3.3 WATER RESOURCES

This section describes the groundwater and surface water resources in the Keystone Project area that could be affected by the proposed Keystone Project and evaluates the potential impacts that may result from Keystone Project implementation. The analysis focuses on major aquifers and wells in the vicinity of the pipeline route, streams and rivers that would be crossed, and reservoirs and larger lakes that are downstream of these crossings.

3.3.1 Environmental Setting

3.3.1.1 Groundwater

The proposed Mainline Project route is located within the glaciated Central Lowlands physiographic province. The Central Lowlands physiographic province is characterized by glacial terrain. Buried stream channels, sand and gravel deposits, and glacial till were deposited following glacial retreat. Shallow groundwater is often contained in the buried stream channels or in recently deposited stream alluvium. Deeper wells also have been constructed into bedrock aquifers; however, the presence of the pipeline and associated construction activities are not likely to affect deeper groundwater aquifers because of the presence of glacial till above these zones. Glacial till typically inhibits the downward migration of groundwater.

In the region of the proposed Keystone Project route, unconsolidated deposit aquifers in Quaternary-aged sediments are the most productive aquifers and are the source of water for thousands of shallow wells (Whitehead 1996). Shallow groundwater in this region is often used for agricultural, domestic, and industrial purposes. The Mainline Project route does not overlie any sole source aquifers, as designated by EPA Regions 5, 6, 7, and 8 (EPA 2007).

Major aquifers and wells in the vicinity of the proposed Mainline Project route are described below by state.

North Dakota

Aquifers

In North Dakota, aquifers present beneath the proposed ROW are generally in unconsolidated glacial and alluvial deposits. Major aquifers in the vicinity of the proposed route are described below.

The Pembina River Aquifer is a productive aquifer located in eastern Cavalier and western Pembina Counties, occupying approximately 20 square miles in the area of the proposed route. The aquifer is surficial and is hydraulically connected to the nearby Pembina River. The groundwater table lies at ground surface within the floodplain along the proposed route.

The Pembina Delta Aquifer contains well yields up to 50 gallons per minute (gpm) (Hutchinson 1977), depending on the location along the proposed route. Depth to the saturated zone in this aquifer is approximately 50 feet below ground surface (bgs).

In Walsh County, the Edinburg Aquifer encompasses approximately 13 square miles, and depths to the saturated zone range from approximately 20 to 40 feet near the proposed route (Downey 1973). Adjacent to the proposed route, the Fordville Aquifer is one of the largest and most used surficial (glacial drift) aquifers in the area. The aquifer contains an average saturated thickness of 20 feet, underlies approximately 33 square miles, and contains approximately 63,000 acre-feet of water in storage. The topography in this area lacks drainage features; consequently, the aquifer receives abundant recharge from precipitation. The Fordville Aquifer is unconfined and is hydraulically connected to the Forest River and tributaries (Downey 1973). During periods of high flow, the aquifer obtains recharge from the North Branch Forest River. Groundwater flow is generally southern toward the Forest River and tributaries. Aquifer test data indicate that the aquifer yields up to 500 gpm (Downey 1973).

Adjacent to the proposed route in Steele and Barnes Counties, the McVille Aquifer lies in a buried river valley. Depth to saturation is on average 80 feet and up to 300 feet in southern Steele County (Downey and Armstrong 1977). In northern Barnes County, near Lake Ashtabula, the McVille Aquifer obtains recharge by precipitation.

The McVille Aquifer, Sand Prairie Aquifer, and Englevale Aquifer are present beneath the proposed route in Ransom County. All of these aquifers consist of buried channel deposits. The Englevale Aquifer consists of buried sand and gravel deposits associated with the historical course of the Sheyenne River (Armstrong 1982). The depth to the saturated zone in the Englevale Aquifer ranges from the land surface up to 80 feet bgs. The thickness of sand and gravel is varied and averages 40 feet.

In Sargent County, the proposed route would cross the Spiritwood Aquifer (also hydraulically connected to the Englevale Aquifer), the Brampton Aquifer, and the Oakes Aquifer. All three of these aquifers are characterized by coarse-grained alluvial channels underlying glacial till. The total area occupied by these aquifers is estimated at 450 square miles (Armstrong 1982). Depth to the saturated zone is typically 10 to 30 feet. In the vicinity of the proposed route, aquifer thicknesses range from approximately 100 to 200 feet.

In Sargent and Dickey Counties, excavation activities for the proposed route may penetrate the Oakes Aquifer. The Oakes Aquifer water table lies at the ground surface and extends to the west to the James River (Armstrong 1980, Koch and Bradford 1976). Subsurface materials in the aquifer consist of deltaic and lacustrine deposits of sand and gravel interbedded with silt and clay. In general, over 40 feet of glacial till, silt, and clay isolate the Oakes Aquifer from the underlying Spiritwood Aquifer. Literature indicates that in some areas the two aquifers are hydraulically connected vertically (Armstrong 1980). The average thickness of the saturated zone is approximately 30 feet, ranging from 2 to 100 feet. The aquifer yields from a few to up to a maximum of 1,500 gpm.

Available water quality information for the aquifers described in North Dakota is presented in Table 3.3.1-1. Literature indicates that, in general, water from these aquifers is not contaminated; however, water from two wells screened in the Oakes Aquifer in North Dakota may contain elevated nitrate concentrations resulting from fertilizers (Armstrong 1980).

The majority of the aquifers described are surficial. Principal aquifers, defined as a regionally extensive aquifer or aquifer system that has the potential to be used as a source of potable water (USGS 2003), are not present beneath the proposed route in North Dakota. The closest principal aquifer is the Lower Cretaceous Aquifer that is located adjacent to the Red River of the North, approximately 30 miles to the east (TransCanada 2007b).

Table 3.3.1-2 lists the locations beneath the proposed Mainline Project ROW where water-bearing zones are expected to be present at 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
Pembina River	ND	Cavalier/Pembina	625	Calcium magnesium bicarbonate type
Pembina Delta	ND	Cavalier/Pembina	340	Calcium magnesium bicarbonate type
Edinburg	ND	Walsh	450–900	--
Fordville/Medford	ND	Walsh	300–600	Calcium sodium bicarbonate type
McVille	ND	Steele/Barnes/ Ransom	2,200	--
Englevale	ND	Ransom	225–4,670	Calcium bicarbonate type
Spiritwood	ND	Sargent	625–2,260	--
Brampton	ND	Sargent	532–1,290	Calcium bicarbonate type in upper groundwater zone
Oakes	ND	Sargent/Dickey	300–800	Calcium bicarbonate type
Oakes	SD	Brown/Marshall	NA	Saline in many locations
Altamont	SD	Clark	500–1,400	--
Floyd	SD	Clark/Beadle/Miner/ Hanson/McCook	1,500–3,200	Sodium, calcium, sulfate rich
Lower James - Missouri	SD	McCook/Hutchinson/ Yankton	775–3,300	Calcium and sulfate rich
High Plains	NE	Cedar/Wayne	200–600	--
Barneston limestone	KS	Marshall	410–2,500	Sulfate (30–1,540 mg/l)
Alluvial deposits	KS	Marshall	470–650	Sulfate (40–60 mg/l)
Terrace (glacial) deposits	KS	Marshall	190–1,070	Sulfate (20–320 mg/l), nitrate (0.40–97 mg/l)
Permian limestones	KS	--	1,000–3,000	--
Glacial drift aquifers	KS	Brown/Doniphan	250–600	--
Missouri River alluvium	KS	--	500–700	--
Glacial drift	MO	--	350–800	--
Deep sandstone/ limestone aquifers	MO	--	>10,000	--

TABLE 3.3.1-2
Water-Bearing Zones Less Than 50 Feet below Ground Surface beneath the Proposed Right-of-Way for the Keystone Mainline Project

