shown in Figure 2.4.12-10. Each test consisted of a test well and four adjacent observation wells. Nearby observation well pairs installed to monitor site groundwater levels were also monitored during the tests. The information obtained during the testing was used to evaluate the transmissivity and storativity of the aquifers. Test results and analysis are presented in Part 5 of this ESPA. The results of the February 2008 pumping tests, including additional analysis performed since 2008 are summarized in Table 2.4.12-9. Data results and analysis are presented in Reference 2.5.4-2.

The Upper Shallow aquifer pumping test was conducted in the vicinity of observation test well cluster OW-2320, which is located in the approximate center of the cooling basin area. The test well cluster consisted of test well TW-2320U (pumping well) and four observation wells (OW-2320U1 through OW-2320U4), located at distances of approximately 15 to 50 feet from the test well as shown in Figure 2.4.12-19. Pressure transducers equipped with data loggers were used to measure water level drawdown and recovery in the test well and the observation wells. The pressure transducer in observation well OW-2320U4 apparently malfunctioned during the test and did not provide usable data.

TW-2320U was pumped at a rate of approximately 3.2 gpm for 48 hours. Based on the results presented in Table 2.4.12-9, a transmissivity of approximately 312.2 square feet per day, a storage coefficient of approximately 3.3 x 10^{-3}, and a hydraulic conductivity of approximately 8.2 feet per day (using a saturated thickness of 38 feet) are estimated for the Upper Shallow aquifer at this location.

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

The Deep aquifer pumping test was located near the northeastern corner of the cooling basin between observation well clusters OW-06, OW-07, and OW-10. The test well cluster consisted of test well TW-2359L and four observation wells (OW-2359L1 through OW-2359L3 screened in the Deep aquifer and OW-2359U1 screened in Lower Shallow aquifer) as shown in Figure 2.4.12-20. TW-2359L was pumped at a rate of approximately 21 gpm for 24 hours. The transducer at OW-2359L1 failed during the test resulting in no useable data for this observation point. Based on the results presented in Table 2.4.12-9, a transmissivity of approximately 2507.3 square feet per day, a storage coefficient of approximately 4.1 x 10^{-4}, and a hydraulic conductivity of approximately 47.3 feet per day (using a saturated thickness of 53 feet) were estimated for the aquifer zone at this location.

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

The site-specific hydraulic conductivity and transmissivity values obtained from the pumping tests are, in general, consistent with regional values for the Chicot Aquifer (Reference 2.4.12-16). The Upper Shallow aquifer hydraulic conductivity values of approximately 8 feet per day from the single well test analysis and 39 feet per day from the distance drawdown test analysis plot approximately on the 20 feet per day slug test contour in Figure 2.4.12-18, indicating reasonable agreement between the test methods. The Deep aquifer hydraulic conductivity values of approximately 47 feet per day from the single well test analysis and 60 feet per day from the distance drawdown test analysis plot between the 10 and 20 feet per day slug test contours, indicating approximately a 3 to 4 times difference between the test methods. It should be noted that the aquifer pumping test wells were open to a thicker sequence of sands than the slug test wells.

2.4.12.2.4.2 Geotechnical Parameters

The geotechnical component of the subsurface investigation program at the VCS site included the collection of soil samples for field and laboratory determination of soil properties. These tests are described in detail in Subsection 2.5.4, including the results of the geotechnical subsurface exploration and testing program conducted at VCS; Reference 2.5.4-1 (power block) and Reference 2.5.4-2 (cooling basin). Geotechnical tests of hydrogeologic interest include:

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

Porosity and Bulk Density Properties

The geotechnical investigation component of the subsurface investigation program at the VCS site included the collection of soil samples for laboratory determination of soil properties. These tests are discussed in detail in References 2.5.4-1 and 2.5.4-2. A summary of the hydrogeologic properties from geotechnical tests is presented in Table 2.4.12-10.

Bulk density (γ_m) values for the various subsurface units are determined from the dry density (γ_d) and water content (ω) measurements using the following formula (Reference 2.4.12-17):

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

Porosity is defined as the percentage of rock or soil that is void of material. Porosity was calculated as a function of void ratio for individual soil samples using the relationship (Reference 2.4.12-17):

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

The effective porosity was determined as a function of the average total porosity and the median grain size (d_{50}) using Figure 2.4.12-21 which is adapted from Reference 2.4.12-18. For the silty sand that comprises the aquifers (d_{50} equal approximately 0.1 mm), the ratio of effective porosity to total porosity is 30 percent (effective porosity from the specific yield curve on Figure 2.4.12-21) divided by 37 percent (average total porosity), or 0.8. For the clay comprising the intervening confining layers (d_{50} equal approximately 0.001 mm), the ratio is 8 percent (from the specific yield curve on Figure 2.4.12-21) divided by 40 percent (average total porosity for clays) or 0.2. It should be noted that applying this relationship to clays is different than applying it to sand. Differences in clay mineralogy may result in differences in the electrostatic forces binding water molecules to the clay particles, thus introducing variability in the specific retention of the clay. Clays also may contain discontinuities resulting from cyclic wetting and drying (mud cracks) or as a result of post-depositional deformation (fractures). These factors could result in the overestimation or underestimation of the effective porosity of a clay.

Table 2.4.12-10 summarizes the total and effective porosities for each sample. The results of the geotechnical laboratory derived hydrogeologic parameters from disturbed geotechnical samples are summarized on Table 2.4.12-11, which provides the maximum, minimum, and mean values for each unit.

Hydraulic Conductivity for Sands Derived from Grain Size Analysis

The hydraulic conductivity of sands can be estimated using the Hazen approximation (Reference 2.4.12-15) and selected geotechnical laboratory data from Table 2.4.12-10.

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

where:

K = hydraulic conductivity (cm per second)

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

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

The effective grain size D_{10} is defined as the grain-size diameter at which 10 percent by weight of the soil particles are finer and 90 percent are coarser. The formula is valid for D_{10} between 0.1 and 3 mm with a coefficient of uniformity less than 5 (Reference 2.4.12-19). For the soils at the VCS site, a C value of 40 is used to represent fine sand with appreciable fines. A summary of the results of the grain size permeability analyses is presented in Table 2.4.12-12. Due to the restrictions on the D_{10} size (between 0.1 and 3 mm), the tests are biased toward the more permeable zones in each sand layer. The test results indicate a narrow range of hydraulic conductivity for all the sand zones tested.

The grain size data can also be used to qualitatively asses the hydraulic conductivity of the sand layers. Figure 2.4.12-22 shows ternary diagrams for the grain size data from each of the sand layers identified beneath the site. The ternary plots indicate that the unsaturated sand zone (geotechnical Sand 1) and the Upper Shallow aquifer (geotechnical Sand 2) have more fines than the underlying sand layers suggesting that these sands have a lower hydraulic conductivity than the Lower Shallow aquifer and the Deep aquifer.

Hydraulic Conductivity for Clayey Layers Derived from Laboratory Analysis

The vertical hydraulic conductivities of the clayey layers between the sand layers were determined using laboratory hydraulic conductivity measurements of undisturbed soil samples. The laboratory tests are performed using a triaxial cell permeameter with confining pressure (see Subsection 2.5.4). The results of these tests are shown on Table 2.4.12-13. The hydraulic conductivity range measured by the test is from a minimum of 2.5×10^{-9} cm per second (7.1×10^{-6} feet per day) to a maximum of 8.3×10^{-6} cm per second (2.4×10^{-2} feet per day). All the listed analyses were performed on materials classified as high plasticity clay.

Hydraulic Conductivity from Guelph Borehole Permeameter In-Situ Field Tests

The Guelph permeameter is a constant-head borehole permeameter designed for in-situ use in the field. The borehole permeameter tests were conducted at 16 locations within and adjacent to the VCS cooling basin at depths of 5 and 10 feet below pre-construction ground surface for a total of 32 tests. Only 18 of the tests are above the method detection limit (Reference 2.5.4-2). The results of the borehole permeameter tests are summarized in Table 2.4.12-14. Based on visual classification of the soils made during borehole preparation, the test results were subdivided into tests performed in sandy material and tests performed in clay. The field saturated hydraulic conductivity in sandy materials (as classified in Reference 2.5.4-2) ranged from 1.44×10^{-6} cm per second (0.0041 feet per day) to 9.70×10^{-4} cm per second (2.75 feet per day), while the tests in clay (as classified in Reference 2.5.4-2) ranged from 6.94×10^{-8} cm per second (0.0002 feet per day) to 2.40×10^{-5} cm per second (0.0680 feet per day).

The results of the borehole permeameter tests are contoured, including the tests below the method detection limit, as shown on Figure 2.4.12-23. The results in both the shallow (5 feet below ground surface) and deep test zones (10 feet below ground surface) show a higher hydraulic conductivity zone near the center of the cooling basin with lower hydraulic conductivity near the outer margin of the cooling basin. The following table relates the range of test results to the elevation of the test zone:

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

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

2.4.12.2.4.3 Summary of Aquifer Properties

Based on the results of geotechnical and hydrogeological testing the hydraulic conductivity values derived from grain size analysis, aquifer pumping tests, and slug tests at the VCS site (included in Part 5 of the ESPA) are considered to be in agreement and within the range of hydraulic conductivity values reported for the region (Reference 2.4.12-16). Results of statistical analysis indicate that the slug tests produce the greatest range of hydraulic conductivity. Following is a summary of hydraulic conductivity ranges determined by different methods:

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

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

As discussed in SSAR Subsection 2.4.12.1.4, the VCS site is underlain by unconsolidated and discontinuous interbedded layers of sand and clay of the Chicot aquifer that dip toward the Gulf of Mexico. The Chicot aquifer at the site is divided informally into the Upper Shallow, Lower Shallow, and Deep aquifers.

2.4.12.2.5 Hydrogeochemical Characteristics

Regional hydrogeochemical data available for observation wells within 7.5 miles of the VCS site were obtained from Reference 2.4.12-10 and are presented in Table 2.4.12-15. The analytical data were compared to EPA Primary and Secondary Drinking Water Standards (Reference 2.4.12-20) and exceedances are identified on the table. The principal exceedances were for total dissolved solids and chloride (Secondary Drinking Water Standards). The data indicate that the highest concentrations of total dissolved solids and chlorides are generally present in the Lissie Formation of the Chicot Aquifer.

The VCS site-specific hydrogeochemical data are presented in Table 2.4.12-16, and includes 20 samples from the Chicot Aquifer. The analytical data were compared to EPA Primary and Secondary Drinking Water Standards and the exceedances are identified in the table. The principal exceedances at the VCS site were total dissolved solids and chloride. The data indicate that total dissolved solids exceedances are present in the Upper Shallow, Lower Shallow, and Deep aquifers at the VCS site. Chloride exceedances are present primarily in the Deep aquifer but are also locally present in the Upper Shallow and Lower Shallow aquifers.

Variations in chemical composition can be used to define hydrochemical facies in the groundwater system. The hydrochemical facies are classified by the dominant cations and anions in a groundwater sample. These facies may be shown graphically on a trilinear diagram (Reference 2.4.12-15). A trilinear diagram showing the regional and VCS site-specific geochemical data is presented on Figure 2.4.12-24. As depicted in Figure 2.4.12-24, the hydrochemical facies of the Chicot Aquifer consists predominantly of calcium chloride in the Deep aquifer, and bicarbonate to chloride anionic range with no dominant cation type in the Upper and Lower Shallow aquifers. The hydrochemical facies of the Evangeline Aquifer is dominated by the sodium cation, with a range of anions from bicarbonate to chloride.

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

Comparison of historical and more recent regional hydrogeochemical data presented in Table 2.4.12-15 indicates a general temporal consistency in groundwater chemistry for the individual aquifers present in the site area. This suggests that long-term variations in groundwater chemistry are not likely to occur at the VCS site.

2.4.12.3 Subsurface Pathways

This section contains an evaluation of subsurface pathways for offsite exposure resulting from a liquid effluent release at the VCS site. To assist with this evaluation, a groundwater flow model was developed to assess pre- and post-construction groundwater conditions at the VCS site.

2.4.12.3.1 Groundwater Flow Model

A numerical groundwater flow model was developed to assist with interpretation of the subsurface hydrogeologic materials and to simulate post-construction groundwater conditions. Modeling efforts began while the subsurface site investigation was being conducted to provide preliminary estimates of the cooling basin seepage rate to the subsurface, predicted groundwater elevation in the power block, and expected post-construction groundwater flow paths using preliminary data evaluations and assumptions. The groundwater model was refined as subsurface data interpretations and evaluations were completed. The conclusions of the final groundwater modeling effort are presented in this subsection. Comparison to the earlier modeling efforts is described in Subsection 2.4.12.3.3.

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

- Seepage rate from the cooling basin into the site groundwater system;
- Post-construction groundwater level in the power block;
- Plant construction dewatering; and
- Postulated, post construction accidental release pathway.

The groundwater flow model is executed under the Visual MODFLOW Version 4.3 environment developed by Schlumberger Water Services (Reference 2.4.12-21).The program consists of a series of pre- and post-processors that feed information to various numerical groundwater flow models developed by others. The groundwater flow model selected for the VCS utilizes a three-dimensional finite-difference groundwater flow model known as MODFLOW-2000 (Reference 2.4.12-22). A subsidiary program known as MODPATH (Reference 2.4.12-23) is used to perform particle tracking to estimate travel time from postulated radwaste accidental release to groundwater within the power block to the nearest receptor for simulation of the accidental release pathway for radionuclides.

A detailed description of the construction, calibration, and results of the model are included in Appendix 2.4.12-C. A description of sorption and radioactive decay effects on offsite exposure is presented in Subsection 2.4.13.

