3.2 SOILS AND SEDIMENTS

3.2.1 Affected Environment

Soil characteristics present in the proposed Project area are identified and evaluated using information from the NRCS Soil Survey Geographic (SSURGO) database (available online at http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx). The evaluation focused on soil characteristics of particular interest to the proposed pipeline construction. The following soil characteristics were evaluated:

- Highly erodible soils—prone to high rates of erosion when exposed to wind or water by removal of vegetation.
- Prime farmland soils—have combinations of soil properties, growing season, and moisture supply needed to produce sustained high yields of crops in an economic manner if they are treated and managed according to acceptable farming methods. Undeveloped land with high crop production potential may be classified as prime farmland.
- Hydric soils— "formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part." (Federal Register, July 13, 1994). These soils, under normal conditions are saturated for a sufficient period of time during the growing season to support the growth of hydrophytic vegetation (USDA 2006).
- Compaction-prone soils—clay loam or finer textures in somewhat poor to very poor drainage classes.
- Stony/rocky soils—have a cobbly, stony, bouldery, gravelly, or shaly modifier to the textural class; or are comprised of more than 5 percent stones larger than 3 inches in the surface layer.
- Shallow-bedrock soils—typically defined as soils that have bedrock within 60 inches of the soil surface. However, for the purpose of this Project, shallow-bedrock soils are defined as those containing bedrock within 80 inches of the surface, because trenching typically would be done to that depth.
- Drought-prone soils—include coarse-textured soils (sandy loams and coarser) that are moderately well to excessively drained.

Table 3.2.1-1 and Table 3.2.1-2 provide summaries of approximate miles of pipeline ROW by state that would cross soils exhibiting these characteristics. The tables include the approximate acreage (including proposed pump station locations) of soils containing these characteristics that would be disturbed by the Project. More detail is provided in Appendix G, including a table listing soil associations from the SSURGO database by milepost along the proposed route (Keystone 2008).

TABLE 3.2.1-1
Approximate Miles of Soil Characteristics Crossed by the Project

State	Total Miles Affected[a]	Highly Erodible	Prime Farmland	Hydric	Compaction-Prone	Stony/ Rocky	Shallow Bedrock	Drought-prone
Montana	282.5	111.5	68.9	1.4	232.1	37.0	4.6	22.7
South Dakota	314.1	124.1	106.1	5.2	252.1	9.2	1.2	66.2
Nebraska	254.1	161.3	104.7	20.8	120.9	13.2	0.3	76.7
Kansas	0	0	0	0	0	0	0	0
Oklahoma	155.4	41.7	69.0	5.8	127.8	35.6	14.0	22.8
Texas	373.4	120.9	168.6	72.8	309.8	7.5	54.7	49.1
Project Total	**1,379.5**	**559.5**	**517.3**	**106.0**	**1,042.7**	**102.5**	**74.8**	**237.5**

[a] Total miles affected include non-sensitive soils and other substrate.
Source: Keystone 2009c; rounded to nearest whole mile.

TABLE 3.2.1-2
Approximate Acreage of Soil Characteristics Crossed by the Project[a]

State	Approximate Acres Affected[a]	Highly Erodible	Prime Farmland	Hydric	Compaction-Prone	Stony/ Rocky	Shallow Bedrock	Drought-prone
Montana	4,087	1,597	1,294	20	3,698	533	29	482
South Dakota	4,485	1,754	1,935	75	4,369	131	23	1,557
Nebraska	3,604	1,929	518	305	482	197	7	390
Kansas	12	0	10	0	14	0	2	14
Oklahoma	2,206	548	434	1,789	906	317	503	1,511
Texas	5,163	1,210	2,304	2,290	3,463	366	474	2,054
Project Total	**19,557**	**7,074**	**6,495**	**4,479**	**12,981**	**1,544**	**1,038**	**6,008**

[a] The approximate acreages in this table should not be considered definitive. For most current estimates of total acreages impacted by state see Table 2.1.4-1.
Source: Keystone 2009a; rounded to nearest whole acre.

