Appendix 3.2-A

Soils

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SOIL MAPPING UNIT DESCRIPTIONS

"Ar" - Arvada fine sandy loam, 0 to 6 percent slope

The Arvada fine sandy loam mapping unit consists of very deep, well drained soils formed in alluvium and colluvium that was derived from sodic shale. It occurs on alluvial fans, fan remnants, fan terraces and hillslopes at elevations from 2,600 to 6,000 feet.

The mean annual precipitation is estimated to be 9 to 14 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 100 to 160 days.

Slopes range from 0 to 25 percent. Parent material consists of moderately fine textured alluvium and colluvium derived from sedimentary rocks.

A typical profile contains a 4 inch light gray fine sandy loam surface layer. The transition subsoil is a brown clay that is approximately 10 inches thick. The substratum is a brown clay loam that extends to approximately to 20 inches in depth.

Permeability within the Arvada soil is very slow. Runoff is high on the gentler slopes and very high on the steeper slopes. The water erosion hazard is very slight and the wind erosion hazard is very slight.

Productivity and Reclamation Potential

There are twenty two plant species that are common to this map unit:
Blue grama, Buffalograss, Thickspick wheatgrass,Western wheatgrass, Sideoats grama, Needle and thread, Alkali sacaton, Bluegrass, Inland saltgrass, Nuttall's alkaligrass, Prairie sandreed, Sand dropseed, Sedge, Tumblegrass, Big sagebrush, Broom snakeweed, Ericameria nauseosa ssp. nauseosa var nauseosa, Fringed sagewort, Greasewood, Nuttall's saltbush, Plains pricklypear, and Plains springparsley.

In a favorable year (above average moisture), the production is approximately 840 lbs/acres. In an unfavorable (drought) year, the production is approximately 420 lbs/acres.

According to NRCS information, this map unit is a poor source for roadfill; limitations include low strength and shrink-swell. This map unit is a poor source for topsoil; limitations include sodium content, too clayey and rock fragments. This map unit is a fair source of overall reclamation material; limitations include sodium content, too alkaline, too clayey, low organic matter content and water erosion.

"ArV" - Arvada variant, 0 to 6 percent slope

The Arvada variant mapping unit consists of very deep, well drained soils formed in alluvium and colluvium that was derived from sodic shale. It occurs on alluvial fans, fan remnants, fan terraces and hillslopes at elevations from 2,600 to 6,000 feet.

The mean annual precipitation is estimated to be 9 to 14 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 100 to 160 days.

Slopes range from 0 to 25 percent. Parent material consists of moderately fine textured alluvium and colluvium derived from sedimentary rocks.

A typical profile contains a 4 inch light gray fine sandy loam surface layer. The transition subsoil is a brown clay that is approximately 10 inches thick. The substratum is a brown clay loam that extends to approximately to 20 inches in depth.

Permeability within the Arvada soil is very slow. Runoff is high on the gentler slopes and very high on the steeper slopes. The water erosion hazard is very slight and the wind erosion hazard is very slight.

Productivity and Reclamation Potential

There are twenty two plant species that are common to this map unit:
Blue grama, Buffalograss, Thickspick wheatgrass,Western wheatgrass, Sideoats grama, Needle and thread, Alkali sacaton, Bluegrass, Inland saltgrass, Nuttall's alkaligrass, Prairie sandreed, Sand dropseed, Sedge, Tumblegrass, Big sagebrush, Broom snakeweed, Ericameria nauseosa ssp. nauseosa var nauseosa, Fringed sagewort, Greasewood, Nuttall's saltbush, Plains pricklypear, and Plains springparsley.

In a favorable year (above average moisture), the production is approximately 840 lbs/acres. In an unfavorable (drought) year, the production is approximately 420 lbs/acres.

According to NRCS information, this map unit is a poor source for roadfill; limitations include low strength and shrink-swell. This map unit is a poor source for topsoil; limitations include sodium content, too clayey and rock fragments. This map unit is a fair source of overall reclamation material; limitations include sodium content, too alkaline, too clayey, low organic matter content and water erosion.

"Ar-SS" – Arvada-Slickspots complex

Arvada fine sandy loam

The Arvada fine sandy loam mapping unit consists of very deep, well drained soils formed in alluvium and colluvium that was derived from sodic shale. It occurs on alluvial fans, fan remnants, fan terraces and hillslopes at elevations from 2,600 to 6,000 feet.

The mean annual precipitation is estimated to be 9 to 14 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 100 to 160 days.

Slopes range from 0 to 25 percent. Parent material consists of moderately fine textured alluvium and colluvium derived from sedimentary rocks.

A typical profile contains a 4 inch light gray fine sandy loam surface layer. The transition subsoil is a brown clay that is approximately 10 inches thick. The substratum is a brown clay loam that extends to approximately to 20 inches in depth.

Permeability within the Arvada soil is very slow. Runoff is high on the gentler slopes and very high on the steeper slopes. The water erosion hazard is very slight and the wind erosion hazard is very slight.

Productivity and Reclamation Potential

There are twenty two plant species that are common to this map unit:
Blue grama, Buffalograss, Thickspick wheatgrass,Western wheatgrass, Sideoats grama, Needle and thread, Alkali sacaton, Bluegrass, Inland saltgrass, Nuttall's alkaligrass, Prairie sandreed, Sand dropseed, Sedge, Tumblegrass, Big sagebrush, Broom snakeweed, Ericameria nauseosa ssp. nauseosa var nauseosa, Fringed sagewort, Greasewood, Nuttall's saltbush, Plains pricklypear, and Plains springparsley.

In a favorable year (above average moisture), the production is approximately 840 lbs/acres. In an unfavorable (drought) year, the production is approximately 420 lbs/acres.

According to NRCS information, this map unit is a poor source for roadfill; limitations include low strength and shrink-swell. This map unit is a poor source for topsoil; limitations include sodium content, too clayey and rock fragments. This map unit is a fair source of overall reclamation material; limitations include sodium content, too alkaline, too clayey, low organic matter content and water erosion.

"Bc" - Barnum very fine sandy loam, 0 to 6 percent slope

The Barnum very fine sandy loam mapping unit consists of very deep, well drained soils formed in calcareous alluvium from red bed sediments. It occurs on flood plains and alluvial terraces with an elevation range from 4,000 feet to 6,600 feet.

The mean annual precipitation is estimated to be 10 to 14 inches. The mean annual air temperature is approximately 47 degrees Fahrenheit. The frost-free season ranges from 110 to 135 days.

Slopes range from 0 to 8 percent. Parent material consists of calcareous alluvium from red bed sediments.

A typical profile contains a 4 inch reddish brown very fine sandy loam surface layer. The transition subsoil and substratum is a reddish brown loam stratified with thin lenses of fine sandy loam and light clay loam that extends to approximately to 60 inches in depth.

Permeability within the Barnum soil is moderate or moderately slow because of stratification. Runoff is low on the gentler slopes and medium on the steeper slopes. The water erosion hazard is very slight to moderate and the wind erosion hazard is very slight to moderate.

Productivity and Reclamation Potential

There are twenty three plant species that are common to this map unit:
Western wheatgrass, Green needlegrass, Needle and thread, Sideoats grama, Little bluestem, Bluegrass, Big bluestem, Fringed sagewort, Wormwood, Sedge, Switchgrass, Yellow Indiangrass, Blue grama, Breadroot scurfpea, Broom snakeweed, Hairy grama, Heath aster, Louisiana sagewort, Prairie coneflower, Silverleaf scurfpea, Leadplant, Skunkbush sumac, and Slimflower scurfpea.

In a favorable year (above average moisture), the production is approximately 2,300 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,300 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content and water erosion. This map unit is a fair source for roadfill; limitations include low strength and shrink-swell. This map unit is a fair source for topsoil; limitations include salinity.

"Cy" - Cushman very fine sandy loam, 6 to 15 percent slope

The Cushman very fine sandy loam mapping unit consists of well drained soils that are moderately deep to bedrock and formed in slopewash alluvium and residuum from interbedded shales and siltstone and fine-grained argillaceous sandstone. It occurs on buttes, fan remnants, hills, piedmonts, ridges and terraces at elevations from 3,500 to 6,000 feet.

The mean annual precipitation is estimated to be 10 to 14 inches. The mean annual air temperature is approximately 45 degrees Fahrenheit. The frost-free season ranges from 105 to 130 days.

Slopes range from 0 to 20 percent. Parent material consists of moderately fine textured slopewash alluvium and residuum.

A typical profile contains a 2 inch light brownish gray very fine sandy loam surface layer. The transition subsoil is a brown clay loam that is approximately 6 inches thick. The substratum is a yellowish brown clay loam that extends to approximately to 14 inches in depth.

Permeability within the Cushman soil is moderate. Runoff is medium. The water erosion hazard is slight and the wind erosion hazard is slight.

Productivity and Reclamation Potential

There are twenty six plant species that are common to this map unit:
Western wheatgrass, Green needlegrass, Needle and thread, Sideoats grama, Little bluestem, Prairie sandreed, Sand dropseed, Fringed sagewort, Louisiana sagewort, Missouri goldenrod, Oligoneuron rigidum var. rigidum, Silverleaf scurfpea, American vetch, Big sagebrush, Blue grama, Bluegrass, Breadroot scurfpea, Buffalograss, Heath aster, Leadplant, Prairie coneflower, Rose, Sedge, Skunkbush sumac, Slimflower scurfpea, and Western yarrow.

In a favorable year (above average moisture), the production is approximately 2,300 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,300 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content, droughty and depth to bedrock. This map unit is a poor source for roadfill; limitations include depth to bedrock, low strength and shrink-swell. This map unit is a fair source for topsoil; limitations include depth to bedrock.

"Dg" – Demar loam, 0 to 6 percent slope

The Demar loam mapping unit consists of deep or very deep, moderately well drained soils formed in clayey alluvium from acid clay shales. It occurs on micro-highs on nearly level to gently sloping alluvial terraces having pronounced micro-relief at elevations from 2950 to 3940 feet.

The mean annual precipitation is estimated to be 12 to 18 inches. The mean annual air temperature is approximately 47 degrees Fahrenheit. The frost-free season ranges from 110 to 140 days.

Slopes range from 0 to 6 percent. Parent material consists of clayey alluvium derived from acid clay shales.

A typical profile contains a 5 inch pale brown loam surface layer. The transition subsoil is a brown silty clay loam that is approximately 7 inches thick. The substratum is a grayish brown silty clay that extends to approximately to 24 inches in depth.

Permeability within the Demar soil is very slow. Runoff is medium. The water erosion hazard is very slight and the wind erosion hazard is very slight.

Productivity and Reclamation Potential

There are fifteen plant species that are common to this map unit:
Western wheatgrass, Blue grama, Needle and thread, Buffalograss, Green needlegrass, Prairie sandreed, Sedge, American vetch, Broom snakeweed, Fringed sagewort, Louisiana sagewort, Scarlet globemallow, Big sagebrush, Ericameria nauseosa ssp. nauseosa var.nauseosa, and Plains pricklypear.

In a favorable year (above average moisture), the production is approximately 1,600 lbs/acres. In an unfavorable (drought) year, the production is approximately 900 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content, water erosion, too clayey, too acid and salinity. This map unit is a poor source for roadfill; limitations include depth to bedrock, low strength and shrink-swell. This map unit is a fair source for topsoil; limitations include too clayey and sodium content.

"Gr" – Grummit clay, 0 to 6, 6 to 15 and 15 to 60 percent slope

The Grummit clay mapping unit consists of shallow, well drained soils formed in clayey residuum from acid shale on uplands. It occurs on gently sloping to very steep uplands at elevations from 2950 to 3940 feet.

The mean annual precipitation is estimated to be 12 to 18 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 110 to 140 days.

Slopes range from 2 to 60 percent. Parent material consists of clayey residuum weathered from acid shales.

A typical profile contains a 3 inch light brownish gray clay surface layer. The transition subsoil is a grayish brown clay that is approximately 4 inches thick. The substratum is a grayish brown and gray clay that extends to approximately to 17 inches in depth.

Permeability within the Grummit soil is moderate or moderately slow in the upper part and moderate in the underlying material. Runoff is low on the gentler slopes and medium on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

Productivity and Reclamation Potential

There are twenty six plant species that are common to this map unit:
Little bluestem, Western wheatgrass, Sideoats grama, Green needlegrass, Blue grama, Big bluestem, Hairy grama, Needle and thread, Prairie sandreed, Rocky Mountain juniper, Sedge, Big sagebrush, Blacksamson Echinacea, Broom snakeweed, Rose, Silver buffaloberry, Skunkbush sumac, Breadroot scurfpea, Fringed sagewort, Leadplant, Louisiana sagewort, Prairie coneflower, Silverleaf scurfpea, Slimflower scurfpea, Violet prairieclover, and Yucca.

In a favorable year (above average moisture), the production is approximately 1,400 lbs/acres. In an unfavorable (drought) year, the production is approximately 800 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include low organic matter content, droughty, too clayey, depth to bedrock and too acid. This map unit is a poor source for roadfill; limitations include depth to bedrock and slope. This map unit is a poor source for topsoil; limitations include depth to bedrock, slope, too clayey and too acid.

"GrE" – Grummit-Rock Outcrop complex

Grummit clay

The Grummit clay mapping unit consists of shallow, well drained soils formed in clayey residuum from acid shale on uplands. It occurs on gently sloping to very steep uplands at elevations from 2950 to 3940 feet.

The mean annual precipitation is estimated to be 12 to 18 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 110 to 140 days.

Slopes range from 2 to 60 percent. Parent material consists of clayey residuum weathered from acid shales.

A typical profile contains a 3 inch light brownish gray clay surface layer. The transition subsoil is a grayish brown clay that is approximately 4 inches thick. The substratum is a grayish brown and gray clay that extends to approximately to 17 inches in depth.

Permeability within the Grummit soil is moderate or moderately slow in the upper part and moderate in the underlying material. Runoff is low on the gentler slopes and medium on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

Productivity and Reclamation Potential

There are twenty six plant species that are common to this map unit:
Little bluestem, Western wheatgrass, Sideoats grama, Green needlegrass, Blue grama, Big bluestem, Hairy grama, Needle and thread, Prairie sandreed, Rocky Mountain juniper, Sedge, Big sagebrush, Blacksamson Echinacea, Broom snakeweed, Rose, Silver buffaloberry, Skunkbush sumac, Breadroot scurfpea, Fringed sagewort, Leadplant, Louisiana sagewort, Prairie coneflower, Silverleaf scurfpea, Slimflower scurfpea, Violet prairieclover, and Yucca.

In a favorable year (above average moisture), the production is approximately 1,400 lbs/acres. In an unfavorable (drought) year, the production is approximately 800 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include low organic matter content, droughty, too clayey, depth to bedrock and too acid. This map unit is a poor source for roadfill; limitations include depth to bedrock and slope. This map unit is a poor source for topsoil; limitations include depth to bedrock, slope, too clayey and too acid.

"Ha" - Haverson loam, 0 to 6 percent slope

The Haverson loam mapping unit consists of very deep, well drained soils that formed in alluvium from mixed sources. It occurs on floodplains and low terraces at elevations from 2950 to 3940 feet.

The mean annual precipitation is estimated to be 14 to 18 inches. The mean annual air temperature is approximately 49 degrees Fahrenheit. The frost-free season ranges from 125 to 180 days.

Slopes range from 0 to 9 percent. Parent material consists of highly stratified, calcareous, recent alluvium derived from mixed sources.

A typical profile contains a 3 inch pale brown loam surface layer. The transition subsoil is a pale brown loam that is approximately 3 inches thick. The substratum is a light brownish gray loam that extends to approximately to 12 inches in depth.

Permeability within the Haverson soil is moderate. Runoff is negligble on the gentler slopes and medium on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

Productivity and Reclamation Potential

There are twenty four plant species that are common to this map unit:
Western wheatgrass, Green needlegrass, Prairie sandreed, Needle and thread, Blue grama, Buffalograss, Bluegrass, Fringed sagewort, Sedge, Heath aster, Western yarrow, Wormwood, Big bluestem, Big sagebrush, Boxelder, Common chokecherry, Green ash, Leadplant, Little bluestem, Louisiana sagewort, Plains cottonwood, Silver buffaloberry, Skunkbush sumac, and Western snowberry.

In a favorable year (above average moisture), the production is approximately 2,800 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,600 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content. This map unit is a fair source for roadfill; limitations include shrink-swell. This map unit is a good source for topsoil.

"He" - Hisle silt loam, 0 to 6 percent slope

The Hisle silt loam mapping unit consists of moderately deep, well drained and moderately well drained soils formed in clayey sediments weathered from clay shale on uplands. It occurs on nearly level to moderately sloping on uplands at elevations around 3,020 feet.

The mean annual precipitation is estimated to be 12 to 16 inches. The mean annual air temperature is approximately 45 degrees Fahrenheit. The frost-free season ranges from 130 to 150 days.

Slopes range from 0 to 15 percent. Parent material consists of clays transported locally or weathered in place from clay shales.

A typical profile contains a 1 inch light gray silt loam surface layer. The transition subsoil is a light brownish gray clay that is approximately 1 inch thick. The substratum is a light brownish gray clay that extends to approximately to 9 inches in depth.

Permeability within the Hisle soil is very slow, but after dry periods initial intake commonly is rapid because of cracks. Runoff is medium on the gentler slopes and very high on the steeper slopes. The water erosion hazard is very slight and the wind erosion hazard is very slight.

Productivity and Reclamation Potential

There are twenty two plant species that are common to this map unit:
Blue grama, Buffalograss, Thickspick wheatgrass, Western wheatgrass, Sideoats grama, Needle and thread, Alkali sacaton, Bluegrass, Inland saltgrass, Nuttall's alkaligrass, Prairie sandreed, Sand dropseed, Sedge, Tumblegrass, Big sagebrush, Broom snakeweed, Ericameria nauseosa ssp. nauseosa var. nauseosa, Fringed sagewort, Greasewood, Nuttall's saltbush, Plains pricklypear, and Plains springparsley.

In a favorable year (above average moisture), the production is approximately 1,100 lbs/acres. In an unfavorable (drought) year, the production is approximately 500 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include sodium content, droughty, too clayey, depth to bedrock and salinity. This map unit is a poor source for roadfill; limitations include low strength, depth to bedrock and shrink-swell. This map unit is a poor source for topsoil; limitations include too clayey, salinity, depth to bedrock and sodium content.

"Ky" – Kyle clay, 0 to 6 percent slope

The Kyle clay mapping unit consists of very deep and well drained soils formed in sediments weathered from clay shale on uplands. It occurs on nearly level to strongly sloping on uplands and colluvial fans at elevations from 2620 to 3610 feet.

The mean annual precipitation is estimated to be 12 to 19 inches. The mean annual air temperature is approximately 47 degrees Fahrenheit. The frost-free season ranges from 130 to 150 days.

Slopes range from 0 to 15 percent. Parent material consists of clayey sediments weathered from calcareous clay shale.

A typical profile contains a 4 inch grayish brown clay surface layer. The transition subsoil is a grayish brown clay that is approximately 4 inches thick. The substratum is a grayish brown clay that extends to approximately to 16 inches in depth.

Permeability within the Kyle soil is very slow, except after dry periods when the initial intake into cracks is rapid. Runoff is medium on the gentler slopes and very high on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

Productivity and Reclamation Potential

There are nineteen plant species that are common to this map unit:
Western wheatgrass, Green needlegrass, Sideoats grama, Needle and thread, Blue grama, Bluegrass, Buffalograss, Sedge, Big sagebrush, Fringed sagewort, Heath aster, Louisiana sagewort, Plains pricklypear, Silverleaf scurfpea, Western yarrow, American vetch, Breadroot scurfpea, Scarlet globemallow, and Slimflower scurfpea.

In a favorable year (above average moisture), the production is approximately 2,300 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,300 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include low organic matter content, water erosion, too clayey and sodium content. This map unit is a poor source for roadfill; limitations include low strength and shrink-swell. This map unit is a poor source for topsoil; limitations include too clayey and sodium content.

"Lo" – Lohmiller silty clay loam, 0 to 6 percent slope

The Lohmiller silty clay loam mapping unit consists of very deep, well drained soils formed in alluvium on bottom lands. It occurs on flood plains and high bottom lands of rivers and streams and on alluvial fans of foot slopes at elevations from 2620 to 3610 feet.

The mean annual precipitation is estimated to be 10 to 19 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 130 to 150 days.

Slopes range from 0 to 8 percent. Parent material consists of calcareous alluvium from sedimentary rock.

A typical profile contains a 4 inch grayish brown silty clay loam surface layer. The transition subsoil is a grayish brown clay loam that is approximately 4 inches thick. The substratum is a grayish brown clay loam that extends to approximately to 60 inches in depth.

Permeability within the Lohmiller soil is slow or moderately slow. Runoff is low on the gentler slopes and medium on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

Productivity and Reclamation Potential

There are twenty four plant species that are common to this map unit:
Western wheatgrass, Green needlegrass, Prairie sandreed, Needle and thread, Blue grama, Buffalograss, Bluegrass, Fringed sagewort, Sedge, Heath aster, Western yarrow, Wormwood, Big bluestem, Big sagebrush, Boxelder, Common chokecherry, Green ash, Leadplant, Little bluestem, Louisiana sagewort, Plains cottonwood, Silver buffaloberry, Skunkbush sumac, and Western snowberry.

In a favorable year (above average moisture), the production is approximately 2,600 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,500 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include low organic matter content, water erosion and too clayey. This map unit is a poor source for roadfill; limitations include low strength and shrink-swell. This map unit is a poor source for topsoil; limitations include too clayey.

"Nf" – Nihill gravelly loam, 15 to 50 percent slope

The Nihill gravelly loam mapping unit consists of very deep, well drained soils formed in gravelly alluvium from mixed sources. It occurs on Pleistocene terraces and terrace remnants at elevations from 2,600 to 6,800 feet.

The mean annual precipitation is estimated to be 10 to 19 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 105 to 130 days.

Slopes range from 0 to 80 percent. Parent material consists of calcareous gravelly alluvium from mixed sources.

A typical profile contains a 5 inch dark brown gravelly loam surface layer. The transition subsoil is a light yellowish brown very gravelly clay loam that is approximately 25 inches thick. The substratum is a very pale brown very gravelly sandy clay loam that extends to approximately to 60 inches in depth.

Permeability within the Nihill soil is moderate. Runoff is medium on the gentler slopes and high on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

Productivity and Reclamation Potential

There are eighteen plant species that are common to this map unit:
Sedge, Needle and thread, Sideoats grama, Blue grama, Hairy grama, Bluegrass, Little bluestem, Sand dropseed, Western wheatgrass, Blacksamson Echinacea, Broom snakeweed, Fringed sagewort, Hairy goldenaster, Louisiana sagewort, Plains pricklypear, Skunkbush sumac, Violet prairieclover, and Wormwood.

In a favorable year (above average moisture), the production is approximately 1,100 lbs/acres. In an unfavorable (drought) year, the production is approximately 600 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content and droughty. This map unit is a fair source for roadfill; limitations include slope. This map unit is a poor source for topsoil; limitations include slope, hard to reclaim (rock fragments) and rock fragments.

"Nu" – Nunn clay loam, 0 to 6 and 6 to 15 percent slope

The Nunn clay loam mapping unit consists of very deep, well drained soils that formed in loess and mixed alluvium. It occurs on terraces or alluvial fans, and in drainageways at elevations from 2620 to 3610 feet.

The mean annual precipitation is estimated to be 14 inches. The mean annual air temperature is approximately 48 degrees Fahrenheit. The frost-free season ranges from 120 to 210 days.

Slopes range from 0 to 25 percent. Parent material consists mixed alluvium.

A typical profile contains a 6 inch grayish brown clay loam surface layer. The transition subsoil is a grayish brown clay loam that is approximately 4 inches thick. The substratum is a pale brown clay loam that extends to approximately to 24 inches in depth.

Permeability within the Nunn soil is moderately slow to slow. Runoff is negligible on the gentler slopes and very high on the steeper slopes. The water erosion hazard is very slight to slight and the wind erosion hazard is very slight.

Productivity and Reclamation Potential

There are twenty six plant species that are common to this map unit:
Western wheatgrass, Green needlegrass, Needle and thread, Sideoats grama, Little bluestem, Prairie sandreed, Sand dropseed, Fringed sagewort, Louisiana sagewort, Missouri goldenrod, Oligoneuron rigidum var. rigidum, Silverleaf scurfpea, American vetch, Big sagebrush, Blue grama, Bluegrass, Breadroot scurfpea, Buffalograss, Heath aster, Leadplant, Prairie coneflower, Rose, Sedge, Skunkbush sumac, Slimflower scurfpea, and Western yarrow.

In a favorable year (above average moisture), the production is approximately 1,900 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,100 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include low organic matter content, too clayey and water erosion. This map unit is a fair source for roadfill; limitations include shrink-swell. This map unit is a poor source for topsoil; limitations include too clayey.

"Pg" – Penrose channery loam, 15 to 40 percent slope

The Penrose channery loam mapping unit consists of shallow, well and somewhat excessively drained soils formed in thin, calcareous, loamy materials weathered in place from limestone and interbedded limy materials. It occurs on hills, plains, ridges, hogbacks, cuestas, and mesa tops at elevations from 3,000 to 6,500 feet.

The mean annual precipitation is estimated to be 11 to 15 inches. The mean annual air temperature is approximately 51 degrees Fahrenheit. The frost-free season ranges from 125 to 165 days.

Slopes range from 1 to 65 percent. Parent material consists of residuum and slope alluvium derived from limestone and interbedded limy materials.

A typical profile contains a 4 inch light brownish gray channery loam surface layer. The transition subsoil is a light gray channery loam that is approximately 11 inches thick. The substratum is limestone bedrock that extends to approximately to 15 inches in depth.

