4.3 WATER RESOURCES

4.3.1 Introduction

This section describes potential impacts to water resources associated with the construction and operation of the proposed Project and connected actions and discusses regulatory mitigation measures that are intended to avoid or minimize the potential impacts. The information, data, methods, and/or analyses used in this discussion are based on information provided in the 2011 Final Environmental Impact Statement (Final EIS) as well as new circumstances or information relevant to environmental concerns that have become available since the Final EIS publication, including the proposed major reroute in Nebraska and numerous minor route adjustments in Montana and South Dakota. The information provided here builds on the information in the Final EIS as well as the 2013 Draft Supplemental EIS and, in many instances, replicates that information with relatively minor changes and updates; other information is entirely new or substantially altered.

Specifically, the following information, data, methods, and/or analyses have been substantially updated from the 2011 document:

- A new section (see Section 4.3.2, Impact Assessment Methodology) was added to explain the assessment methodology used to evaluate potential water resources impacts associated with the proposed Project.
- Additional water resource datasets for both ground and surface water were used in South Dakota and Montana to supplement previous information to allow for a more detailed and accurate assessment of impacts to this resource.
- Ground and surface water literature and databases were reviewed, compiled, and analyzed for the major new proposed routing in Nebraska in order to address water quality, flow, usage, and availability.
- The impacts of releases to groundwater were assessed and include anticipated release assessment, response, and mitigation measures.
- Recommended proposed pipeline inspections and testing steps were developed that would supplement typical TransCanada Keystone Pipeline, LP (Keystone) processes and procedures.
- The activities and impacts associated with acquiring water from ground or surface water sources were assessed.
- The number and type of stream crossings and stream crossing methods have changed due to changes in the proposed Project route as well as updated field survey information provided by Keystone. The stream crossing assessment included a desktop analysis based on National Hydrography Dataset (NHD) information and supplemented by Keystone field survey descriptions.

- Based on the limitations of the data used in the desktop analysis, the intermittent and ephemeral stream categories were combined and both were evaluated as intermittent streams. As a result, potential impacts were assessed consistently for both stream types throughout this section.[1]
- Keystone provided a list of surface waterbodies that may be considered as water sources for potential hydrostatic testing or other proposed Project construction uses along the proposed Project route Proposed watersheds with potential withdrawal permit restrictions and/or conditions that may be present at the time of construction were evaluated.
- Ancillary facilities (e.g., access roads, pump stations, and construction camps) with known locations that intersect state and federally designated or mapped floodplain areas – or, in some instances, effective floodplain areas – in Montana, South Dakota, Nebraska, and Kansas were identified. [2]
- Section 4.3.4, Additional Mitigation, provides a list of additional mitigation measures that, depending on a variety of permitting scenarios, may be required by regulatory review to further reduce impacts to water resources.

The following information, data, methods, and/or analyses have been substantially updated from the 2013 Draft Supplemental EIS:

- An additional sub-analysis was added regarding potential Wild and Scenic River (WSR) spill frequency.
- In response to public and agency comments, text has been revised throughout the section where necessary. Further discussion of impacts and potential mitigation measures related to potential crude oil spills from pipeline operations are provided in Section 4.13, Potential Releases.

Summary

Potential impacts to groundwater resources associated with the proposed Project construction, operation, and connected actions could vary significantly along the proposed route (see Section 4.13.4, Spill Impact Assessment). The impact on groundwater resources would be dependent on many factors including depth to groundwater, soil and hydrogeologic conditions, amount and type of material released, among other factors (see Section 3.13.3, General Description of Proposed Pipeline Transported Crude Oils). The impact of a release would be dependent on the

[1] Ephemeral streams are usually defined as a stream segments that flow briefly from localized precipitation events and whose channel beds are located above the water table year-round. Since flows in ephemeral streams are in rapid response to precipitation, they are typically infrequent and tend to have extreme fluctuations during periods of activity. It is, therefore, difficult to assess normal bankfull flow characteristics, which are often used to establish restoration criteria. Additionally ephemeral streams tend to exhibit less aquatic habitat and may be prone to higher rates of bed and bank adjustment. By combining these streams with intermittent streams, which are more likely to carry water in response to seasonal ground water sources as well as precipitation events and are also more likely to support wetland and aquatic habitats, this Final Supplemental EIS has applied a more rigorous evaluation to ephemeral waterbodies. Intermittent waterbodies can have additional protections under federal and state clean water regulation. These protections are often applied based on individual site conditions, which are evaluated during permitting reviews.

[2] In addition to the planned pipeline, the additional supporting infrastructure for the proposed Project consisting of a pipe yard and a rail siding in North Dakota and two pumps stations in Kansas are not anticipated to impact surface waterbodies; as such, North Dakota and Kanas have no entries in the waterbody summaries or tables.

severity and extent of exposure to humans and the environment. A spill entering the groundwater near a well could be a direct exposure pathway to humans and the environment. A spill to soil 6 feet below the ground that does not impact groundwater would most likely have a reduced impact to humans and the environment. Potential impacts to groundwater resources from construction and operation could be small, medium, or large as defined in Section 4.3.2.1, Groundwater. During construction, groundwater withdrawals could have a short-term impact on localized availability and groundwater table elevation.

The responses to releases to groundwater would be similar from both construction and operation related activities and is dependent on the specific release magnitude and duration. During the proposed Project operation, impacts to groundwater could occur due to potential small (<50 barrels [bbls]), medium (2,100 to 1000 bbls), and large (>1000 bbls) spills of crude. Any refined petroleum releases from construction or crude oil releases from operations could potentially impact groundwater where the overlying soils are permeable and the depth to groundwater is shallow. Other significant factors influencing subsurface migration include groundwater velocities, amount of organic matter in the soil, location of fine grained materials (clay and silt), soil porosity, and the oil's physical and chemical characteristics (e.g. viscosity, solubility). Screening-level overland flow and groundwater flow modeling (see Appendix T, Screening Level Oil Spill Modeling, and E^xponent 2013) indicate the potential impact from large dilbit releases could extend up to 2,246 feet with smaller releases extending hundreds of feet. This is supported by numerous other studies related to tank, pipeline, or other point sources where impacts are typically limited to an area within several hundred feet of the release site. A more detailed discussion of the impacts from potential releases is presented in Section 4.13, Potential Releases.

The proposed pipeline would primarily carry dilbit at an elevated temperature due to pipeline operations, including pipe wall friction and pumping activities. Upon release into the environment, the dilbit temperature would decrease significantly, causing the viscosity to increase and limiting the distance that spills would migrate. Additional details on impacts to groundwater from a release are presented in Section 4.3.3.1, Groundwater, and 4.13.4, Spill Impact Assessment, for both the construction and operation/maintenance scenarios.

In the proposed pipeline area, several regional and local aquifers are present, including the Northern High Plains Aquifer (NHPAQ) and the alluvial aquifers in the Ogallala Formation. These two aquifers represent the most commonly used groundwater sources in the proposed pipeline area. Many private and public wells extract groundwater from these aquifers, including those in several Source Water Protection Areas (SWPAs) in the proposed pipeline area; these aquifers are typically at highest risk of contamination from the proposed Project construction and operation because of the relatively shallow depth of water tables in the alluvial and NHPAQ aquifers (commonly <50 feet) as well as the relatively high permeability of the aquifers and overlying material. The combination of an extensive groundwater-use profile and high sensitivity to releases from the proposed pipeline area make these aquifers particularly sensitive to potential releases.

Potential impacts to groundwater resources during the operational phase of the proposed Project and connected actions include altered groundwater quantity and quality. Measures to avoid and minimize these impacts include pipeline system testing spill and maintenance training, pipeline inspection, periodic system updates and maintenance, and others addressed in Section 4.13, Potential Releases. Federal, state, and local regulatory agency permit requirements would further reduce potential impacts to groundwater resources from construction, maintenance, and operational activities. For instance, Keystone has agreed to incorporate into its operations and maintenance plan a requirement to conduct ground inspections of all intermediate valves and non-staffed pump stations during the first year of operation to ensure that small leaks or potential failures in fittings and seals are identified. Keystone has also agreed to Pipeline and Hazardous Material Safety Administration (PHMSA) Project-specific Special Conditions developed by stakeholders to address pipeline concerns. Those conditions are presented in Appendix B, Potential Releases and Pipeline Safety.

Potential impacts to surface water resources associated with construction of the proposed Project and connected actions would vary depending on the type, location, and seasonal condition of the waterbody at the time of the proposed Project construction. To a large extent, the size of the channel, floodplain, and supporting riparian area would determine both the construction duration and the pipe installation method for each waterbody crossing. The installation method would also depend on waterbody classifications, protected status, or permit requirements that apply to the individual waterbody. The proposed Project would install pipe segments at waterbodies using one of the following methods: non-flowing open cut, flowing open cut, dry flume open cut, dry dam-and-pump, horizontal boring, or horizontal directional drill (HDD). The proposed Project plans to implement the HDD techniques to minimize impacts at 14 of the 1,073 waterbody crossings.

Keystone has developed an HDD contingency plan defining specific responsibilities, procedures, and actions necessary to manage the detection of and response to drilling fluid releases or frac-outs[3] during pipeline installations using HDD techniques. The HDD contractor would be responsible for execution of the HDD operation, including actions for detecting and controlling the inadvertent release of drilling fluid.

Potential impacts to surface water resources from construction would be temporary, short term, long term, or permanent as defined in Section 4.3.2.2, Surface Water. Generally, open-cut crossing impacts would include alteration of the streambed and bank structure, habitat reduction or alteration, increased sediment, riparian vegetation loss, and introduction of non-native vegetation. To mitigate impacts to surface water resources, the Construction, Mitigation, and Reclamation Plan (CMRP) (see Appendix G) would be implemented.

Measures to minimize bed and bank impact include temporary vehicle bridges and minimizing in-stream use of equipment; these and other similar measures would result in proposed Project impacts to surface water resources that would predominately be temporary and short term.

Water withdrawal from surface water resources by the proposed Project would be used for construction processes and would consist of hydrostatic testing, HDD make-up water (drilling mud), dust control, and in the construction camps. The proposed Project may temporarily impact surface water volume in locations designated for proposed Project water withdrawals. During withdrawals, minimal disruption of the normal access to and use of surface water resources would be anticipated in the proposed Project ROW and adjacent areas. The water resources affected by the proposed Project construction, as well as landowner and recreational access, would be restored in accordance with the CMRP following construction.

[3] In some instances, pressurized fluids and drilling lubricants used in the HDD process have the potential to escape the active HDD bore, migrate through the soils, and come to the surface at or near the crossing construction site, an event commonly known as a *frac-out*.

Potential impacts to surface water resources during the operational phase of the proposed Project and connected actions are possible during routine maintenance and ROW inspections. These impacts are anticipated to be infrequent, minimal in nature, and managed in accordance with the proposed Project CMRP. Measures to avoid and minimize these maintenance and repair induced surface-water impacts would include aerial and ground surveillance, maintenance of non-forested vegetation, and restoration and revegetation measures conducted in accordance with the CMRP. Additional potential impacts to surface water resources would include accidental pipeline spills. Section 4.13, Potential Releases, describes the pipeline fluids and safety measures of the proposed Project that could be used to mitigate impacts to surface waterbodies. In addition, an independent risk assessment and engineering analysis were conducted on the proposed Project. These assessments identified mitigation measures applicable to releases that could affect both groundwater and surface waterbodies (Leis et al. 2013, McSweeney et al. 2013).

The permit requirements of federal, state, and local regulatory agencies would further reduce potential impacts to surface water resources from construction, maintenance, and operational activities.

