3.2 ENVIRONMENTAL RISKS AND PUBLIC AND OCCUPATIONAL SAFETY AND HEALTH

The development of an additional storage site and expansion of existing SPR sites would change the potential for accidents associated with construction, operations, and maintenance activities. Greater activity levels typically increase risks; however, in some cases existing pipelines and other equipment would be replaced or modified, and these changes could reduce the potential for spills or the size of spills from this equipment.

This chapter analyzes the potential impacts associated with five categories of accidents at the proposed new or expansion SPR sites:

- Oil spills,
- Brine spills,
- Hazardous material spills,
- Fires, and
- Occupational (worker) injuries.

Section 3.2.1 summarizes the approach for this analysis, including a review of past accidents at existing SPR sites and how those experiences can be used to predict future incidents at the new and expansion sites. Section 3.2.2 then describes the expected future risks associated with these accidents, including the likelihood of the accidents occurring and the potential consequences if they do occur.

3.2.1 Methodology

Risk analysis is a process for identifying and determining both the likelihood of occurrence and the potential consequences of undesirable events including spills of materials such as oil and brine. Risk analyses allow decisionmakers to consider both the potential severity of such an event and its likelihood of occurrence, not just the upper bound consequences, no matter how unlikely they may be. The key concept is:

Risk considers both likelihood (or chance) of occurrence and potential consequences.

For this EIS, DOE examined the likelihood of such events occurring at the new and expanded SPR sites based on the historical frequency of occurrence at the existing SPR sites as well as in other oil distribution activities. The following sections review the historical frequency of oil spills, brine spills, hazardous material spills, fires, occupational injuries, and terrorism. The information in these sections is then used in section 3.2.2 to assess the likelihood and consequences of such events, except terrorism, at the proposed SPR sites.

3.2.1.1 Oil Spills

Oil spills associated with the proposed SPR expansion could occur during marine transport of the crude oil to the United States, transfer of the oil to marine terminals from tankers, and transfer from the terminals to the SPR storage sites through pipelines. If drawdown of SPR crude oil is required, the crude oil is again transported by pipeline to a terminal; from the terminal, the oil can enter the pipeline distribution system or be loaded onto ships or barges for transport to refineries. Thus, crude oil spills can occur during the fill or refill of storage caverns, as well as during drawdown and distribution.

When drawdown is required, the SPR site would need to be refilled. The crude oil spill risks of refill would be comparable to those of fill. Drawdown itself is complicated because the SPR crude oil is a replacement for imported oil. Drawdown and distribution result in shifts between transportation modes as the supply source changes from imports to the caverns, but roughly the same amount of oil is handled in each case.

While accidental releases can occur during long-term storage, the risk of a spill generally is dominated by transfer activities. Furthermore, the maximum quantity filled occurs with the initial fill. This initial-fill activity also represents the greatest incremental chance of spills of all the potential for a spill associated with current import activities because subsequent drawdowns and refills basically would just replace a transfer of oil from an import activity. This analysis focuses on the likelihood of an oil spill during initial-fill activities. Because it is not possible to predict how often or when a cavern would be drawn down and refilled, DOE did not attempt to provide quantitative estimates of the number and size of oil spills during operations (although section 3.2.2.1 does discuss the types of impacts that would occur if an oil spill did occur, including spills from operations).

Historic oil spill rates can be used as a reasonable indicator of the probable chance of accidental oil releases to the environment resulting from operations at an SPR site. Historic data might result in a higher or more conservative estimate of the likelihood of an oil spill because these statistics do not consider improvements in technology, spill control procedures, and operating procedures. New regulations, technology, and updated procedures could significantly reduce the chance of future spills.

The historic rates of oil spills during fill or refill for each of the proposed new and expansion storage sites are summarized in the following separate sections addressing spills from vessels, bulk transfer from terminals, pipelines, and storage sites. Spills from vessels, terminals, and storage sites are a function of the storage site capacity (generally as a surrogate for activity levels), and spills from pipelines are a function of both site capacity and pipeline length. The rates derived below are then applied to the particulars of each new and expansion site in section 3.2.2.1 to predict the number and size of spills associated with the proposed action.

Vessels

The Minerals Management Service (MMS) of the U.S. Department of the Interior has maintained an oil spill database of U.S. tanker spills since the 1970s. Using that database, the MMS estimated oil-spill occurrence, normalized as a function of the volume of oil handled (Anderson and LaBelle 2000). Only spills greater than 1,000 barrels were addressed because of the likelihood that larger spills probably would be identified and reported, and they are more likely to persist and cause impacts than smaller spills. Based on reviewing the annual MMS data, DOE observed that rates for crude oil spills from tankers in U.S. waters have decreased significantly over time.

The MMS data on spills from international transportation of crude oil during the period 1974 to 1985 are described in the 1992 SPR expansion draft EIS (DOE 1992a). That draft EIS reports rates of 0.090 spills per 100 MMB transported in offshore waters and 0.040 spills per 100 MMB transported in harbors or at piers. For U.S. waters, the spill rate in harbors and at piers is higher than the spill rate in offshore waters. Using 1985 to 1999 data from the MMS, the rates are 0.044 spills per 100 MMB in harbors and at ports and 0.029 spills per 100 MMB in offshore waters, or a combined rate of 0.073 spills per 100 MMB from tankers (Anderson and LaBelle 2000). DOE used the combined rate of 0.073 spills per 100 MMB in this EIS analysis.

Terminals

The 1992 draft EIS estimates a rate of 3.3 spills per 100 MMB from terminal transfer operations. This rate is based on the total number of U.S. oil spills from marine transfer operations and the total volume of crude oil and refined petroleum products imported and transferred during 1983 to 1986. This estimate has been revised based on the number of crude oil shoreline spills from the U.S. Coast Guard database and the total waterborne commerce for crude petroleum during 1999 to 2001. During that period, there were 967 shoreline spills and approximately 15.6 percent of all spills were of crude oil, so the revised estimate is 151 crude oil shoreline spills and 11,746 MMB of crude oil in waterborne commerce, or 1.29 spills per 100 MMB. DOE uses the rate of 1.29 spills per 100 MMB in this analysis.