Permeability within the Penrose soil is moderate to moderately slow. Runoff is low on the gentler slopes and very rapid on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

Productivity and Reclamation Potential

There are six plant species that are common to this map unit:
Sideoats grama, Blue grama, Achnatherum scribneri, Indian ricegrass, Juniper, and Little bluestem.

In a favorable year (above average moisture), the production is approximately 800 lbs/acres. In an unfavorable (drought) year, the production is approximately 300 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include low organic matter content, droughty and depth to bedrock. This map unit is a poor source for roadfill; limitations include depth to bedrock. This map unit is a poor source for topsoil; limitations include depth to bedrock, slope and rock fragments.

"Pe" – Pierre clay, 0 to 6 and 6 to 15 percent slope

The Pierre clay mapping unit consists of moderately deep, well drained soils formed in clayey residuum weathered from shale bedrock on uplands. It occurs on nearly nearly level to steep uplands at elevations from 1300 to 3600 feet.

The mean annual precipitation is estimated to be 10 to 13 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 130 to 150 days.

Slopes range from 0 to 30 percent. Parent material consists of residuum weathered from clay shale.

A typical profile contains a 2 inch grayish brown clay surface layer. The transition subsoil is a light brownish gray clay that is approximately 5 inches thick. The substratum is a light brownish gray clay that extends to approximately to 20 inches in depth.

Permeability within the Pierre soil is very slow, except after dry periods when the initial intake may be rapid due to cracks. Runoff is low on the gentler slopes and medium to very high on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

Productivity and Reclamation Potential

There are nineteen plant species that are common to this map unit:
Western wheatgrass, Green needlegrass, Sideoats grama, Needle and thread, Blue grama, Bluegrass, Buffalograss, Sedge, Big sagebrush, Fringed sagewort, Heath aster, Louisiana sagewort, Plains pricklypear, Silverleaf scurfpea, Western yarrow, American vetch, Breadroot scurfpea, Scarlet globemallow, and Slimflower scurfpea.

In a favorable year (above average moisture), the production is approximately 2,200 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,200 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include low organic matter content, depth to bedrock, droughty, too clayey and sodium content. This map unit is a poor source for roadfill; limitations include depth to bedrock, low strength and shrink-swell. This map unit is a poor source for topsoil; limitations include depth to bedrock, too clayey and sodium content.

"Sa" – Samsil clay, 15 to 40 percent slope

The Samsil clay mapping unit consists of shallow, well drained soils formed in alluvium or residuum weathered from shale. It occurs on gently sloping to very steep hills, ridges and breaks of dissected shale plains at elevations from 2620 to 3610 feet.

The mean annual precipitation is estimated to be 14 to 19 inches. The mean annual air temperature is approximately 47 degrees Fahrenheit. The frost-free season ranges from 130 to 150 days.

Slopes range from 2 to 60 percent. Parent material consists of alluvium or residuum weathered from shale.

A typical profile contains a 2 inch light brownish gray clay surface layer. The transition subsoil is a light grayish brown clay that is approximately 5 inches thick. The substratum is a light grayish brown clay that extends to approximately to 11 inches in depth.

Permeability within the Samsil soil is slow. Runoff is medium on the gentler slopes and very high on the steeper slopes. The water erosion hazard is moderate and the wind erosion hazard is moderate.

Productivity and Reclamation Potential

There are twenty six plant species that are common to this map unit:
Little bluestem, Western wheatgrass, Sideoats grama, Green needlegrass, Blue grama, Big bluestem, Hairy grama, Needle and thread, Prairie sandreed, Rocky Mountain juniper, Sedge, Big sagebrush, Blacksamson echinacea, Broom snakeweed, Rose, Silver buffaloberry, Skunkbush sumac, Breadroot scurfpea, Fringed sagewort, Leadplant, Louisiana sagewort, Prairie coneflower, Silverleaf scurfpea, Slimflower scurfpea, Violet prairieclover, and Yucca.

In a favorable year (above average moisture), the production is approximately 1,400 lbs/acres. In an unfavorable (drought) year, the production is approximately 800 lbs/acres.

According to NRCS information, this map unit is a poor source of overall reclamation material; limitations include low organic matter content, droughty, too clayey, depth to bedrock and water erosion. This map unit is a poor source for roadfill; limitations include depth to bedrock, slope, low strength and shrink-swell. This map unit is a poor source for topsoil; limitations include depth to bedrock, slope and too clayey.

"Sc-Ar" – Satanta-Arvada complex

Satanta loam

The Satanta loam mapping unit consists of very deep well drained soils that formed in eolian deposits. It occurs on plains or high stream terraces in the Central High Tablelands at elevations from 2000 to 4500 feet.

The mean annual precipitation is estimated to be 14 to 22 inches. The mean annual air temperature is approximately 56 degrees Fahrenheit. The frost-free season ranges from 140 to 200 days.

Slopes range from 0 to 15 percent. Parent material consists of eolian deposits.

A typical profile contains a 4 inch dark grayish brown loam surface layer. The transition subsoil is a dark grayish brown loam that is approximately 4 inches thick. The substratum is a very dark grayish brown loam that extends to approximately to 19 inches in depth.

Saturated hydraulic conductivity within the Satanta soil is moderately high. Runoff is low on the gentler slopes and medium on the steeper slopes. The water erosion hazard is very slight and the wind erosion hazard is very slight.

Productivity and Reclamation Potential

There are twenty six plant species that are common to this map unit:
Western wheatgrass, Green needlegrass, Needle and thread, Sideoats grama, Little bluestem, Prairie sandreed, Sand dropseed, Fringed sagewort, Louisiana sagewort, Missouri goldenrod, Oligoneuron rigidum var. rigidum, Silverleaf scurfpea, American vetch, Big sagebrush, Blue grama, Bluegrass, Breadroot scurfpea, Buffalograss, Heath aster, Leadplant, Prairie coneflower, Rose, Sedge, Skunkbush sumac, Slimflower scurfpea, and Western yarrow.

In a favorable year (above average moisture), the production is approximately 2,200 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,300 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content. This map unit is a good source for roadfill. This map unit is a good source for topsoil.

Arvada fine sandy loam

The Arvada fine sandy loam mapping unit consists of very deep, well drained soils formed in alluvium and colluvium that was derived from sodic shale. It occurs on alluvial fans, fan remnants, fan terraces and hillslopes at elevations from 2,600 to 6,000 feet.

The mean annual precipitation is estimated to be 9 to 14 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 100 to 160 days.

Slopes range from 0 to 25 percent. Parent material consists of moderately fine textured alluvium and colluvium derived from sedimentary rocks.

A typical profile contains a 4 inch light gray fine sandy loam surface layer. The transition subsoil is a brown clay that is approximately 10 inches thick. The substratum is a brown clay loam that extends to approximately to 20 inches in depth.

Permeability within the Arvada soil is very slow. Runoff is high on the gentler slopes and very high on the steeper slopes. The water erosion hazard is very slight and the wind erosion hazard is very slight.

Productivity and Reclamation Potential

There are twenty two plant species that are common to this map unit:
Blue grama, Buffalograss, Thickspick wheatgrass,Western wheatgrass, Sideoats grama, Needle and thread, Alkali sacaton, Bluegrass, Inland saltgrass, Nuttall's alkaligrass, Prairie sandreed, Sand dropseed, Sedge, Tumblegrass, Big sagebrush, Broom snakeweed, Ericameria nauseosa ssp. nauseosa var nauseosa, Fringed sagewort, Greasewood, Nuttall's saltbush, Plains pricklypear, and Plains springparsley.

In a favorable year (above average moisture), the production is approximately 840 lbs/acres. In an unfavorable (drought) year, the production is approximately 420 lbs/acres.

According to NRCS information, this map unit is a poor source for roadfill; limitations include low strength and shrink-swell. This map unit is a poor source for topsoil; limitations include sodium content, too clayey and rock fragments. This map unit is a fair source of overall reclamation material; limitations include sodium content, too alkaline, too clayey, low organic matter content and water erosion.

"Ta" – Tilford silt loam, 0 to 6 percent slope

The Tilford silt loam mapping unit consists of very deep or deep, well drained soils formed in local alluvium and residuum from weathered reddish shales on uplands and terraces. It occurs on nearly level to rolling on uplands, stream terraces and fans at elevations from 2950 to 3510 feet.

The mean annual precipitation is estimated to be 14 to 18 inches. The mean annual air temperature is approximately 45 degrees Fahrenheit. The frost-free season ranges from 110 to 140 days.

Slopes range from 0 to 15 percent. Parent material consists of silty local alluvium and residuum derived from reddish colored silty shales.

A typical profile contains a 5 inch dark brown silt loam surface layer. The transition subsoil is a dark reddish gray silt loam that is approximately 4 inches thick. The substratum is a reddish brown silt loam that extends to approximately to 16 inches in depth.

Permeability within the Tilford soil is moderate. Runoff is low on the gentler slopes and medium on the steeper slopes. The water erosion hazard is very slight and the wind erosion hazard is very slight.

Productivity and Reclamation Potential

There are twenty six plant species that are common to this map unit:
Western wheatgrass, Green needlegrass, Needle and thread, Sideoats grama, Little bluestem, Prairie sandreed, Sand dropseed, Fringed sagewort, Louisiana sagewort, Missouri goldenrod, Oligoneuron rigidum var. rigidum, Silverleaf scurfpea, American vetch, Big sagebrush, Blue grama, Bluegrass, Breadroot scurfpea, Buffalograss, Heath aster, Leadplant, Prairie coneflower, Rose, Sedge, Skunkbush sumac, Slimflower scurfpea, and Western yarrow.

In a favorable year (above average moisture), the production is approximately 2,500 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,300 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content and water erosion. This map unit is a fair source for roadfill; limitations include low strength. This map unit is a good source for topsoil.

"Zn" – Zigweid loam, 6 to 15 and 6 to 40 percent slope

The Zigweid loam mapping unit consists of very deep, well drained soils formed in alluvium from mixed sedimentary sources. It occurs on fan aprons, alluvial fans, fan piedmonts, fan remnants, terraces, ridges and hills at elevations from 3,500 to 6,600 feet.

The mean annual precipitation is estimated to be 10 to 14 inches. The mean annual air temperature is approximately 46 degrees Fahrenheit. The frost-free season ranges from 105 to 130 days.

Slopes range from 0 to 20 percent. Parent material consists of calcareous, moderately fine textured sediments derived from interbedded shale and soft sandstone.

A typical profile contains a 4 inch light brownish gray loam surface layer. The transition subsoil is a brown clay loam that is approximately 13 inches thick. The substratum is a brown clay loam that extends to approximately to 34 inches in depth.

Permeability within the Zigweid soil is moderate. Runoff is medium on the gentler slopes and rapid on the steeper slopes. The water erosion hazard is very slight and the wind erosion hazard is very slight.

Productivity and Reclamation Potential

There are twenty three plant species that are common to this map unit:
Needle and thread, Little bluestem, Western wheatgrass, Sedge, Prairie sandreed, Sideoats grama, Blue grama, Green needlegrass, Hairy grama, Inland saltgrass, Plains muhly, Big sagebrush, Blacksamson Echinacea, Broom snakeweed, Fringed sagewort, Louisiana sagewort, Missouri goldenrod, Oligoneuron rigidum var. rigidum, Plains pricklypear, Prairie coneflower, Violet prairieclover, Wormwood, and Yucca.

In a favorable year (above average moisture), the production is approximately 1,800 lbs/acres. In an unfavorable (drought) year, the production is approximately 1,000 lbs/acres.

According to NRCS information, this map unit is a fair source of overall reclamation material; limitations include low organic matter content. This map unit is a poor source for roadfill; limitations include low strength and shrink-swell. This map unit is a fair source for topsoil; limitations include slope.

SAMPLED SOIL SERIES DESCRIPTIONS

KYLE
NONCALCAREOUS VARIANT

Soil Mapping Unit "Ky"
Lab/BKS Sample ID: G08020803-007_011

Typical Pedon: Kyle silty clay loam - on a west-facing plane slope of 2 percent in native grass. (Colors are for dry soil unless otherwise stated.)

The Kyle series consists of very deep and well drained soils formed in sediments weathered from clay shale on uplands. Permeability is very slow. Slopes range from 0 to 15 percent. Mean annual precipitation is about 16 inches, and mean annual air temperature is about 47 degrees F.

A - 0-2 inches. Grayish brown (2.5YR 5/2) silty clay loam, moist; moderate medium and fine granular structure; hard, firm, sticky and plastic; thin crust in upper 1/4 inch of light brownish gray (2.5Y 6/2); common fine roots; neutral; clear wavy boundary, slightly alkaline (pH 7.4); noneffervescent.

Bt - 2-17 inches. Olive brown (2.5Y 4/3DW) silty clay, moist; weak coarse blocky structure parting to weak medium blocky; extremely hard, very firm, very sticky and very plastic; few intersecting slickensides; few fine roots; gradual wavy boundary; moderately alkaline (pH 7.9); very slightly effervescent.

C1n – 17-24 inches. Dark grayish brown (2.5Y 4/2D, 2.5Y 3/2W) silty clay, moist; weak coarse subangular blocky structure parting to weak medium and fine blocky; extremely hard, very firm, very sticky and very plastic; few intersecting slickensides; few fine roots; clear wavy boundary; moderately alkaline (pH 8.0); noneffervescent.

C2 – 24-39 inches. Dark grayish brown (2.5Y 4/2D, 2.5Y 3/2W) silty clay, moist; weak medium subangular blocky structure in upper part becoming massive in lower part; extremely hard, very firm, very sticky and very plastic; few intersecting slickensides; common fine and medium nests of gypsum; strong effervescence; slightly alkaline; gradual wavy boundary. moderately alkaline (pH 7.9); noneffervescent.

C3n – 39-60 inches. Dark grayish brown (2.5Y 4/2DW) silty clay, moist; massive; very hard, firm, sticky and plastic; few fine accumulations of carbonate and gypsum; moderately alkaline (pH 7.9). noneffervescent.

Type Location - Fall River County, South Dakota; refer to waypoint 27 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The soil typically does not have carbonates to depths of 4 to 6 inches, but some pedons contain carbonates to the surface. When the soil is dry, cracks 1/2 inch to 2 inches wide and several feet long extend

downward through the solum. The control section averages 60 to 65 percent clay. The soil does not have a mollic epipedon but the upper 10 inches of the solum has an average organic carbon content between 0.6 and 1.7 percent. When the soil is dry, a porous surface crust 1/8 inch to 1/2 inch thick with dry color value of 6 or 7 is typical. Gypsum and other salts are below depths of 20 inches.

The A horizon has hue of 10YR, 2.5Y or 5Y, value of 5 or 6 and 3 to 5 moist, and chroma of 1 to 3. It typically is clay but some is silty clay. It is neutral or slightly alkaline.

The Bw and Bss horizons have hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. Both dry and moist colors of the surface of peds range from 1/2 to 1 value darker than the crushed peds. They are extremely hard or very hard when dry and extremely firm or very firm when moist. They are slightly alkaline or moderately alkaline.

The BCss horizon has hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. It has few to common accumulations of gypsum and other salts in most pedons. It is slightly alkaline or moderately alkaline.

Some pedons have a Bk horizon that has colors similar to the BC horizon. It has few to common accumulations of carbonate. It is slightly alkaline or moderately alkaline.

The Cy horizon has hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. It is clay and some pedons contain up to 35 percent fragments of shale below 40 inches. It has few to many accumulations of gypsum or other salts. Unweathered shale typically is at depths greater than 5 feet but is as shallow as 40 inches in some pedons. It is slightly alkaline or moderately alkaline.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer than typical for the series.

Taxonomic Class - Very-fine, smectitic, mesic Aridic Haplusterts

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 2-60 inches. Saturation percentage was marginal at 24-39 inches. Sodium absorption ratio was marginal at 17-60 inches. Estimated stripping depth is 17 inches.

Geographic Setting (According to Official Series Description) - Kyle soils are nearly level to strongly sloping on uplands and colluvial fans. Slopes are plane to convex, and slope gradients range from 0 to 15 percent. Gilgai microrelief is in most areas. The soil formed in clayey sediments weathered from calcareous clay shale. Mean annual air temperature ranges from 45 to 53 degrees F, and mean annual precipitation ranges from about 12 to 19 inches.

KYLE
NONCALCAREOUS VARIANT

Soil Mapping Unit "Ky"
Lab/BKS Sample ID: G08020803-012_016

Typical Pedon: Kyle silty clay loam- on a west-facing plane slope of 2 percent in native grass. (Colors are for dry soil unless otherwise stated.)

The Kyle series consists of very deep and well drained soils formed in sediments weathered from clay shale on uplands. Permeability is very slow. Slopes range from 0 to 15 percent. Mean annual precipitation is about 16 inches, and mean annual air temperature is about 47 degrees F.

A - 0-2 inches. Brown (10YR 4/3D, 10YR 4/2W) silty clay loam, moist; moderate medium and fine granular structure; hard, firm, sticky and plastic; thin crust in upper 1/4 inch of light brownish gray (2.5Y 6/2); common fine roots; neutral; clear wavy boundary, moderately alkaline (pH 8.0); noneffervescent.

Bt1 - 2-15 inches. Brown (10YR 4/3D, 10YR 4/2W) silty clay, moist; weak coarse blocky structure parting to weak medium blocky; extremely hard, very firm, very sticky and very plastic; few intersecting slickensides; few fine roots; gradual wavy boundary; moderately alkaline (pH 8.0); very slightly effervescent.

Bt2n – 15-26 inches. Dark grayish brown (2.5Y 4/2DW) silty clay, moist; weak coarse subangular blocky structure parting to weak medium and fine blocky; extremely hard, very firm, very sticky and very plastic; few intersecting slickensides; few fine roots; clear wavy boundary; moderately alkaline (pH 8.0); very slightly effervescent.

C1 – 26-36 inches. Dark grayish brown (2.5Y 4/2DW) silty clay, moist; weak medium subangular blocky structure in upper part becoming massive in lower part; extremely hard, very firm, very sticky and very plastic; few intersecting slickensides; common fine and medium nests of gypsum; strong effervescence; slightly alkaline; gradual wavy boundary. moderately alkaline (pH 8.0); very slightly effervescent.

C2 – 36-60 inches. Olive brown (2.5Y 4/3DW) clay, moist; massive; very hard, firm, sticky and plastic; few fine accumulations of carbonate and gypsum; moderately alkaline (pH 8.0); slightly effervescent.

Type Location - Fall River County, South Dakota; refer to waypoint 36 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The soil typically does not have carbonates to depths of 4 to 6 inches, but some pedons contain carbonates to the surface. When the soil is dry, cracks 1/2 inch to 2 inches wide and several feet long extend

downward through the solum. The control section averages 60 to 65 percent clay. The soil does not have a mollic epipedon but the upper 10 inches of the solum has an average organic carbon content between 0.6 and 1.7 percent. When the soil is dry, a porous surface crust 1/8 inch to 1/2 inch thick with dry color value of 6 or 7 is typical. Gypsum and other salts are below depths of 20 inches.

The A horizon has hue of 10YR, 2.5Y or 5Y, value of 5 or 6 and 3 to 5 moist, and chroma of 1 to 3. It typically is clay but some is silty clay. It is neutral or slightly alkaline.

The Bw and Bss horizons have hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. Both dry and moist colors of the surface of peds range from 1/2 to 1 value darker than the crushed peds. They are extremely hard or very hard when dry and extremely firm or very firm when moist. They are slightly alkaline or moderately alkaline.

The BCss horizon has hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. It has few to common accumulations of gypsum and other salts in most pedons. It is slightly alkaline or moderately alkaline.

Some pedons have a Bk horizon that has colors similar to the BC horizon. It has few to common accumulations of carbonate. It is slightly alkaline or moderately alkaline.

The Cy horizon has hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. It is clay and some pedons contain up to 35 percent fragments of shale below 40 inches. It has few to many accumulations of gypsum or other salts. Unweathered shale typically is at depths greater than 5 feet but is as shallow as 40 inches in some pedons. It is slightly alkaline or moderately alkaline.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer than typical for the series.

Taxonomic Class - Very-fine, smectitic, mesic Aridic Haplusterts

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 2-60 inches. Saturation percentage was marginal at 2-16 and 26-36 inches. Sodium absorption ratio was marginal at 15-36 inches. Estimated stripping depth is 2 inches.

Geographic Setting (According to Official Series Description) - Kyle soils are nearly level to strongly sloping on uplands and colluvial fans. Slopes are plane to convex, and slope gradients range from 0 to 15 percent. Gilgai microrelief is in most areas. The soil formed in clayey sediments weathered from calcareous clay shale. Mean annual air temperature ranges from 45 to 53 degrees F, and mean annual precipitation ranges from about 12 to 19 inches.

HISLE
SILT LOAM

Soil Mapping Unit "He"
Lab/BKS Sample ID: G08020803-017_021

Typical Pedon: Hisle silt loam - on an east-facing plane slope of 3 percent in native grass at 3,020 feet elevation. When described the soil was moist below a depth of 2 inches. (Colors are for dry soil unless otherwise stated.)

The Hisle series consists of moderately deep, well drained and moderately well drained soils formed in clayey sediments weathered from clay shale on uplands. Permeability is very slow. Slopes range from 0 to 15 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 45 degrees F.

A - 0-2 inches. Light gray (10YR 7/2) silt loam, moist; weak very thin platy structure parting to weak fine granular; soft, very friable; surface crust about 1/8 inch thick; abrupt smooth boundary; neutral (pH 6.8); noneffervescent.

Bt – 2-15 inches. Grayish brown (10YR 5/2D, 10YR 4/2W) silty clay loam, moist; weak medium prismatic structure parting to strong medium and fine blocky; very hard, firm, sticky and plastic; gradual wavy boundary; neutral (pH 7.3); noneffervescent.

C1k – 15-32 inches. Light yellowish brown (2.5Y 6/3D, 2.5Y 4/3W) clay loam, moist; common medium distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; fine earth is massive; hard, firm, sticky; 50 to 70 percent by volume of fragments of shale; few fine accumulations of carbonate and salt; clear wavy boundary; moderately alkaline (pH 8.0); strongly effervescent.

C2k – 32-52 inches. Brown (10YR 5/3D, 10YR 4/3W) clay loam, fractured soft shale; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) iron stains and mottles in the seams; moderately alkaline (pH 8.0); strongly effervescent.

C3 – 52-60 inches. Light brownish gray (10YR 6/2D, 10YR 4/2W) silt loam, fractured soft shale; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) iron stains and mottles in the seams; moderately alkaline (pH 8.1). slightly effervescent.

Type Location - Shannon County, South Dakota; refer to waypoint 39 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The depth to bedded shale typically is about 20 to 26 inches and ranges from 20 to 40 inches. Colors of the soil commonly are inherited from the underlying shale. A few small pebbles are on the surface and mixed throughout the solum in some pedons.

The E horizon has hue of 10YR or 2.5Y, value of 5 to 8 and 3 to 5 moist, and chroma of 1 to 3. It is silt loam or loam and ranges from slightly acid to slightly alkaline. When dry, the surface is crusted up to 1/8 inch thick.

The Btn horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 7 and 4 to 6 moist, and chroma of 1 to 4. It is clay or silty clay averaging between 50 and 60 percent clay. It ranges from slighty to strongly alkaline. The Btn horizon has weak or moderate, fine to coarse columnar structure parting to moderate or strong, fine to coarse blocky structure in the upper part. Accumulations of salts and carbonates are in the lower Btn horizon of some pedons.

The Bkz horizon has hue of 10R to 5Y, value of 5 to 8 and 3 to 5 moist, and chroma of 1 to 4. It is silty clay or clay. It has few to many accumulations of carbonate and typically has accumulations of gypsum and salts. It ranges from slightly to strongly alkaline. It contains up to 15 percent fragments of shale by volume.

The C horizon has hue of 10R to 5Y, value of 5 to 8 and 3 to 5 moist, and chroma of 1 to 4. It is clay, or silty clay. Fragments of shale increase with depth and range up to 80 percent by volume. It ranges from slightly to strongly alkaline. Most pedons contain accumulations of carbonate and salts.

The Cr horizon is shale and hue of 10R to 5Y. It ranges from slightly acid to moderately alkaline.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer or have slightly less clay than typical for the series.

Taxonomic Class - Fine, smectitic, mesic Leptic Torrertic Natrustalfs

Suitability for Topsoil (According to WDEQ Guideline 1) - No unsuitable or marginal values were present. Strongly calcareous at 15 inches. Estimated stripping depth is 60 inches.

Geographic Setting (According to Official Series Description) - Hisle soils are nearly level to moderately sloping on uplands. Slope gradients range from 0 to 15 percent. Hisle soils formed in clays transported locally or weathered in place from clay shales. The mean annual soil temperature ranges from 45 to 53 degrees F, and mean annual precipitation ranges from 12 to 16 inches.

HISLE
NONCALCAREOUS VARIANT

Soil Mapping Unit "He"
Lab/BKS Sample ID: G08020803-022_026

Typical Pedon: Hisle silty clay loam - on an east-facing plane slope of 3 percent in native grass at 3,020 feet elevation. When described the soil was moist below a depth of 2 inches. (Colors are for dry soil unless otherwise stated.)

The Hisle series consists of moderately deep, well drained and moderately well drained soils formed in clayey sediments weathered from clay shale on uplands. Permeability is very slow. Slopes range from 0 to 15 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 45 degrees F.

A - 0-4 inches. Light gray (10YR 7/2) silty clay loam, moist; weak very thin platy structure parting to weak fine granular; soft, very friable; surface crust about 1/8 inch thick; abrupt smooth boundary; neutral (pH 6.6); noneffervescent.

Bt1 – 4-14 inches. Light olive brown (2.5Y 5/3D, 2.5Y 4/3W) silty clay loam, moist; weak medium prismatic structure parting to strong medium and fine blocky; very hard, firm, sticky and plastic; gradual wavy boundary; neutral (pH 7.1); noneffervescent.