Connected actions include the Bakken Marketlink Project, the Big Bend to Witten 230-kilovolt (kV) Transmission Line, and electrical distribution lines and substations. The potential impacts to groundwater resources associated with the Bakken Marketlink Project facilities are minimal in that no significant large-scale potable aquifers are in the area. The potential impacts to surface water resources include seven intermittent waterbody crossings and one perennial waterbody crossing at Sandstone Creek. The Montana Department of Environmental Quality (MDEQ) has listed Sandstone Creek in the 2012 Integrated Water Quality Report as having designated beneficial uses and impairments to aquatic life. Mitigations and permitting associated with the construction of the Bakken Marketlink Project would likely be similar to those described for the proposed Project route in that area. Additionally, the installation and operation of electrical transmission lines and substations associated with the connected actions and potential impacts to groundwater resources are expected to be limited to small-scale refined petroleum product spills related to vehicle operations and fueling. Potential impacts to surface waterbodies adjacent to these lines, in general, are short-term and/or negligible as these lines typically parallel existing roadways or right-of-ways (ROWs). Transmission line designs would generally avoid impacts to surface water by placing poles away from rivers, streams, and riparian areas and thereby spanning surface waterbodies and sensitive riparian habitats. Pole placements in floodplains would be avoided as much as practicable.

4.3.2 Impact Assessment Methodology

4.3.2.1 Groundwater

The proposed Project could impact groundwater quality as a result of both construction- and operations-related activities. The volume of different crude oil release scenarios is based on the same volumetric divisions included in the spill impact assessment discussion in Section 4.13, Potential Releases. During construction activities, the maximum planned storage capacity of refined petroleum products (motor fuels) in a single container is about 700 bbls. Therefore, potential releases from construction-related activities (most likely from vehicles or bulk storage facilities) would be expected to be no more than about 700 bbls; although, based on historic data, most spills are expected to be small (<50 bbls) (PHMSA 2012; PHMSA 2013). Releases from these sources would primarily be motor fuel or lubricating oils and would be related to vehicle refueling and maintenance activities.

While potential releases during operation and maintenance of the proposed Project would include some of these same activities, operation of the pipeline could also result in releases of crude oil ranging from small (<50 barrels) to large (>1000 barrels). Additionally, small spills could occur from routine maintenance and inspection activities.

As discussed in Section 4.13.4.4, Types of Spill Impact, impacts from refined petroleum products (e.g., gasoline, diesel, heating oil) and some lighter constituents of crude oil are similar. Compared to the heavier constituents of crude oil, these lighter constituents typically travel more readily in soils and groundwater due to their lower viscosity and higher soluble fractions. Information from releases of both crude oil (including heavier and lighter constituents) and refined petroleum products are also included in the discussion of groundwater impact assessment in Section 4.3.3, Potential Impacts.

Most crude oils are more than 95 percent carbon and hydrogen, with small amounts of sulfur, nitrogen, oxygen, and traces of other elements. Crude oils contain lightweight straight-chained alkanes (e.g., hexane, heptane); cycloalkanes (e.g., cyclohexane); aromatics (e.g., benzene, toluene); and heavy aromatic hydrocarbons (e.g., polycyclic aromatic hydrocarbons, asphaltines). Straight-chained alkanes are more easily degraded in the environment than branched alkanes. Cycloalkanes are extremely resistant to biodegradation. Aromatics (i.e., benzene, toluene, ethylbenzene, and xylene [BTEX] compounds) pose the most potential for toxic exposure because of their lower molecular weight, making them more soluble in water than alkanes and cycloalkanes. Refined petroleum products typically have variable concentrations of these more soluble compounds, with lighter fuel products such as gasoline containing as much as 35 percent or greater BTEX, and heavier distillates used as lubricating oils having no significant BTEX fraction. In general, the higher the concentration of BTEX in the petroleum material, the greater the risk to groundwater quality and groundwater receptors (e.g., humans, livestock, and the environment) related to a release of the material.

To evaluate the potential impacts to groundwater resources, regional aquifer information and well locations within 1 mile of the proposed Project were superimposed on the proposed pipeline route using Geographic Information System (GIS) software. While not all wells within 1 mile of the pipeline are identified within state databases, those that were identified were used in the evaluation. Results of the evaluation of water resources and water use in the proposed Project area are included in Section 3.3.2, Groundwater. The potential impacts to groundwater resources from both construction and operation impacts from the proposed Project are discussed in Section 4.3.3, Potential Impacts. Medium to large spills as defined in the summary above would typically require greater than 3 years to attenuate or remediate and, therefore, would be considered a long-term impact. Small releases can generally be remediated within 3 years and would typically be considered short-term impacts.

Additional groundwater-related impacts may also be related to increased local extraction of groundwater during construction and pipeline testing activities. Additional proposed Project-related groundwater use, although temporary, would remove water from aquifers and could potentially decrease groundwater levels in extraction wells, depending on aquifer recharge characteristics.

Operator response actions for oil or fuel spills that reach groundwater would be similar for construction or operations activities (as discussed in Section 4.13, Potential Releases) and would be appropriately scaled based on the magnitude, duration, and location of the specific release event. Keystone would have the responsibility for implementing and following the CMRP; Spill Prevention, Control, and Countermeasure; and Facility Response Plan/ Emergency Response Plan, as applicable, for releases associated with the pipeline system (e.g, pipelines, terminals, pump stations, vehicles). Mainline pipe releases could result in a higher level of response actions. In the case of spill impacts to wells, alternate water supplies would be either permanent (e.g., installing a new well[s] or connecting users to a water supply system) or short term (e.g., water delivery by truck or temporary pipeline). The length of time that short-term water supplies would be temporarily delivered would be based on when drinking water standards and aesthetic criteria are met. Federal and state criteria would need to be met before the temporary system would be terminated. Keystone is required to enter into agreements with well owners whose land would be crossed regarding easements, impacts, and mitigation during construction or operation.

4.3.2.2 Surface Water

In addition to petrochemical spills as mentioned in Section 4.3.2.1, Groundwater, and Section 4.13.4, Spill Impact Assessment, the remaining impacts of the proposed Project on surface water resources are predominately from land-disturbing activities and can be separated into two categories: construction impacts and operations impacts. In many cases, potential impacts overlap between construction and operations. This impact assessment categorizes potential impacts to surface water resources by duration (temporary, short-term, long-term, and permanent) and describes mitigation measures to reduce or minimize impacts. Durations are described as follows:

- Temporary impacts would generally occur during construction, with the resources returning to preconstruction conditions almost immediately afterwards.
- Short-term impacts would continue up to approximately 3 years following construction.
- Long-term impacts would continue for more than 3 years before recovery to pre-construction conditions.
- Permanent impacts would occur as a result of activities that modify resources to the extent that they would not be returned to preconstruction conditions during the life of the proposed Project.

In addition, the impact assessment calculated several different metrics and performed additional evaluations for surface waterbodies, including the following:

- Calculated the number of waterbodies and waterbody types crossed by the proposed pipeline route;
- Evaluated water quality classifications and impairments as published by state agencies for the waterbodies crossed by the proposed pipeline route;
- Evaluated surface water intakes, diversions, or Wellhead Protection Areas for municipal water supplies within 1 mile of the proposed pipeline centerline;

- Calculated the number of mapped floodplains and the total width of mapped floodplains crossed by the proposed pipeline route; and
- Evaluated the same types of surface water resources and waterbody attributes (such as water quality classifications and impairments) impacted by proposed ancillary features such as access roads, pads, and work areas.

4.3.3 Potential Impacts

4.3.3.1 Groundwater

The impacts of the proposed Project on groundwater might potentially occur as a result of construction-related activities and operation-related activities. The volume of different crude oil release scenarios is based on the same volumetric divisions included in the spill impact assessment discussion in Section 4.13, Potential Releases. Potential small (<50 bbls) releases of petroleum products that could impact groundwater quality would be related to spills or leaks of refined petroleum products from equipment and vehicles. Small (<50 bbls) to medium (50 bbls to 1000 bbls) refined petroleum product spills may also occur from tanks in equipment staging areas during the construction (at camps and at the construction location) and operation phases. Medium to large (>50 to 1000 bbls) spills of crude oil may occur during the proposed Project operation. Any refined petroleum releases from construction or crude oil releases from operations could potentially impact groundwater where the overlying soils are permeable and the depth to groundwater is shallow. The factors influencing subsurface migration of a crude oil release that reaches groundwater are discussed in the following subsections.

Construction-Related Impacts

During construction, there would be potential for spills and releases from equipment maintenance areas, camps, HDD locations, and pipeline placement areas. The size of those spills and releases would generally be less than 700 bbls of refined petroleum, which is the size of the largest stationary tank. In addition, fuel tankers could contain up to 9,500 (~225 bbls) gallons of refined petroleum. Spills and releases would generally be minimized because staff would be present during all fueling operations from a truck tanker, and bulk storage tanks are required to have secondary containment. The CMRP (see Appendix G) includes actions designed to help prevent spills and releases.

Other construction activities could result in the following potential impacts on groundwater:

- Removal of some wells within or near the ROW. The removal would need to be coordinated with and approved by the owners.
- Dewatering where groundwater is less than the burial depth of the pipe (typically, burial is 4 to 7 feet) during pipe-laying activities. Dewatering the excavation could generate substantial localized amounts of water to be discharged. The withdrawal and discharge would need to be permitted, monitored, and performed in a manner that has the least impact on the environment.
- Pipeline trench potentially acting as a conduit for groundwater migration and/or as a barrier to near-surface flow in areas of shallow groundwater (<7 feet below ground surface [bgs]). While the near-surface geology is generally rather transmissive, excavating and backfilling

for the pipeline may increase groundwater flow along the buried pipe and associated trench construction. Pipe bedding materials and contact zones between the pipe and bedding or between trench backfill and native soils at the trench margin may allow ground water to flow in the disturbed zone. In addition, the pipe can also act as a barrier for near-surface flow down to the bottom of the pipe. Groundwater would accumulate against the pipe or more likely flow under the pipe, assuming that similar geology exists all around the pipe. Impacts from these processes are believed to be minor. There would also be potential impacts to construction water uses, construction camp potable water, and pipeline testing withdrawals from groundwater.

Each state that would be crossed by the proposed pipeline route has different requirements for water well testing. In Nebraska, Keystone would be required by Nebraska Department of Environmental Quality (NDEQ) to conduct baseline water quality testing for domestic and livestock water wells within 300 feet of the centerline of the approved route upon the request of individual landowners who provide access to perform the testing. These baseline samples would be collected prior to placing the pipeline in service. In the event of a significant release, Keystone would conduct water well testing in the location where the release occurred, as required by NDEQ pursuant to Title 118, Nebraska Administrative Code. Keystone would also provide an alternate water supply for any wells where water quality was found to be compromised by a release or spill. In Montana, pre- and post-construction monitoring would be required. Appendix D (Monitoring Plan) of the MDEQ Major Facility Siting Act Certificate states: “In order to protect groundwater resources, Keystone shall conduct pre- and post-construction monitoring of any wells or springs within 100 feet of the ROW. The survey will be conducted by checking state well records, agency records, and personal communication with landowners and field review. Baseline field surveys of each well or spring will include a visual estimate of flow and water clarity, and field-measured temperature, electrical conductivity, and pH. The results of required surveys will be filed with the agencies before construction commences near these wells and springs.” In South Dakota, as a permit Condition in the South Dakota Public Utilities Commission Final Decision and Order document, Condition 46 (in Exhibit A) states “In the event that a person’s well is contaminated as a result of construction or pipeline operation, Keystone shall pay all costs associated with finding and providing a permanent water supply that is at least of similar quality and quantity; and any other related damages, including but not limited to any consequences, medical or otherwise, related to water contamination.” The South Dakota Public Utilities Commission Order also requires well water testing to be conducted where blasting would occur.

Subsequent subsections present potential impacts to the aquifers beneath the proposed pipeline area resulting from the proposed Project construction and/or operation. Mitigation measures that would be put in place to avoid, minimize, and mitigate releases from pipeline operation are discussed in Section 4.13, Potential Releases.