Pipelines

The U.S. Department of Transportation (DOT) Office of Pipeline Safety maintains a database of reportable pipeline accidents. Reportable accidents are those with gross loss greater than or equal to 50 barrels (2,100 gallons); any fatality or injury; a fire or explosion not intentionally set; highly volatile liquid releases with gross loss of 5 or more barrels; or total costs greater than or equal to $50,000 (DOT 2005). During 1996 to 1999, there were 312 reportable crude oil pipeline accidents. Most of those accidents involved spills of 2,100 gallons (7,900 liters) or more. For that same period, there were 145 crude oil pipeline spills of 10,000 gallons (38,000 liters) or more, of which 33 were more than 100,000 gallons (380,000 liters) (Cutter Information Corp. 2001). According to the Bureau of Transportation Statistics, 1,330.9 billion ton-miles (1,900 ton-kilometers) of crude oil were transported by pipelines in the United States during this period (DOT 2005a).

In a more recent period, 2000 to 2003, the Office of Pipeline Safety reported a total of 225 crude oil pipeline accidents, and the Bureau of Transportation Statistics reported a movement of 1,131.5 billion ton-miles (1,700 billion ton-kilometers) of crude oil through pipelines. These data correspond to accident rates of 0.23 accidents per 100 million ton-miles (150 million ton-kilometers) transported for 1996 to 1999 and 0.20 accidents per 100 million ton-miles transported for 2000 to 2003. Based on a conversion factor of 7 barrels per ton (6.3 barrels per metric ton), the spill rate would be about 0.0028 accidents per 100 million barrel-miles for the 2000 to 2003 period. This rate is somewhat higher than the spill rate for pipelines estimated in the 1992 draft EIS (DOE 1992a), which was 0.0021 spills per 100 million barrel-miles. For this EIS, DOE uses the higher rate of 0.0028 spills per 100 million barrel-miles for analysis.

Storage Sites

Onsite spills typically are identified quickly, and they are likely to be contained, limiting the potential for reportable spills (i.e., those that enter waterways). During 2001 to 2004, there were 6 reportable oil spills from the existing SPR storage sites, none of which were greater than 10 barrels. The oil spills were reported to the appropriate agencies and cleaned up with no observable environmental damage, according to the annual Environmental Reports published by DOE. A substantially lower number of oil spills per year occurred in the 2001 to 2004 period than in previous years. For example, in an earlier period (1987 to 1990) described in the draft EIS (DOE 1992a), a total of 33 spills occurred at the existing SPR storage sites. Three of these spills exceeded 100 barrels and 25 of the 33 spills were less than 10 barrels. Furthermore, the amount of oil received by SPR during 2001 to 2004 was 69.3 MMB more than was received during 1987 to 1990, showing a large decrease in spills per amount received (EIA 2005). The oil spill rate decreased from 42.3 spills per 100 MMB of crude oil received in 1987 to 1990 to 4.3 spills per 100 MMB of crude oil received in 2001 to 2004. The rate of 4.3 spills per 100 MMB was used in this analysis.

3.2.1.2 Brine Spills

Table 3.2.1-1 summarizes data on brine spills from 22 years of operational experience at the existing SPR sites. The table also identifies the percentage of the brine spilled as a fraction of the total brine volume

Table 3.2.1-1: Reportable Brine Spills from Pipeline Systems at Existing SPR Sites

Year	Total Spills	Volume Transferred in Pipeline System (MMB)	Number of Spills per MMB of Brine Transferred	Volume Spilled (barrels)	Percentage of Total Throughput Spilled
1982	43	558	0.077	2,792	0.0005
1983	44	816	0.054	1,632	0.0002
1984	17	558	0.031	1,975	0.0004
1985	16	464	0.035	607,000	0.1308
1986	7	87	0.081	1,734	0.0019
1987	22	212	0.104	608	0.0003
1988	12	> 6.3	NA	586	0.0001
1989	17	591	0.029	825,512	0.1395
1990	12	439	0.027	74,650	0.017
1991	7	415	0.017	7,230	0.002
1992	9	11	1.23	302	0.003
1993	6	33	0.182	370	0.001
1994	2	15	0.133	90	0.0006
1995	3	29	0.103	825	0.0028
1996	5	80	0.062	30	0.00004
1997	0	38	0	0	0
1998	2	14	0.143	39	0.0003
1999	0	18	0	0	0
2000	0	18	0	0	0
2001	1	21	0.048	0.12	5.60 x 10-7
2002	2	53	0.038	13	3.9 x 10-6
2003	0	47	0	0	0
Total	227	4,523	0.050	1,525,388	0.033

MMB = million barrels

Source: DOE Site Environmental Reports for 1982 to 2003

transferred in the pipeline systems. Very large spill volumes occurred in 1985 and 1989, and a sizable spill occurred in 1990. Two spills accounted for almost all of the volume spilled in 1985 (one very large and one large), and no environment impacts were observed from either of these spills. In 1989, the one very large spill originally affected 8 acres (3.2 hectares) of marsh, but strong regrowth was seen in less than one year (Boeing Petroleum Services Inc. 1990b and 1990c). In 1990, a large spill directly into the Gulf of Mexico caused no adverse environmental impacts (Bozzo 1991).

3.2.1.3 Hazardous Material Spills

As discussed in section 2.3.10, spills of hazardous materials from SPR sites must be reported and recorded under several Federal and state laws and regulations, as well as SPR site operating procedures. The type and size of hazardous material spills recorded at existing SPR sites for the years 2003 and 2004 (the most recent years for which data are available) are presented in table 3.2.1-2. As shown, the spills of hazardous materials at existing SPR sites have been infrequent and small. Nine spills have occurred at three of the existing sites and none at the other existing site (Bryan Mound) during the two-year period.

