3.2 SOILS AND SEDIMENTS

3.2.1 Environmental Setting

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— surface 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 proposed 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 proposed Project. More detail is provided in Appendix G, including a table listing soil associations from the SSURGO database by milepost along the proposed Project route.

TABLE 3.2.1-1 Approximate Miles of Soil Characteristics Crossed by the Proposed Project									
State	**Total Miles Affected[a]**	**Highly Erodible (Wind)**	**Highly Erodible (Water)**	**Prime Farmland**	**Hydric**	**Compaction-Prone**	**Stony/ Rocky**	**Shallow Bedrock**	**Drought-prone**
Montana	282.7	5.6	109.7	67.8	1.6	233.5	29.6	4.1	20.9
South Dakota	314.2	16.6	107.6	106.3	5.2	251.8	9.0	1.1	65.6
Nebraska	254.7	93.7	81.5	99.6	21.7	118.6	13.2	0.3	73.8
Kansas	0	0	0	0	0	0	0	0	0
Oklahoma	156.0	14.4	27.4	69.7	5.9	130.5	30.7	14.5	22.4
Texas	376.4	44.8	33.7	170.3	75.2	313.0	6.5	53.1	43.1
Proposed Project Total	**1,383.9**	**175.1**	**359.8**	**513.7**	**109.5**	**1,047.4**	**89.0**	**73.2**	**225.8**

[a] Total miles affected include non-sensitive soils and other substrate.

Note: Rounded to nearest whole mile.

TABLE 3.2.1-2 Approximate Acreage of Soil Characteristics Crossed by the Proposed Project[a]									
State	**Approximate Acres Affected[a]**	**Highly Erodible (Wind)**	**Highly Erodible (Water)**	**Prime Farmland**	**Hydric**	**Compaction-Prone**	**Stony/ Rocky**	**Shallow Bedrock**	**Drought-prone**
Montana	4,086	83	1,608	961	25	3,367	424	58	302
South Dakota	4,488	233	1,553	1,490	76	3,603	128	16	929
Nebraska	3,734	1,465	1,291	1,389	305	1,668	187	5	1,181
Kansas	15	0	1	14	0	15	2	6	0
Oklahoma	2,215	201	390	985	80	1,856	435	200	315
Texas	5,171	640	478	2,311	989	4,299	92	753	614
Proposed Project Total	**19,710**	**2,621**	**5,321**	**7,150**	**1,474**	**14,807**	**1,268**	**1,037**	**3,341**

[a] This table includes land impacted by the centerline ROW and Additional Temporary Workspace Areas (TWAs) (and the 2 pump stations in Kansas). For land acreage affected by pipe stockpile sites, rail sidings, contractor yards, pump stations/delivery facilities, and access roads, see Table 2.1.4-1.

Note: 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 state line, these clayey soils contain thick, dark, organically enriched layers of topsoil. Beginning at MP 572, transitional aeolian sandy soils are present that 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 34 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 topsoil is typically sand mixed with organic matter, with the top 6 inches including vegetative root systems and the native vegetation seed bank. The soils are generally very deep, excessively drained to somewhat poorly drained with intermittent wetland depressions. The rolling to hilly sand dunes that are common in this area have been stabilized by the existing vegetative cover. Where the vegetative cover has been disturbed or removed without restoration, severe wind erosion associated with the prevailing northwesterly winds typically creates steep-sided irregular or conical depressions referred to as 'blowouts'. Blowouts are most commonly associated with fence lines, windmills, and other features where cattle create trackways that allow the initiation of wind funneling (Wedin, Pers. Comm. 2011). In the Sand Hills region 55 percent of soils designated as highly erodible soils are so designated as a result of their susceptibility to wind erosion. The most erosive months of the year are March, April, and May and the least erosive months are the summer months June, July, and August (Wedin, Pers. Comm. 2011). In the spring months, sustained winds of approximately 162 feet per second with gusts with nearly double that velocity can occur (Stubbendieck et al. 1989). In the eastern portion of the Sand Hills region, non dune derived soils originate from glacial loess and drift deposits (Sullivan 1994). In the southern portion of the Sand Hills region (Garfield, Wheeler, and Greeley counties), approximately 24 miles of Valentine soils are present that are highly susceptible to wind erosion and consist of very deep, dry, highly permeable dune deposits. The sandy soils typical of the Sand Hills region have a high infiltration rate and high permeability; however, the fine-grained loess deposits further to the east can be as thick as 200 feet and can locally restrict water flow where fractures are absent (Stanton and Qi 2007, Johnson 1960). In Nebraska, prime farmland soils occupy approximately 39 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 proposed Project comprises two new pump stations and appurtenant facilities, including transmission lines and access roads located in Clay and Butler counties at MP 49.7 and MP 144.6, 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 45 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 45 percent of the pipeline route. The average freeze free period is 270 days.