2.4.12.3.1.1 Site Conceptual Model

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

The topography for the groundwater model for the VCS site was established using the U.S. Geological Survey 1999 National Elevation Dataset. This dataset references surface elevations to the NAVD 88 vertical datum. Climatic parameters of average rainfall and evapotranspiration were determined from records of the Victoria County Groundwater Conservation District (Reference 2.4.12-2) and the Texas A & M University System Texas ET Network. The regional stratigraphy and geomorphology were established from publications of the TWDB (References 2.4.12-4, 2.4.12-8, 2.4.12-14 and 2.4.12-16), the Texas Department of Water Resources (Reference 2.4.12-5) and the U.S. Geological Survey (Reference 2.4.12-3). The stratigraphy at the VCS site was determined by drilling and testing more than 200 geotechnical borings, monitoring wells and cone penetrometer tests in the Chicot aquifer. Groundwater use patterns were established with information available from the U.S. Environmental Protection Agency (Reference 2.4.12-9) and TWDB (References 2.4.12-10, 2.4.12-11 and 2.4.12-12). Hydrology and boundary conditions were determined from publications of the Texas Department of Water Resources (Reference 2.4.12-5) and the TWDB (References 2.4.12-8, 2.4.12-14 and 2.4.12-16).

The conceptual model of the VCS site includes interbedded sand and clay layers based on the site geotechnical boring logs, geophysical logs, monitoring well data and cone penetrometer test results included in Part 5 of the ESP application. Groundwater levels measured in a total of 62 observation wells at the VCS site at different times during 2008 and 2009 were used to develop potentiometric surface maps for the Upper Shallow, Lower Shallow, and Deep aquifer zones established for the Chicot aquifer based on the geotechnical borings. The bottom of the model domain was set at an elevation of -260 ft, which is the approximate bottom elevation of "Sand 10" at the Powerblock area. The bottom elevation of the "Sand 10" layer was based on the average S-wave velocity profile in Subsection 2.5.4 (Figures 2.5.4-A-71 and 2.5.4-A-72). Based on the potentiometric surface maps the groundwater flow direction at the site is generally to the east toward the Guadalupe River. The site-specific potentiometric surface maps show groundwater trends similar to the regional groundwater flow to the southeast, as measured by the TWDB (Reference 2.4.12-6) and modeled by the TWDB Groundwater Availability Model (GAM) of the Central Gulf Coast Aquifer System (Reference 2.4.12-14).

The domain of the GAM model includes the VCS site in Victoria County, Texas. The GAM model is a regional numerical model with four (4) layers and the Chicot aquifer is included as one continuous single layer within the model. In contrast, the site-specific VCS model subdivides the upper Chicot aquifer into various sands and clay units based on the site geotechnical boring logs and test results. Similar subdivision of the upper Chicot aquifer into a series of interbedded sand and clay layers was done for a site-specific groundwater model in Port Arthur, Texas (Reference 2.4.12-28).

To represent the regional flow at the VCS site, a general head boundary (GHB) was assigned to the cells at the north, east and west perimeters of the groundwater model domain in each of the saturated sand layers. The application of the GHB is to "represent heads in a model that are influenced by a large surface water body outside the model domain with a known water elevation. The purpose of using this boundary condition is to avoid unnecessarily extending the model domain outward to meet the element influencing the head in the model. As a result, the General Head boundary condition is usually assigned along the outside edges of the model domain" (Reference 2.4.12-21). The inclusion of a GHB for cells to the north and west in the VCS model was not related to the presence of a large surface water body, but rather to dictate that groundwater flow within the vicinity of the site is consistent with observed aquifer flow patterns without unnecessarily extending the model. The GHB to the east represents the effect of the Guadalupe River.

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

The magnitudes of recharge and evapotranspiration assigned to the VCS groundwater model were similar to those assigned to the GAM model. The GAM model included boundary conditions similar to those assigned in the VCS site groundwater model, including GHBs, river package boundaries, drain package boundaries and constant head boundaries. Thus, based on site-specific geotechnical boring logs and test results and a conceptual hydrogeologic understanding of the VCS site it can be deduced that the VCS site groundwater model has the same framework as that of the regional TWDB GAM model and another site-specific groundwater model in the Chicot aquifer (Reference 2.4.12-28).

2.4.12.3.1.2 Groundwater Model Development

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

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

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

2.4.12.3.1.2.1 Description of Hydro-lithologic Units

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

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

In addition, driller's logs obtained from the Texas Water Development Board of 72 water wells in the vicinity of the VCS site were used to assist in interpretation of the stratigraphy near the site. The elevations of the bottom of each soil layer noted in these well logs were correlated with those from onsite soil borings and cone penetrometer soundings to extend several cross-sections offsite and construct additional regional cross-sections that extend across the domain of the VCS numerical model. The locations of these cross-sections are shown on Figure 2.4.12-26a.

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

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

The hydro-lithologic units simulated by the VCS numerical model were defined based on the following investigations and findings. Pairs of observation wells were drilled at 27 locations across the VCS site. The wells in each pair were completed with 10-foot long screens, each in different sand strata. Hydrogeologic cross-sections BB-BB' and HH-HH' (Figures 2.4.12-31 and 2.4.12-32, respectively) show the approximate elevations of well screens within the various sand strata at a total of six observation well pairs. These cross-sections also show the potentiometric head measured in each observation well on February 18, 2008, and the inferred direction of the vertical groundwater gradient, based on differing heads in the sand strata within which each well screen is completed.

Figure 2.4.12-17 contains several hydrographs, each showing a time series of the potentiometric heads in an observation well pair, including those well pairs shown on cross-sections BB-BB' and HH-HH'. The hydrographs demonstrate a generally consistent vertical potentiometric gradient between the upper and lower screen zones in each well pair. The difference in potentiometric head between the sand strata in Figures 2.4.12-31 and 2.4.12-32 in which the well screens are completed provides evidence that the sands are to some extent hydraulically isolated from each other by the intervening strata comprised predominantly of silt and clay. These finer-grained strata are interpreted to be confining layers acting as aquitards, while the sand strata are interpreted to be aquifers.

This finding forms the basis for subdividing the Chicot Aquifer at the VCS site into the Upper Shallow, Lower Shallow, and Deep aquifer zones. These aquifer zones are represented in the VCS numerical model by Sand 2 (model layer 4), Sand 4 (model layer 6), and Sands 5 and 6 (model layers 8 and 10), respectively. Estimates of the hydraulic properties of the aquitards and aquifers are discussed in Subsection 2.4.12.2.4.

Figure 2.4.12-15 provides a series of potentiometric surface maps for the Upper Shallow, Lower Shallow, and Deep aquifer zones at approximately quarterly intervals from February 2008 to October 2010. Comparison of the maps showing potentiometric surfaces of the three aquifer zones on the same date reveals significant differences in the horizontal hydraulic gradients, particularly with respect to the Upper Shallow and Lower Shallow aquifer zones. Further, as indicated by the hydrographs in Figure 2.4.12-17, the potentiometric surface maps show that on the same date and at the same location on the VCS site, the elevation of the head in each aquifer differs significantly, especially between the Upper Shallow and Lower Shallow aquifer zones. These differences provide additional evidence that the sand strata interpreted on the hydrogeologic cross-sections in Figures 2.4.12-31 and 2.4.12-32 behave as discrete aquifer zones that can appropriately be divided into the Upper Shallow, Lower Shallow, and Deep aquifers.

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

- The results of slug tests and pumping tests (Tables 2.4.12-8 and 2.4.12-9, respectively) show that the hydraulic conductivities of the Upper Shallow, Lower Shallow, and Deep aquifer zones differ significantly.
- During the 24-hour pumping test completed in the Deep aquifer, groundwater levels were monitored in a nearby observation well completed in the Lower Shallow aquifer. The results of that testing, provided in part 5 of the ESP application, indicate that there was no water-level response in the Lower Shallow aquifer, and therefore, the Lower Shallow and Deep aquifers are hydraulically isolated in the area of the test.
- Other investigators, including Haug et al. (Reference 2.4.12-28), have also subdivided the upper Chicot Aquifer in their numerical groundwater model of an area of Port Arthur, Texas.

2.4.12.3.1.2.2 Discussion of the Influence of Windows in Confining Units

The confining units of most interest throughout the VCS site are Clay 1-top (layer 1 in the VCS numerical model), Clay 1-bottom (model layer 3), Clay 3 (model layer 5), and Clay 5-top (model layer 7). A geotechnical description of these clay layers is presented in Subsection 2.5.4. The incorporation of site stratigraphy into the numerical groundwater model is further discussed in Appendix 2.4.12-C. Table 2.4.12-18 summarizes the locations on the VCS site where one or more of the confining units are absent.

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

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

In the groundwater numerical model, the deepest foundation in the eastern part of the power block is set at elevation -35 feet, which is approximately the bottom elevation of Sand 4 (layer 6) in this area (Figures 2.5.4-9 and 2.5.4-10). Therefore, the foundation excavation will completely remove Clay 1-top, Sand 1, Clay 1-bottom, Sand 2, Clay 3, and Sand 4 (and the three windows between Sand 1 and Sand 2) in the modeled eastern part of the power block area. Although SSAR Subsection 2.4.12.3.2.2, states that excavation for the building foundations in the power block area could extend to elevation -15 feet, the groundwater numerical model represents a more conservative scenario with respect to groundwater travel time because it would result in placement of relatively high permeability structural fill across the entire thickness of Sand 4 and a correspondingly shorter travel time for a hypothetical release of radionuclides flowing through Sand 4 to their down-gradient discharge point.

The foundations will be surrounded with structural fill with hydraulic conductivity greater than that of the native soils. Therefore, the fill will provide a hydraulic connection between Sand 1, Sand 2, and Sand 4 in the power block area. The effect of this hydraulic connection has been evaluated with the VCS numerical groundwater flow model by a particle-tracking analysis (Subsection 2.4.12.3.2). This analysis simulates the flow paths and travel times for transport of liquid effluents postulated to be released from the basement of radwaste buildings in the power block. The particle tracking analysis (Subsection 2.4.12.3.2.3) indicates that the postulated release will travel vertically downward within the structural fill until encountering Clay 5-top (model layer 7) and then travel laterally to the east-southeast within the overlying Sand 4 where it eventually discharges into Linn Lake, the Guadalupe River, or the Victoria Barge Canal (Figure 2.4.12-C-35). The travel time to reach the closest VCS site boundary in this direction is discussed in Appendix 2.4.12-C.

Figure 2.4.12-33 shows 16 sample locations where Clay 1-top (model layer 1) is absent, based on a summary of the bottom elevations of each stratum identified in the 53 soil borings and 27 cone penetrometer soundings completed in the cooling basin area. Eleven of the locations where Clay 1-top is absent are east of the cooling basin. In this area, ground surface elevations are generally lower than those within the footprint of the basin (Tables 2.5.4-37 and 2.5.4-41). Unnamed streams draining eastward into the Guadalupe River Valley have eroded the shallow soils and completely removed Clay 1-top in some areas east of the cooling basin. In these areas, the underlying Sand 1 is exposed at the ground surface. Near the escarpment at the west side of the river valley the channels of the unnamed streams are incised into Sand 1. The incised channels were denoted as drains in the VCS numerical model to remove excess groundwater that may seep into the channels under high water table conditions. Pre- and post-construction model runs (Appendix 2.4.12-C) indicate that the combined discharge from the seeps will increase from 0 (pre-construction) to 310 gallons per minute when the cooling basin is filled (Appendix 2.4.12-C, Table 2.4.12-C-8).

Of the 16 locations where Clay 1-top is absent, five locations are within the footprint of the cooling basin. These five locations are widely distributed over the central portion of the approximately 4,900-acre cooling basin, and the absence of this unit is inferred based on widely spaced discrete sample locations. It can be noted that permeameter testing completed in the vicinity of those five locations where Clay 1-top was absent in samples collected from soil borings indicates that the permeability of the shallow soil is generally less than that assumed for Clay 1-top (model layer 1) in the VCS numerical groundwater model (Table 2.4.12-14). This finding suggests that in its current pre-construction condition, the permeability of the shallow soil within the footprint of the cooling basin is not greater than that of Clay 1-top.

While excavation of the surficial soils to construct the cooling basin and embankment dam will partially or completely remove Clay 1-top in some areas, silt and clay are expected to accumulate on the floor of the basin when it is filled, due to re-distribution of fine-grained sediments by currents and wave action and importation of fine-grained sediments in makeup water from the Guadalupe River. These sediments will form a layer of relatively low permeability that will limit post-construction seepage through the bottom of the cooling basin and into Sand 1. A sensitivity analysis of the cooling basin seepage rate in the VCS numerical groundwater model demonstrated that a 10-fold increase in the hydraulic conductivity of Clay 1-top results in only a 2-percent increase in the seepage rate (Table 2.4.12-C-9).

Figure 2.4.12-34 shows Clay 1-bottom (model layer 3) to be absent at three locations in the vicinity of the cooling basin, providing a window that places Sand 1 (model layer 2) in contact with Sand 2 (model layer 4). Each of these three locations is outside of the basin footprint; two (B-2346 and B-2348) are near the southwest corner of Linn Lake, and the third (C-2328) is near the southwest corner of the basin. Sand 1 is unsaturated at each of these locations under pre-construction conditions but will become saturated when the cooling basin is filled because of seepage through the bottom of the basin into Sand 1 (Figure 2.4.12-C-28).

With the cooling basin full, the modeled hydraulic head of 90.5 feet in the basin will induce a downward vertical gradient through Clay 1-top into Sand 1 and through Clay 1-bottom into Sand 2 and result in saturation of Sand 1, including the area near the basin embankment dam (Appendix 2.4.12-C, Figure 2.4.12-C-28). The VCS numerical model predicts that post-construction groundwater discharge to Linn Lake (east of the cooling basin) will approximately double relative to pre-construction flow (Appendix 2.4.12-C, Figure 2.4.12-C-22).

