



Soils and Geologic Resources Technical Report - I-270 Corridor Improvements Environmental Impact Statement

Federal Project No.: STU 2706-043

CDOT Project Code: 25611

Identification Number: FHWA-CO-EIS-24-001

July 2025



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Acronyms and Abbreviations

Acronym	Definition
bgs	below ground surface
BNSF	BNSF Railway
CDPHE	Colorado Department of Public Health and Environment
CDOT	Colorado Department of Transportation
EA	Environmental Assessment
EIS	Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
I-25	Interstate 25
I-270	Interstate 270
I-70	Interstate 70
I-76	Interstate 76
ITS	Intelligent Transportation Systems
mph	miles per hour
NEPA	National Environmental Policy Act
NRCS	Natural Resources Conservation Service
UPRR	Union Pacific Railroad
USGS	United States Geological Survey

1.0 Introduction

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The Federal Highway Administration (FHWA) and Colorado Department of Transportation (CDOT) are preparing an Environmental Impact Statement (EIS) to evaluate potential improvements to the Interstate 270 (I-270) corridor. FHWA and CDOT are the lead agencies for this National Environmental Policy Act (NEPA) process, which was initiated in 2020, initially anticipating an Environmental Assessment (EA). Moving into 2023, CDOT determined a more detailed environmental review was needed and requested that an EIS be prepared.

This technical report evaluates and documents potential impacts to and recommended mitigation measures for soils and geologic resources. It supports the analysis and conclusions in the EIS.

1.1 Project Description

I-270 in Colorado is a controlled-access interstate highway with two through lanes in each direction between Interstate 25 (I-25) and Interstate 70 (I-70) in central Denver and Commerce City (Figure). It has a posted speed limit of 55 miles per hour (mph). The project limits include the I-270 interchanges with Interstate 76 (I-76), York Street, Vasquez Boulevard, and Quebec Street. The project will tie into the I-25 and I-70 system interchanges but improvements to these interchanges are part of projects on I-25 and I-70 and will be designed and approved separately.

The purpose of the I-270 Corridor Improvements Project is to implement transportation solutions that modernize the I-270 Corridor to accommodate existing and forecasted transportation demands. The project needs are:

- Traveler safety on the corridor,
- Travel time and reliability on the corridor,
- Transit on the corridor,
- Bicycle and pedestrian connectivity across I-270, and
- Freight operations on the corridor.

In addition to addressing project needs, CDOT, FHWA, and Cooperating and Participating Agencies have established a key project goal: to minimize environmental and community impacts resulting from the project.

Figure 1. I-270 Corridor Improvements Project Limits



2.0 Alternatives

CDOT developed a range of potential alternatives for I-270 improvements. The alternatives ranged from no improvements to minimal infrastructure improvements without added highway capacity to alternatives that added one or two travel lanes in each direction, which could be operated as transit, general-purpose, or Express Lanes.

A two-level alternatives evaluation process was used to screen the alternatives based on the project's purpose and need and goal, and two build alternatives were carried forward for detailed analysis in the EIS:

- Three General-Purpose Lanes Alternative
- Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative

The No Action Alternative is also fully evaluated as a baseline for comparison.

Additional information on the alternatives development and evaluation process is included in the Alternatives Development Technical Report.