3.2.2 Potential Impacts

3.2.2.1 Construction Impacts

Pipeline construction activities, including clearing, grading, trench excavation, backfilling, 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, soil mixing, 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.

The proposed Project CMR Plan (Appendix B) includes construction procedures that are designed to reduce the likelihood and severity of proposed Project impacts. Proposed 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 (Appendix B). 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 proposed 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 39 percent of the overall proposed Project acreage would be constructed where the soils are characterized as highly erodible by either wind or water. Overall, the majority (67 percent) of 'highly erodible' soils are designated as erodible by water.

Proposed construction methods to reduce soil erosion include installation of sediment barriers (silt fencing, straw or hay bales, and sand bags), trench plugs, temporary slope breakers, drainage channels or ditches, and mulching (see CMR Plan, Appendix B). 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 (Appendix B), 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. 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 the CMR Plan (Appendix B).

Compaction

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

Prime Farmland Soil

Approximately 7,150 acres of prime farmland soil 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 soil may be degraded by construction. Grading and equipment traffic could compact soil, reducing porosity and percolation rates, which can result in increased runoff potential. Construction methods that would reduce impacts to prime farmland soils are summarized in the following sections.

Topsoil and Subsoil Handling

In non-forested agricultural areas, 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 (Appendix B) 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.

Areas along the proposed pipeline route were evaluated to identify areas where special handling and additional soil salvage techniques could be necessary to conserve agricultural capability. Physical (i.e. texture, organic matter content) and chemical (i.e. salinity, sodicity, pH) characteristics of individual soil horizons, as well as more general factors such as geographic setting, climate, and associated ecology, have been evaluated in South Dakota consistent with South Dakota Public Utilities Commission conditions. These same characteristics will be evaluated in other areas where soils with similar chemical and physical characteristics occur in low-precipitation portions of the proposed Project. In general, soils considered for special handling contain suitable growing conditions in the topsoil horizon and upper sub-soil horizon (horizons immediately underlying the topsoil), but contain undesirable soil conditions at greater depths which could potentially result in degradation of agricultural capability if not managed appropriately. Soil characteristics criteria were developed in consultation with the NRCS to determine areas where special handling may be effective. Characteristics that trigger consideration for special handling include soil with contrasting levels of salinity/sodicity, interbedded coarse soil layers, or shallow to moderate depths to bedrock that occur within cultivated fields or high-quality native prairie or rangeland. Candidate soils for special handling are identified using publicly available NRCS soil survey data (SSURGO) for all upper sub-soil horizons located within 24 inches of the surface. These data are overlain on landuse mapping that has been compiled from pedestrian and vehicle surveys and aerial photo-interpretation. The criteria and thresholds for each soil property are presented in Table 3.2.2-1.

TABLE 3.2.2-1
Soil Criteria and Thresholds for Determining Special Handling Techniques in Cultivated Land and High-Quality Prairie or Rangeland

Characteristics	Upper Sub-soil Horizon	Lower Horizons
Salinity (EC)	<8 mmhos/cm[a]	≥4 mmhos/cm higher than EC of upper sub-soil horizon
Sodicity (SAR)	<13	≥13
Coarse Fragments – percent by volume	<15 %	≥15 %
Lithic / Paralithic Contact	Soil series with lithic or paralithic contact between 15 inches and 40 inches of depth from surface	

[a] mmhos/cm = millimhos per centimeter.

