3.13 OIL SPILL RISK ASSESSMENT AND ENVIRONMENTAL CONSEQUENCE ANALYSIS

Transportation of crude oil by pipeline involves risk to the public and the environment in the event of an accident, incident, or an unauthorized action, and subsequent release\(^1\) of oil. Releases of crude oil from the Project and appurtenant facilities, though very unlikely, could occur. Spill frequency, volumes, and causes can be estimated using historic spill data on other pipelines as determined from existing data bases and as supplemented by considerations of new pipeline system age and technological improvements compared with much older systems. Releases of crude oil or other petroleum products would affect the environment to varying degrees, and would be of concern to all stakeholders.

This section includes the following discussions:

- Regulatory and industry standards that apply to design, construction, operation, and maintenance of a crude oil pipeline;
- Safety history of onshore hazardous liquid pipeline operations in the United States, for the Applicant, and for all of the states that would be traversed by the Project;
- A risk assessment of the potential for a project-related oil spill;
- Potential impacts, including factors, assumptions, and classifications related to oil spills;
- Environmental variables that might affect the spilled oil fate, behavior, and magnitude of impacts;
- Resource-specific impacts; and
- Mitigation and conservation measures.

3.13.1 Safety Standards

This section describes the regulatory and industry standards for design, construction, operation and maintenance applicable to the Project pipeline system.

3.13.1.1 U.S. Department of Transportation Standards

The U.S. Department of Transportation (DOT) is mandated to provide pipeline safety under Title 49, USC Chapter 601. DOT’s Pipeline and Hazardous Materials Safety Administration (PHMSA) Office of Pipeline Safety (OPS) administers the national regulatory program to ensure the safe transportation of hazardous liquids, including crude oil, by pipeline. PHMSA and OPS develop safety regulations and other approaches to risk management that address safety in the design, construction, testing, operation, maintenance, and emergency response for pipeline facilities. Many of the regulations are written as performance standards that set the level of safety to be attained and allow the pipeline operator to use various technologies to achieve the required level of safety. PHMSA is responsible for regulations that require safe hazardous materials pipeline operations and thus provide protection to people and the environment from the risk of pipeline incidents.

---

\(^1\) "Releases", in various documents, may also be referred to as “oil spills,” “unauthorized releases,” “uncontrolled releases,” “leaks,” “unintentionally discharged”, or “accidental spills.” This EIS uses the term both “release(s)” and “oil spill(s)” [or just “spill(s)"] to include all of these terms, as well as any spill that results from sabotage or vandalism, and any other unauthorized release during construction, operation, abandonment, and restoration/rehabilitation of the proposed Project.
The rules governing pipeline safety are included in Title 49 Code of Federal Regulations (CFR), Parts 190–199. Of those, Parts 190, 194, 195, 198, and 199 are relevant to hazardous liquid (including crude oil) pipelines. Individual states are permitted to adopt additional or more stringent safety regulations for intrastate pipelines within state borders.

Part 190 describes the pipeline safety programs and rulemaking procedures used by OPS in carrying out their regulatory duties. This Part authorizes OPS to inspect pipelines and describes the procedures by which OPS can enforce the regulations. This part also describes the legal rights and options of the operating companies in response to OPS enforcement actions.

Part 194 contains requirements for onshore oil spill response plans. This Part is intended to reduce the environmental impact of oil unintentionally discharged from onshore oil pipelines.

Part 195 prescribes the safety standards and reporting requirements for transportation of hazardous liquids including crude oil by pipeline. These regulations include detailed requirements on a broad spectrum of areas related to the safety and environmental protection of hazardous liquid pipelines. Subpart A, Section 195.6 defines unusually sensitive areas (USAs), which are drinking water or ecological resource areas. Subpart F, Operations and Maintenance, includes requirements for marking, inspecting, and maintaining pipelines. 49 CFR 195.260 (e) requires a valve on either side of water crossings that are more than 100 feet across (as measured from high water marks). Subpart F, Section 195.452 specifies pipeline integrity management requirements in high-consequence areas (HCAs). HCAs are defined as:

- A commercially navigable waterway, which means a waterway where a substantial likelihood of commercial navigation exists;
- A high population area, which means an urbanized area—as defined and delineated by the U.S. Census Bureau—that contains 50,000 or more people and has a population density of at least 1,000 people per square mile;
- Any other populated area, which means a place—as defined and delineated by the U.S. Census Bureau—that contains a concentrated population, such as an incorporated or unincorporated city, town, village, or other designated residential or commercial area; and
- An unusually sensitive area (USA)—explicitly defined in 49 CFR Part 195.6 as drinking water or ecological resource areas that are unusually sensitive to environmental effects from hazardous liquid pipeline releases.

Drinking water USAs are a subset of all surface water intakes and groundwater-based drinking water supplies that provide potable water for domestic, commercial, and industrial uses, including public water systems, source water protection areas/wellhead protection areas, and sole-source aquifers (NPMS 2006). Specifically, drinking water USAs include:

- The surface water intakes for community water systems and non-transient non-community water systems that do not have an adequate alternative drinking water source;
- The source water protection areas for community water systems and non-transient, non-community water systems that obtain their water supply from a Class I or Class IIA aquifer (Pettyjohn et al. 1991) and do not have an adequate alternative drinking water source. If the source water protection area is not available, the wellhead protection areas (WHPAs) become the USA; and
- The aquifer recharge area for sole-source aquifers within karst terrains.
For a new hazardous liquid pipeline, the regulation requires that HCAs be identified prior to operation and that a written Integrity Management Plan (IMP) be in place within one year of the start of operation. The HCA regulation also requires that operators of new hazardous liquid pipelines complete baseline assessments by the start date for pipeline operation. Depending on the findings of the assessment, the operator must take preventive and mitigating measures to protect the HCA from the consequences of a pipeline failure and release of oil. These measures include conducting a risk analysis of the pipeline segment to identify additional actions that would enhance public safety or environmental protection. Such actions may include, but are not limited to, the following:

- Implementing damage prevention Best Management Practices (BMPs);
- Implementing more thorough programs to monitor cathodic protection where corrosion is a concern;
- Establishing shorter inspection intervals;
- Installing emergency flow restriction devices on the pipeline segment;
- Modifying systems that monitor pressure and detect leaks; and
- Providing additional training to personnel on response procedures, conducting drills with local emergency responders, and adopting other management controls.

Subpart G includes minimum requirements for operator qualification of individuals performing tasks required by the regulations. Subpart H specifies corrosion control requirements.

Another key section being considered as part of this Project is 49 CFR § 195.106, internal design pressure. Keystone submitted an application to PHMSA on October 10, 2008, for a special permit seeking relief from Federal pipeline safety regulations in 49 CFR § 195.106 for certain areas within the three segments of the proposed Keystone XL Pipeline. The special permit application seeks relief from PHMSA to allow Keystone to design, construct and operate the Keystone XL Pipeline using a 0.80 design factor in certain areas within the three pipeline segments in lieu of a 0.72 design factor as required in 49 CFR § 195.106. The existing regulations in § 195.106 provide the method used by pipeline operators to establish the maximum operating pressure (MOP) of a proposed pipeline by using the design formula contained in the section. The formula incorporates a design factor, also called a de-rating factor, which is fixed at 0.72 (or also commonly referred to as 72 percent of the Specified Minimum Yield Strength (SMYS)) for onshore hazardous liquid (including crude oil) pipelines.

Keystone requests the use of a 0.80 design factor (or 80 percent SMYS) (“Alternative MOP”) in lieu of a 0.72 design factor, based on the justification that modern steel pipe manufacturing, construction practices, and operations and integrity management procedures would be implemented which were not available or consistently practiced during the development of most of the current pipeline safety regulations. If PHMSA grants Keystone the special permit for a 0.80 design factor, Keystone would be able to operate the pipeline at approximately 10 percent greater pressure than they could operate at a 0.72 design factor using the same pipe wall thickness and grade of steel strength.

PHMSA is still reviewing the special permit request, but is planning to issue a draft Special Permit Analysis and Findings (SPAF) document to:

- Describe the facts of the special permit application and to discuss any relevant public comments received with respect to the application;
- Present the engineering/safety analysis of the special permit application;
Present preliminary findings regarding whether a special permit should be issued to Keystone for the Project; and if so

Describe the conditions which PHMSA would impose to achieve an equivalent or better level of pipeline safety than would be achieved through compliance with the existing regulation.

PHMSA is also performing its own, separate environmental analysis (EA) of the potential impacts that could result from issuance of a special permit consistent with Keystone’s request. The Keystone special permit request letter, FR notice, supplemental information, and other pertinent documents are available for review under Docket Number PHMSA-2008-0285, in the Federal Document Management System (FDMS) located on the internet at www.Regulations.gov. The PHMSA SPAF and EA will also be placed on the docket and will be available for review and public comment when completed.

Part 198 prescribes regulations for grants to aid state pipeline safety compliance programs.

Part 199 requires operators of gas, liquefied natural gas, and hazardous liquid pipeline facilities to establish programs for preventing alcohol misuse and to test employees for the presence of alcohol and prohibited drugs. It also provides the procedures and conditions for this testing.

Parts 194 and 195 specifically require Keystone to develop a comprehensive Emergency Response Plan (ERP) for the proposed pipeline, and for the ERP to be reviewed and approved by OPS prior to operation. OPS would also conduct periodic inspections of the proposed pipeline during operation, and would review the proposed pipeline’s Integrity Management Plan for High-Consequence Areas that would be prepared by Keystone.

The ERP identifies emergency personnel and the logical sequence of actions that should be taken in the event of an emergency involving the Project system facilities during construction or operation. These actions include written emergency shutdown procedures, communication coordination, and cleanup responsibilities. The main points of the ERP, currently under development by Keystone, appear in Section 3.13.4.5. Keystone has prepared pipeline risk assessments and analyses of incident frequencies and potential spill volumes (Keystone 2009a, b, c) that serve as the risk analyses required for HCAs. More detailed analyses would be conducted by Keystone as part of the ERP process. The pipeline risk assessment summarizes Keystone’s estimate of pipeline miles within various types of HCAs. Keystone has not submitted an Integrity Management Plan for HCAs but will need to complete the baseline assessment prior to the proposed pipeline’s operation. The pipeline risk assessments and analyses of incident frequencies and spill volumes are discussed in more detail below.

3.13.1.2 Standards and Regulations for Affected States

The Project would be an interstate hazardous liquid pipeline. Oversight and inspections of interstate pipelines are carried out by OPS or by a state agency in the states where OPS and the state have an agreement. In all states that would be crossed by the proposed pipeline, OPS regulates, inspects, and enforces interstate liquid pipeline safety requirements.

States may adopt regulations with requirements that supplement or exceed federal requirements. For example, although it is not a federal requirement, all states that would be crossed by the proposed pipeline have adopted state one-call systems to reduce the potential for third-party damage to utilities, including pipelines, during projects that involve excavation or soil boring. Of the states crossed by the proposed pipeline, only the State of Oklahoma has pipeline health and safety procedures, for pipelines within their state boundaries that exceed federal requirements. In Oklahoma, Administrative Code 165 Chapter 20 provides regulations for gas and hazardous liquid pipeline safety. Oklahoma assesses an annual fee on
pipeline operators, in addition to reporting requirements. Oklahoma also requires notices prior to construction.

The proposed pipeline would be required to participate in the one-call system in each state. Pipeline construction contractors would need to use the one-call system of each state to prevent damage to existing subsurface utilities. After construction, the Project would need to participate as an operator, as well as comply with additional requirements for assessments, reporting, and notifications, in Oklahoma.

Keystone has also filed an application with the National Energy Board (NEB) of Canada to construct and operate the Canadian portion of its proposed Keystone XL pipeline. Some regulations and standards referenced in this section pertain to Canadian pipelines. In general, operating stress levels for Canadian pipelines are defined in Canadian Standards Association (CSA) Z662, which is referenced in NEB regulations as an acceptable/preferred pipeline standard. Additional publicly available information pertaining to the Canadian portion of the pipeline and NEB’s review can be viewed via the following link: http://www.neb.gc.ca/clf-nsi/rthnb/pplctnsbfrthnb/trnscndkystn/trnscndkystn_oh12009-eng.html#s1.

3.13.1.3 Industry Standards

The Project pipeline design will comply with pertinent industry standards, including the following:


- ANSI Standards CSA Z662-03 and Z662.1-03. This standard covers the design, construction, operation, and maintenance of oil and gas industry pipeline systems that convey various fluids, including crude oil.

- CSA/National Association of Corrosion Engineers (NACE) MR0175/ISO 15156. Materials for Use in H$_2$S-containing Environments in Oil and Gas Production. This 3-part document gives requirements and recommendations for the selection and qualification of carbon and low-alloy steels, corrosion-resistant alloys, and other alloys for service in equipment used in oil and natural gas production and natural gas treatment plants in H$_2$S-containing environments, the failure of which could pose a risk to the health and safety of the public and personnel or to the environment. NACE MR0175/ISO 15156 consists of three standards: general principles for selection of cracking-resistant materials; cracking-resistant carbon and low alloy steels and the use of cast irons; and cracking-resistant CRAs (corrosion-resistant alloys) and other alloys.

- American Petroleum Institute (API) 570, “Piping Inspection Code–Inspection, Repair, Alteration, and Re-Rating of In-Service Piping Systems”. This code was developed for the petroleum refining and chemical processing industries but may be used for any piping system.

- API RP 1102, “Recommended Practices for Liquid Petroleum Pipelines Crossing Railroads and Highways”. This recommended practice is a requirement of ASME/ANSI B31.4.

- API RP 1109, “Recommended Practice for Marking Liquid Petroleum Pipeline Facilities”. ASME/ANSI B31.4 advises that this API RP 1109 shall be used as a guide.
• NACE RP 0169, “Control of External Corrosion on Underground or Submerged Metallic Piping Systems”. ASME/ANSI B31.4 refers to sections of this recommended practice as a guide for an adequate level of cathodic protection.

Other documents or portions thereof pertaining to transportation of hazardous liquids and incorporated by reference in 49 CFR Part 195 are listed in § 195.3.

PHMSA is considering the following additional standards and technical conditions specific to the special permit request to provide additional safety in the operation of the Project:

• API Specification 5L, Specification for Line Pipe, 44th Edition. API 5L and other specifications and standards address the steel pipe toughness properties needed to resist crack initiation, crack propagation and to ensure crack arrest during a pipeline failure caused by a fracture.
• ASTM International A578/A578M Level B or equivalent. Standard Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications.
• API 1104, “Welding of Pipelines and Related Facilities”. API 1104 covers the gas and arc welding of butt, fillet, and socket welds in carbon and low-alloy steel piping used in the compression, pumping, and transmission of crude petroleum, petroleum products, fuel gases, carbon dioxide, nitrogen and, where applicable, covers welding on distribution systems. It applies to both new construction and in-service welding. This standard also covers the procedures for radiographic, magnetic particle, liquid penetrant, and ultrasonic testing, as well as the acceptance standards to be applied to production welds tested to destruction or inspected by radiographic, magnetic particle, liquid penetrant, ultrasonic, and visual testing methods.
• API Recommended Practice 1165 (First Edition), Recommended Practice for Pipeline SCADA Displays.
• API Recommended Practice 1130, Computational Pipeline Monitoring for Liquid Pipelines, (API RP 1130, 1st Edition 2007)
• API Recommended Practice 1162, Public Awareness Programs for Pipeline Operators, (API RP 1162 (1st edition, December 2003) or the most recent version incorporated in § 195.3).
• NACE International RP 0169 (2002 or the latest version incorporated by reference in § 195.3) and 0177 (2007 or the latest version referenced through the appropriate NACE standard incorporated by reference in § 195.3) (NACE RP 0169 and NACE RP 0177) for interference current levels. NACE RP 0169 was described earlier. NACE RP 0177 addresses mitigation of alternating current and lightning effects on metallic structures and corrosion control systems.
• PHMSA’s “Interim Guidelines for Confirming Pipe Strength in Pipe Susceptible to Low Yield Strength for Liquid Pipelines” dated October 6, 2009.
• The Common Ground Alliance’s damage prevention best practices applicable to pipelines.
3.13.2 Safety History

This section reviews the safety history of onshore hazardous liquid pipeline operations in the United States, including specific hazardous liquid pipeline operating experience in the states that would be traversed by the proposed pipeline.

3.13.2.1 PHMSA’s Oil Pipeline Statistics

Spills are reported to DOT’s PHMSA on standard forms in accordance with PHMSA 49 CFR Part 195.50. PHMSA maintains a database of pipeline incident reports (available online at: http://primis.phmsa.dot.gov/comm/reports/psi.html, accessed in April 2009). Pipeline incident reports encompass onshore and offshore natural gas and hazardous liquid pipelines. Hazardous liquid pipelines include crude oil, oil products, liquefied petroleum gas (LPG), anhydrous ammonia, and other hazardous liquids. In this section, the term “hazardous liquid pipelines” is used for information based on hazardous liquid pipeline data. Reference to “crude oil pipelines” is used for information based specifically on domestic onshore crude oil trunk lines.

Hazardous liquid pipeline incidents include those categorized as “serious” or “significant.” A “serious” hazardous liquid pipeline safety incident is one involving a fatality or an injury requiring in-patient hospitalization. “Significant” hazardous liquid pipeline safety incidents include those that meet one or more of the following criteria: spills releasing 2,100 gallons (50 barrels [bbls])\(^2\) or more; spills of 210 gallons (5 bbls) of highly volatile liquid; spills resulting in total costs of $50,000 or more (1984 dollars); or spills that include fire, explosion, injury, or death.

The PHMSA spill report data web site includes summary tables that provide overviews of serious and significant incidents reported over the last 20 years, ending in 2007. Because the PHMSA data set is truncated on the lower end at the reporting limit of 50 bbls\(^3\), the data understate the actual number of incidents and overstate the average spill volumes.

Table 3.13.2-1 shows the average number of serious incidents in a year for hazardous liquid pipeline operators. The summary data show a decreasing temporal trend in the annual average number of serious pipeline incidents. These data include 113 “serious” incidents reported for 20 years, from 1988 to 2007.

