3.3 WATER RESOURCES

Groundwater and surface water resources that could be potentially impacted by the proposed Project are described in this section. These potentially impacted water resources adjacent to the proposed pipeline route include major aquifers, wells, streams and rivers that would be crossed, and reservoirs and large lakes downstream of these crossings. In addition to their description, an evaluation of potential impacts to water resources from the construction and operation of the pipeline and mitigating measures to minimize impacts is provided.

3.3.1 Environmental Setting

3.3.1.1 Groundwater

Major aquifers and wells in the vicinity of the proposed Project route are described in the following sections by state. Available water quality information for the aquifers described in each state is presented in Table 3.3.1-1. Literature (Libmeyer 1985, Swenson and Drum 1955, Smith et al 2000, La Rique 1966, Whitehead 1996, Rich 2005, Hammond 1994, Cripe and Barari 1978, Newport and Krieger 1959, Stanton and Qi 2006, Ryder 1996, Carr and Marcher 1977, Ryder and Ardis 2002) indicates that, in general, water from these aquifers is not contaminated. Table 3.3.1-2 lists the locations beneath the proposed right-of-way (ROW) where water-bearing zones are expected to be present at less than 50 feet below ground surface (bgs). In addition to the locations presented in Table 3.3.1-2, all floodplains with flowing rivers are likely to have water-bearing zones less than 50 feet bgs.

TABLE 3.3.1-1
Groundwater Quality of Select Subsurface Aquifers

Aquifer	State	County	TDS (mg/L)	Other Water Quality Information
Judith River Formation[1]	MT	Phillips, Valley	500-10,000	Sodium chloride rich in Valley County
Missouri River Alluvium[2]	MT	Valley	800-2,700	NA
Hells Creek/Fox Hills[2]	MT	McCone	500-1,800	Sodium bicarbonate rich
Fox Hills[3]	MT	Dawson, Prairie, Fallon	500-2,500	Sodium bicarbonate rich
Fort Union[3]	MT	McCone, Dawson, Prairie, Fallon	500-5,000	Sodium bicarbonate rich
Yellowstone R. Alluvium[4]	MT	Dawson, Prairie, Fallon	1,000-1,500	Calcium bicarbonate rich
Hells Creek/Fox Hills[5]	SD	Harding, Perkins, Meade	1,000-3,000	Sodium bicarbonate rich
Ogallala [5,6]	SD	Tripp	<500	Sodium bicarbonate rich
Pleistocene River Terrace[7]	SD	Tripp	30-4,000	NA
White River Alluvium[8]	SD	Tripp	287-688	Sodium bicarbonate rich
Ogallala[9]	NE	Keya Paha	100-250	NA
Sand Hills aquifer[10]	NE	Rock-Greely	<500	NA
North Canadian River Alluvium and Terrace[11]	OK	Seminole	<500	Calcium bicarbonate rich
Red River Alluvium[11]	OK	Bryan	1,000-2,000	
Central Oklahoma[12]	OK	Lincoln	<500 (in upper 200 ft)	Calcium magnesium bicarbonate
Ada-Vamoosa[11]	OK	Osage-Pontotoc	<500	Sodium chloride; Sulfate
Arbuckle-Simpson[11]	OK	Coal-Pontotac	<500	Calcium bicarbonate rich
Trinity-Antlers[11]	OK/TX	Bryan, Atoka, Fannin	300-1,500	NA
Texas Coastal Uplands[13]	TX	Hopkins-Angelina	500-1,000	NA

TDS: total dissolved solids

mg/L: milligrams per liter

[1] Libmeyer 1985, [2] Swenson and Drum 1955, [3] Smith et al. 2000, [4] La Rique 1966, [5] Whitehead 1996, [6] Rich 2005, [7] Hammond 1994, [8] Cripe and Barari 1978, [9] Newport and Krieger 1959, [10] Stanton and Qi 2006, [11] Ryder 1996, [12] Carr and Marcher 1977, [13] Ryder and Ardis 2002.

TABLE 3.3.1-2 Water-Bearing Zones Less Than 50 Feet below Ground Surface beneath the Proposed ROW for the Project			
State/County	**Approximate Milepost or Range**	**Approximate Depth to Groundwater (feet bgs)[1]**	**Formation/Aquifer**
Steele City Segment			
Montana			
Phillips	2	8	Cretaceous Bearpaw Shale
Phillips	6	0	Cretaceous Bearpaw Shale
Valley	25-26	<50	Frenchman Creek alluvium
Valley	27	0-45	Late-Cretaceous Judith River Formation
Valley	38-41	0-9	Rock Creek glacial/allluvial sediments
Valley	47	6	Late-Cretaceous Judith River Formation
Valley	55-57	40-43	Late-Cretaceous Bearpaw Shale and Bugg Creek alluvium
Valley	66-72	7-63	Cherry Creek glacial/alluvial sediments
Valley	77-85	10-40	Porcupine Creek and Milk River alluvium
Valley	88	7-22	Milk River/Missouri River alluvial sediments
McCone	94	15	Late-Cretaceous Fox Hills Formation
McCone	99	26	Late-Cretaceous Hells Creek Formation
McCone	109	0	Late-Cretaceous Hells Creek Formation
McCone	119	20-30	Fort Union sands and Flying Creek alluvium
McCone	122-123	<50	Figure Eight Creek alluvium
McCone	133-153	10-45	Fort Union sands; Redwater River alluvium; Buffalo Creek alluvium; glacial drift
Dawson	159-160	10-50	Fort Union sands
Dawson	166-180	10-45	Clear Creek alluvium
Dawson	186-195	4-38	Clear Creek alluvium; Yellowstone River alluvium
Prairie	201-205	0-15	Cabin Creek alluvium
Prairie	209-214	18-40	Alluvium of merging creeks
Fallon	227	<50	Dry Fork alluvium
Fallon	231-234	0	Glacial drift/alluvium
Fallon	235-238	18-45	River alluvium of Dry Creek and its tributaries
Fallon	242-250	5-26	Sandstone Creek and Butte Creek alluvium
Fallon	257-262	0-37	Hidden Water Creek; Little Beaver Creek alluvium
Fallon	264-272	0	Creek alluvium
Fallon	275-279	0	Coal Bank Creek alluvium
Fallon	281-282	<50	Box Elder Creek alluvium
South Dakota			
Harding	289-290	<50	Shaw Creek alluvium
Harding	291-292	<50	Missouri River alluvium

TABLE 3.3.1-2 Water-Bearing Zones Less Than 50 Feet below Ground Surface beneath the Proposed ROW for the Project			
State/County	**Approximate Milepost or Range**	**Approximate Depth to Groundwater (feet bgs)[1]**	**Formation/Aquifer**
Harding	298-301	<50	Various creeks -alluvium
Harding	304-306	<50	Ione Creek alluvium
Harding	317-319	15-40	South Fork of Grand River alluvium
Harding	322-324	<50	Buffalo Creek/Clarks Fork Creek alluvium
Harding	329	<50	Squaw Creek alluvium
Harding	339	20	Red Creek alluvium
Harding	351-355	<50	Moreau Creek alluvium
Meade	380-387	15-45	Tertiary or alluvial
Meade	390-394	25	Tertiary or alluvial
Meade	399	18	Sulphur Creek alluvium
Meade	403-404	14-44	Spring Creek alluvium
Meade	407-408	14	Red Owl Creek alluvium
Meade	411	3	Sampson Creek alluvium
Meade	425	5	Cheyenne River alluvium
Pennington	432-437	<50	Alluvial
Pennington	442	12	Alluvial
Haakon	475	37	Alluvial
Haakon	478-481	14-25	Bad Creek alluvium
Jones	518-519	6	Alluvial
Lyman	535-536	6	White Creek alluvium
Tripp	539	23	Tertiary Ogallala
Tripp	561-564	3-9	Tertiary Ogallala
Tripp	570 -595	6-25	Tertiary Ogallala
Nebraska			
Keya Paha	597-600	<50	Keya Paha River alluvium
Keya Paha	603-616	<50	Sandhills Dune Sand and Tertiary Ogallala aquifer
Keya Paha	613-614	<50	Niobrara River alluvium
Holt/Garfield/Rock	624-675	<50	Sandhills Dune Sand with flowing wells, groundwater seeps, and shallow lakes
Wheeler	692-697	<50	Cedar River alluvium
Nance	726-729	<50	South Branch Timber River alluvium
Nance/Merrick	737-757	26-55	Platte River floodplain alluvium
York	778-779	<50	Beaver Creek alluvium
York	788-789	26-90	West Fork of Big Blue River alluvium
Fillmore/Saline	807-822	<50	South Fork of Turkey Creek alluvium
Jefferson	834-836	22-50	South Fork of Swan Creek alluvium