The properties of topsoil and upper sub-soil horizons are compared to data from all deeper sub-soil horizons to identify contrasting horizons and the NRCS soil series that contain contrasting soil horizons. These soils contain upper sub-soil horizons with suitable reclamation characteristics that are at least 6 inches thick, but are underlain by horizons that contain undesirable soil characteristics identified in Table 3.2.2-1. Each soil series meeting special handling criteria is evaluated to determine the magnitude of the inter-horizon differences in relation to factors such as the physical or chemical characteristics of the other horizons within the soil profile. This case-by-case evaluation of the soil series is used to evaluate the agricultural capability and reclamation potential of soils and anticipated results as a result of proposed Project construction. The exact locations of soils that require special soil handling are mapped and then field-verified along the proposed Project route.

The standard topsoil salvage plan for the proposed Project is to salvage topsoil from the pipeline ROW and other construction sites where excavation or grading would occur. Topsoil stripping depths have been determined through a combination of field surveys along the proposed route and verified using topsoil depths reported by the NRCS soil surveys. Salvage depths would vary from 4 inches in shallow soils to 12 inches in highly productive soils. In general, recommended topsoil salvage depths would be designed to conserve the high organic content soils that do not contain physical or chemical conditions that could inhibit soil capability. Two primary means of salvaging soil in areas that meet the criteria outlined in Table 3.2.2-1 include "over-stripping" and "triple lift".

In areas recommended for over-stripping topsoil, the soil salvage would extend below the surface horizon into the underlying sub-surface soils (usually a B-horizon). This type of salvage would be used as a precautionary approach to conserve native seed and organics in the topsoil and provide a buffer over less desirable sub-soil materials. In general, soils recommended for over-stripping topsoil commonly are of low quality and support perennial grasses.

The triple lift soil salvage technique would be implemented in areas where deep soils would be excavated, primarily over the pipeline trench in cultivated fields. In these areas the topsoil would be salvaged across the entire proposed Project area according to the depth determined during pre-construction surveys. The second-lift material would be salvaged and windrowed next to the salvaged topsoil. The trench spoil material would then be placed adjacent to the second-lift material. Following construction, the soils would be replaced in the opposite order of extraction and would be feathered across the proposed Project area. An example of this procedure is shown in Figure 3.2.2-1.

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. Productivity of range and pasture land along the proposed Project corridor would be restored consistent with easement agreements with landowners and agencies and compensation would be provided 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 the proposed Project CMR Plan (Appendix B).

Wet Weather Conditions

All soil types could be 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. The potential for these impacts would be reduced by scheduling construction during drier months of the year whenever possible. The average precipitation per month for selected locations (one in each state) along the proposed Project route are presented in Table 3.2.2-2.

TABLE 3.2.2-2
Monthly Average Total Precipitation in the Vicinity of the Proposed Project (inches)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Circle, Montana [a]	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 [b]	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 [c]	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 [d]	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
Cushing, Oklahoma [e]	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 [f]	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 [g]	6.7	1.3	8.8	4.8	9.6	5.6	10.0	7.2	6.3	1.8	4.4	1.6	68.1

[a] Source: Western Regional Climate Center (WRCC), Circle, Montana, Station 241758, http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?mt1758

[b] Source: High Plains Regional Climate Center (HPRCC), Midland, South Dakota, Station 395506, http://hprcc1.unl.edu/cgi-bin/cli_perl_lib/cliMAIN.pl?sd5506

[c] 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

[d] Source: High Plains Regional Climate Center (HPRCC), Marion Lake, Kansas, Station 145039, http://hprcc1.unl.edu/cgi-bin/cli_perl_lib/cliMAIN.pl?ks5039

[e] Source: National Oceanic and Atmospheric Association (NOAA), Cushing, Oklahoma, Station CUS02, http://www.srh.noaa.gov/oun/climate/getnorm.php?id=cuso2

[f] Source: National Oceanic and Atmospheric Association (NOAA), Beaumont, Texas, http://www.srh.noaa.gov/lch/climate/coop/KBPT.htm

[g] Source: National Oceanic and Atmospheric Association (NOAA), Houston, Texas, http://www.srh.noaa.gov/hgx/climate/reviews/010308pns.txt

Note: T = Trace amounts

The proposed Project CMR Plan (Appendix B) includes methods to determine when to restrict or stop work for wet weather and summarizes methods to reduce impacts when construction activities are conducted in wet conditions. Work would 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 could 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 the CMR Plan (Appendix B), 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 (Appendix B), this effort would result in an equivalent quantity, size and distribution of rocks to that found on adjacent lands.