Milepost	Description of Water-Bearing Zone
North Dakota	
7	Surficial aquifer
8–12	Surficial aquifer
12–16	Surficial aquifer
29–30	Surficial aquifer
119–121	Surficial aquifer
123–124	Surficial aquifer
193–196	Surficial aquifer
203–218	Surficial aquifer
South Dakota	
218–219	Surficial aquifer
225–227	Surficial aquifer
261–264	Surficial aquifer
266–270	Unconsolidated sand and gravel aquifers
278–290	Unconsolidated sand and gravel aquifers
296–309	Unconsolidated sand and gravel aquifers
342–349	Unconsolidated sand and gravel aquifers
358–371	Unconsolidated sand and gravel aquifers
377–380	Unconsolidated sand and gravel aquifers
390–393	Unconsolidated sand and gravel aquifers
413–438	Unconsolidated sand and gravel aquifers
Nebraska	
438-439	Unconsolidated sand and gravel aquifers
439-447	Unconsolidated sand and gravel aquifers
447–449	Unconsolidated sand and gravel aquifers
452–453	Unconsolidated sand and gravel aquifers
456–457	Unconsolidated sand and gravel aquifers
470–471	Unconsolidated sand and gravel aquifers
500–506	Unconsolidated sand and gravel aquifers
531–623	Unconsolidated sand and gravel aquifers, sandstone aquifers
627–629	Unconsolidated sand and gravel aquifers, sandstone aquifers
631–635	Unconsolidated sand and gravel aquifers, sandstone aquifers
649–652	Glacier drift aquifers
Kansas	
652-657	Glacier drift aquifers
656–659	Unconsolidated sand and gravel aquifers, alluvial aquifers, glacial drift aquifers
660–661	Glacial drift aquifers

TABLE 3.3.1-2 (Continued)	
Milepost	**Description of Water-Bearing Zone**
Kansas (continued)	
662–688	Glacial drift aquifers
688–691	Unconsolidated sand and gravel aquifers, alluvial aquifers, glacial drift aquifers
692–709	Glacial drift aquifers
710–720	Glacial drift aquifers
721–722	Glacial drift aquifers
723–723	Glacial drift aquifers, unconsolidated sand and gravel aquifers
724–724	Glacial drift aquifers, unconsolidated sand and gravel aquifers
725–727	Glacial drift aquifers
727–739	Glacial drift aquifers
741–742	Glacial drift aquifers
743–747	Glacial drift aquifers, alluvial aquifers, unconsolidated sand and gravel aquifers
748–748	Alluvial aquifers, unconsolidated sand and gravel aquifers
751	Alluvial aquifers, unconsolidated sand and gravel aquifers
Missouri	
751	Alluvial aquifers, unconsolidated sand and gravel aquifers
760–763	Unconsolidated sand and gravel aquifers
771–772	Unconsolidated sand and gravel aquifers
839–847	Unconsolidated sand and gravel aquifers
857–859	Unconsolidated sand and gravel aquifers
860–863	Unconsolidated sand and gravel aquifers
867–869	Unconsolidated sand and gravel aquifers
870–875	Unconsolidated sand and gravel aquifers
954–963	Unconsolidated sand and gravel aquifers
969–972	Unconsolidated sand and gravel aquifers
974–978	Unconsolidated sand and gravel aquifers
981–983	Unconsolidated sand and gravel aquifers
1004–1023	Unconsolidated sand and gravel aquifers
1023.3	Sandstone and carbonate-rock aquifers
1024-1025	Unconsolidated sand and gravel aquifers
Illinois	
1025–1026	Unconsolidated sand and gravel aquifers
1045–1051	Unconsolidated sand and gravel aquifers
1053–1056	Unconsolidated sand and gravel aquifers
1058–1061	Unconsolidated sand and gravel aquifers
1069–1082	Unconsolidated sand and gravel aquifers

Note: Miles updated with information in TransCanada 2007d.

Wells

As presented in Appendix G, six public water supply (PWS) wells are located within 1 mile of the centerline of the pipeline. Five of these six wells are located in Pembina County, and one is in Walsh County; the wells are located in the general vicinity of each other, between MP 20 and 31 along the proposed route.

According to Keystone, no private wells are located within 100 feet of the Keystone Project ROW in North Dakota.

South Dakota

Aquifers

In South Dakota, shallow aquifers consist of glacially deposited sands and gravels or are present within glacially associated features such as buried lakes and channels. Shallow aquifers are present in alluvial deposits along stream channels. Deeper aquifers are also present in sandstone bedrock that is isolated from the surface or these shallow unconsolidated aquifers by glacial till.

In northern Brown and Marshall Counties, the James Aquifer underlies the proposed route. The aquifer ranges in thickness from approximately 10 to 100 feet. The aquifer is under artesian conditions. Depth to the saturated zone ranges from 100 to 190 feet bgs in the low-lying areas and as much as 580 feet bgs at higher land elevations (Koch 1975). The aquifer is composed mainly of buried outwash deposits and alluvium from an historical river. Deposits consist of sorted gravels, sand, and silt (Koch 1975). South of Marshall County, in northern South Dakota, underlying major aquifer zones are not present; the proposed route is located between the Tulare Aquifer and the Vermillion Aquifer (Geological Survey Program 2001, in ENSR 2006a). In Day and Clark Counties, near-surface aquifers in the glacial drift are generally not present; however, a number of small stream deposits containing near-surface aquifers are present in northwestern Day County.

In western Clark County and near the Spink County line, the proposed route would cross the underlying Altamont Aquifer along Foster Creek. This aquifer consists of a buried channel system and contains two saturated zones: from 2 to 10 feet bgs and from 35 to 80 feet bgs (Hamilton and Howells 1996). The average thickness of the Altamont Aquifer is approximately 22 feet.

The Floyd Aquifer (a confined aquifer) is present in southwestern Clark, Beadle, Miner, Hanson, and McCook Counties. According to cross-sections, depth to the saturated zone in Miner County is approximately 100 feet bgs near the county line. Near Carthage, the depth to the saturated zone ranges from the land surface to about 100 feet bgs (Koch and McGarvie 1988). Thickness of the Floyd Aquifer ranges between 4 and 100 feet. Also in this region, groundwater is present in the Niobrara Formation, a chalky shale bedrock aquifer. This aquifer is overlain by as much as 600 feet of glacial drift and shale in northern Miner County and as little as 60 feet in southern Miner County (Koch and McGarvie 1988).

The Lower James–Missouri Aquifer is present beneath the proposed route in southern McCook County, in the northern and southern ends of Hutchinson County and Yankton County (Lindgren and Hansen 1990). This aquifer is isolated from the surface by approximately 150 feet of till (Lindgren and Hansen 1990) and is approximately 50 to 75 feet thick in northern Hutchinson County and 130 feet thick in southern Hutchinson County. In Yankton County, depths to the saturated zone in this aquifer are generally 50 to 100 feet bgs; however, the depth to the saturated zone ranges from the land surface to 50 feet bgs at the James River, at Beaver Creek, and along the Missouri River (McCormick 2003).

Deeper aquifers in the region include the Dakota Formation Aquifer (sandstone) in Clark County, present at depths of 900 to 1,100 feet bgs (Jensen 2001c). The aquifer is isolated from the surface by thick deposits of glacial till and/or shale beds (Hamilton 1986). In Beadle County, the Codell Sandstone member of the Carlisle Shale is present at depths ranging from 350 to 500 feet. This aquifer is isolated from the surface by overlying glacial till and Niobrara Formation (Howells and Stephens 1968).

Available water quality information for the aquifers described in South Dakota is presented in Table 3.3.1-1. Literature indicates that, in general, water from these aquifers is not contaminated.

Principal aquifers, defined as a regionally extensive aquifer or aquifer system that has the potential to be used as a source of potable water (USGS 2003), are not present beneath the proposed route in South Dakota (TransCanada 2007b).

Table 3.3.1-2 lists the locations beneath the proposed Mainline Project ROW where water-bearing zones are expected to be present at less than 50 feet bgs.

Wells

As presented in Appendix G, no PWS wells are identified within 1 mile of the centerline of the pipeline in South Dakota. However, the pipeline passes within 0.04 mile of the Marshall County Source Water area and crosses a Zone B Aquifer Protection Area in Kingsbury County.

According to Keystone, no private wells are located within 100 feet of the Keystone Project ROW in South Dakota.

Nebraska

Aquifers

Mainline Project. In Nebraska, the uppermost (shallow) groundwater-bearing zones along the proposed pipeline route include glacial drift and alluvial aquifers.

In Cedar and Wayne Counties, undifferentiated Quaternary-aged sands and gravels form a portion of the High Plains Aquifer (a principal aquifer).

In Stanton County, shallow aquifers are present in Quaternary sands and gravels. The saturated zone may be at or near the land surface in stream valleys and near water body crossings; however, in upland settings, depth to the saturated zone ranges from 30 to 60 feet.