TABLE 3.3.1-2 Water-Bearing Zones Less Than 50 Feet below Ground Surface beneath the Proposed ROW for the Project			
State/County	**Approximate Milepost or Range**	**Approximate Depth to Groundwater (feet bgs)[1]**	**Formation/Aquifer**
Jefferson	847	<50	Tributary to Big Creek alluvium
Gulf Coast Segment			
Oklahoma			
Lincoln	1-4	0	Wildhorse River alluvium
Lincoln	19-20	0	Uchee Creek alluvium
Okfuskee	22-25	0	Deep Creek alluvium
Okfuskee	28-29	0	Unnamed creek alluvium
Okfuskee	30-31	0	Unnamed creek alluvium
Okfuskee	33	40	Very High Groundwater sensitivity area
Okfuskee	38-39	47	North Canadian River - Very High Groundwater Sensitivity Area
Okfuskee	43-45	0	Sand Creek alluvium
Okfuskee	47-48	0	Little Wewoka Creek alluvium
Hughes	50-51	0	Wewoka Creek alluvium
Hughes	58-61	0	Wewoka Creek alluvium
Hughes	66-68	0	Bird Creek -Very High Groundwater sensitivity area
Hughes	70-71	0	Little River alluvium
Hughes	74-76	0	Canadian River alluvium
Coal	87-88	0	Muddy River alluvium
Atoka	127-130	0	Boggy Creek alluvium
Bryan	133-134	0	Unnamed creek alluvium
Bryan	145	0	Whitegrass Creek alluvium
Bryan	155-156	0	Red River alluvium
Texas			
Fannin	156-161	<50	Red River alluvium
Lamar	170	<50	Sanders Creek alluvium
Lamar	172	<50	Maxey Creek alluvium
Lamar	187-191	<50	North Sulfur Creek alluvium
Lamar	201-202	<50	South Sulfur Creek alluvium
Hopkins	212-213	<50	Oak Creek alluvium
Hopkins	216-217	<50	Stous Creek alluvium
Franklin	227-228	<50	Unnamed creek alluvium
Wood	256-257	<50	Big Sand Creek alluvium
Upshur	260-263	<50	Sabine Creek alluvium
Cherokee	297-301	<50	Striker Creek alluvium

TABLE 3.3.1-2 Water-Bearing Zones Less Than 50 Feet below Ground Surface beneath the Proposed ROW for the Project			
State/County	**Approximate Milepost or Range**	**Approximate Depth to Groundwater (feet bgs)[1]**	**Formation/Aquifer**
Rusk	308-313	<50	East Fork Angelina Creek alluvium
Nacogdoches	330-336	<50	Angelina Creek floodplain alluvium
Trinity	345-346	<50	Neches River alluvium
Trinity	350-353	<50	Neches River alluvium
Polk	360-369	<50	Neches River alluvium
Polk	374-375	<50	Bear Creek alluvium
Polk	380	<50	Unnamed creek alluvium
Polk	400-406	<50	Turkey Creek alluvium
Liberty	412-431	<50	Middle Pleistocene sand/silt along Trinity River
Liberty	432-446	<50	Willow Creek/Pine Creek floodplain alluvium
Jefferson	448-480	<50	Late Pleistocene mud/silt in floodplains of various rivers that coalesce.
Houston Lateral			
Texas			
Jefferson	1-18	<50	Late Pleistocene clay/mud in Trinity River floodplain.
Jefferson	19-23	<50	Floodplain of Trinity River
Jefferson	24-42	<50	Late Pleistocene clay/mud/silt
Jefferson	43-45	<50	San Jacinto River floodplain
Jefferson	46-48	<50	Late Pleistocene clay/mud.

[1] bgs = below ground surface; based on available well data.

Keystone 2009.

Note: Mileposting for each segment of the Project starts at 0.0 at the northernmost point of each segment, and increases in the direction of oil flow.

Montana

Aquifers

The proposed pipeline route is present in the Great Plains physiographic province in Montana (Thornbury 1965). Regionally, aquifers beneath the proposed route are part of the Northern Great Plains aquifer system (Whitehead 1996). In Montana, aquifers consist of unconsolidated alluvial and/or glacial aquifers, lower Tertiary-aged aquifers, and upper Cretaceous-aged aquifers. Groundwater resources along alternate pipeline routes considered in Montana are described in Appendix I.

In northern Montana, in Phillips and Valley counties, glacial till is present up to 100 feet thick. The till is relatively impermeable and acts as a confining layer above the Cretaceous-aged Judith River Formation and Clagett Formation (Whitehead 1996). The Judith River Formation water table is present at approximately 150 to 500 feet bgs. Wells typically yield 5 to 20 gallons per minute (gpm). Additionally, the glacial till contains local permeable zones of coarse glacial outwash less than 50 feet bgs that provide

irrigation water. Most groundwater use in Valley County comes from shallow alluvial aquifers along major river drainages such as the Milk River and Missouri River (Whitehead 1996).

In McCone County, the proposed route crosses the upper-Cretaceous Hells Creek/Fox Hills aquifer and the lower Tertiary Fort Union aquifer. Permeable sandstones of the Hells Creek/Fox Hills aquifer yield 5 to 20 gpm; most wells are drilled to depths of 150 to 500 feet bgs (Whitehead 1996). The lower Tertiary Fort Union aquifer consists of interbedded sandstones, mudstones, shale, and coal seams. Water-bearing zones are found in the sandstone layers. The aquifer is confined in most areas. Well yields are typically 15 to 25 gpm; most wells are drilled to depths of 50 to 300 feet bgs (Libmeyer 1985); water depths typically range from 100 to 150 feet bgs (Swenson and Drum 1955).

Beneath the proposed route in Dawson, Prairie, and Fallon counties lies the Lower Yellowstone aquifer system which contains groundwater in the lower Tertiary Fort Union Formation. In this area, the Fort Union Formation is a shallow bedrock aquifer that is used as a groundwater resource in these three counties. The Yellowstone River contains abundant alluvial material along its banks which contain shallow aquifers that are often used for water supply. Well yields in the shallow aquifers along the Yellowstone River range from 50 to 500 gpm (LaRique 1966). Additionally, shallow alluvial aquifers are also present at stream crossings including Clear Creek, Cracker Box/Timber Creek, Cabin Creek, Sandstone Creek, and Butte Creek.

The proposed pipeline project route does not cross any sole-source aquifers in Montana, as designated by EPA Region 8 (EPA 2009).

Wells

No public water supply (PWS) wells or source water protection areas (SWPA) are located within 1 mile of the centerline of the pipeline in Montana (Keystone 2008). A total of eight private water wells are located within approximately 100 feet of the proposed pipeline route within McCone, Dawson, Prairie, and Fallon counties (Keystone 2008).

South Dakota

Aquifers

Similar to Montana, the proposed pipeline route is present in the Great Plains physiographic province in South Dakota (Thornbury 1965). Regionally, aquifers beneath the proposed route are part of the Northern Great Plains aquifer system (Whitehead 1996).

The proposed route crosses the upper-Cretaceous Fox Hills and Hells Creek aquifers (portion of the Northern Great Plains aquifer system) in Harding, Perkins, and Meade counties. The town of Bison uses groundwater from the Fox Hills aquifer for its water supply. These municipal wells are 565 to 867 feet deep and yield up to 50 gpm (Steece 1981). Shallow alluvial aquifers are also present at stream crossings including Little Missouri River, South Fork Grand River, Clarks Fork Creek, Moreau River, Sulphur Creek, Red Owl Creek, and Cheyenne River.

In Haakon, Jones, and Lyman counties major water-producing aquifers are not present. The proposed route is underlain by the upper-Cretaceous Pierre Shale which is not an aquifer. The floodplains of the Bad River and the White River contain shallow alluvial aquifers that are used for water supply.

In southern South Dakota, the proposed route is underlain by the northern portion of the High Plains aquifer and contains Tertiary-aged aquifers and Pleistocene-aged river terrace aquifers (Whitehead 1996).

Tertiary-aged aquifers include the Ogallala, Arikaree, and White River aquifers. The Valentine Formation of the Ogallala aquifer is the water-bearing unit; depth to ground water is typically 10 to 70 feet bgs (Hammond 1994) with wells yielding 250 to 750 gpm. The Arikaree aquifer contains similar properties to the Ogallala, while the White River aquifer has limited yield.