Soils Drained by Drain Tile Systems

Construction of the proposed pipeline would occasionally necessitate disruption of existing drain tile systems. Drainage tiles would be identified and avoided or if necessary repaired or replaced if damaged by pipeline construction. 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. Any demonstrated losses resulting from that occur due to temporary disruption of drain tile systems would be compensated in accordance with landowner and land manager easement agreements.

Sand Hills Topographic Region

In northern and central Nebraska the proposed pipeline route enters portions of the Sand Hills topographic region from MP 595 to MP 707 (Figure 3.2.1-1) in Keya Paha, Rock, Holt, Garfield, Wheeler, Greeley, and Merrick counties (see Section 3.2.1). Many comments on the draft and supplemental draft EIS expressed concerns related to construction in the Sand Hills topographic region. The Sand Hills topographic region contains soils that are especially sensitive to wind erosion. To address concerns related to potential erosion in the Sand Hills, specific construction, reclamation, and post-construction procedures have been developed, as described in the proposed Project CMR Plan (Appendix B), and in two specific Sand Hills construction documents. These documents (*Pipeline Construction in Sand Hills Native Rangelands* and *Sand Hills Construction/Reclamation Unit*, a site-specific reclamation plan that itemizes construction, erosion control, and revegetation procedures in the Sand Hills region) are presented in Appendix H. DOS recognizes that these native rangelands create unique challenges for restoration and reclamation. DOS has confirmed that Keystone consulted with regional experts from the University of Nebraska, University of South Dakota, the Natural Resources Conservation Service (NRCS), and the Nebraska state road department in the development of construction and reclamation plans for the Sand Hills region. The goal of the Sand Hills region reclamation plan that resulted from these consultations is to protect the integrity of this sensitive area through: maintaining soil structure and stability to the greatest extent practicable; stabilizing slopes to prevent erosion; restoring native grass species; maintaining wildlife habitat and livestock grazing production; and meeting the specifications for Sand Hills construction, operation and maintenance contained in the proposed Project CMR Plan (Appendix B) contract documents and details, and all applicable permits and easement descriptions.

To reduce potential impacts related to severe wind or water erosion, the following Best Management Practices (BMPs) have either been incorporated during proposed Project design or would be incorporated during construction in the Sand Hills topographic region if the proposed Project is implemented:

- The location of the proposed ROW has been sited to avoid ridgetops and existing wind blowout areas to the extent practicable;
- Specific training would be provided for construction crews prior to working in the Sand Hills region;
- Minor re-routes would be incorporated if necessary to relocate the ROW to areas with decreased wind or water erosion potential, while avoiding wetlands wherever possible;
- Grading and side-slope cuts would be minimized to the extent practicable;
- Tracked equipment and/or low ground pressure equipment would be utilized to the extent practicable during construction;
- Access to construction areas would be limited through an Access Control Plan while work is being conducted in the Sand Hills region. The plan would detail specific timing to conduct construction activities, methods to reduce traffic volume, restrictions on equipment and vehicles allowed to enter the work area, and procedures to identify and reduce any site specific issues that develop during construction;
- Disturbance of soils and native vegetation would be avoided to the extent practicable;
- Topsoil, if present, would be segregated from subsoil, consistent with proposed Project BMPs;
- Root crowns and root structures would be left in place to the maximum extent practicable;
- Following pipeline installation, revegetation of the ROW would be completed using native seed mixes 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 in place of earthen slope breakers;
- Photodegradable matting would be used to protect 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;
- During pipeline installation into the pipeline ditch, the maximum length of open-ditch would be limited to ten miles. Trench backfilling, final cleanup, erosion control, and revegetation must occur on a schedule that prevents the length of open-ditch from exceeding this limit; and
- Since revegetation with native species typically requires several growing seasons, the ROW through the Sand Hills topographic region would be monitored for several years to ensure that reclamation and revegetation efforts are successful. Any areas where reclamation and

revegetation efforts are initially unsuccessful would be reevaluated and restored (see Appendix H).