In Platte and Colfax Counties, Quaternary-aged aquifers are similar to those to the north in Stanton County. Depth to the saturated zone is generally 50 to 100 feet bgs. Approaching the Platte River and in the Platte River valley, the saturated zone is present at depths of 5 to 15 feet bgs (CSD 1958, in ENSR 2006a). Shallow alluvial aquifers are also present in depressional areas and the headwaters of the Big Blue River near Garrison and Ulysses.

To the south, groundwater is present in Butler, Seward, Saline, Jefferson, and Gage Counties in coarse-grained glacial deposits and stream-valley alluvium (Miller and Appel 1997). These unconsolidated deposits are Quaternary aged and collectively comprise the surficial aquifer in the area (Miller and Appel 1997).

Principal aquifers, defined as a regionally extensive aquifer or aquifer system that has the potential to be used as a source of potable water (USGS 2003), beneath the proposed route in Nebraska include the High Plains Aquifer and the Lower Cretaceous Aquifer. The High Plains Aquifer is present beneath the majority of the Mainline Project route in Nebraska. South of the Platte River, the Lower Cretaceous Aquifer is located adjacent and to the east, underlying the proposed route (TransCanada 2007b).

Available water quality information for these aquifers is presented in Table 3.3.1-1. Waters from the unconsolidated Quaternary deposits and the deeper Cretaceous bedrock sources generally appear to be of similar quality (Verstraeten et al. 1998). Additionally, the High Plains Aquifer contains a range of pH values of 6.1–8.8, specific conductance of 320–960 microSiemens per centimeter (µS/cm), and dissolved nitrate and nitrite concentrations of 4.2–7.6 milligrams per liter (mg/L). The Dakota Aquifer contains a range of pH values of 7.0–7.4, specific conductance of 550–570 µS/cm, and a dissolved nitrate and nitrite concentration of 0.26 mg/L. A wider variation and higher upper ranges of these values in the shallower water-bearing zones are likely due to irrigation.

Table 3.3.1-2 lists the locations beneath the proposed Mainline Project ROW where water-bearing zones are expected to be present at less than 50 feet bgs.

Cushing Extension. The proposed Cushing Extension route traverses southern Jefferson County for approximately 2.5 miles before crossing the state line into Kansas. In this area, shallow aquifers are present in glacial deposits and alluvium.

Principal aquifers, defined as a regionally extensive aquifer or aquifer system that has the potential to be used as a source of potable water (USGS 2003), in southern Jefferson County, Nebraska beneath the proposed Cushing Extension include the Lower Cretaceous Aquifer (TransCanada 2007b).

Table 3.3.1-3 lists the locations beneath the proposed Cushing Extension ROW where water-bearing zones are expected to be present at less than 50 feet bgs.

Wells

Mainline Project. As presented in Appendix G, nine well head protection areas of public water supply wells are present within 1 mile of the centerline of the proposed route in Wayne, Colfax, Seward, and Jefferson Counties. Of the nine wells, seven are present within 300 feet of the proposed ROW. These seven wells are located in Colfax, Seward, and Jefferson Counties.

According to Keystone, no private wells are located within 100 feet of the Keystone Project ROW in Nebraska.

Cushing Extension. Crystal Springs, located approximately 12 miles northwest of the beginning of the Cushing Extension route, supplies the Little Blue Public Water Project. This groundwater resource supplies potable water for several hundred domestic, livestock, and business purposes in Jefferson County and nearby Thayer County. Three public water supply wells are located 0.5 mile east of Fairbury, and six public water supply wells are located west of Fairbury; however, these water supply wells are approximately 11 miles west of the proposed Cushing Extension route.

No PWS wells within 1 mile of the centerline are present for the Cushing Extension route in Nebraska. Information regarding private wells within 100 feet of the Cushing Extension ROW is not available at this time

TABLE 3.3.1-3 Water-Bearing Zones Less Than 50 Feet below Ground Surface beneath the Proposed Right-of-Way for the Keystone Cushing Extension	
Milepost	**Description of Water-Bearing Zone**
Kansas	
6–20	Dakota aquifer
8–10	Alluvial aquifer
9–10	Unconsolidated sand and gravel aquifers
10–12	Alluvial aquifer
13–14	Alluvial aquifer
25–30	Dakota aquifer
31–32	Dakota Aquifer and sandstone aquifers
38–43	Dakota Aquifer and sandstone aquifers
49–51	Alluvial aquifer
68–70	Alluvial aquifer
74–77	Alluvial aquifer
112–114	Alluvial aquifer
116–119	Alluvial aquifer
154–160	Alluvial aquifer
160–161	Alluvial aquifer
163–164	Alluvial aquifer
180–181	Alluvial aquifer
185–185	Alluvial aquifer
189–191	Alluvial aquifer
196–213	Alluvial aquifer

Notes: The Cushing Extension route in Nebraska and Oklahoma does not contain water-bearing zones less than 50 feet below ground surface (Oklahoma Water Resources Board 2004, USGS. 2003)

Mileage updated with information in TransCanada 2007d.

Kansas

Aquifers

Mainline Project. In northeastern Kansas along the proposed Mainline Project route, shallow aquifers consist of alluvium and terrace deposits. The Barneston Limestone Formation also contains groundwater in northern Marshall County (Walters 1954).

In eastern Nemaha County, unconsolidated Pleistocene-age deposits of glacial drift and buried channel deposits are the best potential sources of groundwater (Ward 1974, in ENSR 2006a). Several high yield springs flow from these glacial deposits along the proposed route in Nemaha County (Maxwell Spring) and in Brown County (Sycamore Springs and Sun Springs) (Buchanan et al. 1998**).**

Unconsolidated sand and gravel deposits along the Big Blue River and the Missouri River drainages are used locally as water supply sources. Depth to groundwater is typically less than 10 feet bgs in these areas. Glacial drift aquifers yielding between 50 and 100 gpm remain the most significant source of water supply eastward through the Missouri River basin in Brown and Doniphan Counties, Kansas.

Deep groundwater aquifers in Kansas include the Barneston, Wreford, Beattie, Foraker, and Grenola Limestones. These formations generally yield on the order of 50 gpm to wells where fracture zones are present.

Principal aquifers, defined as a regionally extensive aquifer or aquifer system that has the potential to be used as a source of potable water (USGS 2003), are not present beneath the proposed route in Kansas. Shallow aquifers consist primarily of glacial drift aquifers (TransCanada 2007b).

Available water quality information for these aquifers is presented in Table 3.3.1-1.

Table 3.3.1-2 lists the locations beneath the proposed Mainline Project ROW where water-bearing zones are expected to be present at less than 50 feet bgs.

Cushing Extension. In Washington and Clay Counties in Kansas, the Great Plains Aquifer is exposed at the ground surface or underlies the shallow aquifers present in the area. The Great Plains Aquifer consists of semi-consolidated sedimentary rock and consists of two separate aquifers in Cretaceous-aged sandstone, separated by a confining unit composed of shale (Miller and Appel 1997). Saline water conditions are common in deeper zones; total dissolved solids (TDS) values typically range from 1,000 to 10,000 mg/L. In areas where the aquifer is shallower, or present at the surface, freshwater is present and of better quality.

South of Washington County to the Kansas state border, in Clay, Dickinson, Marion, and Cowley Counties, stream-valley aquifers are present in unconsolidated coarse-grained sand and gravel deposits. Larger river valleys, such as the Republican, Smoky Hill, Cottonwood, and Arkansas Rivers, contain the most productive aquifers. The most notable of these aquifers is the stream-valley aquifer along the Smoky Hill River, ranging laterally in width from 3 to 5 miles. The upper 30 to 50 feet of this aquifer contain freshwater and are highly productive (from 200 to 900 gpm). The stream-valley aquifers along the Cushing Extension in Kansas typically yield from 100 to 1,000 gpm and are hydraulically connected to the surface water in the streams. The water in these aquifers is calcium bicarbonate rich. TDS concentrations are typically less than 500 mg/L, although concentrations up to 7,000 mg/L are present in some areas.

From Clay County to Cowley County in Kansas, The Flint Hills Aquifer is oriented north to south and is present beneath the proposed Cushing Extension. The aquifer consists of Permian-aged limestones. This aquifer exhibits yields up to 1,000 gpm (MacFarlane 2000, in ENSR 2006a), is used for public water supplies, and is a source for numerous small springs. Karst features are common in the aquifer; sinkholes and springs are common along the proposed route. The freshwater aquifer is unconfined; water quality decreases in the deeper zones.