Factors Affecting Subsurface Petroleum Migration and Groundwater Flow

The potential for, and dynamics of, crude oil or refined oil products migrating into groundwater, and subsequent fate and transport[4] in the groundwater as light non-aqueous phase liquid (LNAPL)[5] or as a dissolved-phase plume,[6] is determined by the several factors, including:

- The volume, duration, and areal extent of the petroleum release;
- The viscosity, density, and solubility of the petroleum release;
- The permeability of unsaturated soils and aquifer characteristics within the area of the petroleum release;
- The depth to first groundwater; and
- Horizontal and vertical groundwater gradient and aquifer hydraulic conductivity, including surface water and groundwater interconnections.

Release Volume and Extent

The volume, duration, and extent of a petroleum release are important factors in determining whether or not the release would affect groundwater quality, and to what degree groundwater quality would be affected. Petroleum released to soils at the ground surface or in the subsurface would be absorbed by soil particles, which would limit the migration of the petroleum material downward to groundwater. In order for LNAPL to reach groundwater, the release must be large enough to overcome the natural absorption capacity of the soil through which it migrates. The measure of the maximum amount of petroleum material that a soil can absorb and immobilize is known as *residual saturation*. Typical petroleum residual saturation rates in clean sands range from approximately 5,833 milligrams of petroleum per kilogram of soil for light petroleum products, such as gasoline, to 20,382 to 42,618 milligrams per kilogram of soil for more viscous petroleum products, such as middle distillates, naptha (a major component of dilbit), mineral oil, and paraffin oil (Brost and DeVaull 2000). Residual saturation rates for petroleum products typically increase as soil grain size decreases and viscosity of the petroleum product increases; higher residual saturation rates result in more contaminant mass immobilized within the soil.

Studies related to petroleum product releases from over 600 underground storage tank (UST) leaks indicate that potential surface and groundwater impacts from these releases are typically limited to the area within several hundred feet of the release site (American Petroleum Institute [API] 1998). While this study focuses on refined product, refined product is more mobile than crude oil, such as dilbit and Bakken light (the main liquids to be transported in the proposed pipeline); therefore, this is a conservative comparison. The median length of groundwater plumes composed of soluble petroleum components (BTEX) from these UST sites was 132 feet, and approximately 75 percent of these plumes were under 200 feet (API 1998). Although the petroleum products and release conditions at a crude oil pipeline are somewhat dissimilar from those at a typical UST, the contaminant distribution conditions in soil and groundwater observed

[4] *Fate and transport*: A term alluding to the manner in which a contaminant moves through an aquifer in groundwater, and how concentrations in groundwater are ultimately reduced over time and/or distance.
[5] Light non –aqueous phase liquid: A liquid that does not contain water (e.g., gasoline), has a lower density than water, and would therefore float on a water surface.
[6] Dissolved-phase plume: The portion of a released material that becomes dissolved in groundwater and moves along the direction of groundwater flow.

at UST sites would generally correlate to conditions expected from small to medium releases related to the proposed Project. Released material from a pipeline carrying crude oil and dilbit mixtures would impact adjacent soil. In both UST and pipeline releases there are many variables effecting released material impacts to groundwater including, but not limited to, the distance between the release and groundwater, release material mobility, soil and rock present, and precipitation.

As detailed in Section 4.13, Potential Releases, releases of different volumetric scales (i.e., small, medium, and large) of crude oil from the proposed Project were modeled to evaluate the expected extent of the dissolved-phase petroleum hydrocarbon plume in groundwater that would be expected to be associated with those releases. The release modeling assumed a sandy aquifer similar to many of the alluvial aquifers and of the Tertiary Northern Great Plains Aquifer System (NGPAS) and NHPAQ groups present along the proposed Project route. The model outputs indicate that releases of crude oil from the proposed Project ranging from small (<50 bbls) to large (>1000 barrels) would result in axial lengths of the dissolved-phase petroleum hydrocarbon plumes ranging up to 2,264 feet (see Figure 4.13.4-1).

To further assess groundwater impacts related to a large-scale crude oil release into a coarse-grained, shallow, unconfined aquifer, studies of a 1979 pipeline release near Bemidji, Minnesota, were reviewed because of the material released, similarity of the geology and hydrology, and volume of material released.[7] Approximately 10,700 bbls of crude oil were released onto a glacial outwash (alluvial) deposit consisting primarily of sand and gravel. The water table in the spill area ranged from near ground surface to approximately 35 feet bgs. As of 1996, the leading edge of the subsurface LNAPL plume had migrated approximately 131 feet downgradient from the spill site, and the leading edge of the dissolved contaminant plume had migrated approximately 650 feet downgradient from the spill site.

These studies of the UST sites and the Bemidji release, as well as the results of the petroleum release modeling completed as part of this study (see Section 4.13, Potential Releases), indicate that the size of the oil release is a primary factor influencing the ultimate oil plume dimensions (including the dissolved-phase plume). While there are differences in the rate of oil movement through different soil types, hydrogeologic factors such as hydraulic conductivity and gradient—although important to understanding contaminant migration within an aquifer—are not as significant in determining ultimate plume length (API 1998). Based on a comparison of the UST site releases, the Bemidji release described above, and the release modeling effort completed as part of this study, the petroleum contaminant plume extent in groundwater is not proportional on a one-to-one basis to the volume of the petroleum product released. That is, an incremental increase in release volume typically produces a smaller incremental increase in the areal extent of the impacted groundwater. For example, under the release model developed as part of this study (see Section 4.13, Potential Releases), a release of 50 bbls of crude oil resulted in a groundwater-dissolved contaminant plume that was a maximum of 640 feet long, while a release of >42,000 to 840,000 gallons (or up to 20,000 bbls, which is 400 times as large) resulted in a

[7] In addition to the Bemidji spill, a large dilbit crude oil spill occurred in July 2010 from a 30-inch diameter pipeline near Marshall, Michigan. Released oil entered an adjacent creek and then the Kalamazoo River. Groundwater in glacial deposits were impacted, but all wells (155) within a roughly 200-foot buffer were included in a sampling program, and it was concluded that there were no impacts to the wells from the spill. Unlike the Bemidji spill, the Kalamazoo River spill had significantly greater impacts to surface water.

maximum plume length of 1,050 feet, or roughly twice as long as the plume related to the smaller release.

Viscosity and Density of Released Dilbit and Baken Crude Oil

The pipeline will carry differing grades of crude oil mixed with dilbit to facilitate the flow of the more viscous crude oil. Dilbit is generally derived through the refining process or as a derivative of natural gas. Dilbit contains lighter more mobile and generally more toxic substances than crude oil (which will have many of the same constituents but that are less mobile).

The dilbit that would typically be transported by the proposed pipeline would have a viscosity within the range of 52 to 96 centistokes[8] at a temperature of 38 degrees Celsius (viscosity range of diluted bitumen, Imperial Oil 2002), a viscosity similar to that of corn syrup at room temperature. If the oil was released to the surrounding soils and groundwater, it would cool and the viscosity would increase significantly, with a resultant increase in resistance to flow. Viscosity would also increase somewhat under conditions where diluent material used to decrease the crude viscosity can volatilize to the atmosphere. The relatively high viscosity of the crude oil would not only retard the petroleum flow velocity within soil, but would also result in a residual saturation condition in which small crude oil releases would essentially be immobilized as the petroleum cools and viscosity increases.

The high fluid viscosity and resultant resistance to flow in a compacted granular medium (soil) also suggests a higher likelihood that pipeline releases would preferentially migrate under pressure upward through the disturbed soils excavated during pipeline installation and discharge onto the ground surface, with relatively less crude oil infiltrating under gravity deeper into soil toward groundwater.

The crude oil transported within the proposed pipeline is anticipated to have a specific gravity less than water and would be considered an LNAPL. The bulk of the released material (the LNAPL) would preferentially float on the groundwater surface as LNAPL. However, some constituents of the crude oil would likely separate from the main mass of the released material and either dissolve in the water column or sink, forming a dense non-aqueous phase liquid DNAPL) plume. This would occur mostly with the dilbit rather than the lighter Bakken crude oil. As the dilbit would age and lighter constituents dissolve, the dilbit could slowly sink to form the DNAPL. The viscosity of the DNAPL would eventually increase as the light constituents were lost, reducing the mobility of the oil. Dissolved constituents would move with the groundwater and would be subject to the same properties as the groundwater moving though sediment. DNAPL would also move vertically until reaching denser or more compacted or finer grained sediment that would inhibit downward migration. Depending on the groundwater and sediment parameters (e.g., transmissivity, gradient, grain size) the DNAPL may migrate horizontally, but because of its higher viscosity it would do so at a much lower velocity than the groundwater.

[8] *Centistokes* is a unit of measurement for kinematic viscosity equal to the unit millimeters squared per second. The centistoke is the ratio of a liquid's absolute viscosity in centipoise to the density. *Centipoise* is a unit of measurement for absolute viscosity where one centipoise is equal to the millipascal second, which is one-thousandth of a pascal second.

Soil and Bedrock Permeability

Permeability of soils and aquifer materials also affects transport of LNAPL and dissolved-phase contaminants from petroleum releases to and within groundwater. Shallow unconfined aquifers are commonly overlain by permeable materials and therefore are at risk if the overlying soils are contaminated.

Many petroleum fractions, including BTEX, are present in bituminous crude oil and associated diluents. These fractions can be transported to groundwater by dissolved-phase[9] transport, either by direct contact of groundwater with LNAPL or by infiltration of precipitation and surface water through petroleum-contaminated soil and into groundwater. Once the dissolved-phase petroleum is in groundwater, the material typically flows within the aquifer at a velocity somewhat less than the groundwater flow, as the dissolved-phase petroleum is subject to absorption into soil particles (in a similar manner as described above regarding migrations through soils above the water table) and degradation by naturally occurring bacteria in the aquifer. The LNAPL typically migrates in the direction of groundwater flow at a rate that varies with product viscosity; more viscous materials (such as heavy crude oil) migrate significantly slower than the groundwater flow.

Downward and, less commonly, horizontal migration of contaminants in unsaturated sediments and within aquifers is commonly attenuated[10] by confining layers or zones of finer-grained, lower permeability sediment. Flow through these units is typically very slow or absent. Confining layers are commonly present between aquifer units, and can also be present within aquifers. For example, the Ogallala Formation of the NHPAQ contains many layers of volcanic ash that are much finer than the aquifer materials above and below them; the ash layers typically function as intra-aquifer confining layers. Additionally, glacial till and silty and clayey layers in alluvial aquifers typically form confining layers in those otherwise coarse-grained units.

Depth to Groundwater

Depth to groundwater would also factor into the travel time of petroleum from the point of release to groundwater. Where groundwater is relatively shallow, contaminants can reach groundwater more quickly than in areas where groundwater is deeper, given similar soil types. Where groundwater is in contact with the proposed pipeline, releases from the pipeline would immediately impact groundwater quality nearest the release. Groundwater depths for the purposes of this Final Supplemental EIS were identified on an area-wide basis from wells on or near the proposed route. Specific depths and subsurface hydrogeologic conditions along the entire proposed route would be determined during final investigations and design.

Once specific information is available, then groundwater impacts along the proposed route can more specifically be determined. Following this Final Supplemental EIS, the proponent would prepare final design and installation documents and plans; one of those plans that would be

[9] Dissolved-phase plume: The portion of a released material that becomes dissolved in groundwater and moves along the direction of groundwater flow.
[10] *Attenuation* is a reduction in velocity, volume, extent, and/or concentration.

required is an Integrity Management Plan[11] that specifically identifies sensitive receptors and, among many other requirements, outlines a plan to mitigate releases.