Bt2 – 14-27 inches. Light olive brown (2.5Y 5/3D, 2.5Y 4/3W) silty clay loam, moist; few faint yellowish brown (10YR 5/6) mottles; weak medium and fine subangular blocky structure; very hard, firm, sticky and plastic; many small pebbles and fragments of shale; few fine dark concretions (Fe and Mn oxides); common fine threads and accumulations of carbonate and salt; clear wavy boundary; slightly alkaline (pH 7.8); noneffervescent.

Bt3n – 27-38 inches. Olive brown (2.5Y 4/3D, 2.5Y 4/2W) silty clay, fractured soft shale; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) iron stains and mottles in the seams; moderately alkaline (pH 8.1); noneffervescent.

Cn – 38-60 inches. Olive brown (2.5Y 4/3D, 2.5Y 4/2W) silty clay, fractured soft shale; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) iron stains and mottles in the seams; moderately alkaline (pH 7.9); noneffervescent.

Type Location - Shannon County, South Dakota; refer to waypoint 40 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The depth to bedded shale typically is about 20 to 26 inches and ranges from 20 to 40 inches. Colors of the soil commonly are inherited from the underlying shale. A few small pebbles are on the surface and mixed throughout the solum in some pedons.

The E horizon has hue of 10YR or 2.5Y, value of 5 to 8 and 3 to 5 moist, and chroma of 1 to 3. It is silt loam or loam and ranges from slightly acid to slightly alkaline. When dry, the surface is crusted up to 1/8 inch thick.

The Btn horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 7 and 4 to 6 moist, and chroma of 1 to 4. It is clay or silty clay averaging between 50 and 60 percent clay. It ranges from slighty to strongly alkaline. The Btn horizon has weak or moderate, fine to coarse columnar structure parting to moderate or strong, fine to coarse blocky structure in the upper part. Accumulations of salts and carbonates are in the lower Btn horizon of some pedons.

The Bkz horizon has hue of 10R to 5Y, value of 5 to 8 and 3 to 5 moist, and chroma of 1 to 4. It is silty clay or clay. It has few to many accumulations of carbonate and typically has accumulations of gypsum and salts. It ranges from slightly to strongly alkaline. It contains up to 15 percent fragments of shale by volume.

The C horizon has hue of 10R to 5Y, value of 5 to 8 and 3 to 5 moist, and chroma of 1 to 4. It is clay, or silty clay. Fragments of shale increase with depth and range up to 80 percent by volume. It ranges from slightly to strongly alkaline. Most pedons contain accumulations of carbonate and salts.

The Cr horizon is shale and hue of 10R to 5Y. It ranges from slightly acid to moderately alkaline.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer than typical for the series.

Taxonomic Class - Fine, smectitic, mesic Leptic Torrertic Natrustalfs

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 27-60 inches. Estimated stripping depth is 60 inches.

Geographic Setting (According to Official Series Description) - Hisle soils are nearly level to moderately sloping on uplands. Slope gradients range from 0 to 15 percent. Hisle soils formed in clays transported locally or weathered in place from clay shales. The mean annual soil temperature ranges from 45 to 53 degrees F, and mean annual precipitation ranges from 12 to 16 inches.

BARNUM
SILT LOAM

Soil Mapping Unit "Bc"
Lab/BKS Sample ID: G08020803-032_035

Typical Pedon: Barnum silt loam-rangeland. (Colors are for dry soil unless otherwise stated.)

The Barnum series consists of very deep, well drained soils formed in calcareous alluvium from red bed sediments. Barnum soils are on flood plains and alluvial terraces. Slopes are simple and range from 0 to 8 percent. The mean annual precipitation is about 12 inches, and the mean annual temperature is about 47 degrees F.

A - 0-6 inches. Reddish brown (5YR 4/4) silt loam, moist; moderate very fine granular structure; soft, very friable; calcium carbonate disseminated; clear smooth boundary; slightly alkaline (pH 7.8); noneffervescent.

C1k - 6-17 inches. Reddish brown (5YR 5/4D, 5YR 4/4W) silt loam, moist; massive with lenses of unaltered parent sediment; slightly hard, very friable; calcium carbonate disseminated and as soft masses in some lenses; moderately alkaline (pH 8.3); strongly effervescent.

C2k – 17-39 inches. Reddish brown (5YR 5/4D, 5YR 4/4W) silt loam, moist; massive with lenses of unaltered parent sediment; slightly hard, very friable; calcium carbonate disseminated and as soft masses in some lenses; strongly alkaline (pH 8.6); strongly effervescent.

C3kn – 39-60 inches. Yellowish red (5YR 4/6D, 5YR 4/4W) silt loam, moist; massive with lenses of unaltered parent sediment; slightly hard, very friable; calcium carbonate disseminated and as soft masses in some lenses; strongly alkaline (pH 8.5); strongly effervescent.

Type Location - Johnson County, Wyoming; refer to waypoint 42 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - These soils typically contain free carbonates throughout but may be leached a few inches in some pedons. Organic carbon ranges from .6 to 3 percent in the upper 10 inches and decreases irregularly with depth. The mean annual soil temperature is about 47 to 53 degrees F. The particle size control section is highly stratified and typically averages loam or light clay loam with 18 to 35 percent clay and more than 15 percent fine or coarser sand. Strata of sandy loam, silt loam, silty clay loam, and fine sandy loam are common. Rock fragments are variable between strata but average from 0 to 10 percent pebbles. Exchangeable sodium ranges from 4 to 15 percent throughout the soil. EC typically ranges from 2 to 8 mmhos throughout under natural conditions but may range to 16 mmhos where poorly irrigated.

The A horizon has hue of 7.5YR through 2.5YR, value of 4 through 6 dry, 3 through 5 moist, and chroma of 2 through 6. Reaction is slightly through strongly alkaline.

The C horizon has hue of 5YR through 10R, value of 4 through 7 dry, 3 through 5 moist, and chroma of 2 through 6. Some strata have visual accumulations of salts and carbonates which are typically discontinuous throughout the extent of the pedon. Reaction is slightly through strongly alkaline. Some pedons may have buried horizons below 40 inches.

Range in Characteristics (according to field observations, lab analysis): Textures are finer than typical for the series.

Taxonomic Class - Fine-loamy, mixed, superactive, calcareous, mesic Ustic Torrifluvents

Suitability for Topsoil (According to WDEQ Guideline 1) - Electrical conductivity was unsuitable at 6-39 inches. Sodium absorption ratio was unsuitable at 6-39 inches. Selenium was unsuitable at 6-17 inches. Strongly effervescent at 6 inches. Estimated stripping depth is 6 inches.

Geographic Setting (According to Official Series Description) - Barnum soils are on flood plains and alluvial terraces. These soils formed in calcareous alluvium derived from red beds containing siltstone, shale, and sandstone. Slopes are 0 to 8 percent. Elevations are 4,000 to 6,600 feet. The mean annual precipitation is about 12 inches and ranges from 10 to 14 inches with about half falling as snow or rain in April, May, and early June. The mean annual temperature is about 43 to 49 degrees F. The frost-free season is estimated to range from 110 to 135 days depending upon elevation, aspect, and air drainage.

CUSHMAN
LOAM

Soil Mapping Unit "Cy"
Lab/BKS Sample ID: G08020803-040_043

Typical Pedon: Cushman loam - on south facing slope of about 3 percent under native grass vegetation. (Colors are for dry soil unless otherwise stated.)

The Cushman series consists of well drained soils that are moderately deep to bedrock. These soils formed in slopewash alluvium and residuum from interbedded shales and siltstone and fine-grained argillaceous sandstone. Cushman soils are on buttes, fan remnants, hills, piedmonts, ridges and terraces. Slopes are 0 to 20 percent. The mean annual precipitation is about 13 inches, and the mean annual air temperature is about 45 degrees F

A - 0-2 inches. Light brownish gray (10YR 6/2) loam, moist; moderate medium granular structure; soft, friable, slightly sticky and slightly plastic; common very fine, fine, and few medium roots; clear smooth boundary; neutral (pH 6.6); noneffervescent.

Bt - 2-7 inches. Brown (10YR 5/3) clay loam, moist; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, moderately sticky and moderately plastic; common very fine, fine and few medium roots; few faint clay films on faces of peds and lining pores; clear smooth boundary; slightly alkaline (pH 7.4); noneffervescent.

Btk – 7-13 inches. Brown (10YR 4/3DW) clay loam, moist; moderate coarse prismatic structure parting to strong medium angular blocky; hard, firm, moderately sticky and moderately plastic; few fine, medium and coarse roots; common distinct clay films on faces of peds, lining pores and root channels; clear wavy boundary; moderately alkaline (pH 8.1); strongly effervescent.

Ck – 13-25 inches. Dark grayish brown (10YR 4/2D, 10YR 3/2W) clay loam, moist; moderate coarse prismatic structure parting to moderate fine and very fine subangular blocky; hard, firm, moderately sticky and moderately plastic; few fine roots; few faint clay films on faces of peds; calcium carbonate on faces of peds and in pores as common distinct irregularly shaped filaments and masses; clear smooth boundary; moderately alkaline (pH 8.3); strongly effervescent.

Type Location - Sheridan County, Wyoming; refer to waypoint 50 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Depth to a paralithic contact and bedrock is typically about 28 to 32 inches but ranges from 20 to 40 inches. Depth to continuous horizons of carbonate accumulation is 7 to 26 inches. Depth to the base of the argillic horizon ranges from 10 to 26 inches. Rock fragments range from 0 to 15 percent and are soft shale channers or semirounded sandstone pebbles. The soil is dry in the moisture control section more than half the time cumulative that the soil temperature at a depth of 20 inches is 41 degrees

F., which occurs about April 21-27, and is dry in all parts of the moisture control section for at least 60 consecutive days from July 15 to October 25 and for at least 90 cumulative days during this period. The mean annual soil temperature is 47 to 53 degrees F., and the soil temperature at a depth of 20 inches is 41 degrees F. or more for 175 to 192 days. EC ranges from 0 to 2 mmhos throughout.

The A horizon has hue of 10YR or 2.5Y, value of 4 to 6 dry, 3 to 5 moist, and chroma of 2 to 4. Reaction is neutral or slightly alkaline.

The Bt horizon has hue of 10YR or 2.5Y, value of 4 to 6 dry, 3 to 5 moist, and chroma of 2 to 4. Texture of the Bt is clay loam or loam with 20 to 35 percent clay and more than 15 percent but less than 35 percent fine sand or coarser. Reaction is neutral to moderately alkaline.

The Btk horizon has hue of 10YR or 2.5Y, value of 5 to 7 dry, 4 to 6 moist, and chroma of 2 to 4. Texture is loam or clay loam with 20 to 35 percent clay. Reaction is moderately alkaline or strongly alkaline. Calcium carbonate ranges from 3 to 12 percent.

The Bk horizon has hue of 10YR and 2.5Y, value of 6 to 8 dry, 4 to 6 moist, and chroma of 2 to 4. Texture is loam or clay loam with 20 to 30 percent total clay of which about 2 to 4 percent is carbonate clay. Reaction is typically moderately alkaline but may be strongly alkaline when sodic shales are present. Calcium carbonate equivalent is 5 to 15 percent, but some horizons may exceed 15 percent but are discontinuous or too thin to be considered as a calcic.

The Cr is weakly consolidated sedimentary rock. It is primarily calcareous shale; but siltstone or thinly interbedded fine grained argillaceous sandstone is common. The rock is typically moderately alkaline or strongly alkaline when crushed, but slightly alkaline or neutral shales are not uncommon.

Range in Characteristics (according to field observations, lab analysis): No significant range in characteristics was found.

Taxonomic Class - Fine-loamy, mixed, superactive, mesic Ustic Haplargids

Suitability for Topsoil (According to WDEQ Guideline 1) - No marginal or unsuitable parameters were found. Strongly effervescent at 7 inches. Estimated stripping depth is 25 inches.

Geographic Setting (According to Official Series Description) - Cushman soils are on buttes, fan remnants fan piedmonts, hills and ridges. Slopes range from 0 to 20 percent. The soils formed in moderately fine textured slopewash alluvium and residuum. Surface erosion is common in overgrazed areas, and some thin eolian deposits overlie these soils in some areas. Elevations are 3,500 to 6,000 feet. The mean annual precipitation is 13 inches and ranges from 10 to 14 inches with over half of the annual precipitation falling in April, May, and June and less than one inch falling in each month of July, August, September and October. The mean annual temperature is 43 to 51 degrees F. The frost-free season is about 105 to 130 days depending upon elevation, aspect, and air drainage.

ZIGWEID
SILTY CLAY LOAM

Soil Mapping Unit "Zn"
Lab/BKS Sample ID: G08020803-044_048

Typical Pedon: Zigweid silty clay loam - on a 3 percent southwest facing slope utilized as rangeland. (Colors are for dry soil unless otherwise stated.)

The Zigweid series consists of very deep, well drained soils formed in alluvium from mixed sedimentary sources on fan aprons, alluvial fans, fan piedmonts, fan remnants, terraces, ridges and hills. Slopes range from 0 to 20 percent. Permeability is moderate. The mean annual precipitation is about 13 inches, and the mean annual air temperature is about 46 degrees F.

A - 0-3 inches. Light brownish gray (10YR 6/2) silty clay loam, moist; moderate fine and medium granular structure; slight hard, friable, nonsticky and nonplastic; many very fine and fine roots throughout; clear smooth boundary; slightly alkaline (pH 7.4); noneffervescent.

B1 - 3-14 inches. Brown (10YR 5/3D, 10YR 4/2W) silty clay loam, moist; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots throughout and few medium throughout; carbonates are disseminated throughout; gradual wavy boundary; slightly alkaline (pH 7.7); very slightly effervescent.

B2 – 14-26 inches. Dark grayish brown (10YR 4/2DW) silty clay loam, moist; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots throughout; common fine irregular light gray (10YR 7/2) carbonate threads throughout; gradual wavy boundary; slightly alkaline (pH 7.6); very slightly effervescent.

C1 – 26-36 inches. Yellowish brown (10YR 5/4D, 10YR 4/3W) silt loam, moist; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots throughout; common fine irregular light gray (10YR 7/2) carbonate threads throughout; gradual wavy boundary; slightly alkaline (pH 7.5); very slightly effervescent.

C2 – 36-60 inches. Brown (10YR 5/3D, 10YR 4/2W) loam, moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots throughout; common fine irregular light gray (10YR 7/2) carbonate threads throughout; slightly alkaline (pH 7.7); strongly effervescent.

Type Location - Campbell County, Wyoming; refer to waypoint 56 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Depth to carbonates ranges from 0 to 8 inches. Depth to the Bk horizon and the base of the cambic horizon ranges from 10 to 22 inches. The particle-size control section and soil profile are clay loam or loam. Clay ranges from 18 to 35 percent, silt from 20 to 55 percent, and sand from 15 to 50 percent with more than 15 percent but less than 35 percent fine sand or coarser. Rock fragments range from 0 to 15 but are typically less than 5 percent and are mostly soft shale chips. The moisture control section is usually dry in all parts for 90 cumulative days following the summer solstice and for 60 consecutive days during this period. The mean annual soil temperature is 47 to 53 degrees F. The soil temperature at a depth of 20 inches is 41 degrees F. or warmer for 175 to 192 days.

The A horizon has hue of 5Y, 2.5Y or 10YR, value of 4 to 6 dry, 3 to 5 moist, and chroma of 2 or 3. It is loam or clay loam. Reaction is neutral to moderately alkaline.

The Bw horizon has hue of 5Y, 2.5Y or 10YR, value of 5 or 6 dry, 4 or 5 moist, and chroma of 2 to 4. It is loam or clay loam. Reaction is slightly alkaline or moderately alkaline.

The Bk horizon has hue of 5Y, 2.5Y or 10YR, value of 5 to 7 dry, 4 to 6 moist, and chroma of 2 to 4. It is loam or clay loam. It has 5 to 14 percent calcium carbonate equivalent and may have a few scattered crystals of calcium sulfate. Reaction is moderately alkaline or strongly alkaline.

Some pedons have a C horizon with similar properties as the Bk horizon. Some pedons may have sandy clay loam textures below 40 inches. It typically has 3 to 5 percent less calcium carbonate than the overlying Bk horizon.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer than typical for the series.

Taxonomic Class - Fine-loamy, mixed, superactive, mesic Ustic Haplocambids

Suitability for Topsoil (According to WDEQ Guideline 1) - No marginal or unsuitable parameters were found. Strongly effervescent at 36 inches. Estimated stripping depth is 60 inches.

Geographic Setting (According to Official Series Description) - These soils are on fan aprons, alluvial fans, terraces, fan piedmonts, fan remnants, ridges and hills. In many areas they are dissected. Slopes range from 0 to 20 percent. These soils formed in calcareous, moderately fine textured sediments derived from interbedded shale and soft sandstone. Elevations are 3,500 to 6,600 feet. The mean annual precipitation is 13 inches with over half of the annual precipitation falling in April, May, and June and less than one inch falling in each month of July, August, September, and October. Precipitation ranges from 10 to 14 inches. The mean annual temperature is about 46 degrees F., and ranges from 43 to 51 degrees F. The frost-free season is about 105 to 130 days.

SAMSIL
CLAY LOAM

Soil Mapping Unit "Sa"
Lab/BKS Sample ID: G08020805-001_002

Typical Pedon: Samsil clay loam - on a convex, southwest-facing slope of 15 percent in native grass. When described the soil was moist to 12 inches, dry from 12 to 21 inches, and moist below 21 inches. (Colors are for dry soil unless otherwise stated.)

The Samsil series consists of shallow, well drained soils formed in alluvium or residuum weathered from shale. Permeability is slow. Slope ranges from 2 to 60 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 47 degrees F.

A - 0-3 inches. Light brownish gray (2.5Y 6/2) clay loam, moist; moderate fine granular structure; slightly hard, friable, sticky and plastic; common fine roots; few very fine fragments of shale; clear wavy boundary; slightly alkaline (pH 7.5); noneffervescent.

AC - 3-10 inches. Gray (10YR 5/1D) clay, moist; weak medium subangular blocky structure parting to weak medium granular; hard, friable, sticky and plastic; common fine roots; common fine fragments of soft shale; clear wavy boundary; moderately alkaline (pH 8.4); strongly effervescent.

Ck – 10-18 inches. Very dark gray (10YR 3/1D) silt loam, moist; massive; hard, friable, sticky and plastic; common fine roots; about 50 percent by volume of fragments of soft shale; common distinct olive yellow (2.5Y 6/6) stains on faces of shale fragments; few fine and medium accumulations of carbonate; gradual wavy boundary; moderately alkaline (pH 8.2); strongly effervescent.

Type Location - Pennington County, South Dakota; refer to waypoint 60 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The control section is clay and contains 50 to 65 percent clay. The depth to bedded shale ranges from 6 to 20 inches. Horizons above the shale range from loose to hard when dry, and friable or firm when moist. These horizons contain free carbonates. Effervescence ranges from slight to strong and reaction is slightly alkaline or moderately alkaline. The C1 and C2 horizons and upper part of the Cr horizons commonly have accumulations of carbonate, gypsum, and other salts. Colors throughout, including mottles and stains, are inherited from the shale.

The A horizon has hue of 5Y, 2.5Y, or 10YR, value of 4 to 7 and 3 to 6 moist, and chroma of 2 to 4. It is clay, silty clay, silty clay loam or clay loam and commonly contains few to common fragments of shale ranging from 2 to 25 mm in diameter. It has fine or medium subangular blocky or fine or very fine granular structure. The upper 1/4 to 1/2 inch commonly is a fragile

crust or mulch or very fine granules when dry.

The AC horizon has hue of 5Y, 2.5Y, or 10YR, value of 4 to 7 and 3 to 6 moist, and chroma of 1 to 4. It contains up to 35 percent fragments of shales by volume that range from less than 2 mm to 30 mm in diameter.

The C horizon has hue of 5Y, 2.5Y or 10YR, value of 4 to 7 and 3 to 6 moist, and chroma of 1 to 4. It is clay. The C horizon contains from 35 to more than 50 percent fragments of shale by volume that range from less than 2 mm to 35 mm in diameter.

The Cr horizon has the same range in color as the overlying C horizons. It ranges from medium acid to moderately alkaline.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer and have less clay than typical for the series.

Taxonomic Class - Clayey, smectitic, calcareous, mesic, shallow Aridic Ustorthents

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 3-10 inches. Electrical conductivity was marginal at 10-18 inches. Sodium absorption ratio was marginal at 3-18 inches. Selenium was marginal at 10-18 inches. Strongly effervescent at 3 inches. Estimated stripping depth is 3 inches.

Geographic Setting (According to Official Series Description) - Samsil soils are on gently sloping to very steep hills, ridges and breaks of dissected shale plains. Surfaces mainly are convex, and slope gradients range from 2 to 60 percent or more. The soil formed in alluvium or residuum weathered from shale. Mean annual air temperature ranges from 45 to 48 degrees F, and mean annual precipitation ranges from 14 to 19 inches.

ARVADA
SILTY CLAY LOAM

Soil Mapping Unit "Ar"
Lab/BKS Sample ID: G08020805-012_016

Typical Pedon: Arvada silty clay loam - rangeland. (Colors are for dry soil unless otherwise stated.)

The Arvada series consists of very deep, well drained soils formed in alluvium and colluvium derived from sodic shale. Arvada soils are on alluvial fans, fan remnants, fan terraces and hillslopes. Slopes are 0 to 25 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 46 degrees F.

A - 0-3 inches. Light gray (10YR 7/2) silty clay loam, moist; moderate very thin platy structure parting to moderate very fine granular; soft, very friable, nonsticky and nonplastic; many fine and very fine roots; abrupt smooth boundary; slightly acid (pH 6.3); noneffervescent.

Bt - 3-18 inches. Dark grayish brown (2.5Y 4/2DW) clay loam, moist; moderate medium columnar structure parting to moderate medium angular blocky; extremely hard, firm, sticky and very plastic; common medium roots; many prominent clay films on faces of peds and in root channels; ESP is 20 percent; clear smooth boundary; slightly alkaline (pH 7.6); noneffervescent.

Btn– 18-28 inches. Dark grayish brown (2.5Y 4/2D, 2.5Y 5/2W) silty clay, moist; massive; hard, friable, sticky and plastic; common medium soft masses of calcium carbonate and gypsum as crystals in thin seams and as filaments or threads; 20 percent exchangeable sodium; moderately alkaline (pH 7.9); very slightly effervescent.

C1n – 28-43 inches. Grayish brown (2.5Y 5/2D, 2.5Y 4/2W) silt loam, moist; massive; hard, friable, sticky and plastic; common medium soft masses of calcium carbonate and gypsum as crystals in thin seams and as filaments or threads; 20 percent exchangeable sodium; moderately alkaline (pH 8.2); very slightly effervescent.

C2nsa – 43-60 inches. Very dark grayish brown (10 YR 3/2DW) silt loam, moist; massive; hard, friable, sticky and plastic; common medium soft masses of calcium carbonate and gypsum as crystals in thin seams and as filaments or threads; 20 percent exchangeable sodium; moderately alkaline (pH 8.3); slightly effervescent.

Type Location - Sheridan County, Wyoming; refer to waypoint 72 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Depth to effervescent material ranges from 0 to 19 inches. Depth to layers with greater than 15 percent exchangeable sodium is 4 to 10 inches. The depth to the base of the Bt horizon is 15 inches or more. A thin A

horizon occurs in some pedons. A light colored platy E horizon is generally present but is absent in some pedons. Gravel is typically less than 5 percent but ranges from 0 to 15 percent. The moisture control section is usually dry for 60 consecutive days during the 90 day period following the summer solstice. The mean annual soil temperature is 47 to 53 degrees F., and the soil temperature at a depth of 20 inches is 41 degrees F. or more for 175 to 195 days. The soil has an aridic moisture regime that borders on ustic.

The E and A horizons have hue of 10YR, 2.5Y or 5Y, value of 4 to 7, 4 or 5 moist, and chroma of 2 to 4. Texture is fine sandy loam, loam, silt loam, clay loam or very fine sandy loam. Reaction ranges from neutral through strongly alkaline. EC ranges from 0 to 4 mmhos/cm.

The Btn horizon has hue of 7.5YR, 10YR, 2.5Y or 5Y, value of 4 to 6 dry, 4 or 5 moist, and chroma of 2 to 4. Texture is clay, clay loam, silty clay or silty clay loam and has 35 to 60 percent clay, 10 to 50 percent silt, and 5 to 45 percent sand. This horizon is strongly alkaline or very strongly alkaline (pH 8.8 to 10.0), has 15 to 34 percent exchangeable sodium, and an EC of 4 to 16 mmhos/cm. Some pedons when buffered by gypsum are moderately alkaline. The Btkn horizon, when present, has a calcium carbonate equivalent of 3 to 12 percent and an exchangeable sodium percent of 10 to 30. A thin Bt horizon is present above the Btn in some pedons. Some pedons have a Btkny horizon.

The Bkny horizon has hue of 7.5YR, 10YR or 2.5Y, value of 5 or 6 dry, 4 or 5 moist. Textures are clay, clay loam, silty clay or silty clay loam. Reaction ranges from strongly alkaline or very strongly alkaline (pH 8.6 to 10.0). This horizon contains 4 to 15 percent calcium carbonate equivalent. Some pedons when buffered by gypsum are moderately alkaline. Exchangeable sodium typically ranges from 10 to 30 percent but decreases with increasing depth. Electrical conductivity is 4 to 16 mmhos/cm. Some pedons have a C horizon.

Some pedons have a C horizon below 40 inches. It has properties similar to those of the Bkny horizon.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer than typical for the series.