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Annual Average Serious Incidents per Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-year average (2003–2007)</td>
<td>3</td>
</tr>
<tr>
<td>10-year average (1998–2007)</td>
<td>4</td>
</tr>
</tbody>
</table>

Source: PHMSA 2009 (PHMSA hazardous liquid incident files, April 2009).

Table 3.13.2-2 shows the number of significant incidents in a year for all hazardous liquid pipeline operators. The summary data show a decreasing trend in annual incident frequency, injuries, and spill volume.

---

\(^2\) One barrel (bbl) equals 42 US gallons. Oil volumes are provided in gallons followed by barrels in this EIS.

\(^3\) Of the 600 spills reported in the PHMSA database between 1998 and 2007, 16 percent were reported as less than 2,100 gallons (50 barrels).
Table 3.13.2-3 presents a summary of PHMSA significant pipeline safety incidents for hazardous liquid pipeline, by cause. It represents significant incidents for the 20-year period from 1988 through 2007 for hazardous liquid pipeline systems.
<table>
<thead>
<tr>
<th>Period</th>
<th>Number of Incidents</th>
<th>Fatalities</th>
<th>Injuries</th>
<th>Property Damage a, b</th>
<th>Gross Barrels Lost</th>
<th>Barrels Recovered</th>
<th>Net Barrels Lost</th>
</tr>
</thead>
</table>

a The costs shown in the tables are in 2007 dollars. Costs are adjusted via the Bureau of Economic Analysis, Government Printing Office inflation values.

b For years 2002 and later, property damage was estimated as the sum of all public and private costs reported in the 30-day incident report, adjusted to 2007 dollars. For years prior to 2002, accident report forms did not include a breakdown of public and private costs; therefore, property damage for these years is the reported total property damage field in the report, adjusted to 2007 dollars.

Note: Totals for the period from 1988 through 2008: 2,965 incidents; 43 fatalities; 234 injuries; $1,540,131,011 property damage; 2,881,283 barrels lost; 1,277,622 barrels recovered, and 1,603,661 net barrels lost.

Source: PHMSA 2009.
### TABLE 3.13.2-3

<table>
<thead>
<tr>
<th>Cause</th>
<th>Number of Incidents</th>
<th>Percent of Total Incidents (%)</th>
<th>Fatalities</th>
<th>Injuries</th>
<th>Property Damage a, b (2007 dollars)</th>
<th>Percent of Property Damage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All other causes</td>
<td>674</td>
<td>23</td>
<td>21</td>
<td>97</td>
<td>$309,859,968</td>
<td>20</td>
</tr>
<tr>
<td>Corrosion</td>
<td>697</td>
<td>24</td>
<td>1</td>
<td>17</td>
<td>$291,758,093</td>
<td>19</td>
</tr>
<tr>
<td>Excavation damage</td>
<td>640</td>
<td>22</td>
<td>14</td>
<td>87</td>
<td>$222,658,875</td>
<td>14</td>
</tr>
<tr>
<td>Human error</td>
<td>207</td>
<td>7</td>
<td>6</td>
<td>27</td>
<td>$40,663,171</td>
<td>3</td>
</tr>
<tr>
<td>Material failure</td>
<td>592</td>
<td>19</td>
<td>0</td>
<td>4</td>
<td>$336,430,359</td>
<td>22</td>
</tr>
<tr>
<td>Natural force damage</td>
<td>121</td>
<td>4</td>
<td>0</td>
<td>1c</td>
<td>$293,435,949</td>
<td>19</td>
</tr>
<tr>
<td>Other outside force damage</td>
<td>34</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>$45,324,593</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,965</strong></td>
<td><strong>100</strong></td>
<td><strong>43</strong></td>
<td><strong>234</strong></td>
<td><strong>$1,540,131,011</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

* The costs shown in the tables are in 2007 dollars. Costs are adjusted via the Bureau of Economic Analysis, Government Printing Office inflation values.

b For years 2002 and later, property damage is estimated as the sum of all public and private costs reported in the 30-day incident report, adjusted to 2005 dollars. For years prior to 2002, accident report forms did not include a breakdown of public and private costs; therefore, property damage for these years is the reported total property damage field in the report, adjusted to 2007 dollars.

Note: Significant incidents are those incidents reported by pipeline operators that meet any of the following conditions: (1) fatality or injury requiring in-patient hospitalization; (2) $50,000 or more in total costs, measured in 1984 dollars; (3) highly volatile liquid releases of five barrels or more, or other liquid releases of 50 barrels or more; (4) liquid releases resulting in an unintentional fire or explosion.

Source: PHMSA 2009.
Outside forces incidents listed in Table 3.13.2-3 include: excavation damage from mechanical equipment, such as bulldozers and backhoes (22 percent); natural force damage, including earth movements due to soil settlement, washouts, or geologic hazards and weather effects such as winds, storms, and thermal strains (5 percent); and other outside force damage (1 percent). Older pipelines have a higher frequency of outside forces incidents partly because their location may be less well known and less well marked than it is for newer lines. In addition, the older pipelines contain a disproportionate number of smaller diameter pipes with reduced wall thicknesses, and have a greater rate of incidents related to outside forces. These pipelines are more easily crushed or broken by mechanical equipment or earth movements.

Corrosion constitutes 24 percent of all hazardous liquid pipeline incidents over the past 20 years (Table 3.13.2-3). The frequency of incidents is strongly dependent on pipeline age. Older pipelines have a higher frequency of corrosion incidents, because corrosion is a time-dependent process. Also, new pipe generally uses more advanced coatings and cathodic protection to reduce corrosion potential. Significant improvements in corrosion control technology applied to pipelines installed since the 1950s have resulted in reduced corrosion-related incident frequencies. Accordingly, the oldest pipelines—pre-1950—experience a disproportionate frequency of corrosion-related failures (Keifner and Trench 2001).

It is important to consider pipeline age when assessing risk based on records of incident frequencies. In 2004, the Transportation Research Board (TRB 2004) published a review of pipelines that included “Pipeline Safety Data and Trends” as an appendix. The Appendix P summarizes a detailed analysis of API and DOT hazardous liquid pipeline incident data, and relies heavily on previous work done for API (Keifner and Trench 2001). The API work confirms that hazardous liquid pipeline age is a significant spill risk factor, for various reasons. The study grouped pipelines by decade of construction. The work shows that older pipelines not only suffer a higher frequency of spill incidents in general, but they also specifically suffer a higher frequency of third-party strike spill incidents. This is attributed to many factors, including poorer marking of older pipelines. Further, older pipelines tend to have smaller diameters and thinner pipe walls; consequently, if they are struck by excavation equipment, they are more likely to rupture. Several industry standards and practices, and DOT requirements would tend to reduce the potential for spill incidents associated with the proposed Project pipeline relative to industry experience. These safeguards include use of non-destructive testing during construction, standards for depth of cover, greater use of boring or directional drilling, more effective coatings, and improved identifying markers along the ROWs.

3.13.2.2 TransCanada Company-Specific Oil Pipeline Operating History

TransCanada is a well known and longstanding natural gas transportation company in Canada and the United States, with limited experience operating crude oil pipeline systems. Through a 50/50 joint venture, TransCanada and Alberta Energy Company (now EnCana Corporation) purchased the Platte pipeline in February 1996 and developed and constructed the Express pipeline in 1996. Together, the Express and Platte pipelines constitute a 1,700-mile system between Hardesty, Alberta and Wood River, Illinois. The system became operational in February 1997, with commercial deliveries beginning in April 1997. Alberta Energy Company operated the Express and Platte systems on behalf of the joint venture partnership until October 2000, when TransCanada divested its 50-percent interest to EnCana Corporation.

TransCanada’s limited operating history with crude oil pipelines precludes comparison of accident and oil spill incident rates specific to TransCanada with the industry average rates. The extent of specific operating experience does not affect the regulatory requirements to be met by the operator.

PHMSA’s SPAF will contain more detail on TransCanada’s compliance history. A review of PHMSA enforcement actions was conducted on all natural gas pipelines operated by TransCanada, operator of the

Draft EIS

Keystone XL Pipeline Project
The pipelines reviewed, with dates TransCanada assumed control of the assets, are listed below:

- Gas Transmission Northwest Corp. – Operator ID # 15014 – November 2, 2004
- ANR Pipeline Co. – Operator ID # 405 – February 22, 2007
- Great Lakes Gas Transmission Co. – Operator ID # 6660 – February 22, 2007
- Northern Border Pipeline Company – Operator ID # 13769 – April 1, 2007
- Tuscarora Gas Transmission Co. -  Operator ID # 30838 – December 19, 2006
- Portland Natural Gas Transmission – Operator ID # 31145 – August 3, 2004
- North Baja Pipeline – Operator ID # 31891 – November 2, 2004
- TC Oil Pipeline – Operator ID # 32334 – incorporated December 12, 2007, presently being constructed

Below is a listing of Keystone/TransCanada closed enforcement matters of all types in all PHMSA regions for the time period the above pipelines have been operated by TransCanada:

- All PHMSA Regions: 2 matters
- Notices of: Amendment (NOA) and Probable Violations (NOPV) – 2 matters, both closed cases
- Letters of: – Warning (WL) and Concern (LOC): None
- Civil Penalties: None

TransCanada’s regulatory enforcement history from time of pipeline ownership to December 31, 2009 indicates two 49 CFR Part 192 compliance issues, no outstanding CAOs, and no civil penalties. All past compliance issues have been resolved with TransCanada and closed by PHMSA. All of TransCanada’s pipelines are in 49 CFR Part 192 natural gas service with the exception of the TransCanada Keystone Oil Pipeline which is presently being constructed.

### 3.13.3 Risk Assessment

Risk of oil spills is expressed as a combination of spill frequency and spill volume. Risk of an oil spill was assessed using failure frequencies derived from the general hazardous liquid pipeline operating history. General incident frequencies and spill volumes were reviewed for relevance to the Project. Incidents occurring in Canada have been documented by regulatory agencies and popularly reported (e.g., the Glenavon oil spill; available online:<http://dogwoodinitiative.org/newsstories/pipelineoilspillraisesquestions>). However, data on these incidents are not readily available in formats amenable to pooling with PHMSA data for analysis. For the proposed pipeline, the risk assessment approach was performed at different levels. Initially, a frequency–volume analysis was performed using PHMSA data to provide a general risk assessment. Subsequently, more specific risk assessments used PHMSA data specific to the states that would be crossed by the proposed pipeline. Keystone submitted a project-specific analysis that used various reference frequencies for different types of incidents and was adjusted for project-specific factors (Keystone 2009a, c). Use of these different approaches results in a range of spill frequencies that “bracket” the number of spills expected from the proposed pipeline.
3.13.3.1 Oil Pipeline Incident History in States that would be Traversed by Keystone XL

Incident frequency rates were not extracted from operational history, because the proposed pipeline has not been constructed and the Keystone Mainline and Keystone Cushing Extension are under construction but not operational as of December 2009. Baseline incident frequencies used in the Pipeline Risk Assessment (Appendix P) are historic (PHMSA 2008) but the majority of pipelines in the United States were constructed in the 1970s or earlier and do not necessarily meet current regulatory requirements or BMPs. Baseline frequencies were adjusted by a factor (0.1-1) to account for improved technologies and practices that would be utilized during construction. An adjustment factor less than 1 indicates a frequency less than that reflected in the PHMSA database. The result is that calculations continue to overestimate risk. Keystone completed a Pipeline Risk Assessment (Appendix P) which contains the detailed analysis of the potential incident frequency based on the worst-case spill volumes. Baseline frequencies are given for six threats based on PHMSA data and pipeline design parameters considered for the calculations to be viable for the Project: corrosion, excavation damage, materials and construction, hydraulic, ground movement and washout, and flooding. The occurrence interval, expressed in years, ranges from one incident every 3,400 years for corrosion to one incident every 87,800 years for washout and flooding.

3.13.3.2 Oil Spill Frequency and Spill Volume

Currently, there are approximately 170,000 miles of hazardous liquid pipelines, both offshore and onshore, in the United States (website: <http://primis.phmsa.dot.gov/comm/PipelineBasics.htm>, last accessed on July 28, 2009). That pipeline mileage can be combined with the incident frequencies and spill volumes in the tables below to yield frequency factors. The incident frequency (defined as incidents per mile of pipe per year), using 10 years of hazardous liquid pipeline incident data for the entire United States, is 126 per year (Table 3.13.2-2) over 170,000 miles, or 0.0007 incident per mile per year. Because the number of incidents per year has been decreasing because of better construction and spill prevention, the use of the 10-year average gives a lower and more accurate frequency. The 10-year national data set gives a loss rate of 16.4 gallons (0.3907 bbl) per mile per year.

State-by-state hazardous liquid pipeline incident data from the PHMSA web site were used to examine a more project-specific subset of the data. For each of the state-by-state analyses, incidents were selected from hazardous liquid pipelines located in a single state crossed by the proposed pipeline route. The state-by-state PHMSA data summaries included the 10 years from 1997 through 2008. That data subset gave a frequency of 0.0003 incident per mile per year and a loss rate of 18.9 gallons (0.033 bbl) per mile per year. The incident rate is slightly higher than that given by the national hazardous liquid pipeline data set, and the expected spill volume is about 15 percent larger. Use of state-specific data may not be a statistically reliable predictor of incident frequencies or release volumes for the proposed pipeline because of the relatively small number of incidents reported in most of the subject states in the last 10 years.

Approximately 55,000 miles of crude oil trunk lines are in the United States (website: http://www.pipeline101.com). The detailed incident report database available from the PHMSA web site was used to analyze incidents of crude oil spills that involved onshore hazardous liquid pipelines. The detailed PHMSA data cover the most recent 20 years; they were filtered down to the most recent 10 years. That data subset, including about 600 reported incidents, gave a frequency of 0.00109 incident per mile per year and a loss rate of 43.7 gallons 1.04 bbls (43.7 gallons) per mile per year. Ordinarily on average, onshore crude oil pipeline incidents have comparable frequencies but between two and three times the spill volume compared to all reported hazardous liquid pipeline incidents.

Spill frequencies and volumes estimated from PHMSA data and applied to the proposed pipeline are presented in Tables 3.13.3-1 and 3.13.3-2, respectively. The frequency factors give an overall frequency...
(for spills or leaks greater than 50 bbls) between 0.81 and 3.86 (1.79 if Oklahoma is used instead of Texas) spills per year, depending on which data set is used as the basis. The volume factors give an estimated annual gross spill volume between 18,000 and 60,000 gallons (429 and 1,420 bbls) per year, depending on the data set used as the basis.

This Pipeline Risk Analysis (Keystone 2009a) includes references to the Cushing Extension (currently under construction) and is therefore referred to in this section as it impacts the nominal throughput of the Project.

### TABLE 3.13.3-1
Projected Spill Incidents (>50 Barrels) per Year for the Project

<table>
<thead>
<tr>
<th>Spill Incidents per Year</th>
<th>Full PHMSA Hazardous Liquids Dataset a</th>
<th>PHMSA Data–Keystone States b</th>
<th>PHMSA Data–Crude Oil c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incidents per mile per year</td>
<td>0.0007</td>
<td>0.0003</td>
<td>0.00109</td>
</tr>
<tr>
<td>Steele City (850)</td>
<td>0.15</td>
<td>0.007</td>
<td>0.71</td>
</tr>
<tr>
<td>Cushing Extension (298)</td>
<td>0.42</td>
<td>0.290</td>
<td>0.35</td>
</tr>
<tr>
<td>Gulf Coast (525)</td>
<td>0.24</td>
<td>0.760</td>
<td>1.14</td>
</tr>
<tr>
<td>Project total (1,673 miles)</td>
<td>0.81</td>
<td>1.06</td>
<td>3.86</td>
</tr>
</tbody>
</table>

*Full* includes all hazardous liquid pipelines in the United States, onshore and offshore.

b “Keystone states” includes data only for onshore hazardous liquid pipelines in the states that would be crossed by the proposed pipeline.

c “Crude oil” includes data just for onshore crude oil pipeline incidents, all states. Gulf Coast Segment includes Texas with a much higher number of reported incidents.

Notes:

PHMSA = Pipeline and Hazardous Materials Safety Administration.

Any discrepancy between information for individual items and totals and subtotals is attributable to rounding error.

Source: PHMSA 2009.

The spill frequency analysis conducted by Keystone (Keystone 2009a, c) included a state-by-state spill frequency estimate. This analysis produced a Project leak frequency of one incident in 7,400 years per mile of pipeline. Detailed calculations and hazard-specific tables are available in Keystone’s Pipeline Risk Assessment (Appendix P). Table 3.13.3-2 shows Keystone’s projected spill occurrence along the proposed pipeline for a 10 year interval. Keystone has an additional 1,365 miles of pipeline (Keystone Mainline and Cushing Extension) under construction (permit issued in 2008). Even though the permit has been issued for the Keystone Cushing Extension, the nominal throughput would increase, based on the operation of the Project, from 591,000 barrels per day (bpd) to 900,000 bpd and, therefore, it is included in the table.

### TABLE 3.13.3-2
Spill Occurrence Interval Associated with the Project over 10 Years – Applicant Analysis

<table>
<thead>
<tr>
<th>Spill Occurrence Interval</th>
<th>Conservative Number of Spills per 10 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steele City Segment (850 miles)</td>
<td>1.1</td>
</tr>
<tr>
<td>Keystone Cushing Extension (298 miles)</td>
<td>0.4</td>
</tr>
<tr>
<td>Gulf Coast Segment and Houston Lateral (525 miles)</td>
<td>0.6</td>
</tr>
<tr>
<td>Total (1,672 miles)</td>
<td>2.2</td>
</tr>
</tbody>
</table>

3.13-14

Draft EIS

Keystone XL Pipeline Project
The PHMSA data produce a spill frequency based on historical spill incidents on existing pipeline systems in the Gulf Coast Segment that is higher than that produced by Keystone’s project-specific analysis. While future events cannot be known with certainty, spill frequencies can be used to estimate the number of events that might occur. Actual frequency may differ from the predicted values of either analysis. In addition, PHMSA data reflect incidents on existing pipeline infrastructure. With implementation of the DOT’s Integrity Management Rule, continually improving industry operating practices, and advancements in best available control technology (BACT), the number of spills is expected to decline from historical levels observed on older pipelines. Hazardous liquid pipeline serious and significant incident frequencies have been steadily decreasing, as indicated by the PHMSA trend using 5-year, 10-year, and 20-year incident frequency averages (Tables 3.13.3-1 and 3.13.3-2). The frequency of oil spills from the proposed pipeline and facilities is likely to be lower than the PHMSA data statistical frequency, which reflects past experience.