Aquifer Gradients and Hydraulic Conductivity

Groundwater flow gradient and hydraulic conductivity of the aquifer materials affect the migration rates of LNAPL and dissolved-phase petroleum products in groundwater. Gradient is a function of potentiometric differential (i.e., the tendency of water to flow from areas of higher pressure or elevation to areas of lower pressure or elevation). Hydraulic conductivity is a measure of the ability of the fractured or porous aquifer media to transmit fluid; typically, the smaller the grain size of the aquifer material, the lower the hydraulic conductivity. The groundwater flow velocity in an aquifer is the product of the gradient and the hydraulic conductivity; therefore, the higher the gradient and hydraulic conductivity of an aquifer, the higher the velocity of fluid flow through the aquifer.

As an example, the shallow water-bearing zones in the NHPAQ in eastern Nebraska have an average horizontal flow velocity of about 0.1 feet per day (ft/d) based on an observed gradient of 0.002 (Bleed and Flowerday 1998) and a maximum hydraulic conductivity of 50 ft/d (Gutentag et al. 1984). For the Bemidji release mentioned above, the reported groundwater flow velocity was 0.1 ft/d, and estimates of the aquifer soil hydraulic conductivity ranged from 1.25 to 152 ft/d (Strobel et al. 1998). The average flow velocity in the shallow water-bearing zones of the NHPAQ system is similar to that at Bemidji, and the hydraulic conductivity reported for these zones are also within the range of values reported for Bemidji.

Vertical flow within and between aquifers is also important to consider when evaluating contaminant migration, and is driven by pressure differentials within and between water-bearing units. For example, vertical groundwater flow between the water-bearing units in the NGPAS within the proposed pipeline area is typically upward, while groundwater flow from the Ogallala Formation is downward in areas where the underlying aquitards (e.g., the Pierre Shale) are absent. Vertical flow velocities are typically at least an order of magnitude less than horizontal flow velocities in aquifer systems.

Aquifer-Specific Contamination Risk Evaluation

Based on the release and migration dynamics of refined petroleum products and crude oil in the subsurface as discussed above, the potential risk and likely magnitude of potential impacts to groundwater quality in each of the aquifers and aquifer groups along the proposed pipeline area in Montana, South Dakota, and Nebraska are evaluated in the following subsections. The final subsection provides an overview of the presence of shallow groundwater in the proposed Project vicinity, as well as water wells reported within 1 mile of the proposed Project.

Extreme weather conditions such as heavy precipitation and associated flooding or a long drought can impact the distance from a release point to the water table. In the case of heavy rains, the water table could rise closer to the pipeline thereby decreasing travel time before

[11] The Integrity Management Plan is designed to, at minimum, comply with the Final Rule entitled *Pipeline Safety: Pipeline Integrity Management in High Consequence Areas (Hazardous Liquid Operators With 500 or More Miles of Pipeline)*, Title 49, Code of Federal Regulations, Part 195 Section 452 (49 CFR § 195.452), which was promulgated by the U.S. Department of Transportation (DOT), Research and Special Programs Administration (RSPA) and published on December 1, 2000.

groundwater would be impacted. Conversely, severe droughts would have the opposite effect, increasing travel times and thereby potentially lessening impacts from releases but possibly increasing concentrations.

Alluvial Aquifers and Northern High Plains Aquifer

Alluvial aquifers and the NHPAQ represent the most commonly used sources of groundwater in the proposed pipeline area. Many private and public wells extract groundwater from these aquifers, including those in several SWPAs in the proposed pipeline area. Compared to the other aquifers in the region (Great Plains Aquifer [GPA], Western Interior Plains Aquifer [WIPA], and NGPAS), these aquifers also are typically at highest risk of contamination from the proposed Project construction and operation because of the relatively shallow depth of water tables in the alluvial and NHPAQ aquifers (commonly <50 feet) and the relatively high permeability of the aquifers and overlying material. The combination of an extensive groundwater-use profile and high sensitivity to releases from the proposed pipeline area make these aquifers particularly sensitive to potential releases.

No information regarding conditions related to large-scale petroleum releases was readily accessible for the alluvial aquifers or NHPAQ along the proposed pipeline area; however, the crude oil release in Bemidji, Minnesota, previously discussed, occurred in an environment similar to the NHPAQ and alluvial aquifers. At that location, approximately 20 years after the release, the leading edge of the LNAPL oil remaining in the subsurface at the water table had moved approximately 131 feet downgradient from the spill site, and the leading edge of the dissolved contaminant plume had moved about 650 feet downgradient.

Although the subsurface conditions in the NHPAQ or alluvial aquifers as compared to the Bemidji spill site are not identical, the aquifers exhibit similar characteristics that affect groundwater flow and contaminant transport. The Bemidji site provides a reasonable physical model to establish expectations for the behavior of crude oil released in the NHPAQ system and alluvial aquifers. The Bemidji site studies and information from many other petroleum releases (as described in Section 4.13, Potential Releases) in similar conditions suggest that a spill of similar magnitude in the NHPAQ and alluvial aquifer systems would remain localized to a similar extent as the Bemidji plume.

The results of an evaluation of the Bemidji release and other petroleum releases indicate that the dissolved-phase petroleum contaminant plume from a large-scale release that reaches groundwater in the NHPAQ and alluvial aquifers could be expected to affect groundwater quality up to several hundred feet downgradient of the release source. The LNAPL plume, if any, could be expected to affect a significantly smaller distance downgradient of the release. Downward vertical migration may occur, but the lower specific gravity of petroleum material limits the downward migration of contaminants under all but the most robust vertical gradient conditions in aquifers. Even under such conditions in which groundwater flow to deeper aquifers occurs, similar attenuation to contaminant flow would be expected as with the shallower aquifer, and lateral extent of the petroleum contaminants within the deeper aquifer would typically be similar in magnitude to those described for shallow aquifer distribution.

The presence of the high nitrate concentrations common in the shallow groundwater of the NHPAQ and alluvial aquifers in Nebraska may promote degradation of some portion of the crude oil released into groundwater. Nitrate in groundwater typically encourages biologic degradation of dissolved-phase petroleum hydrocarbons in groundwater.

Aquifer conditions in the NHPAQ in the proposed Project area indicate that recharge to shallow groundwater is typically from local precipitation and surface water, and shallow groundwater generally discharges to local surface waterbodies. Recharge of shallow groundwater in this area typically does not come from deeper aquifer units or from horizontal flow across long distances. Therefore, petroleum releases from the proposed Project would not be expected to affect groundwater quality within recharge areas that provide a source of groundwater to large portions of the NHPAQ or associated alluvial aquifers. Likewise, drought conditions would tend to lessen the impacts to groundwater because the pipeline to groundwater distance is increased and the groundwater gradient is lower, slowing the spread of petroleum hydrocarbons (although possibly increasing concentrations).

Great Plains Aquifer

Across most of the proposed pipeline area where the GPA is present, it is very unlikely that any releases from the proposed pipeline would affect groundwater quality in the aquifer because the aquifer is typically deeply buried beneath younger, water-bearing sediments and/or aquitard units.

Near the proposed pipeline area in southern Nebraska, where the aquifer is closer to the surface and contains groundwater with low salinity, the GPA is typically overlain by water-bearing sediments of the NHPAQ and alluvial aquifers. Water quality in the GPA could be affected by releases in this area, but only under conditions of a strong downward gradient in the overlying aquifer units. Although a significant downward, vertical gradient is observed between the GPA and overlying aquifers across much of Nebraska, downward gradients in the proposed pipeline area in southern Nebraska are minimal or absent. Given the expected scale, characteristics, and behavior of potential petroleum releases related to the proposed pipeline, it is very unlikely that the proposed pipeline area could affect water quality in the GPA.

Northern Great Plains Aquifer System

After the NHPAQ and alluvial aquifers, the NGPAS represents the third most commonly used groundwater resource in the proposed pipeline area. Hydrogeologic conditions within the NGPAS are relatively complex, with several different aquifer and confining units present; however, within the proposed pipeline area, usable groundwater is typically limited to the Tertiary and Late Cretaceous formations within the aquifer group. The upward groundwater gradient across the NGPAS indicates that only those aquifer portions near the ground surface would be susceptible to water quality impacts from potential releases from the proposed pipeline area.

If a release impacts NGPAS aquifer system water quality, similar fate and transport of the petroleum products as those described for the NHPAQ and alluvial aquifers would be expected. Based on available information, the downgradient extent of groundwater impacts related to a large-scale release would typically be limited to several hundred feet of the release source, similar in scale to that expected from a large-scale release to the NHPAQ or alluvial aquifers.

Shallow aquifer conditions in the NGPAS in the proposed pipeline area indicate that recharge to shallow groundwater is typically a mixture of local precipitation, surface water, and water moving upward from lower aquifers under an upward gradient; therefore, it is not expected that petroleum releases would affect significant groundwater resources within areas that provide groundwater recharge to large portions of the NGPAS. A release would likely impact very shallow groundwater, but the spread and depth of penetration would be limited because of the upward gradient from lower aquifers.

Western Interior Plains Aquifer

There is extremely low probability that a release from the proposed pipeline area would affect water quality in the WIPA given the relative typical depth of the WIPA of several hundred feet in the proposed Project area.

Shallow Groundwater and Water Wells

Table 3.3-1 provides a summary of those areas where water-bearing zones are within 50 feet of the ground surface in the proposed pipeline area. These areas are typically found within alluvial aquifers along streams and rivers, within the Ogallala Formation in southern South Dakota and Nebraska, and within the overlying NDEQ-identified Sand Hills Unit alluvium in Nebraska. A summary of known and potential groundwater use along the proposed Project for each state is as follows:

- In Montana, 523 known and reported wells are present within 1 mile of the proposed Project (see Figure 3.3.2-2). No public water supply (PWS) wells or SWPA are located within this area. A total of six private water wells are located within approximately 100 feet of the proposed pipeline area within McCone, Dawson, Prairie, and Fallon counties.
- In South Dakota, 105 known and reported wells are present within 1 mile of the proposed Project (see Figure 3.3.2-3). One PWS well (associated with the Colome SWPA) is identified within 1 mile of the proposed pipeline in Tripp County. This PWS well is screened at a relatively shallow depth (reportedly <54 feet bgs) within the Tertiary Ogallala Formation. The proposed pipeline area would pass through the Colome SWPA in Tripp County. No private water wells are located within approximately 100 feet of the proposed pipeline area in South Dakota.
- In Nebraska, 2,398 known and reported wells are present within 1 mile of the proposed Project pipeline (see Figure 3.3.2-4). A total of 38 known PWS wells are present within 1 mile of the proposed pipeline in Boyd, Boone, York, Fillmore, Saline, and Jefferson counties. The nine SWPAs within 1 mile of the proposed pipeline area include those for the towns of St. Edward, Bradshaw, York, McCool Junction, Exeter, Western, Jansen, and Steele City, and the Rock Creek State Park. The only SWPA traversed by the proposed pipeline area in Nebraska is in Steele City, Jefferson County. A total of 14 private water wells are located within approximately 100 feet of the proposed pipeline area within Antelope, Polk, York, Fillmore, and Jefferson counties.

If a release from the proposed pipeline impacted groundwater wells, Keystone would be required to contact the applicable regulatory authorities and determine agency requirements for the most appropriate course of action (see Section 4.3.3.1, Groundwater, above for Nebraska, Montana, and South Dakota requirements). Those actions might include well abandonment, providing alternate water supplies, and site remediation. Nebraska has specifically required this notification as well as water supply replacement planning and commitment in the NDEQ Supplemental

Environmental Report. South Dakota and Montana have similar requirements. These actions would be detailed in the Keystone spill response plan. Further, if during construction or operation activities an unregistered well is found, Keystone would provide the landowner with technical assistance to register the pre-existing, unregistered well at the landowner's request.

Groundwater Extraction Effects

Construction of the proposed Project would require use of water for activities such as dust control, directional drilling, and hydrostatic testing of the pipeline. It is likely that at least some of the water used for construction would be come from existing groundwater resources in the vicinity of the proposed Project. Since the proposed Project construction effort would be of relatively short duration, it is unlikely that groundwater extraction related to the Project would affect long-term water levels in any aquifer units along the route.