Table 3.2.1-2: Existing SPR Site Spills Other than Crude Oil and Brine from 2003 to 2004

Material	Site	Quantity	Description
Lubricating oil	Big Hill	10 gallons	Spill occurred during transfer of material from bulk storage to 30-gallon day tank; spill was contained and cleaned up.
Diesel fuel	West Hackberry	3 gallons	Spill occurred from day tank of emergency diesel generator.
Battery acid	Bayou Choctaw	2 gallons	Spill occurred in truck maintenance area from overturned truck battery; spill occurred on concrete pad and was remediated.
Hydraulic oil	West Hackberry	4 gallons	Contractor truck hydraulic hose failed causing release of hydraulic oil onto the ground; cleanup complete.
Hydraulic fluid	Bayou Choctaw	0.5 gallons	Release occurred when a seal came off the manlift drive motor; the area was cleaned up immediately.
Raw sewage	Big Hill	Several gallons	Sewage Lift Station #4 overflowed small amount of sewage into sump area and surrounding grass. Pump auto selector switch and station high-level alarm failed to operate properly.
Hydraulic fluid	Big Hill	0.5 gallons	Contractor forklift leaked hydraulic fluids onto surrounding soil.
Hydraulic fluid	Bayou Choctaw	0.5 gallons	Hydraulic fluid leaked when onsite O-ring manlift blew out, causing spill onto building, 401 parking lot; spill cleaned up and new O-ring installed.
Brine pit sludge	Bayou Choctaw	2 gallons	A vacuum-box truck in use for brine pond clean up leaked pit sludge on the roadway outside of the entrance gate.

1 gallon = 0.0037854 cubic meters

Source: SPR Nonreportable Spills (DOE 2003b, 2004h)

This experience suggests that each of the candidate new sites could have one spill a year (9 spills divided by 4 sites divided by 2 years). Most of these spills could be expected to be in the 0.5- to 4-gallon (1.9- to 15-liters) range, although they could be as large as 10 gallons (38 liters). Larger or more frequent spills, or both, are certainly possible, but they are not considered likely based on the limited volumes of hazardous materials at the sites.

3.2.1.4 Fires

Table 3.2.1-3 summarizes reportable fire incidents for the existing SPR sites and terminals from 1992 to 2004. The table summarizes the circumstances of the incident and the SPR operator response. Reportable fire incidents at SPR sites and terminals include electrical fires, vehicle fires, crude oil fires, ignition of combustible gas, and other incidents for which SPR operator response and reporting was required. Several of the reported incidents resulted in minor injuries to SPR site workers or subcontractors or damage to operating equipment. None of the reported incidents resulted in environmental impacts or any long-term impacts to SPR site operations. One incident, an electrical switchgear fire at the St. James Terminal in 1994, required operation of the primary and backup

Table 3.2.1-3: Reported Fire Incidents at Existing SPR Sites and Terminals

Site	Year	Incident	Response
Big Hill	1992	Before pipeline repair work, gas tests taken inside the pipe at the drain point and at the repair point showed that no combustible gas was present. Welding began within 15 minutes of the gas test; after approximately 4 inches of weld, a flash occurred inside the pipe. Root cause: combustible gas collected in the line after the gas test was performed.	The operator used the wheel fire extinguisher to ensure no fire was in the underground piping. Maintenance workers installed a nitrogen packer to prevent reoccurrence. Job Safety Analysis was revised to include the use of a pipe balloon during all welding operations on the inside of pipes regardless of whether gas has been detected.
Bayou Choctaw	1992	A rental, portable centrifugal pump was in use to pump brine from the northern pond into the southern pond. Site security personnel observed that one of the pump tires was on fire. Root cause: electrical short circuit.	Operations personnel extinguished the fire using a fire extinguisher. New procedures were developed to inspect rental equipment.
Bryan Mound	1993	Shift supervisor entered control room and saw smoke pouring out of the Realflex meter system enclosure. A pre-alarm sounded and the operator manually activated the halon system; control room building was evacuated. Root cause: when replacement actuator was first installed it was powered with 115 VAC rather than 24 VAC because updated, as built drawings were not provided to allow the actuator to be connected correctly.	Emergency Response Team responded with fire truck. Two personnel using self-contained breathing apparatus investigated the control room. Library was purged of out-of-date drawings and procedures were reinforced so that correct as-built drawings must be furnished as soon as possible after any configuration change and task should not be closed until drawings have been completed and verified.
St. James Terminal	1994	Subcontractor reported loud noise and smoke coming from switchgear building. The switchgear appeared to be arcing from the load side to the line side, causing extensive heat, which in turn created fire. Root cause: misalignment of main incoming breaker; attributed to lack of adequate SPR-wide maintenance procedures and lack of adequate supervision by technical experts who could verify that existing maintenance procedures were performed and performed correctly; also, a lack of adequate ground-fault protection built into original switchgear design.	Site Emergency Response Team extinguished the fire after all power was confirmed de-energized. Incident caused site to be without commercial power to operate main line crude oil booster pumps. The main site's (350-kilowatt) emergency generator along with the site's spare (169 kilowatt) emergency generator was used to power the facility. Team identified 16 corrective action items. With the completion of all such items, probability of recurrence reduced.
Bayou Choctaw	1995	While attempting to check power on an actuator for a valve, a bolt of fire came from the rear of actuator. Electrician received minor burns. Incident most likely result of conductive contamination on wire insulation that reduced the insulating properties of the conductor, allowing the initial flash. Root cause: design of actuator power terminals and insulating barrier; terminals extend above insulating barrier.	Operations personnel locked out 480-volt actuator supply voltage at motor control center. New safety equipment was provided for electricians to test voltage of actuators. New procedures were established for electricians and instructions provided on how to clean wires of contamination.