PHMSA shows that national hazardous liquid incidents (serious and significant) have dropped over a 10-year period. The first six months of 2009 show that pipeline incidents remain at the 2008 level. A state-by-state evaluation shows Texas to be considerably higher in number of incidents than 48 other states and second only to California in number. Both of these states have a greater number of pipelines and a higher proportion of pipelines that were constructed before improved materials and high standards were developed.

Keystone’s risk analysis (Keystone 2009a) used an additive method that included specific types of incidents and their respective frequencies. The analysis did not include incidents that resulted from causes other than excavation, corrosion, human error, material failure, natural forces, and other outside forces. The PHMSA incident cause data (Table 3.13.2-3) provide an “all other causes” category to account for 23 percent of incidents, many of which are incidents for which a cause was not reported.

Even with the differences identified above, both the PHMSA data and the Keystone data tend to overestimate the likely Keystone spill frequency since over the life of the proposed pipeline, small spills would likely occur (i.e., the probability is ~1.0) but large to very large spills would be very unlikely to occur (i.e., the probability approaches 0). Nevertheless, as indicated by the PHMSA data, there are infrequent occurrences of large to very large spills; and their potential impacts need to be addressed. Keystone’s Pipeline Risk Assessment projects that 50 percent of releases would be three barrels or less and that less than 0.5 percent of releases would be 10,000 barrels or greater (Keystone 2009a, c).

### 3.13.3.3 Construction Spills

The majority of construction spills are small, and composed of refined products (e.g., gasoline, diesel, and lubricating and hydraulic fluids). Most result from vehicle and construction equipment fueling and maintenance. Fueling operations may also be a source of frequent but very small to small spills. Construction staging areas may include portable fuel and oil storage tanks staged onsite during the course of the construction activity. The capacities of such tanks vary, depending on the duration of work and quantity of equipment to be fueled.

In addition to onsite fuel facilities, construction of the proposed pipeline would involve tanker trucks that deliver fuel and other fluids to operating equipment along the construction ROW. Tanker and fuel or maintenance truck accidents or fuel storage tank failures would be the most likely sources of larger construction spills. The potential maximum oil spill volume from these sources would be about 143 bbls (6000 gallons) for diesel or gasoline and about 8 bbls (330 gallons) for lubricating or hydraulic fluid (i.e., six 55-gallon barrels on a pallet). According to the Pipeline Risk Assessment (Appendix P) and in compliance with 49 CFR Part 112 for each staging area, oil storage tanks would have secondary means of containment (berms) for 110 percent of the capacity of the largest tank. In addition, portable oil storage
containers would have berms that hold 110 percent of the total capacity of the containers inside the berm. The Environmental Inspector would inspect storage sites for compliance with a 100-foot setback from the water’s edge.

Potential spills from construction activities are addressed by specific preventive and mitigating measures that will be included in the ERP. Additional measures are discussed in Section 3.13.4.5.

### 3.13.3.4 Operations and Maintenance Spills

The conservative analysis of potential oil spills during operation and associated maintenance is provided in the Keystone XL Project Pipeline Risk Assessment and Environmental Consequence Analysis (Appendix P). The analysis demonstrates that the predicted frequency of any and all operations spills is low, the probability of a large spill occurring is very low, and the risk of a spill that would impact sensitive habitats, especially aquatic habitats, is extremely low. Compliance with applicable state and federal regulations, including PHMSA requirements (see Section 3.13.1) application of Keystone’s IMP and Emergency Response Plan (ERP), as well as adherence to safety procedures will help to ensure long-term, environmentally sound, and safe operation of the pipeline. However, there would be a very small chance that an oil spill from the pipeline may occur.

Operational spills may occur anywhere along a pipeline, including pump stations and within long runs of straight line pipe. Pipeline operation leaks, drips, and spills can occur due to corrosion, damage caused by third parties performing excavation or soil borings, external forces due to landslides or washouts, or other causes. Pump station operational leaks can occur due to circumstances similar to pipeline operational leaks, with additional risks related to filter change and pig launching or receiving operations.

Spills from the proposed pipeline, associated pump stations, valves, or pigging facilities could occur during Project operation at several general locations including the pipeline ROW, pump stations, and staging areas for major maintenance and other contractor activities. Although leak detection systems (addressed later in this section and in detail in the Pipeline Risk Assessment (Keystone 2009a)) would be in place; some leaks might not be detected by the system for an extended period of time. For example, a pinhole leak could potentially be undetectable for days or a few weeks especially if the release volume rate were small. Detection of oil from small pinhole leaks would most likely occur through visual or olfactory identification, either during regular pipeline aerial inspections, ambulatory patrols, or landowner or citizen observation.

A large spill is most likely to result from a large break in the pipeline. For most of the proposed pipeline route, some of the released oil could be contained in the immediate vicinity of the release point. The released oil would however affect the environment adjacent to the spill source. Keystone will prepare an ERP which will describe the response actions, equipment, procedures, and other required elements necessary to rapidly respond to and manage an oil spill response. In some instances, the point of release may be relatively remote and hard for responders to quickly access. Pipeline leak detection technology may identify a leak and shut down flow quickly, but actual response with containment equipment and cleanup crews may be delayed due to one or more of the following factors:

- If the leak is at a remote location, visual leak detection may be difficult and reporting may be delayed;
- Locating the leak may require significant time searching the area where the leak originates;
- Snow, light condition, or other natural factors may hinder visual detection;
- Weather conditions, natural disasters (e.g., floods, landslides, excessive snow fall, avalanches) may delay access to the spill location especially for larger equipment and supply vehicles, and

---

*Draft EIS  Keystone XL Pipeline Project*
Depending on spill volume, proximity, and season, the oil could reach wetlands, freshwater ponds and lakes, streams, or larger rivers (refer to Section 3.13.4.1, Factors Affecting Oil Spill Impacts).

3.13.4 Impacts Related to Oil Spills

Crude or refined oil released into the environment may affect natural resources, protected areas, human uses and services, and aesthetics to varying degrees, depending on the cause, size, type, volume, location, season, environmental conditions, and associated response actions. Small oil spills (e.g., intermittent leaks and drips from construction machinery and operating equipment that are typically very small volumes) would be almost certain to occur during construction and operation of the Project. There would also be a very limited potential for a spill of sufficient magnitude to significantly affect natural resources and human uses of the environment. The previous sections describe the risk or probability of spills of various sizes. In this section, it is assumed that a spill has occurred (probability = 1.0) and the potential impacts are described for a range of potential oil spill scenarios associated with the proposed Project.

Most oil spills are unpredictable in cause, location, time of occurrence, size, and duration (J.L. Mach et al., Hart Associates, Inc. 2000). When an oil spill occurs, the resulting environmental impact depends on a number of factors, including the:

- Amount and duration of oil release, and location with respect to topography, infrastructure, and sensitive receptors;
- Fate and behavior of the spilled oil (i.e., the potential for a spill reaching an environmental receptor, persistence in the environment);
- Chemical composition and physical characteristics of the oil; and
- Toxicity and other adverse effects of the oil to the receptors.

Discussion of oil spill impacts requires a depiction of typical potential spill scenarios and environmental variables that might affect spilled oil fate and behavior. These descriptions are provided with the caveat that they are necessarily simplified and do not represent the entire spectrum of possible values or combinations of values and events that might be realized in actual spills. However, many of these factors and assumptions have been used in previous assessments, and all are based on the peer-reviewed literature, technical reports, and empirical experience of oil spill experts worldwide. Key factors are summarized in the following sections.

3.13.4.1 Factors Affecting Oil Spill Impacts

Impacts related to oil spills can be affected by the release location, type and volume of oil released, nearby receptors and resource uses, seasonal variations, response time and response actions, weather, water levels, and other factors that are described below.

Location of Spill

Most spills would occur and be contained within or in close association with the proposed pipeline ROW or the associated infrastructure such as construction yards, pump stations, and maintenance yards. These spills would typically be small (i.e., much less than a barrel) and would be promptly cleaned up as required by federal, state, and local regulations before they reach offsite lands or waterbodies. During construction, some refined product spills may occur from tank truck accidents along roads leading to the construction sites. Some of these spills may result in much or all of a load being spilled to the land, wetlands, ponds and lakes, or flowing waterbodies adjacent to the road or pad. The maximum volume of gasoline or diesel from a tank truck would be about 6,000 gallons (~143 barrels) and the maximum
lubricating or hydraulic oil would be about 330 gallons (~8 barrels), the contents of a typical pallet of six 55-gallon drums. These unlikely substantial and larger⁴ spills would have limited distribution unless they occurred at or very near an open waterbody.

Almost all spills during operation and maintenance of the proposed pipeline would be crude oil. Most will likely be very small to small, and it is very unlikely that a large or very large spill would occur. Based on experience, spills would be more likely to occur in developing or agricultural areas where excavation activities are common, and at locations where, based on soil and other physical conditions, the corrosion potential is greatest⁵. The locations of greatest concern for potential oil spills would be those that are upgradient of HCAs and USAs, especially wetlands, flowing streams and rivers, and water intakes for drinking water or commercial/industrial users.

**Type of Oil**

For this EIS, the materials that could be spilled are categorized and described as follows:

- **Crude oil** which may be either diluted bitumen (heavy crude) or synthetic crude oil (light crude);
- **Refined oil** (e.g., diesel, gasoline, hydraulic fluid, transmission oil, lubricating oil and grease, waste oil, mineral oil, solvents, transformer oil, and other petroleum-based products); and
- **Other hazardous materials** (e.g., alcohol and petroleum-based solvents, antifreeze, battery acid, paint, field joint coating material, radiography source, water-soluble chemicals, corrosion inhibitors, scale inhibitors, drag-reducing agents, and biocides).

This EIS focuses on crude oil because of the potential for large-volume releases of crude oil into sensitive areas over the approximately 1,380-mile proposed pipeline route. The impacts of refined oil are assessed where appropriate. The volume of other hazardous materials spills typically is small and these spills are most likely to occur at the construction or operation/maintenance sites where materials would be stored in containers of discrete capacities that define worst case maximum spill quantities. Spill prevention, control, and containment (SPCC) plans, secondary containment requirements, and hazardous materials location restrictions would reduce the risk that a release from a hazardous materials container could affect surface waters. Spills of refined oil products and other hazardous materials from construction or operations/maintenance sites would be much more likely to be contained and would be readily cleaned up. Therefore, the discussion of impacts of spills focuses on larger volume crude oil spills along the proposed pipeline ROW. For this EIS, the corrosion inhibitors, scale inhibitors, drag-reducing agents, and biocides are considered part of the crude oil spill.

Crude oil transported by the Project would be derived from the Alberta oil sands region. The oil extracted from the sands is a thick, black oil called bitumen. In order for bitumen to be transported by pipeline, it is either diluted with cutter stock (the specific composition of which is proprietary information to each shipper) or an upgrading technology is applied to convert the bitumen to synthetic crude oil⁶. The precise composition of synthetic crude would vary by shipper and is considered proprietary information. In general, the crude oils would be similar to Western Canada Select (WCS) as a heavy crude and Suncor Synthetic A (OSA) which is a light crude. The physical and chemical composition characteristics of these two types of crude are available at [http://www.crudemonitor.ca/assays.html](http://www.crudemonitor.ca/assays.html).

---

⁴ See later sub-section titled Volume in this section for a definition of spill sizes.
⁵ See section 3.13.1 for a compilation of the safeguards required of the Project to minimize the potential for corrosion to affect the pipeline.
⁶ This EIS uses “crude oil” as the generic term to describe the diluted bitumen and synthetic crude oil (also called “syncrude”) derived from the Alberta oil sands.
Crude oils may differ in their solubility, toxicity, persistence, and other properties that affect their impact on the environment. The effects of a specific crude oil cannot be thoroughly understood without considering its composition and physical properties. Of particular importance are:

- **Specific gravity**, which determines whether the unweathered oil would sink or float upon release to an aquatic environment. A specific gravity of <1.0 means the unweathered oil will float on fresh water.
- **Viscosity**, which determines how readily the oil would flow when released, especially in an area with a down slope or downcurrent gradient to an HCA or USA. Typically, viscosity increases as temperature decreases. This may be an important consideration, as air temperatures along the length of the proposed pipeline corridor may range from well below freezing in winter to in excess of 100 °F in summer.
- **Pour point**, an indicator of the temperature at which the oil changes from liquid to a “solid” material that does not flow. Like viscosity, this is heavily influenced by ambient temperatures.
- **Proportion of volatile and semi-volatile fractions**, an indicator of (1) the amount of oil that would evaporate or volatilize (and thus not affect most resources); (2) the amount of oil that likely would physically persist in the environment as it weathers; and (3) the amount of potentially toxic material that could dissolve or disperse into an aquatic environment and cause toxicological impacts.
- **Proportion and amount of polycyclic aromatic hydrocarbons (PAHs)**, many of which are considered the key toxic fraction of oils.

Information provided by Keystone on example oils similar to those expected to be transported (Western Canadian Select and Suncor Synthetic A) indicates that the Project crude oil may have the following general characteristics:

- Specific gravity <0.93;
- Pour point for heavy crude < -30 °C ; and
- Pour point for synthetic crude < -21 °C.

More characteristics of these example oils are reported in copyrighted assays by Crude Quality, Inc. (website: [http://www.crudemonitor.ca/current.html](http://www.crudemonitor.ca/current.html)). Some characteristics could not be described or distilled from assay data for the example oils for this EIS, including viscosity profiles, proportion of volatile and semi-volatiles compounds, the amount or proportion of PAHs, and toxicity to aquatic organisms based on bioassays. In the discussions that follow, information on these characteristics is therefore drawn from the available literature in the public record.

### Volume

To describe the impacts of spills in this EIS, spills are categorized as:

- Very small spills—less than 5 bbl (<210 gallons);
- Small spills—5–49.9 bbl (210–2,100 gallons);
- Substantial spills—50–499.9 bbl (2,100–21,000 gallons);
- Large spills—500–5,000 bbl (21,000–210,000 gallons); and
- Very large spills—>5,000 bbl (>210,000 gallons).
This size classification is generally similar to the unofficial categories used by OPS for spill reporting. The very small spill and very large spill categories were added to facilitate discussion of the vast majority of spills (less than 210 gallons) and of the very rare spills (greater than 210,000 gallons). The model results from the worst-case discharge scenario for the Project-specific risk analysis (Appendix P; Keystone 2009b) indicates that this scenario would represent <0.1 percent of all spills that might occur and it is extremely unlikely that a very large spill of >10,000 bbls (420,000 gallons) would occur from the Project.

**Habitat, Natural Resources, and Human Use Receptors**

The impact of an oil spill would be heavily influenced by the types of receptors (i.e., habitats, natural resources, and human uses) that might be exposed to the oil. For this EIS, these receptors are generally categorized and described as follows, in increasing order of likely actual environmental impacts and concern to the entire spectrum of stakeholders:

- **Terrestrial–agricultural land.** Includes grazing, field and row crops, fallow fields, and similar land uses.
- **Terrestrial–natural habitat.** Includes native and second-growth forests, naturally restoring grasslands, and similar areas that are not being used directly by people for commercial purposes.
- **Groundwater.** Emphasis is on areas where the water table is close to the ground surface and/or is overlain by soils permeable to oil or by karst formations.
- **Aquatic–wetland habitat.** Includes all areas that meet the definition of wetlands.
- **Aquatic–lake/pond habitat.** Includes agricultural stock ponds, irrigation and drainage ditches, small and large lakes, reservoirs, and similar non-flowing waterbodies.
- **Aquatic–stream/small river habitat.** Includes smaller flowing waterbodies as well as those that are intermittent or ephemeral. These generally do not support commercial boat traffic and are not restricted with dams or major reservoirs. Some may support important recreational resources and activities or may be limited in beneficial uses.
- **Aquatic–large river habitat.** Includes large flowing waterbodies (e.g., Yellowstone River, White River, Niobrara River, Platte River, Missouri River, Loup River, Red River, and Canadian River) that are perennial, may support commercial traffic, and/or may be restricted by dams and major reservoirs.
- **Threatened and endangered species and their critical habitat.** Most are USAs and/or HCAs, and are a special case of resources that may be found in any of the habitats but are limited in population size or spatial distribution.
- **Human use–residential.** Areas where the proposed pipeline ROW is near rural, suburban, or urban populations.
- **Human use–recreational.** Areas, especially lakes, small and large rivers, and reservoirs and associated parks used by people for various recreational activities.
- **Human use–commercial.** Areas that may be closed to normal use during a spill response action and result in substantial economic impacts.

---

7 The directly impacted stakeholders (e.g., ranchers, farmers, homeowners) likely will consider the impacts to his/her resources as very high concern regardless of the overall impact in an ecosystem context. Also, USAs and HCAs may be considered more sensitive to oil spill impacts on a local scale compared to the larger ecosystem scale, partly because of the designation and partly because of their local ecological or human use significance.
• Human use–water intakes. Most are USAs and/or HCAs, and are usually in reservoirs, large rivers, and some groundwater aquifers from which drinking water, industrial cooling water, and/or agricultural water supplies are obtained.

Season

The season in which a spill occurs could dramatically influence its behavior, impacts, and the cleanup response actions. Seasonal variations in potential spill behavior are addressed in this section.