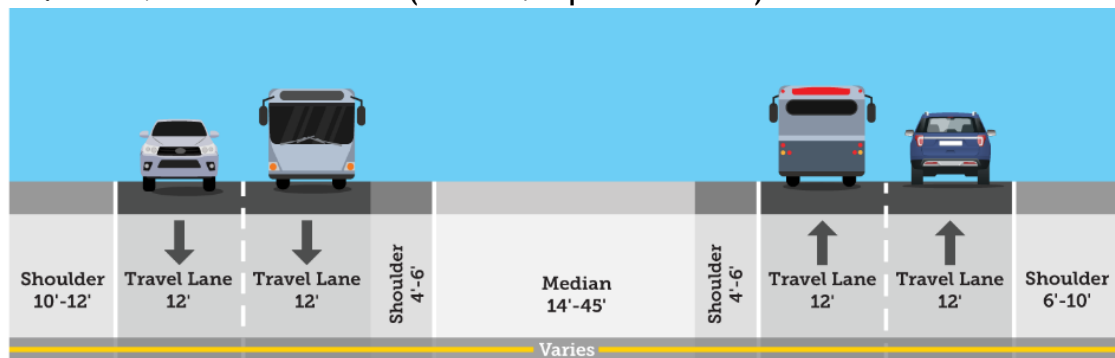
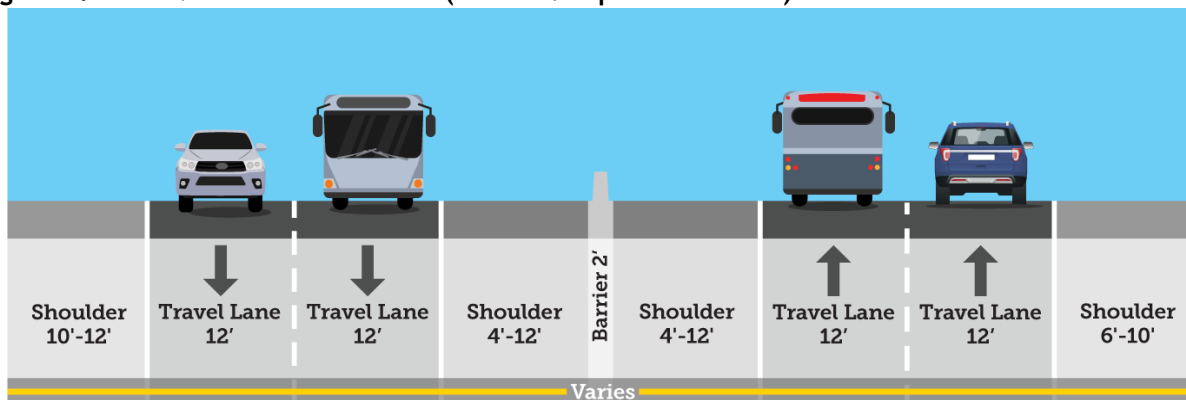
2.1 No Action Alternative

The No Action Alternative evaluates operations of I-270 if a build alternative would not occur along the corridor. It does not address the project Purpose and Need but is carried forward as a baseline for comparison. This alternative would maintain the existing highway configuration of two general-purpose travel lanes in each direction. Bridges and pavement would be maintained and repaired continuously, but underlying infrastructure deficiencies would remain.

The No Action Alternative would include substantial ongoing maintenance and the rehabilitation of 19 existing structures, including seven locations that have structures that are or will be reaching the end of their useful life. The age of the structure, recent bridge inspections, and current ongoing maintenance costs, both planned and emergency maintenance, determine if a structure is or will be reaching the end of its useful life. The seven structure locations along the I-270 corridor that are or will be reaching the end of their useful life are as follows:

- Vasquez Bridge over Sand Creek (E-17-AT)
- York Street Bridge over I-270 (E-17-IC)
- I-270 over South Platte River Eastbound and Westbound Bridges (E-17-IE & E-17-ID)
- I-270 over Burlington Ditch Eastbound and Westbound Bridges (E-17-IG & E-17-IF)
- I-270 over Brighton Boulevard, Union Pacific Railroad (UPRR) and BNSF Railway (BNSF) Eastbound and Westbound Bridges (E-17-II & E-17-IH)
- I-270 over 60th Avenue & BNSF Eastbound and Westbound Bridges (E-17-IK & E-17-IJ)
- I-270 over East 56th Avenue Eastbound and Westbound (E-17-IO & E-17-IN)

The cross section would remain unchanged along I-270 under the No Action Alternative. The No Action Alternative cross sections are shown on **Figure** and **Figure**.