Table 3.2.1-3: Reported Fire Incidents at Existing SPR Sites and Terminals

Site	Year	Incident	Response
Bayou Choctaw	1998	During grinding activities associated with out-of-service pipeline demolition, a vapor flash and loud noise occurred inside and around opening of pipe that previously was cold cut. Worker who experienced ear pain was examined by doctor and released. Direct cause was insufficient low explosive level (LEL) gas monitoring. Monitoring was performed only before task start up and not during the task performance to take into account changing conditions. Root cause: lack of clarity in safe work procedure.	Demolition work immediately shutdown pending a worksite investigation. Work resumed after investigation complete and corrective action taken. Safe work procedure revised to require that hot work tasks and related precautions be specifically identified. With completion of the corrective action, probability of this type of event recurring is reduced.
Bryan Mound	1999	Supervisor observed oil and white smoke coming from a flange on crude oil line. Contractor was in process of tightening bolts on the flange when apparent flash occurred and oil started coming out of the flange. About 6 gallons of crude oil estimated to have leaked out of the flange were confined in construction excavation. Personnel evacuated with no injuries. Root cause: contractor using a propane torch to apply heat shrink to the flange weld caused flash. Records do not indicate that LEL readings were taken within 30 minutes of commencement of hot work, as required by hot work permit.	Emergency Response Team responded with a fire truck and cooled the pipe with water from the fire truck. The oil in the excavation was covered with foam. Nitrogen was injected into the crude oil line upstream of the flange location to extinguish, inert, and cool the inside of the line. Continuous gas monitoring was implemented for all pipe tie-in work to ensure that any combustible gas is immediately detected and hot work shut down before ignition or an unsafe condition occurs.
West Hackberry	2002	Subcontractor operated track hoe fitted with special equipment for clearing trees. Heavy brush caught fire outside the site perimeter fence. No injuries were associated with the incident. Root cause: a pinhole leak apparently developed in the hydraulic hose allowing hydraulic fluid to spray directly onto the exhaust manifold, which ignited.	Track hoe operator was unable to extinguish fire with fire extinguisher. Site fire truck arrived on scene and used combination of water and dry chemical to extinguish the fire. West Hackberry fire department provided support.
Big Hill	2003	A small fire in the battery box caused a subcontractor bulldozer operator to jump off vehicle, causing a back injury. Fire was caused by aerosol can of starter fluid contacting battery. Operator required transport to local hospital for treatment. Root cause: subcontractor did not complete equipment checklist and did not maintain protective battery cover.	Personnel in the area immediately extinguished the fire with a dry chemical fire extinguisher. The established site operator and subcontractor procedures for equipment inspection were reviewed and reinforced.
Big Hill	2004	While an employee was drilling a hole in a swinging gate frame constructed of tubular steel, the drill bit penetrated the gate frame, and apparently flammable vapors trapped inside the tubing were released and ignited, causing a flash fire. Employee received first and second degree burns. Root cause: a biological material contaminant located inside the gate frame tubing at the time of assembly by shipbuilding and repairing industry.	The biological containments had not been previously identified at SPR sites. A lessons-learned notice was issued to all sites concerning this previously unknown hazard.

emergency generators at the St. James terminal, although no interruption in SPR site drawdown operations resulting from the incident was reported. The reportable fire incidents summarized in table 3.2.1-3 were subject to first response by the SPR site operators and Emergency Response Team, incident reporting, investigation, and root-cause analysis. Corrective actions were implemented for the reported incidents to reduce the probability of reoccurrence.

In 1978, during the workover of a well, a very large well pad fire caused a severe injury and one death. The non-burning oil spilled into Black Lake and was contained and recovered. Subsequent monitoring found that oil contamination was restricted to a small portion of Black Lake (NOAA 1992).

3.2.1.5 Occupational Injuries

To analyze the potential impacts of expanding the SPR on the number of occupational injuries, DOE obtained the incident rate of worker injuries and illnesses at existing SPR facilities and at comparable industrial facilities. DOE also obtained information regarding the safety and health management systems of the contractor currently operating the SPR.

3.2.1.6 Terrorism

The EIS evaluates the potential environmental impacts of a release of oil, brine, and other hazardous materials. The consequences could result from an accidental or deliberate system failure, with deliberate failures coming from sabotage or terrorism and accidental ones arising from design or construction flaws, human errors, natural events, and other factors. Because the EIS considers a range of release scenarios, and the proposed equipment design and control systems, which would mitigate the risks of a release, DOE believes that the EIS also informs about the range of potential consequences of a terrorist action. While more catastrophic failures can be imagined, such as simultaneous attacks on multiple pipelines, the leak detection, isolation, and other control systems would limit the total quantities released. Aircraft or incendiary devices attacking well heads might be spectacular, but would produce a localized fire with little if any offsite consequence. Attacks on ships are no different than the potential for such attacks on ships going to or from other facilities. While the range of potential consequences can be described, the probability of a terrorism or sabotage event cannot be predicted to the same degree.

DOE is one of the 17 critical infrastructure and key resource sectors identified in the National Infrastructure Protection Plan prepared by the Department of Homeland Security under Presidential Directive 7. This plan establishes a comprehensive risk management framework, under which critical energy assets and systems such as SPR are being identified and evaluated to determine the need for protective programs. As a part of the plan, the private sector is working closely with the government agencies to ensure sharing of that threat information and best practices. The efforts under the plan provide further assurance that terrorism is carefully and comprehensively addressed in site safety and operations plans, in interactions with local emergency support functions (like fire and police), and in employee training, among other management systems.

3.2.2 Impacts Common to All Alternatives

This section uses the historical accident rates described earlier to estimate the likelihood of new accidents associated with the proposed action. Included in the discussion is a projection of the possible consequences associated with each type of accident, if they were to actually occur.