The Wellington Aquifer lies adjacent to the proposed Cushing Extension route several miles to the west, from Saline County to the Oklahoma border. In southwest Cowley County, a small portion of the aquifer would be crossed by the proposed route. The Wellington Aquifer lies within Permian-aged fractured shales resulting from dissolution of halite, gypsum, and anhydrite that underlies these shales. Groundwater conditions in the Wellington Aquifer, east of Salina, are saline and contain increased chloride and TDS concentrations. Sinkholes are common at the ground surface in this area.

Principal aquifers, defined as a regionally extensive aquifer or aquifer system that has the potential to be used as a source of potable water (USGS 2003), beneath and adjacent to the proposed route include the

Lower Cretaceous Aquifer and the High Plains Aquifer. The Lower Cretaceous Aquifer is located beneath the proposed Cushing Extension in Kansas, in Washington County and northern Clay County. South of Clay County to central Marion County, the Lower Cretaceous Aquifer is located west of the proposed route. South of Marion County, the High Plains Aquifer is located to the west, in the Arkansas River drainage area (TransCanada 2007b).

Table 3.3.1-3 lists the locations beneath the proposed Cushing Extension ROW where water-bearing zones are expected to be present at less than 50 feet bgs.

Wells

Mainline Project. As presented in Appendix G, only one public water supply well is located within 1 mile of the centerline of the proposed route. That well is in Doniphan County.

According to Keystone, no private wells are located within 100 feet of the Keystone Project ROW in Kansas.

Cushing Extension. As presented in Appendix G, 30 PWS wells are located within 1 mile of the centerline of the Cushing Extension. These wells are located in Washington, Dickinson, Butler, and Cowley Counties. Information regarding private wells within 100 feet of the Keystone Project ROW is not available at this time.

Missouri

Aquifers

Water-bearing zones in Missouri are present in glacially deposited sediments, similar to those described for Nebraska and Kansas. Water-bearing zones in the drift deposits consist of sand and gravel lenses that fill pre-glacial valleys cut into the underlying bedrock. Many of these aquifers drain to nearby surface water bodies or adjacent alluvium. The depth to groundwater follows topography, generally being deeper beneath ridges and shallower (approximately 15 to 20 feet) beneath valley floors (Fuller et al. 1957a, 1957b, 1957c, in ENSR 2006a).

Additionally, unconsolidated deposits of sand and gravel along stream channels (such as the Platte River, the Grand River, and the Chariton River drainages) are used locally as water supply sources. Depth to groundwater is typically less than 10 feet bgs in these areas.

Deeper bedrock aquifers along the proposed pipeline route in western and central Missouri consist of sandstones and limestones. Aquifers in this area include the Burlington-Keokuk formation, Ste. Genevieve Formation, Cotter and Kimmswick Formations, and Ardmore Formation (Fuller et al. 1957a, 1957b, 1957c, in ENSR 2006a). The quality of water from the bedrock formations is typically poor (TDS concentrations >10,000 mg/L). As a result, these deeper bedrock aquifers are not used as sources of drinking water or for other uses.

Karst features, including sinkholes, dissolution cavities, caves, and fissures, are present in the subsurface in central Missouri (Veni 2002, in ENSR 2006a). In Caldwell, Lincoln, and St. Charles Counties in Missouri, karst areas are present but are typically less than 1,000 feet long and less than 50 feet deep (Davies et al. 1984).

Regionally, the Mississippian Aquifer (a principal aquifer) is present beneath portions of the proposed Mainline Project route in eastern Missouri (TransCanada 2007b).

Available water quality information for these aquifers is presented in Table 3.3.1-1.

Table 3.3.1-2 lists the locations beneath the proposed Mainline Project ROW where water-bearing zones are expected to be present at less than 50 feet bgs.

Wells

As presented in Appendix G, 20 PWS wells are located within 1 mile of the proposed route in Chariton, Audrain, Lincoln, and St. Charles Counties in Missouri. Of the 20 wells, one well (well No. 14629) is located within 300 feet of the proposed ROW in Chariton County. According to Keystone, no private wells are located within 100 feet of the Keystone Project ROW in Missouri.

Illinois

Aquifers

In Illinois, shallow aquifers are present in the broad floodplain alluvium in the vicinity of the confluence of the Missouri and Mississippi Rivers. Large quantities of groundwater are withdrawn from terrace deposits of the Cahokia Formation, containing Quaternary-aged river deposits. In Madison County, these deposits extend from the Mississippi River for approximately 12 miles inland (Wehrman et al. 2003). Additional shallow sand and gravel aquifers are present in east-central Madison County, in central Bond County, and all along the Kaskaskia River alluvium in Fayette County (Wehrman et al. 2003).

In areas away from the river, aquifer zones less than 45 feet bgs are scattered along the proposed route in Illinois (Berg undated, in ENSR 2006a). Springs are present along or in the vicinity of the proposed route in eastern Madison County, southwestern Bond County, and Fayette County (Wetzel and Webb 2004). Karst features are not present along the Keystone Project route in westernmost Illinois (Davies et al. 1984).

The Mississippian Aquifer (a principal aquifer) is present beneath the far western portion of the proposed Mainline Project route in eastern Illinois, in the region beneath the confluence of the Illinois River, Mississippi River, and Missouri River (USGS 2003).

Table 3.3.1-2 lists the locations beneath the proposed Mainline Project ROW where water-bearing zones are expected to be present at less than 50 feet below ground surface (bgs).

Wells

As presented in Appendix G, 12 PWS wells within 200 feet of the proposed ROW are present. These wells are located in Madison County, between MP 1030 and 1035 of the proposed Mainline Project route**.**

According to Keystone, no private wells are located within 100 feet of the Keystone Project ROW in Illinois.

Oklahoma

Aquifers

The proposed Cushing Extension route passes through Kay, Noble, and Payne Counties in Oklahoma. Aquifers crossed by the route consist of stream valley alluvial terraces. Significant alluvial aquifers include those associated with the Salt Fork Arkansas River in Kay County and the Cimarron River in

Payne County. These aquifers consist of Quaternary-aged deposits of sand and gravel up to 100 feet in thickness and up to several miles wide. Both of these aquifers are high-yielding and are important water sources in Oklahoma (Ryder 1996, in ENSR 2006a); however, the Salt Fork Arkansas River and associated alluvial aquifers are saline and unsuitable for use (Ryder 1996, in ENSR 2006a).

The Arkansas River is located adjacent to and east of the proposed Cushing Extension in Oklahoma. The alluvium and alluvial terraces associated with the river can yield up to 600 gpm. The aquifer is up to 45 feet thick and 5 miles wide (Ryder 1996, in ENSR 2006a).

At the Cimarron River crossing near Cushing, Oklahoma (at the southern end of the proposed route), alluvial terrace deposits contain calcium-magnesium-bicarbonate rich water that is suitable for domestic and irrigation water supplies (Ryder 1996, in ENSR 2006a). TDS concentrations are 400 mg/L or less, and hardness is less than 200 mg/L.

Principal aquifers are not present beneath or adjacent to the Cushing Extension route in Oklahoma (TransCanada 2007b)

Wells

As presented in Appendix G, four PWS wells are located within 1 mile of the centerline of the Cushing Extension in Oklahoma. Three of these wells are located in Kay County, and one is located in Payne County. The well located in Payne County (MP 290) is present within 200 feet of the ROW.

According to Keystone, no private wells are located within 100 feet of the Keystone Project ROW in Oklahoma.

3.3.1.2 Surface Water

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

- Souris-Red-Rainy Rivers region (eastern North Dakota),
- Missouri River region (North Dakota, South Dakota, Nebraska, Kansas, and Missouri), and
- Upper Mississippi region (Missouri and Illinois).

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 H. Levees, water control structures, and flood protection structures along the proposed route are presented in Appendix I.

North Dakota

Water Bodies Crossed

As presented in Appendix J, 167 water body crossings are proposed in North Dakota along the proposed Mainline Project route. According to evaluation of aerial photographs from 2006, water bodies greater than 100 feet in width in North Dakota include:

- Pembina River in Pembina County (approximately 125 feet wide, MP 7),
- Tongue River in Pembina County (approximately 50 to 100 feet wide, MP18), and
- Sheyenne River in Ransom County (approximately 50 to 100 feet wide, MP 169).