3.2.1.1 Montana

The proposed Project route in northern Montana is located within the Northern Great Plains Spring Wheat Land Resource Region (USDA 2006). This region is characterized by glacially deposited till and lacustrine deposits. Soil profiles typically contain thick, dark topsoils that may contain bentonite (smectitic mineralogy). Soils are generally very deep, well-drained, and loamy or clayey. Small areas of alluvial deposits are present along rivers and drainageways and shale is exposed in some uplands. In northern Montana, soils generally are formed in glacial till. From McCone County to Fallon County along the proposed pipeline route (east central Montana), soils are formed on eroded plateaus and terraces. These soils are shallow to very deep, well-drained, and clayey or loamy. Some soils in this area have high bentonite contents and have saline or sodic chemical properties.

In east central Montana, the proposed pipeline route lies within the Western Great Plains Range and Irrigated Land Resource Region (USDA 2006). This region consists of an elevated piedmont plain that is dissected by rivers and that contains steep sided buttes and badlands. Soil types vary from deep organic soils to shallow soils with thin topsoil thickness.

In Montana, prime farmland soils occupy approximately 24 percent of the pipeline route. The average freeze free period is between 120 and 165 days.

3.2.1.2 South Dakota

The proposed Project route in South Dakota is located within the Western Great Plains Range and Irrigated Land Resource Region (USDA 2006). In northwestern South Dakota, soils are shallow to very deep, well-drained, and loamy or clayey. To the southeast through Meade County, soils are shallow to very deep, somewhat excessively drained to moderately well-drained and loamy or clayey. In southern South Dakota from Hakkon to Tripp County, areas of smectitic clays are present that have shrink-swell potential and may cause significant problems for roads and structural foundations. From central Tripp County to the stateline, these clayey soils contain thick, dark, organically enriched layers of topsoil.

Beginning at MP 572, transitional aeolian sandy soils are present prior to entering the Sand Hills region in Nebraska. The Sand Hills region soils generally consist of aeolian sands, sandy alluvium, and lesser amounts of loess and glacial outwash. In southern Tripp County to the state line, soils grade into deep sandy deposits that are similar to the Sand Hills region soils in Nebraska.

In South Dakota, prime farmland soils occupy approximately 33 percent of the pipeline route. The average freeze free period is between 135 and 165 days.

3.2.1.3 Nebraska

The proposed Project route in northern Nebraska is located within the Western Great Plains Range and Irrigated Land Resource Region, and the remainder of Nebraska is located in the Central Great Plains Winter Wheat and Range Land Resource Region (USDA 2006). This region is characterized by a nearly level to gently rolling fluvial plain. Soils are similar to those in the Western Great Plains Range and Irrigated Region with warmer temperatures. Soils in Keya Paha County (northern Nebraska) are similar to those found in southern South Dakota. From Rock County to Greeley County, soils are generally sandy, very deep, excessively drained to somewhat poorly drained. From central to southern Nebraska, soils consist of deep loess deposits that are more susceptible to erosion. Soils in Hamilton County and extending to the state line contain thick, dark, organically-enriched layers of topsoil.

In northern and central Nebraska the pipeline route enters portions of the Sand Hills region from MP 595 to MP 707 (Figure 3.2.1-1) in Keya Paha, Rock, Holt, Garfield, Wheeler, Greeley, and Merrick counties. This region consists of a prairie landscape that supports livestock grazing, wildlife habitat, and recreation. Soils in the Sand Hills region consist of aeolian well sorted sands, sandy alluvium, and lesser amounts of loess and glacial outwash. The soils are generally very deep, excessively drained to somewhat poorly drained. Depressions and drainage areas are present. Wind-blown rolling to hilly sand dunes are common and are stabilized by vegetation. Where vegetation has been removed, severe wind erosion is common and is often referred to as a 'blowout'. In the Sand Hills region, a higher percentage (55 percent) of highly erodible soils is designated as erodible by wind due to the nature of the sandy soils in this region of the Project. In the southern portion of the Sand Hills Region (Garfield, Wheeler, and Greeley counties), approximately 24 miles of Valentine soils are present that consist of very deep, dry, rapidly permeable dune deposits; these soils contain severe wind erosion hazards.

In Nebraska, prime farmland soils occupy approximately 41 percent of the pipeline route. The average freeze free period is between 160 and 180 days.