3.2.2.1 Oil Spills

Table 3.2.2-1 presents the estimated number of oil spills associated with initial filling operations at each of the proposed new and expansion sites. With increased volumes moving in drawdown and refill operations, the overall potential for spills would increase proportional to the amount of drawdown and refill. A total drawdown and total refilling of the site is expected to be an extreme case for the activity in a single year. The values in table 3.2.2-1 represent a reasonable upper bound of the number of oil spills anticipated during any year of SPR storage site operation. Moreover, as stated above, only the initial fill

Table 3.2.2-1: Oil Spill Predictions by Site for Initial Fill

SPR Site	New Site Capacity/ Generation	Pipeline Length (miles)	Predicted Number of Oil Spills per Given Capacity				
			Vessel	Terminal	Pipeline	Storage Site	Total
Bruinsburg[a]							
Pipeline to Peetsville	160 MMB	38	0.12	2.06	0.17	6.88	9.2
Pipeline to Anchorage	160 MMB	109	0.12	2.06	0.49	6.88	9.6
Chacahoula[a]							
Pipeline to St. James Terminal	160 MMB	22	0.12	2.06	0.10	6.88	9.2
Pipeline to Clovelly	160 MMB	53	0.12	2.06	0.24	6.88	9.3
Richton[a]							
Pipeline to Pascagoula	160 MMB	88	0.12	2.06	0.39	6.88	9.5
Pipeline to Liberty	160 MMB	116	0.12	2.06	0.52	6.88	9.6
Stratton Ridge							
Pipeline to Texas City	160 MMB	38	0.12	2.06	0.17	6.88	9.2
Bayou Choctaw							
Pipeline to St. James	20 MMB	37	0.01	0.26	0.02	0.86	1.2
Big Hill							
Big Hill 80	80 MMB	17	0.06	1.03	0.04	3.44	4.6
Big Hill 96	96 MMB	17	0.07	1.24	0.05	4.13	5.5
West Hackberry							
West Hackberry	15 MMB	0	0.01	0.19	—	0.65	0.85

Notes:

[a] Oil spill predictions are not cumulative. The oil spill predictions are based on the total storage capacity of the site traveling through one pipeline.

MMB = million barrels

1 mile = 1.6093 kilometers

activity would be a new activity when looking at overall oil distribution activities. Subsequent drawdown and refills would be replacements for import-related transfer activities.

As shown in table 3.2.2-1, initial fills are estimated to cause anywhere from two oil spills at Bayou Choctaw up to almost 10 oil spills at Bruinsburg, Chacahoula, Richton, or Stratton Ridge, (i.e., any of the sites with an expected addition of 160 MMB in capacity). Most of these spills would be expected at the storage sites, with a smaller number of spills at the associated terminals. The number of oil spills associated with shipping vessels and pipeline operations is predicted to be less than one in every case. Based on historic spill statistics, which account for measures used to contain spills that do occur, the majority of the predicted oil spills would be of low volume. For example, the spills from storage sites would be expected to be less than 100 barrels based on a review of the spills that have occurred to date at the SPR sites.

The potential consequences of such infrequent, small accidental releases of oil are expected to be minor. They could result in localized soil contamination at the storage sites and terminal locations, which would be contained and cleaned up. At the same time, such small oil spills would result in some contaminants migrating into the air, including volatile components (such as toluene and benzene) and sulfur compounds (predominantly mercaptans and hydrogen sulfide gas). While such air contaminants can have toxic effects to both wildlife and people through inhalation (Park and Holiday 1999), they are expected to be released from SPR operations so infrequently and in such small quantities that they would be readily dispersed in the atmosphere and have little effect on ambient air quality along site boundaries.

The impacts of spilled oil on surface water resources or wetlands would vary depending on the amount of oil introduced and the characteristics of the receiving environment. Again, these impacts associated with the proposed action are not expected to be significant because any resulting oil spills in these areas are expected to be infrequent and small. Nevertheless, if a large spill were to occur, the immediate impact would be the presence of a layer or slick of oil floating on the water surface. This slick would pose the potential for damage to physical assets and for negative health effects to wildlife, domestic animals, or people that come into contact with it through dermal exposure to toxic compounds in the oil (Park and Holiday 1999). Where the slick reaches vegetated wetland and shore areas, the oil would adhere to vegetation. Within a short time after any significant spill, DOE’s emergency response procedures would be in operation, acting to contain the oil slick to a limited area and remove as much oil as possible from the environment. Under normal conditions only relatively small amounts of oil would be expected to escape this response action and remain uncontained in the environment.

Wind, waves, and currents would work to disperse any such uncontained oil, breaking up oil slicks into droplets or smaller slicks dispersed over a wide area (assuming a sufficiently large receiving water body). As mentioned, volatile components of the oil would evaporate, leaving behind heavier components that would begin weathering or breaking down into degradation products through a series of physical and chemical processes. Some of these products would be denser than water and sink into the water column and to the floor of the water body. Some components of the oil would oxidize to water-soluble compounds, and then dissolve into and disperse within the water column, posing potential health risks to wildlife and people through ingestion and bio-uptake. Many of the heavy oil components may only partially oxidize, forming tar balls. These dense spheres would sink to the bottom of the water column and could linger in the environment, collecting in bottom sediments. Some oil components could be removed from the water column through biodegradation and bio-uptake. Biodegradation would be more rapid in warm, nutrient-rich environments. In high-energy environments, oil-water emulsions can be formed through the action of waves or strong currents. Because of their tendency to sink to the bottom of the water column, oil-water emulsions also tend to sink to the bottom of the water column, and they could remain in the environment for months or years (EPA 2006).

Where oil spill response efforts contain and remove most spilled oil from the surface water environment, the impacts described earlier would be expected to occur at very limited levels. These impacts would be more pronounced in smaller, low-energy water bodies where little dispersion or dilution could take place and the effects of any uncontained oil would be concentrated in a smaller area. Oil remaining in rivers with strong flow or tidal flushing and in estuaries or the Gulf of Mexico, would disperse more rapidly, resulting in milder impacts over a wider area.

In some cases, the DOE oil spill response effort may involve the use of chemical dispersants. Dispersants remove spilled oil from the water surface by causing the oil to partially break down into products that are soluble in the water column or denser than water and sink. This could reduce impacts associated with the surface oil slick, and prevent the movement of floating oil into sensitive surface environments (marshes, shoreline areas). On the other hand, the use of chemical dispersants could increase the impacts of spilled oil on subsurface aquatic environments and organisms. Areas where dispersants were used on spilled oil would exhibit elevated concentrations of oil components, including toxic compounds, in the water column, and deposition of dense, insoluble oil components on the water-body floor. The decision on dispersant use is driven by an analysis of this trade-off, and identification of the course that would lead to the least environmental impact.