Major water bodies and reservoirs located within 10 miles downstream of proposed water crossings include Weiler Dam/Reservoir, Herzog Dam/Reservoir, Renwick Dam at Icelandic State Park, Charles C. Cook State Game Management Area and wetlands, Homme Lake, Pickart Lake, Lake Ashtabula, Lone Tree Lake, Lake Taayer, and three unnamed reservoirs. The approximate mileposts of these water bodies and their associated pipeline stream crossings are presented in Appendix H. Small glacially formed water bodies (ponds and potholes) also are present along the Mainline Project route through North Dakota.

Sensitive or Protected Water Bodies

The following streams and rivers along the Mainline Project route in North Dakota contain state water quality designations or use designations (Appendix J):

- Pembina River, Tongue River, and North Branch Park River in Pembina County;
- Middle Branch Forest River in Walsh County;
- North Branch Turtle River and Goose River in Nelson County; and
- Sheyenne River in Ransom County.

Impaired or Contaminated Water Bodies

Keystone identified that contamination has been documented in all seven of these sensitive or protected water bodies in North Dakota (Appendix K). Contamination or impairment in each of these water bodies includes unacceptable levels of at least one of the following parameters: sedimentation/siltation, total fecal coliform, biological indicators, TDS, and cadmium.

Water Supplies

Along the proposed ROW in North Dakota, municipal water supplies are largely obtained from groundwater sources.

South Dakota

Water Bodies Crossed

The proposed route crosses 92 water bodies in South Dakota (Appendix J). Based on evaluation of 2006 aerial photographs, the water bodies that would be crossed that are greater than 100 feet in width include:

- James River in Yankton County (approximately 150 feet wide, MP 424), and
- Missouri River in Yankton County, South Dakota and Cedar County, Nebraska (approximately 1,400 feet wide, MP 438). Marne Creek and a river side channel are adjacent to the proposed river crossing on the northern side.

Gavins Point Dam, a major control structure on the Missouri River, is located about 3 miles upstream of the proposed crossing of the Missouri River in South Dakota.

Major water bodies and reservoirs located within 10 miles downstream of proposed water crossings in South Dakota include Renzienhausen Slough, Amsden Lake, Logan Dam/Reservoir, Fordham Reservoir, an unnamed reservoir, Lake Iroquois, Twin Lakes, and Lake Eli. The approximate mileposts of these water bodies and their associated pipeline stream crossings are presented in Appendix H. Small glacially formed water bodies (ponds, potholes, and small lakes) are also present along the Keystone Project route through South Dakota.

Sensitive or Protected Water Bodies

Seven of the water bodies that would be crossed by the proposed route in South Dakota have been assigned water use classifications (Appendix J). Several of these water bodies are crossed more than once. These water bodies include:

- Pearl Creek in Beadle County;
- Redstone Creek and Rock Creek in Miner Counties;
- Wolf Creek in Hanson, McCook, and Hutchinson Counties; and
- James River, Beaver Creek, and the Missouri River in Yankton County at the border with Nebraska.

Impaired or Contaminated Water Bodies

Keystone identified 10 impaired water bodies that would be crossed by the pipeline route in South Dakota (Appendix K). Specific contamination or impairment was documented in only five of these ten water bodies, including:

- Two streams in Day Country (unnamed and mud Creek flowing from Amsden Lake) are impaired due to nutrient levels,
- Wolf Creek in McCook and in Hutchinson Counties is impaired due to ammonia,
- The James River in Yankton County is impaired due to total suspended solids and turbidity.

Water Supplies

Along the proposed Mainline Project ROW in South Dakota, municipal water supplies are largely withdrawn from groundwater sources.

Nebraska

Water Bodies Crossed

Mainline Project. The proposed route crosses 208 water bodies in Nebraska (Appendix J). Based on evaluation of 2006 aerial photographs water bodies crossed that are greater than 100 feet in width include:

- Missouri River in Yankton County, South Dakota and Cedar County, Nebraska (approximately 1,400 feet wide, MP 438),
- Elkhorn River in Stanton County (approximately 225 feet wide, MP 505),
- Shell Creek in Colfax County (approximately 125 feet wide, MP 535), and
- Platte River in Colfax and Butler Counties (approximately 1,500 feet wide, MP 544).

The Platte River at the proposed pipeline crossing is a highly braided stream that is approximately 1,500 feet wide. The river basin contains sandy floodplain deposits up to 3 miles wide. The Elkhorn River is a meandering river that contains numerous oxbows and sloughs along the floodplain.

Major water bodies and reservoirs located within 10 miles downstream of proposed water crossings in Nebraska include Whitetail State Wildlife Management Area, and five unnamed reservoirs. The approximate mileposts of these water bodies and their associated pipeline stream crossings are presented in Appendix H.

Cushing Extension. The Cushing Extension runs from the Mainline Project route approximately 2.5 miles in Nebraska to the Kansas border. Six water body crossings are proposed in Nebraska along the Cushing Extension (Appendix J). These water bodies consist of small intermittent streams and tributaries to the Little Blue River.

No water bodies and reservoirs are located within 10 miles downstream of proposed water crossings in Nebraska along the Cushing Extension.

Sensitive or Protected Water Bodies

Mainline Project. The six water bodies that would be crossed by the proposed pipeline corridor in Nebraska that have been assigned water use classifications (Appendix J) include:

- Missouri River in Cedar County,
- Elkhorn River in Stanton County,
- Platte River in Colfax County,
- Big Blue River in Seward County, and
- West Fork Big Blue River and Swan Creek in Saline County.

Cushing Extension. None of the water body crossings in Nebraska along the Cushing Extension have been assigned a state water use classification.

Impaired or Contaminated Water Bodies

Mainline Project. Keystone identified 19 water crossings on its list of impaired water bodies in Nebraska (Appendix K). Specific contamination or impairment was documented in six of these water bodies including unacceptable levels of at least one of the following parameters: fecal coliform, dieldrin, polychlorinated biphenyls (PCBs), dissolved oxygen (DO), and selenium.

Cushing Extension. Contamination was not documented in any of the water body crossings in Nebraska along the Cushing Extension.

Water Supplies

Mainline Project. Along the proposed Mainline Project ROW in Nebraska, municipal water supplies are largely obtained from groundwater sources.

Cushing Extension. Information regarding the locations of surface water supplies along the Cushing Extension has been requested from appropriate federal, state, and local agencies; however, the information is not yet available. Keystone has committed that they would obtain and evaluate the locations of public surface water supplies along the Cushing Extension prior to initiation of construction activities to ensure the protection of these water resources.

Kansas

Water Bodies Crossed

Mainline Project. The proposed pipeline corridor would cross 203 water bodies in Kansas (Appendix J). Based on an evaluation of 2006 aerial photographs, water bodies that would be crossed that are greater than 100 feet in width include:

- Big Blue River in Marshall County (approximately 200 feet wide, MP 661); and
- Missouri River in Doniphan County, Kansas and Buchannan County, Missouri (approximately 800 feet wide, MP 751). A system of channel controls (levees and jetties) is located along the west bank, and levees and ditches are located along the east bank

.No major water bodies or reservoirs are located within 10 miles downstream of proposed water crossings in Kansas, as presented in Appendix H.

Cushing Extension. The proposed pipeline corridor would cross 172 water bodies in Kansas along the Cushing Extension (Appendix J).

Based on an evaluation of 2006 aerial photographs, water bodies that would be crossed that are greater than 100 feet in width include:

- Little Blue River in Washington County (approximately 175 feet wide, MP 4),
- Smoky Hill River in Dickinson County (approximately 125 feet wide, MP 77), and
- Arkansas River in Cowley County (approximately 600 feet wide, MP 206).

Major water bodies and reservoirs located within 10 miles downstream of proposed water crossings in Kansas include Milford Lake, Herrington Reservoir, Marion Lake Reservoir, and Kaw Lake (Appendix H). Additionally, Turtle Creek Lake, a very large reservoir, is located approximately 15 to 20 miles downstream of the proposed route.