3.2.1.4 Kansas

Construction planned in Kansas as part of the 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. Shallow soils of the Hedville series are present in these areas. These soils are loamy and were developed from the erosion of weathered non-calcareous sandstone. In Kansas, the average freeze free period is between 170 and 190 days.

3.2.1.5 Oklahoma

The proposed Project route in northern Oklahoma is located within the Central Great Plains Winter Wheat and Range Land Resource Region and the Southwestern Prairies Cotton and Forage Region (USDA 2006). The Southwestern Prairies Cotton and Forage Region consists of gently rolling to hilly uplands dissected by numerous streams. From Lincoln County to Seminole County, soils contain siliceous mineralogy and may contain bentonite. Soils range from shallow to very deep, somewhat excessively drained to somewhat poorly drained, and are typically loamy or clayey. Soils formed in alluvium on stream terraces, residuum on hills, and colluvium on footslopes. From southern Hughes County through Atoka County, soils have smectitic, carbonatic, or mixed mineralogy and were formed from limestone residuum. Soils in the southern portion of Oklahoma are generally deep to very deep, well-drained to moderately well-drained, and loamy or clayey.

In Oklahoma, prime farmland soils occupy approximately 43 percent of the pipeline route. The average freeze free period is between 245 and 290 days.

3.2.1.6 Texas

The proposed Gulf Coast segment in Texas is located within the Southwestern Prairies Cotton and Forage Region, the South Atlantic and Gulf Coast Slope Cash Crops, Forest, and Livestock Region and the Atlantic and Gulf Coast Lowland Forest and Crop Region (USDA 2006). The Houston Lateral is located in the Atlantic and Gulf Coast Lowland Forest and Crop Region.

Soils in the Southwestern Prairies Cotton and Forage Region from Fannin County to Franklin County generally consist of deep, black, fertile clay weathered from chalks and marls.

The South Atlantic and Gulf Coast Slope Cash Crops, Forest, and Livestock Region is comprised of smooth marine terraces and hilly piedmont areas. Soils are generally very deep, well-drained to poorly drained, and loamy or clayey. Soils have a siliceous, smectitic, or mixed mineralogy.

The Atlantic and Gulf Coast Lowland Forest and Crop Region is characterized by coastal lowlands, coastal plains, and the Mississippi River Delta. Soils in this region are formed in alluvium on flood plains, in depressions, and on terraces and are sandy and sometimes indurated. Soils have a siliceous, smectitic, or mixed mineralogy and consist of young deltaic sands, silts, and clays.

In Texas, prime farmland soils occupy approximately 52 percent of the pipeline route. The average freeze free period is 270 days.

3.2.2 Potential Impacts and Mitigation

3.2.2.1 Construction Impacts and Mitigation Measures

Pipeline construction activities, including clearing, grading, trench excavation, backfilling, heavy equipment traffic, and restoration along the construction ROW, could adversely affect soil resources. In addition, the construction of pump stations, access roads, construction camps and the tank farm could also affect soil resources. Potential impacts could include temporary and short-term soil erosion, loss of topsoil, short-term to long-term soil compaction, permanent increases in the proportion of large rocks in the topsoil, and short-term to permanent soil contamination. Pipeline construction also could result in damage to existing tile drainage systems. Special considerations and measures would also be undertaken in the Sand Hills region, described in detail, below.

In its Construction Mitigation and Reclamation (CMR) Plan (see Appendix B), Keystone has proposed construction procedures that are designed to reduce the likelihood and severity of Project impacts, and to mitigate where impacts are unavoidable. Potential Project impacts on soils are assessed assuming these construction procedures and applicant proposed environmental protection measures would be implemented.

Soil Erosion

Prior to construction, clearing of the temporary and permanent ROW would remove protective vegetative cover and could potentially increase soil erosion. Soil erosion could also occur during open cut trenching and during spoil storage, particularly where the soil is placed within a streambed. Where soils are exposed close to waterbodies, soil erosion and mobilization to receiving water bodies could impact water quality through increased turbidity or if potentially hazardous substances (such as pesticides or herbicides) are present in the eroded material. To accommodate potential discoveries of contaminated soils, contaminated soil discovery procedures would be developed in consultation with relevant agencies and these procedures would be added to the CMR Plan. If hydrocarbon contaminated soils are encountered during trench excavation, the state agency responsible for emergency response and site remediation would be contacted immediately and a remediation plan of action would be developed in consultation with that agency. Depending upon the level of contamination found, affected soil may be replaced in the trench, land farmed, or removed to an approved landfill for disposal.

