3.6 WATER RESOURCES

This section assesses potential impacts on water resources associated with the proposed new and expansion SPR sites and their associated infrastructure. These resources include both surface and groundwater. For this section, floodplains are considered surface water resources, but wetlands and aquatic organisms are not. Those are addressed in Section 3.7 Biological Resources.

Section 3.6.1 Methodology describes the approach used to evaluate existing conditions and potential impacts associated with the proposed new and expansion SPR sites. Section 3.6.2 discusses the general impacts associated with construction and operations and maintenance at many or all of the SPR storage sites and associated infrastructure. Potential impacts DOE has judged to be minor across all alternatives in this section are not evaluated further. Sites with unique features and the potential for unique impacts are discussed in site-specific sections. Section 3.6.2 references the best management practices presented in Chapter 2 and indicates how those practices would reduce potential impacts.

Sections 3.6.3 through 3.6.10 address each proposed new and expansion site and the no action alternative separately, describing existing water resources that could be affected by the proposed action and potential impacts that warrant site-specific discussion.

3.6.1 Methodology

3.6.1.1 Surface Water

DOE identified and characterized the existing conditions of surface water bodies in all potentially affected areas. Sources of information consulted by DOE include the following: 305(b) reports, 303(d) lists of impaired waters, Louisiana's Title 33 Environmental Regulatory Code, various documents and information from the U.S. Geological Survey's (USGS) Water Resources of the United States Web site (USGS 2006a), EPA's Surf Your Watershed (EPA 2006i) and EnviroMapper (EPA 2006b) databases, and various state agency representatives. DOE identified surface water bodies that could be affected by a proposed SPR because they would:

- Serve as raw water source;
- Be crossed by pipelines, roads, and other utilities;
- Receive brine discharge; or
- Lay in or are directly downgradient of construction and storage sites.

These water bodies generally were characterized by size; relative flow rates; locations; salinity; known uses; and special designations such as scenic rivers, public water supplies, and impaired waters. DOE identified only the major surface water bodies associated with the proposed alternatives. After a preferred alternative is selected, DOE would conduct a delineation of waters of the United States and navigable waterways and secure a jurisdictional determination from USACE and U.S. Coast Guard.

After identifying potentially affected water resources, DOE assessed the proposed activities associated with the construction and operations and maintenance of each proposed site and the potential effect and degree of risk each activity might have on water resources. DOE considered the characteristics of the affected water resources, in particular the capacity of these water resources to assimilate impacts.

To assess the potential impacts resulting from brine disposal in the Gulf of Mexico, DOE conducted a detailed modeling analysis based on empirical (field) data collected from the brine diffuser at Big Hill, Bryan Mound, and the former brine diffuser at West Hackberry. The analysis was then applied to each proposed new and expansion site to evaluate potential impacts. This analysis was able to project the likely increase in salinity levels in the water column, vertical and horizontal extent of the brine plume, and salinity concentration contours as a function of distance from the brine disposal site. The predictions for potential impacts are for a reasonably conservative set of circumstances that are likely to overestimate the extent of the brine plume in most cases.

The report summarizing these modeling results is included in appendix C of this EIS.

DOE also evaluated the extent of proposed new construction in floodplains and whether the proposed alternatives would comply with Executive Order 11988, Floodplain Management. Sections 3.6.2 through 3.6.9 address this information for each site. DOE prepared a detailed Floodplain Assessment and Finding (appendix B) in accordance with Executive Order 11988.

The floodplain calculations summarized in this EIS and the floodplain assessment include all floodplain areas (100-year and 500-year) located within each expansion site, ancillary facilities (tank farms), and all associated ROWs (brine/water lines, oil lines, power lines, and access roads).

The Gulf Coast area of all the proposed sites—except Richton and Bruinsburg—is subject to the effects of hurricanes and associated tidal surges. Hurricanes Katrina and Rita (fall, 2005) demonstrated these effects. The evaluation of water resources in this EIS is based on surface water data gathered before Hurricanes Katrina and Rita struck and field visit observations made after the hurricanes' impacts were rendered. Although the sites (except Richton and Bruinsburg) likely were affected by the tidal surge and an influx of increased salinity, field observations indicate that surface water channel geometries from before the hurricanes remained intact and flood waters receded. The impacts of the hurricanes on salinity and other water quality parameters are not fully understood, and such an analysis is beyond the scope of this report.

Table 3.6.1-1 lists potential impacts evaluated for different components of the proposed actions that are discussed in this section.

Table 3.6.1-1: Types of Surface Water Impacts Analyzed

Source of Construction or Operations and Maintenance Impact	Potential Surface Water Impacts Analyzed
Construction of pipeline, road, utility, and RWI intake structure across and in surface water bodies	Increase in suspended sediments; Change of streambed morphology (causes **headcutting**); Change in flow and salinity regimes caused by berming and channeling
Raw water withdrawal from surface water bodies	Reduction of surface water flow rates, volume, and levels
Brine disposal in the Gulf of Mexico	Increased salinity
Introduction of potential for oil spills	Contamination of water with oil and oil-degradation products
Introduction of potential for brine spills	Increased salinity of receiving water
Introduction of potential spills and routine use of other materials such as fuels, maintenance fluids, and pesticides onsite, with possible runoff to surface waters or infiltration to groundwaters[a]	Contamination of receiving water[a]
Construction in floodplains	Loss of hydraulic flood storage and effect on base flood elevation
Location of RWI and brine diffuser structure	Impeded navigation
Construction in upland areas	Runoff resulting in siltation and sedimentation in surface water bodies

Table 3.6.1-1: Types of Surface Water Impacts Analyzed

Source of Construction or Operations and Maintenance Impact	Potential Surface Water Impacts Analyzed
Introduction of wastewater treatment plant discharges and spills	Contamination of receiving water
Non-point source surface water runoff	Contamination of receiving water
Provision of potable, sanitary, and cleaning water to site	Strain on source water resources

[a] Analysis presented in section 3.2

3.6.1.2 Groundwater

DOE characterized potentially affected groundwater resources by defining the depths, characteristics, uses, and designations of aquifers below and adjacent to the proposed sites. DOE specifically characterized groundwater use by identifying public and private wells listed in available public records, along with available information on delineated groundwater management districts and sole-source aquifers. Information sources consulted by DOE included the following: GIS layers obtained from the state environmental agencies showing SWPAs; USGS and EPA Web sites containing information on target aquifers; EPA's Sole Source Aquifer Database; and state agency representatives and Web sites. The information gathered is provided in sections 3.6.2 through 3.6.9 for each site.

DOE then evaluated potential sources and scenarios that could affect the identified groundwater resources. The probability of impacts was evaluated for the types of impact sources, the nature of potentially affected aquifers, and the uses of aquifers. From there, DOE evaluated the significance of the potential impact based on the regional and local context and intensity. Table 3.6.1-2 lists the different potential groundwater impacts evaluated, most of which are common to most or all of the sites, and most have the potential for only minor impacts on groundwater or they pose a low risk for groundwater impacts. These potential impacts are discussed in the following sections.

Table 3.6.1-2: Types of Groundwater Impacts Analyzed

Source of Construction or Operations and Maintenance Impact	Potential Groundwater Impacts Analyzed
Brine discharges from pipelines (surface) or leakage through the brine wells set in the cavern (subsurface)	Increased salinity of groundwater
Disposal of brine via injection into deep aquifers	Increased salinity of groundwater quality in injection zones and overlying aquifers
Leakage from oil storage caverns (subsurface)	Contamination of groundwater with oil
Leakage from oil pipelines (surface)	Contamination of groundwater with oil
Accidental discharge of fuel, maintenance fluids, pesticides, and herbicides (surface) [a]	Contamination of groundwater[a]

[a] Analysis presented in section 3.2

3.6.2 Impacts Common to Multiple Sites

The following sections describe and evaluate the types of potential impacts to water resources that are generally common to all of the proposed sites. In sections 3.6.2 through 3.6.9, DOE evaluates further the significance of potential impacts for particular sites. In addition, because underground injection of brine is proposed only at Bruinsburg, Bayou Choctaw, and West Hackberry, those potential impacts are not included in this general discussion, but rather are addressed in the site-specific sections.

3.6.2.1 Surface Water Common Impacts

3.6.2.1.1 Impacts of Raw Water Withdrawal from Surface Water

The proposed facilities would withdraw water from surface water bodies for use in cavern solution mining during the construction period. Cavern solution mining would continue for up to 5 years at each site where new caverns would be developed. As part of continuing operations, raw water would be withdrawn for displacement of oil in the caverns during oil drawdown. The potential impacts of raw water withdrawal on surface water bodies are specific to the characteristics of each water body, particularly the channel geometry, water levels, and flow rates at and near the RWI point.

Two of the proposed new sites and two expansion sites (Chacahoula, Stratton Ridge, Big Hill, and West Hackberry, respectively) would withdraw raw water from the ICW. The ICW channel geometry is similar for the proposed RWI points at the four sites. USACE maintains the ICW at 12-feet (3.7 meters) deep at mean low tide, and 130-feet (38-meters) wide at channel bottom (USACE 2005a). Previous modeling of the potential impacts of SPR RWI from the ICW (e.g., for the Big Hill site, DOE 1981, appendix B) indicates that changes to water depth caused by the RWI would be several hundredths of a foot (less than 1.5 centimeters). Water depth change would be greatest at the intake point, decreasing with distance from the intake point. This change in water depth is small compared to daily tidal depth fluctuations of 1.0 foot (30 centimeters) or more in many parts of the ICW. Changes to flow velocities associated with RWI would be several hundredths of a foot per second (several hundredths of a kilometer per hour)—again insignificant in comparison to baseline flow rates. Impacts on water salinity would be highly specific to the affected water body. In the case of the proposed Big Hill site, water salinities at all modeled locations would be expected to change by less than 1 part per thousand because of RWI, compared to natural salinity fluctuations of 1 to 10 parts per thousand (DOE 1981, appendix B). The cited Big Hill modeling effort assumed a water withdrawal rate of 1.4 MMBD, which is significantly higher than the rate proposed at any of the SPR expansion facilities other than Big Hill. Thus, impacts predicted for water withdrawal at Big Hill would be greater than could be expected at any of the proposed expansion sites that would withdraw water from the ICW.

DOE would secure from USACE the necessary permits for the RWI structures and withdrawal (Section 404 permit) and a water quality certificate or Section 401 permit from the state. DOE would comply with any withdrawal limitations or minimum in-stream flow conditions imposed by these agencies.

The three remaining proposed sites (Bruinsburg, Richton, and Bayou Choctaw) would withdraw raw water from surface water bodies other than the ICW. The potential impacts associated with raw water withdrawal at these sites are discussed in the site-specific sections to provide more details.

> Mitigation: No mitigation measures are identified for the sites that would withdraw water from the ICW. For those sites that would withdraw water from other surface water bodies, possible mitigation measures are identified in the Richton site-specific section only.

3.6.2.1.2 Impacts of Brine Disposal in the Gulf of Mexico

Brine from the leaching of the salt caverns or from filling caverns with oil would be discharged into the Gulf of Mexico from all sites except Bruinsburg, Bayou Choctaw, and West Hackberry, where brine would be injected into deep subsurface aquifers via injection wells. Brine would be generated during the cavern development process, which would be expected to last for 4 to 5 years. After that, brine would be generated during cavern filling events or drawdown. The primary surface water impact associated with brine disposal in the Gulf of Mexico would be elevated salinity levels in the water column near the diffuser site.

DOE estimated potential salinity impacts to water from the brine diffuser discharge using a model based on empirical data from operating and formerly operating SPR diffusers. Model results are included in appendix C and are discussed below and in the site-specific sections.

All the proposed brine diffuser locations would be in waters of similar depths (about 30 to 50 feet [9 to 15 meters]) along the coastline. The depth of the diffuser and its placement just above the bottom sediments would ensure that the diffuser does not affect navigation. The bottom of the Gulf of Mexico slopes gently seaward at all the proposed locations except for Chacahoula. The diffuser for Chacahoula is situated near the base of Ship Shoal, where the bottom rises steeply about 10 feet (3.1 meters) onto the shoal. This situation will be discussed in the Chacahoula site-specific section. Salinities in coastal Gulf of Mexico fluctuate, primarily because of varying inputs of fresh water from the Mississippi River. Salinity data relevant to the brine discharge sites are discussed below.

Brine is denser than seawater. After it is discharged through the diffusers, it would mix due to the high velocity of discharge, and the resultant diluted brine would sink to the bottom of the water column; therefore, the bottom current velocity is an important determinant of the dissemination and resultant extent of the brine plume. Based on a review of available oceanographic data, a bottom current velocity of 9 centimeters per second (212 inches per minute) was selected as representative of typical conditions (see appendix C). Table 3.6.2-1 summarizes brine diffusion modeling results for typical conditions. In general, modeling results indicate that the maximum increase in salinity under typical conditions would be 4.3 parts per thousand, which could extend a maximum of 0.8 nautical miles (0.92 mile [1.5 kilometers]) from the diffuser location. Salinity increases of up to 1 part per thousand could extend as far as 1.9 nautical miles (2.2 miles [3.5 kilometers]) from the diffuser under such conditions.

Table 3.6.2-1: Estimated Extent of Brine Plumes Caused by Brine Disposal in the Gulf of Mexico

Site[a]	Projected Distance of Salinity Increases in the Gulf of Mexico
New Sites	
Chacahoula, LA	See site-specific discussion, section 3.6.4
Richton, MS	Increase of 1 ppt salinity out to 1.7 nautical miles from the diffuser Increase of 4 ppt salinity out to 0.70 nautical miles from the diffuser
Stratton Ridge, TX	Increase of 1 ppt salinity out to 1.8 nautical miles from the diffuser Increase of 4 ppt salinity out to 0.80 nautical miles from the diffuser
Expansion Sites	
Big Hill, TX	Increase of 1 ppt salinity out to 1.9 nautical miles from the diffuser Increase of 4 ppt salinity out to 0.80 nautical miles from the diffuser

Notes:

[a] Bruinsburg, Bayou Choctaw, and West Hackberry would dispose of brine by underground injection, not Gulf discharge

[b] ppt = parts per thousand

Nautical mile = 1.15 miles and 1.85 kilometers

Because the brine diffusers for each of the SPR sites would be located at similar water depths along the Gulf of Mexico coastline, data collected from active and formerly active SPR brine discharge locations are considered to be representative of baseline conditions at the other proposed brine discharge sites. Based on seasonal bottom current data from the Big Hill diffuser site, the lowest current velocities (which result in higher salinity plumes) occur in late spring and summer (appendix C, tables C.3-1 and C.3-2). Salinities measured at the Clovelly LOOP brine diffuser stations did not indicate a seasonal trend in salinity concentrations of receiving waters (35 to 36 parts per thousand in June; 28 to 30 parts per thousand in August; and 31 to 32 parts per thousand in November) (Barry A. Vittor & Associates 2002, p. v). The maximum increase in salinity of 4.3 parts per thousand indicated by the model would typically be within normal seasonal variability. It is unclear if low current velocities and high ambient bottom salinities would occur at the same time of the year, which could result in 4.3 parts per thousand salinity above the normal maximum salinity. The potential impacts of increased salinity on biota are evaluated in section 3.7 where biological resources are discussed.

DOE evaluated uncertainties associated with the modeling results and determined that they are unlikely to substantially affect the model outcome or impact analysis. Bottom current velocity and the rate of brine discharge are important determinants on how much salinity concentrations would increase in surrounding water, and both of these factors are realistically accounted for in the model. DOE would not discharge below the rate used in the model (30 feet [9.2 meters] per second). Thus, model results reflect the minimum allowable discharge rate. Discharge rates exceeding 30 feet per second would more readily disperse the brine into the water column and reduce the size of the brine plume. The model was run for the two most prevalent bottom current directions, which are primarily parallel to the shoreline (long-shore currents). Although field data indicate that currents in all directions do occur in this area, net transport would be roughly longshore. The modeling results shown in appendix C present the results when the currents remain constant. This presentation does not show the impacts during transient conditions, such as reversing currents that could increase salinities but would reduce the extent of the plume estimated by the model. The effect of a hurricane, which brings large volumes of water to the shoreline, would be to further dilute the brine plume, and would not result in higher salinities than those forecasted by the model.

NPDES permits would be required for any discharges to surface waters, including the Gulf of Mexico. The permitting process would require that the CORMIX model be used to analyze the potential impacts of the discharge on surrounding waters before a permit is issued. Since this would be done before operation of the brine diffuser, the potential impacts to Gulf of Mexico waters would be analyzed further than that presented in this EIS as a further precaution against adverse impacts to surface waters and biota. In addition, a Section 404/401 permit and possibly a Section 10 permit would be obtained from USACE and the state for the construction of the diffuser and brine diffuser pipeline. As with permits for existing SPR sites, the permits for the new and expansion sites would require that effluent meet certain requirements protective of water quality and biota, and they would also mandate an ongoing monitoring and reporting program to document that the discharge would meet those requirements. Monitoring program results from the Bryan Mound and Big Hill operating SPR brine discharge locations in the Gulf of Mexico are reported in Annual Environmental Reports issued by DOE and in the Discharge Monitoring Reports provided to the state under the NPDES permit. Review of the most current report available (2003) indicates that discharge water quality is consistently within permit requirements (DOE 2004f).

> Mitigation: Because of its unique location in proximity to a shoal area (Ship Shoal), the Chacahoula brine diffuser site and associated brine discharge are discussed in the site-specific section. Mitigation measures specific to that site are identified in that section.

3.6.2.1.3 Impacts Associated with Constructing Pipelines Across Surface Water Bodies

Development of the SPR expansion sites would entail construction of new offsite pipelines associated with all sites except the West Hackberry site, which would use existing pipelines. The new pipelines would cross a variety of water bodies, including intermittent, small, moderate-sized, and larger streams and rivers, and manmade canals including the ICW. These water bodies range from fresh to brackish to saline, with increasing salinity and tidal influence closer to the coastline.

The potential impacts to surface water bodies associated with the construction of pipeline crossings would depend on the construction methods used. Two methods are proposed for crossing streams and rivers: open cut and directional drilling. These methods are described in section 2.3.9; the potential impacts associated with these methods are summarized below.

Directional Drilling: This method would have the least impact on surface water bodies because it involves boring and placing the pipeline underneath the channel. This approach would not entail significant disturbance of water body banks, the water column, or streambeds or bottoms of water bodies. There would be a potential for some bank erosion and delivery of sediment to water bodies in cases where drilling equipment is setup close to water bodies. This would be controlled and effectively reduced through best management practices required by the Erosion and Sediment Control Plan, the Section 404/401 permit, the Section 10 permit, and the NPDES stormwater permit for construction activities. The best management practices would include erosion and runoff control measures, and construction of barriers to sediment movement. Any impacts to surface waters would be small in scale, of short duration, and localized near the drill equipment location.

Open Cut: This method could potentially result in the following conditions:

- A temporary increase in turbidity in the water column resulting from disturbance of bottom sediments and the introduction of sediment in runoff;
- A temporary increase in suspended nutrients and organic matter resulting from disturbance of bottom sediments and the introduction of sediment in runoff; also could lead indirectly to reduced dissolved oxygen levels in the water column;
- Deposition of sediment in water bodies, which could disrupt habitat, lead to reduced channel depth, and cause other changes in stream processes;
- Headcutting, a process of streambed degradation triggered by a disturbance of loose streambed substrate; could lead to the collapse of stream banks, loss of streamside vegetation, and widening of streams; and
- Saltwater intrusion or disruption of salinity regimes where pipeline installation between surface water bodies could open new channels for flow.

Open cut installation of pipelines across surface water bodies could lead to impacts related to resuspension of bottom sediments and organic matter in the water column, which would be of short duration and occur during actual construction activity and extending for a short time after construction activity ended. In water bodies that have no or low current, these impacts would be localized near the construction sites, and would be relatively intense for brief periods. In water bodies with stronger currents, impacts would extend for some distance down current. In such systems, impacts in the water column would be less intense because of flushing and dilution action. DOE would implement construction best management practices to minimize the impacts of open cut pipeline construction through surface water bodies. Some of these best management practices would be required by several regulatory and permit requirements. Specifically, all work would be done in accordance with DOE-prepared Soil Erosion and Sediment Control Plans; Erosion Control, Revegetation and Maintenance Plan; Erosion and Sediment Control permits; NPDES stormwater permit for construction activities; Section 10 permit; and USACE Section 404 permit and 40l Water Quality Certification from the state.

Best management practices could include site-specific runoff controls, installation of geotextiles, use of silt curtains and temporary coffer dams and other methods that minimize suspension of bottom sediments, all of which would be required as part of the state and Federal permits. Such plans would minimize sediment suspension and siltation and channel-filling impacts. As a result of these measures, little or no sediment would be introduced to water bodies from adjacent land areas. In addition, associated secondary impacts such as reduction in stream depth and changes in other stream processes would not be expected to occur.

Headcutting would be a potential impact following pipeline installation in streams with significant current that have streambeds composed of sandy or unconsolidated substrate. Streams in the coastal regions of Mississippi and Louisiana are particularly vulnerable to headcutting following disturbance of streambeds. As headcuts move progressively upstream, they can result in alteration of streambed grade, collapse of stream banks, loss of streamside vegetation, and widening and lateral movement of stream beds. Progressing headcuts cause re-entrainment of sediment and turbidity in the downstream water column. DOE would minimize the potential for headcutting by restoring streambeds to natural contours, stabilizing and revegetating the slope after installation of pipeline crossings, and minimizing or avoiding to the extent possible any permanent alteration in streambed grade at pipeline crossings. Strict compliance with the Erosion and Sediment Control Plan, NPDES stormwater permit for construction activity, and the Section 404/401 permit would reduce the potential for headcutting.

Transport of water from higher salinity to lower salinity regimes could occur where trenches are excavated to install pipelines between surface water bodies. To minimize saltwater intrusion along a pipeline, DOE would install clay plugs at periodic intervals in pipeline trenches during construction. After pipeline installation, DOE would backfill pipeline trenches with sufficient native topsoil to restore surface topography and vegetation and prevent water channeling.

> Mitigation: In addition to the above best management practices, DOE would consider several site-specific mitigation measures to prevent or minimize headcutting and the associated impacts to stream morphology and water quality. Although current plans call for the application of directional drilling only for larger streams (i.e., those wider than 100 feet [31 meters]) and for streams parallel and adjacent to other structures requiring directional drilling—such as highways, railroads, and other pipelines, DOE also would consider the use of directional drilling for installation of pipeline under other streams that are particularly vulnerable to headcutting. This would include unstable streams in the Mississippi and Louisiana coastal zones that have experienced headcutting, streams with moderate to strong currents, and streambeds composed of sand or unconsolidated substrate. DOE would also consider instituting a monitoring program for streams where the open cut method would be used to ascertain if headcutting has started. If headcutting were to occur in these streams, DOE would consider application of remedial measures such as streambed grade stabilization structures.

3.6.2.1.4 Impacts from Erosion and Runoff from Construction Activities

Some construction would take place in upland areas at the storage sites (e.g., Richton and Bruinsburg), at the crude oil storage tank facilities and crude oil terminals, and for some segments of the pipelines, access roads and transmission line ROWs. If there is a downslope water body, construction activities could produce runoff to the surface water that could degrade water quality. As described in Chapter 2, best management practices, such as the use of geotextiles, hay bales, and riprap to impede runoff, would help minimize erosion and prevent sediment runoff in these areas. These measures would effectively control sediment transport offsite, largely preventing sedimentation in any adjoining water bodies. Particular attention would be given to spoils storage areas, where sediment could run off and affect nearby surface waters. Because of the best management practices and sediment and erosion controls that would be implemented, sediment releases to surface waters would be expected to be minimal to none.

Any release of sediment to local water bodies would be expected to occur during heavy precipitation when flushing and assimilative capacity in these water bodies would be at a maximum. The potential impacts of sedimentation to surface water bodies include increased turbidity in the water column; increased suspended nutrients and organic matter in the water column leading indirectly to a reduction in dissolved oxygen levels; and deposition of sediment on water body beds, which could disrupt habitat, cause reduced channel depth, and cause other changes in stream processes. As described above, because the amount of sediment reaching water bodies is projected to be very low or none, any appreciable impacts within surface water bodies would be minor, localized and short-term.

3.6.2.1.5 Impacts of Oil Spills to Surface Water

Oil spills associated with the proposed SPR facilities could occur at storage facilities, along oil pipeline routes, and at oil transfer terminals. Oil released through oil spills could enter any of the water bodies identified in the site-specific sections, which would be near SPR expansion sites or oil transfer terminals, or crossed by oil pipelines. These water bodies include intermittent, small, moderate-sized, and larger streams and rivers, manmade canals (including the ICW), tidal rivers, estuaries, and the Gulf of Mexico.