In response to concerns expressed relative to wind erosion in the Sand Hills topographic region, DOS also contacted an expert in Sand Hills reclamation who provided input to the Keystone plans included in Appendix H. Based on input received through this contact, the following additional considerations relative to Sand Hills erosion are provided (Wedin, Pers. Comm. 2011):

- Use of erosion control mats or blankets may be advisable anywhere in the Sand Hills that is not in a wet meadow environment;
- A fire management plan should be developed and implemented during proposed Project construction;
- Revegetation seed beds should not be over-prepared but rather left more heterogeneous and irregular; and
- Landowners should be reminded that revegetated areas would be attractive as cattle forage and fencing of the revegetated ROW may be advisable, since animal trackways can serve as incipient blowout areas, and due to potentially warmer soils in the immediate vicinity of the proposed pipeline early forage may be concentrated along the ROW over time.

Potential Spills and Leaks

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

3.2.2.2 Potential Additional Mitigation Measures

The following potential mitigation measures have been suggested by regulatory agencies:

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

3.2.2.3 Operations Impacts

During the operational phase of the proposed 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 reduced using measures outlined the proposed Project 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 (CMR Plan, Appendix B).

Compaction

Maintenance activities could lead to localized compaction due to vehicular traffic during maintenance operations. These impacts are expected to be minor. In the event that agricultural productivity is impaired by vehicular compaction associated with the proposed Project, landowners and land managers would be compensated for demonstrated losses associated with decreased productivity (CMR Plan, Appendix B).

Soil Productivity

The ROW would be monitored to identify any areas where soil productivity has been degraded as a result of pipeline construction. Necessary reclamation measures would be implemented to rectify any such concerns. Several commenters on the draft EIS questioned whether landowners would be compensated for loss of soil productivity resulting from operation of the proposed Project. DOS understands that Keystone is negotiating easement agreements with landowners and land management 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 to the extent required by the easement or ROW agreement.

Differential Settling

Once construction is complete, the ROW would be inspected to identify areas of erosion or settling in the first year after construction. Erosion and settling would be monitored through aerial patrols consistent with the Integrity Management Plan (IMP), and through landowner reporting. Landowner reporting would be facilitated through use of a toll-free telephone number that would be provided to all landowners and land managers along the proposed Project ROW (Appendix B).

Sand Hills Topographic Region

To address concerns related to potential erosion in the Sand Hills, specific construction, reclamation, and post-construction procedures have been developed, as described in the proposed Project CMR Plan (Appendix B) and in two specific Sand Hills construction documents presented in Appendix H; *Pipeline Construction in Sand Hills Native Rangelands*, and *Sand Hills Construction/Reclamation Unit* (a site specific reclamation plan that itemizes construction, erosion control, and revegetation procedures in the Sand Hills region). The proposed Project ROW through the Sand Hills would be monitored for several years to ensure that reclamation and revegetation efforts are successful. Any areas where reclamation and revegetation efforts are initially unsuccessful would be reevaluated and restored.

Soil Temperature Impacts

Due to the relatively high temperature of the oil in the pipeline, increased pipeline operation temperatures may cause a localized increase in soil temperatures and a decrease in soil moisture content. 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) was conducted based on operating volumes of 900,000 bpd (see Appendix L). The modeled temperature effects are likely to be conservative since the maximum operating volume of the proposed Project is now 830,000 bpd.

Based on these analytical results, operation of the proposed Project would cause slight increases in soil temperatures at the soil surface of 4 to 8 ˚F primarily during January to May and November to December along the pipeline route in Montana, South Dakota, and Nebraska (see Appendix L), and negligible increases from May to November. Increases in temperatures at the soil surface would be most pronounced directly over the pipeline in the South Dakota portion of the pipeline (up to nearly 10 degrees in March and April). Soil surface temperatures over the pipeline route, and year-round soil surface temperatures would remain unchanged in Oklahoma and Texas. Operation of the proposed Project would cause increases in soil temperature 6 inches below the surface of 10 to 15 ˚F with the largest increases during March and April in the Steele City Segment of the proposed Project (see Appendix L). Soil temperatures close to the pipeline could be as much as 40˚ F warmer than the ambient surrounding soil temperatures (see Appendix L).

See Section 3.4 and Section 3.5 for corresponding effects to wetlands and vegetation due to soil temperature increases.

Potential Spills and Leaks

Impacts due to leaks or spills during operation of the proposed Project are addressed in Section 3.13.