Erosion may result in loss of valuable topsoil from its original location through wind and/or water erosion. A small portion of the Project would encounter droughty soils. Droughty soils would be prone to wind erosion during construction and would be more difficult to successfully stabilize and revegetate following construction. Approximately 31 percent of the overall Project acreage would be constructed

where the soils are characterized as highly erodible by either wind or water. Overall, the majority (69 percent) of 'highly erodible' soils are designated as erodible by water.

In Section 4.5 of its CMR Plan, Keystone has proposed construction methods to reduce soil erosion. These methods include installation of sediment barriers (silt fencing, straw or hay bales, sand bags), trench plugs, temporary slope breakers, drainage channels or ditches, and mulching. These erosion control measures would be implemented wherever soil is exposed, steep slopes are present, or wherever erosion potential is high. To enforce these methods, an Environmental Inspector (EI) would be assigned to each construction spread. The EI would have the authority to stop work and/or order corrective action in the event that construction activities violate the measures outlined in the CMR Plan, landowner requirements, or any applicable permit. Specifically, the EI would inspect temporary erosion control measures on a daily basis in areas of active construction or equipment operation, on a weekly basis in areas without active construction or equipment operation, and within 24 hours of continuous rainfall greater than 0.5 inch. Construction activities would be shut down during the winter months on the Steele City Segment to prevent the need for winter construction techniques. The repair of any ineffective erosion control measures would be completed within 24 hours of detection, where possible. If substantial precipitation or snowmelt events create erosion channels in areas where soil is exposed, additional sediment control measures would be implemented. Potential erosion control measures are described in Section 4.5 of the CMR Plan.

Compaction

On land with soils that are compaction prone, soil compaction may result from the movement of heavy construction vehicles along the construction ROW and additional temporary workspace areas, and on temporary access roads. The degree of compaction is dependant on the moisture content and texture of the soil at the time of construction and compaction would be most severe where heavy equipment operates on moist to wet soils with high clay contents. Detrimental compaction also can occur on soils if multiple passes are made by heavy equipment. If soils are moist or wet where trenchline only topsoil trenching can occur, topsoil would likely adhere to tires and/or tracked vehicles and be carried away. Compaction control measures are described in Section 4.5 of the CMR Plan and include ripping to relieve compaction in particular areas from which topsoil has been removed.

Prime Farmland Soils

Approximately 6,495 acres of prime farmland soils would be directly impacted by construction of the proposed pipeline (see Table 3.2.1-2 for a breakdown by state). Within the ROW, the existing structure of prime farmland soils may be degraded by construction. Grading and equipment traffic could compact soil, reducing porosity and percolation rates, which can result in increased runoff potential. As detailed in Section 4.0 of the CMR Plan, Keystone has proposed construction methods that are designed to reduce these impacts. The top 12 inches of topsoil would be removed and segregated during excavation activities. Stripped topsoil would be stockpiled in a windrow along the edge of the ROW. The work would be conducted to minimize the potential for mixing topsoil and subsoil. Topsoil would not be used to fill low lying areas and would not be used to construct ramps at road or waterbody crossings. Additional methodology detailed in the CMR Plan include ripping to relieve compaction in all areas from which topsoil has been removed, removing all excess rocks exposed due to construction activity, and adding soil amendments to topsoil as warranted by conditions and agreed to by landowners and/or federal or tribal entities. Additional mitigation measures to be employed on pasture and range lands are summarized in Section 4.12 of the CMR Plan.

Keystone is negotiating easement agreements with landowners and agencies that would require Keystone to restore the productivity of the ROW and provide compensation for demonstrated losses from decreased productivity resulting from pipeline operations.