Effects Related to Proposed Pump Stations

Potential groundwater impacts related to the proposed pump stations include releases of refined petroleum products during construction and operation of the pump stations and/or releases of crude oil from the proposed Project during pipeline operation. The extent of groundwater impacts would be dependent on many factors, such as the volume and duration of releases, constituent properties, depth to groundwater, soil characteristics, location of operating water supply wells that would influence hydraulic gradients, aquifer characteristics (e.g., hydraulic conductivity, transmissivity, storativity), and whether the releases reach surface water because groundwater is typically interconnected with surface waterbodies.

Effects Related to Pipe Yard Development

Potential groundwater impacts related to construction and operation of the proposed pipe yard and rail siding in Bowman County, North Dakota would be related to releases of refined petroleum products used as vehicle fuels and lubricants. These releases would typically be relatively small in volume, and downward migration of the petroleum compounds through the soil to groundwater would be minimal based on the depth to groundwater and the fine-grained shale and coal intervals of the Fort Union Group, which would tend to slow and/or prevent downward migration. There is a low potential for groundwater impacts depending on the volume and extent of the release. The extent of groundwater impacts for any releases that reach groundwater at the North Dakota proposed pipe yard and rail siding would be influenced by the same characteristics and parameters discussed above

4.3.3.2 Surface Water

Impacts to surface waters from the proposed Project may occur as a result of a crude oil spill during pipeline testing and operations. A distance of 10 miles downstream has been selected for impact evaluation. This distance was selected as the area within which overall potential affects to resources may occur beyond the modeled distance of oil spreading. Generally, spill plumes would possibly migrate up to 10 miles with residual crude oil materials traveling further. More information regarding impacts resulting from a pipeline spill is provided in Section 4.13, Potential Releases.

The Missouri River in Montana and South Dakota is a source for two rural/tribal water systems: the Fort Peck Assiniboine & Sioux Rural Water Supply System (ASRWSS) and the Mni Wiconi Rural Water Supply System (MWRWSS).

ASRWSS operates a surface water withdrawal from the Missouri River near Poplar, Montana. The diversion is approximately 77 river miles downstream of the proposed Project crossing. The proposed pipeline ROW does not cross any ASRWSS-related infrastructure.

MWRWSS operates a surface water withdrawal from the Missouri River near Pierre, South Dakota. The proposed pipeline ROW would cross MWRWSS water distribution infrastructure at various locations. The U.S. Bureau of Reclamation (BOR) has supplied Keystone with specific requirements and conditions for the construction of pipeline crossings of MWRWSS infrastructure. The BOR, in conjunction with its American Indian tribal partners, may have additional recommendations or comments during subsequent permit and design reviews. The proposed project would follow BOR crossing design and construction requirements as supplied or subsequent requirements as determined necessary by BOR to protect BOR infrastructure.

Impacts to both of these systems would predominantly be operational and stem from potential spills of transported fluids. Impacts to the intake systems and water treatment facilities include additional treatment, increased maintenance, and possibly the temporary loss of supply during spill response and cleanup. Impacts to these water system intakes are anticipated to be infrequent and the result of residual spill material migrating downstream. The possibility of a spill reaching either the ASRWSS intake near Poplar, Montana, or the MWRWSS intake in Pierre, South Dakota, is exceptionally remote due to the following factors: Based on the risk assessment in Appendix P of the FEIS and the consequence analysis by E^{x}ponent 2013, a distance of at least 10 miles downstream from the proposed pipeline was recommended for the identification of sensitive resources that could be affected by a release from the proposed pipeline. A buffer distance of 10 miles downstream has been selected for impact evaluation in the FEIS and Final Supplemental EIS process. Residual crude oil spill materials such as tar balls could travel farther than 10 miles but would not have a widespread effect on surface water resources. The distance from the pipeline crossing to the ASRWSS intake is over 70 miles, and the MWRWSS intake is over 100 miles, both of which are significantly beyond the proposed Project impact assessment buffer. Additionally, depending upon the width of the individual stream crossing and including an additional 500-foot buffer distance from each stream bank, a release event probability is estimated to be one in 18,000 years to one in 47,500 years.

Conditions specific to the MWRWSS are:

- The Lake Oahe reservoir and dam are upstream of the intake and provide a significant barrier to a spill plume or residual material reaching the MWRWSS intake.
- The distance from the pipeline crossing to the Bad River confluence with the Missouri River is 44 miles. The MWRWSS intake is on the Missouri River and more than 3 miles upstream from the confluence with the Bad River.

Section 4.13, Potential Releases, addresses the nature of and response to pipeline crude oil spills. Impacts such as loss of service for portions of the MWRWSS infrastructure would be possible during construction or repair activities associated with the proposed Project. These impacts would be similar in nature to those associated with typical proposed Project crossings of a water supply or other infrastructure. Industry standard care and precautions would be necessary to prevent damage to water supply infrastructure by excavation equipment or related activities.

Spills of crude oil are possible from damage to the proposed Project infrastructure by maintenance and repair work conducted on MWRWSS infrastructure. MWRWSS contractors would take extra precautions to locate and notify the proposed Project operator in the event of MWRWSS infrastructure maintenance or repairs that may be required near Keystone infrastructure.

The proposed Project would potentially affect waterbodies through construction activities and maintenance activities across the states of Montana, South Dakota, and Nebraska. Potential impacts to water features classified as either open water or riverine are addressed in Section 4.4, Wetlands. A pipe yard and rail siding in North Dakota and pump stations in Kansas would be constructed to support the operation of the proposed Project; due to the lack of significant surface water features at either location, these ancillary facilities would be unlikely to affect surface water quality. It is possible that some minor intermittent drainage swales could be impacted, to the extent such are present in the disturbed areas.

The proposed Project route has been selected and modified to minimize the potential for impacts to surface water resources, as well as other sensitive environments, by avoiding them whenever possible and shifting the route to limit the area affected. Table 4.3-1 presents a summary of potential impacts to mapped surface water resources by state based on the proposed Project route. The final pipeline route may be adjusted based on site conditions, at the request of landowners, or additional regulatory review. These adjustments may reduce impacts and eliminate crossings. For example, where the proposed Project parallels a stream reach and crosses several meanders, the pipeline may be offset during regulatory review and, as a result, not have any crossings in that stream reach.

Table 4.3-1 Summary of Impacts to Surface Water Resources by State[a]

	Montana	South Dakota	Nebraska
Total Waterbodies Crossed	459	333	281
Perennial Waterbodies Crossed	9	16	31
Intermittent Waterbodies[b] Crossed	424	313	237
Other Waterbodies Crossed	26	4	13
Waterbodies with State Use Classifications	15	10	40
Waterbodies with Impairments	9	5	10
Mapped Floodplains	12	4	74
Total Width of Mapped Floodplains (miles)	6.2	1.7	16.2

Source: MDEQ, South Dakota Department of Environment and Natural Resources 2012 and NDEQ 2012a and 2012b; Please also refer to data tables in Section 3.3, Water Resources

[a] The summary numbers in this table are for waterbodies and surface water resources that the proposed pipeline would cross.
[b] For the purposes of the Final Supplemental Environmental Impact Statement (Final Supplemental EIS) and based on limitations of the desktop level of investigation, intermittent and ephemeral waterbodies are assessed as a single category of stream.

Construction-Related Impacts

Construction activities could result in the following potential impacts on surface water:

- Temporary increases in total suspended solids concentrations and increased sedimentation during stream crossings or at upland locations with soil erosion and transport to streams.
- Temporary to long-term changes in channel morphology and stability caused by channel and bank modifications.
- Temporary to long-term decrease in bank stability and resultant increase in total suspended solids concentrations from bank erosion as vegetation removed from banks during construction is re-establishing.
- Temporary reductions in stream flow and potential other adverse effects during hydrostatic testing activities and stream crossing construction.
- Impacts to surface water resources associated with hazardous liquids spills and leaks. See Section 4.13, Potential Releases. Construction water uses, construction camp potable water, and pipeline testing withdrawals from surface waterbodies.

Stream Crossings and In-Stream Construction Activities

Depending on the type of stream being crossed, one of six construction methods would be used: non-flowing open cut, flowing open cut, dry flume, dry dam-and-pump, HDD, or horizontal bores.

Open-cut methods would be used at most crossings unless deemed infeasible due to site conditions during construction or where other methods better protect sensitive waterbodies, as determined by the appropriate regulatory authority.

The HDD method would be used to cross 14 major or sensitive waterbodies (see Section 3.3, Water Resources, for a listing of specific crossings).[12] The river crossing procedures and measures to reduce impacts included in the CMRP would be implemented. For waterbody crossings where HDD would be used, disturbance to the channel bed and banks would be minimized, although temporary impacts could occur as a result of accessing the waterbody to withdraw water for hydrostatic testing and for HDD make-up water. Make-up water used for the drilling fluids could, if allowed, be extracted from local surface waterbodies, imported from more distant sources, or extracted from groundwater wells near the HDD crossing. This would be a temporary and limited use of these water resources.

In some instances, pressurized fluids and drilling lubricants used in the HDD process have the potential to escape the active HDD bore, migrate through the soils, and come to the surface at or near the crossing construction site, an event commonly known as a frac-out. Measures identified in a required HDD contingency plan would be implemented, including monitoring of the directional drill bore, monitoring downstream for evidence of drilling fluids, and mitigation measures to address a frac-out should one occur.

[12] In addition to these 14 waterbody crossings, Keystone has designated the Ash Creek Bluff location where an HDD installation would be used in order to mitigate construction impacts to a steep hillside slope. This HDD installation would not cross under Ash Creek.

Permitting requirements would vary based on crossing method, designated waterbody use, and regulatory jurisdiction. Where the HDD method is used for major waterbody crossings or for waterbody crossings where important fisheries resources could be impacted, a site-specific plan addressing proposed additional construction and impact reduction procedures would be developed (see Appendix G, CMRP). Prior to commencing any construction activities at regulated stream-crossings, permits would be required under Section 404 of the Clean Water Act (CWA) through the U.S. Army Corps of Engineers (USACE) and Section 401 Water Quality Certification, per state regulations. Some crossings may require additional permitting under Section 10 of the Rivers and Harbors Act. The agencies responsible for this review could require additional measures to further limit potential project impacts. In addition, water resources projects on designated segments that are determined to have a direct and adverse effect on the free-flowing condition, water quality, or the values for which the rivers were established are prohibited unless impacts can be avoided or eliminated.

Permits required under Sections 401, 402 and 404 of the CWA could include additional site-specific conditions as determined by USACE and appropriate state regulatory authorities. The CWA is U.S. federal law adopted to govern water pollution and maintain regulatory standards to insure surface water resources are fit for human uses and recreation by establishing designated uses and water quality criteria. Section 404 authorizes activities affecting U.S. waters by permit. The USACE is authorized to issue general and individual permits. General permits include Nationwide Permits and are intended to cover a variety of common activities. Individual Permits address more complex activities that are not covered by conditions regulated by general permits and generally more in-depth analysis than general permits. States also have a role in Section 404 decisions through State program general permits, water quality certification, or program assumption.[13] The section 401 certification program allows states to provide 404 permitted projects certification, conditional certification, denials, or waivers. This process allows states to independently incorporate conditions to maintain water quality based on state specific priorities. These conditions enable states to identity issues and the appropriate mitigations and protective measures they require during construction of projects such as the proposed Project, which are permitted under the nationwide portions of the CWA. Keystone has agreed upon many conditions and developed construction plans that would address these potential state concerns. Additional requirements and conditions may be applied during the final permitting review and approval process. More detailed descriptions of each of the crossing method and measures to reduce impacts associated with each method are provided in Appendix G, CMRP, and in Chapter 2.0, Description of the Proposed Project and Alternatives.