If oil spills were to occur, measures outlined in facility Emergency Response Procedures would help minimize the impacts to surface waters. Each existing SPR site complies with Federal Spill, Prevention, Control, and Countermeasures (SPCC) regulations, and with applicable Louisiana, Mississippi and Texas SPCC regulations. This includes development of and compliance with plans to prevent and contain petroleum and hazardous substance spills. SPR sites maintain spill plans in accordance with Title 40 CFR 112 and corresponding state regulations (DOE 2004f). The proposed new and expansion sites would comply with these same regulations, and would maintain appropriate spill prevention and response plans.

Section 2.3 identifies the control measures that would be used to minimize the likelihood of oil spills, and the likelihood that these spills would reach surface waters. These measures include the construction of containment systems to prevent release of oil to surface waters. For example, a dike would be built surrounding the wellhead area at each cavern to contain and control spills that might result from a manifold failure or blowout, and surrounding crude oil storage tanks as well to contain any oil leaked from these tanks. Pipelines would be protected by corrosion-control coating and monitored with pressure gauges and volume meters to rapidly detect any leaks, and systems would be in place to rapidly stop the flow of oil to any leak points.

Spill prevention and response measures that would be implemented include quickly-deployed spill control systems such as booms and absorbent materials. DOE also would contract with an emergency response company that could respond to a spill with additional equipment and response personnel beyond those available to DOE.

These various measures described above would greatly reduce the probability of oil spills, as well as the magnitude of potential consequences.

Section 3.2.1.1 presents the historical rate of oil spills from all components of oil handling facilities associated with SPR sites (the storage sites themselves, oil transport vessels, pipelines, and terminal facilities). Section 3.2.2.1 also quantifies the risk associated with oil spills at each proposed SPR site and associated infrastructure. Based on the historic performance of SPR facilities, DOE projects that a small number of oil spills would occur at each of the proposed new and expansion sites. Section 3.2.2.1 (table 3.2.1.1-1) provides a projection of the likely number of reportable oil spills that could occur at each site during initial fill operations. During any drawdown and refill operations in later years, the overall potential for spills would be proportional to the amount of oil drawn down and replaced. A total drawdown and total refilling of the site would be an extreme case for a single year's activity, and therefore, the values in table 3.2.1.1-1 represent a reasonable upper bound of the number of oil spills anticipated during any year of SPR storage-site operation.

Most of these spills would be expected at the storage sites, with a smaller number of spills at the associated terminals. Because of the spill prevention and response measures described earlier, and based on historic performance statistics, most of the oil spills would be of low volume. The probability of higher-volume spills is very low.

If spilled oil were to reach surface water bodies, impacts on surface water resources would vary, depending on the amount of oil introduced to the water body and the characteristics of the water body. These potential impacts are described in section 3.2.2.1 and include the coating of vegetation and existing features that contact the water surface in the area of the oil slick; the release of volatile and sometimes toxic oil components to the atmosphere; the breakdown and dissolution of oil components, some of which may be toxic, into the water column (particularly in the case where oil dispersant chemicals are used); and the deposition of oil emulsions, partially oxidized oil tar globules, and other dense oil constituents on the water body bottom. Oil components deposited on the water body bottom and left adhering to vegetation could remain in the environment for extended periods (months or years), and continue to break down gradually and release low levels of oil constituents to the water column and sediments.

Elevated concentrations of oil constituents occurring in the water column and on the water surface immediately after a spill would decrease over time because of dispersion, dilution, and degradation. The rate of concentration decline would depend on the size and flushing rate of the water body affected, as discussed below.

Low-Energy Water Bodies

Impacts of oil spills would be pronounced in smaller, low-energy water bodies, such as ponds or slow-moving creeks through marshlands, where little dispersion or dilution could take place, and the effects of any uncontained oil would be concentrated in a small area. In a marshy area with high levels of turbidity and organics in the water column, the oil would adhere to some of these particulates, which would increase the residence time of the contamination. However, these types of water bodies also have high levels of microbes that may aid in degradation of the spilled petroleum compounds.

Higher Energy Water Bodies

Oil released to streams and rivers with strong flow or tidal flushing, or into larger open bodies of water such as the Gulf of Mexico, would disperse more rapidly, resulting in milder impacts over a wider area. River currents would spread contamination downstream, resulting in decreasing concentrations. Over open water, wind would also facilitate mixing and dispersion.

Although the consequences of a very high-volume spill could be substantial, the probability of such a spill is very low, as demonstrated by the quantitative analysis discussed above and in section 3.2. The consequences to water resources of the more likely low-volume spills would be expected to be minimal. The overall risk to water resources associated with oil spills from the proposed SPR sites and infrastructure would be low.

> Mitigation: In addition to control measures, best management practices, and emergency response preparations described earlier, DOE would give preference to oil-spill response measures that remove oil from the environment, and would avoid the use of chemical dispersants. Dispersants would be considered only in cases where their use would clearly result in reduced environmental impacts.

3.6.2.1.6 Impacts of Brine Spills to Surface Water

Accidental brine discharge could potentially occur along the brine pipelines, at the brine ponds located at the salt cavern sites, and at brine pumping facilities at SPR sites. Analysis of the causes of brine spills during the 22-year history of SPR operation (see section 3.2.2.1) indicates that spills typically were caused by corrosion or erosion of piping, equipment failure, operator error, and overtopping of brine ponds during periods of heavy precipitation. Brine released through brine spills could enter any of the surface water bodies identified in the following site-specific sections, which would be near brine-pumping facilities or brine ponds onsite, or would be crossed by brine pipelines. These water bodies include intermittent, small, moderate-sized, and larger streams and rivers, manmade canals (including the ICW), tidal rivers, estuaries, and the Gulf of Mexico.

Section 2.3.3 presents the control measures that would be used to minimize the likelihood of brine spills and the likelihood that these spills would reach surface waters. Measures to prevent leaks from brine ponds would include high-density polyethylene liners or concrete, underdrain systems to detect leakage, regular inspection and maintenance programs, and sufficient freeboard in ponds to prevent overflow. Brine pipelines would be concrete-lined to limit erosion and corrosion and would be pressure-tested to check integrity. Brine would be treated with ammonium bisulfite, which scavenges dissolved oxygen and reduces pipeline corrosion. Engineering controls and monitoring would allow rapid detection of leaks, and systems would be installed to quickly stop the pumping of brine if a leak occurred. These measures would reduce the likelihood of occurrence and limit the volume of brine spills.

Section 3.2.1.2 presents data for historical brine spills from the existing SPR sites, including the number of reportable spills per year and the total volume of brine spills per year. Section 3.2.1.2 also analyzes the risk of brine spills associated with each proposed SPR site.

As discussed in section 3.2.2.1, the immediate effect a brine spill would have on surface water would be an increase in chloride concentration in the receiving water body. Because the chloride concentration in brine is 10 to 100 times higher than in natural waters, brine spills would result in significantly elevated chloride concentrations in the receiving water body. This, in turn, could possibly exceed acute toxicity limits for some aquatic wildlife species.

Impacts to Low-Energy Water Bodies

In low-energy water bodies, such as ponds and creeks that wind through marshlands, dilution of the brine spill would occur mainly through diffusion into surrounding waters and mixing by any tidal influx into the area. In marshland with poor water circulation, chloride concentrations returned to normal within 4 months at one spill site (Boeing Petroleum Services, Inc. 1990b)

Impacts to Higher Energy Water Bodies

In higher energy water bodies, such as rivers and areas subject to strong tidal influence near the coast, the brine would be diluted by incoming tides and spread out by outgoing tides. It would also be spread downstream and diluted by river currents. Elevated chloride concentrations would likely be localized in a surface water body near the point of brine entry. Chloride concentrations would decrease with distance from the point of brine entry to the water body, and over time, because of natural flushing and dispersion. Monitoring at the sites of past brine spills has demonstrated that even relatively high volumes of spilled brine have had little or no impact on large and well-flushed water bodies (e.g., the ICW). In moderately flushed marshland and ponds, chloride concentrations in surface waters and sediments return to normal (before the spill) levels within 2 months (Boeing Petroleum Services, Inc. 1990b).

Although a high-volume brine spill could result in moderate consequences to surface water resources, the probability of such a spill is very low. The consequences to water resources of the more likely low-volume spills would be expected to be minimal. The overall risk to water resources associated with brine spills from the proposed SPR sites and infrastructure would be low.

3.6.2.1.7 Impacts on Floodplains

A substantial portion of the proposed storage sites and associated infrastructure would be located in floodplains. The Bruinsburg, Chacahoula, Stratton Ridge, Bayou Choctaw, and Big Hill sites would be entirely or partially within floodplains, therefore their selection as preferred site(s) would entail new construction in a floodplain. The affected floodplain areas include both 100-year and 500-year floodplains, and in the case of the Chacahoula site, include wetland areas that are normally inundated. Appendix B Floodplains and Wetlands Assessment provides the total area of floodplains that would be affected by the candidate alternatives, which includes the SPR site, pipelines, and power lines. This appendix also provides maps of the proposed SPR developments in relation to floodplains.

The amount of onsite construction in floodplain areas would vary from site to site, and would include developing 1 to 16 wellheads and pads; installing pumps and onsite pipelines; and constructing buildings, access roads, and related infrastructure. At the proposed Bruinsburg, Chacahoula, Stratton Ridge, Bayou Choctaw, and Big Hill sites, some filling as well may be required around cavern well pads, onsite facilities and buildings, and access roads.

The Bruinsburg, Chacahoula, Richton, Stratton Ridge, and Big Hill sites would all entail construction of offsite RWI structures, brine disposal facilities, crude oil and water distribution pipelines, or a combination. Access roads would also need to be located entirely or partially in floodplains.

A comprehensive description of how each candidate site would affect floodplains, and maps indicating the location of the proposed new and expansion sites and associated infrastructure with respect to floodplains, are provided in appendix B. The following sections address individual SPR expansion sites and summarize key information regarding the potentially affected floodplains at each of the proposed new and expansion sites. The site-specific sections also include an estimate of the area of floodplains that would be affected at each site.

DOE regulations (10 CFR Part 1022) require assessment of the potential impacts of the proposed action on natural and beneficial floodplain values in accordance with Executive Order 11988 on Floodplain Management. These include potential impacts on the capacity of the floodplain to provide flood attenuation; preservation of diversity and stability of wildlife species and habitats; cultural resource values (e.g., archeological and historic sites); cultivated resource values (e.g., agriculture, aquaculture, forestry); aesthetic values (e.g., natural beauty); and other values related to the public interest. The potential impacts of the proposed SPR expansion on each of these aspects of floodplain value are assessed in this EIS. Section 3.7 assesses in detail the potential impacts of the proposed actions on wildlife and habitats, including within the floodplain areas that would be affected by the proposed developments. The potential impacts of SPR expansion on floodplains are also described in detail in appendix B.

Federal regulations also require assessment of the potential impacts of the proposed floodplain action on lives and property (10 CFR Part 1022). The key issue for lives and property is whether the proposed action would impact the ability of the affected floodplain area to assimilate or store flood waters, or if the proposed action would exacerbate risks to lives and property during flooding.

The impacts on the affected floodplains associated with the proposed SPR sites would be lessened because most of the proposed infrastructure would be built below ground level. The main impacts on flood storage and flooding attenuation would result from construction of some above-ground structures and placement of fill at new cavern facilities at Bruinsburg, Chacahoula, Stratton Ridge, Bayou Choctaw, and Big Hill. The development of onsite facilities and wellheads and the development of RWI facilities would involve fill of small areas of floodplain. However, these fill areas would be insignificant in comparison to the total areas of the floodplains where they would be located. The Big Hill and proposed Bruinsburg, Chacahoula, and Stratton Ridge sites are all located in floodplains that each extend over hundreds of acres (hectares), parts of the Neches-Trinity Coastal Basin, Louisiana Western Gulf Coastal Plain Province, and the San Jacinto-Brazos Coastal Basin, respectively. The Bayou Choctaw site is also located in a very extensive floodplain area. However, fill areas developed as part of the proposed action at these sites would have an insignificant impact on the flood storage capacity or hydraulic function of the related floodplains.

Construction of pipelines through floodplains would have only short-term, localized effect. Pipelines would be buried below grade, and the land would be returned to its original grade. Thus, pipeline construction is expected to have little or no impact on hydraulic function in the affected floodplains. Pump stations and the pump house for the RWI would be flood-proofed and built at an elevation above the base flood elevation (where practicable).

Although some impacts to floodplains cannot be avoided (e.g., removal of vegetation during site or pipeline construction), such impacts would be mitigated through the use of appropriate engineering designs and good operating procedures. DOE would lessen impacts to floodplains to the extent possible throughout construction of the new or expansion SPR sites. Control measures that DOE would use can be divided into three categories: (1) impact avoidance; (2) impact minimization, meaning the use of low-impact methods or containment measures; and (3) restoration, which includes replanting, rehabilitation, and other post-construction mitigation. These control measures and DOE's Floodplain Finding as required by Executive Order 11988 are described in appendix B.

DOE would comply fully with applicable local and state guidelines and regulations regarding floodplain construction, and would be further regulated by permits that must be obtained for any construction in a floodplain. In general, DOE would be required to evaluate the potential impact of placing fill or structures in a 100-year floodplain and demonstrate that the proposed fill/structures would not increase the base flood elevation. For any floodplains that are also wetlands, DOE would obtain permits from USACE and the state as required under Section 10 of the Rivers and Harbor Act and Section 404 of the CWA for any regulated action involving excavation or filling in wetland, inland waters, or navigable waters. USACE would take protection of floodplains into consideration in issuing these permits. For floodplain areas that are not also wetlands, local permits would be required. Both USACE and local permits would also require best management practices and facility designs that would protect the long-term floodplains function for hydraulic control in the drainage area.

Based on these constraints, DOE expects that overall impacts to floodplain hydraulic function, and therefore to lives and property, would not be significant.

Appendix B addresses whether a practicable alternative to SPR development in a floodplain exists. From the standpoint of individual storage sites, practicable alternatives do not exist because SPR facility locations are dictated by the location and configuration of the salt domes where storage capacity would be developed.

On a programmatic basis, alternatives to development of storage sites in a floodplain exist to the extent that SPR storage capacity could be developed practically in salt domes located outside of floodplains; however, the proposed project depends extensively on water for cavern leaching. It also must be near the Gulf of Mexico or satisfactory deep subterranean formations that can accept brine discharge from the cavern leaching process. The linear nature of the proposed pipelines and the dispersed locations of salt domes, brine discharge capacity, and raw water sources means that some floodplain would be crossed by pipelines, access roads, and other infrastructure regardless of where the storage sites were located; therefore, floodplain impacts could not be avoided altogether. DOE is further constrained in site selection for the storage sites because of statutory requirements that DOE limits its consideration to sites that already have been studied, or to sites proposed by the Gulf Coast states.

In view of these practical and statutory constraints, DOE considers that a practicable alternative to development in floodplain areas does not exist. Further, the minimal impact that SPR development is expected to have on floodplain values would not justify moving SPR development to nonfloodplain sites that have other significant practical and cost disadvantages. Even with the development of SPR sites in floodplain areas, the overall project would still meet the requirement to avoid “adverse effects and incompatible development within floodplain,” as required under 10 CFR Part 1022 and Executive Order 11988.

3.6.2.1.8 Impacts to Navigation

Virtually all of the pipelines and power lines at all proposed sites would traverse surface waters. The affected areas would include many surface water bodies that are primarily low-energy, small, channels through the marshes. These smaller waterways are used mainly for hunting and fishing with canoes, kayaks, and airboats being the primary form of vessel used on these surface water bodies. A few moderate-sized water bodies, listed in the site-specific sections, also would be crossed by SPR infrastructure. In addition, the ICW, which is maintained by USACE and used for commercial transportation, would be crossed by pipelines. At all such pipeline crossings, impacts to navigation would be limited to the construction phase because all pipelines would be buried and would not impair navigation during operations and maintenance. Where directional drilling is used, impacts to navigation even during construction would be negligible. A Section 10 permit (under the Rivers and Harbors Act) and Section 404/401 permits (under the CWA) would be required for pipeline construction through navigable waterways. The permit conditions would include best management practices to minimize impacts to navigation during construction. For these reasons, the proposed pipeline crossings and permanent structures in the navigable waterways would be expected to have negligible impacts on navigation.

At the three proposed expansion sites (Big Hill, West Hackberry, and Bayou Choctaw), the proposed action would make use of existing raw water systems with no incremental effect on navigation. Pumps in the Big Hill RWI would be upgraded with no incremental effect on navigation.

New RWI structures would be placed in the ICW for the proposed Chacahoula and Stratton Ridge sites, in the Leaf River and Gulf of Mexico at Pascagoula for the Richton site, and in the Mississippi River for the Bruinsburg site. These new intakes would include a structure to house the pumps and submerged screened intake pipes. The structures would be designed to minimize impacts to navigation and, except for the Pascagoula RWI, would be built into the waterway bank to avoid impacts to navigation. A typical RWI would be placed along the shoreline with an area dredged from the shoreline that would contain the pumps and the submerged screen intake pipes. This would not impede boat traffic. The Pascagoula RWI would be built on an existing deck, which would be refurbished. As with pipelines, Section 10 and Section 404/401 permits would be required for any construction in navigable waterways, and would include best management practices to avoid impacts to navigation.

The proposed Big Hill site would use existing brine discharge structures, while the Chacahoula, Richton, and Stratton Ridge sites would require new brine discharge structures. All of these discharge structures are or would be located in the Gulf of Mexico, which is heavily used for commercial and recreational boating. The pipelines would be buried and the brine-diffuser structures would be located in water at least 30-feet (9-meters) deep, which would not interfere with marine traffic. The diffuser structures would be constructed so as to protect shrimp nets from being entangled. Again, DOE would secure Section 404/401 and Section 10 permits, which require avoidance of impacts to navigation. The permit conditions for both the intake and brine discharge structure would require placement of all permanent structures at a depth below the draw of normal boat traffic and might require markers to warn boaters of the submerged structure.

The following is a list of some specific measures that DOE would undertake to prevent impacts to navigation:

- Design and build new RWI structures not to intrude into navigation channels;
- Install navigational hazard markers at the intake and discharge sites; and
- Install the pump house for the RWI outside the channel where the RWI structures would be located on navigable waters.

3.6.2.1.9 Impacts From On-Site Wastewater Treatment Plant Discharge

DOE would install and operate an onsite wastewater treatment facility to treat sanitary waste at each of the proposed sites. NPDES permits, as well as applicable state and local permits, would be in place for each of these facilities. The permits would require that treated effluent water meet water quality criteria protective of the surface-water receiving bodies. Monitoring results indicate that the wastewater treatment facilities at existing SPR sites consistently meet their specific discharge requirements (DOE 2004f).

Although DOE would comply fully with discharge requirements, the potential would remain for treated sanitary waste discharge to have some impact on receiving water bodies during normal operation and in spills or upset conditions. Typical impacts associated with routine sanitary wastewater treatment plant discharge include a small elevation of nutrient levels, biochemical oxygen demand, and reduced dissolved oxygen levels in the water column of receiving waters. These impacts would be localized near waste discharge points. Beyond the mixing zones for these discharges, impacts would not be expected. Any water quality impacts would be within acceptable limits as established by NPDES permits. During spills or upset conditions, untreated wastewater could be released to surface waters, resulting in a one-time, short-lived elevation in nutrient levels, microbes, and biochemical oxygen demand in the receiving water body. The duration and severity of impact would depend on the size of the spill and size and flushing action of the receiving water body. However, the onsite wastewater treatment plants would be relatively small in size, precluding the possibility of very large-volume spills of untreated wastes. Historical operating data (DOE 2004f) indicate that the likelihood of such an occurrence would be very low.

3.6.2.1.10 Impacts From Nonpoint Source Surface Water Discharge

Nonpoint source surface-water discharges potentially could occur at the SPR sites during both construction and operations and maintenance periods in the form of contaminated runoff. Runoff from the sites potentially could contain traces of materials spilled or used in small quantities onsite including oil, brine, fuels, cleaning materials, solvents, pesticides, vehicle maintenance fluids, or other materials. Runoff also could contain sediment from disturbed ground surfaces. DOE would practice good housekeeping and management practices to minimize the occurrence and size of any spills, to clean up spilled materials, and to minimize runoff contamination by cleaners or pesticides. Control measures would be taken to prevent sediment in runoff, as described earlier in the discussion of erosion and sedimentation impacts. National or state Pollutant Discharge and Elimination System permits and Stormwater Pollution Prevention Plans, as well as other applicable state and local permits, would be required for all facilities. These permits would include requirements for monitoring and reporting of certain chemicals and water-quality parameters in overland discharge from the sites to adjacent receiving waters. Monitoring results indicate that existing SPR sites consistently meet discharge requirements (DOE 2004f).

Although DOE would comply fully with permit requirements, the potential would remain for contaminants contained in nonpoint source discharges to have some minor impact on receiving water bodies. The potential impacts of oil, brine, chemicals, and sediment releases to surface water bodies have been described in earlier sections and section 3.2.2. The same types of impacts could occur as a result of the release of these same constituents in nonpoint source discharges. The level of impact associated with nonpoint source discharges would be low because the above constituents, if present in runoff, would be present at very low concentrations.

3.6.2.1.11 Impacts Associated with Potable and Miscellaneous Water Use

Small amounts of water for drinking and sanitary purposes would be used at each proposed site. The proposed expansion sites at Bayou Choctaw, West Hackberry, and Big Hill would use the water sources currently used at those sites. Bayou Choctaw pumps and treats groundwater, West Hackberry obtains water from the larger Hackberry public water system, and Big Hill purchases treated (chlorinated) surface water from local suppliers (DOE 2004f). Considering the minimal amount of potable and sanitary water required at the sites, the potential impacts of water used at the proposed expansion and new sites would be negligible.

3.6.2.2 Groundwater Common Impacts

The following paragraphs summarize the general groundwater impacts common to all sites. These do not include potential groundwater impacts associated with the underground injection of brine, which are unique to the Bruinsburg, Bayou Choctaw, and West Hackberry sites and are evaluated in those site-specific sections below.

3.6.2.2.1 Impacts of Brine Releases to Groundwater

Section 3.2.2.1 and section 3.6.2.1.5 discuss the risk of brine spills associated with the proposed SPR sites. A larger-volume brine spill could have consequences for groundwater resources, including groundwater **salinization**; however, the probability of such a large-volume spill is very low. Low-volume spills would be unlikely to reach groundwater. The overall risk to groundwater associated with brine spills is low.

Brine also could be released to groundwater via leaks from brine ponds. Measures to prevent leaking from brine ponds would include high-density polyethylene liners, underdrain systems to detect leakage, and sufficient freeboard to preclude overflow. These controls would guard against an uncontrolled, long-term discharge of brine to groundwater from the brine ponds. The brine ponds at the West Hackberry SPR facility did result in contamination of groundwater (DOE 2004f). At West Hackberry, the brine pond was removed and the brine-impacted groundwater was pumped from the aquifer. Also, brine leaks from pipelines at the Bayou Choctaw and Big Hill operating SPR sites have been reported (DOE 2004f). Groundwater monitoring programs at these sites indicate that the impacts to groundwater were localized.

The characteristics (such as salinity) and current and potential uses of groundwater, along with the geologic characteristics of each site as it relates to potential impacts from any brine discharges, are discussed in the site-specific sections.

3.6.2.2.2 Impacts from Oil Storage Cavern Leakage

Three mechanisms could lead to leakage of brine or oil from a salt cavern: (1) flow paths of sufficient permeability in the salt or associated natural seepage pathways such as faults and joints; (2) flow through hydraulic fractures generated in the walls of the cavern; or (3) leakage along the salt-cement interface in the cased well bore. The following paragraphs summarize the three mechanisms and collectively conclude that it is unlikely for brine or oil to leak from a salt cavern.

Rock salt is essentially impermeable (with a permeability about 10^{-21} to 10^{-19} meters squared). DOE would conduct a detailed geophysical survey for each proposed new site to ensure that the new SPR caverns would not intersect any natural seepage pathways and that the impermeability of the surrounding material meets design requirements; and thus, the leakage of brine or oil through the salt itself or associated natural seepage pathways would be unlikely.

Fractures may develop in the roof or crest of salt caverns if the cavern roof undergoes sufficient downward deflection or sag at the midpoint. With sufficient thickness of roof salt, these fractures would not extend through the whole roof salt and reach the caprock. The remaining unfractured roof salt and the caprock would prevent leakage of brine or oil from a salt cavern.

