3.14 Mineral Resources

Summary

This section summarizes geologic conditions, soil conditions, and impacts to geology, soils, and mineral resources along the Longmont corridor between Boulder and Longmont. Information was gathered on geology and soil settings, mineral resources, and problematic geologic and soil conditions that could affect design and implementation of the alternatives.

Geology and soil conditions that may require mitigation during construction include swelling and potentially heaving soil and bedrock, corrosive soils, collapsible and compressible low-strength soils, soil erosion, shallow groundwater, and seismic risk. In addition, mitigation may be required for changes produced during construction that impact geology and soils, including changes to the permeability of surficial materials, the depth to bedrock, slope stability, and susceptibility to erosion. Subsidence over abandoned mines is not a concern because the area is not undermined. Landslide susceptibility is not a major concern, although slumping of cutbanks and excavations is possible. Mineral resources that may require additional assessment include gravel, oil, and gas resources.

Affected Environment

Geology and soil conditions influence design and implementation of the transportation system. Mineral resources present potential conflicts with building and maintaining the transportation system.

Geology

The area of interest lies on the western flank of the Denver Basin. Rock layers generally dip gently toward the basin center, but dips may be steeper along folds or faults. The entire area is underlain by sedimentary bedrock of the Pierre Shale. Shale dominates this bedrock unit except in the Longmont area, where soft sandstone predominates. The Pierre Shale contains many layers of swelling clay minerals that cause structural damage by expanding when wet and shrinking when dry. Many soils overlying the bedrock also exhibit significant swell potential. Oil and gas are produced from the Pierre Shale and from underlying rock layers.

The Pierre Shale is overlain by a mantle of largely unconsolidated clay, silt, sand, and/or gravel deposited mainly by streams or wind. Alluvium in modern drainages and in ancient elevated terraces supply sand and gravel in the region. Depth to bedrock is typically between 3 and 20 feet, but varies rapidly within short lateral distances from surface exposures to at least 29 feet deep.

Depth to the water table varies over time and over short lateral distances. Seasons, weather events, and irrigation affect temporal variations. The permeability of surficial materials and bedrock, the proximity to natural and manmade water sources, and the proximity to faults and fracture zones affect lateral variations. Depth to the perennial water table ranges from zero to more than 30 feet, but typically is between 5 and 10 feet. Shallow perched water tables are common in some areas.

Soils

Soils across the area have developed on alluvium, windblown deposits, and shale to sandy bedrock. Many of the soils are susceptible to swelling, corrosivity, and/or frost action. Some of the soils are collapsible, and many are compressible and low strength. Some are highly to moderately susceptible to wind erosion. Most soils are deep, but bedrock lies 10 to 40 inches below some soils. Seasonal water tables are as shallow as 6 inches in some areas, and seasonal frequent brief flooding occurs.

Mineral Resources

Mineral resources in the project area include aggregate resources and oil and gas. Aggregate is present in the modern floodplains of St. Vrain Creek and parts of Left Hand Creek, as well as in ancient alluvium on widespread elevated terraces. Alluvium on modern floodplains and on the youngest of the ancient terraces provides the highest quality gravel. Gravel and sand, along with lesser amounts of boulders, cobbles, and clay, have been quarried from the floodplains of Left Hand and St. Vrain creeks in alluvium as much as 20 feet thick. Similar deposits exist at many locations along the Front Range.

The Longmont corridor traverses two active and three abandoned oil and gas fields and lies at the western flank of the active giant Wattenberg field. Production in each field is from Cretaceous rocks, typically at depths of 3,000 to 7,000 feet. New technology and regulatory policies have prompted increased oil and gas exploration and production in the region. Oil and gas resources may lie beneath the project area, but techniques such as directional drilling could be used to tap them.

Problematic Geologic and Soil Conditions

Physical or chemical properties of soil, bedrock, or surficial deposits may affect project design and construction. Problematic geologic and soil conditions include swelling and potentially heaving soil and bedrock, soil with high corrosivity and/or frost action, collapsible or compressible low-strength soil, soil susceptible to erosion, shallow groundwater, and seismic risk. Subsidence over abandoned mines is not a concern because the area is not undermined. Landslide susceptibility is not a major concern, although slumping of cutbanks and excavations is possible.