Spring-Fall

When the spring-fall season begins and ends depends on the location along the proposed pipeline route and the weather regime of the year. For this EIS, this time period is generally defined as the period when the ground is mostly free of snow and access to the proposed pipeline ROW is not restricted by snow and ice. Most of the rivers and creeks are flowing; ponds, lakes, and reservoirs are open water; land is mostly snow-free; and biological use of land and waterbodies is high. Currents, winds, and passive spreading forces would disperse spills that reach the waterbodies. Spills to land would directly affect the vegetation, although dispersal of the spilled material is likely to be impeded by the vegetation. Spills to wetlands may float on the water or be dispersed over a larger area than would spills to dry land or to ice and/or snow-covered land and water bodies associated with the wetlands.

Winter

Winter is the period when waterbodies may be covered with ice and possibly snow, and the land surface may be partially to completely covered with snow. Dispersal of oil spilled to the land generally would be slowed, although not necessarily stopped, by the snow cover. Depending on the depth of snow cover as well as the temperature and volume of spilled material, the spill may reach the underlying dormant vegetation or wetlands, ponds, and lakes. Similarly, spills to flowing rivers and creeks generally would be restricted in area by the snow and ice covering the waterbody, compared to seasons with little or no snow and ice cover. Spills under the ice to creeks, rivers, and ponds/lakes might disperse slowly as the currents are generally slow to non-existent in winter. However, because of snow and ice, winter spills may be harder to detect and, when found, more difficult to contain and clean up.

Breakup or spring melt is the short transition period between winter and spring when thawing begins and river flows increase substantially and quickly, often to flood stages. Major floods may cause bank erosion and ultimately pipeline failure, with the oil entering the river and likely being widely dispersed and difficult to contain or clean up.

Weather and Water Levels

Weather, especially rapid warming periods and heavy rainfall, may cause rapid snowmelt and runoff. These could result in major flood flows that breach levees along larger rivers, erode river banks, alter channels, and expose the proposed pipeline to forces that may break or rupture it. This scenario, although a very low-probability event especially at HDD crossings, could occur at large or small stream or river crossings not spanned by HDD. If spilled oil is released to the flooded area, especially to flowing waters, oil could be distributed to adjacent terrestrial, wetland, and aquatic habitats that normally would not be exposed. These habitats and natural resources, as well as human uses of the habitats and resources, may be exposed to the spilled material.

Winds, especially high-velocity sustained winds, would result in widespread distribution of material released under pressure, primarily from hole(s) in the top hemisphere of an exposed portion of the
pipeline. Ejected material could become a cloud of mist and fine particles, and would be carried
downwind. The extent of distribution would depend on wind velocity, direction of the released spray
(e.g., downward into the ground, horizontal, or skyward), and characteristics of the release (e.g., pressure
in the pipeline, type of oil, size of hole). Under most scenarios, the pressure in the pipeline will drop
quickly, the release will be highly visible, immediate pipeline spill control and shutdown actions will be
taken by the CMP and SCADA as well as the onsite personnel; therefore, the areal extent of the plume
would be limited to the immediate area of the pipeline right of way.

Major flooding or adverse weather conditions (e.g., high winds, tornados, blizzards, and extreme cold)
may limit Keystone’s ability to detect a suspected release and/or hinder or stop the spill response
contractors from implementing timely and effective oil spill containment and cleanup operations.

### 3.13.4.2 Keystone Response Time and Actions

For spills ranging in magnitude from very small to substantial, response time and actions by Keystone and
its response contractors would most likely prevent the oil from reaching sensitive receptors or would
contain and clean up the spills before significant environmental impacts occurred. Most spills in this
category are likely to occur on construction sites or at operations and maintenance facilities, and would
not reach the natural environment.

For large spills, very large spills and potentially some substantial spills, especially those that reach aquatic
habitats, the response time between initiation\(^9\) of the spill event and arrival of the response contractors
would influence the magnitude of impacts to the natural environment and human uses. This is
particularly true if the oil reaches flowing waters in major rivers. Once the response contractors are at the
spill scene, the efficiency, effectiveness, and environmental sensitivity of the response actions (e.g.,
containment and clean up of oil, and protection of resources and human uses from further oiling) would
substantially influence the type and magnitude of additional environmental impacts.

### 3.13.4.3 Factors Affecting the Behavior and Fate of Spilled Oil

The primary and shorter-term processes that affect the fate of spilled oil are spreading, evaporation,
dispersion, dissolution, and emulsification (Payne et al. 1987, Boehm 1987, Boehm et al. 1987, Overstreet
and Galt 1995). These processes are called weathering. Weathering dominates during the first few days
to weeks of a spill. A number of longer term processes also occur, including photodegradation and
biodegradation, auto-oxidation, and sedimentation. These longer-term processes are more important in
the later stages of weathering and usually determine the ultimate fate of the spilled oil.

The chemical and physical composition of oil changes with weathering. Some oils weather rapidly and
undergo extensive changes in character, whereas others remain relatively unchanged over long periods.
Because of evaporation, the effects of weathering are generally rapid (one to a few days) for
hydrocarbons with lower molecular weights (e.g., gasoline, aviation gas, and diesel). Degradation of the
higher weight fractions (e.g., crude oil, transmission and lube oil, and hydraulic fluid) is slower and
occurs primarily through microbial degradation and chemical oxidation. The weathering or fate of spilled
oil depends on the oil properties and on environmental conditions, both of which can change over time.

---

\(^8\) Oil released from a hole in the bottom hemisphere of the pipeline would impact the ground within a few feet of the
pipeline and would behave like any release that flowed onto the ground surface. Also, an aerial release would only
occur where the pipeline is above ground level or where it has been exposed during excavation. The most likely
cause of a release in the top half of the pipeline would be from excavation equipment or similar accident.

\(^9\) “Initiation of the event” means when the oil began to leak or spill to the environment, not when it is detected by
either the SCADA or other means. There may be a substantial delay between initiation and detection, particularly
for slow or pinhole leaks under snow or below ground.
Spreading

Spreading reduces the bulk quantity of oil present in the vicinity of the spill but increases the spatial area over which adverse effects could occur. Thus, oil in flowing systems (e.g., rivers and creeks) rather than contained systems (e.g., wetlands, ponds, and lakes) would be less concentrated in any given location but could cause impacts, albeit reduced in intensity, over a larger area. Spreading and thinning of spilled oil also increases the surface area of the slick; enhancing surface-dependent fate processes such as evaporation, biodegradation and photodegradation (see below), and dissolution.

Adsorption

Crude or refined oil dispersed in soil will adsorb or adhere to soil particles. Crude oil will usually bind most strongly with soil particles in organic soils and less strongly with soil particles in sandy soils. In water, heavy molecular weight hydrocarbons may bind to suspended particulates, and this process can be significant in highly turbid or eutrophic waters. Organic particles (e.g., biogenic material) in soils or suspended in water tend to be more effective at adsorbing oils than inorganic particles (e.g., clays). Sorption processes and sedimentation reduce the quantity of heavy hydrocarbons present in the water column and available to aquatic organisms. However, these processes also render hydrocarbons less susceptible to degradation. Oil in sediment tends to be highly persistent and can cause chronic impacts.

Evaporation

Evaporation is the primary mechanism for loss of low-molecular-weight constituents and light oil products. As lighter components evaporate, remaining petroleum hydrocarbons become denser and more viscous. Evaporation tends to reduce oil toxicity but enhance persistence. Hydrocarbons that volatilize into the atmosphere are broken down by sunlight into smaller compounds. This process, referred to as “photodegradation,” occurs rapidly in air; the rate of photodegradation decreases as molecular weight increases. The crude oil to be transported in the proposed pipeline tends to have a relatively small proportion of constituents that evaporate rapidly, based on data provided by Keystone.

Dispersion

Dispersion of oil increases when water surface turbulence increases. Wind, gravity, tidal currents, or broken ice movement could cause the turbulence. Dispersion of oil into water increases the surface area of oil susceptible to dissolution and degradation processes, and thereby limits the potential for physical impacts. However, some of the oil could become dispersed in the water column or on the bottom as it adheres to particulate matter suspended in the water column. The presence of particulates, including organic matter, silt and clay, and larger sediment particles, is likely to be greatest during spring ice breakup, flood flows, and wind storms.

Dissolution

Dissolution of oil in water is not the primary process controlling the fate of the oil in the environment (i.e., oil generally floats on rather than dissolves into water). However, to the extent that dissolution does occur, it is one of the primary processes affecting the toxic effects of a spill, especially in confined waterbodies. Dissolution increases with decreasing hydrocarbon molecular weight, increasing water temperature, decreasing water hardness or “salinity,” and increasing concentration of dissolved organic matter. Under the same environmental conditions, components of gasoline (e.g., benzene, toluene, ethylbenzene, and xylenes) would dissolve more readily than the heavier fractions of crude oil or fuel oils.

10 In this case, the definition of “dissolution” is to dissolve into water.
**Emulsification**

Emulsification is the incorporation of water into oil and is the opposite of dispersion. Small drops of water become surrounded by oil. External energy from wave or strong current action is needed to emulsify oil. In general, heavier oils emulsify more readily than lighter oils. The oil could remain in a slick, which could contain as much as 70 percent water by weight and could have a viscosity of a hundred to a thousand times greater than the original oil. Water-in-oil emulsions often are referred to as “mousse.”

**Photodegradation**

Photodegradation of oil increases with greater solar intensity. It can be a significant factor controlling the disappearance of a slick, especially of lighter products and constituents, but it would be less important during cloudy days and could be almost nonexistent in winter months. Photodegraded petroleum product constituents tend to be more soluble and more toxic than parent compounds. Extensive photodegradation, like dissolution, could increase the biological impacts of a spill event.

**Biodegradation**

Biodegradation of oil by native microorganisms, in the immediate aftermath of a spill, would likely not be a significant process controlling the fate of oil in waterbodies previously unexposed to oil. Although oil-degrading microbial populations are ubiquitous at low densities, a sufficiently large population must become established before biodegradation can proceed at any appreciable rate. Biodegradation is typically a long term (weeks to years) process that reduces both the toxicity and volume of spilled oil.

### 3.13.4.4 Summary of Environmental Factors Affecting Fate of Spilled Oil

Overall, the environmental fate of released oil is controlled by many factors, and persistence cannot be predicted with great accuracy. Major factors affecting the environmental fate include the type of product, spill volume, spill rate, oil temperature, terrain, receiving environment, time of year, and weather. Crude oil would weather differently than diesel or refined products in that both diesel and refined products would evaporate at a faster rate than crude oil.

The characteristics of the receiving environment, such as the type of land cover, soil porosity, land surface topography and gradient, type of freshwater body, presence of ice and/or snow cover on water or land, and flowing water current velocity, would affect how the spill behaves. In ice-covered waters, many of the same weathering processes occur as in open water. However, ice changes the rates and relative importance of these processes (Payne et al. 1991).

The time of year when a spill occurs has a major effect on the fate of the crude oil. The time of year controls climatic factors such as temperature of the air, water, or soil; depth of snow cover; whether there is ice or open water; and the depth of the active (soil frost) layer. During winter, the air temperature can be so cold as to modify the viscosity of oil so that it would spread less and could even solidify. The lower the ambient temperature, the less crude oil evaporates. Frozen ground would limit the depth of penetration of any spill. Weather also could affect Keystone’s ability to detect, contain, or clean up a spill.

### 3.13.4.5 Keystone Actions to Prevent, Detect, and Mitigate Oil Spills

In addition to the natural environmental factors affecting the fate and behavior of spilled oil, Keystone has designed and committed to a comprehensive slate of processes, procedures, and systems to prevent, detect, and mitigate potential oil spills that may occur during operation of the proposed pipeline. These
are summarized below. The Final ERP would contain further detail and would be completed and reviewed by PHMSA-OPS as a condition for Keystone to operate the proposed pipeline.

**Prevention**

Keystone has conducted a pipeline threat analysis using the pipeline industry-published list of threats under ASME B31.8S and by PHMSA to determine the applicable threats to the proposed pipeline (see Section 2, Appendix P). Safeguards were then developed to protect against these potential threats, which have been identified as follows:

- Incorrect pipeline operations (e.g., overpressure of the pipeline);
- Materials and construction damage (e.g., flaws such as defective welds, dents, cracks, nicks in the coating that are a result of transport or construction, and flaws in the seam of the pipeline created during the manufacturing process);
- Corrosion (e.g., internal, external, and stress-corrosion cracking) including defects that develop over time during operation;
- Accidental damage such as external contact with the pipeline (e.g., third-party backhoes, excavators, and drills); and
- Facility damage from natural hazards (e.g., landslides, floods, and earthquakes).

Safeguards were implemented during the Project’s design phase and would be implemented during construction and operations of the proposed pipeline. These include:

- Pipe specifications that meet or exceed applicable regulations;
- Use of the highest quality external pipe coatings (fusion bond epoxy or FBE) to prevent corrosion;
- Providing 4 feet of soil cover over the buried pipeline in most locations, which exceeds federal standards;
- Implementing a variety of pipeline system inspection and testing programs prior to operation, to prevent leaks. Examples of these programs include: an extensive pipeline quality assurance program for pipe manufacturing and coating; non-destructive testing of 100 percent of girth welds; and hydrostatic testing of the pipeline at 125 percent of the Maximum Operating Pressure (MOP);
- An operational pipeline monitoring system (Supervisory Control and Data Acquisition [SCADA]) that remotely measures changes in pressure and volume every 5 seconds on a constant basis. These data would be immediately analyzed to determine potential product releases anywhere on the pipeline system;
- Periodic pipeline integrity inspection and cleaning programs using internal inspection tools (pigs) to detect pipeline diameter anomalies indicating excavation damage, and loss of wall thickness from corrosion;
- Aboveground aerial and ground surveillance inspections. The aerial inspections would be conducted 26 times per year (not to exceed three weeks apart) to detect leaks and spills as early as possible, and to identify potential third-party activities that could damage the proposed pipeline; and
• Installing mainline valves and intermediate mainline valves and check valves along the proposed pipeline route to reduce or avoid spill effects to PHMSA-defined HCAs.

The implementation of all these measures, described in more detail in section 3.13.1, would ensure that the likelihood of spills to occur would be very small, and that the volume released, in the unlikely event of a spill, would be small.

The regulations require the use of a design safety factor contained in 49 CFR 195.106 to establish a maximum operating pressure for steel pipelines. In October 2008, TransCanada filed a request for a Special Use Permit to PHMSA that if approved would grant a waiver of 49 CFR 195.106 that would allow in certain areas of the pipeline corridor the use of a modified design specification (see section 3.13.1). The modification would allow the pipeline to operate at maximum Operating Pressure (MOP) that would develop internal hoop stresses less than or equal to 0.80 times the Specified Minimum Yield Strength (SMYS) of the steel used to construct the proposed pipeline. Without the waiver from 49 CFR 195.106, internal hoop stresses would not be allowed to exceed 0.72 times the SMYS. In effect, the waiver would allow a small reduction in pipe wall thickness in specified areas along the pipeline corridor given the design MOP of the proposed pipeline system. PHMSA noticed the application for this Special Use Permit in the Federal Register on January 23 2009. The permit request number is PHMSA-2008-0285-0001. PHMSA is considering the request at this time.

TransCanada requested a similar Special Use Permit and waiver for the Keystone Mainline and Cushing Extension in 2006 and the request was granted by PHMSA. In issuing that Special Permit, PHMSA found specifically that allowing Keystone to operate at 80 percent of SMYS is consistent with pipeline safety and that it “will provide a level of safety equal to or greater than that which would be provided if the pipelines were operated under existing regulations.” The Keystone Mainline and Cushing Extension Special Permit contains 51 conditions that Keystone must comply with, addressing such areas as steel properties, manufacturing standards, fracture control, quality control, puncture resistance, hydrostatic testing, pipe coating, overpressure control, welding procedures, depth of cover, SCADA, leak detection, pigging, corrosion monitoring, pipeline markers, in-line inspection, damage prevention program, and reporting. Failure to comply with any condition may result in revocation of the Special Permit. In addition, the Special Permit is not applicable to certain sensitive areas, including commercially navigable HCAs; high population HCAs; highway, railroad, and road crossings; and pipeline located within pump stations, mainline valve assemblies, pigging facilities, and measurement facilities. Issuance of the Special Permit was based on PHMSA’s determinations that the aggregate effect of Keystone’s actions and PHMSA’s conditions provide for more inspections and oversight than would occur on pipelines installed under the existing regulations, and that PHMSA’s conditions would require Keystone to more closely inspect and monitor its proposed pipeline over its operational life than similar pipelines installed without a Special Permit. The pipe is non-destructively examined, hydrostatically tested, and mechanically tested to prove strength, fracture control, and fracture propagation properties in the mill. All pipes are traceable. The pipe is also examined for fatigue-related defects when it is off-loaded from rail cars at stockpile sites.

During operations, Keystone would enforce a specification for sediment and water content in the commodities transported, in addition to implementing a comprehensive Integrity Management Plan that would use prevention tools such as in-line inspection, computational pipeline (CP) system surveys, geotechnical monitoring, corrosion coupons and associated testing, corrosion inhibitor and biocide injection, aerial patrol, and public awareness programs. Ground-level patrols would be undertaken in the event of a suspected leak but would not be routinely undertaken. Aerial patrols would be conducted at least 26 times per year.
Detection

Keystone would utilize a comprehensive SCADA system to monitor and control the proposed pipeline. Data provided by the SCADA system would alert the Operations Control Center (OCC) operator to an abnormal operating condition, indicating a possible spill or leak. A back-up communication system also would be available should SCADA communications fail between field locations and the OCC.

The SCADA system would continuously monitor pipeline conditions and update information provided to the OCC operator. Data received via the SCADA system also would be directed to the dedicated leak detection system, capable of independently sending an alarm to the OCC operator.

Keystone also would incorporate computer-based accumulated gain/loss volume trending to assist in identifying low rate or seepage releases below the 1.5- to 2-percent-by-volume detection threshold referenced in Appendix P, Section 5.0 bounded by flow measurement equipment. By accumulating these gain/loss results over a succession of time intervals, the cumulative imbalance, if any, of the segment can be determined. Once this cumulative imbalance exceeds a prescribed threshold, further investigation and evaluation is required. Thresholds would be established based on the accuracy and repeatability of flow measurement equipment and the extent to which flow imbalances generated by the normal operation of the proposed pipeline can be tuned out.