The proposed pipeline route does not cross any sole-source aquifers in South Dakota, as designated by EPA Region 8 (EPA 2009).

Wells

One PWS well (associated with the Colome SWPA) is identified within 1 mile of the centerline of the pipeline in Tripp County (Keystone 2008). This PWS wells is screened at relatively shallow depth (reportedly less than 54 feet bgs) within the Tertiary Ogallala aquifer. The Project would pass through the Colome SWPA in Tripp County. No private water wells are located within approximately 100 feet of the proposed pipeline route in South Dakota (Keystone 2008).

Nebraska

Aquifers

The proposed route would cross the underlying Northern High Plains aquifer. The Northern High Plains aquifer supplies 78 percent of the public water supply and 83 percent of irrigation water in Nebraska (Emmons and Bowman 1999). Five main members of the aquifer would be crossed by the proposed route. Shallow alluvial aquifers are also crossed by the proposed pipeline route.

In Keya Paha County (northern Nebraska), the proposed route crosses the Tertiary-aged Brule aquifer and the Ogallala aquifer. The Brule aquifer does not yield appreciable water, however the Ogallala aquifer in this area is a major source of water. Wells yield 100 to 250 gpm (Newport and Krieger 1959). Alluvial aquifers are also present at the Keya Paha River and the Niobrara River. The Niobrara River is used as a source of irrigation and municipal water supply (Keystone 2008).

From Rock through Greely counties, the project route is underlain by the Sand Hills and Ogallala aquifers. The Sand Hills aquifer typically has a shallow water table less then 30 feet bgs and is therefore a potential concern (Stanton and Qi 2006). Alluvial aquifers are also present along the Elkhorn River and its tributaries and the Cedar River (Keystone 2008).

Beneath Nance, Merrick, and Hamilton counties, the project route leaves the Sand Hills aquifer and is again underlain by the Ogallala aquifer to the Loup River. From the Loup River to the Platte River, the project route is underlain by the Platte River Valley aquifer system. Shallow aquifers crossed by the proposed Project include the alluvial aquifer of the South Branch Timber Creek, the alluvial aquifer of the Loup River (used for irrigation and domestic water supply), and the alluvial aquifer of the Platte River Valley (used for irrigation, domestic, and municipal water supply) (Keystone 2008).

South of the Platte River, the proposed route crosses the Eastern Nebraska glacial drift aquifer, used for irrigation, domestic, and municipal water supply. Hordville's public water supply comes from wells screened within this aquifer from 160 to 262 feet bgs (Keech 1962).

From York to Jefferson counties, the proposed route crosses the Quaternary glacial drift aquifer of eastern Nebraska (Stanton and Qi 2006). The depth to groundwater is on average 80 feet bgs. Additionally, the project route crosses alluvial aquifers along Beaver Creek, the West Fork of the Big Blue River, and the alluvial floodplain of the South Fork Turkey Creek.

The proposed pipeline route does not cross any sole-source aquifers in Nebraska, as designated by EPA Region 7 (EPA 2009).

Wells

Eight PWS wells are present within 1 mile of the centerline of the proposed route in Hamilton, York, Filmore, Saline, and Jefferson counties (Keystone 2008). The proposed route would not however pass through any identified PWS wellhead protection areas. SWPAs within 1 mile of the Project include those for the towns of Ericson, Hordville, McCool Junction, Exeter, Steele City and the Rock Creek State Park. Additional SWPAs within 1 mile of the Project include those mapped in Hamilton County near Milepost (MP) 772 and York County near MP 781 and 783. A total of 29 private water wells are located within approximately 100 feet of the proposed pipeline route within Greeley, Merrick, Hamilton, York, Fillmore, and Jefferson counties (Keystone 2008).

Kansas

Construction planned in Kansas as part of the proposed Project comprises two new pump stations and appurtenant facilities, such as access roads located in Clay and Butler counties at MP 899 and MP 994, respectively. There are no expected impacts to groundwater resources associated with these activities in Kansas.

Oklahoma

Aquifers

The majority of water supply in eastern Oklahoma comes from shallow alluvial and terrace aquifers (Ryder 1996). Alluvial aquifers are located within the floodplains of major rivers and terrace aquifers are present in historical floodplain terraces. Alluvial aquifers contain a shallow unconfined water table while terrace aquifers typically contain a water table depth of 30 to 50 bgs (Ryder 1996). Major rivers and floodplains that contain these aquifers include the North Canadian River and Red River at the state's southern border. Well yields for these aquifers are up to 500 gpm (Ryder 1996).

Deeper bedrock aquifers include the Central Oklahoma (sometimes referred to as the Garber-Wellington aquifer), the Ada-Vamoosa aquifer, and the Trinity or Antlers aquifer. The Central Oklahoma aquifer consists of confined and unconfined formations. Well yields range from 70 to 475 gpm (Carr and Marchur 1977) and well depths can be as shallow as 20 feet bgs but are also screened at depths up to 1,000 feet bgs. This aquifer lies adjacent to the west of the proposed route in central Oklahoma. The Ada-Vamoosa aquifer is present beneath the proposed route from Osage to Pontotoc counties and is composed of sandstone and interbedded shale. Wells typically yield 25 to 150 gpm and are used for domestic supply (Ryder 1996). The Trinity-Antlers aquifer is located beneath the Red River at the state line between Oklahoma and Texas. In Atoka County, the aquifer is present in Cretaceous-aged sandstone and is unconfined; the aquifer is confined beneath Bryan County to the state border. Water is used for domestic, irrigation, commercial and public water supply (Ryder 1996).

Although the proposed pipeline route does not cross any sole-source aquifers in Oklahoma, the route would pass to the east of the Arbuckle-Simpson aquifer, a designated sole-source aquifer by EPA Region 6 (EPA 2009). The Arbuckle-Simpson aquifer underlies the Arbuckle Mountains and Arbuckle Plains in south central Oklahoma and is composed of sandstone and interbedded shale (Ryder 1996). Water is present to depths up to 3,000 feet bgs and wells typically yield 100 to 500 gpm.

Wells

Within 1 mile of the proposed pipeline route in Hughes, Coal, and Bryan counties, 28 PWS wells are present (Keystone 2008). The number of private water wells located within 100 feet of the proposed pipeline route in Oklahoma is unknown.

Texas

Aquifers

Three principal aquifers are present beneath the Project route, including the Trinity aquifer located south of the Red River at the state line, the Texas Coastal Uplands aquifer system from Hopkins County to the Neches River in Angelina County, and the Texas Coastal Lowlands aquifer system from Polk to Jefferson counties (Ryder 1996). These aquifer systems are composed of multiple aquifers that are described below.

The Trinity aquifer consists of Cretaceous-aged sandstone, siltsone, clay, conglomerate, shale, and limestone. Wells yield 50 to 500 gpm and wells are typically 50 to 800 feet deep (Ryder 1996). Water is used for domestic and agricultural use.

The Texas Coastal Uplands aquifer system consists of two main aquifers: the Paleocene/Eocene Carrizo-Wilcox aquifer and the Eocene Claiborne aquifer, which is situated above the Carrizo Wilcox aquifer. Both aquifers consist of sand, silt, gravel, and clay and are used extensively for agricultural irrigation, domestic, municipal, and industrial water supply (Keystone 2008).

From Polk County to the southern extent of the proposed route, the ROW is present above the Texas Coastal Lowlands aquifer system. The three main aquifers in this system are the Miocene Jasper aquifer, overlain by the late Tertiary Evangeline, which is overlain by the Quaternary Chicot aquifer (Ryder 1996). The Evangeline and Chicot aquifers are used extensively for water supply in this area.

The proposed pipeline route does not cross any sole-source aquifers in Texas, as designated by EPA Region 6 (EPA 2009).

Wells

Within 1 mile of the proposed Gulf Coast Segment pipeline route in Lamar, Wood, Smith, Rusk, Nacogdoches, Angelina, Polk, and Liberty counties, 53 PWS wells are present. Within 1 mile of the proposed Houston Lateral pipeline route, 145 PWS wells are present in Liberty and Harris counties (Keystone 2008). The Project would pass within 1 mile of 36 SWPAs in Texas. A total of three private water wells are located within approximately 100 feet of the proposed pipeline route within Smith and Chambers counties.