Taxonomic Class - Fine, smectitic, mesic Ustertic Natrargids

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 18-28 inches. Electrical conductivity was marginal at 28-60 inches. Sodium absorption ratio was marginal at 28-43 inches and was unsuitable at 43-60 inches. Selenium was marginal at 18-60 inches. Strongly effervescent at 3 inches. Estimated stripping depth is 18 inches.

Geographic Setting (According to Official Series Description) - The Arvada soils are on alluvial fans, fan remnants, terraces and hillslopes. The soils formed in moderately fine textured alluvium and colluvium derived from sedimentary rocks. Slopes range from 0 to 25 percent. Elevations range from 2,600 to 6,000 feet. The average annual precipitation is about 12 inches but ranges from 9 to 14 inches with about half the precipitation occurring during April, May, and early

June. The mean annual air temperature is about 43 to 53 degrees F., and the mean summer temperature is 63 degrees F. The frost-free season is estimated to range from 100 to 160 day

LOHMILLER
LOAM

Soil Mapping Unit "Lo"
Lab/BKS Sample ID: G08020805-017_022

Typical Pedon: Lohmiller loam - on a plane slope of less than 1 percent in a cultivated field. When described the soil was moist throughout. (Colors are for dry soil unless otherwise stated.)

The Lohmiller series consists of very deep, well drained soils formed in alluvium on bottom lands. Permeability is slow or moderately slow. Slopes range from 0 to 8 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 46 degrees F.

A - 0-3 inches. Light gray (10YR 6/1) loam, moist; moderate medium granular structure; hard, friable; many fine roots; neutral; clear smooth boundary; slightly alkaline (pH 7.4); noneffervescent.

AC - 3-15 inches. Dark grayish brown (2.5Y 4/2W) silty clay, moist; weak thin platy structure parting to weak fine granular; very hard, firm; common fine roots, clear smooth boundary; moderately alkaline (pH 7.9); noneffervescent.

C1 – 15-23 inches. Dark grayish brown (2.5Y 4/2W) silty clay, moist; massive; very hard, firm; thin bedding planes evident; common very fine roots; slighty alkaline (pH 7.8); noneffervescent.

C2n – 22-34 inches. Dark grayish brown (2.5Y 4/2W) silty clay, moist; massive; very hard, firm; thin bedding planes evident; common very fine roots; moderately alkaline (pH 8.0); very slightly effervescent.

C3k – 34-38 inches. Grayish brown (2.5Y 5/2W) silty clay, moist; massive; very hard, firm; thin bedding planes evident; common very fine roots; moderately alkaline (pH 8.0); very slightly effervescent.

C4n – 38-60 inches. Dark grayish brown (2.5Y 4/2W) clay, moist; massive; very hard, firm; thin bedding planes evident; common very fine roots; moderately alkaline (pH 8.0); very slightly effervescent.

Type Location - Fall River County, South Dakota; refer to waypoint 73 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Carbonates are within 10 inches of the surface. The control section averages from 35 to 50 percent clay.

The A horizon has hue of 10YR or 2.5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. Some pedons have value of 4 dry and 3 moist in the upper 4 inches. It typically is silty clay loam

or clay loam but is silty clay in some pedons. It ranges from neutral to moderately alkaline.

The C horizon has hue of 10YR, 2.5Y, or 5Y; value of 5 to 7 and 4 to 6 moist; and chroma of 2 to 4. It typically is clay loam or silty clay loam but is silty clay or clay in some pedons. It is stratified with thin layers of loamy sand, fine sandy loam, loam, sandy clay or silt loam. It is slightly alkaline or moderately alkaline. Some pedons have accumulations of carbonates.

Range in Characteristics (according to field observations, lab analysis): Textures have slightly more clay than typical for the series.

Taxonomic Class - Fine, smectitic, calcareous, mesic Torrertic Ustifluvents

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 3-60 inches. Saturation percentage was marginal at 15-34 inches and 38-60 inches. Sodium absorption ratio was unsuitable at 3-60 inches. Electrical conductivity was marginal at 15-23 inches and was unsuitable at 23-60 inches. Selenium was marginal at 15-60 inches. Estimated stripping depth is 3 inches.

Geographic Setting (According to Official Series Description) - Lohmiller soils are on flood plains and high bottom lands of rivers and streams and on alluvial fans of foot slopes. Slopes are typically less than 2 percent but range from 0 to 8 percent. The soils formed in calcareous alluvium from sedimentary rock. Mean annual air temperature ranges from 45 to 48 degrees F, and mean annual precipitation ranges from 10 to 19 inches.

PIERRE
SANDY CLAY LOAM

Soil Mapping Unit "Pe"
Lab/BKS Sample ID: G08020805-023_028

Typical Pedon: Pierre sandy clay loam - on a convex slope of 7 percent in native grass. (Colors are for dry soil unless otherwise stated.)

The Pierre series consists of moderately deep, well drained soils formed in clayey residuum weathered from shale bedrock on uplands. Permeability is very slow. Slopes range from 0 to 30 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 46 degrees F.

A - 0-3 inches. Grayish brown (2.5Y 5/2) sandy clay loam, moist; moderate fine subangular blocky structure parting to weak very fine granular; hard, firm, sticky and plastic; 1 percent pebbles; clear smooth boundary; slightly alkaline (pH 7.8); noneffervescent.

AC- 3-15 inches. Dark grayish brown (2.5Y 4/2W) sandy clay loam, moist; moderate medium and coarse prismatic structure; extremely hard, very firm, very sticky and very plastic; common distinct intersecting slickensides; few fine accumulations of iron; 1 percent pebbles; gradual wavy boundary; moderately alkaline (pH 8.3); strongly effervescent.

C1k – 15-27 inches. Grayish brown (2.5Y 5/2W) clay loam, moist; moderate coarse prismatic structure; extremely hard, very firm, very sticky and very plastic; common distinct intersecting slickensides; few fine nests of iron and common fine accumulations of gypsum; 1 percent pebbles; gradual wavy boundary; strongly alkaline (pH 8.5); violently effervescent.

C2n – 27-38 inches. Dark grayish brown (2.5Y 4/2W) loam, moist; common distinct strong brown (7.5YR 5/6) and yellowish brown (10YR 5/6) iron stains; many fine accumulations of gypsum and carbonate; 1 percent pebbles; gradual wavy boundary; strongly alkaline (pH 8.5); slightly effervescent.

C3k – 38-51 inches. Dark grayish brown (2.5Y 4/2W) loam, moist; common distinct strong brown (7.5YR 5/6) iron stains; 1 percent pebbles; moderately alkaline (pH 8.4); strongly effervescent.

C4n – 51-60 inches. Dark grayish brown (2.5Y 4/2W) sand loam, moist; common distinct strong brown (7.5YR 5/6) iron stains; 1 percent pebbles; moderately alkaline (pH 8.4); very slightly effervescent.

Type Location - Haakon County, South Dakota; refer to waypoint 74 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The soil contains carbonates at or within 6 inches of the surface. The depth to soft shale bedrock ranges from 20 to 40 inches but commonly is at depths of 25 to 35 inches. The horizon above the shale has 0 to 60 percent, by volume soft shale fragments. The control section is 50 to 60 percent clay. When the soil is dry, cracks 1/2 inch to 2 inches wide and several feet long extend downward through the solum. The soil does not have a mollic epipedon, but the upper 10 inches of the solum has an average organic carbon content between 0.6 and 1.7 percent. The soil has a SAR of 1 to 7.

The A horizon has hue of 10YR to 5Y, value of 4 to 6 and 3 to 5 moist, and chroma of 1 to 3. It typically is clay but is silty clay in some pedons. It ranges from slightly acid to moderately alkaline. When the soil is dry it has a light gray (2.5Y 7/2) smooth, porous, platy surface crust ranging from 1/4 to 1 inch in thickness. Where the horizon has mollic colors, it is too thin to be a mollic epipedon. Some pedons do not have an AB horizon.

The Bss horizons have hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 1 to 3. They are extremely hard or very hard when dry and extremely firm to firm when moist. They range from neutral to moderately alkaline.

Bk and C horizons are present in some pedons.

The Cr horizon is soft shale bedrock and ranges from slightly acid to moderately alkaline. Bedding planes are evident in the partially weathered shale in some pedons. Gypsum and other salts are concentrated in very thin seams within the shale in some pedons.

Range in Characteristics (according to field observations, lab analysis): Textures are coarser and have less clay than typical for the series.

Taxonomic Class - Fine, smectitic, mesic Aridic Leptic Haplusterts

Suitability for Topsoil (According to WDEQ Guideline 1) - pH was marginal (alkaline) at 15-38 inches. Sodium absorption ratio was unsuitable at 15-60 inches. Electrical conductivity was unsuitable at 27-60 inches. Selenium was marginal at 15-60 inches. Strongly effervescent at 3 inches. Estimated stripping depth is 15 inches.

Geographic Setting (According to Official Series Description) - Pierre soils are on nearly level to steep uplands. Slope gradient typically is 3 to 15 percent, but ranges from 0 to 30 percent. The soils formed in residuum weathered from clay shale. Gilgai microrelief is in most areas. Mean annual air temperature is 44 to 53 degrees F, and mean annual precipitation ranges from 12 to 16 inches. Growing season is 125 to 140 days; average growing season precipitation is 10 to 13 inches; and growing degree days are 2600 to 3100. Elevation is 1300 to 3600 feet.

HAVERSON
CLAY LOAM

Soil Mapping Unit "Ha"
Lab/BKS Sample ID: G08020805-029_033

Typical Pedon: Haverson clay loam - grassland. (Colors are for dry soil unless otherwise stated.)

The Haverson series consists of very deep, well drained soils that formed in alluvium from mixed sources. Haverson soils are on floodplains and low terraces and have slopes of 0 to 9 percent. The mean annual precipitation is about 15 inches and the mean annual air temperature is about 49 degrees F.

A - 0-4 inches. Brown (10YR 4/3D, 10YR 4/2W) clay loam, moist; strong fine granular structure; slightly hard, very friable; clear smooth boundary; slightly alkaline (pH 7.8); noneffervescent.

AC - 4-15 inches. Brown (10YR 4/3D, 10YR 4/2W) silty clay loam, moist; weak coarse subangular blocky structure; very hard, friable; clear smooth boundary; slightly alkaline (pH 7.7); very slightly effervescent.

C1 – 15-35 inches. Brown (10YR 4/3D, 10YR 4/2W) silty clay loam, moist; massive; hard, friable; gradual smooth boundary; slightly alkaline (pH 7.6); slightly effervescent.

C2n – 35-46 inches. Brown (10YR 4/3D, 10YR 4/2W) silty clay loam, moist; massive; slightly hard, very friable; few fine irregularly shaped masses and seams of lime; slightly alkaline (pH 7.8); slightly effervescent.

C3 – 46-60 inches. Brown (10YR 4/3D, 10YR 4/2W) silty clay loam, moist; massive; slightly hard, very friable; few fine irregularly shaped masses and seams of lime; slightly alkaline (pH 7.8); slightly effervescent.

Type Location - Weld County, Colorado; refer to waypoint 75 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Mean annual soil temperature ranges from 47 to 55 degrees F. and mean summer soil temperature ranges from 59 to 78 degrees F. Organic carbon ranges from 0.5 to 2.0 percent in the surface horizon but decreases irregularly with depth. The particle-size control section is stratified with strata ranging from sandy loam to clay loam, but averaging approximately loam. On a weighted average basis, clay ranges from 18 to 35 percent, silt from 10 to 50 percent, and sand from 20 to 60 percent with more than 15 percent but less than 35 percent being fine or coarser sand. Rock fragments are generally less that 5 percent and range from 0 to 20 percent. Some visible calcium carbonate may occur at any depth in these soils, but it is not concentrated into any consistent horizon of accumulation. This soil is not dry in all parts of the moisture control section for more than one-

half the time the soil temperature is above 41 degrees F. (195 to 210 days) and is not dry for 45 consecutive days following July 15.

The A horizon has hue of 2.5Y or 10YR, value of 4 to 6 dry, 3 to 5 moist and chroma of 2 or 3. When the value of the surface horizon is as dark as 5 dry and 3 moist, the horizon is thin enough so that if mixed to 7 inches it is too light colored or contains too little organic carbon to qualify as a mollic epipedon or are finely stratified. The A horizon usually has granular primary structure but it has subangular blocky structure in some pedons. It is soft or slightly hard. It is neutral through moderately alkaline.

The C horizon has hue of 2.5Y, 10YR or 7.5YR, value of 5 or 6 dry, 4 or 5 moist and chroma of 2 or 3. It is slightly alkaline to very strongly alkaline. It has from less-than-one to about 15 percent calcium carbonate equivalent, which differs erratically from stratum to stratum.

Range in Characteristics (according to field observations, lab analysis): Textures are finer and have more clay than typical for the series.

Taxonomic Class - Fine-loamy, mixed, superactive, calcareous, mesic Aridic Ustifluvents

Suitability for Topsoil (According to WDEQ Guideline 1) - Sodium absorption ratio was marginal at 15-35 inches and unsuitable at 35-60 inches. Estimated stripping depth is 35 inches.

Geographic Setting (According to Official Series Description) - The Haverson soils are on floodplains and low terraces of major rivers. Slope is 0 to 9 percent. The soils formed in highly stratified, calcareous, recent alluvium derived from mixed sources. At the type location the average annual precipitation is 14 to 18 inches with peak periods of precipitation occurring during the early spring and summer. The mean annual air temperature ranges from 47 to 52 degrees F. and the mean summer temperature is 77 degrees F. The frost-free season is 125 to 180 days.

DEMAR
LOAM

Soil Mapping Unit "Dg"
Lab/BKS Sample ID: G08020805-034_038

Typical Pedon: Demar loam - on a plane slope of less than 1 percent. When described the soil was moist to 5 inches and dry below. (Colors are for dry soil unless otherwise stated.)

The Demar series consists of deep or very deep, moderately well drained soils formed in clayey alluvium from acid clay shales. These soils are on terraces. They have very slow permeability. Slopes range from 0 to 6 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 47 degrees F.

A - 0-2 inches. Pale brown (10YR 6/3) loam, moist; weak thin platy structure parting to weak fine granular; slightly hard, friable, slightly sticky; many roots; abrupt wavy boundary; strongly acid (pH 5.3); noneffervescent.

Bt - 2-21 inches. Grayish brown (2.5Y 5/2D) silty clay, moist; moderate medium blocky structure; very hard, very firm, sticky and plastic; very few roots; clear smooth boundary; slightly alkaline (pH 7.7); noneffervescent.

Btn – 21-29 inches. Very dark grayish brown (2.5Y 3/2D) clay, moist; few fine prominent yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; very hard, very firm, sticky and plastic; very few roots; common fine nests of gypsum and other salts; gradual boundary; neutral (pH 6.9); very slightly effervescent.

C1 – 29-46 inches. Dark grayish brown (2.5Y 4/2D) silty clay loam, moist; many coarse prominent brownish yellow (10YR 6/6) mottles; weak coarse subangular blocky structure; very hard, very firm; partially weathered shale fragments make up about 40 percent by volume; common bands of crystals of gypsum; gradual boundary; slightly alkaline (pH 7.6); very slightly effervescent.

C2 – 46-60 inches. Grayish brown (2.5Y 5/2D) silty clay loam, moist; many coarse prominent brownish yellow (10YR 6/6) and yellowish brown (10YR 5/6) iron stains along fractures; neutral (pH 7.3); very slightly effervescent.

Type Location - Butte County, South Dakota; refer to waypoint 76 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The depth to bedded shale ranges from 40 to 60 inches or more. These soils range from neutral to strongly acid in the upper 12 inches and from very strongly acid to extremely acid below this depth.

The E horizon has hue of 10YR or 2.5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 or 3. It typically is loam but is clay loam in some pedons.

The Bt horizon has hue of 10YR or 2.5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 or 3. The clay content of the Bt horizon is between 35 and 60 percent. Structure of the Bt horizon ranges from weak or moderate, medium or coarse columnar in the Bt1 horizon and moderate or strong, medium or coarse blocky in the Bt2 horizon.

The Bz horizon has hue of 10YR or 2.5Y, value of 5 or 6 and 4 to 5 moist, and chroma of 2 to 3. It has common or many accumulations of gypsum and other salts.

The C horizon has hue of 10YR or 2.5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 or 3. It contains 20 to 50 percent fragments of shale.

Range in Characteristics (according to field observations, lab analysis): No significant range in characteristics was found.

Taxonomic Class - Fine, smectitic, mesic Torrertic Haplustalfs

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 2-29 inches. Sodium absorption ratio was marginal at 2-29 inches and unsuitable at 29-60 inches. Selenium was marginal at 46-60 inches. Estimated stripping depth is 2 inches.

Geographic Setting (According to Official Series Description) - Demar soils are on micro-highs on nearly level to gently sloping alluvial terraces having pronounced micro-relief. Slope gradients range from 0 to 6 percent. These soils formed in clayey alluvium derived from acid clay shales. The mean annual air temperature ranges from 45 to 49 degrees F, and mean annual precipitation ranges from 12 to 18 inches.

PENROSE
CLAY LOAM

Soil Mapping Unit "Pg"
Lab/BKS Sample ID: G08020805-039_042

Typical Pedon: Penrose clay loam-grassland. (Colors are for dry soil unless otherwise stated.)

The Penrose series consists of shallow, well and somewhat excessively drained, moderate to slowly permeable soils formed in thin, calcareous, loamy materials weathered in place from limestone and interbedded limy materials. Penrose soils are on hills, plains, ridges, hogbacks, cuestas, and mesa tops. Slopes are 1 to 65 percent. Mean annual precipitation is about 13 inches and mean annual temperature is about 51 degrees F.

A - 0-4 inches. Light brownish gray (2.5Y 6/2) clay loam, moist; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; 25 percent channers; calcareous; clear smooth boundary; slightly alkaline (pH 7.6); slightly effervescent.

C1k - 4-17 inches. Dark grayish brown (10YR 4/2D) clay loam, moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; 20 percent limestone channels; calcareous; abrupt smooth boundary; slightly alkaline (pH 7.7); strongly effervescent.

C2k – 17-36 inches. Grayish brown (10YR 5/2D) silt loam, limestone bedrock; moderately alkaline (pH 8.0); very slightly effervescent.

Cr – 36-48 inches. Grayish brown (10YR 5/2D) silt loam, limestone bedrock; slightly alkaline (pH 7.8); very slightly effervescent.

Type Location - Fremont County, Colorado; refer to waypoint 77 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) –
Soil moisture: The soil moisture control section is moist intermittently April through August; aridic moisture regime bordering on ustic.
Mean annual soil temperature: 52 to 59 degrees F.
Mean summer soil temperature: 68 to 76 degrees F.
Depth to lithic contact: 10 to 20 inches to limestone
Depth to secondary calcium carbonate: 0 to about 5 inches and is not more than 1/4 the thickness of the control section
Gypsum content: 0 to 1.5 percent by weight
Calcium carbonate equivalent: 40 to 75 percent
Electrical conductivity: 0 to 14 millimhos/cm in a major part of the control section
Continuous subhorizons of secondary calcium carbonate and/or sulfate do not occur within the control section although some visible accumulation occurs in some pedons
Particle-size control section (weighted average):

Clay content: 18 to 35 percent
Sand content: 15 to 70 percent
Rock fragments: 0 to 35 percent, dominantly to 10 inches in diameter.

A horizon:
Hue: 7.5YR through 2.5Y
Value: 5 through 8, 3 through 6 moist
Chroma: 1 through 4.
Calcium carbonate equivalent: 35 to 70 percent
Reaction: mildly alkaline or moderately alkaline.
Rock fragments: 0 to 35 percent

C horizon:
Hue: 7.5YR through 2.5Y
Textures of the fine earth fraction: loam, silt loam, clay loam
Clay content: 18 to 35 percent
Rock fragments: 0 to 35
Calcium carbonate equivalent: 40 to 75 percent
Reaction: moderately alkaline or strongly alkaline.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer than typical for the series.

Taxonomic Class - Loamy, carbonatic, mesic Lithic Ustic Torriorthents

Suitability for Topsoil (According to WDEQ Guideline 1) – Boron was unsuitable at 36-48 inches. Strongly effervescent at 4 inches. Estimated stripping depth is 36 inches.

Geographic Setting (According to Official Series Description) –
Parent material: residuum and slope alluvium derived from limestone and interbedded limy materials.
Landform: hills, mesas, and ridges
Slopes: 1 to 65 percent
Elevation: 3,000 to 6,500 feet
Mean annual temperature: 50 to 53 degrees F
Mean annual precipitation: 11 to 15 inches
Precipitation pattern: peak periods between April and August, dries between November and February
Frost-free period: 125 to 165 days.

DEMAR
SILTY CLAY LOAM

Soil Mapping Unit "Dg"
Lab/BKS Sample ID: G08020805-043_047

Typical Pedon: Demar silty clay loam - on a plane slope of less than 1 percent. When described the soil was moist to 5 inches and dry below. (Colors are for dry soil unless otherwise stated.)

The Demar series consists of deep or very deep, moderately well drained soils formed in clayey alluvium from acid clay shales. These soils are on terraces. They have very slow permeability. Slopes range from 0 to 6 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 47 degrees F.

A - 0-3 inches. Pale brown (10YR 6/3) silty clay loam, moist; weak thin platy structure parting to weak fine granular; slightly hard, friable, slightly sticky; many roots; abrupt wavy boundary; slightly acid (pH 6.1); noneffervescent.

Bt - 3-17 inches. Very dark grayish brown (10YR 3/2D) silty clay, moist; moderate medium blocky structure; very hard, very firm, sticky and plastic; very few roots; clear smooth boundary; extremely acid (pH 4.1); noneffervescent.

C1 – 17-30 inches. Dark grayish brown (10YR 4/2D) clay, moist; few fine prominent yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; very hard, very firm, sticky and plastic; very few roots; common fine nests of gypsum and other salts; gradual boundary; extremely acid (pH 3.6); noneffervescent.

C2 – 30-42 inches. Dark grayish brown (10YR 4/2D) clay, moist; many coarse prominent brownish yellow (10YR 6/6) mottles; weak coarse subangular blocky structure; very hard, very firm; partially weathered shale fragments make up about 40 percent by volume; common bands of crystals of gypsum; gradual boundary; extremely acid (pH 3.7); noneffervescent.

Cr – 42-60 inches. Dark grayish brown (10YR 4/2D) clay, moist; many coarse prominent brownish yellow (10YR 6/6) and yellowish brown (10YR 5/6) iron stains along fractures; extremely acid (pH 3.6); noneffervescent.

Type Location - Butte County, South Dakota; refer to waypoint 79 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The depth to bedded shale ranges from 40 to 60 inches or more. These soils range from neutral to strongly acid in the upper 12 inches and from very strongly acid to extremely acid below this depth.

The E horizon has hue of 10YR or 2.5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 or 3.

It typically is loam but is clay loam in some pedons.

The Bt horizon has hue of 10YR or 2.5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 or 3. The clay content of the Bt horizon is between 35 and 60 percent. Structure of the Bt horizon ranges from weak or moderate, medium or coarse columnar in the Bt1 horizon and moderate or strong, medium or coarse blocky in the Bt2 horizon.

The Bz horizon has hue of 10YR or 2.5Y, value of 5 or 6 and 4 to 5 moist, and chroma of 2 to 3. It has common or many accumulations of gypsum and other salts.

The C horizon has hue of 10YR or 2.5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 or 3. It contains 20 to 50 percent fragments of shale.

Range in Characteristics (according to field observations, lab analysis): No significant range in characteristics was found.

Taxonomic Class - Fine, smectitic, mesic Torrertic Haplustalfs

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 3-60 inches. pH was unsuitable (acidic) at 3-60 inches. Estimated stripping depth is 3 inches.

Geographic Setting (According to Official Series Description) - Demar soils are on micro-highs on nearly level to gently sloping alluvial terraces having pronounced micro-relief. Slope gradients range from 0 to 6 percent. These soils formed in clayey alluvium derived from acid clay shales. The mean annual air temperature ranges from 45 to 49 degrees F, and mean annual precipitation ranges from 12 to 18 inches.

SATANTA
LOAM

Soil Mapping Unit "Sc"
Lab/BKS Sample ID: G08020806-001_005

Typical Pedon: Satanta loam - in a cultivated field. (Colors are for dry soil unless otherwise stated.)

The Satanta series consists of very deep well drained soils that formed in eolian deposits. These soils are on plains or high stream terraces in the Central High Tablelands (MLRA 72). Slopes range from 0 to 15 percent. Mean annual temperature is 13 degrees C. (56 degrees F.) and mean annual precipitation is 48 centimeters (19 inches) at the type location.

A - 0-4 inches. Dark grayish brown (10YR 4/2) loam, moist; weak fine granular and weak medium platy structure; friable, slightly hard; many fine and medium roots throughout; clear smooth boundary; strongly acid (pH 5.3); noneffervescent.

Bt - 4-12 inches. Dark yellowish brown (10YR 3/4D) clay loam, moist; weak medium platy structure; friable, slightly hard; many fine and medium roots throughout; abrupt smooth boundary; neutral (pH 7.1); noneffervescent.

BC – 12-17 inches. Brown (10YR 4/3D) sandy clay loam, moist; moderate medium subangular blocky and weak medium platy structure; friable, slightly hard; common fine roots throughout; 10 percent continuous distinct clay films on faces of peds; gradual smooth boundary; slightly alkaline (pH 7.6); strongly effervescent.

C1k – 17-28 inches. Brown (10YR 5/3D) sandy clay loam, moist; moderate medium subangular blocky and moderate medium prismatic structure; friable, hard; common fine roots throughout; common fine moderate continuity tubular pores; 10 percent continuous distinct clay films on faces of peds; gradual smooth boundary; moderately alkaline (pH 7.9); strongly effervescent.