In the event that a volume imbalance is identified and warrants further investigation, Keystone would use measures such as the following to identify the leak location:

- Shut-in pressure testing between isolation valves to identify pressure loss within a pipeline segment;
- Aerial and ground patrols to provide direct observation and identification of leak location;
- Internal inspection surveys; and
- Other methods of external leak detection, including odorant-based.

Spill Response Procedures

Spill response procedures incorporated in the ERP and SPCC Plan that would be prepared by Keystone and reviewed by OPS prior to the start of system operations would be followed in the event of a spill. Procedures that are likely to be included in the final, approved, ERP and SPCC Plan are summarized in this section. ERP and SPCC standard operating and response procedures would be utilized by the OCC operator in responding to abnormal pipeline conditions, including leak alarms. The OCC operator would have the full and complete authority to execute a pipeline shutdown. Keystone’s OCC operator would follow prescribed procedures in responding to possible spills that may be reported from sources such as:

- Abnormal pipeline condition observed by the OCC operator;
- Leak detection system alarm;
- Employee reported abnormal conditions; and
- Third party reported abnormal conditions.

Upon receipt of an abnormal condition report, leak report, or leak alarm, the OCC operator would execute the following procedures:
- Follow prescribed OCC operating and response procedures for specific directions on abnormal pipeline condition or alarm response;
- Dispatch First Responders;
- Shut down the proposed pipeline within a predetermined time threshold if abnormal conditions or leak alarm cannot be positively ruled out as a leak; and
- Complete internal notifications.

All Keystone employees are authorized to communicate directly with the OCC should they observe conditions that may signify a possible spill.

**Response Time**

In the event of a potential pipeline leak or spill, the estimated time to complete an emergency pipeline shutdown and close remotely operable isolation valves is as follows:

- Stop pumping units at all pump station locations: approximately 9 minutes
- Close remotely operable isolation valves: approximately 3 minutes
- Total time: approximately 12 minutes

Consistent with industry practice and in accordance with regulations, including 49 CFR Part 194.115, Keystone’s response time to transfer such additional resources to a potential leak site would follow an escalating or tier system. Dependent on the nature of site-specific conditions and resource requirements, Keystone would meet or exceed the requirements along the entire length of the proposed pipeline system (Table 3.13.4-1).

<table>
<thead>
<tr>
<th>49 CFR Part 194</th>
<th>Tier 1 Resources</th>
<th>Tier 2 Resources</th>
<th>Tier 3 Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-volume area*</td>
<td>6 hours</td>
<td>30 hours</td>
<td>54 hours</td>
</tr>
<tr>
<td>All other areas</td>
<td>12 hours</td>
<td>36 hours</td>
<td>60 hours</td>
</tr>
</tbody>
</table>

* “High-volume area” indicates an area where an oil pipeline with a nominal outside diameter of 20 inches or more crosses a major river or other navigable waters; because of the velocity of the river flow and vessel traffic on the river, this area would require a more rapid response in the case of a worst-case discharge or the substantial threat of such a discharge.

**Spill Response Equipment**

In general, Tier 1 emergency response equipment would be pre-positioned for access by Keystone including: pick-up and vacuum trucks, containment boom, skimmers, pumps, hoses, fittings, and valves, communications equipment including cell phones, two-way radios, and satellite phones, containment tanks and rubber bladders, expendable supplies, including absorbent booms and pads, assorted hand and power tools, including shovels, manure forks, sledge hammers, rakes, hand saws, wire cutters, cable cutters, bolt cutters, pliers, and chain saws, personnel protective equipment, including rubber gloves, chest and hip waders, and air monitoring equipment to detect H2S, O2 Lower Explosive Level, and benzene concentrations.
Additional equipment, including helicopters, fixed-wing aircraft, all-terrain vehicles, snowmobiles, backhoes, dump trucks, watercraft, bull dozers, and front-end loaders also may be accessed depending on site-specific circumstances. Other types, numbers, and locations of equipment would be determined upon concluding the detailed design of the proposed pipeline and completing Keystone’s final ERP (Oil Spill Emergency Response Plan). This plan would be completed in 2010 and submitted to PHMSA for review prior to commencing operations.

The primary task of the Tier 1 response team is to minimize the spread of product on the ground surface or water in order to protect the public and USAs, including ecological, historical, and archeological resources and drinking water locations. The Emergency Site Manager (also known as the Qualified Individual or “QI”) would perform an initial assessment of the site for specific conditions, including the following:

- The nature and amount of the spilled product;
- The source, status, and release rate of the spill;
- Direction(s) of spill migration;
- Known or apparent impact of subsurface geophysical features that may be affected;
- Overhead and buried utility lines and pipelines;
- Nearby population, property, or environmental features and land or water use that may be affected; and
- Concentration of wildlife and breeding areas.

The QI would request additional resources in terms of personnel, equipment, and materials from the Tier 2 and if necessary, the Tier 3 response teams. Once containment activities have been successfully concluded, efforts would then be directed toward the recovery and transfer of free product. Site cleanup and restoration activities would then follow, all of which would be conducted in accordance with the authorities having jurisdiction, including development of a natural resource damage assessment in the event that it is required.

### Spill Response Personnel and Training

The number of emergency responders comprising specific response teams would be determined upon completion of Keystone’s ERP in 2010. Emergency responders would meet or exceed the requirements of 49 CFR Part 194.115, and would typically be comprised of Hazardous Waste Operations and Emergency Response (“HAZWOPER”) trained personnel. The response organization would follow the industry-accepted Incident Command System (ICS) and would typically consist of personnel both onsite and within an established remote or Regional Emergency Operations Center (EOC).

### Locations of Spill Responders

Keystone would base emergency responders consistent with industry practice and in compliance with applicable regulations, including 49 CFR Part 194 and 49 CFR Part 195. Consequently, emergency responders would be based in closer proximity to the following areas:

- Commercially navigable waterways and other water crossings;
- Populated and urbanized areas; and
- Unusually sensitive areas, including ecological, historical, and archeological resources and drinking water locations.

The specific locations of other emergency responders would be determined upon conclusion of the detailed location and design of the proposed pipeline, and completion of Keystone’s ERP.

**Spill Training Exercises and Drills**

Keystone’s spill training exercise and drill program would be designed to meet the requirements of the National Preparedness for Response Exercise Program Guidelines developed by the U.S. Coast Guard and adopted by the PHMSA, the Minerals Management Service (MMS), and EPA. Participation in this program would ensure that the Company meets all federal exercise requirements mandated by the Oil Pollution Act of 1990 (OPA 1990).

The primary elements of the exercise program are notification exercises, tabletop exercises, Company-owned equipment deployment exercises, contractor exercises, unannounced exercises by government agencies, and area-wide exercises up to and including actual field drills conducted by industry and government agencies.

Keystone would ensure that operating personnel participate in exercises or responses on an annual basis in order to ensure that they remain trained and qualified to operate the equipment in the operating environment and to ensure that the ERP is effective. However, personnel and equipment that are assigned to multiple Response Zones would participate in only one deployment exercise per year.

The exercise year for all Project facilities would be from January 1 to December 31.

In addition, Keystone would be required to participate in unannounced federal agency-led exercises, and in other area exercises when requested by appropriate authorities.

### 3.13.4.6 Types of Oil Spill Impacts

**Physical Impacts**

Physical impacts of oil spills to natural resources and human uses typically result from physical coating of soils, sediments, plants, animals, or areas used by people. Physical impacts include, but are not limited to:

- Smothering living organisms so they cannot feed or obtain oxygen;
- Coating feathers or fur, which reduces their insulating efficiency and results in hypothermia;
- Adding weight to the organism so that it cannot move naturally or maintain balance;
- Coating sediments and soils, which reduces water and gas (e.g., oxygen and carbon dioxide) exchange and affects subterranean organisms; and
- Coating beaches, water surfaces, wetlands, and other resources used by people which may result in offensive odors, visual impacts, as well as soiled livestock, crops, clothes, recreational equipment, pets, and hands/feet.

In aquatic areas with high energy (e.g., waves, turbulent river flows, and/or high sediment deposition), the oil may become buried under or mixed into the substratum where it may remain for extended periods of time and may be slowly released to the environment to re-oil downstream habitats and resources. In some cases, the buried oil would be in an anoxic environment and would resist weathering by physical or
biological processes. Upon release to the environment, this “unweathered” oil may result in additional but delayed impacts.

**Chemical and Toxicological Impacts**

Toxicological impacts are the result of chemical and biochemical actions of petrogenic compounds (primarily PAHs and volatile/semi-volatile fractions) on biological processes of individual organisms. Results may include: various toxic effects to animals and birds as they try to remove the oil from their fur or feathers; direct and acute mortality; sub-acute interference with feeding or reproductive capacity; disorientation; narcosis; reduced resistance to disease; tumors; reduction or loss of various sensory perceptions; interference with metabolic, biochemical, and genetic processes; and a host of other acute or chronic effects. Fish and aquatic invertebrates in standing water habitats such as wetlands, lakes and ponds may be narcotized by exposure to dissolved fractions of crude or refined oil if the dose-response exposure is great enough.

Oil spills are not likely to have toxic effects on humans, livestock, and wildlife although fumes from spilled oil may make people sick if they are exposed long enough to high concentrations in the air. Other than response personnel, people generally are restricted from areas where fumes from spilled oil could pose a potential health threat and farmers and ranchers would be encouraged to move their livestock and assisted to do so if necessary in areas where fumes posed a threat to livestock.

**Biological Impacts**

The physical and chemical impact processes described previously are manifested at the organism level. Additional biological and ecological impacts may manifest in local populations, communities, or entire ecosystems depending on the location, size, type, season, duration, and persistence of the spill, as well as the type of habitats and biological resources exposed to spilled oil. Except for some endangered, threatened, or protected species, loss of a small fraction of a population of organisms would result in a minimal impact at a community to ecosystem level. Loss or reproductive impairment of a significant portion of a population or biological community from an oil spill could result in a significant environmental impact. The impact is likely to be greater if the species affected have long recovery times (e.g., low reproductive rates); limited geographic distribution in the affected area; are keystone species in the ecosystem; are key habitat formers; or are otherwise a critical component of the local biological community or ecosystem. Furthermore, if the species or community is a key recreational or commercial resource, biological impacts manifested at the population or community level may constitute a significant impact to human uses of the resource.

**Oil Spill Scenarios**

A range of spill scenarios is provided to facilitate the impact assessment. It is impractical to evaluate all reasonably likely, let alone possible, combinations of factors that are associated with and constitute an oil spill impact assessment. Most spills that may result in significant environmental impacts are likely to be large crude oil spills from the proposed pipeline. For that reason and because a key criterion for the OPS spill reporting system is volume of oil released, spill scenarios were based on the spill volumes discussed in Section 3.13.4.1. The volumes characterizing each of the five categories are meant to be a guide and are not official or fixed. One or more of the factors influencing a spill could change the impacts dramatically. For example, a small spill of 2,000 gallons (~48 bbl) into an inter-connected wetland system in spring where thousands of migrating waterfowl are resting could cause substantial impacts, whereas a very large spill of 230,000 gallons (~5,500 bbl) onto a frozen, snow-covered pasture in winter may result in minimal impact on the natural or human use environment.
The spill scenarios used in this EIS — especially for the large-volume spills — likely overestimate, and in some cases substantially overestimate, the potential spill impacts.

**Very Small and Small Spills**

The most common scenarios are the very small (<5 bbl) and small (5–49.9 bbl) spills of material—usually diesel, hydraulic fluid, transmission oil, or antifreeze—on work pads, roads, and facility parking or work areas. Some of these small spills may result from slow and small (pin hole) leaks of crude oil from the proposed pipeline. Most of these small spills would not reach non-facility land or waterbodies. However, some of the spills could reach natural or cultivated land, or could seep into the soil toward groundwater or into nearby waterbodies remote from the roads and pads. The few spills that could reach terrestrial habitats typically would affect a limited area adjacent to the road, ROW, or pad. Even those spills that do reach waterbodies generally would result in a limited impact because of the small volume of oil involved.

**Substantial and Large Spills**

Substantial (50–499.9 bbl) and large (500–5,000 bbl) spills would be much less likely to occur (see Section 3.13.2. and 3.13.3). Substantial spills would more likely:

- Relate to accidents at or in transit to construction and operation/maintenance sites;
- Comprise refined products (though they may be composed of crude oil from a small leak in the proposed pipeline or at a pump or metering station); and
- Occur on or near roads, construction pads, facility sites, or along the ROW.

Large spills would more likely be crude oil releases from the proposed pipeline and would likely occur in the ROW. Both substantial and large spills would likely result from tanker truck accidents (during construction), major failure of the fuel storage tanks at construction sites, outside forces such as excavators and major earth movement, or corrosion of the pipe. Substantial and especially large spills would be more likely than small ones to reach natural or agricultural lands, or waterbodies adjacent to the ROW, roads, and pads. For those spills that do reach waterbodies, especially flowing streams and rivers, the area of impact generally would be more extensive than for the small spills because of the larger volume of oil involved. Likewise, the potential for large spills to reach groundwater surfaces is greater than for small spills. Large spills that result from a rupture in the proposed pipeline, for whatever reason, would likely be detected quickly by the SCADA system; both automatic and manual responses would be quickly activated to stop and isolate the leak.

**Very Large Spills**

Avery large (>5,000 bbl) spill would be a very unlikely event (see Section 3.13.2 and 3.13.3) and would result from a major rupture or a complete break in the proposed pipeline that releases crude oil somewhere along the ROW. Causes might include: major earth movement resulting from slides; major earth movement resulting from an earthquake; major flood flows eroding river banks at non-HDD crossings; mechanical damage from third-party excavation or drilling work; or vandalism, sabotage, and terrorist actions. The actual volumes spilled could vary depending on a number of factors, including:

- Locations, activation methods, and activation delay times for valves;
- The amount of pressure in the line;
- Location of the break; and
The extent to which the proposed pipeline follows topographic contours, and the location of low spots in the pipeline relative to the break.

Until final alignments are determined and proposed pipeline construction completed, the largest and most likely potential spill volumes cannot be estimated precisely or accurately.

A very large spill would be likely to reach both land and adjacent waterbodies, especially if it occurs in the ice-free seasons and near waterbodies. The proximity of the proposed pipeline to major streams and rivers may be the most important factor in spill scenarios. In general, if the spilled material flows to dry land, natural or agricultural, the oil probably would not disperse far. Crude oil is more viscous and would percolate downward through porous soil more slowly than gasoline, diesel fuel or other refined products. A substantial portion of crude oil may adhere to soil particles, thereby reducing the amount that could potentially reach the groundwater and/or nearby water wells (Section 3.3.1.1). Once at the upper groundwater surface, most crude oil would float and may move downgradient with the groundwater. However, if a very large spill reaches a flowing creek or river, the oil could be dispersed substantial distances downstream. Flood flows could distribute spilled oil over flooded natural, agricultural, or residential/commercial lands and could flow into ponds, reservoirs, and lakes. Whether a very large spill would reach these rivers or streams would depend on several variables, including the oil type, ambient water and air as well as oil temperature, and volume of oil spilled; the topographic relief and slope; presence of snow or vegetation; and response time and actions.

Assessment of Impact Magnitude

Based on the worldwide extensive experience and literature accumulated over the past 50 years by scientists, engineers, planners, economists, managers, and other stakeholders on oil spill impacts to ecosystems and human uses (e.g., API 1992, API 1997, NRC 1985, 2003a, 2003b), one can make the general statement that the magnitude of impact is primarily a function of size of the spill, type of oil, and sensitivity of the receptors affected.

For this EIS, the type of oil expected to have the greatest likelihood of significant impacts is crude oil (diluted bitumen or syncrude) from the proposed pipeline. These two versions of crude oil are similar enough that they are treated as one for purposes of this impact assessment. Therefore variations in spill size and receptor type are key variables for estimating the magnitude of environmental impacts of oil spills from the Project. Spill size can be measured or estimated within a reasonable margin of error in most cases. Receptor sensitivity is more subjective and is influenced by both the perspectives and biases of the evaluators, and the actual sensitivity of the receptors to the oil. For example, a farmer whose grain field is oiled is likely to consider impacts to his field more significant than spill related impacts on a major wetland that supports threatened and endangered species, recreational hunting, and other recreational opportunities. Conversely, a national wildlife refuge manager is likely to have a diametrically opposed evaluation. The relative sensitivities of receptors that could be affected by the Project are presented as a hierarchy in Table 3.13.4-1, based on historical spill sensitivity assessments and typical input from the range of stakeholders taken as a group.

The magnitude of environmental impacts generally increases within a receptor type as spill size increases (i.e., from left to right in the table). Within a spill size, the magnitude of impact increases with increasing sensitivity of the receptors (i.e., from top to bottom in the table). Combining size and sensitivity, the magnitude of impacts generally increases from top left to bottom right in the table. In many oil spills, there are clear differences in the way that stakeholders (e.g., general public, non-governmental organizations, natural resource management agencies, regulatory agencies, enforcement agencies, private businesses, municipal agencies, and others) value spill related impacts on natural resources and habitats compared to spill related impacts on human uses. Table 3.13.4-2 reflects a consensus on the ranking of
these values, recognizing that the concept of “impact assessment and magnitude” is anthropogenic and not a component of ecosystem function.

For this EIS, five levels of environmental impact are considered and are entered into the table to indicate the generally expected magnitude of impacts from oil spills. The magnitude of impact may vary, up or down and possibly substantially, from these general trends—depending on a number of site-specific variables described previously. The five levels of impact are:

- **Negligible Impact** – Little to no detectable impact on most resources; may be some visible presence of oil on land, vegetation, or water. Zero to very few organisms apparently killed or injured. Temporary (days) and spatial distribution localized to spill site. No detectable effects on USAs and HCAs.

- **Minor Impact** – Measurable presence of oil and limited impacts on local habitats and organisms. Temporary (days to weeks) and local (acres). Some organisms, likely birds, fish, and aquatic macroinvertebrates, may be killed or injured in the immediate area. May have very limited effects on USAs and HCAs.