Additional review under Section 10 of the Rivers and Harbors Act could be required for some waterbodies. For navigable water crossings regulated under Section 10 (such as the Yellowstone and Missouri rivers), scour depth calculations would be required to show the maximum expected depth of scour at those locations. This evaluation would include the expected scour depth of the riverbed for a range of flows, including very high flows such as the 100-year and 500-year flows.

[13] http://water.epa.gov/lawsregs/guidance/cwa/dredgdis Water: Discharge of Dredged or Fill Materials (404) - Section 404 Permitting

Temporary crossings would be designed and located to minimize damage to stream banks and adjacent lands. The use of temporary crossings could reduce the impacts to the waterbodies by providing access for equipment to specific locations. These crossings would be designed and constructed to provide unimpeded fish and aquatic organism passage during the period the crossing is in place.

Following completion of waterbody crossings, waterbody banks would preferably be restored to preconstruction contours or to a stable slope. Stream banks would be seeded for stabilization and mulched or covered with erosion control fabric in accordance with the CMRP and applicable state and federal permit conditions. Additional erosion control measures would be installed as specified in any permit requirements. Appropriate care in design and installation would be used with erosion control measures, as these have the potential to cause unintended adverse environmental impacts. For example, placement of rock along the bank at a crossing could induce bank failure further downstream.

Many of the rivers in the proposed Project ROW are unstable and have high sediment supply systems with dynamic active channel(s), depositional bars, and active bank margins. Some of the larger rivers crossed by the proposed Project, such as segements of the Yellowstone and Missouri Rivers in Montana, the Cheyenne River in South Dakota or the Platte River, Loup River, and Prairie Creek in Nebraska are all drainage systems capable of substantial lateral channel migration, bank retreat, and subsequent re-activation of historic floodplains and channels during the life of the proposed Project. All states affected by the proposed Project are prone to ice jams on their major rivers, which often cause substantial backwatering and lateral scour. Channel migration zones (CMZs) are defined by the corridor that each river is expected to occupy over a given timeframe and are based on physical geomorphic parameters and local geologic control. As an example, CMZs for the Yellowstone River in Montana have been mapped (Yellowstone River Conservation District Council 2009) as part of an effort by state and federal agencies to provide additional information for minimizing impacts to major surface water and natural resources, including avoidance of poor development decisions and subsequent damage or loss of infrastructure and property. The proposed Project would incorporate CMZ evaluations in the final design of waterbody crossings.

The minimum pipeline cover at crossings of waterbodies, ditches, drainages, and other similar features would be 5 feet (see Table 2.1-15). The proposed Project has stated this minimum cover depth in the project CMRP (see Appendix G) and has further committed to this minimum cover depth in PHMSA Special Condition 19. Minimum cover depths would be measured to the top of pipe or any coatings and concrete weights applied to the pipe. The pipeline would be installed at the minimum water crossing depth for a distance of at least 15 feet beyond each side of the waterbody.

Where major waterbodies are crossed using the HDD method, the depth from the streambed to the top of the pipe would depend on a number of factors for each crossing design including the width of the crossing and potential scour depth of the waterbody being crossed. The proposed Project supplied HDD installation drawings for the FEIS evaluation (FEIS Volume 5, Appendix D, Site Specific Waterbody Crossing Plans). These plans indicate a typical minimum depth of 30 feet from lowest channel elevation to the top of pipe or coating. The plan supplied for the Niobrara river in Nebraska indicates a depth of over 60 feet from the lowest point in the channel to the top of pipe.

The implementation of appropriate measures to protect pipeline crossings from channel incision and channel migration can reduce the likelihood of washout-related emergencies, reduce maintenance frequency, and limit adverse environmental impacts. The design of the crossings also would include the specification of appropriate stabilization and restoration measures.

Wild and Scenic Rivers

The Wild and Scenic Rivers Act (WSRA) was enacted to preserve the free-flowing condition of rivers with outstanding natural and recreational values. The WSRA designates WSR segments, establishes procedures for adding additional river segments to the list, and provides guidance on how those river segments should be managed. A Wild and Scenic designation protects a river's outstandingly remarkable values and free-flowing character; protects existing uses of the river; prohibits federally-licensed dams and imposes restrictions on other federal and federally-assisted projects that would negatively impact the river's outstanding values; establishes a quarter-mile protected corridor on both sides of the designated river segment; and requires the creation of a cooperative river management plan that addresses, among other things, resource protection, development of lands and facilities, and user capacities. A Wild and Scenic designation does not prohibit development, does not affect water rights, and does not affect existing uses. Uses compatible with the management goals of a particular river are allowed.

The WSRA does not specify any buffer zone spacing or specific criteria by which water resources projects are reviewed. Impacts to designated segments determined to have a direct and adverse impact on the Wild and Scenic qualities of the rivers are prohibited unless impacts can be avoided or eliminated. Additionally, water resources projects upstream, downstream, or on tributaries that would affect the area or unreasonably diminish the scenic, recreational, or fish and wildlife values of the rivers would also require review.

The proposed Project crosses the Niobrara River in Nebraska between two WSRA-designated segments on the Niobrara and Missouri Rivers. The Niobrara National Scenic River segment is approximately 12 miles upstream of the proposed Project MP 626.0, and the Missouri National Recreational River is approximately 46 miles downstream of the proposed Project. The proposed Project does not cross either of these WSR segments. There are several areas along the Niobrara and Missouri Rivers under study for Wild and Scenic designation, and these areas are avoided by the proposed project as well. The National Park Service (NPS) has regulatory authority for the U.S. Department of the Interior (DOI) on Wild and Scenic segments in accordance with Section 7(a) of the WSRA (16 United States Code § 1278). As required under WSRA, USACE would contact the DOI/NPS to determine the need for Section 7(a) evaluations for any Section 404 and 401 permit application initiated under the CWA at all pipeline river crossings, including those upstream, downstream, and on tributaries to the WSRA-designated segments of the Niobrara and Missouri Rivers..

As part of the surface water impact evaluation, a sub-analysis was conducted at the request of the NPS to assess the potential impact of a release from the proposed Project to protected water bodies (National Scenic River, WSR, and National Recreational River) of the Niobrara and Missouri River. This analysis calculated the probability of a spill occurring from the proposed pipeline focusing on the tributary streams that could convey a spill to the specially designated water body. Stream crossings, stream widths, and spill travel distances were identified using GIS and the NHD. Spill incident frequencies were calculated using two different sets of historical pipeline spill data from PHMSA: first, a broader data set including crude oil pipelines greater than 16 inches in diameter; second, a more focused data set narrowed to pipeline spills that impacted surface water. (See Section 4.13.3.5, PHMSA Historical Data, and Appendix K, Historical Pipeline Incident Analysis, for additional information.) The analysis identified that there are 39 stream crossings within 40 miles upstream of the specially designated water bodies that could connect a spill from the proposed Project to the waterbody. Seven of these streams flow perennially, and the remaining streams either flow intermittently or are undefined. Most stream crossings are not large; the average width of the stream crossings is 9 feet, and the largest crossing is 110 feet.

Spill frequencies for stream crossings were calculated based on the total combined distance of all stream widths, including an additional 500-foot buffer distance from each stream bank. The probability of any spill occurring within 500 feet of a stream crossing that could convey a spill to a protected waterbody is one spill every 542 years, based on all historical spills from pipelines greater than 16 inches in diameter. Using data for historical spills that impacted surface water, the probability of any spill occurring within 500 feet of a stream crossing that could convey a spill to a protected waterbody is one spill every 1,202 years. The shortest distance a spill would have to travel to impact a protected waterbody is approximately 29 miles.

Based on the above spill probability, it is unlikely that a spill event would occur during the operational life of the pipeline at one of the identified stream crossings. Additionally, the distance from the proposed pipeline to the specially designated river segments further reduces the probability of a spill reaching the protected waterbodies. Nonetheless, in the event of a large spill or undetected release of sufficient duration, some oil could reach a specially designated river segment if flowing water was present within the stream at the time of a release.

In addition to the NPS requested sub-analysis, the DOI has specific requirements, recommendations, and comments related to HDD and open-cut crossing construction activities that are proposed for use upstream of National WSR segments or tributary rivers as well as streams of WSRA-designated rivers, including the associated floodplain areas (DOI 2012). The open-cut wet crossings pipeline installation method has a high potential to impact water resources during construction activities. This method would typically involve excavation of the channel bed and banks of a flowing stream. Construction equipment and excavated soils would be in direct contact with surface water flow. The degree of impact from construction activities would depend on flow conditions, stream channel conditions, and sediment characteristics.

For the types of crossings listed below, the following measures would be implemented on a site-specific basis:

- Contaminated or Impaired Waters – If required, specific crossing and sediment handling procedures would be developed with the appropriate regulatory agencies, and agency consultation and recommendations would be documented and implemented.
- Sensitive/Protected Waterbodies – If required, specific construction and crossing methods would be developed in conjunction with USACE and U.S. Fish and Wildlife Service (USFWS) consultation or other agencies as applicable. The appropriate method of crossing these waterbodies would be determined by the appropriate agency as applicable.
- HDD Crossings – A frac-out contingency plan would be developed in consultation with the regulatory agencies to address appropriate response and crossing implementation in the event of a frac-out during HDD crossings. Implementation of measures as described in the

proposed Project CMRP (see Appendix G) and additional conditions from permitting agencies would reduce adverse impacts that would result from open-cut wet crossings. All contractors would be required to follow the identified procedures to limit erosion and other land disturbances. The CMRP describes the use of buffer strips, drainage diversion structures, sediment barrier installations, and clearing limits, as well as procedures for waterbody restoration at crossings. (See Chapter 2.0, Description of the Proposed Project and Alternatives, and Appendix G, CMRP, for a discussion of the proposed waterbody crossing methods.)

State Permitting

State-level permitting would also be required for pipeline crossings of state-regulated surface waters. Each state with waterbodies crossed by the proposed Project would have authority under CWA section 401 to protect water quality in waters of the state. This process will depend in part on the federal permitting process and what level of permitting is applied to the proposed Project. The CWA defines a state's role in the 401 Water Quality Certification process. Each state's acceptance or denial of the federal Nationwide Permit program dictates whether additional state level review and possible conditions may be required for a particular Nationwide Permit.

In Montana, the MDEQ may issue state-wide permits for crossings. Some crossings may require location-specific permitting and conditions. This permitting process may also require that where open-cut methods are used, any flowing surface water would be diverted, pumped, or flumed around the trench at pipeline crossings. This would be required where water is present or where significant storm runoff may occur during the construction period. As a result, the non-flowing open-cut and flowing open-cut crossing methods may not be applicable for some regulated crossings under the Section 401 authority of the MDEQ. For CWA Permits, a separate Section 401 review by the MDEQ may be required.

In South Dakota, the Department of Environment and Natural Resources is responsible for CWA permit certification and would review proposed stream and river crossings where necessary and may issue project-specific conditions. During project review, South Dakota my impose similar stipulations to conditions outlined for Montana.

In Nebraska, the Department of Environmental Quality has issued a 401 certification or a significant number of Nationwide Permits; however, it has supplied general additions and modifications under its CWA 401 authority. Additionally the state has denied in part or added specific conditions to other Nationwide Permits. The state of Nebraska is likely to have additional regulatory conditions and permitting to that of Montana and South Dakota.

Stream crossings would need to be protected from erosion and sedimentation. Keystone has submitted plans for erosion control and revegetation, which are provided in Appendix G, CMRP. Additional erosion control and revegetation documentation could be required under supplemental state or federal regulations. For example, MDEQ would require compliance with MEPA, under which Keystone would provide a Storm Water Pollution Prevention Plan. The South Dakota Public Commission Order includes specific measures for protecting stream crossings, such as restricting excavated soil placement, maintaining protective buffers around streams, and revegetating riparian areas with native plant species. In Nebraska, trenches through waterbodies that are dry or contain non-moving water at the time of crossing would not be left open for more than 24 hours to reduce sediment discharge from a sudden storm event resulting in runoff. This commitment would not apply where excavation of rock by blasting or mechanical means may be required in the waterbody.