Sensitive or Protected Water Bodies

Mainline Project. Thirteen of the water bodies and tributaries that would be crossed by the proposed pipeline corridor in Kansas have been assigned water use classifications (Appendix J). Several of these water bodies would be crossed more than once. These water bodies include:

- Deer Creek, North Elm Creek and its tributaries, and Robidoux Creek in Marshall County;
- Wildcat Creek, Nemaha River, and Harris Creek in Nemaha County;
- Walnut Creek, Wolf River Middle and South Forks, Buttermilk Creek, and Squaw Creek in Brown County; and
- Halling Creek, Rock Creek, and Brush Creek in Doniphan County.

Cushing Extension. Thirty of the water bodies and their associated tributaries that would be crossed by the proposed pipeline corridor in Kansas along the Cushing Extension have been assigned water use classifications (Appendix J). Several of these water bodies would be crossed more than once. These water bodies include:

- Little Blue River, Mill Creek, and Coon Creek in Washington County;
- Carter Creek, West Fancy Creek, Lincoln Creek, and Republican River in Clay County;
- Chapman Creek, Smoky Hill River, Carry Creek, and West Branch Lyon Creek in Dickinson County;
- Mud Creek, Cottonwood River, Spring Branch, Catlin Creek, and Doyle Creek in Marion County;
- East Branch Whitewater River, Fourmile Creek, Rock Creek, Spring Branch, Whitewater River, Badger Creek, Dry Creek, Fourmile Creek, and Eightmile Creek in Butler County; and
- Polecat Creek, Stewart Creek, Crooked Creek, Spring Creek, and Arkansas River in Cowley County.

Impaired or Contaminated Water Bodies

Mainline Project. Keystone identified 23 water crossings along the proposed Mainline Project pipeline corridor on its list of impaired water bodies in Kansas; however, specific contamination or impairment was documented in only 15 of these water bodies (Appendix K). Contamination or impairment in these water bodies includes unacceptable levels of at least one of the following parameters: biological impairment, atrazine, beryllium, copper, and pH.

Cushing Extension. Keystone identified 32 water crossings along the Cushing Extension on its list of impaired water bodies in Kansas; however, specific contamination or impairment was documented in only 19 of these water bodies (Appendix K). Contamination in each of these water bodies includes unacceptable levels of at least one of the following parameters: atrazine, fecal coliform, sulfate, chloride, zinc, pH, and biological impairment.

Water Supplies

Mainline Project. Along the proposed route from Jefferson County, Nebraska eastward through Kansas, surface water reservoirs and groundwater wells supply municipal requirements.

In general, Marshall County depends on both surface water and groundwater resources for water supply. Marysville, which historically had depended on Blue River surface water, now obtains its water supply from a wellfield southeast of town along a tributary. This wellfield is located approximately10 miles south of the proposed Blue River crossing. Oketo obtains municipal water from a well on the Big Blue River floodplain. Summerfield and Axtell also are supplied by wells (Walters 1954).

Cushing Extension. Table 3.3.1-4 provides information on surface water intakes within 5 miles of the Cushing Extension ROW in Kansas. There are no surface water intakes within 1 mile of the centerline (TransCanada 2007c).

Missouri

Water Bodies Crossed

The proposed pipeline corridor would cross 560 water bodies in Missouri. Based on an evaluation of 2006 aerial photographs, water bodies greater than 100 feet in width include:

- Missouri River in Doniphan County, Kansas and Buchannan County, Missouri (approximately 800 feet wide, MP 749);
- Platte River in Buchanan County (approximately 200 feet wide, MP 765);
- Grand River in Carroll County (approximately 250 feet wide, MP 843);
- Chariton River in Chariton County (approximately 280 feet wide, MP 865);
- Cuivre River in Lincoln County (approximately 150 feet wide, MP 974);
- Cuivre River in St. Charles County (approximately 225 feet wide, MP 986); and
- Mississippi River in St. Charles County, Missouri and Madison County, Illinois (approximately 2,200 feet wide, MP 1025).

TABLE 3.3.1-4
Surface Water Intakes within 5 Miles of the Keystone Cushing Extension in Kansas

Milepost	County	Approximate Distance from Centerline (miles)
91–100	Marion	2.0
112–122	Marion	1.5
158–166	Butler	2.0
163–173	Butler	1.5
204–210	Cowley	4.8

In this section of the Mainline Project, many levees or embankments are associated with the Missouri River and Mississippi River drainage areas and along the Grand River, Chariton River tributaries, and the Cuivre River (Appendix I). Abandoned stream meanders and ponds are present in the area at the confluence of the Mississippi and Missouri Rivers. At the state border, the proposed route would cross the Mississippi River.

Major water bodies and reservoirs located within 10 miles downstream of proposed water crossings in Missouri include New Mud Lake/Old Mud Lake, Smithville River, five fishing areas, Cut-Off Lake, Middletown Lake, Horseshoe Lake, Mud Lake, and Graus Lake (Appendix H).

Sensitive or Protected Water Bodies

Twenty-eight of the water bodies and tributaries that would be crossed by the proposed pipeline corridor in Missouri have been assigned water use classifications (Appendix J). Several of these water bodies would be crossed more than once. These water bodies include:

- Missouri River, Contrary Creek, Pigeon Creek, and Platte River in Buchanan County;
- Castile Creek, Little Platte River, and Shoal Creek in Clinton County;
- Brush Creek, Crabapple Creek, and Mud Creek in Caldwell County;
- Big Creek and Grand River in Carroll County;
- Salt Creek, Lake Creek, Mussel Fork, and Chariton River and forks, and Puzzle Creek in Chariton County;
- Long Branch, Youngs Creek, Bean Branch, Littleby Creek, and West Fork Cuivre River in Audrain County;
- Brush Creek in Montgomery County;
- Bear Creek and Cuivre River in Lincoln County; and
- Peruque Creek, Dardenne Creek, and Mississippi River in St. Charles County, Missouri.

Impaired or Contaminated Water Bodies

Keystone identified 53 water crossings on its list of impaired water bodies in Missouri; however, specific contamination or impairment was documented in only 13 of these water bodies (Appendix K). Contamination or impairment in each of these water bodies includes unacceptable levels of at least one of the following parameters: chlordane, PCBs, fecal coliform, biological oxygen demand (BOD), volatile suspended solids (VSS), metals, and sediment.

Water Supplies

Along the proposed route eastward through Missouri, surface water reservoirs and groundwater wells are used for municipal requirements.

St. Joseph, Andrews County, is supplied by a groundwater wellfield several miles north of the city (Water-Technology-net 2006). This wellfield would not be crossed by the proposed pipeline, which would be routed south of the city.

Illinois

Water Bodies Crossed

The proposed pipeline corridor would cross 85 water bodyies along the Mainline Project in Illinois. No water body crossings are associated with the 1-mile-long lateral pipeline to the Wood River Terminal. Based on an evaluation of 2006 aerial photographs, water bodies greater than 100 feet in width include:

- Mississippi River in St. Charles County, Missouri and Madison County, Illinois (approximately 2,200 feet wide, MP 1025);
- East Fork Silver Creek/Silver Lake in Madison County (approximately 300 feet wide, MP 1050);

- Hurricane Creek in Fayette County (approximately 100 feet wide, MP 1074); and
- Kaskaskia River in Fayette County (approximately 100 feet wide, MP 1076).

At the state border, the Mississippi River is approximately 2,100 feet wide at the proposed crossing location. The proposed route lies in the floodplain for the next 5 miles. Approximately 3 miles of floodplain associated with the Kaskaskia River would be crossed, upstream from Carlyle Lake (a 26,000-acre multi-purpose lake) and 5 miles east of the proposed eastern end of the pipeline route.

Major water bodies and reservoirs located within 10 miles downstream of proposed water crossings in Illinois include Highland Silver Lake, an unnamed reservoir, and Carlyle Lake (Appendix H). In addition to stream crossings, a number of lakes and ponds are located along the proposed pipeline route.

Sensitive or Protected Water Bodies

Eleven of the water bodies that would be crossed in Illinois have been assigned water use classifications (Appendix J). These water bodies include:

- Mississippi River, Indian Creek, Cahokia Canal, Mooney Creek, Silver Creek, Sugar Fork, Sand Creek, and Silver Lake in Madison County;
- Shoal Creek and Little Beaver Creek in Bond County; and
- Kaskaskia River in Fayette County.