Clay 3 (layer 5) is absent at eight locations east of the cooling basin as shown in Figure 2.4.12-35, creating areas where Sand 2 (the Upper Shallow aquifer) is in contact with Sand 4 (the Lower Shallow aquifer). The Upper and Lower Shallow aquifers merge into one relatively continuous sand unit in these areas. The eight locations where Clay 3 is absent are located at the western edge of the Guadalupe River Valley. This valley is the principal drainage feature toward which shallow groundwater flows in the region of the VCS site (Figure 2.4.12-14). On this basis, it is reasonable to infer that an upward vertical gradient and groundwater flow from Sand 4 to Sand 2 exists within the valley. It is likely that this condition will not be affected significantly by construction of VCS.

Clay 5-top (model layer 7) is shown in Figure 2.4.12-36 to be absent at four locations in the area of the cooling basin. The location at the northeast corner of the basin (Boring B-09) is within the down-gradient flow path of a postulated release of radioactive effluent from the basement of a radwaste building in the power block area (Appendix 2.4.12-C, Figure 2.4.12-C-34). A particle-tracking analysis of that release determined that the effluent would flow vertically downward within the structural fill surrounding the building foundation until encountering Clay 5-top (Figure 2.4.12-C-35). The effluent would then flow laterally down-gradient toward the east-southeast within the overlying Sand 4. The absence of Clay 5-top at Boring B-09 places Sand 4 in contact with Sand 5 at this location and may allow the released effluent to disperse into Sand 5. This condition is depicted on the cross-section in Appendix 2.4.12-C, Figure 2.4.12-C-41.

Groundwater in both Sand 4 and Sand 5 eventually discharges within the Guadalupe River valley to Linn Lake, the Guadalupe River, and the Victoria Barge Canal. The data in Table 2.4.12-7 show that the vertical groundwater gradient at observation well pair OW-2348U/L near Linn Lake is slightly upward, indicating a discharging condition from the Deep aquifer (Sand 5) to the Lower Shallow aquifer (Sand 4). Conversely, at well pair OW-2319U/L near the western side of the cooling basin, the data in Table 2.4.12-7 show the vertical groundwater gradient to be slightly downward from Sand 4 to Sand 5, indicating a recharge condition. Neither of these relationships is likely to be affected significantly by construction of VCS.

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

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

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

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

2.4.12.3.1.2.3 Comparison of Site Specific Hydraulic Conductivities to Published Scientific Literature

The value of vertical hydraulic conductivity of the clay in model layer 1 is based on the results of borehole permeameter tests in layer 1 (the uppermost clay layer) from Table 2.4.12-14. The vertical hydraulic conductivity of the remaining clay layers in the model is based on laboratory permeability testing of undisturbed soil samples from the shallow (layers 3 and 5) and deep (layer 9) confining layers (Table 2.4.12-13). The horizontal hydraulic conductivity of each clay layer in the model is assumed to be ten times the corresponding vertical hydraulic conductivity (Reference 2.4.12-C-9).

The value of horizontal hydraulic conductivity of the sand in model layer 4 is based on the results of a 48-hour pumping test of this layer and optimized through model calibrations. Similarly, the horizontal hydraulic conductivity of the sand in model layer 8 is based on the results of a 24-hour pumping test of this layer and adjusted during model calibration. The horizontal hydraulic conductivity of the sands in model layers 6 and 10 is assumed to be the same as that determined by the pumping test of layer 8 because the grain size distribution of samples from layers 6, 8 and 10 are similar (Figure 2.4.12-22). The vertical hydraulic conductivity of each sand layer in the model is assumed to be one-third of the corresponding horizontal hydraulic conductivity (Reference 2.4.12-C-9).

Values for the hydraulic conductivity of sand and clay layers in the VCS groundwater model were compared to values published in the scientific literature for the Chicot aquifer. Reference 2.4.12-16 provides a range of hydraulic conductivity values determined from qualifying pumping tests in the Chicot aquifer. The range of horizontal hydraulic conductivity values reported in Reference 2.4.12-16 for the Chicot aquifer varies between 13 feet per day and 154 feet per day. The values of horizontal hydraulic conductivity assigned to the “sand units” of the Chicot aquifer in the VCS groundwater model range from 68 feet per day to 103 feet per day and are within the range reported in Reference 2.4.12-16.

Reference 2.4.12-29 describes a groundwater model that simulates the hydrological conditions of the Chicot and Evangeline aquifers that underlie the Houston area. The Chicot and Evangeline are the same aquifers that extend to the VCS site. The horizontal hydraulic conductivity of the highly permeable zones of the Chicot aquifer in the Houston area is reported to be 170 feet per day (Table 2 of Reference 2.4.12-29). The vertical hydraulic conductivity of the permeable unit of the Chicot aquifer reported in Table 2 of Reference 2.4.12-29 is 0.01 feet per day. However, in the groundwater model described in Reference 2.4.12-29, both the Chicot and Evangeline aquifers are modeled as isotropic, with the horizontal and vertical hydraulic conductivities equal to 170 feet/day.

Reference 2.4.12-30 reports that the vertical hydraulic conductivity of the clay units of the Chicot aquifer in the Houston area ranges between 4.63 x 10^{-4} meters per day (1.52 x 10^{-3} feet per day) and 0.73 x 10^{-5} meters per day (2.4 x 10^{-5} feet per day). Except for Clay 1-Top (6 x 10^{-2} feet per day), the vertical hydraulic conductivity assigned to the clay layers in the VCS groundwater model is 7 x 10^{-5} feet per day. This value is within the range reported in Reference 2.4.12-30.

Reference 2.4.12-28 provides estimates of the horizontal and vertical hydraulic conductivities of the various sand and clay units of the Upper Chicot aquifer used in a groundwater model of the Port Arthur, Texas area. The vertical extent of that model is the “Sand 2” hydrostratigraphic unit of the Upper Chicot aquifer, which seems to correspond to Sand 2 in the VCS groundwater model.

Table 1 of Reference 2.4.12-28 lists a horizontal hydraulic conductivity for the surficial clay unit at the Port Arthur site of 1 x 10^{-9} meters per second (2.8 x 10^{-4} feet per day). For the “Sand 1” unit at the Port Arthur site (which seems to correspond to Sand 1 at the VCS site) the values for horizontal hydraulic conductivity range between 3 x 10^{-5} meters per second (8.5 feet per day) and 4 x 10^{-5} meters per second (11.3 feet per day). For the Middle clay unit at the Port Arthur site (which seems to correspond to Clay 2 at the VCS site) the horizontal hydraulic conductivity is listed as 2 x 10^{-5} meters per second (5.7 feet per day) and for the “Sand 2” unit (which seems to correspond to Sand 2 at the VCS site) the value is 1 x 10^{-4} meters per second (28.3 feet per day). The anisotropy ratio of horizontal to vertical hydraulic conductivity for both the sand units and the clay units at the Port Arthur site is modeled as 10:1 (Reference 2.4.12-28).

The horizontal hydraulic conductivity values reported in Reference 2.4.12-16 for the sand layers in the Chicot aquifer bound the values used in the VCS site groundwater model. The anisotropy ratio of horizontal to vertical hydraulic conductivity of 3:1 assigned to the sand layers in the VCS groundwater model falls within the reported range for the Chicot aquifer of 10:1 at the Port Arthur site (Reference 2.4.12-28) and 1:1 in the Houston area (Reference 2.4.12-29).

The anisotropy ratio of horizontal to vertical hydraulic conductivity of 10:1 used in the VCS groundwater model for the clay layers of the Chicot aquifer agrees with that reported in Reference 2.4.12-28 for the clay layers of the Chicot aquifer at the Port Arthur site. The vertical hydraulic conductivity values for the clay layers in the VCS groundwater model are nominally within the range reported in Reference 2.4.12-30 for the Chicot aquifer in the Houston area.

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

2.4.12.3.1.3 Numerical Model

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

The model grid consists of 189 columns, 193 rows, and 11 layers. Grid spacing ranges from 500 feet at the edges to 250 feet in the power block area. Figure 2.4.12-25 is a plan view of the model domain showing the grid and calibration wells.

As stated in Subsection 2.4.12.3.1.2.1, hydrogeologic cross-sections and structure contour maps were developed from the subsurface data obtained from the VCS site subsurface investigation and from regional driller's log databases. These cross-sections and contour maps were used as the basis for the hydrogeologic layers developed for the numerical groundwater model. The locations of the cross-sections are shown in Figure 2.4.12-26a. Figures 2.4.12-26b and 2.4.12-26c present orthogonal hydrogeologic cross-sections E-E' and G-G'.

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

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

Tables 2.4.12-1 and 2.4.12-6 show construction details and monthly groundwater levels for the observation wells, respectively. Potentiometric levels measured on February 18, 2008, in each of the observation wells in the cross-sections and the direction of the vertical groundwater gradient are also shown. The potentiometric levels shown in the regional water wells were measured as each was drilled during the period between 2003 and 2009.

Figures 2.4.12-26d and 2.4.12-26e are orthogonal cross-sections showing the modeled hydrostratigraphy along row 110 and column 92, respectively, of the VCS numerical groundwater model grid. As shown in Figure 2.4.12-26a, the locations of the cross-sections in Figures 2.4.12-26d and 2.4.12-26e approximate the locations of the two hydrostratigraphic cross-sections in Figures 2.4.12-26b and 2.4.12-26c. Comparison of the figures confirms that the hydro-lithologic units of the conceptual model closely match those of the groundwater numerical model. The numerical model cross-sections do not precisely mirror the conceptual model cross-sections because the sets of east-west sections and north-south sections are not constructed on the same vertical plane.

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

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

2.4.12.3.1.4 Boundary Conditions

The pre-construction model boundary conditions are discussed in Appendix 2.4.12-C and are summarized as follows.

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

The evapotranspiration (ET) boundary condition was assigned as a single zone. An extinction depth of 5 feet was used to represent the maximum root penetration depth. It should be noted that Visual MODFLOW stops ET if the groundwater level is below the extinction depth or below the bottom of layer 1, as further explained in Appendix 2.4.12-C.

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

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

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

River boundaries were assigned as discussed in Appendix 2.4.12-C for the Guadalupe River, San Antonio River, Coleto Creek, Black Bayou, and the Victoria Barge Canal.

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

The elevations of the drains simulating Kuy Creek, Dry Kuy Creek, the primary unnamed creeks and the Guadalupe River Valley seeps were estimated from USGS topographic maps (Reference 2.4.12-32 and References 2.4.12-35 through 2.4.12-37) and interpretation of site stratigraphy in the area of the drainage features. The drain elevations were assigned using a Visual MODFLOW formula ($BOT + 1.0), which places the drain elevation 1 foot above the bottom of the cell that represents the creek or seep.

A river boundary condition was assigned to the Victoria Barge Canal, Guadalupe River, Coleto Creek, San Antonio River, and Black Bayou to represent the groundwater and surface water interactions. The Victoria Barge Canal was assigned a stage elevation of 0 ft and a channel bottom of approximately -12 ft based on Reference 2.4.12-31.

The mean stage in the Guadalupe River was estimated using data from USGS stream gages 08176500, 08177520 and 08188800 at Victoria, Bloomington and Tivoli, Texas, respectively (Reference 2.4.12-34). The elevation of the Guadalupe River channel bottom was derived from channel profiles developed from bathymetric survey data. A linear gradient was assumed in order to assign river stage and bottom elevations in the numerical model. At the north end of the model domain a stage elevation of 20 ft and bottom elevation of 10 ft were estimated. At the southeast corner of the model domain a stage elevation of 5 ft and a bottom elevation of -10 ft were estimated. These bottom elevation estimates were extrapolated from bathymetric survey data for a reach of the river located between the upstream and downstream model boundaries, in conjunction with the topography at the river in these areas.

The stage of the Coleto Creek was estimated using the mean stage at the Coleto Creek Reservoir (USGS gage 08177400) and USGS gage 08177500 located on the Coleto Creek near Victoria, Texas (Reference 2.4.12-34). The stage was linearly interpolated from an estimated 72 ft downstream of the Coleto Creek Reservoir at the western boundary of the VCS model domain to a stage elevation of 19 ft at the confluence of the Coleto Creek with the Guadalupe River. The bottom elevation of the river at the western boundary of the model domain (67 ft) was estimated based on a regional cross section developed for the model. A bottom elevation of 14 ft at the confluence of the creek with the Guadalupe River was estimated based on extrapolated bathymetric survey data for the Guadalupe River.

The stage of the San Antonio River was based on linear interpolation of the mean stage at USGS gage 08188570 near McFadden, Texas (Reference 2.4.12-34). A stage elevation of 62 ft was estimated for the San Antonio River at the western boundary of the VCS model domain. The stage elevation was estimated to be approximately 5 feet below the average ground surface elevation within the local river valley, as determined from the National Elevation Dataset and the Lott Lake USGS topographic quadrangle map (References 2.4.12-38 and 2.4.12-35, respectively). The bottom elevation at this location was estimated assuming a river depth of approximately 20 feet. These values were then linearly interpolated to a stage elevation of 5 ft and a bottom elevation of -10 ft at the confluence with the Guadalupe River.

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

2.4.12.3.1.5 Model Calibration

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

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

The second stage of calibration focused on layer 4 using an automated calibration program called PEST (Parameter ESTimation) (Reference 2.4.12-24). This program is part of the Visual MODFLOW program package. The PEST program adjusts model parameters until the fit between model output (head) and field observations is optimized. For the VCS groundwater model, the program was constrained to vary only the hydraulic conductivity values for the Upper Shallow aquifer sand in layer 4. The resulting hydraulic conductivity value was used in the model to finalize the calibration. This stage of the calibration process was performed in lieu of a calibration sensitivity analysis.

2.4.12.3.2 Post-Construction Model Simulations

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

- Surface elevations within the power block were set to an elevation of 95 feet and within the cooling basin, the surface elevations were set to elevation 69 feet. Areas within the cooling basin where layer 1 was 1 foot in thickness (surficial clay absent as a result of excavation or erosion) were assigned a hydraulic conductivity of the underlying sand.
- Permeable backfill and inactive model cells were added to the power block area to represent backfill around buildings and the building locations, respectively.