3.2.2.2 Brine Spills

Table 3.2.2-2 presents the expected number of brine spills associated with the cavern construction and initial fill at each site evaluated in this EIS. These estimates were developed using the volume of oil that would be handled during initial fill at each site, the SPR experience that 7 MMB of brine are generated for every 1 MMB of storage capacity formed within a cavern, and the historic brine spill rate described in section 3.2.1.2.

Table 3.2.2-2: Predicted Number of Brine Spills by Site for Cavern Construction and Initial Fill

SPR Site	Brine Generation[a]	Source of Spill	Pipeline Length (miles)	Predicted Number of Brine Spills[b]
Bruinsburg	1,120 MMB	Brine pipeline	14	56
Chacahoula	1,120 MMB	Brine pipeline	59	56
Richton	1,120 MMB	Brine pipeline	100	56
Stratton Ridge	1,120 MMB	Brine pipeline	10	56
Bayou Choctaw	140 MMB	Brine pipeline	1	7
Big Hill	560 to 672 MMB	Brine pipeline	1	28 to 34
West Hackberry	15 MMB[c]	Brine pipeline	Unknown	<1

Notes:

[a] Brine generation calculated as new oil storage capacity multiplied by seven
[b] During the entire construction period
[c] Brine discharge associated with initial fill

1 mile = 1.6093 kilometers

As shown in table 3.2.2-2, initial cavern creation and fill activities at each site are predicted to cause anywhere from less than one brine spill at West Hackberry to up to 56 brine spills at Bruinsburg, Chacahoula, Richton, and Stratton Ridge. Based on historic spill statistics and measures that would be in place to detect and stop brine spills when they occur, these estimated brine spills most likely would be of low volume (less than 50 barrels). Higher-volume brine spills, while possible, are very unlikely based on SPR experience.

For the Richton alternatives, the predicted number of brine spills would increase if the Leaf River is unable, because of low flow conditions, to supply the full amount of water needed for cavern development or drawdown. In this situation, the 88-mile pipeline between Pascagoula and Richton would supply water from the Gulf Coast. For example, if the Gulf Coast supplied one-third of the needed water volume for cavern construction, there would be another 19 predicted spills of salt water. These spills would involve water with lower salinity (and lower potential impacts) than would be associated with the 56 predicted spills of brine generated by cavern construction. Similarly, some spills could occur if salt water from the Gulf Coast is used during drawdown.

If a brine spill occurs, its impacts would depend on the size of the spill and the characteristics of the receiving environment. Spills to surface soils could result in those soils having greatly increased salt concentrations that prohibit the growth of vegetation in affected areas. Unless the spills are large or sustained, neither of which is predicted for the proposed action, the brine contaminants would be flushed away by rain and affected soils and vegetation would quickly recover.

Brine spills also could affect groundwater and air quality, although these impacts associated with the proposed action would be expected to be small considering the predicted frequency and magnitude of spills. In particular, shallow aquifers could experience small plumes of elevated salinities that would migrate readily along with the groundwater flow and dilute to normal levels some distance from the spill source. In addition, surface spills could result in emissions of nonmethane hydrocarbons to the air, but such emissions could be expected to be small, temporary, and of little consequence to air quality.

The impacts of brine spills to surface waters and wetlands would depend largely on the characteristics of the resources affected. A brine spill would result in the elevation of chloride concentrations to well above natural levels. Chloride concentrations could range to nearly the level of undiluted brine (greater than 200 parts per thousand) near the point of introduction of the brine. Chloride levels would decrease with distance from the spill site and over time, and through the actions of dilution, dispersion, and flushing in the receiving water body.

Although chloride is essential to life, at high concentrations it is toxic to most organisms. Chloride concentrations could exceed the acute and chronic toxicity criteria for aquatic life near the point of a spill immediately after the spill occurred. With time after a brine spill, chloride concentrations in the receiving water body gradually would return to normal (pre-spill) levels. The time required for return to normal levels would be site-specific and depend largely on the degree of flushing in the receiving waters.

The impacts of brine spills on surface water and wetland, and the rate of chloride dissipation in those resources, have been measured and observed in the aftermath of previous brine spills. These observations provide an indication of the likely impacts of brine spills resulting from the proposed SPR expansion. A very large brine spill occurred at Bryan Mound in 1989. Brine from that spill reached surrounding surface waters including the ICW. No impacts to surface water, sediment quality, or biota were observed in the ICW despite the significant volume of brine released to this water body. In the ponds and the moderately drained marshland affected by the spill, chloride concentrations in surface waters and sediments initially were elevated, but they returned to normal (pre-spill) levels within two months. In the poorly drained marshland affected by the spill, chloride concentrations returned to normal within four months. The decay of organic matter in some ponds caused temporarily depressed levels of dissolved oxygen and increased temperatures (Boeing Petroleum Services Inc. 1990b, 1990c).

3.2.2.3 Hazardous Material Spills

As discussed in section 3.2.1.3, the proposed action would be expected to result in one hazardous material spill per year at each of the new sites. Most of these spills would be expected to be in the 0.5- to 4-gallon (1.9- to 15-liters) range, although they could be as large as 10 gallons (38 liters).

The potential environmental consequences of a spill depend on the type of hazards posed by the material, the amount of the spill, and the location of the spill. In general, the spills are expected to be infrequent and generally involve small quantities of materials spilled onsite that are relatively easily remediated or contained onsite, and therefore, they would have negligible impact on the environment. This is demonstrated through the Annual Environmental Reports covering spills at each of the existing sites (DOE 2004f).

Pesticides and herbicides are used in limited and controlled quantities at the existing SPR sites. An accident scenario would involve the spill of 1 or 2 gallons (3.8 to 7.6 liters) of a pesticide compound during manual application. In a spill, protection of aquatic systems would be a high priority because pesticides and herbicides used on site (e.g., Rodeo® by Monsanto) are highly toxic to fish. Pesticides and herbicides also might adhere to sediments; however spills of 1 or 2 gallons (3.8 to 7.6 liters) of pesticide or herbicide would require relatively uncomplicated and localized cleanup. Minor impacts to plant life would occur only in the immediate vicinity of the spill. Because contaminated soil would be collected and disposed of offsite at an approved disposal facility, no long-term impacts on groundwater or surface water would be expected.