3.3.1.2 Surface Water

Surface water resources that would be crossed by the proposed Project are located within three water resource regions (Seaber et al. 1994):

- Missouri River Region (Montana, South Dakota, Nebraska, and northern Kansas);
- Arkansas-White-Red Rivers Region (southern Kansas, Oklahoma, and northern Texas); and
- Texas-Gulf Rivers Region (Texas).

Stream and river crossings are described below by state. Additionally, reservoirs and larger lakes that are present within 10 miles downstream of these crossings are listed in Appendix E. Levees, water control structures, and flood protection structures along the proposed route are also presented in Appendix E.

Montana

Waterbodies Crossed

As presented in Appendix E, 389 waterbody crossings would occur in Montana along the proposed Project route. Of the 389 crossings 20 are perennial streams, 107 are intermittent streams, 243 are ephemeral streams, 15 are canals, and 4 are reservoirs. Based on stream width, adjacent topography, adjacent infrastructure, and sensitive environmental areas, Keystone proposes that three rivers in Montana would be crossed using the horizontal directional drill (HDD) method. These rivers include:

- Milk River in Valley County (approximately 100 feet wide, MP 83);
- Missouri River in Valley and McCone counties (approximately 1,000 feet wide, MP 89); and
- Yellowstone River in Dawson County (approximately 780 feet wide, MP 196).

The remaining 386 waterbodies would be crossed using one of several non-HDD methods described in the Construction, Mitigation, and Reclamation (CMR) Plan (Appendix B). The crossing method for each waterbody would be depicted on construction drawings but would ultimately be determined based on site-specific conditions at the time of crossing. Surface water resources along alternate pipeline routes considered in Montana are described in Appendix I. Several route variations have been suggested to either reduce impacts at a crossing or to address landowner concerns. These are also summarized in Appendix I of the DEIS.

Sensitive or Protected Waterbodies

The following streams and rivers that would be crossed by the proposed Project route in Montana contain state water quality designations or use designations (Appendix E). These waterbodies include:

- Dunham Coulee and Corral Coulee, in Phillips County
- Missouri River, Frenchman Creek, East Fork Cache Creek, Hay Coulee, Rock Creek, Willow Creek, Lime Creek, Brush Fork, Bear Creek, Unger Coulee, Buggy Creek, Alkali Coulee, Wire Grass Coulee, Spring Creek, Mooney Coulee, Cherry Creek, Spring Coulee, East Fork Cherry Creek, Lindeke Coulee, Espeil Coulee, and Milk River in Valley County
- West Fork Lost Creek, Lost Creek, Shade Creek, Jorgensen Coulee, Cheer Creek, Bear Creek, South Fork Shade Creek, Flying V Creek, Figure Eight Creek, Middle Fork Prairie Elk Creek, East Fork Prairie Elk Creek, Lone Tree Creek, Tributary to West Fork Lost Creek, Redwater Creek, and Buffalo Springs Creek in McCone County
- Cottonwood Creek, Berry Creek, Hay Creek, Upper Seven Mile Creek, Clear Creek, Cracker Box Creek, Side Channel Yellowstone River, and Yellowstone River in Dawson County
- Cabin Creek, West Fork Hay Creek, and Hay Creek in Prairie County
- Dry Fork Creek, Pennel Creek, Sandstone Creek, Red Butte Creek, Hidden Water Creek, Little Beaver Creek, Soda Creek, North Fork Coal Bank Creek, South Fork Coal Bank Creek, and Boxelder Creek in Fallon County

Several of these waterbodies would be crossed more than once. The waterbodies crossed by the Project that have state water quality classification are presented in Table 3.3.1.2-1.

TABLE 3.3.1.2-1
Sensitive or Protected Waterbodies in Montana Crossed More than Once

Waterbody Name	Type	Number of Crossings
Corral Coulee	Intermittent/Ephemeral*	5
Cheer Creek	Ephemeral	2
Bear Creek	Ephemeral	2
Shade Creek	Intermittent	3
Flying V Creek	Intermittent/Ephemeral*	2
Buffalo Springs Creek	Perennial/Intermittent*	3
Cabin Creek	Perennial	2
Dry Fork Creek	Perennial/Ephemeral*	5
Soda Creek	Intermittent	2

*In some cases, the stream type may change between crossings.

Impaired or Contaminated Waterbodies

Contamination has been documented in 11 sensitive or protected waterbodies in Montana (Keystone 2008) (Appendix J). Contamination in these waterbodies includes unacceptable levels of at least one of the following parameters: iron, fecal coliform, lead, mercury, phosphorous, total kjeldahl nitrogen (TKN), dissolved oxygen, total dissolved solids, nitrate/nitrite. Impairments in these waterbodies include fish-passage barriers, sedimentation/siltation, alteration in stream-side or littoral vegetative cover, Chlorophyll-a, dissolved oxygen, low flow alteration, and physical substrate habitat alteration.

TABLE 3.3.1.2-2
Impaired or Contaminated Waterbodies in Montana

Waterbody Name	Impairment or Contamination
Frenchman Creek	Alteration in stream-side or littoral vegetative cover; Chlorophyll-a; Low flow alterations
Buggy Creek	Iron
Cherry Creek	Iron
Milk River	Fecal Coliform; Lead; Mercury
Missouri River	Alteration in stream-side or littoral vegetative cover; Other flow regime alterations; Temperature, water
Middle Fork Prairie Elk Creek	Alteration in stream-side or littoral vegetative cover; Phosphorus (Total); Physical substrate habitat alterations; Total Kjehidahl Nitrogen (TKN)
East Fork Prairie Elk Creek	Alteration in stream-side or littoral vegetative cover; Phosphorus (Total); Physical substrate habitat alterations; TKN
Yellowstone River	Fish-passage barrier
Cabin Creek	Oxygen, Dissolved; Sedimentation/Siltation; TKN
Pennel Creek	Total Dissolved Solids
Sandstone Creek	Nitrate/Nitrite (Nitrite + Nitrate as N); TKN

Keystone 2009.

Water Supplies

Along the proposed ROW in Montana, municipal water supplies are largely obtained from groundwater sources and are described in Section 3.3.1.1. The proposed ROW would pass within 1 mile downstream of the Cornwell Reservoir (currently breached) at MP 59 and within 1 mile of the Haynie Reservoir at MP 134. These reservoirs, when functional, are used for irrigation and stock watering.

Major waterbodies and reservoirs located within 10 miles downstream of proposed water crossings include Lester Reservoir, Frenchman Reservoir, Reservoir Number Four, Fort Peck Lake, North Dam, Christenson Reservoir, Lindsay Reservoir, Red Butte Dam, and three unnamed reservoirs. The approximate mileposts of these waterbodies and their associated pipeline stream crossings are presented in Appendix E (Keystone 2009). Wetlands areas are addressed in Section 3.4.

South Dakota

Waterbodies Crossed

As presented in Appendix E, 354 waterbody crossings would occur in South Dakota along the proposed Project route. Of the 354 crossings 14 are perennial streams, 125 are intermittent streams, 206 are ephemeral streams, 4 are natural ponds, and 5 are reservoirs. Based on stream width, adjacent topography, adjacent infrastructure, and sensitive environmental areas, Keystone proposes that three rivers in South Dakota would be crossed using HDD method. These rivers include:

- Little Missouri River in Harding County (approximately 125 feet wide, MP 292);
- Cheyenne River in Meade and Haakon County (approximately 1125 feet wide, MP 426); and
- White River in Lyman County (approximately 500 feet wide, MP 535).

The remaining 352 waterbodies would be crossed using one of several non-HDD methods described in the CMR Plan (Appendix B). The crossing method for each waterbody would be depicted on construction drawings but would ultimately be determined based on site-specific conditions at the time of crossing.

Sensitive or Protected Waterbodies

The following streams and rivers that would be crossed by the proposed Project route in South Dakota contain state water quality designations or use designations (Appendix E). These waterbodies include:

- Little Missouri River, South Fork Grand River, and Clark's Fork Creek in Harding County;
- North Fork Moreau River in Butte County;
- South Fork Moreau River in Perkins County;
- Sulfur Creek, and Red Owl Creek in Meade County;
- Cheyenne River in Pennington County;
- Bad River in Haakon County;
- Williams Creek in Jones County; and

- White River in Lyman County.

In addition, all streams in South Dakota are assigned the beneficial uses of irrigation and fish and wildlife propagation, recreation, and stock watering (SDDENR 2008).