Figure 2. No Action Alternative (west of Vasquez Boulevard)

Figure 3. No Action Alternative (east of Vasquez Boulevard)


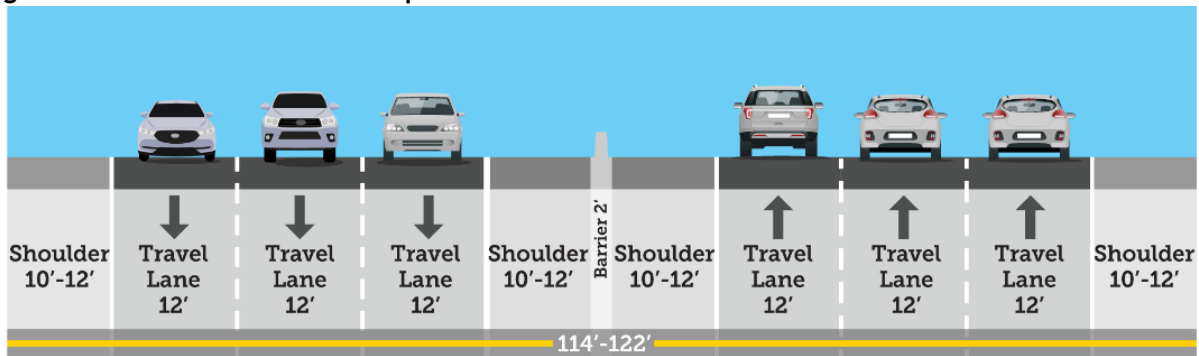
2.2 Build Alternatives

The build alternatives include improving the operational and physical conditions of the I-270 highway; reconfiguring interchanges and ramps; enhancing transit on the corridor; improving bicycle and pedestrian access across I-270; replacing deficient bridges and other infrastructure; and providing modern drainage, water quality, intelligent transportation systems (ITS), and other supporting infrastructure. Both add one new travel lane in each direction and have similar footprints, varying primarily how the additional travel operates.

2.2.1 Three General-Purpose Lanes Alternative

This alternative would reconstruct I-270 to provide three general-purpose lanes in each direction, as shown in Figure.

Figure 4. Three General-Purpose Lanes Alternative



This alternative includes:

Mainline Improvements

- Providing three general-purpose lanes in each direction
- Widening shoulders to meet current standards
- Restriping of the westbound I-270 to northbound I-25 off-ramp to provide dual-exit lane capacity
- Adding emergency turnouts and turnaround.
- Adding one continuous auxiliary lane in each direction between the I-76 and Vasquez Boulevard on-ramps and off-ramps

Interchange Improvements

- Adding an eastbound collector ramp to consolidate incoming movements from the I-76 on-ramps
- Separating the westbound I-270 York Street and I-76 off-ramps
- Improving the Vasquez Boulevard interchange design with improved westbound on-ramp acceleration lanes and the eastbound off-ramp deceleration lanes
- Improving the Quebec Street interchange ramp acceleration and deceleration lengths

Bridge Improvements

- Reconstructing bridges that are at, or will be reaching, the end of their useful life. Bridges carrying travel lanes on I-270 include widening to accommodate additional lanes
 - Replacing the existing York Street bridge over I-270 to meet current bridge standards, accommodate an additional travel lane in each direction on York Street, include a 10-foot multi-use path and a 5-foot sidewalk, and enhance lighting
 - Replacing the existing I-270 bridges over the South Platte River Trail to meet current bridge standards, accommodate this project's bicycle and pedestrian improvements on the South Platte River Trail, and enhance lighting
 - Replacing the existing I-270 bridges over the Burlington Ditch to meet current bridge standards, accommodate future bicycle and pedestrian improvements, and enhance lighting
 - Replacing the existing I-270 bridges over Brighton Boulevard to meet current bridge standards, accommodate this project's bicycle and pedestrian improvements on

- Brighton Boulevard and future bicycle and pedestrian improvements by others, and enhance lighting
- Replacing the existing I-270 bridges over East 60th Avenue and the BNSF crossing to meet current bridge standards, accommodate future bicycle and pedestrian improvements, and enhance lighting
- Replacing the existing I-270 bridges over East 56th Avenue to meet current bridge standards, accommodate this project's bicycle and pedestrian improvements, and enhance lighting
- Replacing the existing Vasquez Boulevard bridge over Sand Creek to meet current bridge standards and accommodate this project's bicycle and pedestrian improvements