Swelling Soil and Bedrock – Swelling soil and bedrock are widespread across the Front Range. The potential for structural damage is great in areas with swelling bedrock less than 10 feet beneath the ground surface and/or with shallow fluctuating water tables. These conditions are common in the Longmont corridor.

Heaving Bedrock – Flat-lying layers of swelling bedrock tend to expand fairly uniformly, but steeply dipping layers with different swell potentials can heave unevenly, causing extreme structural damage. Most bedrock along the Longmont corridor is expected to be gently dipping, but areas of steeply dipping bedrock susceptible to heaving may be present along folds or faults.

Corrosive Soils and Frost Action – Most soils in the area can produce high concentrations of sulfate salts that can lead to corrosion of uncoated steel and concrete in moist conditions. Many of the soils are also susceptible to frost action. Shallow groundwater increases both corrosivity and frost action.

Collapsible Soils and Compressible Low-Strength Soils and Surficial Materials – Low-density soils can compact suddenly when they become wet. Windblown deposits are particularly susceptible to collapse. Many non-swelling clays and clay soils are soft and compressible when wet and exhibit low strength and differential settlement under light to moderate loads when moisture content is high.

Susceptibility to Erosion – Soils along streams are susceptible to erosion at high flow. Most area soils are susceptible to gully wash and sheet wash, particularly where unvegetated. Terrace slopes are highly susceptible to gully wash. Many area soils are susceptible to wind erosion.

Shallow Groundwater – Shallow groundwater increases the risk of flooding and increases problems associated with swelling soil and bedrock, corrosive soil, collapsible or compressible low-strength soil, frost action, and soil erosion. Depths of less than 10 feet to seasonal, perennial, and/or localized water tables are common in the project area. Buried irrigation dewatering pipes and unlined or leaking irrigation ditches contribute to localized high water tables in many places.

Faults and Seismicity – There are no known active faults within the project area. Colorado is in a moderate seismic risk area and could experience damaging earthquakes, but a U.S. Geological Survey risk assessment (USGS, 2006) indicates less than 10 percent probability in 50 years for peak ground acceleration exceeding threshold levels for damage to dwellings not built to resist earthquakes. Steep dips in swelling bedrock adjacent to faults increase the risk of bedrock heaving. Faults also can affect groundwater movement, which in turn can affect geologic conditions such as soil types and slope stability. An inactive fault zone runs along or close to the Longmont corridor between Boulder and Longmont and may help to direct the movement of local groundwater. The path of Left Hand Creek coincides with the fault zone from about a mile north of Niwot to near its confluence with St. Vrain Creek south of Longmont.

Subsidence Risk – The rock layers that were widely mined for coal and clay in other parts of Boulder County are not present between the cities of Boulder and Longmont. Therefore, subsidence over similar abandoned coal and clay mines is not a risk.

Longmont Corridor

In general, geology and soil conditions are similar across the Longmont corridor, as described above. Conditions that are distinctive for the City of Boulder, Boulder County, and the City of Longmont are summarized below.

City of Boulder – Pierre Shale bedrock is at or near the ground surface where alluvial and eolian deposits are thin or absent, notably between Fourmile Canyon Creek and the north edge of Boulder Reservoir. Depth to the water table is typically less than 5 feet in much of the area between Independence and Jay roads and in the lowlands between Lookout Road and SH 52. Areas close to Fourmile Canyon Creek are within the FEMA 100-year flood zone. Between Independence Road and Sixmile Reservoir, the corridor crosses the producing Boulder Oil Field. The closest identified fault suspected of quaternary activity is the Valmont Fault, at 75th Street and Valmont Road, approximately 3 miles east of the southern tip of the Longmont corridor. Additional faults and folds are present in the area, particularly near Boulder and in the area of Boulder and Sixmile reservoirs, but none are considered seismically active.