2.4.12.3.2.1 Cooling Basin Seepage

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

In addition to the cooling basin, the post-construction power block conditions were also simulated. Postulated buildings within the power block area were represented by inactive model cells, which were surrounded by cells with permeable backfill. A power block area recharge rate of 0.8 inch per year was assigned to cells not occupied by buildings and a recharge rate of 0 inch per year was assigned within the cooling basin. The power block area backfill is assumed to be approximately 5 times more permeable than the natural sand units, however mitigating surface features such as finish grading to assure overland flow rather than ponding, storm drains to conduct surface drainage, and vegetation control are assumed to reduce the amount of infiltration through the backfill.

Cooling basin seepage was evaluated by looking at the flow budget in subareas of the model domain. The simulation results indicate an estimated 3930 gpm seepage rate from the cooling basin. The primary impacts of the cooling basin seepage appear to be restricted to the adjacent creeks and seeps. There appears to be minimal impact on Black Bayou, Linn Lake, and the Guadalupe River. Kuy Creek, Dry Kuy Creek, and the downgradient seeps show more than two orders of magnitude increase in base flow (contribution from groundwater). Table 2.4.12-17 provides pre- and post- construction cooling basin seepage estimates.

Another impact of cooling basin seepage would be to raise groundwater levels beneath the power block. Figure 2.4.12-27 presents a simulated potentiometric surface map in model layer 2 (geotechnical Sand 1) in the power block area. The map indicates that groundwater levels are predicted to rise after filling the cooling basin. However, the permeable backfill around the power block buildings provides a pathway for vertical flow to bypass the underlying clay layers and enter the more permeable sands of the Lower Shallow aquifer. The maximum predicted groundwater elevation in the power block area is at approximately 85 feet. Figure 2.4.12-28 presents the simulated potentiometric surface surrounding the cooling basin in layer 2.

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

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

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

Appendix 2.4.12-C presents the results of the sensitivity analysis by comparing the base case seepage rate described above with two sensitivity cases. Sensitivity case 1 appears to be sensitive to a change in the vertical hydraulic conductivity of sediment on the bottom of the cooling basin. An order of magnitude reduction in the vertical hydraulic conductivity of the sediment results in an approximately 14.5 percent reduction in the seepage rate from the cooling basin. Sensitivity case 2 appears to be insensitive to a change in the vertical hydraulic conductivity of the surficial clay layer. An order of magnitude increase in the vertical hydraulic conductivity of the clay results in only an approximately 2 percent increase in seepage from the cooling basin.The value selected for the hydraulic conductivity of the layer 1 clay in the base case represents the maximum value from the Guelph Permeameter testing and therefore would provide an upper bound for the hydraulic conductivity in the clay.

2.4.12.3.2.2 Power Block Area Construction Dewatering Effects

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

Two dewatering scenarios were considered:

- Pre-construction groundwater conditions (cooling basin empty) with dewatering the entire power block area; and
- Post-construction groundwater conditions (cooling basin full) with dewatering the entire power block area.

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

Appendix 2.4.12-C presents the results of the simulations. Dewatering pumping (flow) rates ranged from approximately 990 to 1840 gpm. The finalization of the excavation and dewatering scheme (areal extent, depth, and construction schedule) will be evaluated once a reactor vendor has been selected, during the COL application stage.

2.4.12.3.2.3 Simulation of Accidental Release Pathway

The groundwater flow system downgradient of the power block was evaluated to identify potential exposure points from an accidental release of radionuclides to groundwater. The release is postulated to occur below the basement of a radwaste building in the backfill present in model layer 4 (Upper Shallow aquifer). The release was simulated by placing particles in the power block backfill. The movement of these particles was calculated using MODPATH, which is a companion program to

MODFLOW, that uses its output to perform the particle tracking. Four particle release scenarios are considered:

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

The hypothetical domestic wells are screened to fully penetrate model layer 6 (Lower Shallow aquifer), which is the uppermost aquifer used for water supply in the site area. The wells were pumped at a simulated rate of 50 gpm, which is considered the maximum practical pumping rate for the Lower Shallow aquifer within the site vicinity.

Appendix 2.4.12-C presents a summary of the travel times from the release point to the exposure point at the property boundary as derived from the particle tracking. The results of the particle tracking indicate a travel time of approximately 41,000 days (110 years) to eastern site boundary.

Figure 2.4.12-29 presents the particle track pathways for scenario 1 (without pumping). The particle tracks for the pumping scenarios and a cross-sectional representation are provided in Appendix 2.4.12-C. Modeling results indicates that when the particles are released into the fill they migrate down through the fill into model layer 6 (Lower Shallow aquifer) and then travel laterally toward the east or vertically to model layer 8 (Deep aquifer). The particles eventually discharge into Linn Lake, the Guadalupe River, or the Victoria Barge Canal. None of the pumping scenarios result in capture of particles by the pumping wells. The primary influence of the off-site pumping is to locally divert the particle tracks toward the north prior to the particle continuing to the eastern site boundary.

2.4.12.3.3 Groundwater Modeling Summary and Conclusions

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

- The groundwater levels in the power block area are predicted to be elevation 85 feet or approximately ten feet below the final plant grade of elevation 95 feet.

- The filling of the cooling basin to an elevation 90.5 feet is predicted to raise groundwater levels beneath the site to a point where the currently unsaturated sand layer referred to as the Sand 1 geotechnical unit becomes saturated.
- Seepage from the cooling basin is predicted to increase groundwater contributions (base flow) to Kuy and Dry Kuy Creeks and seeps to the north and east of the VCS site. Seepage from the cooling basin is estimated to be approximately 3930 gpm.
- Seepage from the cooling basin is also predicted to alter the groundwater flow directions in the site area, particularly in the power block area.
- Construction dewatering scenarios were simulated with the cooling basin empty and full with an estimated range of pumping rates between 990 (empty) and 1840 gpm (full).
- Particle tracking suggests that the closest receptor for an accidental release from postulated radwaste buildings would be the eastern property boundary for the VCS site. Pumping of hypothetical domestic wells along property boundaries did not result in the capture of or significant changes in the flow path of any released particles. The shortest travel time is approximately 41,000 days (110 years) to the eastern site boundary.

As mentioned in Subsection 2.4.12.3.1, an earlier numerical groundwater flow model was developed as the subsurface information was being interpreted. The model consisted of seven model layers and the model boundaries were closer to the VCS site than that used for the final modeling effort. The predominant difference between the final model and the earlier model is that the earlier model was developed with the following:

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

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

- The groundwater level in the power block area was predicted to be at an elevation of about 85 feet, which is the same predicted groundwater level obtained from the most recent model.

- Seepage from the cooling basin was estimated to be approximately 5700 gpm. The seepage from the cooling basin was predicted to increase groundwater contributions to the Guadalupe and San Antonio River valleys, and Kuy and Dry Kuy creeks by as much as 15 times the pre-construction amounts.

- Dewatering rates were less than 1000 gpm.

- Particle tracks from the power block area suggested a northeasterly groundwater flow direction.

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

2.4.12.4 Monitoring or Safeguard Requirements

Groundwater level monitoring at the VCS site is being implemented through the use of the groundwater observation wells installed in 2007 and 2008 for the site subsurface investigation.

As part of the detailed design at the COL stage for VCS, the groundwater monitoring well network and environmental monitoring program will be evaluated with respect to the Nuclear Energy Institute Groundwater Protection Initiative (NEI 07-07) (Reference 2.4.12-27) and 10 CFR 20.1406 to determine if any modifications are required to adequately monitor plant effects on the groundwater. Some of the existing VCS observation wells are expected to be taken out of service before construction activities begin in order to avoid their inadvertent destruction. For long-term groundwater monitoring purposes, the remaining observation well network will be evaluated to determine the need for replacement wells. The evaluation will form the basis for the groundwater monitoring program described in the following paragraphs. Considerations to revise the site groundwater monitoring program will include the following components:

- Evangeline Aquifer: Periodic water level measurements in deep observation wells, and geochemical sampling and analysis of onsite production wells would detect changes in the Evangeline Aquifer that may impact groundwater supply availability or the accident release analysis.

- Chicot Aquifer: Periodic water level measurements in the Upper Shallow, Lower Shallow, and Deep aquifer zone observation wells and collection of geochemical samples and analysis will be performed in selected observation wells. The water level monitoring program objective is to detect changes in flow patterns in the aquifer zones of interest that might impact accident analysis and would track temporal trends in groundwater levels that might impact structural stability.

- Operational Monitoring: The process and effluent monitoring program and implementation schedule will be described at the COL stage.

Groundwater level measurements in the Chicot Aquifer observation wells would be collected during construction and after plant startup. Selection of observation wells to be included in the program will be made before the start of operation. The selection process will be based on well condition and position relative to plant site and other observation wells to provide optimal spatial distribution for potentiometric map preparation and vertical hydraulic gradient assessment. Additionally, the long-term viability of the observation wells (i.e., the likelihood that the well will survive construction activities) will be considered in the selection process. Monitoring frequency and duration will be determined during detailed design at the COL stage.

Geochemical sampling and analysis in the Chicot and Evangeline aquifers would be performed during construction and after startup. Analysis may include field parameters (pH, temperature, specific conductance, oxidation-reduction potential, and dissolved oxygen), major cations, major anions, total dissolved solids, and silica. Sampling would be performed in site production wells and selected observation wells. The observation wells to be sampled, the sampling frequency, and the sampling duration would be determined during detailed design at the COL stage.

Safeguards will be used to minimize the potential for adverse impacts to the groundwater by construction and operation of the new units. These safeguards would include the use of lined containment structures around storage tanks (where appropriate) and hazardous materials storage areas, emergency cleanup procedures to capture and remove surface contaminants, and other measures deemed necessary to prevent or minimize adverse impacts to the groundwater beneath the VCS site.

2.4.12.5 Site Characteristics for Subsurface Hydrostatic Loading

Subsurface hydrostatic loading estimates for plant structures at the VCS site were evaluated using a conservative maximum groundwater level of 2 feet below final plant grade (a hypothetical reactor DCD requirement). This corresponds to a maximum groundwater elevation at the VCS of 93 feet based on a final plant grade elevation of 95 feet at the power block area. The maximum hydrostatic loading is estimated using the following formula:

$$\rho_w = z_w \times \gamma_w$$

Where,

ρ_w = hydrostatic pressure (pounds per square foot)

z_w = depth below groundwater level (feet)

γ_w = unit weight of water (62.4 pounds per cubic foot)

Figure 2.4.12-30 presents a graph of building elevation versus hydrostatic pressure. Three lines are provided on the graph: the first representing the hydrostatic pressure using a maximum groundwater level of 2 feet below post-construction plant grade; the second representing the hydrostatic pressure using the maximum observed groundwater level in the power block area elevation 48.47 feet from observation well OW-2253U on January 30, 2008 from Table 2.4.12-6; and the third representing the hydrostatic pressure using the predicted maximum groundwater level in the power block area after the cooling basin is filled; groundwater elevation of 85 feet.

Temporary perimeter dewatering will be required to maintain dry excavations for the construction of the required foundations for the VCS plant structures. Typical dewatering systems for this type of cut and fill excavation would consist of a combination of deep wells, well points, and open pumping from sumps within the excavation. The deep wells and well points would control lateral and vertical inflow and assist in removing water stored within the excavation area. The open pumping system would remove precipitation runoff, and other surface inflow to the excavation.

To prevent uplift of foundation soils in the open excavation, groundwater levels will be maintained approximately 3 to 5 feet below the bottom of the deepest excavation until the foundations are in place. Dewatering rates for a single excavation are expected to range from approximately 990 to 1840 gpm for the different dewatering scenarios as described in Subsection 2.4.12.3.2.2. Alternatives that could reduce the amount of water to be removed include various types of cutoff walls. Cutoff walls could include a slurry wall, grout curtain, or sheet-pile wall. Some dewatering would still need to be performed to remove groundwater in storage, precipitation runoff, and vertical inflow.

After the completion of backfilling around the structures, groundwater levels will be allowed to rise in a controlled manner to prevent rapid hydrostatic pressure buildup or damage to the subsurface backfill materials.