Bicycle and Pedestrian Improvements

- Improving the York Street I-270 ramp terminal intersections with crosswalks, curb ramps, and pedestrian indicators at the ramp terminal traffic signals
- Adding a new 5-foot sidewalk on the west side and reconstructing a 6-foot sidewalk on the east side of Brighton Boulevard under I-270
- Reconstructing East 56th Avenue under I-270 and adding an on-street bicycle lane, a 10-foot multi-use path, and 6-foot sidewalk connecting to existing sidewalks
- Improving the intersection at East 56th Avenue and South Sandcreek Drive to include curb ramps, crosswalks, and lighting that meet current standards
- Improving the intersection at East 56th Avenue and Eudora Street to include curb ramps, crosswalks, and lighting that meet current standards
- Adding attached sidewalks on the west side of South Sandcreek Drive. The new sidewalks would be 8 feet wide from Quebec Street to East 47th Avenue Drive and 6 feet wide from East 47th Avenue Drive to East 49th Avenue, with a pedestrian crosswalk across East 47th Avenue Drive connecting the two segments
- Improving wayfinding at key locations, guiding bicyclists and pedestrians to the nearest RTD bus stops, major road connections, or distances to the next trailhead to avoid out-of-direction travel

Trail Improvements

- Reconfiguring the South Platte River Trail crossing under I-270 to improve bicycle and pedestrian visibility around tight curves and increase vertical clearance from the I-270 overpass
- Improving bicycle and pedestrian visibility on the Sand Creek Trail by straightening out tight curves, adding a center stripe, and enhancing lighting at the Vasquez Boulevard bridge over the Sand Creek Trail
- Adding a multi-use path with bicycle and pedestrian underpasses crossing under two free-flow interchange ramps on the east side of Vasquez Boulevard through the interchange with enhanced lighting
- Adding a multi-use path on the east and west sides of the Vasquez Boulevard bridge over Sand Creek, connecting users from the East 56th Avenue and Vasquez Boulevard intersection to a new connection to the Sand Creek Trail
- Adding a multi-use trail spur, connecting the proposed north-south Vasquez Boulevard multi-use trail to the East 56th Avenue and South Sandcreek Drive intersection

- Adding a multi-use path in the southeast corner of East 56th Avenue and South Sandcreek Drive
- Adding a 10-foot-wide bicycle and pedestrian overpass over I-270 and South Sandcreek Drive approximately halfway between East 56th Avenue and Quebec Street

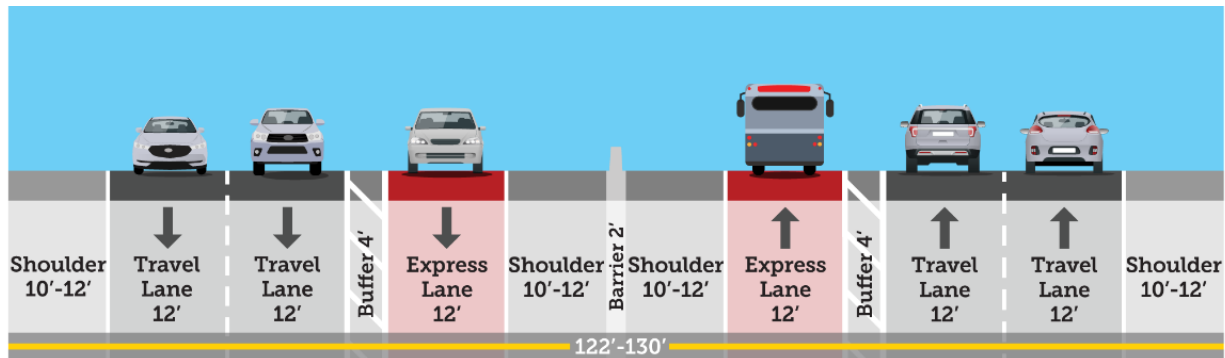
Transit Improvements

- Adding four new bus stops with connecting sidewalks and curb ramps on Quebec Street and South Sandcreek Drive near the I-270/Quebec Street interchange to improve access to RTD routes 88 and 37

2.2.2 Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative

This alternative would reconstruct I-270 with two general-purpose lanes and one Express Lane in each direction, as shown in Figure. Transit vehicles and high-occupancy vehicles (three or more people) could travel in the Express Lane, free of charge. Other travelers, including freight trucks, who choose to pay a fee could also use the new Express Lane.