Impaired or Contaminated Water Bodies

Keystone identified 14 water crossings in Illinois along the Mainline Project route that are on its list of impaired water bodies; however, specific contamination or impairment was documented in only seven of these water bodies (Appendix K). Contamination or impairment in each of these water bodies includes unacceptable levels of at least one of the following parameters: fecal coliform, DO, sediments and siltation, total suspended solids, pH, total nitrogen, total petroleum hydrocarbons (TPH), aldrin, chlordane, manganese, aquatic algae, and silver. Additionally, chlordane and PCBs were reported at the proposed Illinois/Missouri border crossing of the Mississippi River.

Water Supplies

Along the proposed route eastward through Illinois, surface water reservoirs and groundwater wells are used for municipal requirements. Municipalities also are served by Highland Silver Lake and Carlyle Lake in Illinois.

Oklahoma

Water Bodies Crossed

The proposed pipeline corridor would cross 88 water bodies in Oklahoma. Based on an evaluation of 2006 aerial photographs, water bodies greater than 100 feet in width include:

- Salt Fork Arkansas River in Kay County (approximately 300 feet wide, MP 243), and
- Cimarron River in Payne County (approximately 800 feet wide, MP 289).

Major water bodies and reservoirs located within 10 miles downstream of proposed water crossings in Oklahoma include Kaw Lake and Sooner Lake. The approximate mileposts of these water bodies and their associated pipeline stream crossings are presented in Appendix H.

Sensitive or Protected Water Bodies

Two water bodies that would be crossed a total of 10 times in Oklahoma have been assigned water use classifications (Appendix J). These water bodies are:

- Bois d'Arc Creek and Salt Fork Arkansas River in Kay County.

Impaired or Contaminated Water Bodies

Keystone identified 13 water crossings on its list of impaired water bodies in Oklahoma; however, specific contamination or impairment was documented in only six of these water bodies (Appendix K). Contamination or impairment in each of these water bodies includes unacceptable levels of at least one of the following parameters: sulfates, pathogens, turbidity, lead, nitrates, and unknown toxicity.

Water Supplies

Table 3.3.1-5 provides information on surface water intakes within 5 miles of the Cushing Extension ROW in Oklahoma. There are no surface water intakes within 1 mile of the centerline (TransCanada 2007c).

TABLE 3.3.1-5
Surface Water Intakes within 5 Miles of the Keystone Cushing Extension in Oklahoma

Milepost	County	Approximate Distance from Centerline (miles)
246–255	Noble/Pawnee	2.5
280–289	Payne/Lincoln	1.5

3.3.2 Potential Impacts and Mitigation

3.3.2.1 Groundwater

Construction Impacts

Potential impacts to groundwater during construction activities include:

- Groundwater quality degradation during or after construction resulting from disposal of materials and equipment, or vehicle spills and leaks;
- Temporary increases in total suspended solids (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; and
- Degradation of groundwater quality because of blasting.

Spills and Leaks

Overall, it is not anticipated that groundwater quality would be affected by construction activities. Many of the aquifers present in the subsurface beneath the proposed route are isolated by the presence of glacial till, which characteristically inhibits downward migration of water and contaminants into these aquifers; however, shallow or near-surface aquifers are also present beneath the proposed route.

Temporary fueling stations would be used to refuel construction equipment. To prevent releases, fuel tanks or fuel trailers would be placed within secondary containment structures equipped with impervious membrane liners.

Implementation of procedures outlined in Sections 2 and 3 of Keystone's CMR Plan (Appendix B) would ensure that (1) contractors would be prepared to respond to any spill incident; and (2) all contaminants would be contained and not allowed to migrate into the aquifer during construction activities, regardless of the depth of the underlying aquifer.

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 and Erosion

Implementation of measures described in Section 4.5 of Keystone's CMR Plan (Appendix B) would reduce erosion and control surface water runoff during vegetation clearing in the ROW.

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 water wells within 150 feet of the centerline to ensure that water wells are not negatively affected by blasting activities.

Operations Impacts

During the life of the Keystone Project, potential minor short-term groundwater quality degradation would be possible from equipment and vehicle spills or leaks.

Routine operation and maintenance is not expected to affect groundwater resources; however, if a crude oil release occurred, crude oil could migrate into subsurface aquifers and into areas where these aquifers are used for water supplies.

Keystone's ERP describes actions to be taken in the event of a crude oil release or other accident (Appendix C). As noted earlier, the ERP would be finalized prior to initiation of construction. The risk of crude oil releases from the proposed pipeline and an assessment of the potential environmental impacts associated with crude oil releases is addressed in detail in Section 3.13 and Appendix L.

3.3.2.2 Surface Water

Construction Impacts

Potential impacts on surface water resources during construction activities include:

- Temporary to long-term surface water quality degradation during or after construction from disposal of materials and equipment or vehicle spills and leaks,
- 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 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.

Spills and Leaks

Implementation of the procedures in Section 3 in Keystone's CMR Plan (Appendix B) would minimize the potential for spills and leaks to affect surface water resources. During all construction activities, all refueling would be conducted at least 100 feet away from all surface water bodies.

Stream Crossings and In-Stream Construction Activities

Depending on the type of stream crossing, one of four construction methods would be used: the open-cut wet method, the flume method, the dam-and-pump method, or the HDD method. For the most part, open-cut wet crossings are planned for most water bodies along the proposed pipeline route, except for locations where dam-and-pump or flume methods are technically feasible and warranted by resource-specific sensitivities. However, the HDD process would be employed for the following 13 crossings (ENSR 2007i, TransCanada 2007d):

- Pembina River, North Dakota (MP 7);
- South Branch Park River, North Dakota (MP 42);
- Missouri River, South Dakota/Nebraska (MP 438);
- Elkhorn River, Nebraska (MP 505);
- Platte River, Nebraska (MP 544);
- Missouri River, Kansas/Missouri (MP 751);
- Chariton River. Missouri (MP 865);
- Cuivre River, Missouri (MP 974);
- Cuivre River, Missouri (MP 986);
- Mississippi River, Missouri/Illinois (MP 1025);
- Silver Creek, Illinois (MP 1050);
- Hurricane Creek, Illinois (MP 1074); and
- Kaskaskia River, Illinois (MP 1076).

Keystone has committed to the use of the general river crossing procedures and mitigations included in the CMR Plan (Appendix B), and additional mitigations that have been agreed to as a result of this environmental analysis. The CMR Plan would be revised prior to construction to incorporate these additional mitigations, as well as any other mitigations or conditions that COE imposes during final permit negotiations.

For water body crossings greater than 100 feet in width where HDD would be used, no mitigation would be necessary because HDD does not involve direct contact with the surface water body, stream channel bed, or stream channel banks. HDD is not proposed to cross the following streams with widths greater than 100 feet along the Keystone Mainline Project route:

- Tongue River, North Dakota (MP 18);
- Sheyenne River, North Dakota (MP 169);
- James River, South Dakota (MP 424);
- Shell Creek, Nebraska (MP 533);
- Big Blue River, Kansas (MP 661);
- Platte River, Missouri (MP 765); and
- Grand River, Missouri (MP 843).

The following four water bodies along the Cushing Extension route would be crossed using HDD (ENSR 2007i, TransCanada 2007d):

- Republican River, Kansas (MP 51);
- Arkansas River, Kansas (MP 206);
- Salt Fork Arkansas River, Oklahoma (MP 243); and
- Cimarron River, Oklahoma (MP 289).

The Smoky Hill River in Kansas (MP 77) is greater than 100 feet wide but would be crossed by open-cut methods.

Additionally, the following streams contain important fisheries resources:

- West Fork of the Big Blue River, Nebraska (MP 593), and
- Turkey Creek, Nebraska (MP 600).

Where the HDD method is not used for major water body crossings or for water body crossings where important fisheries resources could be impacted, Keystone will submit a site-specific CMR Plan. Water bodies where a site specific CMR Plan would be employed include: Tongue River-North Dakota (MP 18), Sheyenne River-North Dakota (MP 167 [Note: Keystone is considering using HDD for this crossing]), James River-South Dakota (MP 424), Shell Creek-Nebraska (MP 533), West Fork of the Big Blue River-Nebraska (MP 593), Turkey Creek-Nebraska (MP 600), Big Blue River-Kansas (MP 665), Platte River-Missouri (MP 765), Grand River-Missouri (MP 843), Little Blue River-Kansas (MP 4), Smoky Hill River-Kansas (MP 77). Prior to commencing any stream crossing construction activities, Keystone would be required to obtain a permit under Section 404 of the Clean Water Act through the COE . Keystone also would be required to obtain a Section 401 water quality certification as per state regulations.