Range and Pasture Land

On range, pastures and other areas not suitable for farming, construction and maintenance activities may lead to localized soil compaction in soils listed as hydric or compaction prone. This compaction could lead to slower or less successful vegetation reestablishment following construction. Keystone is negotiating easement agreements with landowners and agencies that would require Keystone to restore the productivity of the ROW and provide compensation for demonstrated losses from decreased productivity resulting from pipeline operations. Additional environmental protection measures to be employed on pasture and range lands are summarized in Section 4.12 of the CMR Plan.

Wet Weather Conditions

All soil types could be further impacted by erosion during major or continuous precipitation events. Soils identified as compaction-prone are subject to rutting and displacement as a result of movement of construction vehicles. When saturated, these soils may be particularly sensitive to rutting. Rutting may cause reduced aeration and infiltration of the soil and may cause surface water pooling or water diversion, which increases localized soil erosion.

Stockpiled topsoil and trench spoils could cause water to pond during precipitation events. Despite the protection measures described below, it is possible that precipitation events may cause unavoidable soil erosion by water. Keystone would minimize the potential for these impacts by scheduling construction during drier months of the year. Table 3.2.2-1 below presents the average precipitation per month for selected locations (one in each state) along the proposed pipeline.

TABLE 3.2.2-1
Monthly Average Total Precipitation in the Vicinity of the Project (inches)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Circle, Montana Location[1]	0.4	0.3	0.6	1.3	2.0	2.6	1.9	1.3	1.3	0.8	0.4	0.4	13.4
Midland, South Dakota Location[2]	0.3	0.4	1.1	1.6	2.8	3.1	2.2	1.7	1.4	1.1	0.5	0.3	16.4
Lincoln, Nebraska Location[3]	0.7	0.9	2.1	2.9	4.3	3.6	3.4	3.4	3.0	1.9	1.5	0.8	28.4
Marion Lake, Kansas Location[4]	0.7	0.9	2.4	3.0	4.6	4.9	3.8	3.8	3.2	2.8	1.7	1.0	33.0
Keystone Cushing, Oklahoma Location[5]	1.2	1.9	3.2	3.7	5.8	4.4	2.9	2.7	40.7	3.4	2.9	1.9	38.2
Beaumont/Port Arthur Texas Location[6]	5.7	3.4	3.8	3.8	5.8	6.6	5.2	4.8	6.1	4.7	4.7	5.2	59.9
Houston, Texas Location[7]	6.7	1.3	8.8	4.8	9.6	5.6	10.0	7.2	6.3	1.8	4.4	1.6	5.9

[1] Source: Western Regional Climate Center (WRCC), Circle, Montana, Station 241758, http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?mt1758
[2] Source: High Plains Regional Climate Center (HPRCC), Midland, South Dakota, Station 395506, http://hprcc1.unl.edu/cgi-bin/cli_perl_lib/cliMAIN.pl?sd5506
[3] Source: High Plains Regional Climate Center (HPRCC), Lincoln WSO Airport, Nebraska, Station 254795, http://hprcc1.unl.edu/cgi-bin/cli_perl_lib/cliMAIN.pl?ne4795
[4] Source: High Plains Regional Climate Center (HPRCC), Marion Lake, Kansas, Station 145039, http://hprcc1.unl.edu/cgi-bin/cli_perl_lib/cliMAIN.pl?ks5039
[5] Source: National Oceanic and Atmospheric Association (NOAA), Cushing, Oklahoma, Station CUS02, http://www.srh.noaa.gov/oun/climate/getnorm.php?id=cuso2
[6] Source: National Oceanic and Atmospheric Association (NOAA), Beaumont, Texas, http://www.srh.noaa.gov/lch/climate/coop/KBPT.htm
[7] Source: National Oceanic and Atmospheric Association (NOAA), Houston, Texas, http://www.srh.noaa.gov/hgx/climate/reviews/010308pns.txt
Note: T = Trace amounts
Source: Keystone 2009c.

Section 2.18 of Keystone's CMR Plan describes methodology to determine when to restrict or stop work for wet weather and summarizes methods to mitigate impacts when construction activities are conducted in wet conditions. As described in the CMR Plan, work shall be restricted or suspended during wet conditions when potential rutting could cause mixing of topsoil and subsoil, excessive buildup of mud or soil on tires, increased ponding of surface water in the work area, and the potential for severe compaction. During excessive wet conditions, protection measures that may be implemented include limiting work to areas that have adequately drained soils or have sufficient vegetation cover to prevent mixture of topsoil with subsoil, installing geotextile material or construction mats in saturated areas, or using low-impact construction techniques such as using low-ground weight or wide-track equipment. Additionally, a "stop work" directive would be implemented when recommended by the EI.