3.2.2.4 Potential Additional Mitigation Measures

The following potential mitigation measures have been suggested by regulatory agencies and university professors:

- Conduct ground patrols to detect and repair any differential settling or subsidence holes that develop over the life of the proposed Project in Montana (MDEQ). As discussed in Section 3.13, regular aerial patrols would occur and these patrols would look for evidence of differential settling or subsidence along the proposed Project corridor. Relative to additional ground patrols, Keystone responded to a data request from DOS concerning the feasibility of more ground-level inspections. Keystone responded that based on land owner concerns, additional ground-level inspections are not feasible due to potential disruption of normal land use activities (e.g., farming, animal grazing). PHMSA technical staff indicated that such concerns about landowner acceptance of more frequent ground-level inspections were consistent with their experience with managing pipelines in the region. Although widespread use of ground-level inspections may not be warranted, in the start-up year it is not uncommon for pipelines to experience a higher frequency of spills from valves, fittings, and seals. Such incidences are often related to improper installation, or defects in materials. In light of this fact, DOS in consultation with PHMSA and EPA determined that if the proposed Project were permitted, it would be advisable for the applicant to conduct inspections of all intermediate valves, and unmanned pump stations during the first year of operation to facilitate identification of small leaks or potential failures in fittings and seals. In the normal course of maintenance beyond the first year of operation, Keystone would have crews at various places along the proposed Project corridor (e.g., maintenance inspections of cathodic protection system rectifiers, MLVs, and pump stations). These crews would be trained and experienced in the identification of crude oil releases. It should be noted that the 14 leaks from fittings and seals that have occurred to date on the existing Keystone Oil Pipeline were identified from the SCADA leak detection system and landowner reports.

- Use erosion control mats or blankets in the Sand Hills of Nebraska anywhere that is not in a wet meadow to reduce erosion potential (Professor Wedin, UNL). The construction reclamation plan in the Sand Hills would be determined by a committee of experts from the USFWS Nebraska

Game and Parks Commission and erosion experts including Professor Wedin. The committee would decide when the use of erosion control mats or blankets would be appropriate.

- Revegetation seed beds should not be over-prepared but rather left more heterogeneous and irregular (Professor Wedin, UNL). The construction reclamation plan in the Sand Hills would be determined by a committee of experts from the USFWS Nebraska Game and Parks Commission and erosion experts including Professor Wedin. The committee would decide the level of preparation of seed beds.
- Landowners should be informed that revegetated areas would be attractive as cattle forage and fencing of the revegetated ROW may be advisable, since animal trackways can serve as incipient blowout areas, and due to potentially warmer soils in the immediate vicinity of the proposed pipeline early forage may be concentrated along the ROW over time (Professor Wedin, UNL). Keystone has agreed to inform landowners.
- A fire management plan should be developed and implemented during proposed Project construction (Professor Wedin, UNL). Keystone has agreed to follow the BLM fire management protocol in the Sand Hills that was developed for the proposed Project for federal lands in Montana and South Dakota.

3.2.3 Connected Actions

3.2.3.1 Big Bend to Witten 230-kV Transmission Line

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

3.2.3.2 Bakken Marketlink and Cushing Marketlink Projects

Construction and operation of the Bakken Marketlink Project would include metering systems, three new storage tanks near Baker, Montana, and two new storage tanks within the boundaries of the proposed Cushing tank farm. Keystone reported that the property proposed for the Bakken Marketlink facilities near Pump Station 14 is currently used as pastureland and hayfields and that a survey of the property indicated that there were no waterbodies or wetlands on the property. DOS reviewed aerial photographs of the area and confirmed the current use of the land and that there are no waterbodies associated with the site. A site inspection by the DOS third-party contractor confirmed these findings. As a result, the potential impacts to soils associated with expansion of the pump station site to include the Bakken Marketlink facilities would likely be similar to those described above for the proposed Project pump station and pipeline ROW in that area.

The Cushing Marketlink project would be located within the boundaries of the proposed Cushing tank farm of the Keystone XL Project and would include metering systems and two storage tanks. As a result, the impacts of construction and operation of the Cushing Marketlink Project on soils would be the same as potential impacts associated with construction and operation of the proposed Cushing tank farm described in this section.

Currently there is insufficient information to complete an environmental review of the Marketlink projects. The permit applications for these projects would be reviewed and acted on by other agencies. Those agencies would conduct more detailed environmental reviews of the Marketlink projects. Potential soil and sediment impacts would be evaluated during the environmental reviews for these projects.

3.2.4 References

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