Construction activities for open-cut wet crossings involve excavation of the channel and banks. Construction equipment and soils excavated thus would be in direct contact with surface water flow. The degree of impact from construction activities depends 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.** Keystone would work with the applicable regulatory agency to develop specific crossing and sediment handling procedures and would provide DOS with a copy of that consultation.
- **Water Bodies within 1 Mile Upstream of HCAs.** Water body crossing methods would be developed in consultation with the applicable permitting agencies for each crossing. Keystone would not necessarily implement dry crossing or other measures for construction.
- **Sensitive/Protected Water Bodies.** Keystone would develop specific construction and crossing methods in conjunction with COE permitting and USFWS consultation. The appropriate method of crossing these water bodies would be determined by COE or USFWS, as applicable.

Implementation of measures in Section 7.4 of Keystone's CMR Plan (Appendix B) 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 water body restoration at crossings. See Section 2.2.3 for a discussion of Keystone's proposed water body crossing methods.

Following completion of water body crossings, water body 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. Additional erosion control measures would be installed, if necessary, in accordance with permit requirements. Erosion control measures can themselves cause adverse environmental impacts, however. Geomorphic assessment of water body 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 water body crossings would be assessed by qualified personnel in the design phase of the Project with respect to the potential for vertical channel degradation and lateral channel migration. The level of assessment for each crossing would vary based on the professional judgment of the qualified design personnel. Additionally, personnel would consult with each COE office with jurisdiction and with state resource agencies prior to making these determinations. The pipeline would be installed as 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 also would include the specification of appropriate stabilization and restoration measures.

In accordance with the CWA, all construction activities would comply with the NPDES permit and other applicable permitting; this includes following procedures in Keystone's Storm Water Pollution Prevention Plan, which would be required at the permitting stage.

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 32 surface water sources that could supply water for hydrostatic testing along the Mainline Project route and nine surface water sources along the Cushing Extension route, depending on the flows at the time of testing and the sensitivity of the individual water bodies for other uses (TransCanada 2007d. These sources are listed in Section 8.2 of Keystone's CMR Plan (see Appendix B) and Keystone's Hydrostatic Test Plan (also in Appendix B). Whenever possible, hydrostatic test manifolds would be located more than 100 feet away from wetlands and riparian areas.

All surface water resources utilized for hydrostatic testing would be approved by state or federal 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, Keystone will be responsible for obtaining required water analyses prior to any filling and discharging operations associated with hydrostatic testing.

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 such that applicable federal, state, and local environmental standards are met. Discharged water would meet the 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 any applicable state or local jurisdiction.

Connected Actions

Power Lines and Substations. Measures listed below would be implemented by servicing electric cooperatives or their contractors in the modification or construction of electric transmission lines:

- Construction activities would be performed by methods that prevent entrance, or accidental spillage, of solid matter contaminants, debris, any other objectionable pollutants and wastes into streams, flowing or dry watercourses, lakes, and underground water sources. Such pollutants and waste include, but are not restricted to refuse, garbage, cement, concrete, sanitary waste, industrial waste, radioactive substances, oil and other petroleum products, aggregate processing tailing, mineral salts, and thermal pollution.
- Excavated material or other construction materials would not be stockpiled or deposited near or on stream banks, lake shorelines, or other watercourse perimeters where they can be washed away by high water or storm runoff or can in any way encroach upon the actual watercourse itself. Best Management Practices would be utilized to ensure sediments and other pollutants do not enter any water body

Operations Impacts

Minor temporary to short-term surface water quality degradation is possible from maintenance equipment and vehicle spills or leaks. Although washout-related spills are not considered a part of routine operations, in the event that channel migration or streambed degradation would threaten to expose the pipeline, protective activities such as reburial or bank armoring would be implemented. These activities could result in temporary short-term or long-term adverse impacts to water resources. In its CMR Plan (Appendix B), Keystone has committed to a minimum depth of cover of 5 feet below the bottom of all water bodies, maintained for a distance of at least 15 feet to either side of the edge of the water body. However, in Keystone's Frequency and Volume Analysis Report (DNV 2007) the likelihood of washout-related spills for cover depths less than or equal to 10 feet is estimated to be twice that for cover greater than 10 feet. Channel incision of several meters is typical of many Midwestern streams and rivers; such incision would expose and threaten pipelines buried 5 feet (1.5 meters) below the channel bed. 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. Maintaining an adequate burial depth for pipelines in a zone that extends 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.

As stated in Section 3.3.2.2, all water body crossings would be assessed by qualified personnel in the design phase of the Project with respect to the potential for vertical channel degradation and lateral channel migration. The level of assessment for each crossing would 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

Although spills are not considered a part of routine operations, there is the possibility of a crude oil release occurring with the potential to affect surface water bodies. Keystone has submitted a draft ERP (Appendix C) that describes actions to reduce the potential for crude oil releases to affect surface water and groundwater resources. Potential impacts on water resources from accidental crude oil spills are described in Section 3.13.

As described in Section 3.13, control valves would be installed on both sides of larger perennial streams for the Mainline Project and the Cushing Extension pipelines. In the event of a crude oil release, the presence of valves and enactment of Keystone's ERP and spill containment measures would reduce the potential for any crude oil releases to affect surface water resources.

Connected Actions

Wood River Refinery Expansion. As part of ConocoPhillips' Wood River Refinery expansion, the daily average flows at outfalls 001 and 002 would increase from 7.93 and 7.78 mgd to 10.97 and 10.82 mgd, respectively. These outfalls discharge treated process, sanitary, and stormwater. Outfall 003 discharges stormwater and fire water intermittently, and outfalls 004–008 discharge storm water intermittently. The wastewater treatment system would be upgraded, including construction of a new activated sludge unit. The sludge unit would include a preanoxic denitrification zone that would convert nitrates to nitrogen gas.

Due to the increased flow and production associated with these modifications, load limits in the NPDES permit were increased and phosphorous limits were added (phosphorous additives are necessary for biological activity). These changes were made to existing discharge points (outfalls 001–008). The locations of these outfalls are described in Table 3.3.3-1.

TABLE 3.3.3-1
Locations of Outfalls at the Conoco Phillips' Wood River Refinery

Outfall	Receiving Stream	Latitude	Longitude
001	Mississippi River	38 deg 50' 25" N	90 deg 06' 15" W
002	Mississippi River	38 deg 50' 24" N	90 deg 06' 08" W
003	Unnamed Ditch (tributary to Little Grassy Lake/Mississippi River)	38 deg 49' 40" N	90 deg 04' 03" W
004	Mississippi River	38 deg 50' 35" N	90 deg 06' 14" W
005	Mississippi River	38 deg 50' 25" N	90 deg 06' 14" W
006	Mississippi River	38 deg 50' 27" N	90 deg 06' 14" W
007	Mississippi River	38 deg 50' 13" N	90 deg 06' 15" W
008	Mississippi River	38 deg 50' 13" N	90 deg 06' 15" W

All discharges (outfalls) are located in Madison County, Illinois. The Mississippi River and the unnamed ditch at these locations are classified as General Use streams and do not contain biological stream characterization ratings. According to the IDNR WIRT system, there are no threatened or endangered species inhabiting either of the receiving streams.

The Mississippi River (receiving discharge from outfalls 001, 002, and 004–008) is identified on the Section 303(d) list of impaired waterbodies. Impairment includes PCBs, manganese, and fecal coliform.

An Antidegradation Assessment was conducted pursuant to the Illinois Pollution Control Board regulation for antidegradation. The regulation can be found at 35 Ill. Adm. Code 302.105 (Antidegradation Standard).

Although daily average flows at outfalls 001 and 002 would increase, wastewater treatment improvements are planned as part of the modifications. It was concluded as part of the assessment that both phosphorous and nitrogen would decrease. Biological oxygen demand is not likely to increase. Although sulfate and chloride are expected to increase, because of abundant dilution in the Mississippi River, it was concluded that these parameters would be quickly diluted to below the water quality standard.

The assessment concluded that the proposed upgrades would result in attainment of water quality standards and that all existing uses of the surface water bodies would be fully protected.

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