Impaired or Contaminated Waterbodies

Contamination has been documented in five of these sensitive or protected waterbodies in South Dakota (Keystone 2008) (Appendix J). Contamination or impairment in these waterbodies includes unacceptable levels of at least one of the following parameters: total suspended solids (TSS), salinity, specific conductance, and fecal coliform.

TABLE 3.3.1.2-3
Impaired or Contaminated Waterbodies in South Dakota

Waterbody Name	Impairment or Contamination
South Fork Grand River	Total Suspended Solids, Salinity
South Fork Moreau River	Specific Conductance
Cheyenne River	Total Suspended Solids, Fecal Coliform
White River	Total Suspended Solids, Fecal Coliform
Ponca Creek	Total Suspended Solids, Fecal Coliform

Keystone 2009.

Water Supplies

Along the proposed ROW in South Dakota, municipal water supplies are largely obtained from groundwater sources and are described in Section 3.3.1.1. The proposed ROW would pass within 1 mile of the Wilson Lake Reservoir at MP 415.

Major waterbodies and reservoirs located within 10 miles downstream of proposed water crossings include Lake Gardner and five unnamed reservoirs. The approximate mileposts of these waterbodies and their associated pipeline stream crossings are presented in Appendix E (Keystone 2009).

Nebraska

Waterbodies Crossed

As presented in Appendix E, 160 waterbody crossings would occur in Nebraska along the Project route. Of the 160 crossings 20 are perennial streams, 52 are intermittent streams, 75 are ephemeral streams, 9 are canals, 1 is a natural pond, and 3 are reservoirs. Based on stream width, adjacent topography, adjacent infrastructure, and sensitive environmental areas, Keystone proposes that five rivers in Nebraska would be crossed using the HDD method. These rivers include:

- Keya Paha River in Keya Paha County (approximately 125 feet wide, MP 598);
- Niobrara River in Keya Paha and Rock County (approximately 1,300 feet wide, MP 614);
- Cedar River in Wheeler County (approximately 100 feet wide, MP696);
- Loup River in Nance County (approximately 900 feet wide, MP 739); and

- Platte River in Merrick County (approximately 1,000 feet wide, MP 754).

The remaining 156 waterbodies would be crossed using one of several non-HDD methods described in the CMR Plan (Appendix B). The crossing method for each waterbody would be depicted on construction drawings but would ultimately be determined based on site-specific conditions at the time of crossing.

Sensitive or Protected Waterbodies

The following streams and rivers that would be crossed by the proposed Project route in Nebraska contain state water quality designations or use designations (Appendix E). Several of these waterbodies would be crossed more than once. These waterbodies include:

- Keya Paha River, Niobrara River, and Spring Creek in Keya Paha County;
- Ash Creek in Rock County;
- North Branch Elkhorn River, South Fork Elkhorn River, Elkhorn River, Holt Creek, and Dry Creek in Holt County;
- Cedar River in Wheeler County;
- South Branch Timber Creek and Loup River in Nance County;
- Prairie Creek, Side Channel Platte River, and Platte River in Merrick County;
- Big Blue River, Lincoln Creek, Beaver Creek, and West Fork Big Blue River in York County;
- Turkey Creek in Filmore County; and
- South Fork Swan Creek and Cub Creek in Jefferson County.

Impaired or Contaminated Waterbodies

Contamination has been documented in five of these sensitive or protected waterbodies in Nebraska (Keystone 2008) (Appendix J). Contamination or impairment in these waterbodies includes unacceptable levels of at least one of the following parameters: *E. coli*, low dissolved oxygen, and atrazine.

TABLE 3.3.1.2-4
Impaired or Contaminated Waterbodies in Nebraska

Waterbody Name	Impairment or Contamination
Keya Paha River	E. coli
Niobrara River	E. coli
Loup River	E. coli
Prairie Creek	Low Dissolved Oxygen
Big Blue River	Low Dissolved Oxygen, May-June atrazine

Keystone 2009.

Water Supplies

Along the proposed ROW in Nebraska, municipal water supplies are largely obtained from groundwater sources and are described in Section 3.3.1.1 (Keystone 2008).

Major waterbodies and reservoirs located within 10 miles downstream of proposed water crossings include Atkinson Reservoir, Chain Lake, Rush Lake, Sininger Lagoon, County Line Marsh, Cub Creek Reservoir 13-C, Cub Lake Reservoir 14-C, Big Indian Creek Reservoir 10-A, Big Indian Creek Reservoir 8-E, an unnamed lake, and four unnamed reservoirs. The approximate mileposts of these waterbodies and their associated pipeline stream crossings are presented in Appendix E (Keystone 2009).

Kansas

Construction planned in Kansas as part of the proposed Project comprises two new pump stations and appurtenant facilities, including transmission lines and access roads located in Clay and Butler counties at MP 899 and MP 994, respectively. There are no expected impacts to surface water resources associated with these activities in Kansas.

Oklahoma

Waterbodies Crossed

As presented in Appendix E, 368 waterbody crossings would occur in Oklahoma along the proposed Project route. Of the 368 crossings, 83 are perennial streams, 137 are intermittent streams, 136 are ephemeral streams, 8 are seasonal, 1 is an artificial path(an artificial path is any man-made or modified flow path), and 3 are unclassified. Based on stream width, adjacent topography, adjacent infrastructure, and sensitive environmental areas, Keystone proposes that six rivers in Oklahoma would be crossed using the HDD method. These rivers include:

- Deep Fork in Creek County (approximately 125 feet wide, MP 23);
- North Canadian River in Okfuskee and Seminole County (approximately 250 feet wide, MP 39);
- Little River in Hughes County (approximately 110 feet wide, MP 70);
- Canadian River in Hughes County (approximately 700 feet wide, MP 75);
- Clear Boggy Creek in Atoka County (approximately 80 feet wide, MP 127); and
- Red River in Bryan County, OK and Fannin County TX (approximately 750 feet wide, MP 155).

The remaining 362 waterbodies would be crossed using one of several non-HDD methods described in the CMR Plan (Appendix B). The crossing method for each waterbody would be depicted on construction drawings but would ultimately be determined based on site-specific conditions at the time of crossing.

Sensitive or Protected Waterbodies

The following streams and rivers that would be crossed by the proposed Project route in Oklahoma contain state water quality designations or use designations (Appendix E). These waterbodies include:

- Red River in Bryan County;
- Bird Creek and Little River in Hughes County;

- Euchee Creek in Lincoln County;
- Little Hilliby Creek in Okfuskee County; and
- Sand Creek, Wewoka Creek, Little Wewoka Creek, and North Canadian River in Seminole County.

Impaired or Contaminated Waterbodies

Contamination has been documented in six of these sensitive or protected waterbodies in Oklahoma (Keystone 2008) (Appendix J). Contamination in these waterbodies includes unacceptable levels of at least one of the following parameters: chloride, Fish bioassessments, TDS, *Enterococcus* spp, *E. coli*, and lead. Impairments in these waterbodies include turbidity and dissolved oxygen.

TABLE 3.3.1.2-5
Impaired or Contaminated Waterbodies in Oklahoma

Waterbody Name	Impairment or Contamination
Canadian River	Enterococcus Bacteria, Lead, Total Dissolved Solids, Turbidity
Euchee Creek	Eschericihia coli, Enterococcus bacteria, Turbidity
Hilliby Creek	Fish bioassessments
Little River	Enterococcus bacteria, Lead, Turbidity
Little Wewoka Creek	Dissolved Oxygen
Sand Creek	Chloride, Total Dissolved Solids

Keystone 2009.

Water Supplies

Along the proposed ROW in Oklahoma, municipal water supplies are largely obtained from groundwater sources and are described in Section 3.3.1.1 (Keystone 2008).

Major waterbodies and reservoirs located within 10 miles downstream of proposed water crossings include Stroud Lake. The approximate milepost of this waterbody and its associated pipeline stream crossings is presented in Appendix E (Keystone 2009).