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Table 2.4.12-1 (Sheet 1 of 3)
Observation Well Construction Details

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

Table 2.4.12-1 (Sheet 2 of 3)
Observation Well Construction Details

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

Table 2.4.12-1 (Sheet 3 of 3)
Observation Well Construction Details

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

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

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

Table 2.4.12-2
Groundwater Observation and Test Wells and Monitoring Intervals

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

Table 2.4.12-3 (Sheet 1 of 2)
Listing of EPA Safe Drinking Water Information System Groundwater Systems in Victoria County, Texas

Water System Name	Water System Type[(a)]	County Served	Population Served	Primary Water Source Type	System Status	Water System ID
Arenosa Creek Estates	Community	Victoria	159	Groundwater	Active	TX2350042
Brentwood Subdivision	Community	Victoria	4950	Groundwater	Active	TX2350005
City of Victoria	Community	Victoria	61005	Surface Water	Active	TX2350002
Coleto Creek Mobile Home Park	Community	Victoria	84	Groundwater	Active	TX2350035
Coleto Water Company	Community	Victoria	468	Groundwater	Active	TX2350036
Devereux Foundation	Community	Victoria	270	Groundwater	Active	TX2350008
Key Road Subdivision	Community	Victoria	43	Purchased Groundwater	Active	TX2350055
North Victoria Utilities	Community	Victoria	207	Groundwater	Active	TX2350049
Quail Creek MUD	Community	Victoria	1533	Groundwater	Active	TX2350004
South Winds Mobile Home Village	Community	Victoria	45	Groundwater	Active	TX2350009
Victoria County WCID 1	Community	Victoria	2800	Groundwater	Active	TX2350001
Victoria County WCID 2	Community	Victoria	696	Groundwater	Active	TX2350006
Bloomington High School	Non-transient, Non-community	Victoria	400	Groundwater	Active	TX2350016
Industrial ISD Inez Elementary	Non-transient, Non-community	Victoria	230	Groundwater	Active	TX2350018
Invista S A R L	Non-transient, Non-community	Victoria	900	Groundwater	Active	TX2350014
Nursery ISD Elementary School	Non-transient, Non-community	Victoria	125	Groundwater	Active	TX2350021
Victoria County Navigation District	Non-transient, Non-community	Victoria	70	Groundwater	Active	TX2350051
William Wood Elementary School	Non-transient, Non-community	Victoria	100	Groundwater	Active	TX2350022
Guadalupe Elementary School	Non-transient, Non-community	Victoria	143	Groundwater	Active	TX2350017
Martin Luther Lutheran Church	Non-transient, Non-community	Victoria	313	Groundwater	Active	TX2350060
Mission Valley Elementary School	Non-transient, Non-community	Victoria	120	Groundwater	Active	TX2350020
Zion Lutheran Church	Non-transient, Non-community	Victoria	143	Groundwater	Active	Tx2350059
Dacosta Sons of Hermann Lodge 265	Transient, Non-community	Victoria	500	Groundwater	Active	TX2350048
Linden Hill Motel	Transient, Non-community	Victoria	450	Groundwater	Active	TX2350019
Midway Truck Stop	Transient, Non-community	Victoria	400	Groundwater	Active	TX2350041

Table 2.4.12-3 (Sheet 2 of 2)
Listing of EPA Safe Drinking Water Information System Groundwater Systems in Victoria County, Texas

Water System Name	Water System Type[(a)]	County Served	Population Served	Primary Water Source Type	System Status	Water System ID
Raisin Windmill	Transient, Non-community	Victoria	400	Groundwater	Active	TX2350050
Speedy Stop 46	Transient, Non-community	Victoria	300	Groundwater	Active	TX2350044
Spring Creek RV Park	Transient, Non-community	Victoria	25	Groundwater	Active	TX2350040
TX DOT Comfort Station US Hwy 59 North	Transient, Non-community	Victoria	100	Groundwater	Active	TX2350047
TX DOT Comfort Station US Hwy 59 South	Transient, Non-community	Victoria	100	Groundwater	Active	TX2350046
Spiritual Renewal Center	Transient, Non-community	Victoria	100	Groundwater	Active	TX2350057
Gold Mine Restaurant	Transient, Non-community	Victoria	25	Groundwater	Active	TX2350061
Poppes Pub & Grub	Transient, Non-community	Victoria	100	Groundwater	Active	TX2350058

Source: References 2.4.12-9 and 2.4.12-10

(a) Community water systems serve the same people year-round (e.g. in homes or businesses); non-transient, non-community water systems serve the same people, but not year-round (e.g. schools that have their own water system); and transient, non-community water systems do not consistently serve the same people (e.g. rest stops, campgrounds, gas stations).

Table 2.4.12-4 (Sheet 1 of 2)
Victoria County Historical Water Use

Year	Source	Municipal (AF)	Manufacturing (AF)	Steam Electric (AF)	Irrigation (AF)	Mining (AF)	Livestock (AF)	Total (AF)
1974	GW	7,644	1,636	5,123	15,983	787	174	31,347
1974	SW	0	28,136	1,946	109	456	1,372	32,019
Total	N/A	7,644	29,772	7,069	16,092	1,243	1,546	63,366
1980	GW	10,265	876	2,178	25,799	102	713	39,933
1980	SW	0	33,412	1,610	300	607	466	36,395
Total	N/A	10,265	34,288	3,788	26,099	709	1,179	76,328
1984	GW	12,378	836	3,635	20,201	2,265	702	40,017
1984	SW	0	15,992	1,876	133	319	468	18,788
Total	N/A	12,378	16,828	5,511	20,334	2,584	1,170	58,805
1985	GW	12,853	772	3,716	11,045	3,163	702	32,251
1985	SW	0	14,089	3,622	831	319	468	19,329
Total	N/A	12,853	14,861	7,338	11,876	3,482	1,170	51,580
1986	GW	12,288	657	3,307	9,216	0	682	26,150
1986	SW	0	16,825	2,191	384	0	453	19,853
Total	N/A	12,288	17,482	5,498	9,600	0	1,135	46,003
1987	GW	12,025	642	2,780	10,337	2,814	711	29,309
1987	SW	0	20,196	1,735	431	0	474	22,836
Total	N/A	12,025	20,838	4,515	10,768	2,814	1,185	52,145
1988	GW	12,511	509	2,322	16,863	2,585	744	35,534
1988	SW	0	27,322	24	703	0	496	28,545
Total	N/A	12,511	27,831	2,346	17,566	2,585	1,240	64,079
1989	GW	12,287	533	1,474	18,244	2,409	774	35,721
1989	SW	0	26,683	33	133	0	515	27,364
Total	N/A	12,287	27,216	1,507	18,377	2,409	1,289	63,085
1990	GW	11,545	489	865	13,151	2,409	763	29,222
1990	SW	0	19,543	22	548	0	508	20,621
Total	N/A	11,545	20,032	887	13,699	2,409	1,271	49,843
1991	GW	11,323	492	987	10,509	3,086	780	27,177
1991	SW	0	19,543	38	0	0	521	20,102
Total	N/A	11,323	20,035	1,025	10,509	3,086	1,301	47,279
1992	GW	11,919	632	876	10,297	3,096	839	27,659
1992	SW	0	12,599	32	429	0	559	13,619
Total	N/A	11,919	13,231	908	10,726	3,096	1,398	41,278
1993	GW	12,156	501	1,409	11,012	3,025	811	28,914
1993	SW	0	16,697	26	459	0	541	17,723
Total	N/A	12,156	17,198	1,435	11,471	3,025	1,352	46,637
1994	GW	12,084	557	1,117	14,258	3,016	754	31,786
1994	SW	0	18,471	21	133	0	503	19,128
Total	N/A	12,084	19,028	1,138	14,391	3,016	1,257	50,914

Table 2.4.12-4 (Sheet 2 of 2)
Victoria County Historical Water Use

Year	Source	Municipal (AF)	Manufacturing (AF)	Steam Electric (AF)	Irrigation (AF)	Mining (AF)	Livestock (AF)	Total (AF)
1995	GW	12,325	554	1,965	11,051	3,015	692	29,602
1995	SW	0	18,624	41	460	0	462	19,587
Total	N/A	12,325	19,178	2,006	11,511	3,015	1,154	49,189
1996	GW	13,781	588	1,872	11,797	3,015	1,044	32,097
1996	SW	0	18,999	21	492	0	696	20,208
Total	N/A	13,781	19,587	1,893	12,289	3,015	1,740	52,305
1997	GW	12,470	567	1,928	8,748	3,015	611	27,339
1997	SW	0	22,267	6,050	364	0	407	29,088
Total	N/A	12,470	22,834	7,978	9,112	3,015	1,018	56,427
1998	GW	13,809	521	1,643	10,164	3,015	671	29,823
1998	SW	0	47,247	8,050	424	0	447	56,168
Total	N/A	13,809	47,768	9,693	10,588	3,015	1,118	85,991
1999	GW	13,289	717	2,446	7,237	3,015	678	27,382
1999	SW	0	37,651	8,050	302	0	451	46,454
Total	N/A	13,289	38,368	10,496	7,539	3,015	1,129	73,836
2000	GW	13,712	619	2,189	6,708	3,015	649	26,892
2000	SW	0	23,645	8	0	0	435	24,088
Total	N/A	13,712	24,264	2,197	6,708	3,015	1,084	50,980
2001	GW	8,662	612	542	7,339	2,293	286	19,734
2001	SW	0	23,702	1,701	0	0	788	26,191
Total	N/A	8,662	24,314	2,243	7,339	2,293	1,074	45,925
2002	GW	10,483	499	261	7,301	2,293	292	21,129
2002	SW	0	19,607	818	0	0	803	21,228
Total	N/A	10,483	20,106	1,079	7,301	2,293	1,095	42,357
2003	GW	10,320	515	261	3,900	2,293	308	17,597
2003	SW	0	20,243	818	66	0	847	21,974
Total	N/A	10,320	20,758	1,079	3,966	2,293	1,155	39,571
2004	GW	9,156	508	303	2,966	2,293	303	15,529
2004	SW	0	19,966	952	0	0	834	21,752
Total	N/A	9,156	20,474	1,255	2,966	2,293	1,137	37,281
2005 Total(a)	N/A	13,162	20,842	2196	2619	3015	1201	46,035
2006 Total(a)	N/A	13,619	21,398	883	2306	0	1285	39,491

Source: Reference 2.4.12-11

Abbreviations:
AF = acre-feet
GW = Groundwater
N/A = Not Applicable
SW = Surface Water
(a) = Draft Data Subject to Revision

Table 2.4.12-5
Victoria County Projected Water Use

Category	Demand/Shortage	2010	2030	2060
Municipal	Demand (AF)	14,590	16,378	18,034
—	Shortage (AF)	0	0	0
Manufacturing	Demand (AF)	28,726	35,035	43,520
—	Shortage (AF)	0	0	6,566
Steam Electric	Demand (AF)	2,026	2,035	3,365
—	Shortage (AF)	0	0	0
Irrigation	Demand (AF)	3,944	4,905	6,041
—	Shortage (AF)	0	0	0
Mining	Demand (AF)	9,936	7,402	4,759
—	Shortage (AF)	0	0	0
Livestock	Demand (AF)	1,085	1,085	1,085
—	Shortage (AF)	0	0	0
Total	Demand (AF)	60,307	66,840	76,084
—	Shortage (AF)	0	0	6,566

Source: Reference 2.4.12-12

Abbreviations:
AF = acre-feet

Table 2.4.12-6 (Sheet 1 of 3)
VCS Groundwater Level Measurements

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

Table 2.4.12-6 (Sheet 2 of 3)
VCS Groundwater Level Measurements

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

Table 2.4.12-6 (Sheet 3 of 3)
VCS Groundwater Level Measurements

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

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

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

Table 2.4.12-7 (Sheet 1 of 14)
Vertical Hydraulic Gradient Calculations

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

Table 2.4.12-7 (Sheet 2 of 14)
Vertical Hydraulic Gradient Calculations

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

Table 2.4.12-7 (Sheet 3 of 14)
Vertical Hydraulic Gradient Calculations

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

Table 2.4.12-7 (Sheet 4 of 14)
Vertical Hydraulic Gradient Calculations

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

Table 2.4.12-7 (Sheet 5 of 14)
Vertical Hydraulic Gradient Calculations

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

Table 2.4.12-7 (Sheet 6 of 14)
Vertical Hydraulic Gradient Calculations

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

Table 2.4.12-7 (Sheet 7 of 14)
Vertical Hydraulic Gradient Calculations

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

Table 2.4.12-7 (Sheet 8 of 14)
Vertical Hydraulic Gradient Calculations

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

Table 2.4.12-7 (Sheet 9 of 14)
Vertical Hydraulic Gradient Calculations

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

Table 2.4.12-7 (Sheet 10 of 14)
Vertical Hydraulic Gradient Calculations

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

Table 2.4.12-7 (Sheet 11 of 14)
Vertical Hydraulic Gradient Calculations

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

Table 2.4.12-7 (Sheet 12 of 14)
Vertical Hydraulic Gradient Calculations

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

Table 2.4.12-7 (Sheet 13 of 14)
Vertical Hydraulic Gradient Calculations

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

Table 2.4.12-7 (Sheet 14 of 14)
Vertical Hydraulic Gradient Calculations

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

Notes:

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

Table 2.4.12-8 (Sheet 1 of 4)
VCS Site Slug Test Results

Observation Well	Surface Elevation (NAVD 88)	Depth (ft)	Geologic Unit	Saturated Thickness (ft)	Hydraulic Conductivity in ft/d					Notes
					Falling		Rising		Arithmetic Mean	
					Bouwer-Rice	Butler	Bouwer-Rice	Butler		
OW-01U	71.46	63	Upper	10	13.97	20.70	37.10	31.69	25.87	
OW-02U	74.68	66	Upper	10	4.46	11.45	12.62	23.37	12.98	
OW-03U	74.89	56	Upper	NA	NA	NA	NA	NA	NA	Dry
OW-04U	78.97	88.13	Upper	3.5	3.34	3.49	1.91	1.81	2.64	
OW-05U	77.56	59.28	Upper	10	NA	NA	26.79	31.06	28.93	Missing Falling Head data
OW-06U	78.98	65.98	Upper	7	10.63	17.70	23.25	23.08	18.67	
OW-07U	77.39	66.13	Upper	10	NA	NA	26.43	87.14	56.79	Missing Falling Head data
OW-09U	77.36	62.85	Upper	10	28.71	33.84	26.18	23.02	27.94	
OW-10U	77.69	60.1	Upper	NA	NA	NA	NA	NA	NA	Insufficient water for testing
OW-2150U	80.44	67.05	Upper	9.1	0.05	0.08	2.46	4.46	1.76	
OW-2150U	80.44	67.05	Upper	9.1	0.05	0.07	NA	NA	0.06	Duplicate Test
OW-2150 Average	80.44	67.05	Upper	9.1	**0.05**	**0.08**	**2.46**	**4.46**	**0.91**	Well Average
OW-2169U	79.47	68.7	Upper	10	14.50	30.15	28.44	30.87	25.99	
OW-2181U	79.24	53.02	Upper	10	4.08	13.53	8.95	12.82	9.85	
OW-2185U	79.48	78.24	Upper	4.5	9.92	15.15	10.79	13.86	12.43	
OW-2253U	80.86	68.25	Upper	8.5	10.80	11.58	12.48	15.36	12.56	
OW-2284U	80.42	78.45	Upper	5	0.85	0.95	1.37	1.82	1.25	
OW-2284U	80.42	78.45	Upper	5	0.58	3.04	NA	NA	1.81	Duplicate Test
OW-2284U Average	80.42	78.45	Upper	5	**0.72**	**2.00**	**1.37**	**1.82**	**1.53**	Well Average
OW-2301U	81.23	63	Upper	7	12.29	20.62	14.24	21.46	17.15	
OW-2304U	68.33	54.33	Upper	10	60.44	61.99	35.62	53.45	52.88	
OW-2307U	76.75	68.11	Upper	10	9.64	10.33	7.13	14.67	10.44	