C2k – 28-43 inches. Grayish brown (10YR 5/2D) sandy clay loam, moist; moderate medium prismatic and moderate medium subangular blocky structure; friable, hard; common fine roots throughout; common fine and medium moderate continuity tubular pores; 10 percent continuous distinct clay films on faces of peds; clear smooth boundary; moderately alkaline (pH 7.9); strongly effervescent.

Type Location - Haskell County, Kansas; refer to waypoint 82 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) –
Calcium carbonate equivalent in the series control section: less than 15 percent
Coarse fragments: 0 to 10 percent gravel by volume
Depth to carbonates: 30 to 91 centimeters (12 to 36 inches)

Mollic epipedon thickness: 20 to 51 centimeters (8 to 20 inches)
Phases recognized: Sandy substratum, gravelly substratum, dry, elevation greater than 1219 meters (4,000 feet)

A horizon:
Hue: 10YR
Value: 4 to 5, 2 to 3 moist
Chroma: 2 to 3
Reaction: slightly acid to slightly alkaline
Texture: loam, very fine sandy loam, clay loam, fine sandy loam
Comments: Some pedons have a BA horizon that is intermediate in color and texture between the A and Bt horizons.

Bt horizon:
Hue: 7.5YR to 2.5Y
Value: 4 to 6, 3 to 5 moist
Chroma: 2 to 4
Reaction: neutral to moderately alkaline
Texture: loam, sandy clay loam, clay loam with 15 to 35 percent fine and coarser sand and less than 50 percent sand

Bk or 2Bkb horizons:
Hue: 7.5YR to 2.5Y
Value: 4 to 6, 3 to 5 moist
Chroma: 2 to 6
Reaction: slightly to strongly alkaline
Texture: loam, sandy clay loam, clay loam with 15 to 35 percent fine and coarser sand and less than 50 percent sand

C or 3Ck horizons:
Hue: 10YR, 2.5Y
Value: 5 to 7, 4 to 6 moist
Chroma: 2 to 6
Reaction: slightly or moderately alkaline
Texture: loam, silt loam, clay loam, sandy clay loam, very fine sandy loam, loamy fine sand, fine sandy loam
Comments: Some pedons have a BCk horizon that has few carbonates that occur as seams, threads or concretions.

Range in Characteristics (according to field observations, lab analysis): Textures are coarser than typical for the series.

Taxonomic Class - Fine-loamy, mixed, superactive, mesic Aridic Argiustolls

Suitability for Topsoil (According to WDEQ Guideline 1) - pH was marginal (acidic) at 0-4 inches. Strongly effervescent at 12 inches. Estimated stripping depth is 43 inches.
Geographic Setting (According to Official Series Description) –
Landscape: terraces on nearly level to undulating plains
Landform: plains, high stream terraces
Slopes: 0 to 15 percent
Elevation: 610 to 1372 meters (2000 to 4500 feet)
Parent material: eolian deposits
Mean annual air temperature: 7 to 14 degrees C. (45 to 57 degrees F.)
Mean annual precipitation: 35 to 56 centimeters (14 to 22 inches)
Frost-free period: 140 to 200 days
Thornthwaite Annual PE Index: 25 to 40

LOHMILLER
SILTY CLAY LOAM

Soil Mapping Unit "Lo"
Lab/BKS Sample ID: G08020806-012_016

Typical Pedon: Lohmiller silty clay loam- on a plane slope of less than 1 percent in a cultivated field. (Colors are for dry soil unless otherwise stated.)

The Lohmiller series consists of very deep, well drained soils formed in alluvium on bottom lands. Permeability is slow or moderately slow. Slopes range from 0 to 8 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 46 degrees F.

A - 0-5 inches. Light gray (10YR 6/1) silty clay loam, moist; moderate medium granular structure; hard, friable; many fine roots; neutral; clear smooth boundary; slightly alkaline (pH 7.4); noneffervescent.

C1n - 5-18 inches. Very dark grayish brown (10YR 3/2D) silty clay loam, moist; massive; very hard, firm; thin bedding planes evident; common very fine roots; moderately alkaline (pH 8.2); noneffervescent.

C2n – 18-37 inches. Brown (10YR 4/3D) silty clay, moist; massive; very hard, firm; thin bedding planes evident; common very fine roots; moderately alkaline (pH 8.4); noneffervescent.

C3n – 37-47 inches. Brown (10YR 5/3D) silty clay loam, moist; massive; very hard, firm; thin bedding planes evident; common very fine roots; moderately alkaline (pH 8.3); very slightly effervescent.

C4n – 47-60 inches. Dark grayish brown (10YR 4/2D) clay loam, moist; massive; very hard, firm; thin bedding planes evident; common very fine roots; moderately alkaline (pH 8.1); very slightly effervescent.

Type Location - Fall River County, South Dakota; refer to waypoint 84 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Carbonates are within 10 inches of the surface. The control section averages from 35 to 50 percent clay.

The A horizon has hue of 10YR or 2.5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. Some pedons have value of 4 dry and 3 moist in the upper 4 inches. It typically is silty clay loam or clay loam but is silty clay in some pedons. It ranges from neutral to moderately alkaline.

The C horizon has hue of 10YR, 2.5Y, or 5Y; value of 5 to 7 and 4 to 6 moist; and chroma of 2 to 4. It typically is clay loam or silty clay loam but is silty clay or clay in some pedons. It is

stratified with thin layers of loamy sand, fine sandy loam, loam, sandy clay or silt loam. It is slightly alkaline or moderately alkaline. Some pedons have accumulations of carbonates.

Range in Characteristics (according to field observations, lab analysis): No significant range in characteristics was found.

Taxonomic Class - Fine, smectitic, calcareous, mesic Torrertic Ustifluvents

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 18-37 inches. Saturation percentage was marginal at 0-18 inches. Sodium absorption ratio was marginal at 5-18 inches and 37-47 inches and was unsuitable at 18-37 inches. Electrical conductivity was marginal at 5-18 inches and 37-60 inches and was unsuitable at 18-37 inches. Estimated stripping depth is 5 inches.

Geographic Setting (According to Official Series Description) - Lohmiller soils are on flood plains and high bottom lands of rivers and streams and on alluvial fans of foot slopes. Slopes are typically less than 2 percent but range from 0 to 8 percent. The soils formed in calcareous alluvium from sedimentary rock. Mean annual air temperature ranges from 45 to 48 degrees F, and mean annual precipitation ranges from 10 to 19 inches.

KYLE
LOAM

Soil Mapping Unit "Ky"
Lab/BKS Sample ID: G08020806-017_020

Typical Pedon: Kyle loam- on a west-facing plane slope of 2 percent in native grass. (Colors are for dry soil unless otherwise stated.)

The Kyle series consists of very deep and well drained soils formed in sediments weathered from clay shale on uplands. Permeability is very slow. Slopes range from 0 to 15 percent. Mean annual precipitation is about 16 inches, and mean annual air temperature is about 47 degrees F.

A - 0-2 inches. Grayish brown (2.5YR 5/2) loam, moist; moderate medium and fine granular structure; hard, firm, sticky and plastic; thin crust in upper 1/4 inch of light brownish gray (2.5Y 6/2); common fine roots; neutral; clear wavy boundary; slightly acid (pH 6.3); noneffervescent.

Bt1 - 2-7 inches. Very dark grayish brown (10YR 3/2D) silty clay loam, moist; weak coarse blocky structure parting to weak medium and fine blocky; very hard, very firm, sticky and plastic; common fine roots; gradual wavy boundary; neutral (pH 7.3); noneffervescent.

Bt2 – 7-17 inches. Brown (10YR 4/3D)silty clay loam, moist; weak coarse subangular blocky structure parting to weak medium and fine blocky; extremely hard, very firm, very sticky and very plastic; few intersecting slickensides; few fine roots; clear wavy boundary; moderately alkaline (pH 7.9); strongly effervescent.

Ck – 17-30 inches. Brown (10YR 4/3D) clay loam, moist; weak coarse subangular blocky structure parting to weak medium and fine blocky; extremely hard, very firm, very sticky and very plastic; few intersecting slickensides; few fine roots; clear wavy boundary; moderately alkaline (pH 8.0); strongly effervescent.

Type Location - Fall River County, South Dakota; refer to waypoint 85 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The soil typically does not have carbonates to depths of 4 to 6 inches, but some pedons contain carbonates to the surface. When the soil is dry, cracks 1/2 inch to 2 inches wide and several feet long extend downward through the solum. The control section averages 60 to 65 percent clay. The soil does not have a mollic epipedon but the upper 10 inches of the solum has an average organic carbon content between 0.6 and 1.7 percent. When the soil is dry, a porous surface crust 1/8 inch to 1/2 inch thick with dry color value of 6 or 7 is typical. Gypsum and other salts are below depths of 20 inches.

The A horizon has hue of 10YR, 2.5Y or 5Y, value of 5 or 6 and 3 to 5 moist, and chroma of 1 to

3. It typically is clay but some is silty clay. It is neutral or slightly alkaline.

The Bw and Bss horizons have hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. Both dry and moist colors of the surface of peds range from 1/2 to 1 value darker than the crushed peds. They are extremely hard or very hard when dry and extremely firm or very firm when moist. They are slightly alkaline or moderately alkaline.

The BCss horizon has hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. It has few to common accumulations of gypsum and other salts in most pedons. It is slightly alkaline or moderately alkaline.

Some pedons have a Bk horizon that has colors similar to the BC horizon. It has few to common accumulations of carbonate. It is slightly alkaline or moderately alkaline.

The Cy horizon has hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 2 to 4. It is clay and some pedons contain up to 35 percent fragments of shale below 40 inches. It has few to many accumulations of gypsum or other salts. Unweathered shale typically is at depths greater than 5 feet but is as shallow as 40 inches in some pedons. It is slightly alkaline or moderately alkaline.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer and have less clay than typical for the series.

Taxonomic Class - Very-fine, smectitic, mesic Aridic Haplusterts

Suitability for Topsoil (According to WDEQ Guideline 1) - Saturation percentage was marginal at 2-7 inches. Strongly effervescent at 7 inches. Estimated stripping depth is 30 inches.

Geographic Setting (According to Official Series Description) - Kyle soils are nearly level to strongly sloping on uplands and colluvial fans. Slopes are plane to convex, and slope gradients range from 0 to 15 percent. Gilgai microrelief is in most areas. The soil formed in clayey sediments weathered from calcareous clay shale. Mean annual air temperature ranges from 45 to 53 degrees F, and mean annual precipitation ranges from about 12 to 19 inches.

SAMSIL
NON CALCAREOUS VARIANT

Soil Mapping Unit "Sa"
Lab/BKS Sample ID: G08020806-021_023

Typical Pedon: Samsil clay loam- on a convex, southwest-facing slope of 15 percent in native grass. When described the soil was moist to 12 inches, dry from 12 to 21 inches, and moist below 21 inches. (Colors are for dry soil unless otherwise stated.)

The Samsil series consists of shallow, well drained soils formed in alluvium or residuum weathered from shale. Permeability is slow. Slope ranges from 2 to 60 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 47 degrees F.

A - 0-2 inches. Light brownish gray (2.5Y 6/2) clay loam, moist; moderate fine granular structure; slightly hard, friable, sticky and plastic; common fine roots; few very fine fragments of shale; clear wavy boundary; neutral (pH 6.7); noneffervescent.

AC - 2-9 inches. Light yellowish brown (2.5Y 6/3D) silty clay, moist; weak medium subangular blocky structure parting to weak medium granular; hard, friable, sticky and plastic; common fine roots; common fine fragments of soft shale; clear wavy boundary; slightly alkaline (pH 7.8); noneffervescent.

C - 9-18 inches. Grayish brown (2.5Y 5/2D) silt, moist; massive; hard, friable, sticky and plastic; common fine roots; about 50 percent by volume of fragments of soft shale; common distinct olive yellow (2.5Y 6/6) stains on faces of shale fragments; few fine and medium accumulations of carbonate; gradual wavy boundary; slightly alkaline (pH 7.6); noneffervescent.

Type Location - Pennington County, South Dakota; refer to waypoint 88 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The control section is clay and contains 50 to 65 percent clay. The depth to bedded shale ranges from 6 to 20 inches. Horizons above the shale range from loose to hard when dry, and friable or firm when moist. These horizons contain free carbonates. Effervescence ranges from slight to strong and reaction is slightly alkaline or moderately alkaline. The C1 and C2 horizons and upper part of the Cr horizons commonly have accumulations of carbonate, gypsum, and other salts. Colors throughout, including mottles and stains, are inherited from the shale.

The A horizon has hue of 5Y, 2.5Y, or 10YR, value of 4 to 7 and 3 to 6 moist, and chroma of 2 to 4. It is clay, silty clay, silty clay loam or clay loam and commonly contains few to common fragments of shale ranging from 2 to 25 mm in diameter. It has fine or medium subangular blocky or fine or very fine granular structure. The upper 1/4 to 1/2 inch commonly is a fragile crust or mulch or very fine granules when dry.

The AC horizon has hue of 5Y, 2.5Y, or 10YR, value of 4 to 7 and 3 to 6 moist, and chroma of 1 to 4. It contains up to 35 percent fragments of shales by volume that range from less than 2 mm to 30 mm in diameter.

The C horizon has hue of 5Y, 2.5Y or 10YR, value of 4 to 7 and 3 to 6 moist, and chroma of 1 to 4. It is clay. The C horizon contains from 35 to more than 50 percent fragments of shale by volume that range from less than 2 mm to 35 mm in diameter.

The Cr horizon has the same range in color as the overlying C horizons. It ranges from medium acid to moderately alkaline.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer and have less clay than typical for the series.

Taxonomic Class - Clayey, smectitic, calcareous, mesic, shallow Aridic Ustorthents

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 2-9 inches. Estimated stripping depth is 18 inches.

Geographic Setting (According to Official Series Description) - Samsil soils are on gently sloping to very steep hills, ridges and breaks of dissected shale plains. Surfaces mainly are convex, and slope gradients range from 2 to 60 percent or more. The soil formed in alluvium or residuum weathered from shale. Mean annual air temperature ranges from 45 to 48 degrees F, and mean annual precipitation ranges from 14 to 19 inches.

PIERRE
SILTY CLAY LOAM

Soil Mapping Unit "Pe"
Lab/BKS Sample ID: G08020806-024_027

Typical Pedon: Pierre silty clay loam - on a convex slope of 7 percent in native grass. (Colors are for dry soil unless otherwise stated.)

The Pierre series consists of moderately deep, well drained soils formed in clayey residuum weathered from shale bedrock on uplands. Permeability is very slow. Slopes range from 0 to 30 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 46 degrees F.

A - 0-2 inches. Grayish brown (2.5Y 5/2) silty clay loam, moist; moderate fine subangular blocky structure parting to weak very fine granular; hard, firm, sticky and plastic; 1 percent pebbles; clear smooth boundary; strongly acid (pH 5.4); noneffervescent.

Bt- 2-18 inches. Brown (10YR 5/3) silty clay, moist; moderate medium and coarse prismatic structure; extremely hard, very firm, very sticky and very plastic; common distinct intersecting slickensides; few fine accumulations of iron; 1 percent pebbles; gradual wavy boundary; slightly alkaline (pH 7.7); strongly effervescent.

C1n – 18-31 inches. Grayish brown (10YR 5/2) silty clay, moist; moderate coarse prismatic structure; extremely hard, very firm, very sticky and very plastic; common distinct intersecting slickensides; few fine nests of iron and common fine accumulations of gypsum; 1 percent pebbles; gradual wavy boundary; slightly alkaline (pH 7.8); strongly effervescent.

C2n – 31-37 inches. Light brownish gray (2.5Y 6/2) silty clay, moist; common distinct strong brown (7.5YR 5/6) and yellowish brown (10YR 5/6) iron stains; many fine accumulations of gypsum and carbonate; 1 percent pebbles; gradual wavy boundary; slightly alkaline (pH 7.7); very slightly effervescent.

Type Location - Haakon County, South Dakota; refer to waypoint 89 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The soil contains carbonates at or within 6 inches of the surface. The depth to soft shale bedrock ranges from 20 to 40 inches but commonly is at depths of 25 to 35 inches. The horizon above the shale has 0 to 60 percent, by volume soft shale fragments. The control section is 50 to 60 percent clay. When the soil is dry, cracks 1/2 inch to 2 inches wide and several feet long extend downward through the solum. The soil does not have a mollic epipedon, but the upper 10 inches of the solum has an average organic carbon content between 0.6 and 1.7 percent. The soil has a SAR of 1 to 7.

The A horizon has hue of 10YR to 5Y, value of 4 to 6 and 3 to 5 moist, and chroma of 1 to 3. It typically is clay but is silty clay in some pedons. It ranges from slightly acid to moderately alkaline. When the soil is dry it has a light gray (2.5Y 7/2) smooth, porous, platy surface crust ranging from 1/4 to 1 inch in thickness. Where the horizon has mollic colors, it is too thin to be a mollic epipedon. Some pedons do not have an AB horizon.

The Bss horizons have hue of 2.5Y or 5Y, value of 5 or 6 and 4 or 5 moist, and chroma of 1 to 3. They are extremely hard or very hard when dry and extremely firm to firm when moist. They range from neutral to moderately alkaline.

Bk and C horizons are present in some pedons.

The Cr horizon is soft shale bedrock and ranges from slightly acid to moderately alkaline. Bedding planes are evident in the partially weathered shale in some pedons. Gypsum and other salts are concentrated in very thin seams within the shale in some pedons.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer than typical for the series.

Taxonomic Class - Fine, smectitic, mesic Aridic Leptic Haplusterts

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 2-37 inches. pH was marginal (acid) at 0-2 inches. Strongly effervescent at 2 inches. Estimated stripping depth is 2 inches.

Geographic Setting (According to Official Series Description) - Pierre soils are on nearly level to steep uplands. Slope gradient typically is 3 to 15 percent, but ranges from 0 to 30 percent. The soils formed in residuum weathered from clay shale. Gilgai microrelief is in most areas. Mean annual air temperature is 44 to 53 degrees F, and mean annual precipitation ranges from 12 to 16 inches. Growing season is 125 to 140 days; average growing season precipitation is 10 to 13 inches; and growing degree days are 2600 to 3100. Elevation is 1300 to 3600 feet.

GRUMMIT
SILTY CLAY

Soil Mapping Unit "Gr"
Lab/BKS Sample ID: G08020806-028_030

Typical Pedon: Grummit silty clay - on a convex slope of 5 percent in native grass. When described, the soil was moist to bedded shale. (Colors are for dry soil unless otherwise stated.)

The Grummit series consists of shallow, well drained soils formed in clayey residuum from acid shale on uplands. Permeability is moderate or moderately slow. Slopes range from 2 to 60 percent. Mean annual precipitation is about 15 inches, and mean annual temperature is about 46 degrees F.

A - 0-2 inches. Light brownish gray (10YR 6/2) silty clay, moist; moderate fine granular structure; loose, friable; many fine roots; many very fine fragments of shale; clear smooth boundary; neutral (pH 6.8); noneffervescent.

AC - 2-8 inches. Grayish brown (10YR 5/2) silty clay, moist; weak coarse subangular blocky structure; hard, friable; many fine roots; 25 percent very fine fragments of shale; gradual wavy boundary; slightly alkaline (pH 7.4); noneffervescent.

C - 8-20 inches. Grayish brown (10YR 5/2) silty clay, moist; common distinct mottles of yellowish brown (l0YR 5/6); weak coarse subangular blocky structure; hard, friable; partially weathered fragments of shale make up 35 percent by volume; common roots; clear smooth boundary; slightly alkaline (pH 7.7); noneffervescent.

Type Location - Butte County, South Dakota; refer to waypoint 90 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Depth to shale ranges from 10 to 20 inches. Colors throughout the soil are inherited from the shale. The horizons overlying the bedded shales typically average 50 to 65 percent clay but ranges from 35 to 65 percent clay. The low clay percentage is due to sand-size shale fragments. Consistence ranges from loose to hard when dry but is friable when moist. The soil ranges from strongly acid to extremely acid.

The A horizon has hue of 10YR or 2.5Y, value of 5 or 6 and 3 or 4 moist, and chroma of 1 or 2 dry or moist. It typically is clay but is clay loam in some pedons. It has weathered fragments of shale that make up 5 to 35 percent by volume. The A horizon contains less than 1 percent more organic matter than the C.

The C horizon has hue of 10YR, 2.5Y, or 5Y; value of 5 or 6 and 3 or 4 moist; and chroma of 1 or 2. Weathered fragments of shale make up 20 to over 50 percent by volume of the C horizon.

The fissile shale is very hard and brittle and will not disperse in water or in sodium hexametaphosphate.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer than typical for the series.

Taxonomic Class - Clayey, smectitic, acid, mesic, shallow Aridic Ustorthents

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 0-20 inches. Estimated stripping depth is 20 inches.

Geographic Setting (According to Official Series Description) - Grummit soils are gently sloping to very steep on uplands. Slope gradients range from 2 to 60 percent. The soil formed in clayey residuum weathered from acid shales. Mean annual temperature ranges from 43 to 50 degrees F, and mean annual precipitation is about 12 to 18 inches.

SAMSIL
SILTY CLAY LOAM

Soil Mapping Unit "Sa"
Lab/BKS Sample ID: G08020806-021_023

Typical Pedon: Samsil silty clay loam - on a convex, southwest-facing slope of 15 percent in native grass. When described the soil was moist to 12 inches, dry from 12 to 21 inches, and moist below 21 inches. (Colors are for dry soil unless otherwise stated.)

The Samsil series consists of shallow, well drained soils formed in alluvium or residuum weathered from shale. Permeability is slow. Slope ranges from 2 to 60 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 47 degrees F.

AC - 0-7 inches. Dark grayish brown (10YR 4/2D) silty clay loam, moist; moderate fine granular structure; slightly hard, friable, sticky and plastic; common fine roots; few very fine fragments of shale; clear wavy boundary; slightly alkaline (pH 7.5); very slightly effervescent.

C – 7-19 inches. Dark grayish brown (10YR 4/2D) silty clay, moist; weak medium subangular blocky structure parting to weak medium granular; hard, friable, sticky and plastic; common fine roots; common fine fragments of soft shale; clear wavy boundary; slightly alkaline (pH 7.6); slightly effervescent.

Type Location - Pennington County, South Dakota; refer to waypoint 92 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - The control section is clay and contains 50 to 65 percent clay. The depth to bedded shale ranges from 6 to 20 inches. Horizons above the shale range from loose to hard when dry, and friable or firm when moist. These horizons contain free carbonates. Effervescence ranges from slight to strong and reaction is slightly alkaline or moderately alkaline. The C1 and C2 horizons and upper part of the Cr horizons commonly have accumulations of carbonate, gypsum, and other salts. Colors throughout, including mottles and stains, are inherited from the shale.

The A horizon has hue of 5Y, 2.5Y, or 10YR, value of 4 to 7 and 3 to 6 moist, and chroma of 2 to 4. It is clay, silty clay, silty clay loam or clay loam and commonly contains few to common fragments of shale ranging from 2 to 25 mm in diameter. It has fine or medium subangular blocky or fine or very fine granular structure. The upper 1/4 to 1/2 inch commonly is a fragile crust or mulch or very fine granules when dry.

The AC horizon has hue of 5Y, 2.5Y, or 10YR, value of 4 to 7 and 3 to 6 moist, and chroma of 1 to 4. It contains up to 35 percent fragments of shales by volume that range from less than 2 mm to 30 mm in diameter.

The C horizon has hue of 5Y, 2.5Y or 10YR, value of 4 to 7 and 3 to 6 moist, and chroma of 1 to 4. It is clay. The C horizon contains from 35 to more than 50 percent fragments of shale by volume that range from less than 2 mm to 35 mm in diameter.

The Cr horizon has the same range in color as the overlying C horizons. It ranges from medium acid to moderately alkaline.

Range in Characteristics (according to field observations, lab analysis): Textures are slightly finer than typical for the series.

Taxonomic Class - Clayey, smectitic, calcareous, mesic, shallow Aridic Ustorthents

Suitability for Topsoil (According to WDEQ Guideline 1) - Marginal texture (clay) was found from 7-19 inches. Saturation percentage was marginal at 7-19 inches Estimated stripping depth is 7 inches.

Geographic Setting (According to Official Series Description) - Samsil soils are on gently sloping to very steep hills, ridges and breaks of dissected shale plains. Surfaces mainly are convex, and slope gradients range from 2 to 60 percent or more. The soil formed in alluvium or residuum weathered from shale. Mean annual air temperature ranges from 45 to 48 degrees F, and mean annual precipitation ranges from 14 to 19 inches.

BARNUM
CLAY

Soil Mapping Unit "Bc"
Lab/BKS Sample ID: C08100918-001_005

Typical Pedon: Barnum clay-rangeland. (Colors are for dry soil unless otherwise stated.)

The Barnum series consists of very deep, well drained soils formed in calcareous alluvium from red bed sediments. Barnum soils are on flood plains and alluvial terraces. Slopes are simple and range from 0 to 8 percent. The mean annual precipitation is about 12 inches, and the mean annual temperature is about 47 degrees F.

A - 0 to 3 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; moderate very fine granular structure; soft, very friable; noneffervescent; neutral (pH 7.3); clear smooth boundary. (3 to 6 inches thick)

ACk - 3 to 7 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; moderate very fine granular structure; soft, very friable; strongly effervescent, calcium carbonate disseminated; slightly alkaline (pH 7.6); clear smooth boundary.

Ck1 - 7 to 12 inches; reddish brown (2.5YR 5/5) clay, reddish brown (2.5YR 4/5) moist; massive with lenses of unaltered parent sediment; slightly hard, very friable; strongly effervescent, calcium carbonate disseminated and as soft masses in some lenses; slightly alkaline (pH 7.6).