Boulder County – Young windblown sandy and silty deposits cover much of the area north of Left Hand Creek, but bedrock is exposed where the windblown deposits are thin or absent. Windblown deposits also cover the southeastern edge of the project area in Boulder County and most of the area between Left Hand Creek and St. Vrain Creek. Depth to the water table is typically less than 5 feet in the floodplains of Left Hand Creek and St. Vrain Creek, including much of the area between Ogallala Road and Hover Road. Areas close to Dry Creek No.2, Left Hand Creek, Dry Creek No.1, and St. Vrain Creek are within the FEMA 100-year flood zone. Sand or gravel may have been quarried from alluvium along both sides of Left Hand Creek between Niwot and Longmont. At Niwot, the Longmont corridor crosses between the abandoned Holland West oil field just to the northwest and the west flank of the giant producing Wattenberg gas field to the southeast. Immediately northeast of Niwot and continuing along the south edge of Longmont, the Longmont corridor passes through the producing Holland West gas field. The Colorado State Land Board Mineral Inventory (Cappa, et al., 2000) assigns commodity ratings of 1 out of 5 for oil and gas and 4 out of 5 for industrial minerals to a land tract in northwest Niwot; these ratings are based on nearby oil and gas production and on potential aggregate production from the same alluvial unit that stretches to the north edge of Boulder Reservoir.

City of Longmont – Young windblown sand and silt deposits cover most of the area north and east of St. Vrain Creek. Bedrock is at or near the ground surface on the north side of St. Vrain Creek. An area of man-made land just southeast of the Sugar Mill was produced by feeding a slurry of “lime” byproducts from sugar beet processing into low ground areas and burying them with local soil. The resulting land tends to be wet and very low strength. Depth to the water table in the floodplains of Left Hand and St. Vrain creeks is typically less than 5 feet, including much of the area along the BNSF tracks between Martin Street and County Line Road. Areas close to Left Hand Creek, Dry Creek No.1, and St. Vrain Creek are within the FEMA 100-year flood zone. Sand and gravel quarried at multiple locations along St. Vrain Creek are processed in ready-mix concrete, concrete product, and asphalt plants. Clay, claystone, and shale also have been quarried, and brick, tile, and pipe were produced near the northwest corner of the 9th Avenue/Hover Road intersection. Sand or gravel was also quarried from alluvium at the intersection of SH 119 and Hover Road. Overburden and underground clay were recently excavated for a project at the Fox Hills Country Club, but the site has been closed and reclaimed. Along the south edge of Longmont, the Longmont corridor passes through the producing Holland West gas field. In the vicinity of the Sugar Mill, it is adjacent to the abandoned Longmont oil field. The Colorado State Land Board Mineral Inventory (Cappa, et al., 2000) assigns a tract in southwest Longmont a commodity rating of 4 out of 5 for oil and gas based on past production and 4 out of 5 for industrial minerals for potential aggregate production from alluvial deposits equivalent to those that line both flanks of Left Hand Creek over most of its extent from Longmont westward.

Impact Evaluation

There is no significant distinction in geology, soils, or mineral resource impacts between Alternative A (Double Track to West) and Alternative B (Double Track to East). The geologic factors expected to present the greatest challenges to construction are shallow groundwater, swelling soils and bedrock, and low-strength soils. Changes initiated during construction, such as changing the permeability of surficial materials, changing the depth to bedrock, changing slope stability, or changing susceptibility to erosion, can alter geologic or soil conditions and lead to more extensive geologic or soil impacts. None of the geologic or soil conditions preclude building either of the rail alignments. No further indirect impacts were identified for geology, soils, or mineral resources.

Methodology

Geologic conditions and hazards along the Longmont corridor were identified using information from geologic, hydrologic, and soils maps, reports, and documents from the Colorado Geological Survey, the U.S. Geological Survey, the U.S. Department of Agriculture Natural Resources Conservation Service (USDA/NRCS), other governmental agencies, and geotechnical and engineering consulting firms. This information was supplemented with field reconnaissance and with discussions with City of Longmont engineering staff regarding soil conditions and the “lime” fill area near the Sugar Mill in Longmont.