Figure 5. Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative



This alternative includes:

Mainline Improvements

- Providing two general-purpose lanes and one Express Lane in each direction that accommodates transit
- Remainder of mainline improvements identified in the Three General-Purpose Lanes Alternative

Interchange Improvements

This alternative includes the same interchange improvements identified in the Three General-Purpose Lanes Alternative.

Bridge Improvements

This alternative includes the same bridge improvements identified in the Three General-Purpose Lanes Alternative.

Bicycle, Pedestrian, Trail, and Transit Improvements

This alternative includes the same bicycle, pedestrian, trail, and transit enhancements identified in the Three General-Purpose Lanes Alternative.

3.0 Context

There are no federal or state laws that apply specifically to geologic or soil resources. However, the CDOT NEPA Manual (2023, Version 7) requires this analysis to:

- Ensure that geologic/soil resources are identified and that their natural and economic values and visual aesthetics are protected,
- Identify potential negative impacts that the project could have on geology or soils, and
- Comply with CDOT's environmental stewardship policy which ensures that the statewide transportation system is constructed and maintained in an environmentally responsible, sustainable, and compliant manner.

4.0 Methods

The section describes the methods of data collection for soils and geology.

- A review of the United States Geological Survey (USGS) Geologic map of the Commerce City quadrangle, which includes parts of Denver and Adams Counties was conducted (Lindvall, 1980) to identify the geologic units in the study area.
- A review of the National Resources Conservation Service (NRCS) online Web Soil Survey was conducted to identify soil types in the study area.
- A review of the Federal Emergency Management Agency (FEMA) Earthquake Risk Index mapping was conducted to identify the risk for earthquakes in the study area.
- A review of the I-270 Corridor Improvements Modified Environmental Site Assessment technical report to identify if there are landfills in the area that might contribute to soils and geology impacts, such as differential settlement.

The study area for soils and geology includes the impact limits for the build alternatives that include both temporary and permanent impact areas needed to build the project (Figure and Figure). It includes complex and varied soil and ground conditions. Soil considerations and potential hazards include slope stability, expansive soils, differential settlement, erosion, presence of bedrock, hazardous materials, and flooding. Knowledge of these conditions is necessary for designing the project and being able to avoid potential hazard areas.

5.0 Existing Conditions

5.1 Surficial Soil

Surficial soils within the project area consist of 12 different soil units (Table) present on interfluvial, plains, floodplains, terraces, drainage ways, and gravel pits (NRCS, 2023). The soils are alluvial and eolian deposits and are present in various combinations in the project area. The NRCS has not published detailed soil information for the southern part of the project area to the south of Quebec Street in the City and County of Denver (NRCS, 2023).

Table 1. Summary of Surficial Soils in the Project Area

Soil Unit Descriptions	Typical Soil Profile	Parent Type
Ascalon Sandy Loam 0%-3% slopes: Well drained, occurs on interfluves.	0 to 6 inches: sandy loam 6 to 12 inches: sandy clay loam 12 to 19 inches: sandy clay loam 19 to 35 inches: sandy clay loam 35 to 80 inches: sandy loam	Wind-reworked alluvium and/or calcareous sandy eolian deposits
Blakeland Loamy Sand 3%-9% slopes: Somewhat excessively drained, occurs on plains.	0 to 9 inches: loamy sand 9 to 60 inches: sand	Alluvium derived from mixed and/or eolian deposits derived from mixed
Ellicott-Glenberg Complex 0%-3% slopes: Somewhat excessively drained, occurs on floodplains.	0 to 4 inches: sand 4 to 13 inches: sand 13 to 30 inches: sand 30 to 44 inches: sand 44 to 80 inches: coarse sand	Non-calcareous, stratified sandy alluvium
Loamy Alluvial Land, Moderately Wet: Somewhat poorly drained, occurs on drainageways.	0 to 6 inches: variable 6 to 36 inches: stratified loam to clay loam 36 to 60 inches: sand	Alluvium derived from mixed sources
Gravel Pits	0 to 6 inches: extremely gravelly sand 6 to 60 inches: extremely gravelly sand	Not specified
Nunn Clay Loam 0%-1% slopes: Well drained, occurs on terraces.	0 to 6 inches: clay loam 6 to 10 inches: clay loam 10 to 26 inches: clay loam 26 to 31 inches: clay loam 31 to 47 inches: loam 47 to 80 inches: loam	Pleistocene aged alluvium and/or eolian deposits
Nunn Clay Loam 1%-3% slopes: Well drained, occurs on terraces	0 to 9 inches: clay loam 9 to 13 inches: clay loam 13 to 25 inches: clay loam 25 to 38 inches: clay loam 38 to 80 inches: clay loam	Pleistocene aged alluvium and/or eolian deposits
Terrace Escarpments: Terraces	0 to 3 inches: gravelly sand 3 to 60 inches: gravelly sand	Alluvium derived from mixed
Truckton Sandy Loam 1%-3% slopes: Well-drained, occurs on plains.	0 to 9 inches: sandy loam 9 to 21 inches: sandy loam 21 to 32 inches: loamy sand 32 to 60 inches: coarse sand	Eolian deposits derived from mixed
Truckton Sandy Loam 5%-9% slopes: Well-drained, occurs on plains.	0 to 9 inches: sandy loam 9 to 21 inches: sandy loam 21 to 32 inches: loamy sand 32 to 60 inches: coarse sand	Eolian deposits derived from mixed