Construction in Rocky Soils

In areas where rocky soil or shallow bedrock is present, pipeline backfill activities could result in concentration of large clasts near the surface. As detailed in Section 4.11 of the CMR Plan, specific construction methods would be utilized to ensure that disturbed areas are returned to conditions consistent with pre-construction use and capability. These methods include topsoil removal, segregation and redistribution during backfilling, and off-site removal of excess rocks and rock fragments. The size threshold for rock removal would be consistent to that which is found in adjacent undisturbed areas off the ROW. As stated in the CMR Plan, this effort would result in an equivalent quantity, size and distribution of rocks to that found on adjacent lands. In areas where blasting is required, procedures would be followed as described in Section 4.7 of the CMR Plan. Specifically, the drilling pattern, in preparation for blasting, would be conducted in a manner so that smaller rock fragmentation (maximum 1 feet in diameter) would be achieved. This would enable increased use of blasted rock as backfill material after the pipe has been padded in accordance with Project specifications.

Soils Drained by Drain Tile Systems

Construction of the proposed pipeline would, in places, necessitate disruption of existing drain tile systems. In Section 5.0 of its CMR Plan, Keystone and its contractors have committed to identifying and avoiding or, where necessary, repairing or replacing drainage tiles that could be damaged by pipeline construction (Keystone 2008, CMR Plan Sec 5.4). Adherence to these procedures should eliminate or compensate for any long-term impacts to drain tile function, however, temporary impacts to the drain tile system would be experienced during construction and existing soils could become saturated during wet weather conditions or during periods of continuous precipitation. Wet weather measures are described above. Keystone's easement agreements with landowners, agencies and/or tribal entities would require Keystone to provide compensation for any demonstrated losses, including flooding that could occur because of temporary disruption of drain tile systems.

Sand Hills Region

The Sand Hills region contains soils that are especially sensitive to wind erosion. Specific construction, reclamation, and post-construction activities that would be employed are described Section 4.15 in the CMR Plan and in the Project brochure *Pipeline Construction in Sand Hills Native Rangelands* prepared for the DOS (Appendix H). Keystone recognizes that these native rangelands create unique challenges for restoration and reclamation. During Project scoping and in preparation of the documents mentioned above, Keystone engaged in discussions with regional experts from the University of Nebraska, University of South Dakota, the Natural Resources Conservation Service (NRCS), and Nebraska state road department.

To mitigate potential impacts related to severe erosion, the following Best Management Practices (BMPs) would be incorporated during the construction phase in the Sand Hills region (Keystone 2009c).

- Minor re-routes would be incorporated to locate the right of way in areas of increased soil moisture (decreased erosion potential), while avoiding wetlands wherever possible.
- Specific training would be provided for construction crews prior to working in the Sand Hills region.
- Keystone would prepare an Access Control Plan to be incorporated while work is being conducted in the Sand Hills region. The plan would detail specific timing to conduct construction activities, ways to reduce traffic volume during construction, restriction of equipment and vehicle types, and measures to address site specific issues.
- Disturbance of fragile soils and native vegetation would be avoided to the extent practicable.
- Topsoil would be segregated from subsoil, consistent with Project BMPs.
- Following pipeline installation, revegetation of the ROW would be completed using native seed adapted to the Sand Hills region.
- Straw or native prairie hay would be crimped into the exposed soil to prevent wind erosion. Annual cover crops could also be used for vegetative cover.
- Straw wattles would be used where appropriate to provide erosion control instead of slope breakers that are composed of soil.
- Photodegradable matting would be used on steep slopes or other areas that are prone to high wind exposure such as ridgetops or north and west facing slopes. Biodegradable pins would be used to hold the matting in place.
- If necessary, fencing would be incorporated to keep livestock from grazing on vegetation within the ROW to hasten vegetation re-establishment.
- Reclamation and revegetation on the ROW would be monitored for several years. Areas of failure would be repaired.