Texas

Waterbodies Crossed

As presented in Appendix E, 633 waterbody crossings would occur in Texas along the proposed Gulf Coast Segment route, and 20 waterbody crossings would occur along the proposed Houston Lateral route. Of the 633 crossings on the Gulf Coast Segment, 199 are perennial streams, 198 are intermittent streams, 215 are ephemeral streams, 5 are seasonal, 2 are artificial path (an artificial path is any man-made or modified flow path), 9 are canal/ditch, and 5 are unclassified. Of the 20 crossings on the Houston Lateral, 5 are perennial streams, 2 are intermittent streams, 8 are ephemeral streams, 2 are artificial path (an artificial path is any man-made or modified flow path), and 3 are canal/ditch. Based on stream width, adjacent topography, adjacent infrastructure, and sensitive environmental areas, Keystone proposes that 22 waterbodies in Texas would be crossed using the HDD method. These waterbodies include:

Gulf Coast Segment

- Red River in Bryan County, OK and Fannin County TX (approximately 750 feet wide, MP 155)
- Bois d'Arc Creek in Fannin and Lamar counties (approximately 125 feet wide, MP 161)
- North Sulphur River in Lamar and Delta counties (approximately 350 feet wide, MP 190);
- South Sulphur River in Delta and Hopkins counties (approximately 100 feet wide, MP 201);
- White Oak Creek in Hopkins County (approximately 300 feet wide, MP 212);
- Big Cyprus Creek in Franklin County (approximately 75 feet wide, MP 228);
- Waterbody in Wood County (approximately 250 feet wide, MP 254);
- Big Sandy Creek in Upshur County (approximately 180 feet wide, MP 256);
- Sabine River in Upshur and Smith counties (approximately 175 feet wide, MP 262);
- East Fork Angelina River in Rusk County (approximately 50 feet wide, MP 312);
- Angelina River in Nacogdoches and Cherokee counties (approximately 80 feet wide, MP 333);
- Neches River in Angelina and Polk counties (approximately 150 feet wide, MP 367);
- Menard Creek in Liberty County (approximately 50 feet wide, MP 414);
- Neches Valley Canal Authority (approximately 150 feet wide, MP 459);
- Lower Neches Valley Canal Authority in Jefferson County (approximately 150 feet wide, MP 460);
- Willow Marsh Bayou in Jefferson County (approximately 280 feet wide , MP 467);
- Hillebrandt Bayou in Jefferson County (approximately 490 feet wide, MP 471); and
- Port Arthur Canal and Entergy Corridor in Jefferson County (approximately 1700 feet wide, MP 478).

Houston Lateral Segment

- Trinity Creek Marsh in Liberty County (MP 18);
- Trinity River in Liberty County (MP 23);
- Cedar Bayou in Harris County(MP 36); and
- San Jacinto River in Harris County(MP 43).

The remaining 615 waterbodies on the Gulf Coast Segment and 16 waterbodies on the Houston Lateral would be crossed using one of several non-HDD methods described in the CMR Plan (Appendix B). The crossing method for each waterbody would be depicted on construction drawings but would ultimately be determined based on site-specific conditions at the time of crossing.

Sensitive or Protected Waterbodies

The following streams and rivers that would be crossed by the proposed Project route in Texas contain state water quality designations or use designations (Keystone 2008) (Appendix E). Several of these waterbodies would be crossed more than once. These waterbodies include:

Gulf Coast Segment

- Big Sandy Creek in Wood County;
- Big Sandy Creek in Upshur County;
- Angelina River in Cherokee County;
- Angelina River and East Fork Angelina River in Rusk County;
- Angelina River in Nacogdoches County;
- Pine Island Bayou in Hardin County;
- Neches River, Piney Creek, and Big Sandy Creek in Polk County; and
- Hillebrandt Bayou in Jefferson County.

Impaired or Contaminated Waterbodies

Contamination has been documented in 3 of these sensitive or protected waterbodies in Texas (Keystone 2008) (Appendix J). Contamination in these waterbodies includes unacceptable levels of at least one of the following parameters: bacteria, low dissolved oxygen, and lead.

TABLE 3.3.1.2-6
Impaired or Contaminated Waterbodies in Texas

Waterbody Name	Impairment or Contamination
Angelina River above Sam Rayburn Reservoir	Bacteria
Big Sandy Creek	Bacteria
East Fork Angelina River	Bacteria, Lead
Hillebrandt Bayou	Dissolved Oxygen
Hurricane Creek	Bacteria
Jack Creek	Bacteria
Neches River below Lake Palestine	Bacteria, lead
Pine Island bayou	Dissolved Oxygen
Piney Creek	Bacteria, Dissolved Oxygen
Willow Creek	Dissolved Oxygen
Cedar Bayou above Tidal	Bacteria, Benthic Macroinvertebrates
San Jacinto River above Tidal	Dioxin, PCB's

Keystone 2009.

Water Supplies

Along the proposed ROW in Texas, municipal water supplies are largely obtained from groundwater sources and are described in Section 3.3.1.1.

Major waterbodies and reservoirs located within 10 miles downstream of proposed water crossings for the Gulf Coast Segment and the Houston Lateral include Pat Mayse Lake/WMA, proposed George Parkhouse Reservoir, Lake Cypress Springs, Lake Bob Sandlin, proposed Little Cypress Reservoir, Lake Greenbriar,

Prairie Creek Reservoir, Lake Tyler, proposed Lake Columbia, Lake Striker, Drainage in David Crockett National Forest, Fiberboard Lake, Drainage in Big Thicket National Preserve, Drainage in Trinity River National Wildlife Refuge, Daisetta Swamp, drainage in Big Thicket National Preserve, Drainage in J.D. Murphree WMA, Highlands Reservoir, George White Lake, and McCracken Lake. The approximate mileposts of these waterbodies and drainage areas and their associated pipeline stream crossings are presented in Appendix E (Keystone 2009).

3.3.1.3 Floodplains

Floodplains are relatively low, flat areas of land that surround some rivers and streams and convey overflows during flood events. Floodwater energy is dissipated as flows spread out over a floodplain, and significant storage of floodwaters can occur through infiltration and surficial storage in localized depressions on a floodplain. Floodplains form where overbank floodwaters spread out laterally and deposit fine-grained sediments. The combination of rich soils, proximity to water, riparian forests, and the dynamic reworking of sediments during floods creates a diverse landscape with high habitat quality. Floodplains typically support a complex mosaic of wetland, riparian, and woodland habitats that are spatially and temporally dynamic.

Changing climatic and land use patterns in much of the west-central United States has resulted in region-wide incision of many stream systems. Stream systems cutting channels deeper into the surrounding floodplain cause high floodplain terraces to form along valley margins. These floodplain terraces are common along the Project route and receive floodwaters less frequently than the low floodplains adjacent to the streams.

From a policy perspective, the Federal Emergency Management Agency (FEMA) defines a floodplain as being any land area susceptible to being inundated by waters from any source (FEMA 2005). FEMA prepares Flood Insurance Rate Maps that delineate flood hazard areas, such as floodplains, for communities. These maps are used to administer floodplain regulations and to mitigate flood damage. Typically, these maps indicate the locations of 100-year floodplains, which are areas with a 1-percent chance of flooding occurring in any single year.

Executive Order 11988, Floodplain Management, states that actions by federal agencies are to avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplain development wherever there is a practicable alternative. Each agency is to provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities for:

- Acquiring, managing, and disposing of federal lands, and facilities;
- Providing federally undertaken, financed, or assisted construction and improvements; and
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities.

Designated floodplains crossed by the proposed route are listed in Table 3.3.1.3-1.

TABLE 3.3.1.3-1 Designated Floodplain Areas Crossed by the Proposed Pipeline Route[1]		
Location	**Approximate Mileposts**	**Watercourse Associated with Floodplain**
Steele City Segment		
Montana		
Valley	81 – 84	Milk River
Valley/McCone	87 – 90	Missouri River
McCone	146 – 147	Redwater River
Dawson	193 – 196	Yellowstone River
South Dakota		
Harding	291 – 292	Little Missouri River
Meade/Pennington	424 – 426	Cheyenne River
Haakon	480 – 482	Bad River
Lyman/Tripp	537 – 539	White River
Nebraska		
Keya Paha	599 – 599	Keya Paha River
Rock	615 – 615	Niobrara River
Nance	738 – 793	Loup River
Merrick	755 – 758	Platte River
Gulf Coast Segment		
Oklahoma		
Creek	19 – 20	Tributary to Deep Fork
Creek	21 – 22	Deep Fork
Creek	22 – 23	Deep Fork
Okfuskee	23 – 23	Deep Fork
Okfuskee	38 – 40	North Canadian River
Seminole	40 – 40	North Canadian River
Seminole	43 – 44	Sand Creek
Seminole	58 – 59	Wewoka Creek
Hughes	60 – 60	Jacobs Creek
Hughes	74 – 74	Canadian River
Hughes	74 – 75	Canadian River
Coal	85 – 88	Muddy Boggy Creek
Atoka	126 – 127	Clear Boggy Creek
Atoka	127 – 128	Clear Boggy Creek
Atoka	131 – 131	Cowpen Creek
Bryan	155 – 155	Red River
Texas		
Fannin	155 – 156	Red River
Fannin	161 – 161	Bois d'Arc Creek