- **Substantial Impact** – Patchy to continuous presence of oil on terrestrial and aquatic habitats near the spill site. Impacts may be present for weeks to a few months and affect tens of acres or a few miles of stream/river habitat. May have local biological community and population level effects on organisms and human uses of the area. May have detectable effects on USAs and HCAs.

- **Major Impact** – Patchy to continuous and heavy presence of oil on terrestrial and aquatic habitats near the spill site and for substantial distances downgradient. Impacts may be present for weeks to months and potentially for a year or more. Area may include many acres to sections of land or wetlands, and several miles of riverine habitat. May have local biological community and population-level impacts on organisms and habitats, and disruption of human uses of local oiled areas. May have substantial effects on exposed USAs and HCAs.

- **Catastrophic Impact** – Mostly continuous or nearly continuous presence of oil on all habitats near and/or for substantial distances downgradient of the spill site. Impacts may be present for months to years. Area may include many acres to sections of land or wetlands, and several to numerous miles of river or other aquatic habitat. May be both local and regional disruption of human uses. May be both local and regional impacts to biological populations and communities. May have significant to catastrophic effects on exposed USAs and HCAs.
<table>
<thead>
<tr>
<th>Type of Receptor</th>
<th>Size of Spill (in barrels)</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very Small (&lt;5)</td>
<td>Small (5-49.9)</td>
<td>Substantial (50-499.9)</td>
<td>Large (500-5000)</td>
<td>Very Large (&gt;5000)</td>
</tr>
<tr>
<td>Terrestrial–agricultural land</td>
<td>Negligible</td>
<td>Negligible to minor</td>
<td>Minor to substantial</td>
<td>Minor to substantial</td>
<td>Substantial</td>
</tr>
<tr>
<td>Terrestrial–natural habitat</td>
<td>Negligible</td>
<td>Minor</td>
<td>Minor to substantial</td>
<td>Substantial</td>
<td>Substantial</td>
</tr>
<tr>
<td>Groundwater</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible to minor</td>
<td>Minor to substantial</td>
<td>Substantial</td>
</tr>
<tr>
<td>Aquatic–wetlands</td>
<td>Negligible</td>
<td>Minor</td>
<td>Minor to substantial</td>
<td>Substantial</td>
<td>Major to catastrophic</td>
</tr>
<tr>
<td>Aquatic–lakes and ponds</td>
<td>Negligible</td>
<td>Negligible to minor</td>
<td>Minor to substantial</td>
<td>Substantial</td>
<td>Major</td>
</tr>
<tr>
<td>Aquatic–streams and small rivers</td>
<td>Negligible</td>
<td>Negligible to minor</td>
<td>Substantial</td>
<td>Major</td>
<td>Major to catastrophic</td>
</tr>
<tr>
<td>Aquatic–large rivers</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Minor</td>
<td>Substantial to major</td>
<td>Major to catastrophic</td>
</tr>
<tr>
<td>Threatened and endangered species and habitat</td>
<td>Negligible to minor</td>
<td>Minor to substantial</td>
<td>Substantial</td>
<td>Substantial to major</td>
<td>Major to catastrophic</td>
</tr>
<tr>
<td>Human use–commercial</td>
<td>Negligible</td>
<td>Negligible to minor</td>
<td>Minor</td>
<td>Minor to substantial</td>
<td>Substantial to major</td>
</tr>
<tr>
<td>Human use–residential</td>
<td>Negligible</td>
<td>Negligible to minor</td>
<td>Minor</td>
<td>Minor to substantial</td>
<td>Substantial to major</td>
</tr>
<tr>
<td>Human use–recreational</td>
<td>Negligible</td>
<td>Negligible to minor</td>
<td>Minor to substantial</td>
<td>Substantial to major</td>
<td>Major to catastrophic</td>
</tr>
</tbody>
</table>

*a In increasing order of sensitivity from top to bottom.*
3.13.5 Resource-Specific Impacts

This section addresses potential impacts related to the resources described in Sections 3.1 through 3.12 from very small spills (less than 5 bbl and mostly less than 1 bbl) to very large spills (>5,000 bbl). The impact assessment is based on the past 60 years of nationwide experience and relevant literature. As discussed earlier (sections 3.13.3.3 and 3.13.3.4), the vast majority of historical pipeline-related spills have been:

- Very small or small;
- Contained within the boundaries of the secondary containment or at least on the ROW, pads, and roadways;
- Cleaned up expeditiously; and
- Characterized by natural resources impacts that are limited in area, duration, and size.

However, because large to very large spills from large oil pipelines have occurred or could occur, albeit with very low probability, the impacts of such spills are also discussed.

Additional or corroborative information on the potential impacts of oil spills is presented in Section 4.0 of the Keystone XL Project Pipeline Risk Assessment and Environmental Consequence Analysis (Keystone 2009d).

3.13.5.1 Air

Impacts on air quality from an oil spill would be localized and transient, even for very large spills. Evaporation of the lighter hydrocarbon fractions typically occurs within one to a few days, and the vapors are usually dissipated below risk levels within a short distance of the source. The oil spill response contractors or Keystone pipeline health and safety personnel would monitor air for hydrocarbon vapors. They would restrict public access to areas exceeding specified risk levels while also ensuring that authorized personnel within the restricted areas are equipped with and using appropriate personal protective equipment. They would also advise the nearby farmers and ranchers of potential hazards to livestock and other farm animals, and assist them in moving the livestock to protect the livestock from deleterious hydrocarbon concentrations.

Based on models by Hanna and Drivas (1993), the majority of volatile organic compounds (VOCs) from crude oil spills would likely evaporate almost completely within a few hours after the spill occurred, especially during late spring/early fall when air and soil surface temperatures are higher. Emissions of VOCs, such as benzene, ethylbenzene, xylene, and toluene, would peak within the first several hours after the spill starts and drop by two orders of magnitude after approximately 12 hours. The heavier compounds take longer to evaporate, particularly at the colder temperatures typical of the winter season, and might not peak until more than 24 hours after the spill. In the event of an oil spill on land, the air quality effects would be less severe than those for a spill on water because some of the oil could be absorbed by vegetation or into the ground. However, some effects might last longer on land before the VOC compounds are completely dissipated.

Diesel fuel oil, kerosene and similar hydrocarbons could be spilled during refueling, from a broken diesel pipeline, or from accidents involving vehicles or equipment. A diesel spill would evaporate faster than a crude oil spill. Ambient hydrocarbon concentrations would be higher than for a crude oil spill but also would persist for a shorter time. Also, because any such spill would probably be smaller than potential crude oil spills, any air quality effects from a diesel spill likely would be even lower than for other spills.
Gasoline and many of the solvents would evaporate and disperse very rapidly. Almost all the volume released would evaporate, except for small amounts that may seep into the upper soil and vegetation layers from which it would be released over a day or days. Gasoline vapors are generally not toxic at the concentrations experienced in spills but they may be subject to fires and explosions. Keystone and its contractors would restrict the public as well as cleanup personnel from potentially dangerous areas.

Impacts on air quality related to oil spills would be localized and short term. The associated VOC air emissions would result in little impact on the biological or physical resources of the project area.

### 3.13.5.2 Geology

The proposed Project does not involve geological features that have received state or federal protection. Consultation with Indian tribes along the proposed route is ongoing, and at this time none have identified any geological features of tribal significance along the route, although concerns related to paleontological resources have been identified. These and other geologic resources are addressed in the following sections.

**Paleontological Resources**

Most spills would be confined to a construction or facility pad, access roadway, or pipeline ROW, or to an adjacent area. The primary exceptions would be large to very large spills from pipelines that affect areas beyond the ROW. For example, a large to very large spill may enter a river crossing the ROW, and oil may be carried for several miles downstream. Any paleontological resources exposed along the river banks within the river reaches affected by the spill could be affected. Cleanup activities could also damage the paleontological resources. Keystone, in collaboration with appropriate local, state, and federal agencies and Indian tribes would develop a Paleontological Mitigation Plan and, in Montana, an MOU to identify and protect significant fossil resources that may be encountered during construction or damaged as the result of an oil spill.

**Mineral and Fossil Fuel Resources**

For surface and near-surface resources such as sand, gravel, clay and stone, small to substantial spills may result in localized reduction in resource availability and value depending on actions involved in the incident response and subsequent remedial activities. For large and very large spills, the impacts may be proportionally greater. However, the distribution of these mineral resources and their relatively undeveloped state along the ROW indicate that the overall potential for impacts to the resources and their associated industries would be small.

The proposed route would cross deposits of sand, gravel, clay, and stone; but the acreage of deposits covered by the proposed ROW is insignificant compared to the total acreage of deposits present in each state. The proposed route would not cross any currently active aggregate mining operations. Thus, impacts from spills in the vicinity of these resources would be negligible for small or even substantial spills that are rapidly contained. Even large spills would result in minor impact because of the wide spatial distribution of these resources and their current state of development.

The proposed Project route would not cross the well pads of any active or proposed oil or gas wells, although active oil and gas wells are located nearby the proposed ROW (Keystone 2009a). Impacts of spills of any size that are rapidly and effectively addressed would not be likely to result in any contamination or alteration of these oil and gas resources due to the proposed pipeline’s location and the depth and containment afforded by the extraction equipment, operations, and sites.
Geologic Hazards

The importance of geologic hazards in the context of oil spills is the potential that such hazards could be the source of external forces that could potentially damage the pipeline and increase the oil spill risk. The proposed pipeline would not be located within mountain belts but rather within the relatively flat and stable continental interior. Consequently, the potential for impacts from geologic hazards is lower than for facilities located in active mountain belts or coastal areas. Nonetheless, at some locations along the proposed route, seismic hazards, landslides, subsidence, or flooding may occur. Locations where such risks exist are presented in Section 3.1.4.1.

Seismic Hazards

As part of its National Pipeline Mapping System (NPMS) program, the DOT has compiled data from a variety of sources to identify areas of high geologic hazard potential for pipelines (DOT 1996). The Integrity Management Rule of 2002 states that segments of pipeline with a high geologic risk and the potential to affect HCAs must implement protective measures. HCAs are specific locales and areas where a release could result in more significant adverse consequences.

In accordance with federal regulations (49 CFR 195), Keystone would conduct an internal inspection of the proposed pipeline if an earthquake, resulting landslide, or soil liquefaction event was suspected of causing abnormal pipeline movement. Thus, any damage to the proposed pipeline would quickly be detected, and impacts resulting from crude oil releases would be minimized.

In the event that an oil spill is caused by an earthquake the oil would likely move downgradient on land and/or on the water, and impact habitat, biological resources, agricultural, commercial and/or recreational activities, and other activities as described in Section 3.1.

Landslides

Most of the proposed project route is not located in landslide-prone terrain, but the proposed route does cross areas of high landslide potential as described by the NPMS and presented in Table 3.1.4.1-10. Keystone has considered landslide potential in its routing work and has selected crossings of these areas where the landslide potential is considered minimal.

The Project would be designed and constructed in accordance with 49 CFR, Part 195. These specifications require that proposed pipeline facilities are designed and constructed in a manner to provide protection from washouts, floods, unstable soils, landslides, or other hazards that may cause the proposed pipeline facilities to move or sustain abnormal loads. Proposed pipeline installation techniques, especially padding and use of rock-free backfill, are designed to provide protection to the proposed pipeline from minor earth movements.

Keystone plans to limit the potential for increased landslide risk by preserving or improving the contour of native slopes; preserving or improving drainage patterns; and, in some circumstances, considering the use of light-weight granular material surrounding the pipe to protect it from small ground movements. Keystone has proposed erosion and sediment control and reclamation procedures in its CMR Plan (Appendix B) that are expected to limit the potential for erosion and enable slopes to remain in a stable configuration following construction. The proposed mitigation measures would reduce the risks to the proposed pipeline and environment due to landslide hazards.

The potential for landslide activity would be monitored during operations through aerial and ground patrols and through landowner awareness programs, which are designed to encourage reporting from local landowners of events that may suggest instability or other threats to the integrity of the proposed pipeline.
In addition to the landowner/tenant communication measures contained in Keystone’s CMR Plan (Appendix B), Keystone would develop and implement a Landowner Awareness Plan that specifically addresses landslide awareness with landowners and complies with the recommendations in API Recommended Practice 1162 (Public Awareness Programs for Pipeline Operators).

In the event that an oil spill is caused by a landslide, the oil would likely move downgradient on land and/or on the water, and impact habitat, biological resources, agricultural, commercial and/or recreational activities, and other activities as described in Section 3.1.

**Subsidence**

Although a potential result of soil liquefaction during seismic events, subsidence hazard generally is a consequence of the presence of karst features, such as sinkholes and fissures. Keystone reviewed national karst maps (Tobin and Weary 2005) to determine areas of potential karst terrain (i.e., areas where limestone bedrock is near the surface) along the proposed pipeline route (see Section 3.1 for a Karst map). The overall risk to the Project and environment from karst-related subsidence is expected to be minimal.

In the event that an oil spill is caused by subsidence, the oil would likely collect in the subsided area. To the extent the volume exceeds that which could be retained in the subsided area, the surplus oil would likely move downgradient on land and/or on the water, and impact habitat, biological resources, agricultural, commercial and/or recreational activities, and other activities as described in Section 3.1.

**Floods**

Floods can cause lateral and vertical scour that could expose the proposed pipeline to damage. Keystone has not completed scour analysis for all stream crossings, but proposes to use HDD at major river crossings and to bury the proposed pipeline under at least 5 feet of cover for at least 15 feet (CMR Plan, Appendix B) on either side of the bank full width of all rivers, creeks, streams, ditches, and drains. Although there is a risk of pipeline exposure due to lateral or vertical scour at water crossings, Keystone’s Site Specific Waterbody Crossing Plans (Appendix D) detail procedures that would be used at water crossings to reduce these potential risks.

In the event that an oil spill is caused by a flood, the oil would likely move downcurrent with the flood water and impact habitat, biological resources, agricultural, commercial and/or recreational activities, and other activities as described in Section 3.1.

**3.13.5.3 Soils and Sediments**

**Soils**

The impact of oil spills on soil is a function of several variables, including the type of oil (in this case, refined versus crude), permeability of the soil, type and amount of vegetation and other surface cover, and the release point (e.g., above or on the surface or below ground).

Crude oil, lubricating oil, and similar heavy oils would be somewhat less likely to reach the surface soil layers than refined oil (for example, gasoline or diesel), which could infiltrate through the vegetation, debris, and litter cover. Refined products would be more likely to reach the soil, especially in the warmer snow-free seasons, because their low viscosity would allow penetration into vegetation and even thin snow layers.

Once oil reaches the soil surface, the depth of penetration into the soil would depend on the porosity of the soil and the extent to which it is frozen or water saturated. The area affected would be limited to that...
area immediately adjacent to and covered by the spill. Porous soils (e.g., sand, gravel, and moraines) are more permeable than clays and silts. Karst areas, especially where the karst formations are close to the surface and the overlying soils are porous, may be especially vulnerable to impacts from a spill, if the oil reaches and moves through the karst.

Spills could affect soils indirectly by affecting the vegetation, which in turn could die and expose the soil to water and wind erosion or solar heating, even if the soil itself was not directly affected by the spilled material. Spill cleanup is more likely to affect the soils than the presence of the spilled material itself, unless the cleanup is well controlled and heavy traffic and digging are minimized (especially for summer spills). Oil that adsorbs to or is retained between soil grains may weather only slowly over one to several years and cause low-level chronic impacts to plants and subterranean animals.

**Sediments**

Sediments (defined here as submerged soils in wetlands and aquatic habitats) are typically fine grained, saturated with water and may be covered by or integrated with a substantial amount of organic material primarily from riparian and aquatic vegetation. The sediment may be more coarse-grained in fast-flowing streams and rivers, and in areas where glacial moraines dominate the soil types. Crude or refined oils typically do not penetrate beyond the surface layer in sediments unless (1) there is a substantial amount of turbulence that mixes the oil and sediments, followed by deposition of the mixture in low energy areas; (2) the interstitial spaces are large enough (e.g., in gravel and coarse sand) to allow for penetration of the oil as it sinks; or (3) physical activities associated with spill response actions mix the surface-deposited oil-sediment mixture into deeper subsurface levels of the sediment profile. Refined products also typically would not penetrate sediments because of the water content but may penetrate or be mixed further into the sediments under the same turbulent or cleanup actions as for crude oil.

Oil deposited on and remaining in the top sediment layer, especially in aerobic environments, may affect the benthic biological community but would be subject to biodegradation by microbes, which would eliminate long-term impacts. Oil that is incorporated into sediments, especially in the anaerobic subsurface levels, may weather very slowly. However, because the anaerobic surface levels are isolated from most of the biological community, this scenario would result in negligible environmental impacts.

### 3.13.5.4 Water Resources

**Surface Water**

Spills could affect surface freshwater quality if spilled material reaches waterbodies directly or from flowing over the land. However, the vast majority of spills would be confined to a pad, a road, or an area in or adjacent to the proposed pipeline ROW. The volumes of most spills would be very small to small (i.e., fewer than 50 bbl). In addition, for some portion of the winter months each year, spill responders could remove almost all spilled material from frozen ground or ice-covered waterbodies prior to snowmelt. During the rest of the year, spills could reach and affect wetlands, ponds and lakes, as well as creeks and rivers before spill response is initiated or completed.

An oil spill that reached a freshwater body could cause reduced DO concentrations and increased toxicity to aquatic organisms. Because oil slicks are less permeable to oxygen than water, spilled material that reached wetlands ponds or small lakes could lower DO concentrations due to a decreased influx of atmospheric oxygen and the relatively high rate of natural sediment respiration in many shallow waterbodies. In small, shallow waterbodies with limited water movement and thus mixing of the water column (e.g., small lakes, farm reservoirs, stock ponds) and often with an already high organic load in the waterbody, the addition of oil may increase biodegradation rates to the point that oxygen levels are further...
reduced. The low DO levels may result in the death of fish, amphibians, macroinvertebrates, and vegetation in these waterbodies.