No-Build Alternative

Under the No-Build Alternative, smaller ground areas would be affected than for the two alternatives. However, where grade separations or intersection redesigns are planned, the geologic and soil conditions are expected to be the same as for Alternative A and Alternative B.

Alternatives

There is no significant distinction in geologic or soil impacts between Alternative A and Alternative B.

Direct Impacts

Rail Alignment

Direct impacts associated with geology, soils, and mineral resources for the two alternatives include the potential loss of opportunity to mine or extract mineral resources, and unsatisfactory subgrade materials such as swelling soils and bedrock, corrosive soils, and collapsible or compressible low-strength soils, all amplified where shallow groundwater exists. The effects of these conditions can be altered by construction practices that change the permeability of surficial materials, the depth to bedrock, slope stability, and/or susceptibility to erosion. If unmitigated, the effects of geologic conditions, such as swelling bedrock, increase over time by cumulative effect. Seismic risk also is considered from a long-term perspective.

Station Areas

All station sites overlie the Pierre Shale. Surficial materials above the Pierre Shale are primarily alluvial sand and gravel and/or windblown sand and silt. These deposits vary from zero to more than 25 feet thick.

East and West Gunbarrel Sites – The alluvial and/or soil cover over the Pierre Shale bedrock is thin. Perennial water tables are typically at 5-10 feet beneath ground surface, but some locales have perched water tables and some areas are perennially wet at the surface. Several irrigation ditches cross the area. Frequent brief flooding and seasonally high water tables of 1-2 feet beneath the ground surface severely limit shallow excavation, as does depth to bedrock of 20 inches or less in some areas. Most soils have high to moderate swell potential and are highly to moderately corrosive. The soils are highly susceptible to frost action and are moderately susceptible to wind erosion. The Gunbarrel sites are approximately 3 miles from the Valmont Fault.

1st Avenue/Terry Street Site – The upper sandy zone of the Pierre Shale is covered with very thin veneers of alluvium to the south and windblown deposits to the north. The soils are highly corrosive. The perennial water table is typically 5-10 feet beneath the ground surface, but shallow perched water tables also are present. Seasonal water tables at 0.5-1.5 feet beneath the ground surface severely limit shallow excavation. Most soils have low to moderate swell potential. They are highly susceptible to frost action and are moderately to very highly susceptible to wind erosion.

Sugar Mill Site – The upper sandy zone of the Pierre Shale is exposed in the southwest half of the site and is covered by thin windblown deposits to the northeast and thin alluvium to the south. Most soils have high to moderate swell potential in the northeast part of the site and low to moderate swell potential elsewhere. Soils are highly to moderately corrosive across the area. Limitations to shallow excavation are moderate to severe in the northeast due to clay texture. Limitations are severe to the south due to frequent brief flooding and seasonal water tables from 0.5-4 feet beneath the ground surface. Shallow perched water tables are present locally. The area immediately north of the BNSF railroad tracks tends to be perennially wet. The water table south of the railroad tracks is generally 5 feet or less below ground surface. Most soils are moderately to highly susceptible to frost action. Some are moderately to very highly susceptibile to wind erosion. In the extreme southeast corner of the site is an area of “man-made land” produced from sugar-beet byproduct slurries buried with native surficial materials. The resulting soft fill, which is commonly wet, would require stabilization techniques such as geogrids and specialized fills before construction. Two wells were drilled on the site in the 1970s, one of which produced oil and gas for 6 years.

Layover/Storage Facilities

Front Range Community College Layover Site – The area is underlain by the Pierre Shale. Surficial materials include windblown deposits with collapsible and compressible low-strength soils. Swell potential is generally moderate. Some soils are highly corrosive. Groundwater is less than 3 feet to less than 10 feet beneath the ground surface. Limitations to shallow excavation are moderate to severe due to clay texture. The Colorado State Land Board Mineral Inventory (Cappa, et al., 2000) assigns the area a commodity rating of 1 out of 5 for oil and gas and 4 out of 5 for industrial minerals based on past oil and gas production and potential sand and gravel production.