Table 2.4.12-8 (Sheet 2 of 4)
VCS Site Slug Test Results

Observation Well	Surface Elevation (NAVD 88)	Depth (ft)	Geologic Unit	Saturated Thickness (ft)	Hydraulic Conductivity in ft/d					Notes
					Falling		Rising		Arithmetic Mean	
					Bouwer-Rice	Butler	Bouwer-Rice	Butler		
OW-2352U	62.91	58.6	Upper	10	3.78	5.03	11.53	12.79	8.28	
OW-01L	71.46	112.95	Lower	10	43.26	73.30	48.94	49.32	53.71	
OW-01L	71.46	112.95	Lower	10	33.55	25.72	45.98	59.56	41.20	Duplicate Test
OW-01L Average	71.46	112.95	Lower	10	**38.41**	**49.51**	**47.46**	**54.44**	**47.45**	Well Average
OW-02L	74.68	109.13	Lower	10	23.26	24.84	20.46	36.29	26.21	
OW-03L	74.89	100	Lower	10	83.66	94.77	120.80	120.80	105.01	
OW-03L	74.89	100	Lower	10	80.62	96.53	NA	NA	88.58	Duplicate Test
OW-03L Average	74.89	100	Lower	10	**82.14**	**95.65**	**120.80**	**120.80**	**96.79**	Well Average
OW-04L	78.97	113.49	Lower	10	4.18	8.40	7.39	11.66	7.91	
OW-06L	78.98	98.62	Lower	10	87.21	88.25	31.36	29.45	59.07	
OW-08U	81.71	103.03	Lower	10	24.67	39.35	82.12	69.06	53.80	
OW-2169L	79.47	103.2	Lower	10	1.07	1.32	36.16	36.52	18.77	
OW-2181L	79.24	99.2	Lower	5.2	0.01	0.03	0.01	0.03	0.02	Multiple sat. thicknesses
OW-2185L	79.48	102.96	Lower	10	6.17	8.10	19.40	27.27	15.24	
OW-2269U	80.45	93.35	Lower	9.6	0.79	1.13	2.49	3.41	1.96	
OW-2269U	80.45	93.35	Lower	9.6	1.56	2.25	NA	NA	1.91	Duplicate Test
OW-2269U Average	80.45	93.35	Lower	9.6	**1.18**	**1.69**	**2.49**	**3.41**	**1.93**	Well Average
OW-2284L	80.42	113.4	Lower	10	26.23	38.88	23.94	35.84	31.22	
OW-2302U	80.32	98.18	Lower	10	19.49	42.45	45.01	25.94	33.22	
OW-2302U	80.32	98.18	Lower	10	NA	NA	48.96	50.07	49.52	Duplicate Test
OW-2302U Average	80.32	98.18	Lower	10	**19.49**	**42.45**	**46.99**	**38.01**	**41.37**	Well Average
OW-2304L	68.33	98.44	Lower	5	16.58	115.20	55.97	60.49	62.06	

Table 2.4.12-8 (Sheet 3 of 4)
VCS Site Slug Test Results

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

Table 2.4.12-8 (Sheet 4 of 4)
VCS Site Slug Test Results

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

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

🟨 Highlighted rows indicate multiple tests on the same well with the arithmetic mean (average) determined for all tests on the well.

Data source: Reference 2.5.4-2

Table 2.4.12-9 (Sheet 1 of 2)
Summary of Aquifer Pumping Test Results

TW-2320U Aquifer Pumping Test **48 hour test**

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

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

Table 2.4.12-9 (Sheet 2 of 2)
Summary of Aquifer Pumping Test Results

TW-2359L Aquifer Pumping Test **24 hour test**

Observation Well	Saturated Thickness (ft)	Theis Method		Cooper-Jacob Method		Hantush-Jacob Method		Vertical/Horizontal Hydraulic Conductivity (unitless)
		Transmissivity (ft2/d)	Storage Coefficient (unitless)	Transmissivity (ft2/d)	Storage Coefficient (unitless)	Transmissivity (ft2/d)	Storage Coefficient (unitless)	
OW-2359L2	53	2526	7.33 x 10^{-5}	2546	6.43 x 10^{-5}	2455	1.59 x 10^{-3}	0.0073
OW-2359L3	53	2502	7.64 x 10^{-5}	2509	7.48 x 10^{-5}	2527	7.33 x 10^{-4}	0.0055
Combination/ Drawdown	53	2508	7.35 x 10^{-5}	2495	7.36 x 10^{-5}	2551	1.04 x 10^{-3}	0.0014
Combination/ Recovery	53	2440	—	—	—	—	—	—
mean		2494	7.44 x 10^{-5}	2517	7.09 x 10^{-5}	2511	1.12 x 10^{-3}	0.0047
Hydraulic Conductivity (ft/d)		47.0	—	47.5	—	47.4	—	—

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

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

Table 2.4.12-10 (Sheet 1 of 6)
Hydrogeologic Properties from Geotechnical Tests

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

Table 2.4.12-10 (Sheet 2 of 6)
Hydrogeologic Properties from Geotechnical Tests

Boring No.	Sample No.	Sample Depth (ftbgs)	USCS Symbol	Geotechnical Unit	Hydrogeologic Unit	Dry Unit Weight (γ_d) (pcf)	Void Ratio (e)	Specific Gravity (G_s)	Moisture Content (ω) (%)	Porosity[(a)] (n) (%)	Effective Porosity[(b)] (n_e) (%)	Bulk Density[(c)] (γ_m) (pcf)	Bulk Density (γ_m) (g/cm^3)
B-2174UD	UD 2	30–31.7	CH	Clay 1 Bottom	Shallow Confining layer	100.5	0.71	—	24.0	41.5	8.3	124.6	1.99
B-2182UD	UD-5	33–34.7	CH	Clay 1 Bottom	Shallow Confining layer	97.2	0.78	2.77	29.6	43.8	8.8	126.0	2.02
B-2269UD	UD-5	50–51.7	CH	Clay 1 Bottom	Shallow Confining layer	103.0	0.64	2.70	21.8	38.9	—	125.5	2.01
B-2319UD	UD 4	25.0–27.0	CH	Clay 1 Bottom	Shallow Confining layer	106.5	—	2.72	20.7	—	—	128.5	2.06
B-2319UD	UD 4	25.0–27.0	CH	Clay 1 Bottom	Shallow Confining layer	105.3	—	—	21.4	—	7.8	127.8	2.05
B-2319UD	UD-4	26.65	CH	Clay 1 Bottom	Shallow Confining layer	109.1	—	2.72	19.2	—	—	130.1	2.08
B-2321UD	7	38.5–40.2	CH	Clay 1 Bottom	Shallow Confining layer	101.9	—	2.78	21.3	—	—	123.6	1.98
B-2321UD	UD 6	28.5–30.2	CH	Clay 1 Bottom	Shallow Confining layer	96.4	—	2.72	25.5	—	—	121.0	1.94
B-2321UD	UD 7	38.5–40.2	CH	Clay 1 Bottom	Shallow Confining layer	102.8	—	2.78	21.0	—	—	124.4	1.99
B-2321UD	UD 7	38.5–40.2	CH	Clay 1 Bottom	Shallow Confining layer	106.6	0.63	2.78	14.8	38.6	—	122.4	1.96
B-2321UD	UD-6	30.2	CH	Clay 1 Bottom	Shallow Confining layer	96.1	—	2.72	23.9	—	—	119.1	1.91
B-2321UD	UD-8	49.75	CH	Clay 1 Bottom	Shallow Confining layer	92.2	—	2.72	28.5	—	7.7	118.4	1.89
B-2352UD	5	24.0–25.7	CH	Clay 1 Bottom	Shallow Confining layer	94.4	—	2.67	28.0	—	—	120.8	1.93
B-2352UD	UD 5	24–25.7	CH	Clay 1 Bottom	Shallow Confining layer	100.7	0.66	2.67	22.7	39.6	—	123.6	1.98
B-2359UD	3	30.8–32.8	CH	Clay 1 Bottom	Shallow Confining layer	91	—	2.78	30.2	—	—	118.4	1.89
B-2359UD	UD 5	40.0–41.7	CH	Clay 1 Bottom	Shallow Confining layer	103.4	—	—	22.0	—	7.9	126.1	2.02
B-2359UD	UD-4	36.45	CH	Clay 1 Bottom	Shallow Confining layer	103.96	—	2.73	21.6	—	—	126.4	2.02
B-2359UD	UD-5	41.15	CH	Clay 1 Bottom	Shallow Confining layer	108.96	—	2.71	18.4	—	—	129.0	2.06
B-2302UD	UD 7	59.0–60.2	SC-SM	Sand 2	Upper Shallow Aquifer	106.4	—	—	20.1	—	—	127.8	2.04
B-2302UD	UD 9	63.5–66	SP-SM	Sand 2	Upper Shallow Aquifer	103.0	0.63	2.68	21.1	38.7	30.9	124.7	2.00
B-2319UD	UD 5	35.0–37.0	ML	Sand 2	Upper Shallow Aquifer	106.2	—	2.72	18.8	—	—	126.2	2.02
B-2359UD	UD 7	55.0–56.7	ML	Sand 2	Upper Shallow Aquifer	108.4	0.53	2.65	14.3	34.6	27.6	123.9	1.98
B-2174UD	UD 3	75–76.7	CL	Clay 3	Lower Confining layer	117.1	0.47	—	15.8	32.0	6.40	135.6	2.17
B-2182UD	UD-7	65–66.7	SC	Clay 3	Lower Confining layer	95.4	—	2.74	20.9	—	—	115.3	1.85
B-2182UD	UD-7	65–66.7	SC	Clay 3	Lower Confining layer	93.3	0.84	2.74	25.0	45.5	9.10	116.7	1.87
B-2269UD	UD-7	70–71.7	CH	Clay 3	Lower Confining layer	84.4	—	2.72	36.6	—	—	115.2	1.84
B-2269UD	UD-7	70–71.7	CH	Clay 3	Lower Confining layer	95.5	0.78	2.72	28.3	43.7	8.75	122.5	1.96

Table 2.4.12-10 (Sheet 3 of 6)
Hydrogeologic Properties from Geotechnical Tests

Boring No.	Sample No.	Sample Depth (ftbgs)	USCS Symbol	Geotechnical Unit	Hydrogeologic Unit	Dry Unit Weight (γ_d) (pcf)	Void Ratio (e)	Specific Gravity (G_s)	Moisture Content (ω) (%)	Porosity(a) (n) (%)	Effective Porosity(b) (n_e) (%)	Bulk Density(c) (γ_m) (pcf)	Bulk Density (γ_m) (g/cm^3)
B-2269UD	UD-8	73–74.7	CH	Clay 3	Lower Confining layer	100.6	0.66	2.67	22.4	39.6	7.92	123.1	1.97
B-2274UD	UD-4	67–68.7	CH	Clay 3	Lower Confining layer	89.24	—	2.76	32.6	—	—	118.3	1.89
B-2274UD	UD-4	67–68.7	CH	Clay 3	Lower Confining layer	93.6	0.84	2.76	28.1	45.7	9.14	119.9	1.92
B-2302UD	11	69.5–71.5	CH	Clay 3	Lower Confining layer	96.8	—	2.74	24.2	—	—	120.2	1.92
B-2302UD	UD 10	66.0–68.5	CH	Clay 3	Lower Confining layer	103.7	—	—	22.5	—	—	127.0	2.03
B-2304UD	7	73.5–75.5	MH	Clay 3	Lower Confining layer	92.6	—	2.78	29.8	—	8.2	119.7	1.91
B-2304UD	UD 7	73.5–75.5	MH	Clay 3	Lower Confining layer	92.3	0.9	2.78	27.6	46.8	—	122.8	1.97
B-2304UD	UD 8	83.5–85.5	CH	Clay 3	Lower Confining layer	90.8	—	—	30.9	—	—	120.2	1.92
B-2304UD	UD-8	85.3	CH	Clay 3	Lower Confining layer	90.8	—	2.71	29.6	—	9.4	117.8	1.88
B-2319UD	8	75–77	SP-SM	Clay 3	Lower Confining layer	96.6	—	2.73	25.3	—	—	118.9	1.90
B-2319UD	UD 6	55.0–57.0	ML	Clay 3	Lower Confining layer	91.9	—	2.71	30.7	—	—	117.7	1.88
B-2319UD	UD 7	65.0–67.0	CL	Clay 3	Lower Confining layer	103.4	—	—	20.1	—	—	121.0	1.94
B-2319UD	UD 8	75.0–77.0	SP-SM	Clay 3	Lower Confining layer	98.7	0.73	2.73	24.6	42.1	—	120.1	1.92
B-2319UD	UD-7	66.6	CL	Clay 3	Lower Confining layer	103.2	—	2.66	18.8	—	—	124.2	1.99
B-2321UD	UD 9	58.5–61.0	CL	Clay 3	Lower Confining layer	106.6	—	—	20.0	—	8.4	123.0	1.97
B-2321UD	UD-10	65.05	CL	Clay 3	Lower Confining layer	116.5	—	2.67	13.7	—	—	122.6	1.96
B-2321UD	UD-9	59.45	CL	Clay 3	Lower Confining layer	104.0	—	2.68	19.3	—	—	127.9	2.05
B-2352UD	UD 8	68.0–69.4	SM	Clay 3	Lower Confining layer	107.3	0.56	2.68	14.4	35.9	—	132.4	2.12
B-2359UD	UD 10	70.0–71.7	CH	Clay 3	Lower Confining layer	114.1	—	—	16.6	—	—	124.0	1.98
B-2359UD	UD-10	71.6	CH	Clay 3	Lower Confining layer	110.7	—	2.72	16.8	—	7.2	122.8	1.96
B-2174UD	UD 4	90–90.9	CL	Sand 4	Lower Shallow Aquifer	118.1	0.44	—	15.6	30.7	24.6	133.0	2.13
B-2182UD	UD 12B	95–97.5	SP-SM	Sand 4	Lower Shallow Aquifer	103.5	0.64	2.72	17.7	39.0	31.2	129.3	2.07
B-2182UD	UD-11	90.5–93	CL	Sand 4	Lower Shallow Aquifer	114.3	—	2.77	15.8	—	—	136.5	2.18
B-2182UD	UD-11	90.5–93.0	CL	Sand 4	Lower Shallow Aquifer	125.6	0.38	2.77	12.3	27.3	21.9	121.8	1.95
B-2182UD	UD-12T	95–97.5	CL	Sand 4	Lower Shallow Aquifer	117.4	—	2.73	15.4	—	—	132.3	2.12
B-2302UD	UD 14	108.5–111	SM	Sand 4	Lower Shallow Aquifer	110.2	0.54	2.71	17.8	34.9	27.9	141.0	2.26
B-2302UD	UD-16	122.2	CH	Sand 4	Lower Shallow Aquifer	97.6	—	2.72	25.5	—	—	135.5	2.17