TABLE 3.3.1.3-1 Designated Floodplain Areas Crossed by the Proposed Pipeline Route[1]		
Location	**Approximate Mileposts**	**Watercourse Associated with Floodplain**
Lamar	165 – 166	Slough Creek
Lamar	170 – 171	Sanders Creek
Lamar	172 – 172	Cottonwood Creek
Lamar	174 – 174	Doss Creek
Lamar	189 – 190	North Sulphur River
Delta	190 – 190	North Sulphur River
Lamar	190 – 190	North Sulphur River
Delta	190 – 192	North Sulphur River
Delta	200 – 201	South Sulphur River
Hopkins	201 – 203	South Sulphur River
Upshur	256 – 256	Big Sandy Creek
Wood	256 – 257	Big Sandy Creek
Upshur	257 – 258	Big Sandy Creek
Upshur	260 – 263	Sabine River
Smith	263 – 263	Sabine River
Smith	268 – 268	Simpson Creek
Smith	268 – 268	Simpson Creek
Nacogdoches	324 – 325	Angelina River
Nacogdoches	333 – 336	Angelina River
Nacogdoches	341 – 341	Red Bayou
Angelina	341 – 341	Red Bayou
Angelina	344 – 344	Watson Branch
Angelina	347 – 348	Neches River
Angelina	350 – 350	Neches River
Angelina	351 – 352	Neches River
Angelina	358 – 358	Neches River
Angelina	359 – 360	Hurricane Creek
Angelina	362 – 362	Neches River
Angelina	362 – 363	Neches River
Angelina	365 – 366	Neches River
Angelina	366 – 367	Neches River
Angelina	367 – 370	Neches River
Polk	373 – 373	Piney Creek
Polk	373 – 373	Piney Creek
Polk	373 – 374	Piney Creek
Polk	375 – 375	Neches River
Polk	376 – 376	Neches River

TABLE 3.3.1.3-1 Designated Floodplain Areas Crossed by the Proposed Pipeline Route[1]		
Location	**Approximate Mileposts**	**Watercourse Associated with Floodplain**
Polk	401 – 402	Menard Creek
Polk	404 – 405	Dry Branch
Polk	414 – 414	Menard Creek
Hardin	446 – 447	Pine Island Bayou
Hardin	447 – 448	Pine Island Bayou
Liberty	448 – 449	Pine Island Bayou
Jefferson	449 – 449	Pine Island Bayou
Jefferson	449 – 449	Pine Island Bayou
Jefferson	451 – 452	Pine Island Bayou
Jefferson	455 – 456	Cotton Creek
Jefferson	462 – 462	North Fork Taylor Bayou
Jefferson	463 – 463	North Fork Taylor Bayou
Jefferson	465 – 466	Willow Marsh Bayou
Jefferson	466 – 466	Willow Marsh Bayou
Jefferson	467 – 470	Willow Marsh Bayou
Jefferson	471 – 471	Willow Marsh Bayou
Jefferson	472 – 472	Willow Marsh Bayou
Jefferson	479 – 479	Neches River

Sources: Interpretation of USGS 1:24,000 Topographic Maps and PHMSA (http://www.npms.phmsa.dot.gov); FEMA 100-year floodplain maps.

Two pump stations along the Gulf Coast route are within the 100-year floodplain. Pump Station 39 at MP 333.6 in Cherokee County, Texas is in the Angelina River floodplain. Pump Station 41 at MP 432.6 in Liberty County, Texas is within the Batiste Creek floodplain.

As proposed, the Project has 10 MLVs in the 100-year floodplain (CK-MLV-175, CK-MLV-220, CK-MLV-325, MLV-115, MLV-190, MLV-240, MLV-255, MLV-305, MLV-320, and MLV-330). The proposed locations are listed in Table 3.3.1.3-2; however Keystone the determination of those valves will be made during final design.

TABLE 3.3.1.3-2 Proposed Mainline Valve Locations within Designated 100-Year Floodplains			
County	**MLV**	**Approximate Milepost**	**Watercourse Associated with Floodplain**
Gulf Coast Segment			
Oklahoma			
Okfuskee	MLV-115	38.43	North Canadian River
Texas			
Hopkins	CK-MLV-175	202.05	South Sulphur River
Upshur	MLV-190	261.38	Sabine River
Polk	CK-MLV-220	369.59	Neches River

TABLE 3.3.1.3-2 Proposed Mainline Valve Locations within Designated 100-Year Floodplains			
County	**MLV**	**Approximate Milepost**	**Watercourse Associated with Floodplain**
Liberty	MLV-240	432.66	Tributary to Batiste Creek
Jefferson	MLV-255	469.68	Willow Marsh Bayou
Houston Lateral			
Texas			
Liberty	MLV-305	21.75	Trinity River
Harris	MLV-320	42.92	San Jacinto River
Harris	CK-MLV-325	44.38	San Jacinto River
Harris	MLV-330	48.57	San Jacinto River

3.3.2 Potential Impacts and Mitigation

3.3.2.1 Groundwater

Construction Impacts

Potential impacts to groundwater during construction activities would include:

- Temporary to long-term surface water quality degradation during or after construction from disposal of materials and equipment;
- Temporary increases in TSS concentrations where the water table is disturbed during trenching and excavation activities (drawdown of the aquifer is possible where dewatering is necessary)
- Increased surface water runoff and erosion from clearing vegetation in the ROW
- Degradation of groundwater quality due to potential blasting

Many of the aquifers present in the subsurface beneath the proposed route are isolated by the presence of glacial till or other confining units, which characteristically inhibits downward migration of water and contaminants into these aquifers. However, shallow or near-surface aquifers are also present beneath the proposed route and may be impacted by construction activities. These shallow or near-surface aquifers are predominately present along alluvial stream valleys.

Construction impacts to groundwater resources associated with spills and leaks are discussed in Section 3.13.

TSS Concentrations

Although there is potential for dewatering of shallow groundwater aquifers and potential changes in groundwater quality (such as increases in TSS concentrations) during trenching and excavation activities, these changes are expected to be temporary. Shallow groundwater aquifers generally recharge quickly because they are receptive to recharge from precipitation and surface water flow.

Runoff, Erosion, and Dust Control

Implementation of measures described in Section 4.5 of Keystone's CMR Plan (Appendix B) would reduce erosion (Section 3.2.2.1) and control surface water runoff during vegetation clearing in the ROW. However infiltration to groundwater will ultimately be reduced due to vegetation clearing in the ROW. Groundwater or surface water resources may be needed to control dust during construction activities.

Blasting

Where required for pipeline construction, blasting has the potential to affect groundwater resources. Keystone would prepare a blasting plan for any locations where blasting would be necessary. Prior to construction, Keystone would file its blasting plan with applicable state or local jurisdictions, where required. Keystone's blasting plan would include provisions to avoid impacts to groundwater and to incorporate post-blasting testing for surface water and water wells within 150 feet of the centerline to ensure that water resources are not negatively affected by blasting activities.

Hydrostatic Testing

Groundwater withdrawal for hydrostatic testing may be necessary at certain locations where surface water sources can not be used. Infiltration of hydrostatic testing waters would temporarily increase local groundwater levels, however the duration of increase would be minimal. Discharge waters will meet all water quality requirements prior to discharge and would therefore not impact groundwater quality. All applicable water withdrawal and discharge permits would be acquired prior to hydrostatic testing.

Operations Impacts

Routine operation and maintenance is not expected to affect groundwater resources.

Operational impacts to groundwater resources associated with spills and leaks are discussed in Section 3.13.

3.3.2.2 Surface Water

Construction Impacts

Potential impacts on surface water resources during construction activities would include:

- Temporary increases in TSS concentrations and increased sedimentation during stream crossings;
- Temporary to short-term degradation of aquatic habitat from in-stream construction activities;
- Changes in channel morphology and stability caused by channel and bank modifications;
- Temporary to long term decrease in bank stability and resultant increase in TSS concentrations from bank erosion as vegetation removed from banks during construction is re-establishing;
- Temporary reduced flow in streams and potential other adverse effects during hydrostatic testing activities; and
- Temporary degradation of surface water quality and alteration of aquatic habitat from blasting activities within or adjacent to stream channels.