In winter, however, a small spill would not likely cause an oxygen deficit in most waters because biological abundance and activity are depressed, thus water column respiration rates are low to negligible. Furthermore, sediment respiration has less relative effect in lakes that are too deep to freeze solid. Such lakes tend to be supersaturated with DO in winter (BLM and MMS 1998). An exception to such conditions could occur if spilled material were introduced to a waterbody beneath the ice cover, in very restricted waters with depleted oxygen levels and a concentrated population of overwintering fish.

During open water periods in most waterbodies, especially larger lakes, rivers, and streams, spilled materials would result in no detectable impacts on DO levels. The high water volume (relative to the volume of oil) or the high rate of water flow would disperse oil before it affected DO concentrations.

The primary effect of an oil spill would be direct toxicity to aquatic plants and animals. Containment and cleanup response likely would recover the bulk of spilled oil, but sufficient oil could remain trapped in sediments or aquatic vegetation that some long-term, low-level toxicity might occur on a local basis. Long-term toxicity would be less likely to occur in larger lakes and rivers because oil would be diluted or dispersed within the sediment over large areas by currents and wind and wave action. Spills into larger rivers and creeks, especially during open water periods, might result in some toxicity within the water column itself. However, because of the large and rapid dilution of the oil relative to the flow volumes, these impacts would likely be limited to the first few back eddies, calm water regions and reservoir pools downstream of where the spill entered the river. In the smaller flowing streams, an oil spill could cause direct toxicity impacts in the water column and sediments because of the lower relative volume and rate of water flow, and thus higher likelihood of direct contact between the biota and the dispersed oil. Some toxicity might persist in these streams for a few weeks to months, until toxic compounds trapped in the sediment were washed out or until oiled sediment was covered by cleaner sediment.

Most oil spills reaching larger lakes would result in minimal effects on water quality. DO levels would not be affected. Direct toxicity would be minimal because of the high dilution volume in these lakes. Spreading of the spill over the lake surface could be considered an effect on water quality. This effect could exist for days to a few weeks, until the slick was cleaned up or the oil was stranded on the shoreline.

Although spills are not considered a part of routine operations, there is the possibility of a crude oil release occurring with the potential to affect surface waterbodies. A large spill could affect drinking water sources and irrigation water supplies. Implementation of the procedures in Section 3 of Keystone’s CMR Plan (Appendix B) would minimize the potential for spills and leaks to affect surface water resources. Keystone’s ERP would describe actions to be taken to reduce the potential for crude oil releases to affect surface water and groundwater resources.

Minor temporary to short-term surface water quality degradation is possible from maintenance equipment and vehicle spills or leaks. During all construction activities, all refueling would be conducted at least 100 feet away from all surface waterbodies. Although washout-related spills are not considered a part of routine operations, in the event that channel migration or streambed degradation threatened to expose the proposed pipeline, protective activities such as reburial or bank armor would likely be implemented. In its CMR Plan (Appendix B), Keystone has committed to a minimum depth of cover of 5 feet below the bottom of all waterbodies, maintained for a distance of at least 15 feet on each side of the edge of the waterbody (CMR Plan, Appendix B).

Control valves would be installed on both sides of larger perennial streams for the Project. In the event of a crude oil release, the presence of valves and enactment of Keystone’s ERP and spill containment
measures would minimize (though not eliminate) the potential for substantial crude oil releases to affect surface water resources.

**Groundwater**

Substantial spills of refined products, especially diesel, and substantial to very large spills of crude oil may reach groundwater where the overlying soils are porous and not water saturated, and the water table is relatively near the surface. Areas near major wetlands and meandering streams or rivers are key examples where the water table may be close to the surface and the soils are wet to saturated, depending on rainfall and snowmelt conditions. In some of these areas, it may be difficult to distinguish between groundwater and surface water.

Diesel fuel or gasoline has a low viscosity and likely would percolate toward the water table, where it would float on the water. It may move downgradient with the groundwater, although potentially at a lower rate than the groundwater. Some of the diesel may become dispersed in the groundwater, contaminating the groundwater for agricultural or domestic drinking supply uses. Some of the diesel may become adsorbed or adhere to soil grains and remain there for years as it very slowly weathers or degrades. The oil-contaminated groundwater may contaminate surface waters (e.g., wetlands, ponds and lakes, streams and rivers) if the groundwater surfaces and discharges into these surface water areas.

Crude oil is more viscous than refined products and would percolate downward more slowly. Furthermore, a substantial portion of the crude oil may adhere to the soil particles, thereby reducing the amount that reaches groundwater. Once crude oil reaches the groundwater surface, most of it would float and may move downgradient with the groundwater, although probably more slowly. The oil also would undergo some biodegradation, adsorption to soil particles, and dispersion into water, causing a natural attenuation and remediation of the contamination. Like diesel fuel, crude oil may reduce or eliminate agricultural or domestic use of the groundwater and may contaminate surface waterbodies if the contaminated groundwater discharges into these waters.

Overall, it is not anticipated that groundwater quality would be affected by disposal activities, spills, or leaks during construction activities. Many of the aquifers present in the subsurface beneath the Steele City segment of the proposed route are isolated by the presence of glacial till, which characteristically inhibits downward migration of water and contaminants into these aquifers. However, shallow or near-surface aquifers are also present beneath the proposed route. Temporary fueling stations would be used to refuel construction equipment. To prevent releases, fuel tanks or fuel trailers would be placed within secondary containment structures equipped with impervious membrane liners. Implementation of procedures outlined in Keystone’s CMR Plan (Appendix B) would assure that (1) contractors would be prepared to respond to any spill incident; and (2) all contaminants would be contained and not allowed to migrate into the aquifer during construction activities, regardless of the depth of the underlying aquifer.

During the life of the Project, potential minor short to long-term groundwater quality degradation is possible from equipment and vehicle spills or leaks. Routine operation and maintenance is not expected to affect groundwater resources; however, if a crude oil release occurred, crude oil could migrate into subsurface aquifers and into areas where these aquifers are used for water supplies. Keystone’s ERP would describe actions to be taken in the event of a crude oil release or other accident.

**Wetlands**

Impacts of crude oil spills or refined product spills on wetlands are influenced by the type of oil, the amount and proportion of water surface area covered, the type of vegetation present in the wetland, and cleanup response actions. Refined products tend to be more toxic than crude oil, while crude oil tends to cause more physical impacts (e.g., smothering). Because refined or crude oil tends to remain on the water
surface, it may affect oxygen exchange between water and air, and may result in a low DO environment under the slick if the slick is large and continuous. Toxic components of a refined product slick may dissolve and disperse over a large area. Because the oil adheres to the vegetation, dense stands of emergent vegetation can act like oil booms and collect oil at the edges of the stands. As noted earlier, crude oil tends to infiltrate the vegetation stands less than refined products because the crude oil is more viscous. Aggressive and intrusive cleanup methods can mix oil with water and sediments (which are often anoxic below the surface layer), where the oil may have long-lasting impacts. Furthermore, these cleanup methods may have greater direct effects on vegetation, sediments, and animals than oil. Passive cleanup methods, especially natural attenuation and biodegradation processes, are likely to cause less impact on wetland resources.

Spills of refined product (e.g., diesel or gasoline) that affect wetlands would be more likely to occur during construction. The majority of these spills would be very small to small spills from construction pads or access roads. If the spills occur in winter, the wetland may be covered in ice and spilled product may be contained by snow or remain on top of the ice. In either case, the spilled oil would likely be recovered before it directly affected wetland habitat and associated organisms. For spills occurring during the rest of the year, most of the product would float on the water or wet soil surface, although some of the volatile fraction may dissolve or disperse in water where it could injure or kill organisms. Although gasoline spills evaporate quickly, there may be a short-term acute toxicological effect on animals in the wetland, and vegetation may be chemically “burned” from the water line up. Diesel spills tend to be more persistent, and diesel may infiltrate sediments as well as adhere to emergent vegetation. Potential impacts may include toxicological effects on plants and animals, smothering if oil is thick and/or continuous, and chemical burning of vegetation at water level (or over the tidal range in the southern portion of the Project in Texas).

Crude oil spills could occur only during operation. Most spills that could affect wetlands would occur in the ROW, either where the proposed pipeline would cross wetlands or waterbodies (e.g., ponds, lakes, reservoirs, streams, rivers, or adjacent riparian habitats) or where the spill site is on land but upgradient of the wetland. Crude oil spills that occur in winter may be restricted in the area affected, because the cold plus snow would increase the oil viscosity and the snow would act as a sorbent to slow the flow. In warmer seasons, large to very large spills of crude oil may flow into the wetlands, where oil would cover the water surface, coat plants and animals, and restrict oxygen exchange between air and water. Some of the crude oil may sink, become incorporated into the sediments, and remain there for years, depending on the amount of biodegradation and chemical or physical weathering that takes place.

Very small to substantial refined product or crude oil spills would generally cause negligible to minor impacts on wetlands unless the wetland is small and isolated from other waterbodies. In these cases, the ecological impacts may be substantial because the majority of the wetland may be exposed to the oil. Some substantial and many to most large to very large spills (likely of crude oil) could generally result in substantial to catastrophic ecological impacts on wetlands because of the large size of the spill and the proportion of the wetlands that would be affected. Impacts may approach a catastrophic level in areas where the wetlands are heavily used by migratory waterfowl and the spill occurs during the spring or fall migration.

3.13.5.5 Biological Resources

Vegetation

Most very small to substantial spills would occur during construction on maintenance pads, roads, or facility sites, and the spilled oil would not leave the construction sites. Most spills in the proposed pipeline ROW during construction and operation also reach land and not aquatic habitats. Consequently,
the effects of most spills would not reach natural or agricultural terrestrial habitats and would negligibly affect the vegetation or associated animals. However, some of the substantial as well as large to very large spills could reach the adjacent vegetation and habitat by directly flowing from the facility or by spilling from a pipeline leak in the ROW.

For the winter months along much of the ROW, there may be sufficient snow cover to slow the flow of spilled oil and to allow spill cleanup efforts to occur before oil spreads substantial distances from the spill source. Thus, even a large spill would result in a limited impact to vegetation and habitat. However, cleanup operations could cause impacts on vegetation and habitat, if activities are not implemented carefully and with regard for minimal disturbance of the surface soils and vegetation. During the rest of the year when there is less to no snow cover, the spilled oil may flow farther on the land surface.

Most oil spills would cover less than an acre, but large to very large spills might cover several to tens of acres, depending on topography as well as the amount of water in and on the soil, and the density, rigidity, and structural complexity of grass/forb/shrub vegetation on the surface of the land. Overall, most past spills on terrestrial habitats have caused minor ecological damage, and ecosystems have shown a good potential for recovery, with wetter areas recovering more quickly (Jorgenson and Martin 1997, McKendrick 2000). The length of time that a spill persists depends on several factors, including oil and soil temperature, availability of oleophilic (oil-loving) microorganisms, soil moisture, and the concentration of the product spilled. For the most part, effects of land oil spills would be localized and are not expected to contaminate or alter the quality of habitat outside a limited area. Spills that occur within or near streams, rivers, and lakes could indirectly affect riparian vegetation and habitat along these waterbodies.

In the event that a large to very large spill occurred in an area that is “flooded”, especially if there were a downward gradient from the spill site, the oil may be transported over large areas and coat vegetation, including row crops, wild lands, seasonal wetlands, and grazing lands. The vegetation may be injured, killed or coated with oil but populations would suffer no significant adverse impacts. However, the vegetation may not be suitable for grazing animals and any commercial row or field crops would not be marketable.

**Birds**

Spills on or near the roads, pads, or facilities would not affect populations of birds, although a few individual shorebirds, waterfowl, raptors and very few passerine birds could be exposed to the spilled oil. These exposed individuals are likely to die from hypothermia or from the toxic effects of ingesting the oil. Potential similar impacts would be limited to a few individual birds, especially waterfowl and shorebirds, using the small ponds and creeks that could be affected by the very small to small spills. There may be a minor impact to scavenging birds and mammals if they eat the oiled carcasses. These spills would not cause a population-level impact.

A substantial to very large spill onto dry land could cause the mortality of shorebirds and passerines from direct contact with oil. If the spilled material entered local or interconnected wetlands, water-dependent birds and waterfowl and additional shorebirds could be exposed. The numbers of individuals oiled would depend primarily on wind conditions and the numbers and location of birds following entry of the spill into the water. Impacts may be detectable at the local population level, especially for resident species with limited geographic distribution.

If the spill entered a wetland, stream, or river, a variety of waterfowl and shorebird species could be present, particularly during the spring and fall migrations. Such losses are likely to cause negligible to minor impacts at the regional population level but may cause significant impacts at the local population level.
If raptors, eagles, owls, vultures, and other predatory or scavenging birds are present in the spill vicinity, they could become secondarily oiled by eating oiled birds. Mortality of breeding raptors likely would represent a minor loss for the local population but is not likely to affect the regional population.

If a large spill moved into the wetlands, adjacent riparian habitats, or the open water habitats of the major rivers along the ROW, several waterfowl species that breed, stage, or stop there during migration may be at risk. A spill entering a major river in spring, especially at flood stage, could significantly affect waterfowl in the short term by contaminating overflow areas or open water where spring migrants of several waterfowl and shorebird species concentrate before occupying nesting areas or continuing their migration.

Lethal effects would be expected to result from moderate to heavy oiling of any birds contacted. Light to moderate exposure could reduce future reproductive success because of pathological effects on liver or endocrine systems (Holmes 1985) that interfere with the reproductive process and are caused by oil ingested by adults during preening or feeding. Oiled individuals could lose the water repellency and insulative capacity of their feathers and subsequently die from hypothermia. Stress from ingested oil can be additive to ordinary environmental stresses, such as low temperatures and metabolic costs of migration. Oiled females could transfer oil to their eggs, which at this stage could cause mortality, reduced hatching success, or possibly deformities in young. Oil could adversely affect food resources, causing indirect, sub-lethal effects that decrease survival, future reproduction, and growth of the affected individuals.

In addition to the expected mortality due to direct oiling of adult and fledged birds, potential effects include: mortality of eggs due to secondary exposure by oiled brooding adults; loss of ducklings, goslings, and other non-fledged birds due to direct exposure; and lethal or sub-lethal effects due to direct ingestion of oil or ingestion of contaminated foods (e.g., insect larvae, mollusks, other invertebrates, or fish). Taken together, the effects of a large spill may be particularly significant for individual waterfowl and their post-spill brood. Population depression at the local or regional scale would be greater than for smaller spills. However, the effects of even a large spill would be attenuated with time as habitats are naturally or artificially remediated and populations recover to again utilize them.

**Mammals**

Most oil spills, even large to very large ones, would result in a limited impact on most of the terrestrial mammals found in the proposed pipeline area. The extent of impacts would depend on the type and amount of oil spilled; the location and terrain of the spill; the type of habitat affected; the mammals’ distribution, abundance, and behavior at the time of the spill; and the effectiveness of the spill cleanup response. The proportion of habitat affected would be very small relative to the size of the habitat utilized by most of the mammals. In addition, most of the mammals would not be present or would be limited in abundance and distribution in the project area during the winter months.

A large to very large spill that reaches the land in or adjacent to the proposed pipeline ROW could affect terrestrial mammals directly or indirectly through impacts to their habitat or prey. For example, a large spill likely would affect vegetation, the principal food of the larger herbivorous mammals—both wild (e.g., ungulates) and domestic (i.e., cattle, sheep, and horses). Some to most of these animals probably would not ingest oiled vegetation, because they tend to be selective grazers and are particular about the plants they consume. Many of the predators and scavengers (e.g., bears and raccoons) may feed on birds, other mammals, reptiles, and fish that are killed or injured by exposure to oil and thus become exposed themselves to oil toxicity impacts. However, these effects would not generally be life threatening or long term for the predator/scavenger (White et al. 1995). For most spills, control and cleanup operations (ground traffic, air traffic, and personnel) at the spill site would frighten wild animals away from the spill.
and reduce the possibility of these animals grazing on the oiled vegetation. Nevertheless, the spilled oil could affect the vegetation and reduce its availability as food for several years. This impact would be limited in area and would not affect the overall abundance of food for the grazing mammals in the project vicinity.

For large spills that are not immediately or successfully cleaned up, the potential for contamination would persist for a longer time and the likelihood of animals being exposed to the weathered oil would be greater. Cleanup success could vary, depending on the environment. Over time, any remaining oil would gradually degrade. Although oiling of animals would not likely remain a threat after cleanup efforts, some toxic products could remain in soil, aquatic sediments, or in or on plant tissues for some time. Depending on the spill environment, part of the oil could persist for up to 5 years.

Small mammals and furbearers could be affected by spills due to oiling or ingestion of contaminated forage or prey items. These impacts would be localized around the spill area and would not cause population-level impacts.

**Fish and Other Aquatic Species**

If the oil reached aquatic habitats, spills could affect fish, macroinvertebrates (e.g., mussels, crustaceans, insects, and worms), algae and other aquatic plants, amphibians, and reptiles. Aquatic habitats include wetlands (Section 3.4) as well as ponds, lakes, reservoirs, drainage ditches, streams and rivers, (Section 3.7). There are about 30 miles of pipeline ROW over karst formation in Oklahoma and another 21 miles in Texas where there are potential aquatic resources; however, these karst formations are typically overlain with at least 50 feet of sediment and are unlikely to be impacted by an oil spill (Section 3.1.4.1)

The vast majority of spills would be very small to substantial and the impacts would likely be negligible to minor. Most spills would be confined to a construction or maintenance pad, road, facility site, adjacent area, or the proposed pipeline ROW. Spill response would contain and remove almost all of the oil from ice-covered waterbodies prior to snowmelt during winter. During the rest of the year, spills could reach and affect waterbodies and aquatic habitats before spill response is initiated or completed.