Table 2.4.12-10 (Sheet 4 of 6)
Hydrogeologic Properties from Geotechnical Tests

Boring No.	Sample No.	Sample Depth (ftbgs)	USCS Symbol	Geotechnical Unit	Hydrogeologic Unit	Dry Unit Weight (γ_d) (pcf)	Void Ratio (e)	Specific Gravity (G_s)	Moisture Content (ω) (%)	Porosity(a) (n) (%)	Effective Porosity(b) (n_e) (%)	Bulk Density(c) (γ_m) (pcf)	Bulk Density (γ_m) (g/cm^3)
B-2319UD	UD 10	95.0–97.0	SP	Sand 4	Lower Shallow Aquifer	103.2	—	2.72	11.2	—	—	129.8	2.08
B-2321UD	UD 12	93.0–95.7	SP-SM	Sand 4	Lower Shallow Aquifer	101.2	0.66	2.69	22.7	39.8	31.8	122.5	1.96
B-2321UD	UD 12	93.0–95.7	SP-SM	Sand 4	Lower Shallow Aquifer	101.9	—	2.69	21.3	—	—	114.8	1.84
B-2359UD	11	77.0–78.7	SC-SM	Sand 4	Lower Shallow Aquifer	106.2	—	2.72	19.4	—	—	124.2	1.99
B-2359UD	UD 11	77.0–78.7	SC-SM	Sand 4	Lower Shallow Aquifer	101.9	0.67	2.72	19.9	40.0	32.0	123.6	1.98
B-2359UD	UD 14	88.5–90.5	ML	Sand 4	Lower Shallow Aquifer	96.6	0.78	2.74	25.3	43.8	35.1	121.0	1.94
B-2359UD	UD-12	80.25	SC	Sand 4	Lower Shallow Aquifer	107.2	—	2.66	18.2	—	—	126.7	2.03
B-2182UD	UD-13	120–121.7	SC	Clay 5 Top	Deep Confining layer	111.0	0.52	2.71	18.7	34.3	6.9	131.8	2.11
B-2182UD	UD-13	120–121.7	SC	Clay 5 Top	Deep Confining layer	104.6	—	2.71	20.4	—	—	125.9	2.02
B-2302UD	UD-19	147	CL	Clay 5 Top	Deep Confining layer	—	—	2.69	21.5	—	10.0	116.6	1.87
B-2304UD	UD 11	111.0–113.0	CH	Clay 5 Top	Deep Confining layer	103.6	—	—	22.7	—	6.2	135.1	2.16
B-2304UD	UD 13	121.0–123.0	CH	Clay 5 Top	Deep Confining layer	110.0	—	—	21.0	—	—	—	—
B-2304UD	9	98.5–101	CH	Clay 5 Top	Deep Confining layer	99.8	—	2.74	25.8	—	—	127.1	2.03
B-2304UD	UD 9	98.5–101.0	CH	Clay 5 Top	Deep Confining layer	101.5	0.69	2.74	22.8	40.7	—	133.1	2.13
B-2304UD	UD-11	112.9	CH	Clay 5 Top	Deep Confining layer	103.6	—	2.71	21.7	—	—	125.5	2.01
B-2304UD	UD-13	122.95	CH	Clay 5 Top	Deep Confining layer	108.0	—	2.71	18.6	—	8.1	124.6	1.99
B-2321UD	14	128.5–130	CH	Clay 5 Top	Deep Confining layer	96.8	—	2.75	25.5	—	—	126.0	2.02
B-2321UD	UD 14	128.5–130.3	CH	Clay 5 Top	Deep Confining layer	97.0	—	2.75	25.0	—	—	128.1	2.05
B-2321UD	UD 15	130.5–132.5	CH	Clay 5 Top	Deep Confining layer	106.8	—	—	20.3	—	—	121.5	1.94
B-2321UD	UD-15	132.5	CH	Clay 5 Top	Deep Confining layer	102.2	—	2.71	21.0	—	—	121.3	1.94
B-2359UD	18	112–113.1	SC	Clay 5 Top	Deep Confining layer	92.4	—	2.77	25.5	—	—	128.5	2.06
B-2359UD	UD 17	110–111.7	SM	Clay 5 Top	Deep Confining layer	106.9	0.58	2.71	17.4	36.8	—	123.6	1.98
B-2359UD	UD 19	114.0–116.6	SM	Clay 5 Top	Deep Confining layer	105.7	0.60	2.70	17.3	37.4	—	116.0	1.86
B-2304UD	UD 15	141.0–143.5	SP-SM	Sand 5	Deep Confining layer	99.2	0.69	2.68	17.9	40.8	7.4	125.5	2.01
B-2182UD	UD-15	145–147.5	ML	Clay 5 Bottom	Deep Confining layer	95.4	—	2.70	26.8	—	7.5	124.0	1.98
B-2182UD	UD-15	145–147.5	ML	Clay 5 Bottom	Deep Confining layer	102.5	0.65	2.70	25.3	39.2	8.2	116.9	1.87
B-2269UD	UD-11	150–151.7	CH	Clay 5 Bottom	Deep Confining layer	103.7	—	2.70	21.8	—	—	121.0	1.94

Table 2.4.12-10 (Sheet 5 of 6)
Hydrogeologic Properties from Geotechnical Tests

Boring No.	Sample No.	Sample Depth (ftbgs)	USCS Symbol	Geotechnical Unit	Hydrogeologic Unit	Dry Unit Weight (γ_d) (pcf)	Void Ratio (e)	Specific Gravity (G_s)	Moisture Content (ω) (%)	Porosity[a] (n) (%)	Effective Porosity[b] (n_e) (%)	Bulk Density[c] (γ_m) (pcf)	Bulk Density (γ_m) (g/cm^3)
B-2269UD	UD-11	150–151.7	CH	Clay 5 Bottom	Deep Confining layer	105.0	0.60	2.70	21.8	37.7	7.8	128.4	2.05
B-2359UD	UD-20	121.25	CH	Clay 5 Bottom	Deep Confining layer	85.9	—	2.72	34.0	—	—	126.3	2.02
B-2174UD	UD 8	145–147	SM	Sand 6	Deep Aquifer	101.0	0.66	2.68	17.5	39.8	31.8	127.9	2.05
B-2174UD	UD 10	183–185	SM	Sand 6	Deep Aquifer	109.8	0.55	2.72	15.7	35.5	28.4	115.1	1.84
B-2182UD	UD 16	180–182.5	SM	Sand 6	Deep Aquifer	107.0	0.57	2.68	15.1	36.3	29.0	118.7	1.90
B-2269UD	UD 16	280–281.2	SC	Sand 6	Deep Aquifer	107.5	0.56	2.69	18.6	35.9	28.8	127.0	2.03
B-2182UD	UD-17	215–217.5	CL	Clay 7	Deep Aquifer	101.7	—	2.72	22.8	—	—	123.2	1.97
B-2174UD	UD 15	265–267	SC	Sand 8	Deep Aquifer	108.6	0.52	2.65	19.3	34.2	27.4	127.5	2.04
B-2274UD	UD 12	221.1–223.6	SC	Sand 8	Deep Aquifer	114.7	0.45	2.66	10.6	31.0	24.8	126.9	2.03
B-2274UD	UD 13	240–242.5	CL	Sand 8	Deep Aquifer	114.1	0.48	—	15.6	32.4	26.0	131.9	2.11
B-2274UD	UD-13	240–242.5	CL	Sand 8	Deep Aquifer	112.9	—	2.70	17.1	—	—	132.2	2.12
B-2182UD	UD-25	303–304.2	CH	Clay 9	Deep Bottom Confining layer	91.3	—	2.79	26.5	—	—	115.5	1.85
B-2182UD	UD-26	320–321.5	CL	Clay 9	Deep Bottom Confining layer	115.5	—	2.73	14.9	—	9.0	119.8	1.92
B-2182UD	UD-28	330–332	CH	Clay 9	Deep Bottom Confining layer	97.3	0.76	2.74	28.0	43.1	6.6	132.2	2.12
B-2182UD	UD-29	333–334.7	CH	Clay 9	Deep Bottom Confining layer	96.9	—	2.72	24.7	—	—	132.7	2.12
B-2182UD	UD-30	340–341.1	CL	Clay 9	Deep Bottom Confining layer	116.9	—	2.73	15.5	—	8.6	124.6	1.99
B-2182UD	UD-30	340–341.1	CL	Clay 9	Deep Bottom Confining layer	117.6	0.45	2.73	15.0	31.1	—	120.8	1.93
B-2182UD	UD-31	343–344	CL	Clay 9	Deep Bottom Confining layer	115.9	0.48	2.74	15.8	32.2	—	135.1	2.16
B-2274UD	UD-16	300–301.8	CH	Clay 9	Deep Bottom Confining layer	90.9	—	2.76	26.8	—	6.2	135.2	2.16
B-2274UD	UD-16	300–301.8	CH	Clay 9	Deep Bottom Confining layer	95.4	0.81	2.76	25.0	44.7	6.4	134.2	2.15
B-2274UD	UD-17	320–322.5	MH	Clay 9	Deep Bottom Confining layer	99.2	0.71	2.72	24.3	41.6	—	115.2	1.84
B-2274UD	UD 18	330.1–332.6	SM	Sand 10	Deep Bottom Confining layer	110.6	0.54	2.71	14.0	35.1	8.9	119.2	1.91
B-2274UD	UD 19	350.1–352.6	SM	Sand 10	Deep Bottom Confining layer	104.7	0.60	2.69	20.5	37.5	8.3	123.3	1.97
B-2182UD	UD-33	380–381.7	CH	Clay 11	Deep Bottom Confining layer	84.9	—	2.78	33.8	—	7.0	126.1	2.02
B-2182UD	UD-33	380–381.7	CH	Clay 11	Deep Bottom Confining layer	86.6	1.00	2.78	32.2	50.0	7.5	126.2	2.02
B-2182UD	UD-37	400–402.5	CL	Clay 11	Deep Bottom Confining layer	91.4	—	2.76	29.3	—	—	113.6	1.82
B-2182UD	UD-37	400–402.5	CL	Clay 11	Deep Bottom Confining layer	103.1	0.67	2.76	23.6	40.1	10.0	114.4	1.83

Table 2.4.12-10 (Sheet 6 of 6)
Hydrogeologic Properties from Geotechnical Tests

Boring No.	Sample No.	Sample Depth (ftbgs)	USCS Symbol	Geotechnical Unit	Hydrogeologic Unit	Dry Unit Weight (γ_d) (pcf)	Void Ratio (e)	Specific Gravity (G_s)	Moisture Content (ω) (%)	Porosity[a] (n) (%)	Effective Porosity[b] (n_e) (%)	Bulk Density[c] (γ_m) (pcf)	Bulk Density (γ_m) (g/cm^3)
B-2269UD	UD-18	375–376.6	CL	Clay 11	Deep Bottom Confining layer	104.1	0.67	2.78	22.3	40.0	—	118.1	1.89
B-2269UD	UD-20	400–402.1	CH	Clay 11	Deep Bottom Confining layer	85.7	—	2.77	32.9	—	8.0	127.4	2.04
B-2269UD	UD-20	400–402.1	CH	Clay 11	Deep Bottom Confining layer	102.7	0.69	2.77	24.1	40.7	8.0	127.3	2.04
B-2274UD	UD-20	380–381.8	MH	Clay 11	Deep Bottom Confining layer	86.0	—	2.76	34.9	—	—	113.8	1.82
B-2274UD	UD-20	380–381.8	MH	Clay 11	Deep Bottom Confining layer	89.6	0.92	2.76	31.0	48.0	8.1	127.5	2.04
B-2274UD	UD-21	390–391.8	CH	Clay 11	Deep Bottom Confining layer	83.6	—	2.75	36.7	—	—	116.0	1.86
B-2274UD	UD-22	400–401.3	CH	Clay 11	Deep Bottom Confining layer	98.2	—	2.72	26.3	—	9.6	117.4	1.88
B-2274UD	UD-22	400–401.3	CH	Clay 11	Deep Bottom Confining layer	96.7	0.76	2.72	25.6	43.1	—	114.3	1.83
B-2174UDR	UD-26	445–446	CH	Clay 13	Deep Bottom Confining layer	96.2	—	2.78	27.6	—	—	124.0	1.98
B-2174UDR	UD-26	445–446	CH	Clay 13	Deep Bottom Confining layer	98.7	0.76	2.78	26.2	43.2	8.6	121.5	1.94
B-2174UDR	UD-27	490–492.5	CH	Clay 13	Deep Bottom Confining layer	109.6	—	2.73	20.2	—	—	122.8	1.96
B-2274UD	UD-26	580–582.5	CL	Clay 17	Deep Bottom Confining layer	111.0	—	2.70	17.8	—	—	130.8	2.09