Pump Stations

In addition to pipeline crossings, the locations of pump stations were evaluated for potential impacts to surface waters. The NHD (U.S. Geological Survey 2012) indicates that three proposed pump station boundaries (PS-9 in Phillips County, Montana; PS-10 in Valley County, Montana; and PS-20 in Tripp County, South Dakota) are currently located in areas that contain unnamed intermittent streams. Aerial imagery indicates these areas are tilled fields or fenced range locations crossed by grassy swales. Field surveys also indicated that PS-9 is located in tilled crop land and is not in an intermittent stream. Field surveys in the spring of 2009 and 2010 of PS-10 indicated a rill/drainage feature without water present. For PS-20, field surveys did not identify any intermittent streams at this location.

The initial location and design supplied for PS-24 in Nebraska near the Loup River, while not placed in a mapped floodplain, indicates that PS-24 may have limited or no access during periods of flood. It is possible for one or more access routes to be impassable during high water events. As the location and design for PS-24 is finalized, Keystone has indicated that the proposed Project would develop an access plan for this pump station that takes into account access issues during flood conditions. Any other pump stations located near known flood areas would also be evaluated for access during flood conditions.

Hydrostatic Testing and Water Withdrawals

Water hydrostatic testing is performed to expose defective materials or welds that have missed prior detection, expose possible leaks, and serve as a final validation of the integrity of the constructed system. A hydrostatic test is conducted on individual segments of pipeline prior to completion. Buried high-pressure oil pipelines are tested for strength by pressurizing them to pressures above the maximum pressure that would be used during pipeline operations along their length with water drawn from local water sources. As allowable, water used for hydrostatic testing would be obtained from nearby surface water resources, groundwater, or municipal sources. These sources include streams, rivers, privately owned reservoirs, and private or public wells.

Table 4.3-2 lists the surface waterbodies that may be considered for potential hydrostatic test water sources along the proposed Project route as provided by Keystone. The proposed Project CMRP Section 8 (see Appendix G) specifies the applicant's committed actions for securing pipeline hydrostatic test water. The Federal Energy Regulatory Commission (FERC) has developed criteria for the minimum separation distance for hydrostatic test manifolds from wetlands and riparian areas appropriate for natural-gas-pipeline construction. Although the proposed Project is not subject to FERC authority, hydrostatic test manifolds would be located more than 100 feet away from wetlands and riparian areas to the maximum extent possible, consistent with FERC criteria.

Table 4.3-2 Potential Hydrostatic Test Water Sources along the Proposed Project Route[a, b, c, d]

County	Approximate Milepost	Waterbody Name	Maximum Water Withdrawal (million gallons)
Montana			
Phillips	25	Frenchman Creek	32
Valley	83	Milk River	32
Valley/McCone	89	Missouri River	55
Dawson	196	Yellowstone River	55
South Dakota			
Harding	295	Little Missouri River	27
Harding	315	Gardner Lake	67
Perkins	361	North Fork Moreau River	36
Meade	430	Cheyenne River	35
Haakon	486	Bad River	22
Tripp	541	White River	39
Nebraska[e]			
Boyd	618	Keya Paha River	37
Holt	626	Niobrara River	37
Antelope	713	Elk Horn River	37
Nance	762	Loup River	37
Polk	775	Platte River	47

[a] These volumes are estimated at this time. Final volumes would be included in appropriate water use permits for each state. At that time, the state permitting agency would determine which rivers can be used, whether it approves the volume, and any permitting conditions associated with the withdrawals. Water would be used for hydrostatic test water, drilling mud for HDD operations, and dust control.
[b] Additional water sources would be needed for dust control. These additional sources would require lower volumes (up to 6 million gallons on average). Dust control water sources would be permitted in accordance with state permit requirements and could include existing irrigation wells.
[c] Groundwater sources (irrigation wells) may be used for water sources instead of the rivers listed. These water sources and the volumes to be used would be purchased from landowners and would be permitted in accordance with state requirements.
[d] These water volumes would be required for the duration of construction.
[e] Additional water would be withdrawn from irrigation wells in several counties crossed by the proposed Project for dust control, hydrostatic testing, and HDD operations.

In an effort to avoid or minimize impacts to sensitive waterbodies, Keystone would take into account environmental conditions when developing plans and obtaining required permitting for water withdrawal from surface waterbodies such as stream crossings in already depleted and drought-prone watersheds.

During droughts, surface water withdrawal permits from larger rivers with existing water rights would be regulated by state regulatory agencies to preserve existing water rights and environmental requirements. If adequate water is not available from rivers, Keystone would use alternative water sources nearby such as local private wells or municipal sources for HDD operations, hydrostatic testing of the mainline, and dust control during these dry conditions. Keystone has indicated that in the event surface water is unavailable, groundwater would be used for HDD operations, hydrostatic testing, and dust control. Water would be purchased from nearby willing sellers with available water rights.

Additionally, the proposed Project would cross the central Platte River using the HDD method at approximate Milepost 775. Activities associated with the proposed Project in that area include temporary water withdrawals for drilling fluids and hydrostatic testing. Lower Platte River Basin water depletions in Nebraska could affect resources by reducing the amount of water available in the Basin. The state of Nebraska in cooperation with the USFWS has developed plans to manage water depletions in conjunction with Section 7 Endangered Species Act consultations (USFWS 2009a). For the proposed Project, temporary water withdrawals during hydrostatic testing in the lower Platte River Basin would avoid impacts to resources since the volume of water needed would be returned to its source within a 30-day period. Temporary water withdrawals are considered to have no effect, as described by the USFWS Platte River species *de minimus* depletions threshold, which states “temporary withdrawals of water (e.g., for hydrostatic pipeline testing) that return all the water to the same drainage basin within 30 days' time are considered to have no effect, and do not require consultation” (USFWS 2009b). Sections 3.8 and 4.8 discuss potential impacts to threatened and endangered species and species of conservation concern.

Withdrawals from impaired or contaminated waterbodies would be avoided and only used if approved as a water source. All surface water resources used for hydrostatic testing would be approved by the appropriate permitting agencies prior to initiation of any hydrostatic testing activities. Planned withdrawal rates for each water resource would be evaluated and approved by these agencies prior to use. No resource would be used for hydrostatic testing without receipt of applicable permits. As stated in Section 8.2 of the proposed Project CMRP (see Appendix G), required water analyses would be obtained prior to obtaining any water for filling or any discharging operations associated with hydrostatic testing.

The water withdrawal methods described in the proposed Project CMRP would be implemented and followed. These procedures include screening of intake hoses to prevent the entrainment of fish or debris, keeping the hose at least 1 foot from the bottom or bed of the water resource, prohibiting the addition of chemicals into the hydrostatic test water, and avoiding discharging any hydrostatic test water that contains visible oil or sheen (from pipe or equipment) following hydrostatic testing activities. Any contaminated water would be disposed of in accordance with local, state, and federal regulations.

As a standard procedure and as part of its water withdrawal and discharge permits, Keystone would identify water rights, as per state requirements, that could be affected by temporary interruptions of water flow. Keystone would also abide by mitigation measures outlined in applicable water withdrawal and discharge permits to protect sensitive receptors, such as fisheries.

Hydrostatic test water would be discharged at an approved location along the waterway/wetland or to an upland area within the same drainage as the source water where it may evaporate or infiltrate. Discharged water would be tested for water quality prior to release in the environment to ensure it meets applicable water quality standards imposed by the discharge permits for the permitted discharge locations. Hydrostatic test water would be tested for water quality during storage or during transfer to storage prior to discharge. If needed, hydrostatic test water can be stored in the pipe following testing or in portable storage vessels or containment. Where hydrostatic test water does not meet standards for discharge proper, treatment or disposal is required. The proposed Project CMRP incorporates additional measures designed to minimize the impact of hydrostatic test water discharge, including regulation of discharge rate, the use of energy dissipation devices, channel lining, and installation of sediment barriers as necessary.

4.3.3.3 Operational-Related Impacts

Surface water impacts associated with potential crude oil spills from pipeline operation are addressed in Section 4.13, Potential Releases.

Channel migration or streambed degradation could expose the pipeline, resulting in temporary, short-term, or long-term adverse impacts to water resources; however, protective activities such as reburial or bank armoring would be implemented to reduce these impacts. As described in the proposed Project CMRP (see Appendix G), a minimum depth of cover of 5 feet below the bottom of all waterbodies would be maintained for a distance of at least 15 feet to either side of the edge of the waterbody. General channel incision or localized headcutting could threaten to expose the pipeline during operations. In addition, channel incision could sufficiently increase bank heights to destabilize the slope, ultimately widening the stream. Sedimentation within a channel could also trigger lateral bank erosion, such as the expansion of a channel meander opposite a point bar. Bank erosion rates could exceed several feet per year. Not maintaining an adequate burial depth for pipelines in a zone that extends at least 15 feet beyond either side of the active stream channel could necessitate bank protection measures that would increase both maintenance costs and environmental impacts. Potential bank protection measures could include installing rock, wood, or other materials keyed into the bank to provide protection from further erosion or re-grading the banks to reduce the bank slope. Disturbance associated with these maintenance activities has the potential to create additional water quality impacts.

The proposed Project would use reasonable care and employ generally accepted engineering practices in the design phases of the proposed Project to insure the proper evaluation of the potential for channel aggradation/degradation and lateral channel migration. The level of assessment for each crossing would vary based on the best judgment of the design personnel. The proposed pipeline would be installed as determined to be necessary to address any hazards identified by the assessment. The pipeline would be installed at the design crossing depth, which may exceed the minimum cover depth of 5 feet over the top the pipe for waterbody crossings, and extend for at least 15 feet beyond each side of the waterbody being crossed. The design of the crossings would also include the specification of appropriate stabilization and restoration measures.

The measures to protect water resources during operations are specified in the CMRP (see Appendix G). In South Dakota, the water protection conditions that were developed by the South Dakota Public Utility Commission as part of its Amended Final Decision and Order (Notice of Entry HP09-001) would be implemented.

4.3.3.4 Floodplains

The proposed pipeline would cross mapped and unmapped floodplains in Montana, South Dakota, and Nebraska. The proposed pipeline would be constructed under many river channels with potential for vertical and lateral scour. In floodplain areas adjacent to waterbodies, the contours would be restored to as close to previously existing contours as practical, and the disturbed area would be revegetated following construction in accordance with the CMRP (see Appendix G). Therefore, after construction, the proposed pipeline would not obstruct flows over designated floodplains, resulting in only minor changes to topography, and thus would not affect local flood dynamics or flood elevations.

Ancillary features such as pump stations, mainline valves, and access roads in mapped and unmapped floodplain areas would be assessed prior to permitting and designed to minimize impacts to floodplains. These facilities would be constructed after consultation with the appropriate county agencies to ensure that the design meets county requirements and to obtain the necessary permits associated with construction in the 100-year floodplain zones. Table 4.3-3 shows the infrastructure in mapped floodplains.