With the borehole and casing sealed properly following standard practices, the leakage brine or oil from a salt cavern along the salt-cement interface in the cased well-bore would be unlikely. Wells would be double-cased and grouted to prevent contamination of strata above the caverns. After installation, a nitrogen well-leak test, occurring over a period of five days, would be performed. This test is designed to detect small leaks in the well walls and wellhead. For additional protection, a dike would surround the wellhead area at each cavern. If any spills occur due to a manifold failure or blowout, drains on either side of the dike would contain the spill.

To protect against cavern leakage, the cavern would be pressure-tested before oil is injected. The test sensitivity level is leakage of up to 100 barrels of oil per year. DOE anticipates that the cavern integrity would surpass this limit. In addition, the caverns would be thousands of feet below sea level, and the rock aquifers at this depth would contain saline water that would be unusable as a potable source. The saline water of the rock aquifers likely would not affect shallow groundwater aquifers or surface waters.

3.6.2.2.3 Impacts to Groundwater Due to Raw Water Withdrawal from Surface Waters

Withdrawal of raw water from surface water during drought periods could result in a cumulative impact to nearby groundwater table levels. The incremental impacts from each site would be negligible, given that typically recharge flows from ground water toward the surface waters at all of the proposed new and expansion sites. Recharge of the aquifer from surface waters would only occur during short periods of high water following extended periods of heavy precipitation. Withdrawal from a surface water during periods of low water could result in an increase in hydraulic gradient and flow from the aquifer to the surface water. However, the impact to the groundwater table would be very small at Richton and Bruinsburg. Because the other sites withdraw water from the Intracoastal Waterway, which is tidally influenced, there would be no impact on the groundwater table. Also, raw water withdrawals would be permitted by the applicable state, and DOE would adhere to any monitoring requirements or withdrawal restrictions.

3.6.3 Bruinsburg Storage Site

Development and operation of the proposed Bruinsburg site would involve the following activities:

- Construction and operation of 16 storage caverns and associated facilities, including a wastewater treatment plant;
- Construction and operation of a pipeline, RWI structure on the Mississippi River, and power line running along the raw water pipeline from the main site substation to the RWI:
- Construction and operation of a brine disposal pipeline to 60 offsite brine disposal wells spaced along the brine and crude oil pipeline ROW and a road along the brine pipeline for construction and maintenance activities associated with brine wells;
- Construction and operation of two crude oil pipelines—one to the Peetsville pump station and the other to the Anchorage bulk storage terminal;
- Construction and operation of two new tank farms—one at Anchorage and the other at Peetsville, each consisting of four 0.4 MMB capacity oil storage tanks;
- Addition of site support facilities including construction of a 7-foot (2.2-meter) security fence, clearing of a 300-foot (91-meter) security buffer beyond the security fence, and refurbishment of access roads to the site and RWI structure.

The following sections describe the potential effects on water resources and potential impacts at the Bruinsburg storage site and associated infrastructure. The common impacts described in section 3.6.2 also apply to the Bruinsburg site.

3.6.3.1 Bruinsburg Surface Water

3.6.3.1.1 Bruinsburg Surface Water: Affected Environment

The Bruinsburg site is located at an elevation of approximately 82 feet (25 meters) above sea level (measured at the USGS site, ID 072900650) 3 miles (4.8 kilometers) east of the Mississippi River. It is also located in the South Independent Streams Basin, which covers approximately 2.8×10^6 acres (1.1×10^6 hectares). The major waterways located in this basin include Bayou Pierre, Coles Creek, Buffalo River, and Homochitto River. The land in the basin is gently rolling to hilly terrain, and it is categorized as 73 percent forested and 23 percent agricultural land. Elevations in the basin range from approximately 10 to 550 feet (3.1 to 170 meters) above sea level. Agriculture and silviculture (the agriculture of trees) are the predominant uses of the basin. The proposed SPR site area is also agricultural.

3.6.3.1.2 Bruinsburg Surface Water: Construction Impacts

The common impacts to surface water discussed in section 3.6.2.1 are applicable to the proposed Bruinsburg site. The potential raw water withdrawal impacts of this site are discussed in the following paragraphs. Brine from the Bruinsburg site would be disposed of through deep injection wells, creating no impacts to the Gulf of Mexico associated with this site.

Table 3.6.3-1 and figure 3.6.3-1 list the site location and some of the nearby surface water bodies and show specific surface water bodies that could be affected by this proposed site.

Table 3.6.3-1: Potentially Impacted Surface Waters, Bruinsburg

Water Body Name and Relevant Segment	Description	State Designations,[a,b] Uses, and Impaired Segments
Cavern Site		
Bayou Pierre	River through agricultural area; tributary to the Mississippi River; perennial	• Recreation • Habitat-critical for the Bayou darter, which, because of silt and sedimentation, is a threatened species in Bayou Pierre • Impaired for aquatic life support and primary and secondary recreational contact
RWI from Mississippi River		
Mississippi River	Major drainage river	• Recreation • Major commercial river
Coles Creek	Upland creek; perennial	• Impaired use for aquatic life support and secondary recreational contact • Impairments are biological, nutrient, low DO, pesticides, sedimentation and siltation, salinity, pathogens
Crude Oil Pipelines to Anchorage		
Located in Mississippi		•
Coles Creek	Upland creek; perennial	• Impaired use for aquatic life support and secondary recreational contact • Impairments are biological, nutrient, low DO, pesticides, sedimentation and siltation, salinity, pathogens
Blueskin Creek	Upland stream; intermittent	N/A
Fairchilds Creek	Upland creek; perennial	• Impaired use for aquatic life support • Impaired use for nutrients, low DO, siltation, and pesticides
Sandy Bayou	Upland stream; intermittent	N/A
Dunbar Bayou	Upland stream; intermittent	N/A
Perkins Creek	Upland creek; intermittent	N/A
Second Creek	Upland creek; perennial	• Impaired use for aquatic life support • Impaired for biological, low DO, salinity, siltation, and pesticides
St. Catherine Creek	Upland creek; perennial	• Impaired use for aquatic life support and primary and secondary recreational contact • Impaired for salinity and chlorides and suspended solids
Callahan Branch	Upland creek; intermittent	N/A
Town Creek	Upland creek; intermittent	• Aquatic life support and secondary recreational contact • Impaired use for aquatic life support • Impaired for nutrients, low DO, pathogens, biological impairment, sedimentation/siltation, suspended solids, pesticides, turbidity, and other habitat alteration.
Hurricane Creek	Upland stream; intermittent	• Aquatic life support • Impaired use for nutrients, low DO, biological impairment, sedimentation/siltation, pesticides, pH, and flow alteration
Homochitto River	Upland river; tributary to Mississippi River; perennial	• Recreation • Impaired use for aquatic life support and secondary recreational contact • Impaired for nutrients, low DO sediment and siltation, pathogens, and pesticides
Dry Fork	Upland stream; perennial	N/A
Browns Creek	Upland stream; perennial	• Aquatic life support and secondary recreational contact. • Evaluated for nutrients, low DO, siltation, pathogens, and pesticides

Table 3.6.3-1: Potentially Impacted Surface Waters, Bruinsburg

Water Body Name and Relevant Segment	Description	State Designations,[a,b] Uses, and Impaired Segments
Buffalo River	Upland river; tributary to Mississippi River; perennial; 2004 average streamflow varies between 70 ft/sec^3 (March) to less than 2,000 ft/sec^3 (September)	• Impaired use for aquatic life support • Impaired for biological, low DO, salinity, and pesticides
Located in Louisiana		
Middle Fork Thompson Creek	Upland stream; perennial	• Impaired use for aquatic life support; • Cause of impairment unknown
Thompson Creek	Upland river; tributary to Mississippi River; perennial	• Impaired use for aquatic life support • Impaired for nutrients, biological, low DO, and salinity
White Bayou	Upland stream; intermittent	N/A
Bayou Baton Rouge	Upland stream; intermittent	N/A
Monte Sano Bayou	Upland stream; perennial	N/A
Mississippi River	Major river	• Aquatic life support, primary and secondary recreational contact, and public water supply
Crude Oil Pipelines to Peetsville		
James Creek	Upland creek; perennial	• Impaired use for aquatic life support and secondary recreational contact • Impaired for nutrients, low DO, pesticides, pathogens, biological impairment, unknown toxicity, flow alteration, suspended solids, and sediment/siltation
Widows Creek	Upland creek; intermittent	N/A
Willis Creek	Upland creek; perennial	• Impaired use for aquatic life support • Impaired for nutrients, low DO, pesticides, and sediment/siltation
Clarks Creek	Upland creek; perennial	N/A
Hughes Creek	Upland creek; perennial	• Impaired use for aquatic life support • Impaired for nutrients, low DO, other habitat alterations, and sediment/siltation
Whetstone Creek	Upland creek; intermittent	N/A
Bakers Creek	Upland creek; perennial	• Impaired use for aquatic life support and secondary recreational contact • Impaired for nutrients, low DO, pathogens, biological impairment, and other habitat alteration
Caney Branch	Upland stream; perennial	N/A
Crow Creek	Upland creek; intermittent	N/A
Johnson Creek	Upland creek; perennial	• Impaired use for aquatic life support • Impaired for nutrients, low DO, pesticides, sediment/siltation
Foster Creek	Upland creek; perennial	• Impaired use for aquatic life support • Impaired for sediment/siltation
Homochitto River	Upland river; perennial	• Recreation • Impaired use for aquatic life support and secondary recreational contact • Impairment caused by sedimentation/siltation, pathogens, nutrients, low level pesticides
Cedar Creek	Upland creek; perennial	• Impaired use for aquatic life support • Impaired for pesticides

Table 3.6.3-1: Potentially Impacted Surface Waters, Bruinsburg

Water Body Name and Relevant Segment	Description	State Designations,[a,b] Uses, and Impaired Segments
Dry Creek	Upland creek; intermittent	• Impaired use for aquatic life support and secondary recreational contact • Impaired for nutrients, pesticides, sediment/siltation, and pathogens

Notes:

[a] All of the waters in MDEQ's basin approach are classified as Fish and Wildlife. Basin waters carrying other classifications are noted accordingly (MDEQ 2006a).

[b] Louisiana State designations are defined as:

Primary Recreation: "any recreational or other water use in which there is prolonged and intimate body contact with the water involving considerable risk of absorbing waterborne constituents through the skin or of ingesting constituents from water in quantities sufficient to pose a significant health hazard."

Secondary Recreation: "any recreational or other water use in which body contact with the water is either incidental or accidental, and in which the probability of ingesting appreciable quantities of water is minimal."

Fish and Wildlife Propagation: "the use of water for aquatic habitat, food, resting, reproduction, cover, and/or travel corridors for any indigenous wildlife and aquatic life species associated with the aquatic environment. This use also includes the maintenance of water quality at a level that prevents damage to indigenous wildlife and aquatic life species associated with the aquatic environment and contamination of aquatic biota consumed by humans."

Drinking Water Supply: "refers to the use of water for human consumption and general household use."

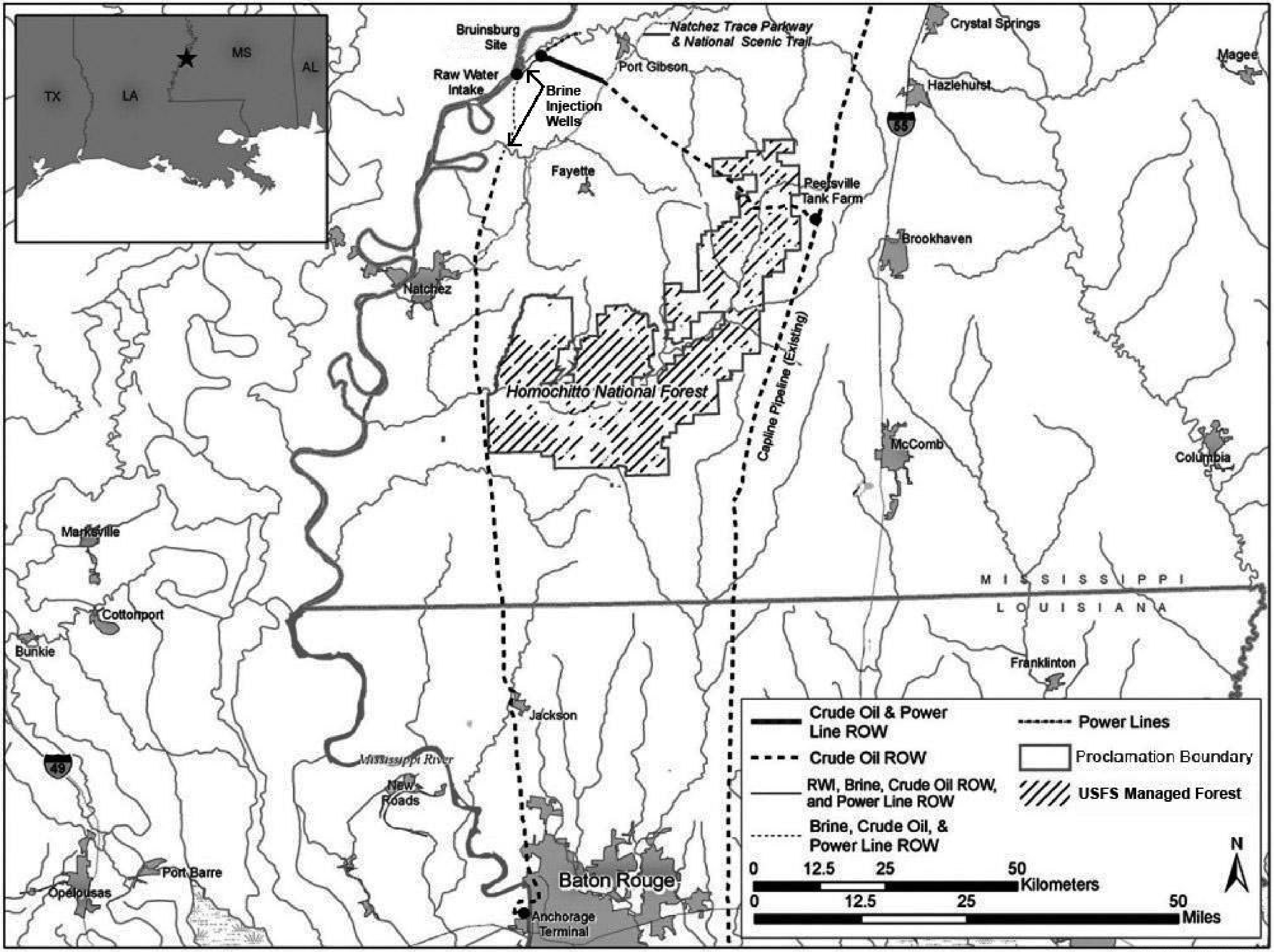
Oyster Propagation: "the use of water to maintain biological systems that support economically important species of oysters, clams, mussels, or other mollusks so that their productivity is preserved and the health of human consumers of these species is protected."

Agriculture: "the use of water for crop spraying, irrigation, livestock watering, poultry operations, and other farm purposes not related to human consumption."

Outstanding Natural Resource Waters: "include water bodies designated for preservation, protection, reclamation, or enhancement of wilderness, aesthetic qualities, and ecological regimes, such as those designated under the Louisiana Natural and Scenic Rivers System or those designated by the department as waters of ecological significance. Characteristics of outstanding natural resource waters include, but are not limited to, highly diverse or unique in stream and/or riparian habitat, high species diversity, balanced trophic structure, unique species, or similar qualities."

Source: LDEQ 2005

Figure 3.6.3-1: Regional Surface Water Map for Bruinsburg Site



ICF20061113DBP004

The proposed SPR facility site at Bruinsburg would be located less than 1 mile east of Bayou Pierre. Bayou Pierre discharges to the Mississippi River 3 miles downstream of the proposed site. Bayou Pierre, the primary local drainage, would not be impacted directly by the proposed facility or the pipelines or RWI structure.

The proposed RWI pipeline to the Mississippi River would cross no water bodies. The brine disposal pipeline would cross only one upland creek, Coles Creek. The crude oil pipeline to Anchorage would cross several streams, including several that discharge downstream into the Mississippi River to the west. Most of these streams are identified by Mississippi or Louisiana as having impaired quality because of sedimentation, low dissolved oxygen, pesticides, and elevated nutrients, all of which are characteristic of agricultural runoff (MDEQ 2006b). The crude oil pipeline to Peetsville would also cross several upland water bodies, including the Homochitto River—a tributary of the Mississippi River—and Clark's Creek, which discharges to the Homochitto River. Directional drilling would minimize impacts during construction activities, and it also would be implemented for some of the larger water bodies including the Homochitto River.

The extent of 100-year and 500-year floodplains in the project area were determined based on the Federal Emergency Management Agency's flood insurance rate maps covering the project area. The potential impacts to floodplains are discussed at length in section 3.6.2.1.7. The proposed Bruinsburg site is located in a predominantly undeveloped area that has numerous floodplains associated with the Mississippi River and Bayou Pierre, and tributaries listed in table 3.6.3-1. The pipelines associated with the proposed Bruinsburg project, also cross through the floodplains of the listed surface waters. Table 3.6.3-2 lists the total area of floodplains affected by the proposed project. In addition, floodplains along pipeline routes would be temporarily disturbed during construction, but would be brought up to original grade after construction.

Table 3.6.3-2: Total Area of Floodplains Affected by Bruinsburg Storage Site

Floodplain	Area (acres)[a]	Area (hectares)[a]
100-year	270	110
500-year	22	9
Total	**292**	**119**

[a] Numbers have been rounded to two significant figures

The Bruinsburg site would withdraw water from the Mississippi River at a point 3.5 miles (5.7 kilometers) southwest of the proposed SPR site. At the proposed withdrawal point, the Mississippi River is approximately 0.50-miles (0.80-kilometers) wide, and it has an annual average flow rate of approximately 2.7×10^5 cubic feet per second (7.5×10^3 cubic meters per second) (Data for Vicksburg, MS) (Riverweb 2004f). Six NPDES discharge permits have been issued in the Bruinsburg RWI area (EPA 2006c); at least one of these discharges is to the Mississippi River upstream of the RWI (the receiving waters for the remaining permits are not listed). Information about the volume of this discharge is unavailable. These discharges would not affect the proposed RWI because the water would not be used for potable water.

Raw water withdrawal from the Mississippi River for the Bruinsburg site would be 1.2 MMBD (78 cubic feet per second [2.2 cubic meters per second]) during drawdown, and 1.2 MMBD (78 cubic feet per second [2.2 cubic meters per second]) during solution mining. These measurements represent a small fraction (less than 0.003 percent) of the average river flow. The RWI would be expected to have no appreciable effect on water levels, downstream water flow, water availability for other users, dilution and assimilation capacity of the river for pollutants, or water quality.

If one of the proposed Bruinsburg alternatives is selected, DOE would apply for a Permit to Withdraw for Beneficial Uses from the Public Waters of Mississippi and coordinate with the Mississippi Office of Land and Water Resources to ensure that Minimum Instream Flows would be maintained during the period of withdrawal. This RWI also would be coordinated and permitted by USACE through the Section 404 process.

3.6.3.1.3 Bruinsburg Surface Water: Operations and Maintenance Impacts

Section 3.6.2.1 discusses potential surface water impacts related to operations and maintenance at all sites. The potential impacts related to raw water withdrawal are also applicable to the operations and maintenance phase.

3.6.3.2 Bruinsburg Groundwater

3.6.3.2.1 Bruinsburg Groundwater: Affected Environment

The proposed Bruinsburg site is located over a shallow aquifer, the Southern Hills Aquifer; and a deep aquifer, the Mississippi Embayment Aquifer System (MEAS). The Southern Hills Aquifer system extends from near Vicksburg, MS at its northernmost point to Baton Rouge, LA at its southern extent, and is bounded on the east and west by the Pearl and Mississippi rivers (EPA 2006g, 2004h; USGS 2002b). This system consists of four aquifer units, including a Shallow **Alluvial** (Pleistocene) aquifer and Pliocene, Miocene, and Oligocene units (LAGS 2000)[1].

The different units of the Southern Hills Aquifer system originate in outcroppings that run in roughly east-west bands across southern Mississippi. The aquifers dip downward towards the coastline and the Mississippi River Valley. Groundwater flow in the aquifer system is generally to the south, i.e., down-dip or downgradient.

The Southern Hills Aquifer system is an important groundwater resource in the region. It is designated by EPA as a sole source aquifer and is the primary groundwater resource aquifer for southwestern Mississippi and southeastern Louisiana. It is the only source of drinking water for more than 50 percent of the residents in a large area of southeastern Louisiana (EPA 2006f, 2004g, 2004h). The Shallow Alluvial aquifer and the Miocene unit of the Southern Hills Aquifer system serve as water resources for much of southern Mississippi and southeastern Louisiana (MDEQ 2004b; USGS 1981; USGS 2005a; Walley 2006). Thus, Bruinsburg is located in the origination area or recharge zone of the Southern Hills Aquifer system, and is upgradient of the great majority of the system. In the vicinity of the Bruinsburg site, the bottom of the Southern Hills aquifer system is approximately 800 feet (244 meters) below grade (USGS 1982). Most of the Miocene outcropping area is covered by an overlying confining layer of loess, up to 90 feet (27 meters) thick. This overlying confining layer greatly reduces vertical recharge to the Miocene unit (MDEQ 2004b).

[1] Some references (USGS 2005b) refer to five aquifer units, including a lower Pliocene to upper Miocene unit. The aquifer units or permeable zones within the Southern Hills Aquifer system and the larger Coastal Lowlands Aquifer system (of which the Southern Hills system is a part) are heterogeneous and discontinuous across the system. The system is generally devoid of widespread confining units, and permeable zones are distinguished by their different hydraulic conductivities rather than their separation by confining units. Stratigraphic comparisons and identification of permeable zones across the entire system are difficult, and in some areas arbitrary (USGS 2005b). Due to the absence of confining layers these permeable zones or aquifer units are extensively interconnected and effectively form a single large aquifer system.

Examples of the uses of the Southern Hills Aquifer downgradient of the Bruinsburg site include the designated source water protection area (SPWA) and municipal supply wells in Russo, MS, located approximately 10 miles downgradient from Bruinsburg. Other major pumping centers in Mississippi relying on the Miocene unit include Natchez, Brookhaven, Hazlehurst, Colombia, McComb, Moss Point, Picayune, Ellisville, Hattiesburg, Laurel, Biloxi, Gulfport, and Pascagoula (MDEQ 2004b), at distances of 30 to 190 miles (48 to 310 kilometers) downgradient of Bruinsburg. Smaller wells exist throughout the area of Mississippi downgradient of Bruinsburg.

In Louisiana, the area of Baton Rouge (approximately 100 miles (160 kilometers) downgradient of Bruinsburg) withdrew 131 million gallons (0.50 million cubic meters) per day from the Southern Hills Aquifer system in 2000. This withdrawal was largely from the Pliocene unit, but also to a lesser extent from other units in the system (USGS 2002b; USGS 2005a). Other major pumping centers relying on the Southern Hills Aquifer system include St. Franksville, Amite, Franklinton, Bogalusa, Hammond, Covington, Denham Springs, and Slidell, LA (USGS 2002b), at distances of 80 to 145 (130 to 230 kilometers) miles downgradient from Bruinsburg. Hundreds of smaller wells tap the Southern Hills Aquifer system in Louisiana. Many of these wells are located along the border with Mississippi, within roughly 60 miles (97 kilometers) of Bruinsburg (USGS 2002b).

Total withdrawal from the Southern Hills Aquifer system in 2000 was 290 million gallons per day (1.1 million cubic meters per day), of which 49 percent was used for public water supply, 39 percent was used for industrial uses, and the remainder was used for power generation, rural domestic use, and other uses (USGS 2002b).

In the Bruinsburg area, the Southern Hills Aquifer system is underlain by a thick confining layer known as the Vicksburg-Jackson confining unit, or locally as the Yazoo Clay layer. Below this confining layer is a second major aquifer system, the MEAS. Bruinsburg is located over the southernmost, downgradient, down-dipping section of the MEAS, which is a large system extending from southeastern Arkansas eastward into northeastern Mississippi and southern Tennessee, and southward into central Louisiana and just south of the southern Mississippi border, into southeastern Louisiana.

The MEAS comprises six aquifer units with outcropping zones extending in arch-shaped bands across northern Louisiana, southeastern Arkansas, northeastern Mississippi, and southern Tennessee (USGS 2005a). Thus, the MEAS is at or near the surface in areas significantly northeast, north, and northwest (and upgradient) of Bruinsburg. The MEAS aquifer units increase in thickness, and the lower units increase in depth below grade, with distance to the south, and as they approach the central axis of the aquifer system along the Mississippi river corridor (USGS 2005a). Groundwater flow in the MEAS is driven by gravity in the downgradient direction; i.e., towards the central axis of the MEAS along the Mississippi River, and to the south (USGS 2005a).