Fire protection chemicals (e.g., aqueous film-forming foam) are stored in relatively large quantities at the existing SPR sites. In a fire, any aqueous film foam released would be captured in collection ponds that border each fixed fire-control system, thus preventing the compound from reaching groundwater or surface water. These collection ponds are generally large enough to retain one discharge. Releases outside of the containment could occur in high winds or storms when the chemicals could be blown out of the containment area. In addition, if rainwater overfills the collection ponds, a release to surface water could occur. For portable fire-control systems, the largest spill scenario would involve spills of 55 gallons (210 liters) or less. Such a spill would be contained before it could reach surface water or groundwater.

While aqueous film foam does not pose a risk to human health, it exhibits varying degrees of aquatic toxicity and has a high biochemical and chemical oxygen demand. If allowed to flow freely into groundwater or surface water, it could cause severe environmental consequences. These materials also contain fluorocarbon **surfactants** (5 percent or less) that are not biodegradable. If discharged to adjacent surface water, it could result in temporary oxygen depletion in those waters in addition to inducing toxic effects in some aquatic species (DOE 1989). The most serious accident at an SPR site involving aqueous film foam occurred in 1986 at the West Hackberry site when 5,000 barrels of oil flowed into a nearby lake. The foam was used to blanket the oil on the lake. The combination of the oil spill and the foam blanket resulted in the death of 100 to 200 fish in the area (Bozzo 1991).

An accident involving ammonium bisulfite could result from a storage tank rupture. This spill scenario could involve up to 5,000 gallons (18,927 liters) of the material. Any spill likely would be contained by the brine ponds that border the ammonium bisulfite storage areas. If a tank rupture occurred simultaneously with high winds or storms, ammonium bisulfite could be blown outside of the pond area or rainwater might overfill the collection ponds. In this case, an ammonium bisulfite spill could have a temporary impact on adjacent onsite vegetation. A small area could be burned, but the vegetation likely would consist of a grass that would recover quickly. As brine released into the Gulf of Mexico is required to have oxygen content, it is possible that a spill of ammonium bisulfite into the pond could necessitate aerating the brine pond before continuing disposal. If the brine is released unaerated at the same time that a transient anoxic area is present at the diffuser location, the anoxic situation could be exacerbated. In addition, there could be releases of ammonia or sulfur gas from the surface of the brine (Personal Communication, 1991). The onsite Emergency Response Teams are trained in proper protection in handling ammonium bisulfite spills, and therefore, no adverse effects on workers would be anticipated from spill response activities. In dermal exposure, if exposed skin were immediately flushed with water, recovery likely would occur quickly. Ammonium bisulfite is not acutely toxic, and no long-term impacts of a spill would be anticipated.

Other hazardous materials (e.g., cleaning agents) at existing SPR sites are stored in 55-gallon (one barrel) quantities or less, so any spills of such materials likely would be small and contained without causing significant or long-term environmental contamination. Fuels such as diesel fuel and gasoline and some lubricating oils are stored in larger quantities, and any spills of these materials would cause impacts similar to those described for oil spills. Laboratory reagents generally are stored in smaller quantities, generally in indoor locations, and so, they are unlikely to reach outdoor areas if spilled.

3.2.2.4 Fires

In 1990, DOE performed an independent reevaluation of SPR drawdown-critical or mission-essential systems and facilities to identify needed upgrades to the SPR fire protection program and assess the need for new fixed-fire protection systems. The study indicated that there were no “eminent-danger” scenarios when a credible fire event could adversely affect the mission of SPR. The SPR fire protection program is designed to limit fire risk to the lowest practical limit (Edwards 1991b). The information presented in section 3.2.1.4 demonstrates that historic occurrence of fires since 1992 has, indeed, been low.

Nevertheless, a potential exists for fires to occur at the SPR expansion sites and proposed new sites. The 1990 DOE reevaluation identified three potential fire scenarios: a well-pad accident, a tank fire, and a pump fire. Although the possible consequences of each of these fire scenarios are potentially serious for damage to property, the probability of their occurrence is extremely small and the potential for offsite consequences is also very limited. The availability of automatically activated and manually activated fire protection and shutdown systems and the actions of onsite Emergency Response Teams likely would extinguish fires before severe consequences occurred. Also, as discussed in section 3.2.1.4, serious fire events are expected to be very rare.

The environmental consequences of fires may include short-term exceedance of ambient air quality standards, including standards for particulate emissions; short-term releases of toxic air pollutants (e.g., fluoranthrene and pyrene); and potential stormwater and surface water contamination from runoff of the materials that is burning, products of incomplete combustion, and firefighting agents such as foam.

3.2.2.4.1 Well-Pad Accident

The caverns used for oil storage are maintained under pressure, and therefore, a well-pad accident could result in severe onsite consequences with respect to fire. The only reportable fire at an SPR site that resulted in a fatality occurred in 1978 at the West Hackberry site. It was caused by a well-pad accident. As part of a workover procedure, contractors were pulling casing out of a well. After pulling 14 joints of casing out of the hole, the mud in the casing began flowing from the top of the casing into the hole. The mud and a packer, previously set in the lower sections of the casing, were forced up from the inside of the casing to the surface by pressure from below. Workers on the rig could not control the flow of the mud from the casing. The flow continued unchecked until the packer blew out of the casing followed by a flow of oil. An oil mist formed from the flow of oil was drawn into the air manifold intakes of the diesel engine on the rig and nearby diesel engines, causing them to overspeed. An explosion and fire occurred while two employees were still attempting to shut down the rig engine; both men were severely burned, and one later died from his injuries (DOE 1978).

The immediate cause of the accident appeared to be a poor packer seat in the casing. In addition, employees failed to follow the written workover procedure (e.g., depressurize the well before workover). Also, there was an inadequate safety valve on the rig, and the site was in the construction phase so that the full complement of emergency response equipment was not yet on the site. Since the time of this accident, new policies and procedures have been implemented to prevent similar occurrences in the future (DOE 1978).