Ck2 - 12 to 25 inches; reddish brown (2.5YR 5/5) loam, reddish brown (2.5YR 4/5) moist; massive with lenses of unaltered parent sediment; slightly hard, very friable; strongly effervescent, calcium carbonate disseminated and as soft masses in some lenses; slightly alkaline (pH 7.5).

Ckn - 25 to 38 inches; reddish brown (2.5YR 5/5) silt loam, reddish brown (2.5YR 4/5) moist; massive with lenses of unaltered parent sediment; slightly hard, very friable; strongly effervescent, calcium carbonate disseminated and as soft masses in some lenses; moderately alkaline (pH 8.2).

C - 38 to 44 inches; reddish brown (2.5YR 5/5) sandy loam to sandy clay loam, reddish brown (2.5YR 4/5) moist; massive with lenses of unaltered parent sediment; slightly hard, very friable; slightly effervescent; moderately alkaline (pH 8.3).

Ck3 - 44 to 48 inches; reddish brown (2.5YR 5/5) sandy loam to sandy clay loam, reddish brown (2.5YR 4/5) moist; massive with lenses of unaltered parent sediment; slightly hard, very friable; strongly effervescent, calcium carbonate disseminated and as soft masses in some lenses; moderately alkaline (pH 8.3).

Type Location - Johnson County, Wyoming; refer to waypoint 103 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - These soils typically contain free carbonates throughout but may be leached a few inches in some pedons. Organic carbon ranges from .6 to 3 percent in the upper 10 inches and decreases irregularly with depth. The mean annual soil temperature is about 47 to 53 degrees F. The particle size control section is highly stratified and typically averages loam or light clay loam with 18 to 35 percent clay and more than 15 percent fine or coarser sand. Strata of sandy loam, silt loam, silty clay loam, and fine sandy loam are common. Rock fragments are variable between strata but average from 0 to 10 percent pebbles. Exchangeable sodium ranges from 4 to 15 percent throughout the soil. EC typically ranges from 2 to 8 mmhos throughout under natural conditions but may range to 16 mmhos where poorly irrigated.

The A horizon has hue of 7.5YR through 2.5YR, value of 4 through 6 dry, 3 through 5 moist, and chroma of 2 through 6. Reaction is slightly through strongly alkaline.

The C horizon has hue of 5YR through 10R, value of 4 through 7 dry, 3 through 5 moist, and chroma of 2 through 6. Some strata have visual accumulations of salts and carbonates which are typically discontinuous throughout the extent of the pedon. Reaction is slightly through strongly alkaline. Some pedons may have buried horizons below 40 inches.

Range in Characteristics (according to field observations, lab analysis): Textures in the top 12 inches are finer than typical for this series. A natric horizon was identified within the profile, which is not typical of this series.

Taxonomic Class - Fine-loamy, mixed, superactive, calcareous, mesic Ustic Torrifluvents

Suitability for Topsoil (According to WDEQ Guideline 1) – Electrical conductivity was marginal from 25-48 inches. Saturation percentage was marginal from 38-48. Clay percentage was marginal from 0-12 inches. Estimated stripping depth is 25 inches.

Geographic Setting (According to Official Series Description) - Barnum soils are on flood plains and alluvial terraces. These soils formed in calcareous alluvium derived from red beds containing siltstone, shale, and sandstone. Slopes are 0 to 8 percent. Elevations are 4,000 to 6,600 feet. The mean annual precipitation is about 12 inches and ranges from 10 to 14 inches with about half falling as snow or rain in April, May, and early June. The mean annual temperature is about 43 to 49 degrees F. The frost-free season is estimated to range from 110 to 135 days depending upon elevation, aspect, and air drainage.

NUNN
CLAY

Soil Mapping Unit "Nu"
Lab/BKS Sample ID: C08100918-006_010

Typical Pedon: Nunn clay-grassland. (Colors are for dry soil unless otherwise stated.)

The Nunn series consists of very deep, well drained soils that formed in loess and mixed alluvium. Nunn soils are on terraces or alluvial fans, and in drainageways. Slopes range from 0 to 25 percent. The mean annual precipitation is about 14 inches and the mean annual air temperature is about 48 degrees F.

A - 0 to 2 inches; grayish brown (10YR 5/2) clay, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; soft, very friable; noneffervescent; slightly acid (pH 6.1); clear smooth boundary. (2 to 8 inches thick)

E - 2 to 9 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure parting to moderate medium subangular blocky; hard, very friable, sticky and plastic; few faint clay films on faces of peds; noneffervescent; slightly alkaline (pH 7.4); clear smooth boundary. (0 to 7 inches thick)

Bt - 9 to 26 inches; pale brown (10YR 6/3) heavy clay to clay loam, brown (10YR 4/3) moist; moderate medium and coarse prismatic structure parting to moderate medium subangular blocky; very hard, firm, very sticky and very plastic; many distinct clay films on faces of peds; slightly effervescent; moderately alkaline (pH 7.9); clear smooth boundary. (6 to 24 inches thick)

BCk - 26 to 34 inches; pale brown (10YR 6/3) clay to clay loam, brown (10YR 5/3) moist; weak medium subangular blocky structure; very hard, firm, very plastic; few faint clay films on faces of peds; visible calcium carbonate occurring as small concretions; strongly effervescent; moderately alkaline (pH 8.3); gradual smooth boundary. (0 to 10 inches thick)

2Ckny1 - 34 to 38 inches; light yellowish brown (10YR 6/4) clay to clay loam, dark yellowish brown (10YR 4/4) moist; massive; very hard, firm, sticky and plastic; visible sodium and gypsum; visible calcium carbonate occurring as concretions, thin seams and streaks; violently effervescent; moderately alkaline (pH 8.3); gradual smooth boundary.

2Ckny2 - 38 to 42 inches; light yellowish brown (2.5Y 6/3) clay, light olive brown (2.5Y 5/3) moist; massive; very hard, firm, sticky and plastic; visible sodium and gypsum; some visible calcium carbonate but less than in the horizon above; violently effervescent; strongly alkaline (pH 8.9).

2Ckny3 - 42 to 48 inches; light yellowish brown (2.5Y 6/3) clay, light olive brown (2.5Y 5/3) moist; massive; very hard, firm, sticky and plastic; visible sodium and gypsum; some visible

calcium carbonate but less than in the horizon above; violently effervescent; strongly alkaline (pH 8.9).

Type Location - Larimer County, Colorado; refer to waypoint 114 on map included in this report.

Range in Soil Characteristics (According to Official Series Description) - Mean annual soil temperature at depth of 20 inches is 47 to 54 degrees F, and mean summer temperature is 59 to 79 degrees F. The mollic epipedon is 7 to 19 inches thick, depth to lime is 10 to 30 inches, and the solum is 16 to 46 inches thick. Organic carbon in the mollic epipedon ranges from .8 to 3 percent. The soil is typically 90 to 100 percent base-saturated. Rock fragments are typically less than 5 percent and range from 0 to 15 percent. The soil temperature at depth of 20 inches is 41 degrees F or warmer for about 200 to 240 days. The soils are moist in some part of the moisture control section for about 56 to 152 days while the soil temperature is 41 degrees F or above.

The A horizon has hue of 5Y to 7.5YR, value of 4 or 5, 2 or 3 moist, and chroma of 1 to 3. Usually it has granular or crumb structure but the structure is subangular blocky in some pedons. This horizon is soft or slightly hard. It is slightly acid to slightly alkaline.

The Bt horizon has hue of 5Y to 7.5YR, value of 3 to 7, 2 to 6 moist, and chroma of 2 to 5. It is typically clay, silty clay loam or clay loam and has 35 to 50 percent clay, 15 to 45 percent silt, and 15 to 45 percent sand with more than 15 percent, being fine sand or coarser. Some pedons have sandy clay loam textures in the lower parts of the argillic layer, however, the weighted clay average is greater than 35 percent in the control section. It is slightly acid to moderately alkaline. CEC of the Bt horizon ranges from 60 to 90 millequivalents per 100 grams of clay.

The Bk or C horizon has hue of 5Y to 7.5YR, value of 5 to 7, 4 to 6 moist, and chroma of 2 to 4. They are typically clay loam with more than 28 percent clay, however, where the C horizon has less than 28 percent clay it contains more than 15 percent fine or coarser sand and has a texture of sandy clay loam, loam or sandy loam. These horizons are slightly alkaline to strongly alkaline and have 4 to 15 percent calcium carbonate equivalent.

Range in Characteristics (according to field observations, lab analysis): An E horizon was identified in place of a BA. Three natric and gypsic C horizons were identified at the bottom of this profile, which is not typical.

Taxonomic Class - Fine, smectitic, mesic Aridic Argiustolls

Suitability for Topsoil (According to WDEQ Guideline 1) – Electrical conductivity was marginal from 26-38 inches and unsuitable from 38-48 inches. pH was marginal from 38-48 inches. Sodium absorption ratio was unsuitable from 26-38 inches. Clay percentage was marginal from 0-2 inches and 9-48 inches. Estimated stripping depth is 26 inches.

Geographic Setting (According to Official Series Description) - The Nunn soils are on terraces or alluvial fans, or in drainageways. Slope gradients range from 0 to 25 percent. The soils formed in

mixed alluvium. At the type location the average annual precipitation is 13 inches, 9 inches of which falls during the months of April through September. Mean annual air temperature is 47 to 53 degrees F, and an average summer temperature is 67 degrees F. The frost-free period is 120 to 210 days.

ORIGINAL LABORATORY DATA SHEETS

ENERGY LABORATORIES, INC. * 400 W Boxelder Rd * Gillette, WY 82718-5315
Toll Free 866.686.7175 * 307.686.7175 * FAX 307.682.4625 * gillette@energylab.com

LABORATORY ANALYTICAL REPORT

Client: Knight Piesold and Company
Project: 451b Dewey-Burdock Soils
Workorder: G08020803

Report Date: 03/28/08
Date received: 02/28/08

POWERTECH (USA) INC.

		Analysis	OM	Coarse Fragments	Sand	Silt	Clay	Texture	SAT	pH-sat paste	EC-sat paste	Ca-sat paste	Mg-sat paste	Na-sat paste	SAR-sat paste
		Units	%	%	%	%	%		wt%	s_u_	mmhos/cm	meq/L	meq/L	meq/L	unitless
Sample ID	Client Sample ID	Depth	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results
G08020803-001	Hole #17	0-3	3.0	< 0.1	8	46	46	SiC	75.7	5.8	0.51	3.00	0.73	0.24	0.2
G08020803-002	Hole #17	3-8	1.6	< 0.1	5	45	50	SiC	72.0	5.7	0.39	2.36	0.54	0.27	0.2
G08020803-003	Hole #17	8-24	1.7	< 0.1	3	44	53	SiC	80.0	5.7	0.78	5.44	1.49	0.73	0.4
G08020803-004	Hole #17	24-40	1.3	< 0.1	< 1	46	54	SiC	75.9	5.8	1.25	7.52	3.76	2.02	0.8
G08020803-005	Hole #17	40-54	0.8	< 0.1	1	48	51	SiC	78.9	5.0	3.49	24.5	23.0	4.43	0.9
G08020803-006	Hole #17	54-60	0.9	< 0.1	9	46	45	SiC	75.7	4.5	3.83	23.4	30.8	4.78	0.9
G08020803-007	Hole #27	0-2	2.5	< 0.1	9	58	33	SiCL	63.3	7.4	0.56	2.41	1.14	2.41	1.8
G08020803-008	Hole #27	2-17	1.3	< 0.1	4	47	49	SiC	83.5	7.9	4.60	24.2	10.3	29.0	7.0
G08020803-009	Hole #27	17-24	1.2	4.5	4	43	53	SiC	77.5	8.0	6.16	22.7	14.0	50.3	11.7
G08020803-010	Hole #27	24-39	1.0	1.8	3	47	50	SiC	84.5	7.9	5.62	22.3	13.3	43.4	10.3
G08020803-011	Hole #27	39-60	0.8	< 0.1	5	50	45	SiC	79.0	7.9	5.88	21.9	15.9	44.7	10.3
G08020803-012	Hole #36	0-2	2.1	1.9	14	54	32	SiCL	68.0	8.0	0.64	2.10	0.88	3.61	3.0
G08020803-013	Hole #36	2-15	1.3	< 0.1	9	46	45	SiC	84.2	8.0	4.98	23.8	11.1	34.0	8.1
G08020803-014	Hole #36	15-26	1.1	< 0.1	9	46	45	SiC	78.6	8.0	6.15	23.3	16.2	47.7	10.7
G08020803-015	Hole #36	26-36	0.9	< 0.1	9	41	50	SiC	84.1	8.0	7.41	28.6	24.6	60.4	11.7
G08020803-016	Hole #36	36-60	0.8	< 0.1	11	39	50	C	77.4	8.0	6.22	22.7	21.3	45.8	9.8
G08020803-017	Hole #39	0-2	4.1	< 0.1	19	55	26	SiL	50.0	6.8	0.57	3.04	1.95	0.14	< 0.1
G08020803-018	Hole #39	2-15	1.9	4.3	17	46	37	SiCL	63.7	7.3	0.49	2.40	1.58	0.42	0.3
G08020803-019	Hole #39	15-32	1.0	1.7	31	37	32	CL	58.4	8.0	0.83	2.67	2.76	2.60	1.6
G08020803-020	Hole #39	32-52	0.7	< 0.1	27	36	37	CL	62.6	8.0	5.14	22.6	51.2	10.7	1.8
G08020803-021	Hole #39	52-60	0.7	< 0.1	21	72	7	SiL	75.4	8.1	5.25	23.5	54.5	10.1	1.6
G08020803-022	Hole #40	0-4	4.2	< 0.1	17	50	33	SiCL	71.4	6.6	0.59	3.15	1.47	0.14	0.1
G08020803-023	Hole #40	4-14	2.4	< 0.1	12	55	33	SiCL	60.7	7.1	0.58	3.54	1.48	0.50	0.3
G08020803-024	Hole #40	14-27	1.5	< 0.1	7	58	35	SiCL	57.8	7.8	0.76	4.25	1.64	1.95	1.1
G08020803-025	Hole #40	27-38	1.6	< 0.1	1	52	47	SiC	74.8	8.1	1.52	4.42	2.01	9.67	5.4
G08020803-026	Hole #40	38-60	1.7	< 0.1	3	51	46	SiC	75.8	7.9	4.42	24.0	11.3	25.1	6.0
G08020803-027	Hole #41	0-4	4.2	3.9	25	56	19	SiL	45.5	7.7	1.03	7.70	2.69	0.23	0.1
G08020803-028	Hole #41	4-21	1.1	1.7	11	54	35	SiCL	64.2	7.7	3.78	27.7	20.1	8.30	1.7
G08020803-029	Hole #41	21-36	0.6	1.2	< 1	95	5	Si	63.8	8.6	13.3	25.3	100	148	18.7
G08020803-030	Hole #41	36-45	0.8	1.8	18	64	18	SiL	42.4	8.7	16.6	27.9	122	216	25.0
G08020803-031	Hole #41	45-60	0.5	0.9	34	49	17	L	33.6	8.7	14.8	25.9	107	175	21.4
G08020803-032	Hole #42	0-6	3.4	1.5	22	62	16	SiL	44.6	7.8	7.56	28.7	54.2	37.2	5.8
G08020803-033	Hole #42	6-17	1.3	6.0	26	60	14	SiL	40.2	8.3	15.4	30.9	191	135	12.9
G08020803-034	Hole #42	17-39	0.6	< 0.1	28	62	10	SiL	35.0	8.6	14.5	31.2	187	125	12.0
G08020803-035	Hole #42	39-60	0.6	< 0.1	30	56	14	SiL	37.1	8.5	10.9	28.5	109	83.5	10.1
G08020803-036	Hole #43	0-2	11.7	1.1	24	48	28	CL	63.7	6.2	1.11	5.45	3.92	0.61	0.3
G08020803-037	Hole #43	2-14	2.1	< 0.1	22	36	42	C	68.8	7.4	0.89	5.28	3.27	0.87	0.4
G08020803-038	Hole #43	14-38	1.0	< 0.1	32	36	32	CL	43.3	8.5	0.61	1.13	1.12	4.10	3.9
G08020803-039	Hole #43	38-60	0.8	< 0.1	50	28	22	L	39.8	8.8	1.76	1.25	1.76	15.3	12.5
G08020803-040	Hole #50	0-2	2.3	2.6	44	38	18	L	30.8	6.6	0.37	1.97	1.10	0.14	0.1

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LABORATORY ANALYTICAL REPORT

POWERTECH (USA) INC.

Client: Knight Piesold and Company
Project: 451b Dewey-Burdock Soils
Workorder: G08020803

Report Date: 03/28/08
Date Received: 02/28/08

		Analysis	OM	Coarse Fragments	Sand	Silt	Clay	Texture	SAT	pH-sat paste	EC-sat paste	Ca-sat paste	Mg-sat paste	Na-sat paste	SAR-sat paste
		Units	%	%	%	%	%		wt%	s_u_	mmhos/cm	meq/L	meq/L	meq/L	unitless
Sample ID	**Client Sample ID**	**Depth**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
G08020803-041	Hole #50	2-7	1.8	2.6	32	34	34	CL	46.9	7.4	0.58	3.72	2.03	0.29	0.2
G08020803-042	Hole #50	7-13	1.9	2.4	26	38	36	CL	66.8	8.1	0.42	2.37	1.47	0.42	0.3
G08020803-043	Hole #50	13-25	1.0	3.1	44	29	27	CL	39.1	8.3	0.48	1.53	1.52	1.62	1.3
G08020803-044	Hole #56	0-3	6.0	< 0.1	16	56	28	SiCL	74.9	7.4	0.96	7.78	1.33	0.09	< 0.1
G08020803-045	Hole #56	3-14	2.5	< 0.1	< 1	72	28	SiCL	48.0	7.7	1.07	8.69	1.92	0.29	0.1
G08020803-046	Hole #56	14-26	2.2	< 0.1	8	60	32	SiCL	50.8	7.6	3.08	32.2	8.13	1.42	0.3
G08020803-047	Hole #56	26-36	2.0	1.5	18	56	26	SiL	46.4	7.5	3.43	36.7	9.58	2.45	0.5
G08020803-048	Hole #56	36-60	1.2	3.0	34	44	22	L	39.2	7.7	3.70	36.9	12.1	2.29	0.5
G08020803-049	Hole #57	0-2	2.1	5.4	22	42	36	CL	73.1	7.6	2.49	32.1	1.11	0.23	< 0.1
G08020803-050	Hole #57	2-8	0.7	< 0.1	32	38	30	CL	64.3	7.6	2.55	30.7	3.92	0.35	< 0.1

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LABORATORY ANALYTICAL REPORT

Client: Knight Piesold and Company
Project: 451b Dewey-Burdock Soils
Workorder: G08020803

Report Date: 03/28/08
Date Received: 02/28/08

POWERTECH (USA) INC.

		Analysis	B-Hot H20	Se-Hot H20
		Units	mg/kg	mg/kg
Sample ID	Client Sample ID	Depth	Results	Results
G08020803-001	Hole #17	0-3	0.3	< 0.01
G08020803-002	Hole #17	3-8	0.3	< 0.01
G08020803-003	Hole #17	8-24	0.5	< 0.01
G08020803-004	Hole #17	24-40	0.6	< 0.01
G08020803-005	Hole #17	40-54	0.8	< 0.01
G08020803-006	Hole #17	54-60	0.8	< 0.01
G08020803-007	Hole #27	0-2	0.3	< 0.01
G08020803-008	Hole #27	2-17	2.0	0.03
G08020803-009	Hole #27	17-24	2.3	0.07
G08020803-010	Hole #27	24-39	1.6	0.06
G08020803-011	Hole #27	39-60	1.1	0.08
G08020803-012	Hole #36	0-2	0.4	< 0.01
G08020803-013	Hole #36	2-15	1.7	0.02
G08020803-014	Hole #36	15-26	2.3	0.03
G08020803-015	Hole #36	26-36	2.3	0.03
G08020803-016	Hole #36	36-60	1.5	0.03
G08020803-017	Hole #39	0-2	0.2	< 0.01
G08020803-018	Hole #39	2-15	0.3	< 0.01
G08020803-019	Hole #39	15-32	0.4	< 0.01
G08020803-020	Hole #39	32-52	0.9	0.04
G08020803-021	Hole #39	52-60	2.5	0.03
G08020803-022	Hole #40	0-4	0.3	< 0.01
G08020803-023	Hole #40	4-14	0.3	< 0.01
G08020803-024	Hole #40	14-27	0.4	< 0.01
G08020803-025	Hole #40	27-38	0.8	0.02
G08020803-026	Hole #40	38-60	0.7	0.06
G08020803-027	Hole #41	0-4	0.4	< 0.01
G08020803-028	Hole #41	4-21	0.7	0.03
G08020803-029	Hole #41	21-36	7.7	0.25
G08020803-030	Hole #41	36-45	4.2	0.24
G08020803-031	Hole #41	45-60	1.5	0.22
G08020803-032	Hole #42	0-6	1.0	0.07
G08020803-033	Hole #42	6-17	1.1	0.15
G08020803-034	Hole #42	17-39	1.8	0.09
G08020803-035	Hole #42	39-60	1.2	0.04
G08020803-036	Hole #43	0-2	0.4	< 0.01
G08020803-037	Hole #43	2-14	0.2	< 0.01
G08020803-038	Hole #43	14-38	0.5	< 0.01
G08020803-039	Hole #43	38-60	0.8	0.01
G08020803-040	Hole #50	0-2	0.1	< 0.01

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LABORATORY ANALYTICAL REPORT

POWERTECH (USA) INC.

Client: Knight Piesold and Company
Project: 451b Dewey-Burdock Soils
Workorder: G08020803

Report Date: 03/28/08
Date Received: 02/28/08

		Analysis	B-Hot H20	Se-Hot H20
		Units	mg/kg	mg/kg
Sample ID	Client Sample ID	Depth	Results	Results
G08020803-041	Hole #50	2-7	0.1	< 0.01
G08020803-042	Hole #50	7-13	0.3	< 0.01
G08020803-043	Hole #50	13-25	0.2	< 0.01
G08020803-044	Hole #56	0-3	0.2	< 0.01
G08020803-045	Hole #56	3-14	0.3	< 0.01
G08020803-046	Hole #56	14-26	0.3	< 0.01
G08020803-047	Hole #56	26-36	0.3	< 0.01
G08020803-048	Hole #56	36-60	0.2	< 0.01
G08020803-049	Hole #57	0-2	0.3	< 0.01
G08020803-050	Hole #57	2-8	0.3	< 0.01

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LABORATORY ANALYTICAL REPORT

Client: Knight Piesold and Company
Project: 451b Dewey-Burdock Soils
Workorder: G08020805

Report Date: 03/31/08
Date Received: 02/28/08

POWERTECH (USA) INC.