In southern Mississippi and central Louisiana, an extensive, thick, clay confining unit (Vicksburg-Jackson confining unit) separates the MEAS from the overlying potable water aquifers of the Southern Hills Aquifer system (USGS 2005a). In the vicinity of the Bruinsburg site, this thick clay confining layer is 300- to 500-feet (91- to 150-meters) thick (Taylor 2005; USGS 2005a). This confining layer precludes movement of water between the upper Southern Hills Aquifer system and the lower MEAS.

Of particular interest within the MEAS is the Middle Claiborne unit, which is composed largely of the Sparta Sands aquifer, and is generally referred to as the Sparta aquifer. The Sparta aquifer is an important source of water in its northern sections (i.e., in southeastern Arkansas, northern Louisiana, northeastern Mississippi, and southern Tennessee), where this aquifer is relatively near the surface and contains fresh water. In 2000, water was withdrawn from the Sparta aquifer in Louisiana at the rate of 68 million gallons (257 thousand cubic meters) per day (USGS 2002b). This water was used for public water supply (55 percent), industry (40 percent), and other uses (5 percent) (USGS 2002b). Significant amounts of water are withdrawn from the Sparta/Central Claiborne Aquifer in the cities of Stuttgart, Pine Bluff, El Dorado, and Magnolia, Arkansas; Ruston, Jonesboro, Monroe, and Bastrop, Louisiana; and Yazoo City and Jackson, Mississippi. Large withdrawals are also made in the Memphis, Tennessee area (USGS 2005a).

All of these Sparta withdrawal areas are upgradient (from 35 to over 240 miles [56 to 390 kilometers]) of the Bruinsburg site. The freshwater limit (1,000 parts per million dissolved solids concentration isopleth) of the Sparta aquifer extends in an arch upgradient of Bruinsburg, roughly 60 miles (97 kilometers) to the northwest, 50 miles (81 kilometers) to the north, and 35 miles (56 kilometers) to the northeast. The 10,000 parts per million dissolved solids concentration isopleth extends in an arch upgradient of Bruinsburg, approximately 45 miles (72 kilometers) to the northwest, 40 miles (64 kilometers) to the north, and 20 (32 kilometers) miles to the northeast (USGS 2005a). Thus, the usable portions of the aquifer are many miles upgradient of the Bruinsburg site.

The MEAS aquifer units increase in dissolved solids content in the downgradient direction, and with depth below grade. These units contain fresh water in the northern areas where they are relatively near the surface, but become saline downgradient. Bruinsburg is located in the downgradient portion of the MEAS. The top of the Sparta aquifer is 1,900 feet (580 meters) below grade at this point. The dissolved solids concentration within the aquifer at this point is over 10,000 parts per million (USGS 2005a).

3.6.3.2.2 Bruinsburg Groundwater: Construction Impacts

All of the general groundwater-related impacts discussed in section 3.6.2.2 are applicable to the proposed Bruinsburg site. However, impacts to the Miocene aquifer unit from surface or near-surface discharges at Bruinsburg would not be likely because of the presence of the thick overlying, low permeability layer of loess. This confining layer would act as a barrier to infiltration of spilled contaminants to the underlying Miocene aquifer.

The crude oil pipeline to Peetsville would cross through one SWPA in the town of Russum, MS, where there are three public supply wells. The crude oil pipeline to Anchorage would pass through three SWPAs in the towns of Washington and Fenwick, MS. Potential impacts to groundwater resources in these SWPAs are unlikely, considering the low probability of an uncontrolled spill from pipelines within the SWPA that would subsequently penetrate to groundwater.

Brine from the Bruinsburg site would be disposed of through deep well injection. The proposed brine injection rate would require a complex of 60 injection wells spaced 1,000 feet (300 meters) apart, resulting in an 11-mile (18-kilometer) injection corridor or injection field, which would begin approximately 3 miles (5 kilometers) from the storage site.

Based on review of well log information, DOE has identified two formations in the MEAS beneath Bruinsburg, the Sparta and Wilcox units, as potentially suitable disposal formations for injected brine. At the northern end of the proposed injection area, the top of the Sparta unit is at approximately 1,900 feet (580 meters) below grade, and the unit is approximately 750 to 1,000 feet (230 to 300 meters) thick. The top of the Wilcox unit is approximately 3,300 feet (1,000 meters) below grade, and this unit is approximately 3,700 feet (1,100 meters) thick.

The total disposal capacity of these formations, and the pressure buildup likely to occur as a result of brine injection, are not known at this time. If DOE were to select this alternative, the total disposal capacity and pressure build up would be determined during the development of the detailed design.

Based on review of currently available well logs, DOE has concluded that the Sparta formation alone may not have adequate capacity to handle the proposed brine injection volumes and rates, necessitating development of injection wells in both the Sparta and Wilcox formations. Considering the likely heterogeneity of the proposed injection formations over the length of the disposal corridor, additional testing would be required to assess the capacity of these formations for receiving injected brine at the proposed rates, as well as to provide confidence that brine injection would not adversely affect the quality of either the overlying water supply aquifer or the upgradient freshwater portions of the formations that would receive the brine.

The proposed injection area would be located at least 35 miles (56 kilometers) downgradient of the freshwater portions and withdrawal areas of the Sparta and Wilcox units, and both of these aquifers have dissolved solids concentrations greater than 10,000 parts per million at the proposed brine disposal area (USGS 2005a). Brine injected into these aquifers at Bruinsburg would travel further downgradient with the general direction of groundwater flow, and also by gravity along the bedding that dips towards the south. Thus, the injected brine would be carried into increasingly saline portions of the aquifers, and away from the freshwater portions of the aquifers that constitute current or potential sources of fresh water. Permitting for the proposed brine-disposal system would be subject to the requirements of the Underground Injection Control (UIC) Program regulations, including the prohibition on injection into formations that contain waters of 10,000 parts per million total dissolved solids or less (40 CFR Parts 144-146). Permitting would require a determination that injection would not adversely impact freshwater portions of the injection formations.

The Yazoo Clay formation, approximately 300- to 500-feet (91- to 152-meters) thick, separates the Sparta aquifer (the uppermost of the two proposed injection aquifers) from the overlying potable water aquifers of the Southern Hills Aquifer system. Quantitative performance data are not available for the Yazoo Clay layer. However, this layer is characterized as very low permeability (Taylor 2005) and could therefore be expected to serve as an effective barrier to the migration of brine upward into the potable Southern Hills Aquifer system.

Brine would be injected into a portion of the aquifer with dissolved solid concentrations in excess of 10,000 parts per million and would travel into an increasingly saline portion of the aquifer. As a result of this, and the presence of the Yazoo Clay formation serving as a barrier to upward migration, there would be no impact on potable portions of the Sparta or Wilcox aquifers from brine disposal at Bruinsburg.

There is a low potential that injected brine potentially could discharge to the shallow water source aquifer through leaks in the brine disposal wells. Moreover, these wells would be sealed, and pressure tested to assure that leakage would not occur. DOE would also implement a shallow groundwater monitoring program at the site to ensure protection of groundwater quality. Also, permitting of the brine disposal facility would be subject to UIC Program regulations, which specifically prohibit the over pressuring of injection zones to the point that the injected brine could rise into overlying aquifers (40 CFR Parts 144-146).

3.6.3.2.3 Bruinsburg Groundwater: Operations and Maintenance Impacts

Potential impacts from operation and maintenance activities would be similar to those discussed above for construction. The brine disposal wells also would be used during drawdown events.

3.6.4 Chacahoula Storage Site

The proposed new Chacahoula SPR project would include the following activities:

- Construction and operation of storage caverns, well pads, and associated facilities including a wastewater treatment plant, a security fence and buffer, and access roads to the site and RWI structure;
- Construction and operation of an RWI structure on the ICW and an RWI pipeline;
- Construction and operation of a brine disposal pipeline and brine diffuser discharge system in the Gulf of Mexico; and
- Construction and operation of two crude oil pipelines, a pipeline to the existing St. James terminal on the Mississippi River and a pipeline to LOOP's Clovelly Terminal in Galliano.

The following sections describe the potentially affected water resources and potential impacts specific to the Chacahoula storage site and associated infrastructure. The common impacts described in section 3.6.2 also apply to the proposed Chacahoula site.

3.6.4.1 Chacahoula Surface Water

3.6.4.1.1 Chacahoula Surface Water: Affected Environment

The Chacahoula site is located in the Louisiana portion of the Western Gulf Coastal Plain Province. This low-lying area is composed of the Mississippi River floodplain, coastal marshes, and a series of terraces and low hills. The site would be located at an elevation of 6 to 7 feet (1.8 to 2.1 meters) above sea level in a permanently inundated swamp, in the Terrebonne sub-basin of the Mississippi River Drainage Basin. Local drainage at the Chacahoula site is to Bubbling Bayou to the south and a canal that runs north-south, just east of the site. The proposed SPR site and the proposed pipeline routes would be located primarily in marshlands and would cross numerous small and some larger water bodies. However, the proposed oil pipeline running north to the oil terminal adjacent to the Mississippi River would cross some land at slightly higher elevation.

3.6.4.1.2 Chacahoula Surface Water: Construction Impacts

The common impacts to surface water discussed in section 3.6.2.1 are applicable to the proposed Chacahoula site. The particular surface water bodies that would be crossed or potentially impacted by this alternative are listed below in table 3.6.4-1. A map showing the location of most of these waters is presented in figure 3.6.4-1.

Surface water in the region is typically used for recreational boating and fishing. For example, Bayou Black is used for recreational boating and commercial boat tours; Bay Junop is used for recreation and fishing; and the ICW is used for recreational boating and fishing. The ICW also has considerable commercial activity, as barges haul petroleum, petroleum products, foodstuffs, building materials, manufactured goods, and other materials up and down that water body. To support this commercial traffic, USACE maintains navigable depths in the ICW through dredging and locks.

Some of the water bodies are recognized by the EPA and Louisiana as having "impaired" water quality. For example, Bayou Black is listed as impaired based on low dissolved oxygen concentrations; Lost Lake is listed as impaired based on high organic content and low dissolved oxygen levels; and Bayou

Table 3.6.4-1: Potentially Impacted Surface Waters, Chacahoula

Water Body Name (and Relevant Segment)	Description	State Designations,[a] Uses, and Impaired Segments
Cavern Site		
Bubbling Bayou	Channel through marsh; perennial	• Primary contact recreation, secondary contact recreation, and fish and wildlife propagation
Canals running along western and eastern sides of site	Canal/ditch	N/A
Exit Row Raw Water Intake and Brine P/L		
Bayou Black	Channel through marsh; perennial	• Uses: recreational boating, boat tours, aquatic life • Impaired by low DO
RWI Pipeline to ICW		
Canal running along eastern edge of site	Canal/ditch	N/A
Tributary to Bubbling Bayou 0.5 miles from site	Small stream	N/A
Shell Canal	Canal; Perennial	N/A
Bubbling Bayou	Channel through marsh	• Primary and secondary contact recreation and fish and wildlife propagation
Bayou Black	River through developed agricultural and oil fields	• Substantial surface water body used for recreational boating and commercial boat tours. Bayou Black is listed as "impaired," based on dissolved oxygen concentrations
Bayou de Cade	Canal through marsh; perennial	N/A
Bayou Cocodrie	Channel through marsh; perennial	• Agriculture, primary and secondary contact recreation, fish and wildlife propagation, outstanding natural resource waters, and limited aquatic life and wildlife use
Several unnamed canals	Small canals through marsh	N/A
Intracoastal Waterway	Major commercial and recreational waterway; USACE maintains navigable depths in the water way through dredging and locks; perennial	• The ICW is used for both recreational boating and for commerce • Primary and secondary contact recreation and fish and wildlife propagation • The ICW has a good deal of commercial activity; barges haul petroleum, petroleum products, foodstuffs, building materials, and manufactured goods • The USACE maintains navigable depths in the water way through dredging and locks
Brine Disposal Pipeline		
Bayou Penchant	River (major drainage) through marsh; 30-mile long river with peak stream flows of up to 13,000 cfs	• 30-mile long river with peak stream flows of up to 13,000 cfs • Classified as "impaired" by EPA based on turbidity, oil and grease concentrations, and total organic solids concentrations • The Penchant Basin is currently the focus of a USGS ecological restoration program
Bayou Cocodrie	Channel through marsh; perennial	• Agriculture, primary and secondary contact recreation, fish and wildlife propagation, outstanding natural resource waters, and limited aquatic life and wildlife use

Table 3.6.4-1: Potentially Impacted Surface Waters, Chacahoula

Water Body Name (and Relevant Segment)	Description	State Designations,[a] Uses, and Impaired Segments
Coulee Michel	Stream; perennial	N/A
Bay Junop	Coastal bay	• Recreation and fishing
Intracoastal Waterway	Major commercial and recreational waterway; USACE maintains navigable depths in the water way through dredging and locks; perennial	• The ICW is used for both recreational boating and for commerce • Primary and secondary contact recreation and propagation of fish and wildlife • The ICW has a good deal of commercial activity; barges haul petroleum, petroleum products, foodstuffs, building materials, and manufactured goods • The USACE maintains navigable depths in the water way through dredging and locks
St. James Crude Oil Pipeline		
St. James Parish Canal	N/A	N/A
Mississippi River	Upland channel, perennial	• Primary/secondary contact recreation, propagation of fish and wildlife, and drinking water supply
Baker Canal	N/A	N/A
Citamon Bayou	Channel through marsh; perennial	Primary and secondary contact recreation, agriculture, propagation of fish and wildlife
Cutgrass Coulee	N/A	N/A
Bayou Verrett	Channel through marsh; perennial	Primary and secondary contact recreation, agriculture, propagation of fish and wildlife
Clovelly Crude Oil Pipeline		
Petit Bois Bayou	Channel through marsh; perennial	N/A
Intracoastal Waterway	Major commercial and recreational waterway; USACE maintains navigable depths in the water way through dredging and locks; perennial	• The ICW is used for both recreational boating and for commerce • Primary and secondary contact recreation and propagation of fish and wildlife • The ICW has a good deal of commercial activity; barges haul petroleum, petroleum products, foodstuffs, building materials, and manufactured goods • The USACE maintains navigable depths in the water way through dredging and locks
Bayou Terrebone	Upland channel; perennial	• Primary and secondary contact recreation, propagation of fish and wildlife; oyster propagation
Bayou LaFourche	Channel through marsh; perennial	• Primary and secondary contact recreation, propagation of fish and wildlife; domestic raw water supply
Petit Chackbay Bayou	Channel through marsh; perennial	N/A

Table 3.6.4-1: Potentially Impacted Surface Waters, Chacahoula

Water Body Name (and Relevant Segment)	Description	State Designations,[a] Uses, and Impaired Segments
Company Canal	Canal; ditch	• Agriculture, fish and wildlife propagation, drinking water, primary and secondary contact recreation
Canal Tisamond Foret	Canal; ditch	N/A

Notes:

[a] State designations are defined as follows:

Primary Contact Recreation: "any recreational or other water use in which there is prolonged and intimate body contact with the water involving considerable risk of absorbing waterborne constituents through the skin or of ingesting constituents from water in quantities sufficient to pose a significant health hazard."

Secondary Contact Recreation: "any recreational or other water use in which body contact with the water is either incidental or accidental, and in which the probability of ingesting appreciable quantities of water is minimal."

Fish and Wildlife Propagation: "the use of water for aquatic habitat, food, resting, reproduction, cover, and/or travel corridors for any indigenous wildlife and aquatic life species associated with the aquatic environment. This use also includes the maintenance of water quality at a level that prevents damage to indigenous wildlife and aquatic life species associated with the aquatic environment and contamination of aquatic biota consumed by humans."

Drinking Water Supply: "refers to the use of water for human consumption and general household use."

Oyster Propagation: "the use of water to maintain biological systems that support economically important species of oysters, clams, mussels, or other mollusks so that their productivity is preserved and the health of human consumers of these species is protected."

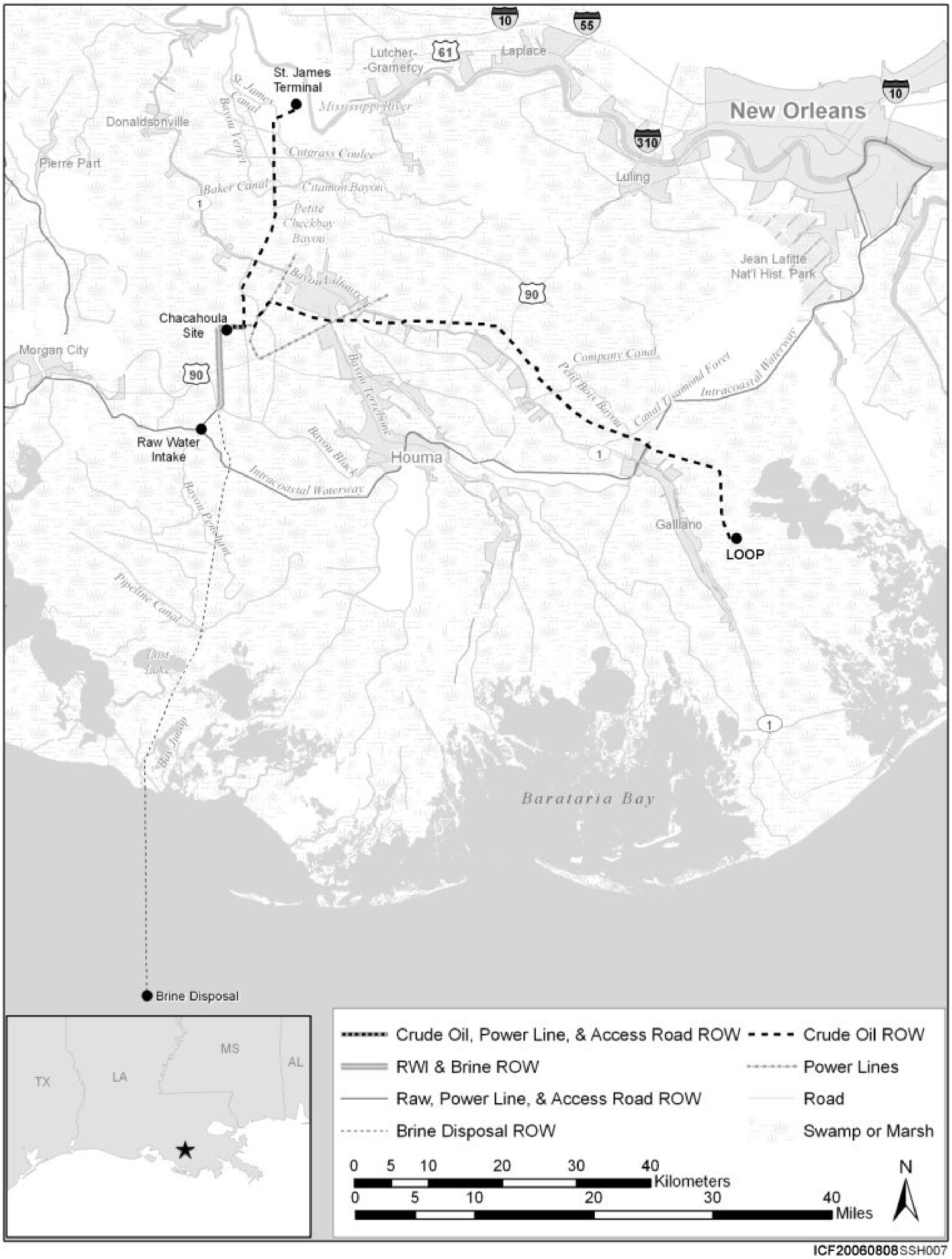
Agriculture: "the use of water for crop spraying, irrigation, livestock watering, poultry operations, and other farm purposes not related to human consumption."

Outstanding Natural Resource Waters: "include water bodies designated for preservation, protection, reclamation, or enhancement of wilderness, aesthetic qualities, and ecological regimes, such as those designated under the Louisiana Natural and Scenic Rivers System or those designated by the department as waters of ecological significance. Characteristics of outstanding natural resource waters include, but are not limited to, highly diverse or unique in stream and/or riparian habitat, high species diversity, balanced trophic structure, unique species, or similar qualities."

cfs = cubic feet per second; N/A = not available; 1 mile = 1.609 kilometers

Source: LDEQ 2005

Figure 3.6.4-1: Regional Surface Water Map for Chacahoula Site



Terrebonne is listed as impaired based on a variety of contaminants and the presence of invasive, noxious plant species. Bayou Penchant is also classified as impaired based on turbidity, oil and grease concentrations, and total organic solids concentrations. The Penchant Basin is currently the focus of a USGS ecological restoration program. Similarly, Bay Junop is the subject of an ongoing ecological restoration program, including an oyster restoration project supported by EPA.

The RWI pipeline would run to the south through mostly undeveloped marsh land, and would cross one substantial water body, Bayou Black, before reaching the ICW. The brine disposal pipeline would run along the same route, but then would continue south to the Gulf of Mexico through mostly undeveloped marshland, crossing several substantial water bodies. The crude oil pipeline to St. James Terminal on the Mississippi River to the north would cross several creeks and run primarily through marshlands. The crude oil pipeline to Clovelly would cross upland rivers and streams, and then streams through costal marsh as it approaches the Clovelly LOOP. The majority of the potentially affected surface water for the Chacahoula site would be fresh water, except where the brine pipeline and the Clovelly crude oil pipeline approach the coastline.

Directional drilling would be used to minimize the impacts of crossing water bodies at some of the larger rivers, including Bayou Penchant, Bayou Lafourche, Bayou Terrebonne, and the ICW.

The Chacahoula site would withdraw raw water from the ICW. The potential surface water impacts are addressed in section 3.6.2.1.1, and would be expected to be insignificant.

The extent of 100-year and 500-year floodplains in the project area were determined based on the Federal Emergency Management Agency (FEMA) Flood Insurance Rate maps covering the project area. The potential impacts to floodplains are discussed in section 3.6.2.1.7 and in appendix B. Table 3.6.4-2 provides a summary of the floodplains located within the proposed project area.

Table 3.6.4-2: Total Area of Floodplains Affected by Chacahoula Storage Site

Floodplain	Area (acres)[a]	Area (hectares)[a]
100-year	140	55
500-year	N/A	N/A
Total[b]	**140**	**55**

Notes:

[a] Numbers have been rounded to two significant figures
[b] Numbers may not equal total due to rounding

With respect to floodplains, the Chacahoula site, terminal, and RWI structure would result in a disturbance of approximately 140 acres (55 hectares) of the 100-year floodplain. All onsite construction for the storage area, therefore, would occur within a floodplain. To minimize wetland and floodplain impacts, just the areas of the onsite facilities, access road, and around the cavern pads would be filled, the remainder of the site would remain at current grade. Offsite construction in floodplain would include temporary disturbances during pipeline construction.

The floodplain in which the Chacahoula site is located extends over thousands of acres, and is part of the Louisiana Western Gulf Coastal Plain Province.

3.6.4.1.3 Chacahoula Surface Water: Operations and Maintenance Impacts

The potential effects of discharging brine through diffusers into the Gulf of Mexico are discussed in Section 3.6.2.1.2. Potential impacts were modeled based on monitoring data at operating SPR brine diffuser sites in the Gulf of Mexico, and the impacts from the Chacahoula discharge would be very localized. As discussed in section 3.6.2.1.2 above, the proposed location of the brine diffuser is at the base of a 10-foot (3-meter) escarpment called Ship Shoal. As for the other proposed sites, potential salinity impacts of the Chacahoula brine discharge on the Gulf of Mexico were estimated based on an empirical model. However, the empirical plume model does not show effects of bottom topography, such as Ship Shoal. At Chacahoula, the brine plume movement is restricted by the upward sloping sea bottom to the north (shoreward), west, and south (Ship Shoal). Flow along the bottom to the east is possible, as the water bottom slopes downward to the east along Ship Shoal. The bathymetry (which is the ocean bottom equivalent to land’s topography) at the Chacahoula diffuser would likely result in pooling of approximately 2 feet (0.6 meters) of above-ambient salinity water near the bottom.

> Mitigation: A preconstruction survey could be undertaken to evaluate the possibility of avoiding Ship Shoal. If required, a more detailed model could define potential impacts to water quality and biological resources.

3.6.4.2 Chacahoula Groundwater

3.6.4.2.1 Chacahoula Groundwater: Affected Environment

In the Chacahoula salt dome area, the subsurface water system is the Mississippi River Alluvial Aquifer, which is principally comprised of interconnected fresh-water-bearing sands and gravels, overlain by a 100-foot (30-meter) confining layer of clay and silt to form an artesian aquifer system (Arthur 2001). This aquifer is the most heavily pumped in Mississippi, and 98 percent of the groundwater pumped is used for agriculture.