Construction impacts to surface water resources associated with spills and leaks are discussed in Section 3.13.

Stream Crossings and In-Stream Construction Activities

Depending on the type of stream crossing, one of six construction methods would be used: the non-flowing open-cut method, the flowing open-cut method, the dry flume method, the dry dam-and-pump method, the HDD method, or the horizontal bore crossing method. More detailed descriptions of each crossing method and mitigation measures associated with each method are provided in the CMR Plan (Appendix B) and in the Project Description (Section 2.0). Each stream crossing and chosen method would be shown on construction drawings but may be amended or changed based on site-specific conditions during construction. Open-cut methods would be used at most crossings, unless deemed not feasible due to site conditions during construction or to protect sensitive waterbodies, as determined by the appropriate regulatory authority. At 38 major and sensitive waterbody crossings the HDD method would be used.

Keystone has committed to the use of the general river crossing procedures and mitigations included in the CMR Plan (Appendix B). The CMR Plan would be revised prior to construction to incorporate additional mitigations, as well as any other mitigations or conditions that the U.S. Army Corps of Engineers (USACE) imposes during final permit negotiations. For waterbody crossings where HDD would be used, disturbance to the channel bed and banks is avoided, however mitigating measures may be needed in the instance of a frac-out.

Where the HDD method is not used for major waterbody crossings or for waterbody crossings where important fisheries resources could be impacted, Keystone would develop a site-specific plan addressing proposed additional construction and mitigation procedures (CMR Plan, 7.4). Prior to commencing any stream crossing construction activities, Keystone would be required to obtain a permit under Section 404 of the Clean Water Act (CWA) through the USACE and Section 401 water quality certification as per state regulations and these agencies could require measures to limit unnecessary impacts such as requiring all the non-HDD crossings to be done in the dry if water is present at the time of the crossing.

Construction activities for open-cut wet crossings involve excavation of the channel and banks. 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, Keystone would implement the following measures on a site-specific basis:

- **Contaminated or Impaired Waters.** If required, Keystone would work with the applicable permitting agency to develop specific crossing and sediment handling procedures and provide the DOS with a copy of that consultation.
- **Sensitive/Protected Waterbodies.** Keystone would develop specific construction and crossing methods in conjunction with USACE and U.S. Fish and Wildlife Service (USFWS) consultation. The appropriate method of crossing these waterbodies would be determined by USACE or USFWS, as applicable.
- **Frac-out Plan.** Keystone will develop a plan in consultation with the regulatory agencies to continue the HDD if a frac out occurs with the understanding that the impacts of continuing may be less than reassessing the situation and starting over or using a conventional crossing method on smaller streams such as the Milk River.

Implementation of measures in Section 7.5 through Section 7.11 of Keystone's CMR Plan (Appendix B) and additional conditions from permitting agencies would reduce adverse impacts resulting from open-cut wet crossings. All contractors would be required to follow the identified procedures to limit erosion and

other land disturbances. Keystone's CMR Plan 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 Section 2.0 and the CMR Plan for a discussion of Keystone's proposed waterbody crossing methods.)

Following completion of waterbody crossings, waterbody banks would be restored to preconstruction contours, or at least to a stable slope. Banks would be seeded with native vegetation, mulch, or erosion control fabric, where possible. If necessary, additional erosion control measures would be installed in accordance with permit requirements. However, erosion control measures can themselves cause adverse environmental impacts. For example, placement of rock along the bank at a crossing could induce bank failure further downstream. Geomorphic assessment of waterbody crossings could provide significant cost savings and environmental benefits. 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, limit adverse environmental impacts, and in some cases improve stream conditions.

Therefore, all waterbody crossings should be assessed by qualified personnel in the design phase of the Project with respect to the potential for channel aggradation/degradation and lateral channel migration. The level of assessment for each crossing could vary based on the professional judgment of the qualified design personnel. The pipeline should be installed as necessary to address any hazards identified by the assessment. The pipeline should be installed at the design crossing depth for at least 15 feet beyond the design lateral migration zone, as determined by qualified personnel. The design of the crossings also should include the specification of appropriate stabilization and restoration measures.

In accordance with the CWA, all construction activities would comply with the National Pollutant Discharge Elimination System (NPDES) permit and other applicable permitting. This includes following the procedures in a Stormwater Pollution Prevention Plan.

Hydrostatic Testing

Water used for hydrostatic testing would be obtained from nearby surface water resources. These sources include streams, rivers, and privately owned reservoirs. Keystone has identified 50 potential surface water sources that could supply water for hydrostatic testing along the proposed project route depending on the flows at the time of testing and the sensitivity of the individual waterbodies for other uses. These sources are listed in Table 1 in Section 8.2 of Keystone's CMR Plan (Appendix B). Hydrostatic test manifolds would be located more than 100 feet away from wetlands and riparian areas to the maximum extent possible.

Keystone has committed that the Project would not withdraw hydrostatic test water from any waterbody where such withdrawal would create adverse affects. All surface water resources utilized for hydrostatic testing would be approved by the appropriate permitting agencies prior to initiation of any testing activities. Planned withdrawal rates for each water resource would be evaluated and approved by these agencies prior to testing. No resource would be utilized for hydrostatic testing without receipt of applicable permits. As stated in Keystone's CMR Plan (Appendix B), Keystone would be responsible for obtaining required water analyses prior to any water filling and discharging operations associated with hydrostatic testing.

The water withdrawal methods described in Section 8.0 of Keystone's CMR Plan (Appendix B) 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 off the bottom of the water resource,

prohibiting the addition of chemicals into the test water, and avoiding discharging any water that contains visible oil or sheen following testing activities.

Hydrostatic test water would be discharged to the source water at an approved location along the waterway or to an upland area within the same drainage as the source water where it may evaporate or infiltrate. Discharged water would be tested to ensure it meets applicable water quality standards imposed by the discharge permits for the permitted discharge locations. Keystone's CMR Plan 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 (see Appendix B, Section 8.4). Section 3.7 discusses additional mitigation measures necessary to protect fisheries.

Blasting

Where required for pipeline construction, blasting has the potential to affect surface water resources. Keystone would prepare a blasting plan for any locations where blasting would be necessary. Prior to construction, Keystone would file its blasting plan with applicable state or local jurisdictions, where required. Post-blasting testing procedures for surface water resources would be incorporated if required by applicable state or local jurisdictions.

Operations Impacts

Channel migration or streambed degradation could potentially 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. In its CMR Plan (Appendix B), Keystone has committed to a minimum depth of cover of 5 feet below the bottom of all waterbodies, maintained for a distance of at least 15 feet 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 meters per year. Not maintaining an adequate burial depth for pipelines in a zone that extends at least 15 feet (5 meters) beyond either side of the active stream channel may 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 regarding the banks to reduce the bank slope. Disturbance associated with these maintenance activities may potentially create additional water quality impacts.

All waterbody crossings would be assessed by qualified personnel in the design phase of the proposed Project with respect to the potential for channel aggradation/degradation and lateral channel migration. The level of assessment for each crossing could vary based on the professional judgment of the qualified design personnel. The 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 for at least 15 feet beyond the design lateral migration zone as determined by qualified personnel. The design of the crossings would also include the specification of appropriate stabilization and restoration measures

Operational impacts to surface water resources associated with spills and leaks are discussed in Section 3.13.

In addition to the measures that Keystone has committed to use to protect water resources during operation, the following potential mitigation measures have been suggested by regulatory agencies:

- In Montana, avoid crossing water ponds and/or reservoirs (MDEQ);
- Avoid wet crossings of any stream, lake, reservoir, or pond in the state of Montana (MDEQ); and
- In Montana, any construction equipment and construction-related vehicles crossing a water body should use a crossing location that is within the dewatered reach created by the selected dry crossing construction method (MDEQ).

3.3.2.3 Floodplains

The pipeline would be constructed under river channels with potential for lateral scour. In floodplain areas adjacent to waterbodies, Keystone would restore the contours to as close to previously existing contours as practical and would revegetate the construction ROW in accordance with its CMR Plan (Appendix B). Therefore, after construction the pipeline would not obstruct flows over designated floodplains.

Although two pump stations and 10 MLVs would be in the 100-year floodplain as currently proposed, the effect of those facilities on floodplain function would be minor.

3.3.3 Connected Actions

The construction and operation of electrical distribution lines and substations associated with the proposed pump stations, and the Lower Brule to Witten 230-kV electrical transmission line would have negligible effects on water resources.

3.3.4 References

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