3.2.2.4.2 Tank Fire

The crude oil surge tank at Big Hill has a double-deck, open-top, floating-pontoon roof design. It is equipped with a manually activated foam system for protection of the roof-to-shell seal area. Any involvement of this tank with a fire ordinarily would occur in the seal area. The initial response to any such incident would include determining the extent of the tank fire and activating the fixed-foam system (Boeing Petroleum Services, Inc. 1989).

As unlikely as it is, if the tank became fully involved in a fire, the possibility of a “boil over” exists. This could occur as heavy residuals that might contain water or water-oil emulsion accumulate and begin sinking toward the tank bottom. The result of the super-heated residuals contacting the water could result in a boil over. The contents of the tank then could erupt into extremely violent and quickly expanding steam-oil froth, sending a fireball hundreds of feet (meters) into the air, and project burning oil over the sides of the tank for several hundred feet (meters) in each direction (Boeing Petroleum Services, Inc. 1989). While this description is specific to the tank at Big Hill, similar scenarios would apply to any new or expansion site with a storage tank at the facility, a tank farm, or marine terminal.

To extinguish a fully involved tank, foam applications would be applied from ground level. In the example of a tank with a 100-foot (30-meter) diameter, a minimum application rate of about 790 gallons (3000 liters) per minute of foam would be required for about 55 minutes; such an application would require about 43,000 gallons (160,000 liters) of foam. In such a scenario, activation of the raw water injection system would release large amounts of slightly saline water at the Big Hill site that potentially could reach the groundwater or surface water in the site vicinity (Boeing Petroleum Services Inc. 1989).

3.2.2.4.3 Pump Fire

The pump pad areas at the SPR sites have many flanges, valves, and gaskets that often are manually controlled, and therefore, they offer the potential for human error. For example, valves may be left in the wrong orientation or bolts or screws may be left loose. Such error can lead to leaks or fires (Edwards 1991a).

Pumps operated at SPR sites generally can be shut off from a variety of locations. In a situation of a leak from a pump or other equipment, after a pump is shut down or the area of the leak is isolated, the likelihood of a fire is dramatically decreased as the source of additional fuel for a fire would no longer be available. The fire safety emergency shutdown system automatically shuts down any area where there is a leak or a fire. Specific areas of the SPR site also can be shutdown from the Operations Control Room or various locations around the site. For example, in a leak or a fire situation at a specific cavern during oil fill, all pumps and valves associated with that cavern and the pipelines leading to and from it, would be shut down remotely without any personnel entering the area of the leak or fire. Such mechanisms ensure that a leak or a fire can be contained quickly to the initial starting point and prevent potential injury during shutdown (Edwards 1991a). In an electrical power loss, manual shutdown of pumps and valves is also possible.

The crude oil pumps and related pumping facilities at existing SPR sites are protected by an automatic foam deluge system. These foam systems are subject to routine maintenance and testing, and they would significantly reduce the possibility of a major fire in the pump area. The foam deluge system would be activated by ultraviolet and infrared fire detectors. After they are activated, they can provide foam in a matter of seconds. The foam deluge would quickly suppress, extinguish, and blanket any pooled (two-dimensional) ground fire associated with any crude oil release. The foam deluge would contain but not extinguish three-dimensional fires associated with the pump seal or piping (Boeing Petroleum Services, Inc. 1989). Additional response activities would be needed to extinguish that type of fire. The probability of the occurrence of a pump fire is unlikely; as such a fire has never occurred on an SPR site. The onsite location of these pumps and redundant operational controls limit the potential for environmental impacts should a fire occur.

3.2.2.5 Occupational Injuries

Currently each SPR site operates under a centralized environmental management system that conforms to International Organization for Standardization (ISO) 14001. The SPR Contractor, DynMcDermott, voluntarily maintains certification to the ISO 14001 standard and has attained accreditation in the ISO 9001 Quality Management Program. In conjunction with these certifications, each SPR site, including the proposed expansion sites at Bayou Choctaw, Big Hill, and West Hackberry, has attained and maintained Occupational Safety and Health Administration (OSHA) Voluntary Protection Program Star Status and DOE Voluntary Protection Program Star Status since 1991 (DOE 2004g; OSHA 2006a; OSHA 2006b). The approval process for these programs requires applicants to submit a comprehensive application and undergo a rigorous OSHA onsite evaluation of their worksite and its safety and health management system.

All SPR sites exceeded OSHA Voluntary Protection Program Star status and achieved Star among Star status. The VPP STAR Program is designed for exemplary worksites with comprehensive, successful safety and health management systems. Companies in the Star Program have achieved injury and illness rates at or below the national average of their respective industries. Star participants are reevaluated every three to five years and incident rates are reviewed annually (OSHA 2004a). The reported Lost Workday Case Rate for the SPR sites was less than one workday lost (0.83 days) due to injury per 200,000 worker hours, as compared to the Bureau of Labor Statistics average of 5.3 days, the OSHA VPP Star Among Star level of 2.3, and the OSHA VPP Super Star level of 1.33 (NIST 2005.)

Based on this record, DOE expects that the proposed new and expansion sites would achieve OSHA and DOE VPP Certification and that proposed expansion sites would maintain certification and have lower rates of worker injury, illness, and lost work days than similar types of industrial facilities.

3.2.3 No-Action Alternative

The no-action alternative would limit the impacts from SPR construction and operation to those that have already occurred or that would 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, and hence any additional environmental impacts such as those from spills of oil and brine would not occur. 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 were developed by a commercial entity for oil and gas purposes some spill risk would 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.

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 that exists from the existing pipelines. For the portions of the pipeline in new ROW, the No-Action alternative would not have any spill risk. For the sites of terminals that are in developed petroleum storage areas it is possible that a commercial entity could develop those sites for storage and some spill risk would occur. For the terminal sites in undeveloped areas there would be no spill risk associated with the No-Action Alternative.