The aquifer depth ranges from approximately 800 feet (244 meters) below ground surface near Bayou Choctaw to roughly 1,400 feet (427 meters) near the Chacahoula dome. Depth to the base of fresh water is approximately 250 feet (76 meters) below ground surface at the site. The depth to salt in the site area is approximately 1,100 feet (335 meters) below ground surface, and the top of the caprock is at a depth of about 875 feet (267 meters) at its highest point (DOE 1978b). The cavern system would be hundreds of feet below the base of the fresh water aquifer.

> An **aquifer** is a body of rock or soil that is capable of transmitting groundwater and yielding usable quantities of water to wells or springs.

According to the Louisiana Department of Transportation and Development water well registry, several groundwater wells are located in the vicinity of the Chacahoula site (LADOTD 2005). The identified wells are primarily screened (i.e., draw water from) within an interval that is between 150 and 200 feet (46 and 61 meters) below the ground surface, and consist almost exclusively of oil rig supply and industrial-use wells. Depth to groundwater at these wells is generally less than 10 feet (3 meters) below the ground surface, with reported well yields up to 3.34 cubic feet per second (0.0946 cubic meters per second). The general groundwater flow direction at the Chacahoula site is expected to be to the south. These wells are screened hundreds of feet above the proposed storage depth. Also, they are protected from surface and near surface discharges by the upper low-permeability layer.

Water use in Lafourche Parish, where the Chacahoula site is located, is dominated by surface water sources, and groundwater use represents an average of about 2 percent of the total water usage, and is primarily associated with industrial and livestock usage. Groundwater is not used for public water supplies in Lafourche Parish (Whelan 2006; EPA 2006a).

3.6.4.2.2 Chacahoula Groundwater: Construction Impacts

All of the general groundwater-related impacts discussed in section 3.6.2.2 are applicable to the proposed Chacahoula site. However, the likelihood of impacts to groundwater at Chacahoula would be further minimized because of the presence of a 100-foot (30-meter) clay confining layer above the aquifer layer at the site (DOE 1978b). This clay layer would impede any infiltration of spills to the aquifer. This alternative would not use groundwater or discharge through underground injection wells to the groundwater. There would be no significant impact to groundwater.

3.6.4.2.3 Chacahoula Groundwater: Operations and Maintenance Impacts

The evaluation of potential impacts from construction of the proposed Chacahoula project above would also apply to the operations and maintenance impacts.

3.6.5 Richton Storage Site

Construction and operation of the proposed SPR site at Richton would involve the following activities:

- Construction and operation of 16 storage caverns with a combined capacity of 160 MMB and associated facilities including a wastewater treatment plant and access road;
- Construction and operation of RWI structures on the Leaf River and the Gulf of Mexico at Pascagoula;
- Installation of a utility line from the substation at the Leaf River RWI to the new power lines providing electricity to the storage site and construction of a new, wide, gravel access road along the pipeline ROW from Old Augusta Road to the RWI;
- Construction and operation of two multi-purpose pipelines to Pascagoula and brine diffuser discharge system in the Gulf of Mexico;
- Construction of a bulk oil storage marine terminal at Pascagoula, which would include modifications to barge dock, storage tanks, utilities, and associated support facilities; and
- Construction and operation of pipeline to Liberty and bulk storage terminal in Liberty, which would include construction of storage tanks, utilities, associated support facilities, and a mid-station pump station along the crude oil pipeline to Liberty.

The following sections describe the potentially affected water resources and potential impacts specific to the Richton storage site and associated infrastructure. The common impacts described in section 3.6.2 also apply to the Richton site, unless otherwise noted.

3.6.5.1 Richton Surface Water

3.6.5.1.1 Richton Surface Water: Affected Environment

The Richton site would be located within the Thompson's Creek drainage sub-basin of the Leaf River drainage basin and within the Mississippi portion of the Gulf Coastal Plain Province. The cavern site is in an uplands area, at about 250 feet (76 meters) above sea level elevation, and the majority of surface waters affected would be uplands and fresh water systems. Water may become increasing brackish in the coastal, marshy areas as the brine disposal pipeline approaches the Gulf of Mexico.

3.6.5.1.2 Richton Surface Water: Construction Impacts

The common impacts described in section 3.6.2.1 are applicable to the Richton site. Primary surface water bodies that could potentially be affected by development of the Richton site are listed in table 3.6.5-1 and shown in figures 3.6.5-1 and 3.6.5-2.

Since the Richton SPR site and most of the pipelines would be located outside the coastal area, any of the impacts to surface water would impact fresh water systems, rather than brackish systems. The majority of the water bodies that would be crossed by pipelines are listed by the State as impaired due to runoff issues, including sediment/siltation, low-oxygen levels and elevated nutrient levels.

DOE would use directional drilling techniques to minimize impacts of laying pipeline across rivers at some of the larger rivers. Some of the rivers where this method could be employed include Thompson Creek, Chickasawhay River, Bogue Homo, Leaf River, Pearl River, and Bogue Chitto River.

The potential effects of discharging brine through diffusers into the Gulf of Mexico are discussed in section 3.6.2.1.2. Potential impacts were modeled on monitoring data at operating SPR brine diffuser sites in the Gulf of Mexico, and the impacts from Richton discharge would be very localized. The plume of increased salinity would extend into the Pascagoula Ship Channel. Under typical conditions, the resultant salinity would only be elevated by 1 part per thousand in the channel. Under low current velocity conditions, salinity could be elevated by 4 parts per thousand in the ship channel. It is possible that elevated salinity water could accumulate at the bottom of the dredged channel under certain conditions.

Raw water demand for the Richton site would be about 1.2 MMBD (78 cubic feet per second [50 million gallons per day] or 2.2 cubic meters per second). The RWI structure for Richton would be located along the north bank of the Leaf River approximately 450 feet (140 meters) downstream of the confluence with the Bogue Homo, and approximately 4 miles (6.4 kilometers) east of New Augusta. The RWI point is well upstream of the fall line, and the water is fresh. Another RWI would be located at Pascagoula in the Gulf of Mexico.

During cavern creation, drawdown, or maintenance, withdrawal from the Leaf River would be used during normal and high flow conditions in the Leaf River. Under low flow conditions in the Leaf River, the withdrawal would be supplemented by a secondary source(s) including a RWI from the Gulf of Mexico at Pascagoula. The RWI at Pascagoula would be designed to handle about 0.5 MMBD of the proposed 1.2 MMBD total volume. During construction or maintenance, when flows in the Leaf River reach the Minimum Instream Flow that is designated by the regulatory agencies to protect special status species, withdrawal from the Leaf River would be reduced or terminated until the Minimum Instream Flow in the Leaf River is reached. During this period, DOE would withdraw from the Gulf of Mexico. If necessary, other possible supplemental sources could be considered in consultation with the regulatory agencies including possible groundwater sources, existing surface water withdrawals from other surface water bodies, and a possible onsite off-stream reservoir. If low flow conditions exist in the Leaf River during emergency drawdown events (declared as a National Emergency), DOE would withdraw water from the Gulf of Mexico and/or from other supplemental sources identified during the consultation process, and, as necessary to reach the proposed Richton oil distribution rate of 1.0 MMBD, from the Leaf River.

Table 3.6.5-1: Potentially Affected Surface Waters, Richton

Water Body Name (and Relevant Segment)	Description	State Designations,[a] Uses, and Impaired Segments
Cavern Site		
Drains to Harper Branch to west	Upland channel; perennial	N/A
Fox Branch to north	Upland channel; perennial	N/A
Pine Branch to south	Upland channel; perennial	N/A
RWI (south to the Leaf River)		
Leaf River (pipeline crosses river and RWI in river)	Upland channel; perennial; New Augusta (closest gauge to site) $7Q_{10}$ is 497 cfs and downstream at Mclain $7Q_{10}$ is 598 cfs	N/A
Bogue Homo	Upland channel; perennial	N/A
Merritt Springs Branch	Upland channel; perennial	N/A
Mill Creek	Upland channel; perennial	• Impaired use for aquatic life support • Types of impairment: biological impairment, nutrients, low DO/organic enrichment, pesticides, salinity, and sedimentation/siltation
Crude Oil Pipeline to Liberty		
Lotts Creek	Upland stream; perennial	N/A
Bogue Homo	Upland channel; perennial	N/A
Gardner Creek	Upland channel; perennial	N/A
Collins Creek	Upland channel; intermittent	• Impaired use for aquatic life support • Types of impairment: nutrients, low DO, pesticides, and sediment/siltation
Silver Creek	Upland channel; perennial	• Impaired use for aquatic life support and secondary recreational contact • Types of impairment: biological impairment, pathogens, nutrients, low DO, pesticides, and sediment/siltation
Upper Little Creek	Upland channel; perennial	• Impaired use for aquatic life support and secondary recreational contact • Types of impairment: biological impairment, nutrients, low DO, pesticides, pathogens, and sediment/siltation
Gully Creek	Upland channel; perennial	N/A
Boggy Prong	Channel through marsh; Intermittent	N/A
Graves Creek	Upland channel; perennial	N/A
Tallahala Creek	Upland channel; perennial; 2004 peak stream flow of 337 cfs	• Impaired use for aquatic life support and secondary recreational contact • Types of impairment: suspended solids, unionized ammonia, metals, pH, bio impairment, nutrients, low DO, pathogens, pesticides, and sediment/siltation
Burleman Branch	Upland channel; intermittent	N/A
Reese Creek	Upland channel; perennial	N/A
Rice Patch branch	Intermittent	N/A

Table 3.6.5-1: Potentially Affected Surface Waters, Richton

Water Body Name (and Relevant Segment)	Description	State Designations,[a] Uses, and Impaired Segments
Jakes Creek	Intermittent	N/A
Little Black Creek	Intermittent	• Impaired use for aquatic life support and secondary recreational contact • Types of impairment: bio impairment, nutrients, low DO, pesticides, pathogens, and sediment/siltation
Parkers Creek	Perennial	N/A
Black Creek	Perennial; 2004 peak stream flow of 1,516 cfs	• Recreation; • Impaired use for aquatic life support and primary and secondary recreational contact • Types of impairment: nutrients, low DO pesticides, pathogens, and sediment/siltation
Perkins Creek	Perennial	N/A
Burketts Creek	Perennial	N/A
Sandy Run	Perennial	N/A
Love Creek	Upland channel; perennial	N/A
Lake Serene	Lake; perennial	N/A
Tangipahoa River	Upland channel; perennial; 2003 peak stream flow of 300 cfs	• Impaired use for aquatic life support and primary and secondary recreational contact • Types of impairment: metals, pH, biological impairment, nutrients, low DO, pesticides, pathogens, and sediment/siltation
Minnehaha Creek	Upland channel; intermittent	• Impaired use for secondary recreational contact • Type of impairment: pathogens
Hominy Creek	Upland channel; perennial	N/A
Martin Creek	Upland channel; intermittent	N/A
Little Tangipahoa River	Upland channel; perennial	• Impaired use for aquatic life support and secondary recreational contact • Types of impairment: bio impairment, nutrients, low DO, pesticides, pathogens, sediment/siltation, and unknown toxicity
Bars Branch	Upland channel; perennial	• Impaired use for aquatic life support • Type of impairment: unknown
Magees Creek	Upland channel; perennial	• Recreation • Impaired use for aquatic life support and primary recreational contact • Type of impairment: nutrients, pesticides, and sediment/siltation
Dry Creek	Upland channel; perennial	• Impaired use for aquatic life support and primary and secondary recreational contact • Type of impairment: biological impairment, pathogens, nutrients, low DO, pesticides, and sediment/siltation

Table 3.6.5-1: Potentially Affected Surface Waters, Richton

Water Body Name (and Relevant Segment)	Description	State Designations,[a] Uses, and Impaired Segments
Leaf River	Upland river; perennial; annual average streamflow is 2,600 cfs	• Impaired use for aquatic life support and primary and secondary recreational contact • Type of impairment: nutrients, pathogens, pesticides, and sediment/siltation
Black Creek	Upland river; perennial	• Wild and scenic river • Recreation • Impaired use for aquatic life support and primary and secondary recreational contact • Type of impairment: pathogens, nutrients, low DO, biological impairment, pesticides, sediment/siltation, suspended solids, thermal modifications, and turbidity
Pearl River	Upland river, primary drainage for area (drainage area at Columbia is 5,720 square miles); perennial; annual average flow is 8,000 to 10,000 cfs	• Recreation • Impaired use for aquatic life support, primary and secondary recreational contact, and fish consumption • Types of impairment: mercury, pathogens, nutrients, low DO, biological impairment, pesticides, pH, sediment/siltation, and suspended solids
Bogue Chitto River	Upland channel, primary drainage for area (drainage area near Tylertown is 492 square miles); Perennial; average annual flow is 500 to 1,000 cfs	• Impaired use for aquatic life support and primary and secondary recreational contact • Types of impairment: biological impairment, low DO, pH, nutrients, pesticides, sediment/siltation, mercury, pathogens, and metals
East Fork Amite River	Upland channel; intermittent	• Impaired use for aquatic life support and primary recreational contact • Types of impairment: biological impairment, low DO, pH, nutrients, pesticides, sediment/siltation, and pathogens
Multi-purpose Pipelines to Pascagoula		
Thompson Creek	Upland channel; perennial	• Impaired use for aquatic life support • Types of impairment: biological impairment, nutrients, low DO/organic enrichment, pesticides, salinity, and sedimentation/siltation
Big Island Branch	Upland channel; perennial	N/A
Gaines Creek	Upland channel; perennial	• Impaired use for aquatic life support • Type of impairment: sediment/siltation
Atkinson Creek	Upland channel; perennial	N/A

Table 3.6.5-1: Potentially Affected Surface Waters, Richton

Water Body Name (and Relevant Segment)	Description	State Designations,[a] Uses, and Impaired Segments
Chickasawhay River	Upland channel; perennial	• Recreation • Impaired use for aquatic life support and primary and secondary recreational contact • Types of impairment: biological impairment, nutrients, sediment/siltation, pesticides, pathogens, suspended solids, pH, and salinity
Several small creeks	N/A	N/A
Big Creek	Upland channel; perennial	N/A
Escatawpa River	Upland channel; perennial; average annual flow is 750 to 1,000 cfs	• Fish and Wildlife with a DO requirement (>3.0 mg/L)
Black Creek	Upland river; perennial	• Recreation • Impaired use for aquatic life support and primary and secondary recreational contact • Types of impairment: pathogens, nutrients, low DO, biological impairment, pesticides, sediment/siltation, suspended solids, thermal modifications, and turbidity
Mill Creek	Upland channel; Perennial	• Impaired use for aquatic life support • Types of impairment: biological impairment, nutrients, low DO/organic enrichment, pesticides, salinity, and sedimentation/siltation
Crane Creek	Channel; perennial	• Impaired use for aquatic life support • Types of impairment: nutrients, pesticides, sediment/siltation
White Creek	Channel; perennial	N/A
Indian Creek	Channel; perennial	• Impaired use for aquatic life support • Types of impairment: biological impairment, nutrients, low DO, pesticides, and other habitat alterations
Big Cedar Creek	Channel; perennial	N/A
Big Oktibee Creek	Channel; perennial	N/A
Waterhole Branch	Channel; perennial	N/A
Holy Creek	Channel; perennial	N/A
McSwain Branch	Channel; perennial	N/A
Courthouse Creek	Channel; perennial	N/A
Wilson Lake	Lake; perennial	N/A

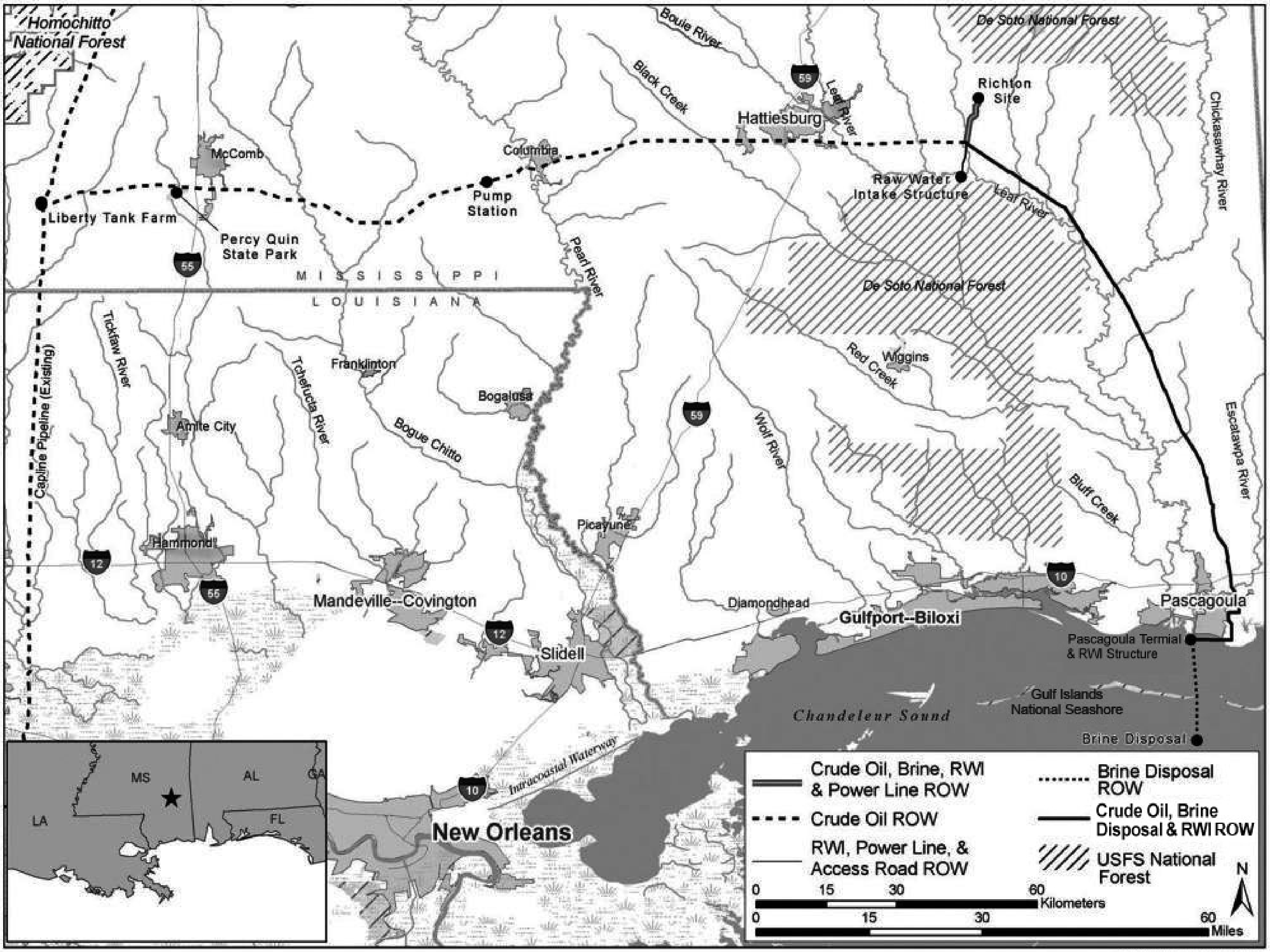
Notes:

[a] All of the waters in the MDEQ's basin approach are classified as Fish and Wildlife. Basin waters carrying other classifications are noted accordingly (MDEQ 2006a).

cfs = cubic feet per second (1 cfs = 0.03 cubic meters per second); DO = dissolved oxygen; $7Q_{10}$ = 7-day, 10-year low flow rate; N/A = not available;

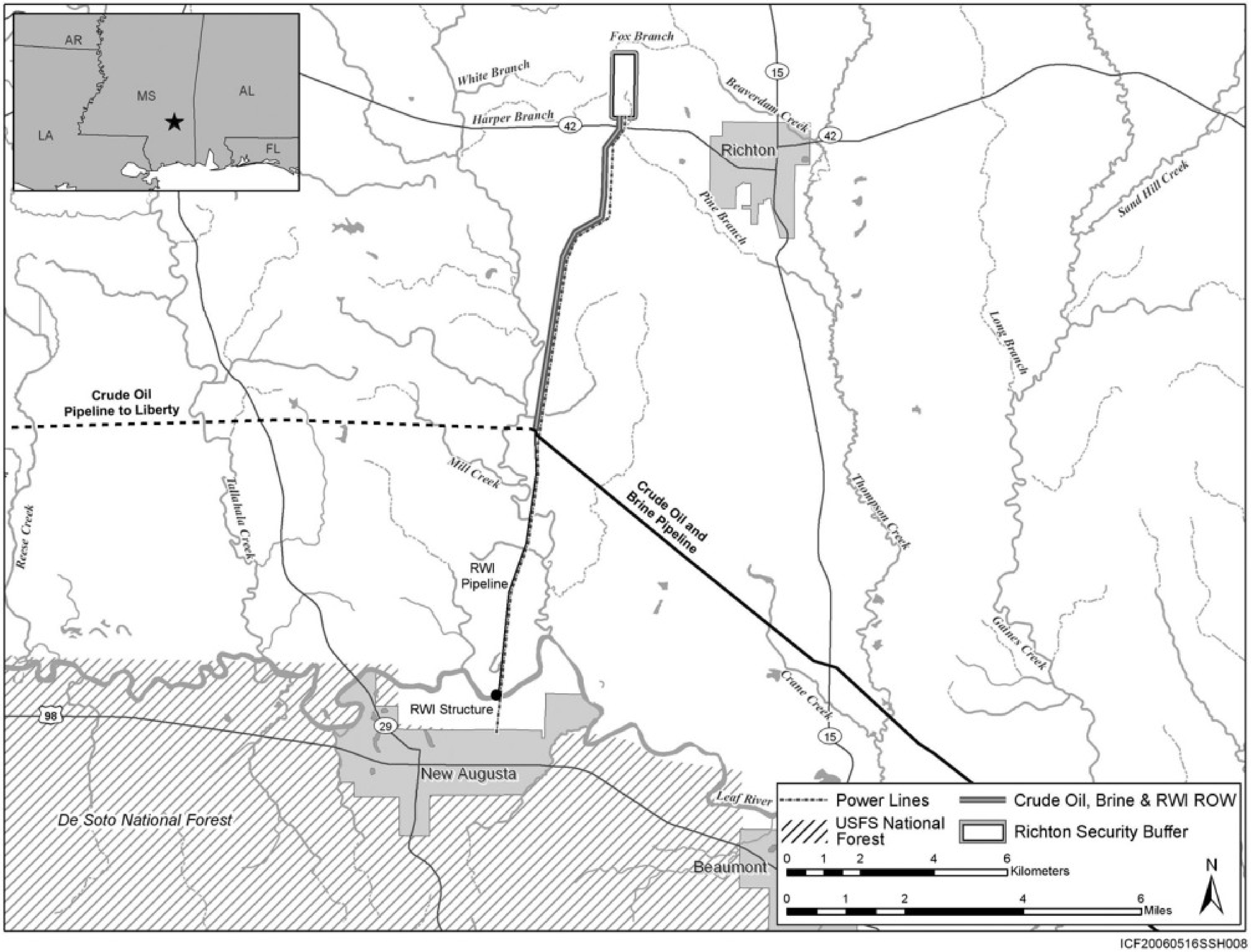
Source: MDEQ 2005

Figure 3.6.5-1: Regional Surface Water Map for Richton Site



ICF20061127SSH012

Figure 3.6.5-2: Local Surface Water Map for Richton Site



The flow rate of the Leaf River is highly variable. From December 1983 to September 1991, discharge of the river at New Augusta ranged from 590 to 74,000 cubic feet per second (17 to 2,100 cubic meters per second). Average discharge for the period was 4,100 cubic feet per second (120 cubic meters per second), average annual minimum and maximum discharges were 720 cubic feet per second (20 cubic meters per second), and 30,100 cubic feet per second (850 cubic meters per second), respectively (DOI 1980).

Mississippi regulations establish the Minimum Instream Flow at which water withdrawal is permitted from State waters. This minimum threshold is set at the **$7Q_{10}$** flow rate (the 7-day, 10-year low flow rate). Only flow in excess of the $7Q_{10}$ can be withdrawn. However, because the Leaf River supports several federally listed species, the Minimum Instream Flow may be set higher to protect these species. More detail is provided on this subject in section 3.7.5. Based on flow data for the period 1939–1991 from stream gauges upstream of the proposed RWI site, MDEQ has estimated a $7Q_{10}$ for the Leaf River at New Augusta of 503 cubic feet per second (14 cubic meters per second). Thus, the river flow rate would have to be at least 581 cubic feet per second (16 cubic meters per second) to allow withdrawal at the full demand rate of 78 cubic feet per second (2.2 cubic meters per second). Over the 52-year period investigated by MDEQ, there were 160 days in which the Leaf River flow rate fell below the $7Q_{10}$. Overall, MDEQ results indicate that flow in the river would be sufficient to meet the raw water demand of the Richton site 99 percent of the time, although there could be dry years during which the river flow would be below the $7Q_{10}$ flow rate for as much as 15 percent of the time (MDEQ 1992). Cavern development, when the maximum amount of raw water would be required, would take up to 5 years unless low flow conditions in the Leaf River limit the water withdrawal and thereby slow down the solution mining process. Based on the 52-year record, it is unlikely that a sustained period of low water would occur during cavern development. However, if it did, additional water would be withdrawn from the Gulf of Mexico for cavern construction.