Vona Sandy Loam 0%-1% slopes: Well drained, occurs on plains.	0 to 9 inches: sandy loam 9 to 22 inches: sandy loam 22 to 60 inches: loamy sand	Eolian sands
Vona Sandy Loam 1%-3% slopes: Well drained, occurs on plains.	0 to 9 inches: sandy loam 9 to 22 inches: sandy loam 22 to 60 inches: loamy sand	Eolian sands

Figure 6. Soil Units (West Section of I-270 Corridor)

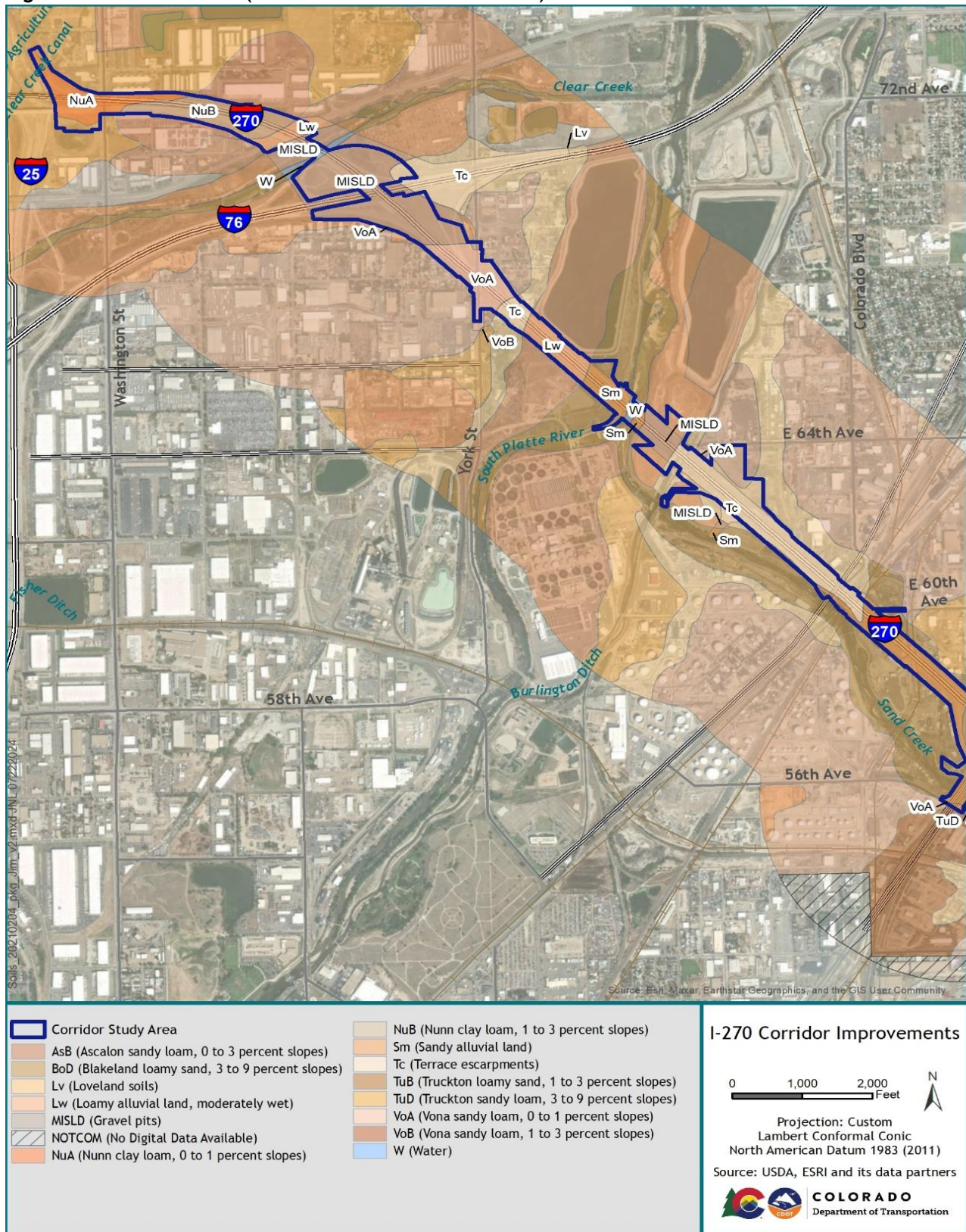
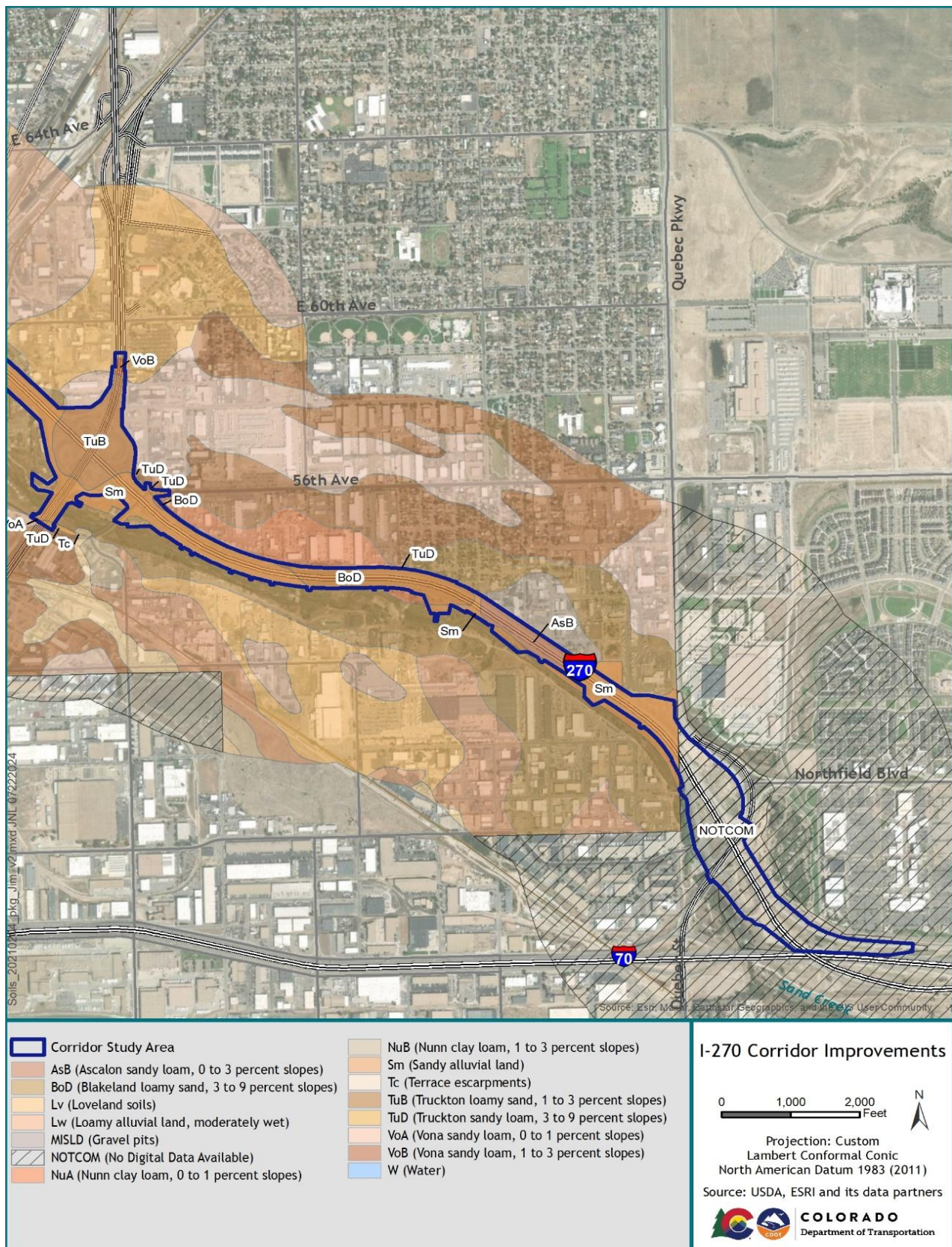