(a) $n = \frac{e}{1+e} \times 100$ (Reference 2.4.12-17)

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

(c) $\gamma_m = \gamma_d \times (1 + \omega / 100)$ (Reference 2.4.12-17)

Abbreviations:

ftbgs = feet below ground surface
USCS = Unified Soil Classification System
pcf = pounds per cubic foot
Data Source: Reference 2.5.4-1 and 2.5.4-2

Table 2.4.12-11
Summary Statistics for Hydrogeologic Properties from Geotechnical Tests

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

Abbreviations:

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

Table 2.4.12-12
Grain-Size Derived Hydraulic Conductivity

Boring	Sample Interval	Geologic Unit	D_{10} (mm)	D_{10} (cm)	Coefficient of Uniformity	K (cm/sec)	K (ft/day)
B-2319	13.5–15	Sand 1	0.1287	0.01287	1.85	6.63×10^{-3}	18.8
B-2359	19.8–21.3	Sand 1	0.1039	0.01039	1.73	4.32×10^{-3}	12.2
B-2359	24.8–26.3	Sand 1	0.1327	0.01327	1.67	7.04×10^{-3}	20.0
B-2304A	38.5–40	Upper	0.1018	0.01018	1.76	4.15×10^{-3}	11.8
B-2320UD	63.5–66	Upper	0.10	0.01	2.08	4.00×10^{-3}	11.3
B-2320	75–76.5	Upper	0.1090	0.0109	2.37	4.75×10^{-3}	13.5
B-2321	78.5–80	Upper	0.1295	0.01295	1.70	6.71×10^{-3}	19.0
B-2174UD	95–96.4	Lower	0.1425	0.01425	2.37	8.12×10^{-3}	23.0
B-2265	98.5–98.9	Lower	0.1620	0.0162	1.73	1.05×10^{-2}	29.8
B-2304	88.5–90	Lower	0.1283	0.01283	2.15	6.58×10^{-3}	18.7
B-2319	90–91.5	Lower	0.1151	0.01151	2.48	5.30×10^{-3}	15.0
B-2319UD	95–97	Lower	0.13	0.013	2.02	6.76×10^{-3}	19.2
B-2319	100–101.5	Lower	0.1434	0.01434	2.91	8.23×10^{-3}	23.3
B-2321UD	93–95.7	Lower	0.13	0.013	2.12	6.76×10^{-3}	19.2
B-2352	73.5–75	Lower	0.1050	0.0105	4.00	4.41×10^{-3}	12.5
B-2359	94.8–96.3	Lower	0.1527	0.01527	2.36	9.33×10^{-3}	26.4
B-2160	168.5–170	Deep	0.1134	0.01134	4.60	5.14×10^{-3}	14.6
B-2170R	153.5–155	Deep	0.1094	0.01094	2.12	4.79×10^{-3}	13.6
B-2304UD	141–143.5	Deep	0.11	0.011	1.87	4.84×10^{-3}	13.7

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

Table 2.4.12-13
Laboratory Hydraulic Conductivity Tests

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

Data Source: Reference 2.5.4-2.
USCS = Unified Soil Classification System (CH = high plasticity clay

Table 2.4.12-14 (Sheet 1 of 2)
VCS Cooling Basin Permeability Values from Borehole Permeameter Tests

Borehole Number	Northing (NAD 83 TXSC)	Easting (NAD 83 TXSC)	Surface Elevation (NAVD 88)	Material Type USCS	Test Elevation (NAVD 88)	Saturated Permeability (cm/s)	Saturated Permeability (ft/d)
B-2309P-U	13405492.3	2600435.2	76.25	SC	71.25	1.0 x 10^{-8}	3.0 x 10^{-5}
B-2309P-L	13405491.6	2600445.1	76.13	SP-SC	66.13	1.44 x 10^{-6}	0.0041
B-2311P-U	13407705.7	2602287.6	75.71	SC	70.71	6.94 x 10^{-8}	0.0002
B-2311P-L	13407703	2602296.9	75.33	CH	65.33	1.0 x 10^{-8}	3.0 x 10^{-5}
B-2312P-U	13410699.8	2604161.2	75.46	SC	70.46	1.76 x 10^{-7}	0.0005
B-2312P-L	13410694.3	2604153.2	75.5	SP-SC	65.5	4.00 x 10^{-5}	0.1134
B-2313P-U	13412117.4	2605610.9	77.88	SC	72.88	1.0 x 10^{-8}	3.0 x 10^{-5}
B-2313P-L	13412115.6	2605606.1	77.97	SC	67.97	2.67 x 10^{-6}	0.0076
B-2314P-U	13413938	2607776.5	75.48	CH	70.48	4.73 x 10^{-6}	0.0134
B-2314P-L	13413940.7	2607782.6	75.42	CH	65.42	1.0 x 10^{-8}	3.0 x 10^{-5}
B-2325P-U	13401288.3	2603699.2	73.79	SP-SC	68.79	1.71 x 10^{-6}	0.0049
B-2325P-L	13401292.3	2603696.5	73.85	SC	63.85	4.20 x 10^{-4}	1.1907
B-2326P-U	13403069.2	2605616.5	70.97	SC	65.97	1.0 x 10^{-8}	3.0 x 10^{-5}
B-2326P-L	13403074.7	2605620.4	70.76	SC	60.76	1.44 x 10^{-6}	0.0041
B-2327P-U	13404711.4	2607393.8	71.24	SC	66.24	1.0 x 10^{-8}	3.0 x 10^{-5}
B-2327P-L	13404712.2	2607384	70.81	SC	60.81	1.60 x 10^{-5}	0.0454
B-2328P-U	13406233.3	2609021.3	68.13	SC	63.13	1.60 x 10^{-5}	0.0454
B-2328P-L	13406222.9	2609021.2	68.42	SP-SC	58.42	9.70 x 10^{-4}	2.7500
B-2329P-U	13407878	2610791.9	68.07	SC	63.07	1.0 x 10^{-8}	3.0 x 10^{-5}
B-2329P-L	13407871.4	2610784.7	68.06	SC	58.06	1.0 x 10^{-8}	3.0 x 10^{-5}
B-2330P-U	13410096.3	2613184	67.89	CH	62.89	1.88 x 10^{-6}	0.0053
B-2330P-L	13410088.7	2613185	68.18	SC	58.18	5.37 x 10^{-7}	0.0015
B-2339P-U	13399916.5	2608670.1	68.75	CH	63.75	1.99 x 10^{-6}	0.00564
B-2339P-L	13399911.2	2608674.7	68.63	CH	58.63	2.40 x 10^{-5}	0.06804
B-2341P-U	13401608.5	2610954.3	65.22	CH	60.22	2.70 x 10^{-6}	0.0077

Table 2.4.12-14 (Sheet 2 of 2)
VCS Cooling Basin Permeability Values from Borehole Permeameter Tests

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

USCS is the Unified Soil Classification System:

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

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

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

Table 2.4.12-15 (Sheet 1 of 2)
Regional Hydrogeochemical Data

Sample Location	Sample Date	Sample Depth (ft bgs)	Unit	pH (standard units)	Specific Conductance (µmhos/cm)	Total Dissolved Solids (mg/L)	Total Hardness (mg/L as CaCO3)	Total Fe (mg/L)	Gross Alpha (pCi/L)	Gross Beta (pCi/L)	ORP (mV)	Temperature (°C)
National Primary DWS	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**15**	**—**	**—**	**—**
National Secondary DWS	**—**	**—**	**—**	**6.5–8.5**	**—**	**500**	**—**	**—**	**—**	**—**	**—**	**—**
7924601	4/11/2001	40	Lissie	6.75	1646	**913**	401	1.36	1.8 ± 1.7	4.9 ± 2.6	NA	22.2
7924601	3/30/2005	40	Lissie	NA	2150	**1217**	501	2.09	2.1 ± 4.6	1.9 ± 4.2	NA	22.4
7924901	2/5/1959	90	Lissie	7.8	967	**560**	294	NA	NA	NA	NA	NA
7924901	6/28/1979	90	Lissie	8.2	987	**560**	306	NA	NA	NA	NA	NA
7924901	8/25/1983	90	Lissie	8.3	1072	**584**	286	NA	NA	NA	NA	NA
7924902	3/26/1997	125	Lissie	7.2	918	**531**	293	NA	NA	NA	57.5	22.8
7924902	4/11/2001	125	Lissie	6.91	1016	**572**	286	NA	2.6 ± 1.6	4.1 ± 2.7	NA	23.2
7924902	3/22/2005	125	Lissie	NA	994	**575**	292	NA	4.8 ± 3.2	10 ± 2	NA	23.2
7924904	2/4/1959	254	Chicot	7.2	2050	**1113**	597	NA	NA	NA	NA	NA
7932101	5/16/1969	250	Lissie	7.5	1848	**899**	541	NA	NA	NA	NA	NA
7932101	8/16/1975	250	Lissie	7.7	1823	**904**	529	NA	NA	NA	NA	NA
7932101	6/28/1979	250	Lissie	7.8	1573	**782**	399	NA	NA	NA	NA	NA
7932103	3/26/1997	142	Lissie	7.09	1750	**1088**	493	NA	NA	NA	52.2	23.3
7932103	4/11/2001	142	Lissie	6.77	1940	**1107**	451	NA	4.5 ± 2.7	6.3 ± 3.9	NA	23.2
7932403	4/20/1992	150	Chicot	6.51	1579	**936**	545	0.025	4.8 ± 2.2	9.6 ± 2.1	53.3	23.6
7932404	2/4/1959	100	Chicot	7.4	1430	**753**	429	NA	NA	NA	NA	NA
7932602	4/28/1959	595	Lissie	7.9	1940	**1064**	57	NA	NA	NA	NA	NA
7932602	4/14/1971	595	Lissie	7.6	2058	**1040**	56	NA	NA	NA	NA	NA
8017501	8/25/1983	1026	Goliad	**8.6**	1430	**733**	44	NA	NA	NA	NA	NA
8017503	5/31/1949	1062	Evangeline	7.8	NA	**718**	120	NA	<4.0	4.6 ± 2.6	–165.3	28.3
8017503	4/22/1992	1062	Evangeline	7.63	1265	**725**	126	NA	NA	NA	NA	NA
8017504	5/12/1949	1059	Evangeline	7.7	NA	**700**	126	NA	NA	NA	NA	NA
8017506	7/30/1965	420	Evangeline	7.81	1050	**591**	131	0.02	NA	NA	NA	NA
8017511	5/12/1949	1130	Evangeline	7.7	NA	**700**	126	NA	NA	NA	NA	NA
8017902	1/29/1959	500	Gulf Coast	7.5	1640	**898**	164	NA	NA	NA	NA	NA
8017904	7/22/1981	1001	Gulf Coast	8.5	1591	**832**	132	NA	NA	NA	NA	NA
8017904	8/25/1983	1001	Gulf Coast	8.2	1584	**827**	129	NA	NA	NA	NA	NA
8017905	6/4/1981	1010	Evangeline	7.93	1240	**843**	132	NA	NA	NA	NA	NA
8017905	4/22/1992	1010	Evangeline	7.69	1489	**856**	115	0.138	<4	6.3 ± 2.9	–219.4	29.7
8017905	3/26/1997	1010	Evangeline	7.56	1403	**823**	113	0.098	NA	NA	–98	29.3
8017905	3/29/2005	1010	Evangeline	NA	1538	**830**	117	0.135	7.4 ± 4.7	6.4 ± 2.7	NA	29.3
San Antonio River (USGS 08188570)	12/19/2006	0	—	8.1	1310	**740**	350	NA	NA	NA	NA	20
Guadalupe River (USGS 08176500)	3/25/1994	0	—	8.1	579	339	240	0.008	NA	NA	NA	22.5

Table 2.4.12-15 (Sheet 2 of 2)
Regional Hydrogeochemical Data

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

Source: References 2.4.12-10
Abbreviations:
— = Not Applicable
DWS = Drinking Water Standard
NA = Not Analyzed
Bold values exceed National Primary or Secondary DWS (Reference 2.4.12-20)

Table 2.4.12-16 (Sheet 1 of 2)
VCS Site Hydrogeochemical Data

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

Table 2.4.12-16 (Sheet 2 of 2)
VCS Site Hydrogeochemical Data

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

(a) Calculated from Table 2.4.12-1 by the following equation: (Top of screen — Bottom of Screen)/2.

(b) Abbreviations:
— = Not Applicable
B = Estimated result. Result is less than the reporting limit.
DWS = Drinking Water Standard
E = Matrix interference
N = Spiked analyte recovery is outside stated control limits. Method performance confirmed using Laboratory Control Spike sample results.
NA = Not Analyzed
Bold values exceed National Primary or Secondary DWS (Reference 2.4.12-20)

Table 2.4.12-17
Estimated Cooling Basin Seepage

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

(RED) numbers indicate flow out of the model or base flow to creeks and rivers.
BLUE numbers indicate flow into the model — surface water inflow to groundwater.
Rates rounded to the nearest 10 gpm.

(a) “+” indicates an increase in flow from pre- to post-construction conditions and a “–“ indicates a decrease.

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

Table 2.4.12-18
Summary of Locations Where Confining Layers are Absent

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