There are three NPDES permits on record permitting discharge into the Leaf River in the area of the Richton RWI structure. These three sources are permitted to discharge a total of 50,000 gallons per day (0.071 cubic feet or 0.002 cubic meters per second) (EPA 2006c). Reduction in the Leaf River flow associated with raw water withdrawal by the Richton SPR site would reduce the capacity of the river to assimilate wastes. This could result in higher concentrations of wastes in the river water column for waste streams that enter the river immediately downstream of the RWI station. The potential impacts to these discharges would also be considered during the permitting process for the RWI.

According to a permit database search conducted by the MDEQ, Mississippi has issued five current surface water withdrawal permits for the Leaf River. The permitted withdrawal amounts range from 0.0014 cubic feet per second (3.9×10^{-5} cubic meters per second) for livestock usage to 178 cubic feet per second (5.05 cubic meters per second) for industrial use. The total amount of Leaf River water withdrawal currently permitted is approximately 221 cubic feet per second (6.3 cubic meters per second) (Crawford 2006). Additional parties withdraw small amounts of water from the Leaf River, but are not required to obtain withdrawal permits, so there are no data available on these withdrawals (MDEQ 2006c).

The largest user of Leaf River water is the Eaton Plant of the Mississippi Power Company in Petal, MS. This plant is approximately 25 miles upstream of the Richton site. Its permit allows up to 178 cubic feet per second (5.05 cubic meters per second) to be withdrawn from the Leaf River. According to periodic NPDES permit (MS0002917) monitoring, however, the facility returns most or all of the withdrawn water to the river because it is used for cooling purposes. The next largest user of Leaf River water is Leaf River Cellulose, a pulp and paper mill in Richton. Its permit allows for up to 40.23 cubic feet per second (1.14 cubic meters per second) (Crawford 2006). Leaf River Cellulose holds a NPDES permit (MS0031704, as

Georgia Pacific) and, like the Mississippi Power Company, most or all of this water is used for cooling purposes and is recycled back into the river.

Withdrawal of water from the Leaf River for the Richton site would have minimal impacts on the river while it is flowing near or above its average flow rate of 4,100 cubic feet per second (116 cubic meters per second). At such times, raw water withdrawal would constitute less than 2 percent of river flow. However, the river flow can be expected to fall to near or below its average annual minimum discharge rate of 720 cubic feet per second (20 cubic meters per second) at some point every year. At this average annual minimum flow rate, water demand for the Richton site would constitute 11 percent of river flow. Although the probability is relatively low, the possibility exists that the river flow rate could drop to or below the minimum flow rate of 581 cubic feet per second (16 cubic meters per second) that would be required to meet the water demands for cavern development and maintain the minimum flow rate of 503 cubic feet per second (14 cubic meters per second) under the state $7Q_{10}$ regulation. Under this low flow scenario, water would be withdrawn for cavern construction from the Gulf of Mexico.

If one of the Richton alternatives is selected, DOE would apply for a Permit to Withdraw for Beneficial Uses from the Public Waters of Mississippi and coordinate with the Mississippi Office of Land and Water Resources to ensure that Minimum Instream Flows are maintained during the period of withdrawal. The withdrawal would also be coordinated with and permitted by USACE and the USFWS through the Section 404 permit process and the ESA.

DOE has evaluated potential impacts to floodplains in section 3.6.2.1.7 and appendix B. The extent of 100-year and 500-year floodplains in the Richton project area, including the site and pipelines, was determined based on the FEMA Flood Insurance Rate maps covering the project area. The Richton storage site is located in a predominantly undeveloped area with rolling topography. The proposed storage site is not located within the 100-year or 500-year floodplain, but all 49 acres (20 hectares) of the Pascagoula terminal would be located within the 100-year floodplain. Additionally, some of the pipelines do cross floodplains. However, as previously discussed, impacts associated with pipelines would be limited to the construction phase.

> Mitigation: To ensure adequate flow and assimilative capacity in the Leaf River, DOE would commit to withdrawing only that flow that is in excess of the $7Q_{10}$ minimum level during cavern construction. DOE would secure an agreement with Federal and state regulatory agencies that requires water conservation, supplemental sources, or agreements with upstream users to ensure that adequate instream flow is maintained in the river.

3.6.5.1.3 Richton Surface Water: Operations and Maintenance Impacts

Drawdown of oil from the cavern would occur sporadically during the operational phase of the project. If low flow conditions exist in the Leaf River during emergency drawdown events (declared as a National Emergency), DOE would withdraw water from the Gulf of Mexico, from other supplemental sources identified during the consultation process, and from the Leaf River to reach the proposed Richton oil distribution rate of 1.0 MMBD. Under this scenario, water withdrawal from the Leaf River could result in flow below the 7Q10. However, given the analysis of Leaf River flow provided in section 3.6.5.1.2, and the infrequency of drawdown events, it is unlikely that a drawdown event would coincide with drought conditions in the Leaf River.

3.6.5.2 Richton Groundwater

3.6.5.2.1 Richton Groundwater: Affected Environment

In the Richton storage site area, the aquifers are in descending order by depth: the Upper Aquifer, Upper Claiborne, and Wilcox. Each of these aquifers is separated by a very low-permeability confining unit. The salt dome has pushed through the aquifers, so that only the Upper Aquifer is above the dome. It begins just below the surface and extends to a depth of 1,100 feet (350 meters), just slightly above the domal caprock. The groundwater table is approximately 10 to 30 feet (3 to 9 meters) below land surface. The aquifer contains abundant freshwater, which grades with depth to moderately saline water to brine near the salt dome (PB-KBB 1991).

The Upper Claiborne aquifer abuts the side of the salt dome structure, and is characterized by a low permeability of 12 inches (320 millimeters) per year and moderately saline water that grades to brine. The base of the freshwater zone is approximately 590 feet (180 meters) below land surface. The Upper Claiborne is 1,500 to 2,000 feet (460 to 620 meters) below land surface and entirely below the base of the fresh-water zone at the site. The virtually confined Wilcox Aquifer, where not pierced by the dome, extends from approximately 1,900 to 5,300 feet (590 to 1,600 meters) below land surface. The Wilcox groundwater is brackish throughout the basin and very saline to brine near the Richton salt dome.

Groundwater flows south or southeast in each aquifer. In the Upper Aquifer, groundwater flows almost directly to the south, following the down dip of the aquifer toward local discharge into the Leaf River and other streams, and eventual discharge into the Gulf of Mexico.

The Upper Aquifer is the only aquifer used within a 6-mile (10-kilometer) radius of the site. Eight wells in this area tap the Upper Aquifer for a variety of uses—municipal, domestic, agricultural, and industrial purposes. The proposed SPR site does not appear to be within the SWPA for the Richton well field (Dunn 2005).

The pipeline to Liberty River would pass through or adjacent to the following groundwater supplies:

- Upgradient of the SWPA for the town of Quinlivan, MS;
- Downgradient of the SWPA at Fernwood, MS;
- Upgradient of the SWPA in Foxworth, MS;
- Downgradient of the SWPA at Columbia, MS;
- Downgradient of the SWPA at Oak Grove, MS;
- Through the SWPA at Pine Grove, MS; and
- Through the SWPA at Tylertown, MS.

The pipeline to Pascagoula would pass through or run adjacent to the following groundwater SWPA:

- Adjacent to the SWPA at Central, MS;
- Adjacent to the SWPA at Helena, MS; and
- Through the SWPA at Pascagoula, MS.

3.6.5.2.2 Richton Groundwater: Construction Impacts

The potential groundwater impacts associated with construction of the proposed Richton site and infrastructure are as described in the section 3.6.2.2. Although pipelines would be constructed through and adjacent to several groundwater SWPA areas, as described above, the probability of contaminant discharge during pipeline and facility construction is very low. There would be no brine disposal wells at this site, and wells installed to support cavern dissolution at the SPR facility would be grouted and pressure-tested to assure that leaks would not occur.

Four new oil storage tanks would be constructed at each of the Pascagoula and Liberty terminals. Construction of these tanks would not impact groundwater resources. Potential impacts from these types of tanks are discussed in the section 3.6.2.1.5. The tanks would be constructed with berms to avoid discharge and would be integrity-tested on a regular basis. Also, they would be used for buffering capacity, and only filled at specific times during cavern drawdown and filling.

3.6.5.2.3 Richton Groundwater: Operations and Maintenance Impacts

Potential sources of groundwater contamination include the brine ponds and pipelines, leakage of oil from the storage caverns, and other material spills. Potential impacts of each of these sources associated with the Richton site are comparable to those described above for construction and in section 3.6.2.2.

Discharge during operations and maintenance from the new oil storage tanks at Pascagoula and Liberty is unlikely. These tanks would be used as buffer for capacity, and would only be filled with oil during selected operational events, such as drawdown or cavern filling.

3.6.6 Stratton Ridge Storage Site

The Stratton Ridge site would involve the following activities:

- Construction and operation of 16 storage caverns for a combined capacity of 160 MMB and associated facilities including a wastewater treatment plant and access road;
- Construction and operation of a raw water pipeline and an intake structure on the ICW;
- Construction and operation of two brine ponds, a brine disposal pipeline, and brine diffuser discharge system in the Gulf of Mexico, including an offshore section with diffuser; and
- Construction and operation of a pipeline to Texas City, an extension to BP Facility, and a new tank farm in Texas City.

The following sections describe the potentially affected water resources and potential impacts specific to the Stratton Ridge storage site and associated infrastructure. The general impacts described in section 3.6.2 also apply to the Stratton Ridge site.

3.6.6.1 Stratton Ridge Surface Water

3.6.6.1.1 Stratton Ridge Surface Water: Affected Environment

The westernmost of the candidate new sites, Stratton Ridge would be located approximately 7 miles (11 kilometers) from the Texas shoreline. It is located east of the mouth of the Brazos River in the San Jacinto-Brazos Coastal Basin, within the Austin-Oyster Creek watershed. The site drains into Oyster Creek to the south. Oyster Creek flows through the urban areas of Lake Jackson and Clute, and then southeast through the coastal marshes to the Gulf of Mexico. No perennial streams were observed on the site during an October 2005 site visit. However, there was evidence of temporary water channels during periods with greater amounts of precipitation. One permanent small pond less than 1 acre (0.4-hectares) in size is located in the northwestern corner of the site (Fisher, et al. 1972).

3.6.6.1.2 Stratton Ridge Surface Water: Construction Impacts

The general impacts to surface water discussed in section 3.6.2.1 are applicable to the proposed Stratton Ridge site. Specific surface water bodies that could be affected by the proposed site are listed in table 3.6.6-1 and primary water bodies are shown in figure 3.6.6-1.

The predominant surface water quality problems in the San Jancinto-Brazos Coastal Basin are elevated fecal coliform bacteria and depressed dissolved oxygen levels (H-GAC 2005). The tidal portion of Oyster Creek has experienced a fish kill in the past due to low-oxygen conditions and has previously been listed on Texas's 303d list for elevated bacteria levels (TCEQ 2004c). Other streams within the coastal basin have elevated levels of nitrogen, phosphorus, metals, VOCs, and suspended sediments (TCEQ 2004c).

The proposed Stratton Ridge site and associated pipelines would be located in the coastal marshlands of Texas, except where the Texas City oil pipeline would enter the developed area as it approaches the terminal. Except for the ICW, most of the water bodies that would be crossed by pipelines are small. DOE would use directional drilling to lay pipeline below the ICW to minimize impacts during construction.

The Stratton Ridge site would withdraw raw water from the ICW. Potential impacts associated with this withdrawal are addressed in section 3.6.2.1.1 and would be insignificant.

The potential effects of discharging brine through diffusers into the Gulf of Mexico are discussed in section 3.6.2.1.2. Potential impacts were modeled based on monitoring data at operating SPR brine diffuser sites in the Gulf of Mexico, and the impacts from Stratton Ridge discharge would be localized.

The potential impacts of floodplains associated with the Stratton Ridge project is discussed in section 3.6.2.1.7 and in Appendix B. The extent of 100-year and 500-year floodplains in the project area, including the site and pipelines, was determined based on the FEMA flood insurance rate maps covering the project area. The Stratton Ridge storage site is located in a predominantly undeveloped wetland area. Table 3.6.6-2 provides a summary of the floodplains located within the project area.

Table 3.6.6-2: Total Area of Floodplains Affected by Stratton Ridge Storage Site

Floodplain	Area (acres)[a]	Area (hectares)[a]
100-year	140	55
500-year	190	75
Total [b]	**330**	**130**

Notes:

[a] Numbers have been rounded to two significant figures
[b] Numbers may not equal total due to rounding

All of the Stratton Ridge site lies within either the 100-year or the 500-year floodplain. A portion of the offsite pipeline construction would occur within a floodplain, but would only result in temporary impacts during construction. The floodplain in which the Stratton Ridge site is located extends over hundreds of square miles, and is part of the San Jacinto-Brazos Coastal Basin.

Table 3.6.6-1: Potentially Affected Surface Waters, Stratton Ridge

Water Body Name (and Relevant Segment)	Description	State Uses, Categories[a], and Impaired Segments
Cavern Site		
Oyster Creek (runs along southern property boundary)	Stream through marsh; primary drainage for the area; perennial	• Aquatic life use, contact recreation use, general use, fish consumption use, and public water supply use • Category 5b: aquatic life use not supported in 2004 due to depressed DO
Several isolated ponds present within the proposed facility footprint	N/A	N/A
RWI to Intracoastal Waterway		
Ridge Slough	Channel through marsh; intermittent	N/A
Bastrop Bayou	Channel through marsh; intermittent	• Aquatic life use, contact recreation use, general use, and fish consumption use • No category listed: aquatic life, contact recreation, and general uses are fully supported, but the fish consumption use was not assessed
Little Slough	Channel through marsh; perennial	N/A
Intracoastal Waterway	Major commercial and recreational waterway; USACE maintains navigable depths in the waterway through dredging and locks; perennial	• Used for both recreational boating and for commerce • Primary and secondary contact recreation and propagation of fish and wildlife • Has a good deal of commercial activity; barges haul petroleum, petroleum products, foodstuffs, building materials, and manufactured goods
Salt Bayou	Channel through marsh; intermittent	N/A
Essex Bayou	Channel through marsh; intermittent	N/A
Brine Disposal Pipeline Gulf of Mexico		
Bastrop Bayou	Channel through marsh; intermittent	• Aquatic life use, contact recreation use, general use, and fish consumption use • No category listed: the aquatic life, contact recreation, and general uses are fully supported, but the fish consumption use was not assessed
Little Slough	Channel through marsh; perennial	N/A
Ridge Slough	Channel through marsh; intermittent	N/A
Intracoastal Waterway	Major commercial and recreational waterway; USACE maintains navigable depths in the waterway through dredging and locks; perennial	• Used for both recreational boating and for commerce • Primary and secondary contact recreation and propagation of fish and wildlife • Has a good deal of commercial activity; barges haul petroleum, petroleum products, foodstuffs, building materials, and manufactured goods
Salt Bayou	Channel through marsh; intermittent	N/A
Essex Bayou	Channel through marsh; intermittent	N/A

Table 3.6.6-1: Potentially Affected Surface Waters, Stratton Ridge

Water Body Name (and Relevant Segment)	Description	State Uses, Categories[a], and Impaired Segments
Crude Oil Pipeline to Texas City (Parallel to Existing DOE Pipeline)		
Halls Bayou	Channel through marsh; perennial	• Aquatic life use, contact recreation use, fish consumption use • Category 5a: contact recreation use not supported in 2004 due to bacteria.
Willow Bayou	Channel through marsh; intermittent	N/A
Highland Bayou	Channel through marsh; intermittent	• Aquatic life use, contact recreation use, and fish consumption use • Category 5c: contact recreation use not supported and aquatic life use partially supported in 2002 due to bacteria and low dissolved oxygen. Fish consumption use was not assessed in 2002.
Austin Bayou	Channel through marsh; intermittent	N/A
Chocolate Bayou	Channel through marsh; perennial; annual average drainage flow = 88 cfs in 2003	• Aquatic life use, contact recreation use, and fish consumption use • No category listed: the aquatic life, contact recreation, and general uses are fully supported, but the fish consumption use was not assessed • Low DO killed 10,000 fish in 1998
Big Slough	Channel through marsh; intermittent	N/A
Bastrop Bayou	Channel through marsh, intermittent	• Aquatic life use, contact recreation use, general use, and fish consumption use • No category listed: the aquatic life, contact recreation, and general uses are fully supported, but the fish consumption use was not assessed
New Bayou	Channel through marsh; intermittent	N/A
Cottonwood Bayou	Channel through marsh; perennial	• Maintain waterfowl habitat
Persimmon Bayou	Channel through marsh; intermittent	N/A
Little Slough	Channel through marsh; perennial	N/A

Notes:

[a] Texas Commission on Environmental Quality (TCEQ) assigns each assessed water body to one of five categories to provide information to the public, EPA, and internal agency programs about water quality status and management activities. The categories indicate the status of the water body, how the state would approach identified water quality problems, and include the following:

Category 1 – Attaining the water quality standard and no use is threatened.

Category 2 – Attaining some of the designated uses; no use is threatened; and insufficient or no data and information are available to determine if the remaining uses are attained or threatened.

Category 3 – Insufficient or no data and information to determine if any designated use is attained.

Category 4 – Standard is not supported or is threatened for one or more designated uses but does not require development of a Total Maximum Daily Load (TMDL).

Category 4a – TMDL has been completed and approved by EPA.

Category 4b – Other pollution control requirements are reasonably expected to result in attainment of the water quality standard in the near future.

Category 4c – Nonsupport of the water quality standard is not caused by a pollutant.

Category 5 – The water body does not meet applicable water quality standards or is threatened for one or more designated uses by one or more pollutants. Category 5 water bodies comprise the 303(d) List.

Category 5a – A TMDL is under way, is scheduled, or will be scheduled.

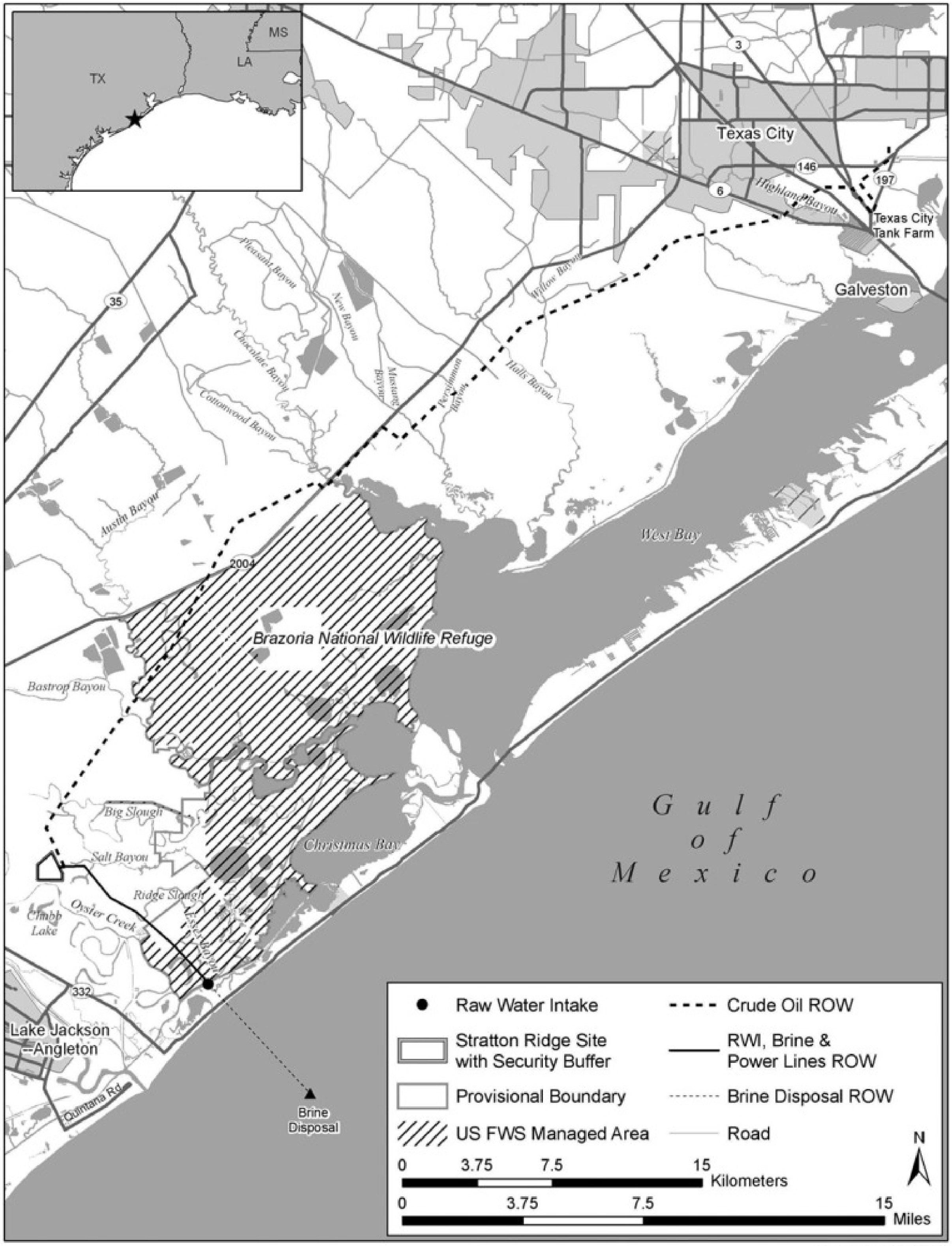
Category 5b – A review of the water quality standards will be conducted before a TMDL is scheduled.

Category 5c – Additional data and information will be collected before a TMDL is scheduled.

DO = dissolved oxygen; cfs = cubic feet per second (1 cfs = 0.03 cubic meters per second); N/A = not available

Source: TCEQ 2004a

Figure 3.6.6-1: Regional Surface Water Map for Stratton Ridge Site



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3.6.6.1.3 Stratton Ridge Surface Water: Operations and Maintenance Impacts

Potential impacts from operations and maintenance are similar to those from construction. Brine would be discharged to the Gulf of Mexico and raw water would be taken from the ICW during the operational phase, although at lower rates than during the construction phase.

3.6.6.2 Stratton Ridge Groundwater

3.6.6.2.1 Stratton Ridge Groundwater: Affected Environment

Ground surface elevation at the proposed SPR site is approximately 17 feet (5.2 meters) above sea level. Table 3.6.6-3 characterizes the aquifer system underlying Stratton Ridge. The Upper Chicot is an important aquifer in the region, is the most widespread source of fresh groundwater in Brazoria County, and the only one in the Stratton Ridge area. It is primarily used for irrigation and aquaculture, and there has been concern about decreasing water levels in the Chicot Aquifer over the past decade.

Table 3.6.6-3: Aquifers Underlying the Proposed Stratton Ridge SPR Site Area

Aquifer	Depth to Top of Aquifer (depth below land surface)	Overlying Soils/ Permeability (centimeters/second)[a]	Water Quality; Degree of Salinity[b]
Upper Chicot	10 feet (3 meters)	Beaumont clays at surface; 5.0×10^{-5} at surface to 9.0×10^{-2} in sands	Fresh water to slightly saline
Lower Chicot	300 feet (90 meters)	Discontinuous clay beds; sands, 1.0×10^{-2}	Slightly saline to saline
Evangeline	Away from dome 1,100 feet (340 meters)	Clay beds, join intermittently; 1.0×10^{-2} average in sands	Saline to brine
Jasper (Miocene)	Away from dome > 2,000 feet (> 600 meters)	Burkeville aquiclude; highly impermeable	Saline to brine

Notes:

[a] 1 centimeter = 0.394 inches
[b] Salinity determined by dissolved solids content, in parts per thousand (ppt): Fresh water, Less than 1 ppt; Slightly saline, 1–3 ppt; Moderately saline, 3–10 ppt; very saline, 10–35 ppt; brine, more than 35 ppt

3.6.6.2.2 Stratton Ridge Groundwater: Construction Impacts

All of the general groundwater impacts discussed in section 3.6.2.2 are applicable to the proposed Stratton Ridge site.