Table 4.3-3 Ancillary Facilities Crossing Designated Floodplain Areas for the Proposed Pipeline Route

State	County	Approximate Project ROW Milepost[a]	Waterbody Associated with Floodplain[b]	Facility Type[c]	Ancillary Facility Identifier
MT	Valley	60	Spring Creek	Access Roads	CAR-084, CAR-225
MT	Valley	62	Morgan Creek	Transmission Line	PS-10
MT	Valley	66	Cherry Creek	Transmission Line	PS-10
MT	Valley	72	East Fork Cherry Creek	Transmission Line	PS-10
MT	Valley	83 - 86	Milk River	Access Roads Transmission Line	CAR-120, CAR-122, CAR-123 PS-10
MT	Valley & McCone	89 - 91	Missouri River	Access Roads HDD portals	CAR-124, CAR-125 2
MT	McCone	148 - 149	Redwater River	Transmission Line	PS-12
MT	Dawson	197 - 198	Yellowstone River	Access Roads HDD portal Valve Other	CAR-127, CAR-292 1 MLV-10 PY-07 SITE 4
SD	Harding	295	Little Missouri River	HDD portal Transmission Line	1 PS-15
SD	Haakon	486	Bad River	Transmission Line	PS-19
SD	Lyman & Tripp	541 - 542	White River	Access Roads HDD portal	CAR-080, CAR-237 1
NE	Boyd	618	Meglin Cr	Access Road	CAR-306
NE	Boyd	618	Unnamed Tributary to Keya Paha River	Access Road	CAR-306
NE	Boyd	618	Keya Paha River	Access Road HDD portal	CAR-307 1
NE	Boyd	626	Niobrara	HDD portal	1
NE	Antelope	713 - 714	Elkhorn River	Access Roads HDD portal	CAR-253, CAR-286 1
NE	Nance	761 - 762	Loup River	Access Roads HDD portals	CAR-264, CAR-268 2
NE	Polk	775 - 776	Platte River	HDD portal	1
NE	York	801 - 802	Unnamed Tributary to Beaver Creek	Access Road	CAR-274, CAR-218

State	County	Approximate Project ROW Milepost[a]	Waterbody Associated with Floodplain[b]	Facility Type[c]	Ancillary Facility Identifier
NE	Saline	838 - 838	Unnamed Tributary to North Fork Swan Creek	Access Road	CAR-280

[a] Ancillary facilities floodplain crossings are listed by the proposed Project milepost numbers and are not necessarily adjacent to the proposed Project ROW at that milepost.
[b] Ancillary facilities may cross unmapped floodplain areas.
[c] Additional ancillary facility floodplain crossings may be incurred when final route adjustments are made.

4.3.4 Additional Mitigation

The following mitigation measures are included in addition to those proposed or planned by Keystone:

- USEPA and other previous commenters have recommended consideration of ground-level inspections as an additional method to detect leaks. The PHMSA report (2007) on leak detection presented to Congress noted that there are limitations to visual leak detection, whether the visual inspection is done aerially or at ground-level. A limitation of ground-level visual inspections as a method of leak detection is that pipeline leaks may not come to the surface on the ROW and patrolling at ground level may not provide an adequate view of the surrounding terrain. A leak detection study prepared for the Pipeline Safety Trust noted: "A prudent monitor of a pipeline ROW would look for secondary signs of [spills] such as vegetation discoloration or oil sheens on nearby land and waterways on and off the ROW" (Accufacts 2007). PHMSA technical staff concurred with this general statement and noted that aerial inspections can provide a more complete view of the surrounding area that may actually enhance detection capabilities. Also, Keystone responded to a data request from the U.S. Department of State (the Department) concerning additional ground-level inspections and expressed concerns that frequent ground-level inspection may not be acceptable to landowners because of the potential disruption of normal land use activities (e.g., farming, animal grazing). Although widespread use of ground-level inspections may not be warranted, in the start-up year it is not uncommon for pipelines to experience a higher frequency of spills from valves, fittings, and seals. Such incidences are often related to improper installation or defects in materials.
- Dust suppression chemical runoff could adversely impact sensitive areas and areas of high water quality present in the proposed Project area. Many of these chemicals are salts of various formulations. Overuse could cause potential localized degradation of groundwater quality where groundwater is near the surface. Part 2.14 of the Revised CMRP mentions the use of calcium chloride as an element of the proposed Project's dust control program with its application limited to roads only. Water-only dust suppression applications near sensitive surface and ground water resources would provide additional protection for these sensitive resources and eliminate the need for salt-based compounds in these areas. Additional protective measures may be required by the appropriate regulating agencies.
- This proposed Project could require authorization under the NDEQ National Pollutant Discharge Elimination System Construction Storm Water General Permit. Conditions of this permit may require modifications to the stabilization of disturbed ground procedure(s) as

discussed within the CMRP. Namely, the Construction Storm Water General Permit requires that ground inactive for 14 days be stabilized (either permanent or temporary stabilization) where National Pollutant Discharge Elimination System permit conditions would supersede any state-level regulation that is less stringent.

- Keystone has supplied a completed HDD design for the Yellowstone River crossing, which accommodates the 100-year CMZ and locates the entry and exit points outside that identified CMZ. Public sources for 100-year CMZ mapping is not readily available for the remaining rivers crossed by the proposed Project. For the stream crossings, designs where 100-year CMZ data does not exist, Keystone referenced available sources including 100-year flood data, conducted additional scour analysis, performed a lateral migration analysis, and reviewed historic aerial imagery to evaluate scour and lateral migration based on the design life of the pipeline (50 years).
- Permitting agencies may require access structures such as culverts and bridges necessary for the proposed Project's long-term operation over regulated waterbodies to meet design and construction conditions that ensure unimpeded fish and aquatic organism passage during the lifetime of the structure. Many recent and reliable engineering manuals provide methods for designing and constructing fish-friendly, road-stream crossings. These methods could be used when road-stream crossings on fish-bearing streams require permitted design.
- For construction camps built along the proposed pipeline route, construction activities and pipeline testing would use water from surface waterbodies, imported water, or groundwater from a local well. Water would be used for drinking, dust suppression, vehicle washing, and other purposes. Water withdrawal from surface waterbodies or wells would need to be permitted and approved by various agencies and water rights owners. There are currently plans for four construction camps in Montana, three in South Dakota, and one camp in Nebraska. Waterbodies with habitats and species sensitive to or potentially impacted by flow reductions would be thoroughly analyzed to prevent adverse effects.

4.3.5 Connected Actions[14]

4.3.5.1 Bakken Marketlink Project

Groundwater

No significant large-scale potable water aquifers underlie the Bakken Marketlink Project area, although alluvium is likely present that contains potable groundwater. The Upper Cretaceous Hells Creek/Fox Hills Aquifer of the NGPAS underlies the area, but water quality in this area of the aquifer is relatively saline. Larger potable water aquifers within recent alluvium are present within several miles to the east and west of the Bakken Marketlink Project area, and Lower Tertiary rocks of the NGPAS containing potable water are present within a few miles west of the western terminus of the Bakken Marketlink Project area (Whitehead 1996, LaRocque 1966). Well depths are also typically greater than 50 feet. Because of the limited amount of potable water that would be directly beneath the Bakken Marketlink Project area and the significant

[14] Connected actions are those that 1) automatically trigger other actions which may require environmental impact statements, 2) cannot or will not proceed unless other actions are taken previously or simultaneously, 3) are interdependent parts of a larger action and depend on the larger action for their justification.

depth to groundwater in this area, it is not likely that releases would significantly impact groundwater resources in the area (see Sections 3.3.2, Groundwater, and 4.3.3.1, Groundwater, for additional discussion of the NGPAS).

Surface Water

Construction and operation of the Bakken Marketlink Project would include metering systems and three new storage tanks near Baker, Montana. Based on a GIS analysis of the planned route and intersections with waterbodies identified in the 2012 NHD, the preliminary Bakken Marketlink Project route would cross seven intermittent waterbodies as well as one perennial waterbody, Sandstone Creek, which has beneficial uses listed in the MDEQ Final Water Quality Integrated Report (MDEQ 2012).

The property proposed for the Bakken Marketlink Project facilities near the proposed Project PS-14 is currently used as pastureland and hayfields. A site inspection of the property indicated that there were no waterbodies or wetlands on the property. The potential impacts associated with expansion of the pump station site, to include the Bakken Marketlink Project facilities, would likely be similar in scope and duration to the proposed Project. The Bakken Marketlink Project pipeline construction and operations would also likely be similar in scope and duration to those of the proposed Project.

4.3.5.2 Big Bend to Witten 230-kV Transmission Line

Groundwater

Groundwater along the alignment of the Big Bend to Witten 230-kV Transmission Line is present primarily in recent alluvium of the White and Missouri Rivers and in Quaternary glacial deposits near the Missouri River. Groundwater is typically present at depths of less than 50 feet bgs in these unconsolidated deposits. The deposits overlie the Cretaceous Pierre Shale, which is a regional aquitard. Water-bearing units of the GPA and WIPA beneath the Pierre Shale are typically saline and not used for drinking water or irrigation purposes.

Potential impacts to groundwater resources related to the installation and operation of the Big Bend to Witten 230-kV Transmission Line are expected to be limited to small-scale refined petroleum product releases related to vehicle operations and fueling. Hydrogeologic conditions and fate and transport of releases would be similar to conditions described for alluvial aquifers in the proposed pipeline area.

Surface Water

The Big Bend to Witten 230-kV electrical transmission line would cross three perennial streams along the preferred route (see Appendix J, Basin Electric Big Bend to Witten 230-kV Transmission Project Routing Report). Potential impacts to crossings of surface water resources would be minimized by spanning them entirely. Transmission project construction would use a typical span length ranging from 650 to 950 feet. The largest perennial waterbody crossed is the White River, which has a maximum waterbody width of 570 feet.

In addition, the transmission line would run parallel to and within 100 feet of perennial and intermittent streams for a cumulative distance of 28,000 feet. As determined by permitting agencies, an adequate buffer between the transmission line corridor and adjacent surface waters would be needed to minimize continued impacts to surface water features during initial construction and long-term operation and maintenance activities.

4.3.5.3 Electrical Distribution Lines and Substations

Groundwater

Potential impacts to groundwater resources related to the installation and operation of electrical transmission lines associated with the proposed pipeline area are expected to be limited to small-scale refined petroleum product releases related to vehicle operations and fueling during operations and maintenance. Hydrogeologic conditions and fate and transport of releases would be similar to conditions described for the proposed pipeline area adjacent to the planned transmission lines.

Surface Water

The proposed Project would require electrical service from local power providers for pump stations and other aboveground facilities in Montana, South Dakota, Nebraska, and Kansas.

Based on a GIS analysis of the planned locations for electrical lines, substations, and intersections with waterbodies identified in the 2012 NHD, there would be a total of 217 waterbodies crossed in Montana; of that total, Duck Creek is the only waterbody classified as perennial: 192 waterbodies are intermittent, 13 are canals/ditches, and 12 are unidentified waterbodies. Using the same GIS comparison, there would be a total of 250 waterbodies crossed in South Dakota. Of the total, 16 are perennial, 218 are intermittent, and 16 are unidentified waterbodies. In Nebraska, there would be an approximate total of 281 waterbodies crossed. These include 31 perennial, 237 intermittent, and 13 unidentified waterbodies. The existing Keystone pump station facilities in Kansas would need new electrical transmission distribution lines installed. Westar has supplied a route design for the transmission line between Osage Road and Redwood Road for the Keystone PS-27 (Riley pump station) in Clay County Kansas. This segment crosses one perennial and one intermittent waterbody. The design indicates appropriate avoidance of surface water impacts associated with pole locations and access ways.

There is no information provided regarding the locations of poles or other on-the-ground features associated with the remaining Kansas pump station transmission routes that could impact the waterbodies identified above; however, effects on surface waters are expected to be limited based on permitting requirements and generally accepted practices used during the construction of distribution lines. These lines typically span surface waterbodies; equipment crossings are likely to use existing access or temporary crossings; and standard construction erosion controls are employed to limit sedimentation, similar to methods that would be used for the proposed pipeline.

Poles placed in effective and designated floodplain areas have the potential to snag and collect debris being conveyed by flood water. Poles in these locations would be inspected to remove any accumulated debris as necessary following flood subsidence. Obstructions in the floodplain have the potential to induce scour and sedimentation; however, based on typical sizing and spacing of poles, the affects to the environment are considered negligible.

4.3.6 References

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