		Analysis	OM	Coarse Fragments	Sand	Silt	Clay	Texture	SAT	pH-sat paste	EC-sat paste	Ca-sat paste	Mg-sat paste	Na-sat paste	SAR-sat paste
		Units	%	%	%	%	%		wt%	s_u_	mmhos/cm	meq/L	meq/L	meq/L	unitless
Sample ID	Client Sample ID	Depth	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results
G08020805-001	Hole #60	0-3	3.4	3.5	30	40	30	CL	69.2	7.5	0.75	4.69	2.03	1.47	0.8
G08020805-002	Hole #60	3-10	1.8	< 0.1	20	38	42	C	74.1	8.4	1.55	1.18	1.86	13.5	11
G08020805-003	Hole #60	10-18	1.3	4.8	24	70	6	SiL	69.5	8.2	9.21	22.1	61.0	79.7	12
G08020805-004	Hole #63	0-2	3.0	14.3	52	36	12	L	33.2	6.4	0.79	5.94	1.88	0.56	0.3
G08020805-005	Hole #63	2-6	1.9	8.8	39	38	23	L	40.1	7.3	0.92	8.85	1.68	0.34	0.2
G08020805-006	Hole #63	6-18	1.9	8.2	22	51	27	CL	40.1	7.4	2.99	30.1	9.02	5.25	1.2
G08020805-007	Hole #64	0-6	2.4	< 0.1	14	53	33	SiCL	62.6	7.1	0.97	6.25	4.69	0.35	0.2
G08020805-008	Hole #64	6-17	1.7	< 0.1	8	59	33	SiCL	64.7	8.1	0.67	2.87	2.96	1.74	1.0
G08020805-009	Hole #64	17-33	0.8	< 0.1	6	61	33	SiCL	54.2	8.5	2.27	1.60	5.81	16.0	8.3
G08020805-010	Hole #64	33-42	0.7	< 0.1	10	61	29	SiCL	48.8	8.0	8.02	27.8	61.1	50.6	7.6
G08020805-011	Hole #64	42-60	0.6	< 0.1	16	57	27	SiCL	45.9	8.1	7.62	27.7	50.5	45.2	7.2
G08020805-012	Hole #72	0-3	3.3	< 0.1	17	51	32	SiCL	53.4	6.3	0.52	2.98	1.09	0.32	0.2
G08020805-013	Hole #72	3-18	1.2	< 0.1	26	39	35	CL	55.3	7.6	0.49	1.74	0.51	2.86	2.7
G08020805-014	Hole #72	18-28	1.2	2.8	10	47	43	SiC	69.7	7.9	4.52	20.2	12.3	30.1	7.5
G08020805-015	Hole #72	28-43	1.0	1.7	16	69	15	SiL	69.0	8.2	8.21	23.5	50.0	69.8	12
G08020805-016	Hole #72	43-60	0.8	2.1	22	53	25	SiL	67.4	8.3	10.0	21.9	73.5	94.0	14
G08020805-017	Hole #73	0-3	3.1	< 0.1	44	35	21	L	51.1	7.4	0.99	5.50	3.21	2.31	1.1
G08020805-018	Hole #73	3-15	1.7	< 0.1	16	41	43	SiC	77.6	7.9	6.51	8.5	9.4	52.4	18
G08020805-019	Hole #73	15-23	0.9	< 0.1	2	58	40	SiC	97.4	7.8	11.2	24.7	26.4	113	22
G08020805-020	Hole #73	23-34	1.1	< 0.1	< 1	60	40	SiC	95.5	8.0	12.9	35.5	35.5	134	22
G08020805-021	Hole #73	34-38	0.9	< 0.1	6	42	52	SiC	75.1	8.0	13.8	34.0	36.9	142	24
G08020805-022	Hole #73	38-60	0.9	< 0.1	4	31	65	C	97.7	8.0	12.2	33.0	31.8	123	22
G08020805-023	Hole #74	0-3	1.6	< 0.1	59	16	25	SCL	36.0	7.8	0.73	5.47	2.04	0.79	0.4
G08020805-024	Hole #74	3-15	0.8	< 0.1	54	19	27	SCL	46.2	8.3	0.69	1.62	1.45	4.66	3.8
G08020805-025	Hole #74	15-27	0.6	< 0.1	36	35	29	CL	51.5	8.5	5.68	5.4	15.9	55.9	17
G08020805-026	Hole #74	27-38	1.3	< 0.1	40	37	23	L	37.9	8.5	13.7	28.2	95.0	162	21
G08020805-027	Hole #74	38-51	0.5	< 0.1	50	31	19	L	34.3	8.4	13.2	25.9	92.3	150	20
G08020805-028	Hole #74	51-60	0.4	< 0.1	64	17	19	SL	33.1	8.4	12.7	23.9	82.0	143	20
G08020805-029	Hole #75	0-4	2.5	< 0.1	28	45	27	CL	60.4	7.8	0.84	4.62	1.79	2.13	1.2
G08020805-030	Hole #75	4-15	2.2	< 0.1	14	53	33	SiCL	63.9	7.7	1.78	7.76	2.94	8.47	3.7
G08020805-031	Hole #75	15-35	1.3	< 0.1	16	55	29	SiCL	52.2	7.6	6.61	28.4	15.6	48.5	10
G08020805-032	Hole #75	35-46	1.0	< 0.1	15	58	27	SiCL	53.9	7.8	8.46	28.3	24.1	74.1	14
G08020805-033	Hole #75	46-60	1.0	< 0.1	12	59	29	SiCL	54.5	7.8	8.23	27.4	24.2	69.8	14
G08020805-034	Hole #76	0-2	1.9	< 0.1	48	39	13	L	31.5	5.3	1.04	3.70	2.44	2.75	1.6
G08020805-035	Hole #76	2-21	1.3	< 0.1	14	42	44	SiC	69.1	7.7	5.77	19.6	14.2	43.2	11
G08020805-036	Hole #76	21-29	0.9	2.7	20	39	41	C	67.0	6.9	6.84	23.5	16.7	53.1	12
G08020805-037	Hole #76	29-46	1.0	5.7	19	45	36	SiCL	60.6	7.6	4.87	7.22	6.07	43.4	17
G08020805-038	Hole #76	46-60	0.6	< 0.1	10	58	32	SiCL	53.8	7.3	4.57	3.85	3.15	44.1	24
G08020805-039	Hole #77	0-4	2.0	1.7	36	37	27	CL	52.6	7.6	0.54	4.10	1.14	0.43	0.3
G08020805-040	Hole #77	4-17	1.5	< 0.1	22	41	37	CL	68.4	7.7	1.21	6.47	3.13	4.01	1.8

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LABORATORY ANALYTICAL REPORT

POWERTECH (USA) INC.

Client: Knight Piesold and Company
Project: 451b Dewey-Burdock Soils
Workorder: G08020805

Report Date: 03/31/08
Date Received: 02/28/08

		Analysis	OM	Coarse Fragments	Sand	Silt	Clay	Texture	SAT	pH-sat paste	EC-sat paste	Ca-sat paste	Mg-sat paste	Na-sat paste	SAR-sat paste
		Units	%	%	%	%	%		wt%	s_u_	mmhos/cm	meq/L	meq/L	meq/L	unitless
Sample ID	**Client Sample ID**	**Depth**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
G08020805-041	Hole #77	17-36	0.9	< 0.1	22	73	5	SiL	67.2	8.0	5.66	23.7	44.8	27.1	4.6
G08020805-042	Hole #77	36-48	0.8	< 0.1	24	61	15	SiL	64.9	7.8	6.62	23.8	62.6	32.0	4.9
G08020805-043	Hole #79	0-3	5.1	< 0.1	18	46	36	SiCL	58.5	6.1	0.78	1.65	1.19	4.02	3.4
G08020805-044	Hole #79	3-17	1.6	< 0.1	12	41	47	SiC	73.7	4.1	4.61	22.4	22.1	22.9	4.9
G08020805-045	Hole #79	17-30	0.9	6.8	18	33	49	C	72.4	3.6	4.75	24.7	20.4	21.9	4.6
G08020805-046	Hole #79	30-42	0.9	5.0	22	32	46	C	65.1	3.7	2.50	11.4	7.65	9.50	3.1
G08020805-047	Hole #79	42-60	0.9	9.5	16	37	47	C	61.9	3.6	2.30	10.1	6.32	7.31	2.6

ENERGY LABORATORIES, INC. * 400 W Boxelder Rd * Gillette, WY 82718-5315
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LABORATORY ANALYTICAL REPORT

Client: Knight Piesold and Company
Project: 451b Dewey-Burdock Soils
Workorder: G08020805

Report Date: 03/31/08
Date Received: 02/28/08

POWERTECH (USA) INC.

		Analysis	B-Hot H20	Se-Hot H20
		Units	mg/kg	mg/kg
Sample ID	Client Sample ID	Depth	Results	Results
G08020805-001	Hole #60	0-3	0.2	< 0.01
G08020805-002	Hole #60	3-10	0.4	0.01
G08020805-003	Hole #60	10-18	1.5	0.11
G08020805-004	Hole #63	0-2	0.1	< 0.01
G08020805-005	Hole #63	2-6	< 0.1	< 0.01
G08020805-006	Hole #63	6-18	0.3	< 0.01
G08020805-007	Hole #64	0-6	< 0.1	< 0.01
G08020805-008	Hole #64	6-17	0.2	< 0.01
G08020805-009	Hole #64	17-33	1.1	0.03
G08020805-010	Hole #64	33-42	2.7	0.12
G08020805-011	Hole #64	42-60	1.5	0.06
G08020805-012	Hole #72	0-3	0.2	< 0.01
G08020805-013	Hole #72	3-18	0.2	< 0.01
G08020805-014	Hole #72	18-28	1.1	0.12
G08020805-015	Hole #72	28-43	2.0	0.27
G08020805-016	Hole #72	43-60	1.6	0.10
G08020805-017	Hole #73	0-3	0.2	< 0.01
G08020805-018	Hole #73	3-15	0.8	0.06
G08020805-019	Hole #73	15-23	2.5	0.34
G08020805-020	Hole #73	23-34	2.3	0.44
G08020805-021	Hole #73	34-38	1.7	0.42
G08020805-022	Hole #73	38-60	1.8	0.37
G08020805-023	Hole #74	0-3	0.2	< 0.01
G08020805-024	Hole #74	3-15	0.2	< 0.01
G08020805-025	Hole #74	15-27	1.1	0.08
G08020805-026	Hole #74	27-38	2.5	0.21
G08020805-027	Hole #74	38-51	1.7	0.20
G08020805-028	Hole #74	51-60	1.3	0.16
G08020805-029	Hole #75	0-4	0.3	< 0.01
G08020805-030	Hole #75	4-15	0.4	< 0.01
G08020805-031	Hole #75	15-35	0.5	< 0.01
G08020805-032	Hole #75	35-46	0.7	< 0.01
G08020805-033	Hole #75	46-60	0.9	0.01
G08020805-034	Hole #76	0-2	0.2	< 0.01
G08020805-035	Hole #76	2-21	1.2	0.02
G08020805-036	Hole #76	21-29	0.8	< 0.01
G08020805-037	Hole #76	29-46	0.6	0.04
G08020805-038	Hole #76	46-60	0.5	0.17
G08020805-039	Hole #77	0-4	0.2	< 0.01
G08020805-040	Hole #77	4-17	0.5	< 0.01

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LABORATORY ANALYTICAL REPORT

POWERTECH (USA) INC.

Client: Knight Piesold and Company
Project: 451b Dewey-Burdock Soils
Workorder: G08020805

Report Date: 03/31/08
Date Received: 02/28/08

		Analysis	B-Hot H20	Se-Hot H20
		Units	mg/kg	mg/kg
Sample ID	Client Sample ID	Depth	Results	Results
G08020805-041	Hole #77	17-36	4.4	0.03
G08020805-042	Hole #77	36-48	6.3	0.04
G08020805-043	Hole #79	0-3	0.6	< 0.01
G08020805-044	Hole #79	3-17	0.9	< 0.01
G08020805-045	Hole #79	17-30	0.6	< 0.01
G08020805-046	Hole #79	30-42	0.4	< 0.01
G08020805-047	Hole #79	42-60	0.3	< 0.01

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LABORATORY ANALYTICAL REPORT

POWERTECH (USA) INC.

Client: Knight Piesold and Company
Project: 451b Dewey-Burdock Soils
Workorder: G08020806

Report Date: 04/07/08
Date Received: 02/28/08

		Analysis	OM	Coarse Fragments	Sand	Silt	Clay	Texture	SAT	pH-sat paste	EC-sat paste	Ca-sat paste	Mg-sat paste	Na-sat paste	SAR-sat paste
		Units	%	%	%	%	%		wt%	s_u_	mmhos/cm	meq/L	meq/L	meq/L	unitless
Sample ID	Client Sample ID	Depth	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results
G08020806-001	Hole #82	0-4	3.0	0.9	51	32	17	L	35.7	5.3	1.78	8.96	4.91	0.19	0.08
G08020806-002	Hole #82	4-12	1.9	2.0	40	27	33	CL	49.3	7.1	1.16	5.93	3.57	1.95	0.89
G08020806-003	Hole #82	12-17	1.6	< 0.1	54	24	22	SCL	40.7	7.6	0.98	5.10	3.38	1.46	0.71
G08020806-004	Hole #82	17-28	1.3	< 0.1	54	24	22	SCL	39.0	7.9	0.99	3.09	3.19	3.75	2.12
G08020806-005	Hole #82	28-43	0.7	< 0.1	58	22	20	SCL	39.2	7.9	2.98	6.68	12.5	14.1	4.55
G08020806-006	Hole #83	0-3	3.2	< 0.1	14	53	33	SiCL	53.3	4.8	0.43	1.23	0.72	1.20	1.22
G08020806-007	Hole #83	3-17	1.6	< 0.1	14	43	43	SiC	52.2	4.8	0.31	0.40	0.23	1.82	3.23
G08020806-008	Hole #83	17-33	1.0	< 0.1	9	47	44	SiC	69.4	5.7	4.85	25.3	25.0	22.3	4.44
G08020806-009	Hole #83	33-42	0.6	< 0.1	6	69	25	SiL	78.1	7.6	5.71	26.5	35.1	30.4	5.47
G08020806-010	Hole #83	42-52	0.5	< 0.1	8	69	23	SiL	82.3	7.9	6.61	26.0	46.3	38.3	6.37
G08020806-011	Hole #83	52-60	0.4	< 0.1	12	79	9	SiL	74.9	7.9	6.67	24.4	42.7	42.6	7.36
G08020806-012	Hole #84	0-5	8.0	< 0.1	4	59	37	SiCL	87.0	7.4	1.87	1.83	6.46	12.7	6.22
G08020806-013	Hole #84	5-18	1.8	< 0.1	9	52	39	SiCL	83.2	8.2	11.8	24.5	105	112	14.0
G08020806-014	Hole #84	18-37	0.8	< 0.1	12	46	42	SiC	76.8	8.4	14.0	22.8	149	148	15.9
G08020806-015	Hole #84	37-47	1.1	< 0.1	6	55	39	SiCL	70.8	8.3	11.6	23.5	103	108	13.5
G08020806-016	Hole #84	47-60	0.6	< 0.1	32	37	31	CL	59.7	8.1	8.14	21.8	60.2	61.6	9.63
G08020806-017	Hole #85	0-2	4.2	< 0.1	32	48	20	L	51.5	6.3	0.43	2.37	1.44	0.23	0.16
G08020806-018	Hole #85	2-7	2.3	< 0.1	20	41	39	SiCL	80.6	7.3	0.71	4.24	2.39	0.73	0.40
G08020806-019	Hole #85	7-17	1.6	< 0.1	16	46	38	SiCL	68.9	7.9	0.71	2.58	1.79	2.93	1.98
G08020806-020	Hole #85	17-30	1.3	< 0.1	22	40	38	CL	65.4	8.0	1.71	4.81	4.08	9.26	4.39
G08020806-021	Hole #88	0-2	3.0	2.1	21	46	33	CL	64.7	6.7	0.54	3.27	1.99	0.43	0.26
G08020806-022	Hole #88	2-9	1.8	< 0.1	11	43	46	SiC	77.9	7.8	0.80	4.04	1.88	2.48	1.44
G08020806-023	Hole #88	9-18	1.3	< 0.1	14	82	4	Si	77.9	7.6	3.99	31.4	13.3	13.6	2.88
G08020806-024	Hole #89	0-2	4.4	3.1	12	54	34	SiCL	72.4	5.4	0.80	4.78	2.49	0.32	0.17
G08020806-025	Hole #89	2-18	2.4	3.7	9	45	46	SiC	87.3	7.7	1.41	5.88	4.12	5.67	2.54
G08020806-026	Hole #89	18-31	1.5	< 0.1	6	43	51	SiC	83.7	7.8	3.75	23.8	14.0	16.3	3.75
G08020806-027	Hole #89	31-37	1.5	< 0.1	3	49	48	SiC	86.0	7.7	3.98	27.7	15.5	16.0	3.44
G08020806-028	Hole #90	0-2	2.5	< 0.1	1	48	51	SiC	84.1	6.8	0.37	2.25	0.89	0.42	0.34
G08020806-029	Hole #90	2-8	1.8	< 0.1	2	44	54	SiC	89.8	7.4	0.44	2.82	0.78	0.76	0.56
G08020806-030	Hole #90	8-20	1.5	< 0.1	6	41	53	SiC	89.0	7.7	0.78	4.84	1.35	1.86	1.06
G08020806-031	Hole #91	0-4	2.0	< 0.1	26	44	30	CL	65.3	7.6	1.21	10.9	3.22	0.65	0.24
G08020806-032	Hole #91	4-19	1.2	< 0.1	22	67	11	SiL	85.3	7.8	4.65	25.3	14.5	26.3	5.89
G08020806-033	Hole #91	19-40	0.5	< 0.1	16	74	10	SiL	79.9	8.4	12.7	23.7	81.7	144	19.8
G08020806-034	Hole #91	40-48	0.8	< 0.1	19	47	34	SiCL	80.9	8.4	13.7	23.4	98.1	156	20.0
G08020806-035	Hole #91	48-60	0.6	< 0.1	10	68	22	SiL	94.3	8.3	14.4	25.1	109	170	20.7
G08020806-036	Hole #92	0-7	2.3	< 0.1	18	44	38	SiCL	74.9	7.5	0.79	4.99	1.58	2.09	1.15
G08020806-037	Hole #92	7-19	1.6	< 0.1	12	48	40	SiC	88.2	7.6	3.32	27.6	9.68	10.4	2.42
G08020806-038	Hole #93	0-4	2.9	< 0.1	50	38	12	L	41.8	7.2	0.77	6.13	1.94	0.22	0.11
G08020806-039	Hole #93	4-8	2.1	< 0.1	50	32	18	L	39.4	7.5	0.71	6.25	1.80	0.14	0.07
G08020806-040	Hole #94	0-2	6.3	< 0.1	8	48	44	SiC	85.7	6.9	0.92	4.54	3.22	1.06	0.54

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LABORATORY ANALYTICAL REPORT

POWERTECH (USA) INC.

Client: Knight Piesold and Company
Project: 451b Dewey-Burdock Soils
Workorder: G08020806

Report Date: 04/07/08
Date Received: 02/28/08

		Analysis	OM	Coarse Fragments	Sand	Silt	Clay	Texture	SAT	pH-sat paste	EC-sat paste	Ca-sat paste	Mg-sat paste	Na-sat paste	SAR-sat paste
		Units	%	%	%	%	%		wt%	s_u_	mmhos/cm	meq/L	meq/L	meq/L	unitless
Sample ID	**Client Sample ID**	**Depth**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
G08020806-041	Hole #94	2-8	1.8	< 0.1	8	48	44	SiC	87.8	7.6	0.66	3.55	1.58	1.61	1.00
G08020806-042	Hole #94	8-20	1.2	6.0	19	41	40	SiC	85.6	7.5	2.27	20.6	5.30	3.89	1.08
G08020806-043	Hole #94	20-32	1.0	3.1	16	45	39	SiCL	82.6	7.6	3.00	26.0	9.46	5.36	1.27
G08020806-044	Hole #94	32-44	1.2	8.9	9	49	42	SiC	87.2	7.6	3.81	26.2	18.1	13.4	2.84
G08020806-045	Hole #94	44-60	0.9	5.0	12	47	41	SiC	87.0	7.8	5.22	23.7	27.5	29.4	5.82
G08020806-046	Hole #95	0-2	3.6	< 0.1	39	43	18	L	46.4	7.1	0.70	5.33	2.36	0.10	0.05
G08020806-047	Hole #95	2-8	2.0	< 0.1	41	39	20	L	43.8	7.6	0.93	7.16	2.64	0.40	0.18
G08020806-048	Hole #95	8-17	1.2	< 0.1	40	41	19	L	39.5	7.9	0.65	3.56	2.66	0.71	0.40
G08020806-049	Hole #95	17-24	0.7	< 0.1	35	39	26	L	51.3	8.3	0.90	1.18	2.30	5.73	4.34
G08020806-050	Hole #95	24-38	1.0	< 0.1	34	33	33	CL	62.7	8.3	6.10	15.6	37.7	41.7	8.08

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LABORATORY ANALYTICAL REPORT

Client: Knight Piesold and Company
Project: 451b Dewey-Burdock Soils
Workorder: G08020806

Report Date: 04/07/08
Date Received: 02/28/08

POWERTECH (USA) INC.

		Analysis	B-Hot H20	Se-Hot H20
		Units	mg/kg	mg/kg
Sample ID	Client Sample ID	Depth	Results	Results
G08020806-001	Hole #82	0-4	0.3	< 0.01
G08020806-002	Hole #82	4-12	0.3	< 0.01
G08020806-003	Hole #82	12-17	0.3	< 0.01
G08020806-004	Hole #82	17-28	0.3	< 0.01
G08020806-005	Hole #82	28-43	0.5	< 0.01
G08020806-006	Hole #83	0-3	0.3	< 0.01
G08020806-007	Hole #83	3-17	0.3	< 0.01
G08020806-008	Hole #83	17-33	1.9	< 0.01
G08020806-009	Hole #83	33-42	5.4	0.02
G08020806-010	Hole #83	42-52	8.4	0.04
G08020806-011	Hole #83	52-60	5.2	0.07
G08020806-012	Hole #84	0-5	1.0	< 0.01
G08020806-013	Hole #84	5-18	1.6	0.02
G08020806-014	Hole #84	18-37	2.8	0.05
G08020806-015	Hole #84	37-47	2.9	0.02
G08020806-016	Hole #84	47-60	1.8	< 0.01
G08020806-017	Hole #85	0-2	0.2	< 0.01
G08020806-018	Hole #85	2-7	0.2	< 0.01
G08020806-019	Hole #85	7-17	0.5	< 0.01
G08020806-020	Hole #85	17-30	0.8	< 0.01
G08020806-021	Hole #88	0-2	0.2	< 0.01
G08020806-022	Hole #88	2-9	0.4	< 0.01
G08020806-023	Hole #88	9-18	1.2	< 0.01
G08020806-024	Hole #89	0-2	0.3	< 0.01
G08020806-025	Hole #89	2-18	0.5	< 0.01
G08020806-026	Hole #89	18-31	1.3	0.02
G08020806-027	Hole #89	31-37	1.5	0.01
G08020806-028	Hole #90	0-2	0.3	< 0.01
G08020806-029	Hole #90	2-8	0.4	< 0.01
G08020806-030	Hole #90	8-20	0.8	< 0.01
G08020806-031	Hole #91	0-4	0.2	< 0.01
G08020806-032	Hole #91	4-19	0.3	0.02
G08020806-033	Hole #91	19-40	1.5	0.07
G08020806-034	Hole #91	40-48	1.0	0.08
G08020806-035	Hole #91	48-60	1.0	0.10
G08020806-036	Hole #92	0-7	0.2	< 0.01
G08020806-037	Hole #92	7-19	0.7	< 0.01
G08020806-038	Hole #93	0-4	< 0.1	< 0.01
G08020806-039	Hole #93	4-8	0.1	< 0.01
G08020806-040	Hole #94	0-2	0.6	< 0.01

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LABORATORY ANALYTICAL REPORT

Client: Knight Piesold and Company
Project: 451b Dewey-Burdock Soils
Workorder: G08020806

Report Date: 04/07/08
Date Received: 02/28/08

POWERTECH (USA) INC.

		Analysis	B-Hot H20	Se-Hot H20
		Units	mg/kg	mg/kg
Sample ID	Client Sample ID	Depth	Results	Results
G08020806-041	Hole #94	2-8	0.4	< 0.01
G08020806-042	Hole #94	8-20	0.5	< 0.01
G08020806-043	Hole #94	20-32	0.7	< 0.01
G08020806-044	Hole #94	32-44	1.1	< 0.01
G08020806-045	Hole #94	44-60	0.8	0.02
G08020806-046	Hole #95	0-2	0.2	< 0.01
G08020806-047	Hole #95	2-8	0.1	< 0.01
G08020806-048	Hole #95	8-17	0.1	< 0.01
G08020806-049	Hole #95	17-24	0.2	< 0.01
G08020806-050	Hole #95	24-38	1.5	0.15

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LABORATORY ANALYTICAL REPORT

Prepared by Casper, WY Branch

Client: BKS Environmental Associates Inc
Project: 451B Dewey-Burdock Baseline Soils
Workorder: C08100918

Report Date: 12/29/08
Date Received: 10/21/08

POWERTECH (USA) INC.

		Analysis	Calcium, sat_paste	Magnesium, sat_paste	Sodium, sat_paste	Coarse Frags	Sand	Silt	Clay	Texture	pH SatPst	Saturation SatPst	EC SatPst	SAR	Organic Matter
		Units	meq/L	meq/L	meq/L	%	%	%	%		s_u_	%	mmhos/cm	unitless	%
Sample ID	Client Sample ID	Depth	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results
C08100918-001	103	0-3	14.8	4.22	2.35	1	33	21	46	C	7.3	37.7	1.91	0.76	3.9
C08100918-002	103	3-12	23.3	12.1	1.98	3	23	27	50	C	7.6	34.6	2.60	0.47	1.9
C08100918-003	103	12-25	36.9	16.6	2.5	< 1	31	49	20	L	7.5	31.2	3.75	0.48	0.8
C08100918-004	103	25-38	33.8	89.7	46.7	2	25	65	10	SiL	8.2	28.5	10.3	5.97	0.7
C08100918-005	103	38-48	31.3	84.7	38.7	3	57	23	20	SL - SCL	8.3	23.4	9.66	5.12	0.3
C08100918-006	114	0-2	11.7	4.05	2.27	2	23	33	44	C	6.1	49.6	1.57	0.81	7.1
C08100918-007	114	2-9	6.98	2.66	2.09	5	32	38	30	CL	7.4	26.6	1.03	0.95	2.0
C08100918-008	114	9-26	25.7	8.1	29.1	9	31	29	40	C - CL	7.9	36.7	4.58	7.10	1.1
C08100918-009	114	26-38	20.7	11.1	94.4	6	35	25	40	C - CL	8.3	41.5	9.19	23.7	0.8
C08100918-010	114	38-48	24.1	29.4	267	6	39	19	42	C	8.9	39.7	20.6	51.9	0.5
C08100918-011	115	0-3	20.5	4.19	3.14	4	49	25	26	SCL	7.7	25.7	2.08	0.90	1.3
C08100918-012	115	3-19	3.90	2.23	0.65	< 1	55	25	20	SL - SCL	8.2	26.0	0.58	0.37	0.8
C08100918-013	115	19-27	3.18	3.41	1.83	2	57	25	18	SL	8.2	22.8	0.73	1.01	0.5
C08100918-014	116	0-5	12.0	3.77	2.27	< 1	53	15	32	SCL	7.1	29.6	1.47	0.81	2.1
C08100918-015	116	5-18	8.99	6.27	13.0	7	59	17	24	SCL	8.2	26.8	2.31	4.70	1.0
C08100918-016	116	18-36	0.90	2.79	6.45	< 1	53	17	30	SCL	8.6	25.7	0.94	4.78	0.7
C08100918-017	116	36-48	2.33	7.94	17.2	2	69	11	20	SL - SCL	8.7	23.1	2.54	7.65	0.4

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LABORATORY ANALYTICAL REPORT

Prepared by Casper, WY Branch

Client: BKS Environmental Associates Inc
Project: 451B Dewey-Burdock Baseline Soils
Workorder: C08100918

Report Date: 12/29/08
Date Received: 10/21/08

POWERTECH (USA) INC.