BNSF Storage Track Layover Site – The area is underlain by the Pierre Shale. Surficial materials include windblown deposits with collapsible and compressible low-strength soils. Swell potential is generally low to moderate. Soils are highly to moderately corrosive and are highly susceptible to frost action. Groundwater is commonly 5-10 feet beneath the ground surface, with seasonal water tables at 2-4 feet beneath the ground surface. Away from the existing BNSF alignment, some areas are within the FEMA 100-year flood zone. Limitations to shallow excavation are moderate to severe due to flooding hazard and shallow water tables. Potential resources include floodplain sand and gravel, as well as oil and gas, which was produced in the past less than 1,000 feet from the site.

Indirect Impacts

No indirect impacts were identified for the geology, soils, or mineral resources within the Longmont corridor.

Conceptual Mitigation

Conceptual mitigation for the impacts described herein require following best engineering practices developed for the region over time. These measures include deep foundation systems, specialized piers and footings, subsurface drainage systems, and overexcavation with backfill of appropriate type, moisture content, and compaction to mitigate swelling or heaving soils and bedrock; geogrids, geotextiles, and appropriately engineered fills to mitigate low-strength compressible or collapsible soils; coated and resistant steel and concrete to mitigate corrosive soils; engineered fills, dewatering systems, and removal of buried agricultural tiles, where necessary, to mitigate high groundwater; slope cuts conforming to engineering guidelines for stability; shoring of slope cuts and shallow excavations; slope design, drainage systems, cover during construction, and prompt revegetation to combat erosion; and constructing in conformance with guidelines for stability in seismic events of expected magnitude. Table 3.14-1 describes the recommended conceptual mitigation measures for each of these problematic conditions under both alternatives.

TABLE 3.14-1
Proposed Conceptual Mitigation Measures – Mineral Resources

		Conceptual Mitigation Measures	
Impact	**Impact Type**	**Alternative A: Double Track to West**	**Alternative B: Double Track to East**
Swelling soil and bedrock	Construction	Engineering techniques such as the use of deep foundations, specialized piers and footings, overexcavation with moisture treatment and compaction of backfill, engineered or imported fill, subsurface drainage systems, and surface water diversions	Same as Alternative A
Heaving bedrock	Construction	Engineering techniques such as overexcavation with imported and/or engineered fill and groundwater control	Same as Alternative A
Collapsible soils and compressible low-strength surficial materials	Construction	Engineering techniques such as the use of geogrids, geotextiles, excavation and/or engineered fill, compaction, pre-construction flooding and/or loading, shoring of excavations, retaining walls, and drainage systems	Same as Alternative A
Corrosive soils and frost action	Construction and operation	Engineering techniques such as the use of coated and resistant steel and concrete and drainage systems	Same as Alternative A
Shallow groundwater	Construction and Operation	Engineering techniques such as modification of ground elevation, use of engineered fills, dewatering systems, and removal of buried agricultural pipes	Same as Alternative A
Faults and seismicity	Construction	Engineering techniques to ensure construction conforms to anticipated probable maximum seismic event	Same as Alternative A
Permeability of surficial materials	Construction	Engineering techniques such as drainage systems to appropriately direct surface water, runoff, and subsurface water	Same as Alternative A
Depth to bedrock	Construction	Engineering techniques to mitigate adverse bedrock conditions, stabilization slopes, appropriately route surface water and runoff, and protect areas susceptible to erosion	Same as Alternative A
Slope stability	Construction	Engineering techniques such as slope cuts for stability, shoring slope cuts and shallow excavations, and retaining walls	Same as Alternative A
Soil erosion	Construction and Operation	Engineering techniques such as drainage systems to appropriately direct surface water and runoff, slope design, covering during construction, and prompt and appropriate revegetation	Same as Alternative A

Source: Longmont Environmental Evaluation Team, 2006