The above described BMPs and protection measures are also described in Section 4.15 in the CMR Plan.

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

- The creation of a site specific erosion control and revegetation plan for agency approval prior to the start of construction (MDEQ).
- Ripping of subsoils on range and pasture lands if requested by the landowner or land management agency (MDEQ).

Potential Spills and Leaks

Construction impacts and mitigation resulting from fuel or lubricating oil leaks or spills during construction are addressed in Section 3.13.

3.2.2.2 Operations Impacts and Mitigation

During the operational phase of the Project, small scale, isolated surface disturbance impacts could occur from pipeline maintenance traffic and incidental repairs. This could result in accelerated erosion, soil compaction and related reductions in the productivity of desirable vegetation or crops. Impacts related to excavation and topsoil handling would be limited to small areas where certain pipeline maintenance activities take place. During operation, these types of impacts would be addressed with the affected landowner or land management agency and a mutually agreeable resolution reached.

Soil Erosion

Operational maintenance of cleared areas could lead to minor increases in soil erosion by wind or water, however these impacts would be very localized in nature. These impacts are expected to be minor. If necessary, localized soil erosion would be mitigated using measures outlined in Section 4.5 of its CMR Plan (Appendix B). BMPs may include installation of sediment barriers (silt fencing, straw or hay bales, sand bags, etc.), trench plugs, temporary slope breakers, drainage channels or ditches, and mulching. These erosion control measures would be implemented wherever soil is exposed, steep slopes are present, or wherever erosion potential is high (Keystone 2008, CMR Plan Sec 4.5).

Compaction

Maintenance activities could lead to localized compaction due to vehicular traffic during maintenance operations. These impacts are expected to be minor. Although not anticipated, Keystone recognizes its responsibility to restore agricultural productivity and maintain productivity of range and pasture land soils on the ROW. In the event that agricultural productivity is impaired by vehicular compaction, Keystone would compensate landowners for demonstrated losses associated with decreased productivity resulting from pipeline operation (Keystone 2008, CMR Plan Sec 4.11).

Soil Productivity

The ROW would be monitored to identify any areas where soil productivity has been degraded as a result of pipeline construction. Reclamation measures would be implemented to rectify any such concerns, as outlined in the CMR Plan (Appendix B).

Differential Settling

Although Keystone has committed to returning the ROW to its pre-construction topography, some differential settling could occur. Once construction is complete, Keystone would inspect the ROW to identify areas of erosion or settling in the first year after construction. Keystone would monitor erosion and settling through aerial patrols, which are part of Keystone's Integrity Management Plan, and through landowner reporting. Landowner reporting would be facilitated through use of Keystone's toll-free telephone number, which would be made available to all landowners on the ROW (Appendix B).

Soil Temperature Impacts

Due to the relatively high temperature of the oil in the pipeline, increased pipeline operation temperatures may cause a very localized increase in soil temperatures and a decrease in soil moisture content. Keystone conducted a detailed analysis of the effects of pipeline operations on winter and summer soil temperatures in six locations along the proposed route (one in each state), based on operating volumes of 900,000 bpd (Keystone 2009c).

The study concluded that the pipeline does have some effect on the surrounding soil temperature, however, these effects occur primarily at the pipeline depth. Near-surface soil temperatures are influenced mainly by climate, with minimal effects from pipeline operations. Direct temperature effects on vegetation are expected to be minimal and vary seasonally. Potential positive vegetation responses may include accelerated seeding emergence and increased production directly above the pipeline. Potential negative vegetation responses may include decreased water availability and decreased production directly above the pipeline. In conclusion, Keystone does not anticipate any significant overall effect to crops and vegetation associated with heat generated from the operating pipeline. If negative impacts to agricultural productivity did occur, these impacts would be addressed by Keystone's easement agreements. Keystone would be required to restore the productivity of the ROW and/or compensate landowners for demonstrated losses associated with decreased productivity resulting from pipeline operation.

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

- Conduct ground patrols to detect and repair any differential settling or subsidence holes that develop over the life of the Project (MDEQ).

Potential Spills and Leaks

Operational impacts and mitigation resulting from leaks or spills during operations are addressed in Section 3.13.

3.2.3 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 soil resources.

3.2.4 References

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