		Analysis	B-CACL2	Se-ABDTPA
		Units	mg/kg-dry	mg/kg-dry
Sample ID	Client Sample ID	Depth	Results	Results
C08100918-001	103	0-3	1.0	0.009
C08100918-002	103	3-12	1.0	0.011
C08100918-003	103	12-25	0.91	0.011
C08100918-004	103	25-38	1.4	0.064
C08100918-005	103	38-48	1.5	0.097
C08100918-006	114	0-2	0.83	0.011
C08100918-007	114	2-9	0.67	0.022
C08100918-008	114	9-26	0.93	0.028
C08100918-009	114	26-38	1.2	0.021
C08100918-010	114	38-48	3.1	0.039
C08100918-011	115	0-3	< 0.43	0.013
C08100918-012	115	3-19	< 0.44	0.010
C08100918-013	115	19-27	< 0.43	0.008
C08100918-014	116	0-5	< 0.43	0.009
C08100918-015	116	5-18	< 0.44	0.007
C08100918-016	116	18-36	0.85	0.006
C08100918-017	116	36-48	2.2	0.064

LABORATORY ANALYTICAL REPORT

Client: Powertech (USA) Inc
Project: 548 Knight Piesold Dewey Burdock LAD
Workorder: C08071014

Revised Date: 11/07/08
Report Date: 11/04/08
Date Received: 07/22/08

POWERTECH (USA) INC.

		Analysis	As	Ba	Cd	Cr	Pb	Se	Ag	V
		Units	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry
Sample ID	Client Sample ID	Depth	Results	Results	Results	Results	Results	Results	Results	Results
C08071014-001	W002NW 1	0-11	9.1	128	0.6	19.2	15.3	0.6	< 0.6	39.6
C08071014-002	W002NW 1	11-19	8.6	144	0.6	18.5	13.8	0.8	< 0.5	37.4
C08071014-003	W002NW 1	19-30	8.1	138	< 0.5	13.3	12.4	0.9	< 0.5	26.8
C08071014-004	W002NW 1	30-43	7.6	95.7	< 0.5	12.1	11.3	0.9	< 0.5	23.5
C08071014-005	W002NW 1	43-60	7.1	57.3	< 0.5	9.2	9.9	0.6	< 0.5	19.7
C08071014-006	W002NE 2	0-11	10.5	141	0.7	19.4	15.1	< 0.6	< 0.6	46.6
C08071014-007	W002NE 2	6-14	9.2	130	0.6	17.4	14.8	< 0.6	< 0.6	39.1
C08071014-008	W002NE 2	14-29	9.4	189	0.6	17.6	15.3	< 0.5	< 0.5	39.6
C08071014-009	W002NE 2	29-45	9.9	119	0.6	16.6	15.1	0.9	< 0.5	34.2
C08071014-010	W002NE 2	45-60	9.0	74.7	< 0.5	9.7	10.4	< 0.5	< 0.5	22.4
C08071014-011	W002SE 3	0-11	9.6	147	0.6	14.3	15.3	< 0.6	< 0.6	32.4
C08071014-012	W002NE 2	5-20	11.6	152	0.6	11.9	12.3	< 0.5	< 0.5	30.0
C08071014-013	W002NE 2	20-36	10.4	135	< 0.5	13.6	14.1	0.6	< 0.5	29.0
C08071014-014	W002NE 2	36-55	9.5	127	< 0.5	15.2	14.9	0.6	< 0.5	29.9
C08071014-015	W002NE 2	55-60	9.6	133	0.6	16.4	17.4	0.7	< 0.6	34.4
C08071014-016	W002SW 4	0-11	8.6	142	0.6	19.9	14.6	< 0.6	< 0.6	41.9
C08071014-017	W002SW 4	11-23	8.7	142	0.6	19.7	14.1	1.1	< 0.5	42.3
C08071014-018	W002SW 4	23-36	11.1	219	0.7	19.9	17.9	1.8	< 0.5	43.1
C08071014-019	W002SW 4	36-60	7.8	89.5	< 0.5	14.0	11.4	0.6	< 0.5	28.8
C08071014-020	W001NW 5	0-11	9.4	120	0.7	16.1	15.7	< 0.6	< 0.6	39.7
C08071014-021	W001NW 5	6-13	9.7	115	0.6	18.0	15.1	0.5	< 0.5	41.6
C08071014-022	W001NW 5	13-23	8.8	138	0.6	17.3	15.9	0.9	< 0.5	37.8
C08071014-023	W001NW 5	23-37	9.4	140	0.5	14.8	14.2	0.8	< 0.5	30.8
C08071014-024	W001NW 5	37-55	9.9	157	< 0.5	15.1	13.8	0.6	< 0.5	32.6
C08071014-025	W001NW 5	55-60	8.2	114	0.6	15.3	15.8	0.5	< 0.5	26.7
C08071014-026	W001NE 6	0-11	10.0	155	< 0.5	15.3	16.1	0.7	< 0.5	30.4
C08071014-027	W001NE 6	28-38	7.7	75.6	0.6	10.9	13.6	< 0.5	< 0.5	21.2
C08071014-028	W001NE 6	38-49	10	79.1	0.7	11.0	12.9	0.6	< 0.5	24.5
C08071014-029	W001NE 6	49-60	9.9	110	< 0.5	13.4	13.8	0.7	< 0.5	26.4
C08071014-030	W001SE 7	0-11	9.4	143	0.8	17.3	14.8	0.8	< 0.5	39.9
C08071014-031	W001SE 7	11-17	8.8	120	0.7	18.6	14.5	0.9	< 0.5	37.6
C08071014-032	W001SE 7	17-27	9.0	118	0.7	16.5	14.4	1.4	< 0.5	29.6
C08071014-033	W001SE 7	27-40	8.8	79.1	0.6	14.0	13.1	0.8	< 0.5	28.1
C08071014-034	W001SE 7	40-60	9.1	91.0	0.7	13.1	13.8	0.7	< 0.5	24.9
C08071014-035	W001SW 8	0-11	10.3	119	0.6	16.1	14.3	0.6	< 0.5	39.0
C08071014-036	W001SW 8	7-31	9.6	118	0.5	15.1	13.6	1.3	< 0.5	30.6
C08071014-037	W001SW 8	31-42	7.6	164	< 0.5	11.5	10.5	0.6	< 0.5	24.2
C08071014-038	W001SW 8	42-60	8.8	190	0.6	16.1	12.3	0.5	< 0.5	32.6
C08071014-039	NW 09	0-11	8.9	88.1	< 0.5	12.2	11.5	0.7	< 0.5	34.0
C08071014-040	NW 09	8-21	7.4	113	< 0.5	15.6	15.3	0.8	< 0.5	21.3

Burdock Land Application Area

LABORATORY ANALYTICAL REPORT

Client: Powertech (USA) Inc
Project: 548 Knight Piesold Dewey Burdock LAD
Workorder: C08071014

Revised Date: 11/07/08
Report Date: 11/04/08
Date Received: 07/22/08

POWERTECH (USA) INC.

		Analysis	As	Ba	Cd	Cr	Pb	Se	Ag	V
		Units	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry
Sample ID	Client Sample ID	Depth	Results	Results	Results	Results	Results	Results	Results	Results
C08071014-041	NW 09	21-36	7.5	99.3	< 0.5	16.3	15.2	0.8	< 0.5	30.1
C08071014-042	NW 09	36-46	7.4	93.4	< 0.5	14.5	14.6	0.9	< 0.5	30.3
C08071014-043	NW 09	46-60	8.3	94.2	< 0.5	16.3	15.3	0.7	< 0.5	27.6
C08071014-044	NE 10	0-11	9.4	115	< 0.5	23.0	17.9	0.8	< 0.5	43.3
C08071014-045	NE 10	8-22	13.3	158	< 0.5	26.1	18.0	1.0	< 0.5	44.5
C08071014-046	NE 10	22-33	8.3	109	< 0.5	21.3	18.1	1.2	< 0.5	73.7
C08071014-047	NE 10	33-41	7.6	86.7	< 0.5	16.4	18.1	0.7	< 0.5	30.1
C08071014-048	NE 10	41-55	7.5	94.6	< 0.5	17.1	17.9	0.6	< 0.5	28.6
C08071014-049	SE 11	0-11	8.0	107	< 0.5	17.1	17.6	0.7	< 0.5	32.7
C08071014-050	SE 11	10-20	7.6	111	< 0.5	16.7	16.6	0.7	< 0.5	33.2
C08071014-051	SE 11	20-34	8.0	119	< 0.5	16.3	14.8	0.8	0.7	36.1
C08071014-052	SE 11	34-43	7.5	109	< 0.5	16.8	15.5	0.8	< 0.5	30.7
C08071014-053	SW 12	0-11	9.9	142	< 0.5	20.1	14.9	1.4	< 0.5	38.1
C08071014-054	SW 12	14-33	8.3	111	< 0.5	19.3	16.5	0.8	< 0.5	33.0
C08071014-055	Sec.3SW 13	0-11	9.2	98.4	< 0.5	17.1	15.8	0.9	< 0.5	29.3
C08071014-056	Sec.3SW 13	10-27	8.5	73.0	< 0.5	14.4	13.7	0.7	< 0.5	25.5
C08071014-057	Sec.3SW 13	37-48	10.7	62.5	< 0.5	12.3	13.9	0.6	< 0.5	22.3
C08071014-058	Sec.3SW 13	48-55	10.0	59.5	< 0.5	12.0	13.4	0.5	< 0.5	22.5
C08071014-059	Sec.3SW 13	55-60	9.4	45.7	< 0.5	9.0	11.5	< 0.5	< 0.5	16.7
C08071014-060	Sec.3NW 14	0-11	15.9	111	1	15.8	16.4	1.3	< 0.5	33.0
C08071014-061	Sec.3NW 14	13-28	13.5	104	0.9	16.0	19.1	1.2	< 0.5	26.0
C08071014-062	Sec.3NW 14	28-35	20.2	103	1.8	15.5	17.7	1.5	< 0.5	26.6
C08071014-063	Sec.3NW 14	35-54	12.1	82.0	0.7	20.2	19.9	1.1	< 0.5	25.4
C08071014-064	Sec.3NW 14	54-60	17.0	103	0.8	16.3	18.3	1.8	< 0.5	35.2
C08071014-065	Sec.3NW 15	0-11	9.7	94.3	< 0.5	24.3	17.2	1.4	< 0.5	33.5
C08071014-066	Sec.3NW 15	7-18	9.8	118	< 0.5	25.3	17.3	2.1	< 0.5	33.4
C08071014-067	Sec.3NW 15	18-29	7.1	105	< 0.5	17.4	10.4	0.7	< 0.5	27.2
C08071014-068	Sec.3NW 15	29-39	5.0	114	< 0.5	12.6	7.5	< 0.5	< 0.5	20.0
C08071014-069	Sec.3NW 15	39-60	6.3	134	< 0.5	15.4	9.2	< 0.5	< 0.5	22.0
C08071014-070	Sec.14NW 16	0-11	8.8	109	< 0.5	15.8	15.4	< 0.5	< 0.5	25.6
C08071014-071	Sec.14NW 16	7-13	8.5	100	< 0.5	17.2	15.2	< 0.5	< 0.5	26.0
C08071014-072	Sec.14NW 16	13-22	8.3	199	< 0.5	16.2	14.5	0.8	< 0.5	26.8
C08071014-073	Sec.14NW 16	22-38	10.6	186	< 0.5	17.1	15.9	1	< 0.5	27.4
C08071014-074	Sec.14NW 16	38-60	8.2	144	< 0.5	18.1	17.0	0.9	< 0.5	25.7
C08071014-075	Sec.14NE 17	0-11	8.8	139	< 0.5	18.1	16.5	< 0.5	< 0.5	26.0
C08071014-076	Sec.14NE 17	6-15	7.6	212	< 0.5	13.5	11.9	< 0.5	< 0.5	19.2
C08071014-077	Sec.14NE 17	15-26	6.5	66.9	< 0.5	9.7	9.0	< 0.5	< 0.5	12.6
C08071014-078	Sec.14NE 17	26-46	7.0	108	< 0.5	9.0	8.8	< 0.5	< 0.5	12.6
C08071014-079	Sec.14NE 17	46-60	6.9	82.3	< 0.5	10.3	9.6	< 0.5	< 0.5	13.0
C08071014-080	Sec.14SE 18	0-11	9.0	112	< 0.5	20.2	18.0	0.7	< 0.5	34.4

Burdock Land Application Area

LABORATORY ANALYTICAL REPORT

Client: Powertech (USA) Inc
Project: 548 Knight Piesold Dewey Burdock LAD
Workorder: C08071014

Revised Date: 11/07/08
Report Date: 11/04/08
Date Received: 07/22/08

POWERTECH (USA) INC.

		Analysis	As	Ba	Cd	Cr	Pb	Se	Ag	V
		Units	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry
Sample ID	Client Sample ID	Depth	Results	Results	Results	Results	Results	Results	Results	Results
C08071014-081	Sec.14SE 18	7-15	9.2	130	< 0.5	18.3	17.5	0.8	< 0.5	31.9
C08071014-082	Sec.14SE 18	15-20	7.8	107	< 0.5	18.0	17.2	1.1	< 0.5	28.1
C08071014-083	Sec.14SE 18	20-36	7.2	70.5	< 0.5	14.3	18.9	1.1	< 0.5	19.8
C08071014-084	Sec.14SE 18	36-48	7.1	63.1	< 0.5	14.2	23.1	0.7	< 0.5	17.1
C08071014-085	Sec.14SE 18	48-60	8.8	32.3	< 0.5	14.5	27.1	0.8	< 0.5	19.2
C08071014-086	Sec.14SW 19	0-11	8.7	127	< 0.5	19.3	17.2	0.6	< 0.5	30.3
C08071014-087	Sec.14SW 19	15-30	7.5	138	< 0.5	19.5	16.4	0.8	< 0.5	29.4
C08071014-088	NW30-NW 20	0-11	8.1	210	< 0.5	8.7	7.8	< 0.5	< 0.5	16.5
C08071014-089	NW30-NW 20	21-37	7.6	275	< 0.5	9.3	9.0	0.6	< 0.5	15.3
C08071014-090	NW30-NW 20	37-48	39.1	251	1.5	10.6	16.8	3.0	1.3	37.0
C08071014-091	NW30-NE 21	0-11	10.4	185	< 0.5	18.1	14.9	0.6	< 0.5	29.3
C08071014-092	NW30-NE 21	11-16	9.7	205	0.5	19.2	15.2	0.6	< 0.5	28.7
C08071014-093	NW30-NE 21	16-36	8.2	262	0.6	13.0	11.1	0.5	< 0.5	21.3
C08071014-094	NW30-NE 21	36-42	8.6	243	< 0.5	12.3	11.5	0.6	< 0.5	18.9
C08071014-095	NW30-NE 21	42-60	8.8	118	0.6	10.3	10.4	0.5	< 0.5	17.9
C08071014-096	NW30-SE 22	0-11	12.7	166	0.6	12.3	12.8	0.7	< 0.5	18.3
C08071014-097	NW30-SE 22	16-31	10.8	193	0.6	14.1	12.2	0.6	< 0.5	23.8
C08071014-098	NW30-SE 22	42-49	7.7	167	0.6	9.5	9.0	0.8	< 0.5	15.9
C08071014-099	NW30-SE 22	49-60	8.5	191	0.6	9.6	9.2	0.8	< 0.5	16.2
C08071014-100	NW30-SW 23	0-11	9.7	236	0.6	15.4	13.7	0.7	< 0.5	24.2
C08071014-101	NW30-SW 23	10-22	12.3	411	0.7	9.6	9.2	0.8	< 0.5	17.9
C08071014-102	NW30-SW 23	22-34	13.6	383	0.5	8.0	8.6	1	< 0.5	15.2
C08071014-103	NW30-SW 23	34-48	9.1	248	0.6	8.9	8.4	0.7	< 0.5	16.0
C08071014-104	NW30-SW 23	48-60	9.5	190	< 0.5	7.8	8.0	0.5	< 0.5	14.5
C08071014-105	NE30-SE 24	0-11	10.7	166	0.7	10.7	11.2	0.8	< 0.5	19.3
C08071014-106	NE30-SE 24	12-24	10.2	127	0.7	12.7	12.1	1.1	< 0.5	17.6
C08071014-107	NE30-SE 24	24-36	12.3	112	< 0.5	12.0	14.3	2.5	< 0.5	16.9
C08071014-108	NE30-SE 24	36-48	9.8	104	< 0.5	11.5	12.9	1.9	< 0.5	14.0
C08071014-109	NE30-SE 24	48-60	11.8	126	< 0.5	12.7	18.3	1.8	< 0.5	13.6
C08071014-110	NE30-SW 25	0-11	14.0	193	0.7	14.4	13.3	1.3	< 0.5	28.8
C08071014-111	NE30-SW 25	8-21	10.7	418	0.7	16.1	12.9	1.1	< 0.5	29.3
C08071014-112	NE30-SW 25	21-38	9.0	244	0.6	13.0	12.2	0.7	< 0.5	20.0
C08071014-113	NE30-SW 25	38-48	10.6	305	0.7	12.1	12.1	0.8	< 0.5	18.1
C08071014-114	NE30-SW 25	48-60	8.6	205	0.5	11.5	11.8	0.6	< 0.5	19.0
C08071014-115	NE30-NW 26	0-11	20.2	399	1.1	15.2	18.1	1.5	< 0.5	39.6
C08071014-116	NE30-NW 26	5-12	24.5	343	1	15.9	17.9	1.4	< 0.5	31.3
C08071014-117	NE30-NW 26	12-26	18.1	241	0.7	13.8	14.7	2.1	< 0.5	27.8
C08071014-118	NE30-NW 26	26-36	13.1	117	0.6	11.8	16.2	3.0	< 0.5	18.1
C08071014-119	NE30-NE 27	0-11	11.7	161	0.5	13.8	15.9	0.8	< 0.5	23.7
C08071014-120	NE30-NE 27	6-13	9.8	182	0.6	13.3	13.1	1.2	< 0.5	25.8

Dewey Land Application Area

LABORATORY ANALYTICAL REPORT

Client: Powertech (USA) Inc
Project: 548 Knight Piesold Dewey Burdock LAD
Workorder: C08071014

Revised Date: 11/07/08
Report Date: 11/04/08
Date Received: 07/22/08

POWERTECH (USA) INC.

		Analysis	As	Ba	Cd	Cr	Pb	Se	Ag	V
		Units	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry
Sample ID	Client Sample ID	Depth	Results	Results	Results	Results	Results	Results	Results	Results
C08071014-121	NE30-NE 27	13-37	8.3	116	< 0.5	9.3	9.4	0.6	< 0.5	19.1
C08071014-122	NE30-NE 27	37-44	13.6	130	1.2	8.2	7.8	0.9	< 0.5	25.3
C08071014-123	NE30-NE 27	44-60	8.9	115	0.7	11.8	14.0	< 0.5	< 0.5	22.9
C08071014-124	NWNW29 28	0-11	12.8	267	0.6	18.3	12.1	1.6	< 0.5	35.2
C08071014-125	NWNW29 28	14-27	11.6	165	0.6	14.6	12.3	1.4	< 0.5	23.8
C08071014-126	NWNW29 28	27-37	13.0	139	0.6	14.1	12.2	0.7	< 0.5	26.4
C08071014-127	NWNW29 28	37-48	11.0	118	0.6	13.0	12.7	0.6	< 0.5	20.4
C08071014-128	NWNW29 28	48-60	10	100	0.6	12.2	12.2	0.5	< 0.5	15.3
C08071014-129	NENW29 29	0-11	17.8	112	< 0.5	16.5	15.6	1.8	< 0.5	21.6
C08071014-130	NENW29 29	15-24	11.2	91.2	< 0.5	16.5	12.7	0.7	< 0.5	14.3
C08071014-131	NENW29 29	24-36	16.3	119	< 0.5	20.3	21.9	1.2	< 0.5	16.8
C08071014-132	NENW29 29	36-48	22.7	134	< 0.5	19.8	21.7	1.5	< 0.5	19.0
C08071014-133	NENW29 29	48-60	29.2	148	< 0.5	20.1	20.6	2.8	< 0.5	18.8
C08071014-134	SENW29 30	0-11	12.8	146	< 0.5	17.1	15.8	1.1	< 0.5	22.4
C08071014-135	SENW29 30	18-26	12.1	105	0.8	12.3	11.2	0.5	< 0.5	18.0
C08071014-136	SENW29 30	26-36	10.4	73.7	< 0.5	10.6	9.8	< 0.5	< 0.5	21.6
C08071014-137	SENW29 30	36-46	10.2	81.2	2.7	13.4	10.7	1.1	< 0.5	21.4
C08071014-138	SENW29 30	46-60	9.6	73.6	0.7	11.8	10.3	0.6	< 0.5	20.2
C08071014-139	SWNW29 31	0-11	14.0	130	< 0.5	14.0	17.8	1.4	< 0.5	16.7
C08071014-140	SWNW29 31	34-48	13.2	118	< 0.5	12.2	15.0	1.2	< 0.5	15.2
C08071014-141	SWNW29 31	48-60	15.8	194	< 0.5	16.9	18.2	1.4	0.5	15.7
C08071014-142	NWSW29 32	0-11	12.6	210	0.6	18.5	14.0	1.2	< 0.5	36.8
C08071014-143	NWSW29 32	5-18	11.3	245	0.6	17.8	13.5	1.6	< 0.5	29.8
C08071014-144	NWSW29 32	18-34	13.5	126	< 0.5	16.7	16.1	1.2	< 0.5	24.6
C08071014-145	NWSW29 32	34-48	12.1	138	< 0.5	18.3	21.4	1.9	< 0.5	18.6
C08071014-146	NWSW29 32	48-60	15.9	119	< 0.5	16.8	21.0	1.7	< 0.5	16.7
C08071014-147	NESW29 33	0-11	12.4	204	0.5	18.6	13.3	0.9	< 0.5	30.9
C08071014-148	NESW29 33	10-15	10.0	231	0.6	12.5	10.9	1.2	< 0.5	20.1
C08071014-149	NESW29 33	15-32	9.2	126	0.5	12.0	10.2	1.0	< 0.5	19.3
C08071014-150	NESW29 33	32-45	10	97.2	0.6	12.9	10.4	0.8	< 0.5	17.8
C08071014-151	NESW29 33	45-60	10.2	101	0.5	11.6	10.2	0.7	< 0.5	18.1
C08071014-152	SESW29 34	0-11	9.9	170	0.6	16.0	12.7	0.7	< 0.5	28.0
C08071014-153	SESW29 34	14-30	10.9	283	1.3	13.7	12.6	0.8	< 0.5	22.6
C08071014-154	SESW29 34	30-48	12.4	141	0.5	14.8	19.1	1.1	< 0.5	20.5
C08071014-155	SESW29 34	48-60	11.1	114	< 0.5	14.8	15.1	1.8	< 0.5	20.1
C08071014-156	SWSW29 35	0-11	23.0	821	0.8	15.4	14.2	2.2	< 0.5	32.5
C08071014-157	SWSW29 35	6-22	16.1	919	0.5	17.6	14.6	1.4	< 0.5	29.9
C08071014-158	SWSW29 35	28-54	11.2	338	0.5	17.7	14.6	1.4	< 0.5	27.7
C08071014-159	SWSW29 35	54-60	10.7	165	< 0.5	15.0	13.0	0.9	< 0.5	24.7
C08071014-160	SESE30 36	0-11	10	264	0.7	23.8	17.5	0.7	< 0.5	36.5

Dewey Land Application Area

LABORATORY ANALYTICAL REPORT

Client: Powertech (USA) Inc
Project: 548 Knight Piesold Dewey Burdock LAD
Workorder: C08071014

Revised Date: 11/07/08
Report Date: 11/04/08
Date Received: 07/22/08

		Analysis	As	Ba	Cd	Cr	Pb	Se	Ag	V
		Units	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry	mg/kg-dry
Sample ID	Client Sample ID	Depth	Results	Results	Results	Results	Results	Results	Results	Results
C08071014-161	SESE30 36	10-21	8.9	299	0.6	22.4	15.8	0.9	< 0.5	36.8
C08071014-162	SESE30 36	21-29	8.3	287	0.5	21.2	15.5	1.3	< 0.5	34.8
C08071014-163	SESE30 36	29-39	8.1	210	< 0.5	19.9	15.3	1.5	< 0.5	32.8
C08071014-164	SWSE30 37	0-11	9.5	194	< 0.5	17.6	14.0	0.7	< 0.5	32.3
C08071014-165	SWSE30 37	11-30	7.5	179	< 0.5	13.1	11.0	0.6	< 0.5	25.2
C08071014-166	SWSE30 37	30-40	6.9	421	< 0.5	10.3	9.6	< 0.5	< 0.5	22.9
C08071014-167	SWSE30 37	40-60	6.8	160	< 0.5	10.7	9.6	0.5	< 0.5	23.1
C08071014-168	NWSE30 38	0-11	9.2	188	< 0.5	15.4	13.4	0.7	< 0.5	32.2
C08071014-169	NWSE30 38	9-14	8.4	196	< 0.5	13.3	10.9	0.6	< 0.5	28.7
C08071014-170	NWSE30 38	14-30	9.3	307	< 0.5	10.1	9.3	0.6	< 0.5	22.1
C08071014-171	NWSE30 38	30-43	9.0	180	< 0.5	10.7	9.9	0.6	< 0.5	25.6
C08071014-172	NWSE30 38	43-60	9.6	212	< 0.5	12.5	11.2	0.6	< 0.5	25.9
C08071014-173	NESE30 39	0-11	9.9	190	< 0.5	15.5	13.1	0.8	< 0.5	36.5
C08071014-174	NESE30 39	12-30	8.7	170	< 0.5	14.5	12.5	1.2	< 0.5	31.8
C08071014-175	NESE30 39	30-40	8.5	260	< 0.5	14.1	11.8	0.7	< 0.5	23.2
C08071014-176	NESE30 39	40-54	7.5	199	< 0.5	12.2	10.6	0.6	< 0.5	22.2
C08071014-177	NESE30 39	54-60	7.2	134	< 0.5	10.8	9.8	0.6	< 0.5	18.1