The oil pipeline to Texas City would pass adjacent to or through the following groundwater source areas:

- The 100-year capture zone for the public water system in Hitcock, TX (in the vicinity of the Texaco City Terminal);
- The Area of Primary Influence for the Peterson Landing, TX public water system; and
- The Oyster Creek public water system in Oyster, TX (Owojori 2006).

The brine pipeline to the Gulf of Mexico and the RWI pipeline would pass adjacent to or through four public water systems in Oyster Creek, TX. Freeport, a major center of development, is located 6.0 miles (9.7 kilometers) south of the site, and reportedly draws their drinking water from the Brazos River (Meeks

2005). However, some residents in the smaller coastal towns in the vicinity of the project, including Liverpool, Danbury, Angleton, Lake Jackson, Clute, and Oyster Creek, draw water from wells. Groundwater in the area is also used for rice farm irrigation, livestock, and industry.

The underlying Chicot Aquifer is an important groundwater resource, and any potential contaminant discharges from the SPR could result in degradation of water quality. However, best management practices outlined in section 3.6.2.2 should mitigate such an occurrence. Overall, the probability of discharges along the brine or oil pipelines is low, and there should be no impacts to these groundwater uses.

3.6.6.2.3 Stratton Ridge Groundwater: Operations and Maintenance Impacts

Potential impacts due to operations and maintenance activities at Stratton Ridge are discussed in section 3.6.2.2. The site-specific factors affecting any impacts are discussed above for construction impacts.

3.6.7 Bayou Choctaw Storage Site and Associated Infrastructure

Proposed expansion of the Bayou Choctaw site would include the following activities:

- Construction of two new storage caverns and associated well pads and access roads;

- Possible additional acquisition of one existing storage cavern and minor upgrades of existing infrastructures used, which would include new roads, bridge replacement, and modifications to onsite pipelines;

- Expansion of the capacity of the existing RWI system, which currently withdraws water from Cavern Lake located north of the site;

- Construction of an offsite brine disposal pipeline and six new brine injection wells; and

- Installation of new onsite pipelines.

The following sections describe the potentially affected water resources and potential impacts specific to the Bayou Choctaw storage site and associated infrastructure. The common impacts described in section 3.6.2 also apply to the Bayou Choctaw site.

3.6.7.1 Bayou Choctaw Surface Water

3.6.7.1.1 Bayou Choctaw Surface Water: Affected Environment

The proposed expansion of Bayou Choctaw site includes new cavern and road construction activities at the existing SPR site, a new offsite brine pipeline and brine injection wells south of the existing SPR site, and an increase in RWI and brine discharge. Surface water bodies that could potentially be affected by development of the Bayou Choctaw site include the following:

- Cavern Lake and connected surface water bodies near the point of RWI; and
- Various streams and bayous draining the inland Bayou Choctaw site.

The Bayou Choctaw SPR site, brine pipeline, and brine injection wells are located in the east-central portion of Iberville Parish and the Louisiana portion of the Western Gulf Coastal Plain Province. This low-lying area, approximately 5 feet (1.5 meters) above sea level, is composed of the Mississippi River floodplain, coastal marshes, and a series of Pleistocene terraces and low hills. The undeveloped portions of the Bayou Choctaw SPR site consist of forested (cypress swamp) and open-water wetlands connected to Bull Bay and Bayou Bourbeaux west of the site.

Bayou Bourbeaux and several small canals are connected to the forested and open-water wetlands on the SPR site and drain excess water from the site into Bull Bay and wetlands in the southern portion of the site that extend to the south. These surface water bodies drain into the ICW (also called Bayou Choctaw) to the west, and to the marsh to the south via drainage streams.

Additionally, a manmade pond, Cavern Lake, is located at the site, adjacent to Bayou Bourbeaux. This pond resulted from the collapse of former Cavern No. 7. The pond is approximately 26 meters (85 feet) deep with a surface area of about 12 acres (4.9 hectares), and is connected to the ICW via a canal. It is assumed that the lake is conical in shape containing a volume of 338 acre-feet (4.17×10^5 cubic meters) of water (DOE 1978b).

3.6.7.1.2 Bayou Choctaw Surface Water: Construction Impacts

The proposed Bayou Choctaw expansion project would utilize existing facilities, develop two new storage caverns and possibly also acquire an existing third cavern. Offsite construction would include installing a new brine disposal pipeline and adding six new brine injection wells to the existing brine injection well network. All of the potential impacts general to SPR sites listed in section 3.6.2.1 are applicable to Bayou Choctaw. Bayou Choctaw would inject brine into the subsurface and would not discharge to the Gulf of Mexico, as discussed below. Potential impacts of extracting raw water from an onsite lake are described below.

Surface waters that could potentially be affected by the project are listed below in table 3.6.7-1 and shown in figure 3.6.7-1. The facility site is located within a swampy area. The brine pipeline would originate from the existing brine injection wells and extend to the new area; no specific surface water bodies would be crossed by the brine disposal pipeline.

The Bayou Choctaw SPR facility would have a maximum raw water demand of 0.615 MMBD to achieve the planned maximum drawdown rate. Raw water demand during leaching would be considerably lower at 0.110 MMBD. Raw water for the site would be withdrawn from Cavern Lake, which would be replenished by flow from the ICW by way of two canals (the north-south and east-west canals) that connect Cavern Lake to the ICW.

Potential impacts to these surface waters associated with raw water withdrawal for the Bayou Choctaw site were studied in detail in the 1976 EIS for the Bayou Choctaw SPR facility (DOE 1976 and appendix G.1). This study assumed a water withdrawal rate of 0.667 MMBD. Based on the 1976 study, maximum depth change (height differentials) in any of the affected bodies of water resulting from raw water withdrawal would be in the order of several thousandths of a foot (i.e., less than a millimeter). Flow velocities induced by RWI would range from 0.18 feet per second (0.20 kilometers per hour) in the north-south canal, to 0.23 feet per second (0.25 kilometers per hour) in the ICW. The raw water withdrawal would slightly affect salinity levels in Cavern Lake and possibly in the smaller connecting water bodies (north-south canal, east-west canal). Modeling conducted for the 1976 EIS (DOE 1976) indicates that overall salinity changes would be less than 1 part per thousand in Cavern Lake.

DOE has evaluated the potential impacts to floodplains in section 3.6.2.1.7 and appendix B. Because the entire site is located within the 100-year floodplain and the undeveloped portions consist of forested and open water wetlands, construction of all new onsite and offsite pipelines and brine disposal wells would

Table 3.6.7-1: Potentially Affected Surface Waters, Bayou Choctaw

Water Body Name (and Relevant Segment)	Description	State Designations,[a] Uses, and Impaired Segments
Cavern Site		
Drained by several creeks flowing through and around site into wetlands on southern portion of site and to the south, and then into Bayou Choctaw (ICW). The site is at 5 feet (1.5 meters) above sea level.	Creeks through marsh; perennial	N/A
Cavern Lake	Manmade pond resulting from the collapse of former Cavern No. 7; connected to the ICW via canal	N/A
Bayou Bourbeaux runs north-south through site	Creek through marsh; perennial	N/A
Bull Bay (drains Bayou Bourbeaux west of site)	Coastal bay	N/A
RWI (only flow increase, no new pipeline)		
Intracoastal Waterway (also called Bayou Choctaw)	Major commercial and recreational waterway	• Used for both recreational boating and for commerce • Primary and secondary contact recreation and propagation of fish and wildlife • Has a good deal of commercial activity; barges haul petroleum, petroleum products, foodstuffs, building materials, and manufactured goods • USACE maintains navigable depths in the waterway through dredging and locks

Notes:

[a] State designations are defined as:

Primary Recreation: "any recreational or other water use in which there is prolonged and intimate body contact with the water involving considerable risk of absorbing waterborne constituents through the skin or of ingesting constituents from water in quantities sufficient to pose a significant health hazard."

Secondary Recreation: "any recreational or other water use in which body contact with the water is either incidental or accidental, and in which the probability of ingesting appreciable quantities of water is minimal."

Fish and Wildlife Propagation: "the use of water for aquatic habitat, food, resting, reproduction, cover, and/or travel corridors for any indigenous wildlife and aquatic life species associated with the aquatic environment. This use also includes the maintenance of water quality at a level that prevents damage to indigenous wildlife and aquatic life species associated with the aquatic environment and contamination of aquatic biota consumed by humans."

Drinking Water Supply: "refers to the use of water for human consumption and general household use."

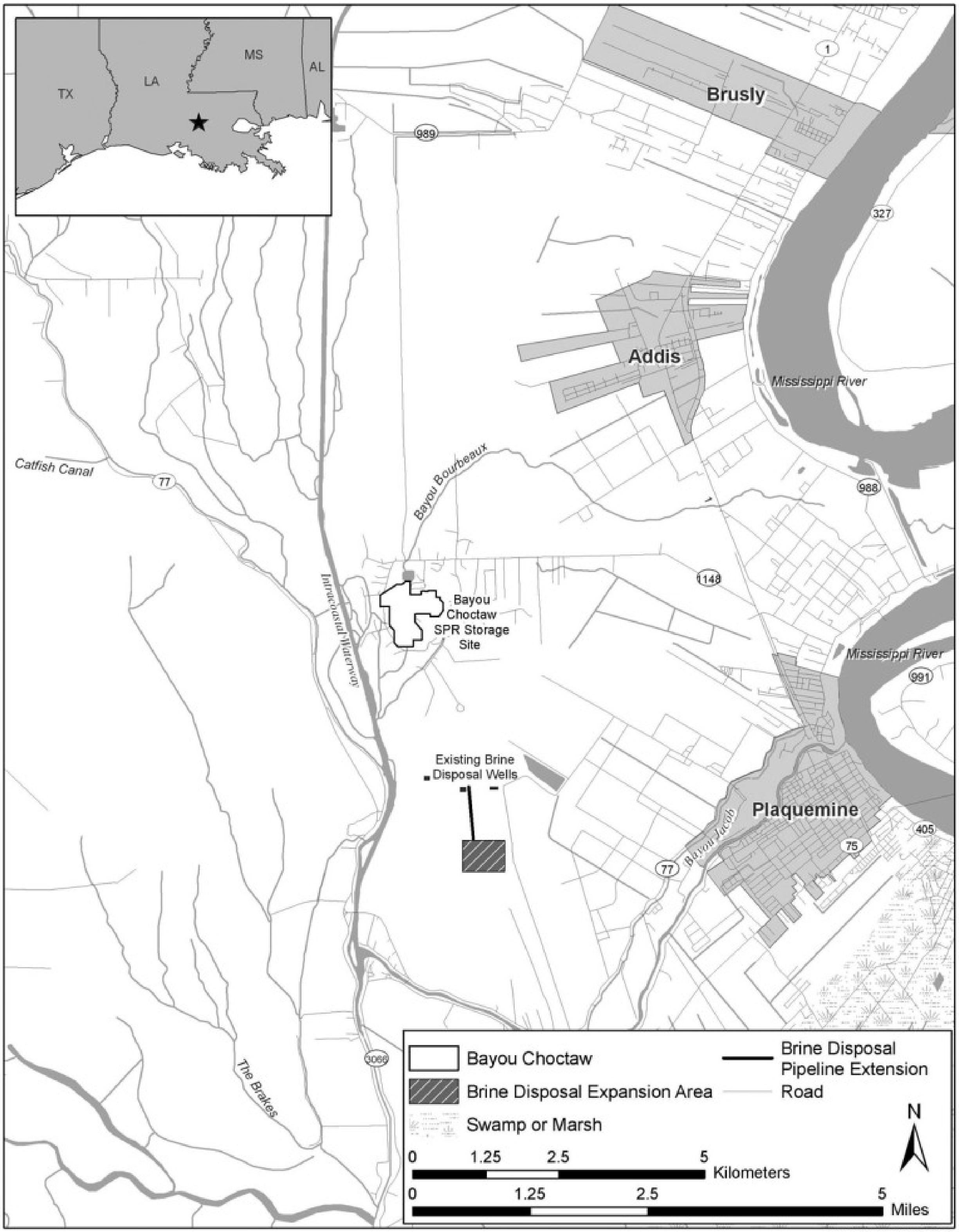
Oyster Propagation: "the use of water to maintain biological systems that support economically important species of oysters, clams, mussels, or other mollusks so that their productivity is preserved and the health of human consumers of these species is protected."

Agriculture: "the use of water for crop spraying, irrigation, livestock watering, poultry operations, and other farm purposes not related to human consumption."

Outstanding Natural Resource Waters: "include water bodies designated for preservation, protection, reclamation, or enhancement of wilderness, aesthetic qualities, and ecological regimes, such as those designated under the Louisiana Natural and Scenic Rivers System or those designated by the department as waters of ecological significance. Characteristics of outstanding natural resource waters include, but are not limited to, highly diverse or unique in stream and/or riparian habitat, high species diversity, balanced trophic structure, unique species, or similar qualities."

Source: LDEQ 2005

Figure 3.6.7-1: Local Surface Water Map for Bayou Choctaw Site



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occur within the floodplain. Construction of the pads for the two new caverns and the new access roads would require filling approximately 5 acres (2 hectares) of floodplains. The floodplain in which the Bayou Choctaw site is located is an extensive floodplain, part of the West Gulf Coastal Plain. Table 3.6.7-2 provides a summary of the floodplains located within the project area.

Table 3.6.7-2: Total Area of Floodplains Affected by Bayou Choctaw Storage Site

Floodplain	Area (acres)[a]	Area (hectares)[a]
100-year	24	10
500-year	N/A	N/A
Total	**24**	**10**

[a] Numbers have been rounded to two significant figures

3.6.7.1.3 Bayou Choctaw Surface Water: Operations and Maintenance Impacts

The potential impacts on surface water from the expanded Bayou Choctaw site would be similar to those described above for construction. The RWI would be operational during the life of the facility.

3.6.7.2 Bayou Choctaw Groundwater

3.6.7.2.1 Bayou Choctaw Groundwater: Affected Environment

In the Bayou Choctaw Dome area, the subsurface water system is principally comprised of Pleistocene-aged, interconnected freshwater bearing sands that form the Plaquemine artesian aquifer system. The Plaquemine aquifer is highly permeable with porosities of 40 percent and permeability coefficients of approximately 1,000 to 2,000 gallons per day (3.8 to 7.6 cubic meters per day). The aquifers in the vicinity of the Bayou Choctaw site are able to deliver large quantities of slightly-to-moderately-saline water (DOE 1978b, pp. 3.2-8, 3.2-9). Although the underlying aquifer is an important groundwater resource, there are no Groundwater Protection Areas in the vicinity of the Bayou Choctaw site, indicating that groundwater use is fairly limited in this geographic area, especially as a potable source.

According to the Louisiana Department of Transportation and Development water well registry, a number of groundwater wells are located in the vicinity of the Bayou Choctaw site (LADOTD 2005). The identified wells are primarily screened at depths ranging from approximately 120 to 250 feet (37 to 76 meters) below ground surface, and consist of industrial, rig supply, and public supply wells. Some shallower monitoring wells are installed at depths ranging from 3 to 40 feet (0.91 to 12 meters) below ground surface. Groundwater depths reported from the identified wells generally range from 1 to 5 feet (0.30 to 1.5 meters) below ground, and have reported well yields up to 2.7 cubic feet per second (0.076 cubic meters per second).

3.6.7.2.2 Bayou Choctaw Groundwater: Construction Impacts

The general impacts to groundwater discussed in section 3.6.2.2 are applicable to the Bayou Choctaw site. Although the aquifer underlying the site is used as a drinking water supply by Baton Rouge to the northeast, groundwater from the site is expected to flow toward the ICW to the west and to the marsh to the south. Thus, any contaminant discharges from the site should not impact groundwater quality in Baton Rouge. There would be no use of groundwater for this proposed candidate alternative.

Proposed new and existing injection wells would be used to dispose of brine from cavern development. The Bayou Choctaw proposed expansion would utilize the existing brine disposal injection system with the addition of a new, brine filtration system and six new injection wells.

The brine would be disposed of via injection into subsurface saline strata at two injection areas located south of the dome. The existing system is comprised of a well field with 10 disposal wells and was designed to accommodate a maximum of 0.01 MMB per hour of displaced brine. The proposed new injection area would be located approximately 3,000 feet (900 meters) south of the existing area and would inject brine into the same receiving formation. According to previous studies, the proposed receiving formation for injection of brine ranges in depths from 5,000 to 7,000 feet (1,500 to 2,100 meters), which is significantly below any aquifers containing fresh or slightly saline water. (DOE 1978b, pp. A.4-10, C.6-8). The aquifers used for potable water and those used for brine injection are confined aquifers that are separated by impermeable strata. The potential impacts of brine disposal in the existing disposal wells has been extensively studied in previous EIS studies (DOE 1976; DOE 1978b) and were found to be minimal. Therefore development of six new brine disposal wells that would inject brine into the same formation would result in minimal impacts on groundwater. The brine disposal rate would remain at the permitted rate of 0.110 MMBD. Thus, impacts to groundwater associated with the disposal of brine by deep well injection would be minimal.

According to the USGS, large withdrawals from the aquifer system in the Baton Rouge area have altered groundwater flow patterns. Saltwater now encroaches into formerly fresh-water areas and local officials are concerned about the impacts of increasing salinities on public water supplies (USGS 1999). The proposed Bayou Choctaw project would not contribute to saltwater encroachment into fresh groundwater resources, since the brine would be injected into the deep saline strata, far below fresh groundwater. Also, the aquifers used for potable water and those used for brine injection are confined aquifers that are separated by impermeable strata (DOE 1976; DOE 1978b).

3.6.7.2.3 Bayou Choctaw Groundwater: Operations and Maintenance Impacts

Potential impacts due to operations and maintenance at Bayou Choctaw would be similar to those described above for the construction phase. Use of brine injection wells would continue through the operational phase.

3.6.8 Big Hill Storage Site and Associated Infrastructure

The Big Hill site would take advantage of the existing infrastructure, but still require an expansion or upgrade of several major systems, including the following activities:

- Construction and operation of new storage caverns;
- Installation of a new RWI and injection pumps as well as new motors to the existing RWI system, which draws water from the ICW;
- Construction of an additional anhydrite pond for brine disposal adjacent to the existing ponds;
- Replacement of a segment of the existing brine pipeline to repair corrosion damage;
- Construction and operation of pipeline to Sun Terminal in Nederland and new onsite oil injection pumps; and

- Site-support facilities including construction of a security fence, clearing a security buffer beyond the security fence, and construction of access roads.

The following sections describe the potentially affected water resources and potential impacts specific to the Big Hill storage site and associated infrastructure. The general impacts described in section 3.6.2 also apply to the Big Hill site.

3.6.8.1 Big Hill Surface Water

3.6.8.1.1 Big Hill Surface Water: Affected Environment

The existing Big Hill SPR site is located within the Neches-Trinity Coastal Basin in the Texas portion of the Gulf Coastal Plain Province. The proposed cavern expansion site is located on a local topographic high between elevations of 10 to 30 feet (3 to 9 meters) above sea level. DOE would construct 8, 10, or 12 MMB caverns to expand capacity by 80 or 96 MMB. Surface drainage is toward a pond and unnamed stream to the north and a wetland-stream complex to the south.

The predominant surface water quality problems for the Neches-Trinity Coastal Basin include depressed dissolved oxygen levels, high nutrient concentrations, and elevated concentrations of aluminum (Lower Neches Valley Authority (LNVA 2004). These deficiencies are related to the sluggish water flow, point and nonpoint source pollution, and industrial contamination. Most water bodies are designated for fish consumption use, contact recreation, and aquatic life support (TCEQ 2004). The construction of artificial shipping channels and pipeline canals to serve these industries has facilitated saltwater encroachment into previously fresh waters.

3.6.8.1.2 Big Hill Surface Water: Construction Impacts

The particular water bodies in the area are listed below in table 3.6.8-1 and shown in figure 3.6.8-1. The existing brine disposal pipeline runs from the cavern site, crosses the ICW and continues through an extensive coastal marsh complex that includes the McFaddin National Wildlife Refuge to the Gulf of Mexico. Only the initial 1.3 miles (2.1 kilometers) of the brine disposal pipeline would be replaced with the proposed expansion of Big Hill, so construction would not extend into the ICW for the National Wildlife Refuge. The new crude oil pipeline would cross several perennial and intermittent canals and bayous.

Brine would be discharged to the Gulf of Mexico through an existing brine-diffuser system, and potential impacts are described in section 3.6.2.1.2. The most currently available NPDES monitoring report (2003) indicates that discharge water quality is consistently within permit requirements at Big Hill (DOE, 2004f). Brine discharge would result in localized elevations in salinity.

As in the past, the Big Hill site would withdraw raw water from the ICW. Impacts associated with raw water withdrawal from the ICW are addressed in Section 3.6.2.1.1 and would be expected to be minimal.

DOE has evaluated potential impacts to floodplains in section 3.6.2.1.7 and in appendix B. The proposed Big Hill expansion site is located partially in a predominantly undeveloped, extensive floodplain system. However, a large percentage of this proposed expansion site would be located outside of the 100-year and the 500-year floodplain. The proposed expansion would utilize areas that are already built up above the floodplain elevations from previous construction activities. The expansion site would affect 11 acres (5 hectares) of the 100-year floodplain and approximately 27 acres (11 hectares) for the 500-year floodplain associated with the onsite facilities (wellpads, roads, anhydrite pond, and well heads). The

Table 3.6.8-1: Potentially Affected Surface Waters, Big Hill

Water Body Name (and Relevant Segment)	Description	State Uses, Categories[a], and Impaired Segments
Cavern Site		
The cavern site drains to unnamed pond and stream to the north and wetlands-stream complex to the south	N/A	N/A
RWI (flow increase only; no new pipeline)		
Intracoastal Waterway	Major commercial and recreational waterway; USACE maintains navigable depths in the water way through dredging and locks; perennial	• Used for both recreational boating and for commerce • Primary and secondary contact recreation and propagation of fish and wildlife • No category listed: the aquatic life, contact recreation and general uses are fully supported, but the fish consumption use was not assessed in 2004 • Has a good deal of commercial activity; barges haul petroleum, petroleum products, foodstuffs, building materials, and manufactured goods
Spindletop Marsh	Swamp	N/A
Salt Bayou Marsh and Salt Bayou	Swamp	N/A
Brine Disposal Pipeline (upgrade of 7,000 feet)		
Un-named canal	N/A	N/A
Intracoastal Waterway	Major commercial and recreational waterway; USACE maintains navigable depths in the water way through dredging and locks; perennial	• See above; used for both recreational boating and commerce • Primary and secondary contact recreation and propagation of fish and wildlife • No category listed: the aquatic life, contact recreation and general uses are fully supported, but the fish consumption use was not assessed in 2004 • Has a good deal of commercial activity; barges haul petroleum, petroleum products, foodstuffs, building materials, and manufactured goods
Tributary to Star Lake	Marshlands upstream of the McFaddin National Wildlife Refuge	• Areas of concern: nitrate+nitrite nitrogen, depressed DO, orthophosphorus, and total phosphorus
Spindletop Marsh	Swamp	N/A
Salt Bayou Marsh and Salt Bayou	Swamp	N/A
McFaddin National Wildlife Refuge	Extensive coastal marsh	• 55,000-acre national wildlife refuge
Crude Oil Pipeline to Sun Terminal at Nederland (23-mile)		
Several Unnamed canals	N/A	N/A
Taylor Bayou (above tidal)	Lake, perennial	• Aquatic life use, contact recreation use, general use, fish consumption use • Category 5c: aquatic life use not supported in 2004 due to depressed DO

Table 3.6.8-1: Potentially Affected Surface Waters, Big Hill

Water Body Name (and Relevant Segment)	Description	State Uses, Categories[a], and Impaired Segments
Willow Marsh Bayou	Channel through marsh; perennial	• Aquatic life use, contact recreation use, fish consumption use • No category listed: the aquatic life use is fully supported, but the contact recreation and fish consumption uses were not assessed in 2004
Hildebrant Bayou	Channel through marsh, perennial	• Aquatic life use, contact recreation use, general use, fish consumption use • Category 5c: aquatic life use partially supported in 2004 due to depressed DO

Notes:

[a] TCEQ assigns each assessed water body to one of five categories to provide information to the public, EPA, and internal agency programs about water quality status and management activities. The categories indicate the status of the water body, and how the state would approach identified water quality problems:

Category 1 – Attaining the water quality standard and no use is threatened.

Category 2 – Attaining some of the designated uses; no use is threatened; and insufficient or no data and information are available to determine if the remaining uses are attained or threatened.

Category 3 – Insufficient or no data and information to determine if any designated use is attained.

Category 4 – Standard is not supported or is threatened for one or more designated uses but does not require the development of a Total Maximum Daily Load (TMDL).