The effects of oil spills on freshwater fish, macroinvertebrates, and other aquatic organisms have been documented and discussed in numerous previous spills (Poulton et al. 1997, Taylor and Stubblefield 1997, Vandermulen et al. 1992, API 1992a, 1992b, and 1997). Specific effects would depend on the concentration of petroleum present, the length of exposure, and the stage of development involved (larvae and juveniles are generally most sensitive). If lethal concentrations are encountered (or sub-lethal concentrations over a long enough period), mortality of aquatic organisms might occur. However, extensive mortality caused by oil spills is seldom observed except in small, enclosed waterbodies and in the laboratory environment. Most acute-toxicity values (96-hour lethal concentration for 50 percent of test organisms [LC50]) for fish are generally from 1 to 10 parts per million (ppm) of the toxic hydrocarbons. Concentrations observed under the oil slick of oil spills have usually been less than the acute values for fish, macro invertebrates, and plankton. For example, extensive sampling following the Exxon Valdez oil spill (approximately 11,000,000 gallons in size) revealed that hydrocarbon levels were well below those known to be toxic or to cause sub-lethal effects in fish and plankton (Neff 1991). The low concentration of hydrocarbons in the water column following even a large oil spill appears to be the primary reason for the lack of lethal effects on fish and plankton. The concentration in flowing rivers and creeks in the project area also would be relatively low, even for most substantial to large oil spills.

If an oil spill of sufficient size occurred in a small water body with restricted water exchange (e.g., ponds and small, slow-flowing creeks) that contained fish or other sensitive aquatic species, lethal and sub-lethal effects could occur for the fish and food resources in that water body. Toxic concentrations of oil in a confined area would result in greater lethal impacts on larval/juvenile fish than adults. Larval/juvenile
fish are generally more sensitive than adults (Hose et al. 1996, Heintz et al. 1999). Sub-lethal effects include changes in overwintering and spawning behavior, reduction in food resources, consumption of contaminated prey, and temporary displacement (Morrow 1974, Brannon et al. 1986, Purdy 1989). If a large to very large spill reached a slow-flowing, small to moderate size river in summer, the impacts due to toxic exposures may be greater than in the same river when flows are higher and water temperatures are cooler.

McKim (1977) reviewed results from 56 toxicity tests and found that, in most instances, larval and juvenile stages were more sensitive than adults or eggs. Increased mortality of larval fish is expected because they are relatively immobile and are often found at the water’s surface, where contact with oil is most likely. Adult fish would be able to avoid contact with oiled waters during a spill in the open water season, but survival would be expected to decrease if oil were to reach an isolated pool of ice-covered water.

An example of potential impacts on fish food resources is provided by Barsdate et al. (1980), who studied the limnology of an arctic pond near Barrow with no outlet, after an experimental oil spill. They found that half of the oil was lost during the first year. The remaining oil was trapped along the edge of the pond; most of it sank to the bottom by the end of summer. Researchers found no change in pH, alkalinity, or nutrient concentrations. Photosynthesis was briefly reduced and then returned to normal levels after several months. Carex aquatilis, a vascular plant, was affected after the first year because of emerging leaves encountering oil. Certain aquatic insects and invertebrates that lived in these plant beds were reduced in numbers, presumably from entrapment in the oil on plant stems. Some of the insects were still absent six years after the spill. There were no fish in this pond; therefore, the impact of the loss of a prey base to the fish could not be measured. Reducing food resources in a closed lake or pond, as described above, would decrease fitness and potentially reduce reproduction until prey species recovered.

Another potential impact could occur if oil that spilled before or during the spring floods from spring snowmelt or extremely high rainfall was dispersed into some of the adjacent wetlands or lakes with continuous or ephemeral connection to the rivers and large creeks. This oil may be left stranded when the water recedes and the oil may cause limited toxic or physical smothering effects to riparian, terrestrial and aquatic plants and animals in the flooded area. Lethal effects to fish in streams and some lakes would be unlikely during high-water events such as floods, because toxic concentrations of oil would be unlikely to be reached. However, toxic levels may be reached in lakes that are normally not connected to the river/creek system except during the high-water periods. If the oil concentrations in the water column reach toxic levels, these fish could suffer mortality or injury.

Although lethal effects of oil on fish have been established in laboratory studies (Rice et al. 1979, Moles et al. 1979), large kills following oil spills are not well documented. This is likely because toxic concentrations are seldom reached. In instances where oil does reach the water, sub-lethal effects are more likely to occur, including changes in growth, feeding, fecundity, survival rates, and temporary displacement. Other possibilities include interference with movements to feeding, overwintering, or spawning areas; localized reduction in food resources; and consumption of contaminated prey.

Most oil spills are not expected to measurably affect fish populations in the project area over the life of the Project. Oil spills occurring in a small body of water containing fish with restricted water exchange might be expected to kill a small number of individual fish but are not expected to measurably affect fish populations. The same assessment is generally applicable to many of the macroinvertebrates, amphibians, and reptiles because they are motile and generally have a wide geographic distribution. However, freshwater mussels, all of which are sedentary and many of which have limited geographic distribution could be affected at a population level in large to very large spills that affect a substantial segment of a stream or river.
Although very unlikely, a potential large to very large spill under or adjacent to a river could affect water quality, aquatic resources, and other water-associated resources (e.g., birds and riparian habitats), as well as subsistence and recreational uses of the downcurrent areas. The spill would take some time to work its way from the proposed pipeline to the sediment surface and, in a large to very large spill, the spill could be detected before it reaches the river or other waterbody. If the spill went undetected, especially under ice, it likely would not be detected for an extended period, and the volume of oil could be substantial compared to the volume of the receiving water downcurrent from the spill. Fish and macroinvertebrates in the deeper pools may be exposed and likely would die. Early-arriving birds may be exposed in any open water pools and cracks in the river ice. A catastrophic failure of the proposed pipeline would be more easily and rapidly detected. Depending on the season of occurrence (e.g., winter freezeup compared to spring breakup or summer open water), however, containment and cleanup of a large or very large oil spill could be difficult. The energized fluid released would mix with water and the oil is likely to emulsify, dissolve, disperse, and adhere to sediment particles. Fish, birds, other aquatic animals and plants, and riparian habitats could be affected for a substantial portion of the downcurrent channel.

Sensitive, Threatened and Endangered Species

Most of the potential impacts to the habitats used by threatened, endangered, and protected species are included in the previous discussions of impacts on biological resources. The important additional consideration for these species is that, by definition, they have limited distribution and/or population sizes. Although exposure to oil may adversely affect only a few individuals or a small, localized population of individuals, such a loss may represent a significant portion of the population and its gene pool. Consequently, even a very small or small spill could substantially affect a threatened or endangered species. The probability of impacts on threatened, endangered, and protected species would be low because spills would typically occur on pads, on roads, or at facility sites that have been located to avoid or minimize any impacts on these habitats and species.

Spilled oil is more likely to affect species that heavily use or completely depend on aquatic and wetland habitats than those in terrestrial habitats. The oil may be transported over substantial distances into flowing streams and rivers, especially with substantial to very large spills, and thus affect a substantial portion of some populations of aquatic species (i.e., freshwater mussels, fish, herptiles, and water birds).

In the event of a spill sufficiently large to affect the habitat or individuals of any sensitive, threatened or endangered species, Keystone would implement provisions of the ERP to protect these habitats and species from oiling and conduct such cleanup operations as required by local, state, and federal agencies to return the impacted areas to a baseline condition. In addition, the state, tribal, and federal natural resource trustee agencies may require a Natural Resource Damage Assessment (NRDA) to assess the magnitude of the impacts and the type/amount of suitable restoration actions to offset the loss of natural resource services.

3.13.5.6 Land Use, Recreation and Special Interest Areas, and Visual Resources

Agricultural land and rangeland is the predominant land use along the proposed pipeline corridor, comprising about 78 percent of land crossed by the Project. A large to very large spill could affect agricultural activities; including irrigation water supplies (see Section 3.9). Potential effects would be minimized by implementing Keystone’s CMR Plan and ERP.

Most spills—very small to very large—would be confined to construction and maintenance pads, roads, facility sites, or the immediate vicinity of the proposed pipeline ROW. Therefore, impacts from spills on recreational uses and wilderness-type values of scenic quality, solitude, naturalness, or
primitive/unconfined recreation likely would be confined to the same areas and would be negligible to minor.

For some substantial to very large spills, most likely from the proposed pipeline in the ROW, and especially those that reach a stream or river, the impacts may be substantial to catastrophic. The spilled oil might be visible and thus could result impact on recreation values for weeks for most spills to a few years in a very large spill. Fishing, boating, kayaking, tubing, camping, scenic values, and other recreational pursuits could be affected by an oil spill in a riverine environment that is used by recreationists. The obvious short-term effects, including visual, odor, physical soiling of clothes, equipment, and person, and adverse publicity could result from the oil residues in areas of use. The long-term effects would possibly be reduction or loss of fishing and diminished scenic value of the area, as oil residue could take one to several years to weather and not be detectable.

3.13.5.7 Cultural Resources

Most spills would likely be confined to maintenance or construction pads, roadways, facility sites, the proposed pipeline ROW, or an adjacent area. Avoidance of known cultural resources which have been previously identified is planned as part of project design at this time. Cultural resources that can not be avoided due to unanticipated spills will be mitigated through documentation and/or data recovery excavations. A plan for unanticipated discovery of cultural resources will be included within an Unanticipated Discoveries Plan within the PA. As a result of these avoidance and construction mitigation efforts, it is anticipated that cultural resources in the ROW would be adversely impacted by small spills or by subsequent small spill cleanup. The proposed pipeline route and location of pump stations and other facilities have been selected to minimize proximity to and therefore any conflicts with, identified cultural and historical resources.

For large spills off of the facility sites or roadways, there is a chance that cultural resources could be impacted. Some of these resources may not have been identified during the survey process as they may fall outside of the APE. Measures to avoid the potential harm to historic properties should be undertaken as part of the spill clean up. Mitigation measures will be undertaken as part of this process. Previously unidentified historic properties which could be discovered as part of the spill clean up should be reviewed under the Unanticipated Discoveries Plan within the PA.

The proposed pipeline corridor also crosses a number of National Historic Trails administered by the NPS. In these areas, special care would be required during any cleanup or remediation activities to limit damage to the historic values of the trail systems. Because occurrence of most of the surface and subsurface cultural resources near the proposed facilities and pipeline ROW would have been documented, the risk of impact is low.

Depending on where the spill occurs, Keystone’s Unanticipated Discoveries Plan would address protocols for any potential cultural resources encountered during a spill or associated cleanup activities. Implementation of the plan(s) would avoid spill impacts on inadvertently encountered cultural resources.

3.13.5.8 Socioeconomics

Oil spills, especially low-probability large or very large spills, may affect one to several components of the socioeconomic environment, including:

- Agricultural activities including farming, ranching, and livestock grazing on wild land;
- Water intakes and water supplies (e.g., drinking water and agricultural irrigation water);
- Other commercial activities;
- Native American traditional or historically-significant areas; and
- Populated areas, especially residential areas, and other HCAs.

The risk to populated areas and HCAs along the Project’s proposed pipeline can be compared with the historical average risk to the general population per year associated with hazardous liquids transmission pipelines; that risk is 1 in 27,708,096 (DOT 2006). The predicted risk of fatality to the public from incidents associated with the proposed pipeline over and above the normal United States death rate would be negligible (approximately 0.000004 percent).

Short-term disruption in local agricultural production could result from a spill that enters agricultural lands or wild lands used by grazing livestock. The extent of the economic impact would depend on the number of productive acres affected. Spills that affect farmed areas may result in loss of the crop, which would be reimbursed by Keystone. The oil would weather and likely have minimal impact on the next season’s crop. Therefore, the short-term economic impact to agricultural interests would be minor.

If a spill affected recreational lands, businesses relying on hunting, fishing, and sightseeing activities could experience a short-term negative impact. If the spill impacted commercial facilities or water intakes that provide cooling water to commercial or agricultural operations, there may be a short-term (usually a few hours to a day or so) economic impact until the water supply is restored to operation.

Response to oil spills could generate positive local economic activity for the duration of the spill response activity.

### 3.13.6 Mitigation Measures

The Project’s pipeline system would be designed, constructed, and maintained in a manner that meets or exceeds industry standards and regulatory requirements (see section 3.13.1). The Project would be built within an approved ROW. Signage would be installed at all road, railway, and water crossings, indicating that a pipeline is located in the area, to help prevent third-party damage or impact to the proposed pipeline. Keystone would manage a crossing and encroachment approval system for all other operators. Keystone would ensure safety near its facilities through a combination of programs encompassing engineering design, construction, and operations; public awareness and incident prevention programs; and emergency response programs.

To prevent or mitigate potential oil spills during construction of the proposed pipeline, measures would be implemented at each construction or staging area where fuel, oil, or other liquid hazardous materials are stored, dispensed, or used. SPCC plans and other required hazardous material management plans would be required of all the contractors working on construction of the Project (Appendix C). Implementation of the procedures in Section 3 of Keystone’s CMR Plan (Appendix B) would minimize the potential for spills and leaks to affect surface water resources. Keystone’s ERP would describe actions to be taken to reduce the potential for crude oil releases to affect surface water and groundwater resources.

To prevent or mitigate potential oil spills during construction of the proposed pipeline, measures would be implemented at each construction or staging area where fuel, oil, or other liquid hazardous materials are stored, dispensed, or used. In addition to the mitigation included in the CMR Plan (Appendix B), Keystone has agreed to the following mitigation measures:
For all locations subject to CWA Section 311, Keystone would prepare a site-specific oil SPCC Plan that contains all requirements of 40 CFR Part 112 for every location used for staging fuel or oil storage tanks and for every location used for fuel or oil transfer. Each SPCC Plan would be prepared prior to introducing the subject fuel, oil, or hazardous material to the subject location.

Prior to construction, all project personnel would be given an orientation outlining the environmental permit requirements and environmental specifications including the requirement that fuel or oil storage tanks cannot be placed closer than 100 feet to wetlands or waterbodies.

Environmental inspectors would place signs a minimum of 100 feet from the boundaries of all wetlands and waterbodies prior to construction. The construction contractor would not be allowed to place a fuel or oil storage tank without first getting the environmental inspector to inspect the tank site for compliance with the 100-foot setback requirement and receiving approval of the tank site from the environmental inspector.

During construction, no fuel or storage tank would be allowed to be relocated within or to a new construction yard by the contractor without first getting the environmental inspector to inspect the tank site for compliance with the 100-foot setback requirement and receiving approval of the tank site from the environmental inspector.

Fuel and storage tanks would be placed only at contractor yards. No fuel and storage tanks would be placed on the construction ROW.

No oil or hazardous material storage, staging, or transfer (with the exception of refueling stations) would occur within 50 feet of any surface waterbody, surface drainage, storm drain drop inlet, USA, or HCA. As described previously, refueling stations would not be located within 100 feet of these areas.

Any fuel truck that transports and dispenses fuel to construction equipment or project-related vehicles along the construction ROW or within equipment staging and material areas would carry an oil spill response kit and spill response equipment onboard at all times. In the event that response materials are depleted through use, or their condition is deteriorated through age, the materials would be replenished prior to placing the fueling vehicle back into service.

Fixed fuel dispensing locations would be provided, with a means of secondary containment to capture fuel from leaks, drips, and overfills.

In the event of an unanticipated spill or leak, remedial actions to soil resources may range from the excavation and removal of contaminated soil to allowing the contaminated soil to recover through natural environmental fate processes (e.g., evaporation, biodegradation). Decisions concerning remedial methods and extent of the cleanup would account for state mandated remedial cleanup levels, potential effects to sensitive receptors, volume and extent of the contamination, potential violation of water quality standards, and the magnitude of adverse impacts caused by remedial activities.

Historically, the most significant risk associated with operating a crude oil pipeline is the potential for third-party excavation damage. Keystone would mitigate this risk by implementing a comprehensive Integrated Public Awareness Program focused on education and awareness. The program would provide awareness and education that encourages use of the state one-call system before people begin excavating. Keystone’s operating staff also would complete regular visual inspections of the ROW and monitor activity in the area.

Keystone’s preventative maintenance, inspection, and repair program would monitor the integrity of the proposed pipeline and make repairs if necessary. Keystone’s pipeline maintenance program would
include routine visual inspections of the ROW, regular inline inspections, and collection of predictive data. Data collected in each year of the program would be fed back into the decision-making process for development of the following year’s inspection, maintenance, and repair program. The pipeline system would be monitored 24 hours a day, 365 days a year.

In compliance with applicable regulations governing the operation of pipelines, periodic inline inspections would be conducted to collect information on the status of pipe for the entire length of the system. Inline inspections would be used to detect internal and external corrosion, a major cause of pipeline spills. From this type of inspection, suspected areas of corrosion or other types of damage (e.g., a scratch in the pipe from third-party excavation damage) can be identified and proactively repaired. Additional types of information collected along the proposed pipeline would include cathodic protection readings, geotechnical investigations, and aerial patrol reports. In addition, line patrol, leak detection systems, SCADA, fusion-bond epoxy coating and construction techniques with associated quality control would be implemented.

In summary, the reliability and safety of the Project can be expected to be well within industry standards. Further, the low probability of large, catastrophic spill events and the routing of the proposed pipeline to avoid most sensitive areas suggest a low probability of impacts to human and natural resources. Nevertheless, the potential for construction and operation-related spills exists. The commitments and procedures described for reliability and safety in this section and in Appendices B and C are intended to mitigate risks and spill effects, particularly when considered in combination with rapid and effective response and cleanup procedures.

3.13.7 References


CDC. See Centers for Disease Control and Prevention.


DOT. See U.S. Department of Transportation.

EPA. See U.S. Environmental Protection Agency.


NPMS. See National Pipeline Mapping System.
NRC. See National Research Council.


PHMSA. See Pipeline and Hazardous Materials Safety Administration.


TRB. See Transportation Research Board.


Region 5: <http://www.epa.gov/safewater/sourcewater/pubs/qrg_ssamap_reg5.pdf>,
Region 6: <http://www.epa.gov/safewater/sourcewater/pubs/qrg_ssamap_reg6.pdf>,
Region 7: <http://www.epa.gov/safewater/sourcewater/pubs/qrg_ssamap_reg7.pdf>,