Category 4a – TMDL has been completed and approved by EPA.

Category 4b – Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard in the near future.

Category 4c – Nonsupport of the water quality standard is not caused by a pollutant.

Category 5 – The water body does not meet applicable water quality standards or is threatened for one or more designated uses by one or more pollutants. Category 5 water bodies comprise the 303(d) List.

Category 5a – A TMDL is under way, is scheduled, or will be scheduled.

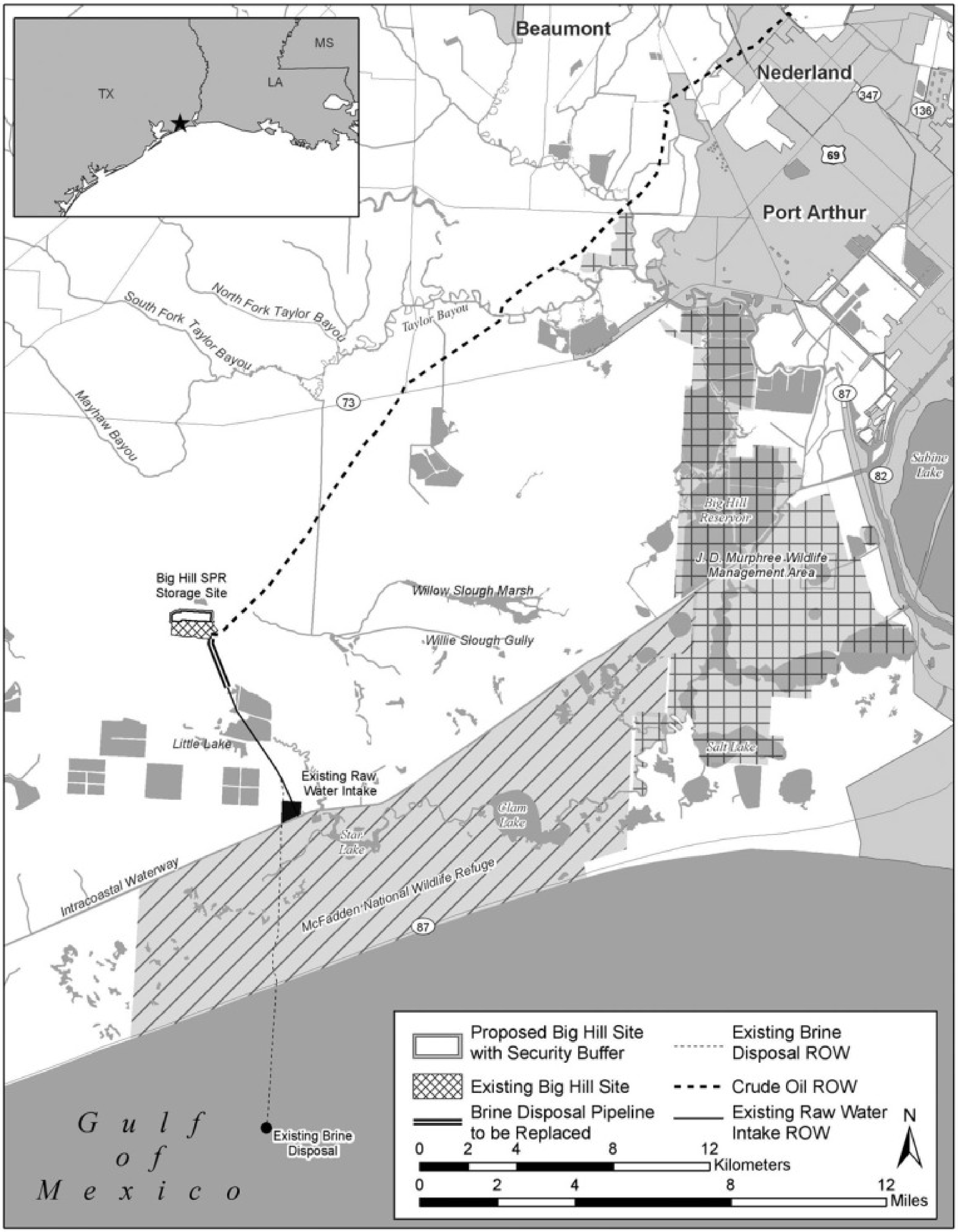
Category 5b – A review of the water quality standards will be conducted before a TMDL is scheduled.

Category 5c – Additional data and information will be collected before a TMDL is scheduled.

DO = dissolved oxygen; N/A = not available; 1 acre = 0.404 hectare; 1 foot = 0.30 meters; 1 mile = 1.609 kilometers

Source: TCEQ 2004a

Figure 3.6.8-1: Regional Surface Water Map for Big Hill Site



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floodplain in which the Big Hill site is located extends over hundreds of square miles, and is part of the Neches-Trinity Coastal Basin.

3.6.8.1.3 Big Hill Surface Water: Operations and Maintenance Impacts

Operations and maintenance activities would have the same potential impacts as described above for the construction phase and in section 3.6.2.1. The RWI and the Gulf of Mexico brine discharge diffuser would also be active during the operational phase.

3.6.8.2 Big Hill Groundwater

3.6.8.2.1 Big Hil Groundwater: Affected Environment

Table 3.6.8-2 characterizes the aquifers underlying the Big Hill site. The groundwater surface varies from a depth of approximately 6.6 feet (2.0 meters) below land at the center of the hill to almost ground level near the base of the hill 26 feet (8.0 meters) above sea level. The fresh water base of the upper unit of the Chicot aquifer, which normally sits at approximately 1,200 feet (370 meters) below land surface, has been uplifted to as high as 98 feet (30 meters) below land directly above the salt dome. Slightly saline groundwater exists in the lower unit of the Chicot at a depth of 300 feet (90 meters). The interface of the Upper Chicot and Lower Chicot is virtually unconfined at the site. Both the semi-confined Evangeline and the totally-confined Jasper are pierced by the salt dome. Both aquifers are too deep and too saline to be used as a water supply or affected by surface operations.

Table 3.6.8-2: Characterization of Aquifers Underlying the Big Hill Site

Aquifer	Depth to Top of Aquifer (Below Land Surface)	Overlying Soils/ Permeability (cm/sec)	Degree of Salinity[a]
Upper Chicot	7.0 feet (2.0 meters)	Porous; west and south surface edges less porous, $1.0x10^{-2}$	Mostly fresh water
Lower Chicot	300 feet (90 meters)	Intermittent clay bed, $1.0x10^{-6}$ to $1.0x10^{-4}$; sands $1.0x10^{-2}$	Slightly saline
Evangeline	Away from dome, 1,500 feet (460 meters)	Discontinuous thick clay bed, $1.0x10^{-6}$ to $1.0x10^{-4}$	Moderately saline to brine
Jasper	Away from dome, > 2,000 feet (600 meters)	Burkeville Aquiclude, highly impermeable	Moderately saline to brine

Notes:

[a] Salinity determined by dissolved solids content, in parts per thousand (ppt): fresh water, less than 1 ppt; slightly saline, 1–3 ppt; moderately saline, 3–10 ppt; very saline, 10–35 ppt; brine, more than 35 ppt

cm/sec = centimeters per second

Sources: Barbie 1991a and 1991b; Hart 1981; TWDB 1971; Davies 1984

3.6.8.2.2 Big Hill Groundwater: Construction Impacts

Potential impacts general to the SPR sites are discussed in section 3.6.2.2, and are applicable to the Big Hill site expansion.

The Chicot Aquifer is an important groundwater resource in Louisiana and Texas. It is a sole source aquifer, and according to the Louisiana Department of Environmental Quality, there is a concern about over-pumping, which results in salt water intrusion into the aquifer (Jennings 2006). Use of the aquifer for irrigation of rice farms, in addition to other uses, in this area puts pressure on the groundwater resource. According to the EPA's Federal Reporting Data System, no municipal wells are within 5 miles (8 kilometers) hydraulically downgradient of the Big Hill site. Since the land surrounding the site is swampy and contains many oil fields, extensive development of groundwater resources in the near future appears unlikely, and any impacts from the proposed project are unlikely.

The existing water intake and brine discharge pipelines run through coastal marsh, south from Big Hill to the ICW and the Gulf of Mexico, respectively. There is little population or established use of groundwater in the area between Big Hill and the ICW and Gulf of Mexico region. No towns or major withdrawal centers are along the pipelines' path toward the Gulf of Mexico. Impacts to groundwater along the pipeline route would be unlikely, but if they did occur, there would be none to minimal impact to current groundwater usage.

3.6.8.2.3 Big Hill Groundwater: Operations and Maintenance Impacts

Likewise, the general impacts discussion in section 3.6.2.2 captures the potential operations and maintenance impacts to groundwater at Big Hill. The site specific groundwater conditions discussed above in construction impacts would also apply to operations and maintenance impacts. The ongoing groundwater monitoring program at the Big Hill SPR site indicates that groundwater has not been impacted by brine releases from the brine pond (DOE 2004f). One small release was identified from an underground brine pipeline, but it was quickly remediated (DOE 2004f). This historic data indicates very low probability of any impacts to groundwater from the proposed project.

3.6.9 West Hackberry Storage Site

The proposed West Hackberry expansion would use the existing infrastructure, including the existing RWI system, crude oil distribution system, and brine disposal system, without the need for significant upgrades. The only changes would be the following:

- Acquisition and use of three existing 5–MMB caverns adjacent to the site (no new cavern leaching or drilling would be required);
- Construction of new onsite pipelines to connect the acquired caverns to the existing onsite water, brine, and crude oil systems;
- Installation of firewater main line and string flush and oily water lines; and
- Addition of site support facilities including construction of a security fence, clearing a security buffer beyond the security fence, construction of cavern spill containment features, and new site access road.

The following sections describe the potentially affected water resources and potential impacts specific to the West Hackberry storage site and associated infrastructure. The general impacts described in section 3.6.2 also apply to the West Hackberry site.

3.6.9.1 West Hackberry Surface Water

3.6.9.1.1 West Hackberry Surface Water: Affected Environment

The West Hackberry site would include no new offsite pipelines and no significant upgrades to the RWI facility, crude oil distribution capabilities, or the brine disposal system. Surface water bodies that could potentially be affected by the West Hackberry expansion site include inland water bodies surrounding or downstream of the West Hackberry site. In addition, the ICW would continue to serve as the source of raw water for the site, as it has in the past.

The West Hackberry site is located approximately 6.0 miles (10 kilometers) west of Calcasieu Lake within the estuarine part of the Calcasieu River Basin. Local drainage is to Black Lake and Black Lake Bayou, which surround the site to the north, west, and southwest. The site is approximately 5.0 to 10.0 feet (1.5 to 3.0 meters) above sea level. The surface water system in the vicinity of the site is comprised of brackish marsh interconnected with a network of bayous and canals that connect to Black Lake, Calcasieu Lake, Calcasieu River, Calcasieu Ship Channel, and the ICW. In general, the surface waters in the area are brackish, with a salinity of approximately 12 parts per thousand (Nipper et al. 2005).

The surface water system in the area is used for a variety of purposes, including transportation, industrial activities, commercial fishing, rice farming, livestock watering, irrigation of crops, and as habitat for wildlife (DOE 1978d, p. 3.2-6). The major water quality issues in this area result from saltwater intrusion into freshwater systems, priority organics, and indicators of pathogens. For example, the Louisiana Department of Environmental Quality issued an informal fish consumption advisory primarily related to organic contamination for the Calcasieu River **estuary** to the Gulf of Mexico.

3.6.9.1.2 West Hackberry Surface Water: Construction Impacts

The proposed expansion at West Hackberry would involve acquisition of existing storage caverns adjacent to the existing SPR site. As noted above, the expansion would utilize the existing brine disposal, RWI, crude oil intake, and oil distribution systems. Brine would be disposed of in subsurface injection wells, and raw water would be withdrawn from the ICW.

The primary water bodies in the area are listed in table 3.6.9-1 and shown in figure 3.6.9-1.

Because there is no offsite pipeline construction associated with this proposed site, potential construction impacts to surface water would be limited to the vicinity of the West Hackberry site itself. Brine would be disposed of via deep well injection, and would not affect surface water. The West Hackberry site would withdraw raw water from the ICW. Potential impacts associated with raw water withdrawal from the ICW are addressed in section 3.6.2.1.1, and would be expected to be minimal.

DOE has evaluated the potential impacts to floodplains in section 3.6.2.1.7 and appendix B. The West Hackberry expansion would involve acquisition of existing storage caverns adjacent to the existing SPR site. While a very small portion of the land to be acquired is within a floodplain, no new onsite construction would be required within the floodplain. As noted above, the proposed expansion would utilize the existing brine disposal, RWI, crude oil intake, and oil distribution systems. It would not require any new offsite construction in the floodplain. Therefore, no impacts to floodplains in the project area would result from project construction or operation.

Table 3.6.9-1: Potentially Impacted Surface Waters, West Hackberry

Water Body Name (and Relevant Segment)	Description	State Designations, Uses,[a] and Impaired Segments
Cavern Site		
Black Lake	Lake; perennial	• Primary and secondary contact recreation and fish and wildlife propagation
Black Lake Bayou	Stream through marsh; perennial	• Agriculture, primary and secondary contact recreation, and outstanding natural resource water • Portions of Black Lake Bayou are used recreationally and are classified as natural and scenic by the Louisiana Department of Wildlife and Fisheries
RWI (flow increase)		
Intracoastal Waterway	Major commercial and recreational waterway; USACE maintains navigable depths in the waterway through dredging and locks; perennial	• Used for both recreational boating and commerce • Primary and secondary contact recreation and fish and wildlife propagation • The ICW has a good deal of commercial activity; barges haul petroleum, petroleum products, foodstuffs, building materials, and manufactured goods

Notes:

[a] State designations are defined as:

Primary Recreation: "any recreational or other water use in which there is prolonged and intimate body contact with the water involving considerable risk of absorbing waterborne constituents through the skin or of ingesting constituents from water in quantities sufficient to pose a significant health hazard."

Secondary Recreation: "any recreational or other water use in which body contact with the water is either incidental or accidental, and in which the probability of ingesting appreciable quantities of water is minimal."

Fish and Wildlife Propagation: "the use of water for aquatic habitat, food, resting, reproduction, cover, and/or travel corridors for any indigenous wildlife and aquatic life species associated with the aquatic environment. This use also includes the maintenance of water quality at a level that prevents damage to indigenous wildlife and aquatic life species associated with the aquatic environment and contamination of aquatic biota consumed by humans."

Drinking Water Supply: "refers to the use of water for human consumption and general household use."

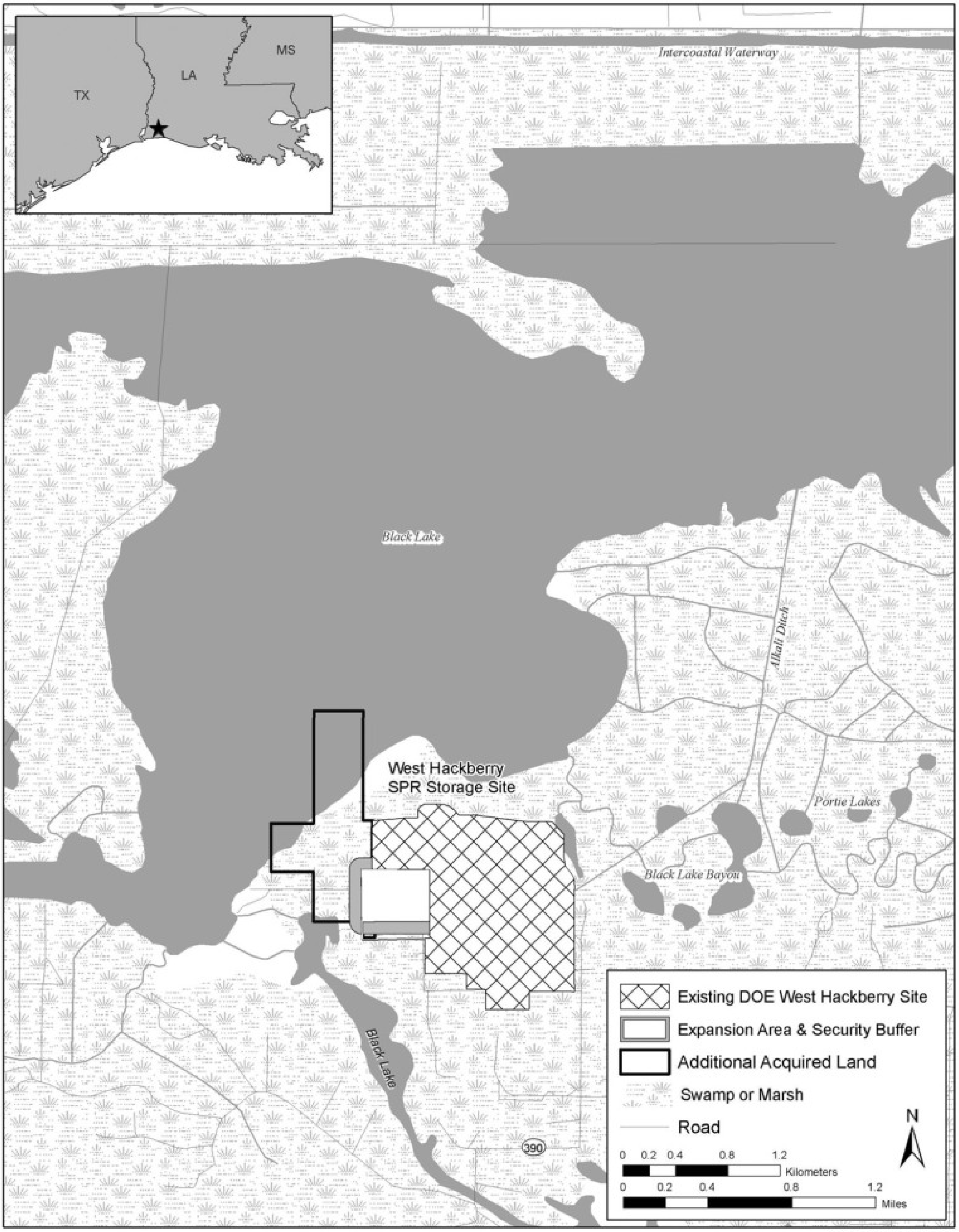
Oyster Propagation: "the use of water to maintain biological systems that support economically important species of oysters, clams, mussels, or other mollusks so that their productivity is preserved and the health of human consumers of these species is protected."

Agriculture: "the use of water for crop spraying, irrigation, livestock watering, poultry operations, and other farm purposes not related to human consumption."

Outstanding Natural Resource Waters: "include water bodies designated for preservation, protection, reclamation, or enhancement of wilderness, aesthetic qualities, and ecological regimes, such as those designated under the Louisiana Natural and Scenic Rivers System or those designated by the department as waters of ecological significance. Characteristics of outstanding natural resource waters include, but are not limited to, highly diverse or unique in stream and/or riparian habitat, high species diversity, balanced trophic structure, unique species, or similar qualities."

Source: LDEQ 2005

Figure 3.6.9-1: Regional Surface Water Map for West Hackberry Site



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3.6.9.1.3 West Hackberry Surface Water: Operations and Maintenance Impacts

The potential impacts to surface water discussed in section 3.6.2.1 are applicable to the West Hackberry site. No additional site-specific issues regarding potential impacts to surface water were identified.

3.6.9.2 West Hackberry Groundwater

3.6.9.2.1 West Hackberry Groundwater: Affected Environment

The site is underlain by the Chicot Aquifer, which extends from the ground surface to over 1,000 feet (305 meters) below grade in the site area. In general, the Chicot is mostly fresh water in the upper reaches, but becomes increasingly saline with depth (DOE 1992a). The aquifer is underlain by the Evangeline and Jasper Aquifers, as summarized in table 3.6.9-2 below.

The underlying Chicot Aquifer is a sole source aquifer, and according to the Louisiana Department of Environmental Quality, there is concern about over-pumping, which could result in saltwater intrusion into the aquifer (Jennings 2006). Use of the aquifer for irrigation of rice farms, in addition to other uses, puts pressure on the groundwater resource. Although groundwater only provides 20 percent of total water usage in the area, with surface water providing the remaining 80 percent, the Chicot Aquifer is an important water resource.

Table 3.6.9-2: Aquifers in Vicinity of West Hackberry Expansion Site

Aquifer	Groundwater Description	Depth of Aquifer
Chicot	Mostly fresh water north of Cameron Parish and saline water in the coastal region	Ranges from less than 100 feet thick in Beauregard Parish to more than 7,000 feet under the Gulf of Mexico; extends from the surface to 1,100 feet below land surface
Evangeline	Freshwater north of Calcasieu Parish and saline water from southern Calcasieu Parish to the coast	Not available for site
Jasper	Saline water from the middle of Beauregard Parish south to the coast	Not available for site

1 foot = 0.30 meters

Source: DOE 1978c

There are a number of groundwater wells located in the vicinity of the West Hackberry site (LADOTD 2005). Louisiana Department of Transportation and Development records indicate that the wells are screened at depths ranging from 10 to 500 feet (3.0 to 150 meters) below land surface within the Chicot Aquifer system, and consist of industrial, monitoring, and domestic use wells. Groundwater depths reported from the shallower wells generally range from 3.0 to 15 feet (0.90 to 4.6 meters) below land surface. Groundwater depths from the wells screened in the deeper intervals (e.g., 200 to 500 feet [61 to 150 meters] below land surface) range from approximately 30 to 60 feet (9 to 18 meters) deep, and have reported well yields up to 4.46 cubic feet per second (0.13 cubic meters per second). Hydraulic conductivities of the Chicot Aquifer reportedly range from 40 to 220 feet per day (12 to 67 meters per day). The general groundwater flow direction at the West Hackberry site is expected to be south towards the Gulf of Mexico.

3.6.9.2.2 West Hackberry Groundwater: Construction Impacts

The general impacts to groundwater discussed in section 3.6.2.2 are applicable to the West Hackberry site. Given that the site is underlain by a sole source aquifer, any impacts to the aquifer could result in impacts to water use in the area. Also, the aquifer is found at shallow depths, making it more susceptible to any surface discharges of contaminants during construction. However, best management practices described in section 3.6.2.2 would result in very low probability of a discharge or significant impact to groundwater.

In addition to the general impacts, deep injection wells would be used to dispose of brine at the West Hackberry site. The injection wells would be used during cavern filling operations as the caverns already exist. The potential impacts of brine disposal via deep well injection were assessed and modeled in detail in the 1977 final EIS for the West Hackberry site (FEA 1977). This study determined that brine disposal would not result in negative impacts to groundwater resources. The West Hackberry expansion would use the existing SPR brine disposal facilities and the proposed maximum brine disposal rate for the West Hackberry expansion would be well below the disposal rate considered for the 1977 EIS.

3.6.9.2.3 West Hackberry Groundwater: Operations and Maintenance Impacts

The general impacts associated with operations and maintenance discussed in section 3.6.2.2 would be applicable to West Hackberry, as discussed in the previous subsection. There have been some brine discharges to groundwater and soils from a former brine pond at the operating West Hackberry SPR. However, the current site monitoring there includes 11 monitoring wells and 15 recovery wells, which are showing improvement in groundwater quality (DOE 2004f). If there should be a release at the West Hackberry site in the future, this monitoring network would help with early identification and rapid remedial response.

3.6.10 No-Action Alternative

The no-action alternative would limit the impacts from SPR construction and operation to those that have already occurred or that will occur at the existing SPR storage sites at Bayou Choctaw, Big Hill, Bryan Mound, and West Hackberry. The existing environments for the proposed new SPR storage site alternatives would be maintained. The Bruinsburg storage site would likely remain in agricultural use because of the lack of development pressure. The Chacahoula storage site could remain undeveloped. However, existing oil and gas activities occur near the Chacahoula storage site and if the proposed site could be developed by a commercial entity for oil and gas purposes, some spill risk to water resources could exist. The Richton site would likely remain in use as a pine plantation because of the lack of development pressure. Dow, British Petroleum, Conoco, and Occidental energy companies have storage facilities on the Stratton Ridge dome and it is possible that the Stratton Ridge storage site could be developed for cavern storage by a commercial entity, which could involve brine spill risk to water resources.

For the portions of the proposed storage site pipelines that follow existing ROWs, the risk of a spill associated with the no-action alternative would be limited to spill risk to water resources that already exists from the existing pipelines. For the portions of the pipeline in new ROW, the no-action alternative would not have any spill risk to water resources. For the sites of terminals that are in developed petroleum storage areas, it is possible that a commercial entity could develop them for storage and some spill risk to water resources could occur as a result. Sites in undeveloped areas are unlikely to be developed as terminals and present no foreseeable risk.

Potential impacts to surface and groundwater would not occur as a result of the selection of the no-action alternative.