Figure 7. Soil Units (East Section of I-270 Corridor)



5.2 Regional Geology

The entire project lies within the Commerce City map quadrangle, and the corresponding 7.5-minute geologic map was used to review the geological context of the project (Lindvall, 1980). Surficial geology in the project area consists of seven units present in various combinations (Table). The bedrock underlying the project area is classified as the Denver and Arapahoe Formations of the Upper Cretaceous Age (Lindvall, 1980). This formation consists of brown, yellowish-brown, gray, and blue-gray interbedded sandstone, claystone, siltstone, shale, and conglomerate.

Table 2. Summary of Geological Units in the Project Area

Geological Unit Name	Geological Unit Descriptions
Artificial Fill	Human-made unit, clay, silt, sand, gravel and a variety of debris consisting of concrete, brick, wood, metal, plastic, glass, vegetation, and other trash. Includes engineered and compacted fill for highways, buildings, and bridge abutments; engineered and semi-engineered fill for dams, canals, and railway embankments; stream channelization dikes; sanitary landfills; and uncompacted materials in local rubbish dumps. May also include smelter slag waste deposits.
Holocene-age Post-Piney Creek alluvium	Light- to dark-grayish-brown clay, silt, sand, and small amounts of gravel. Areas of dark-brown and dark-bluish-black humic (organic) bog clays are interbedded in places with sand and silt.
Holocene-age Piney Creek alluvium	Brown, light-brown, light- to dark-gray, interbedded sand, silt, and clay. Generally, well stratified. Humic materials common in upper one to two feet; interbedded gravel in lower part.
Pleistocene-age Louviers alluvium	Reddish- to yellowish-brown pebbly arkosic sand, coarse sand, cobble gravel, and a few boulders.
Pleistocene-age Slocum alluvium	Brown to reddish-brown, well-stratified pebbly clay, silt, sand, and gravel. A few scattered cobbles and boulders.
Pleistocene-age Broadway alluvium	Pink to light brown, generally well-stratified sand and gravel in well-defined terraces on the east side of the South Platte River valley.
Pleistocene-age and Holocene-age eolian sand	Fine, light-brown sand, sandy silt, and clay.

5.3 Surface Water

Sand Creek flows northwest along the western side of I-270 before joining the South Platte River in the northern portion of the study area. Clear Creek flows northeast under I-270 near the northern terminus of the study area before intersecting with the South Platte River. The South Platte River flows north, under, and perpendicular to I-270 and near the center of the study area. The South Platte River is a highly manipulated stream, subject to altered flow regime because of water diversions; storage projects (Cat Lake and Miller Reservoir); treatment facilities; residential, commercial, and industrial use; and urban runoff.

The study area contains many roadside ditches, swales, and stormwater detention basins associated with runoff and drainage from I-270 and adjacent infrastructure. Other sources of hydrology include stock ponds, stormwater runoff occurring as sheet flow across the interstate, and stormwater directed into permanent water quality features. Based on the information provided by both the Mile High Flood District and FEMA, portions of the project study area near Clear Creek, Sand Creek, and the South Platte River floodways are within the 100-year and 500-year floodplain.

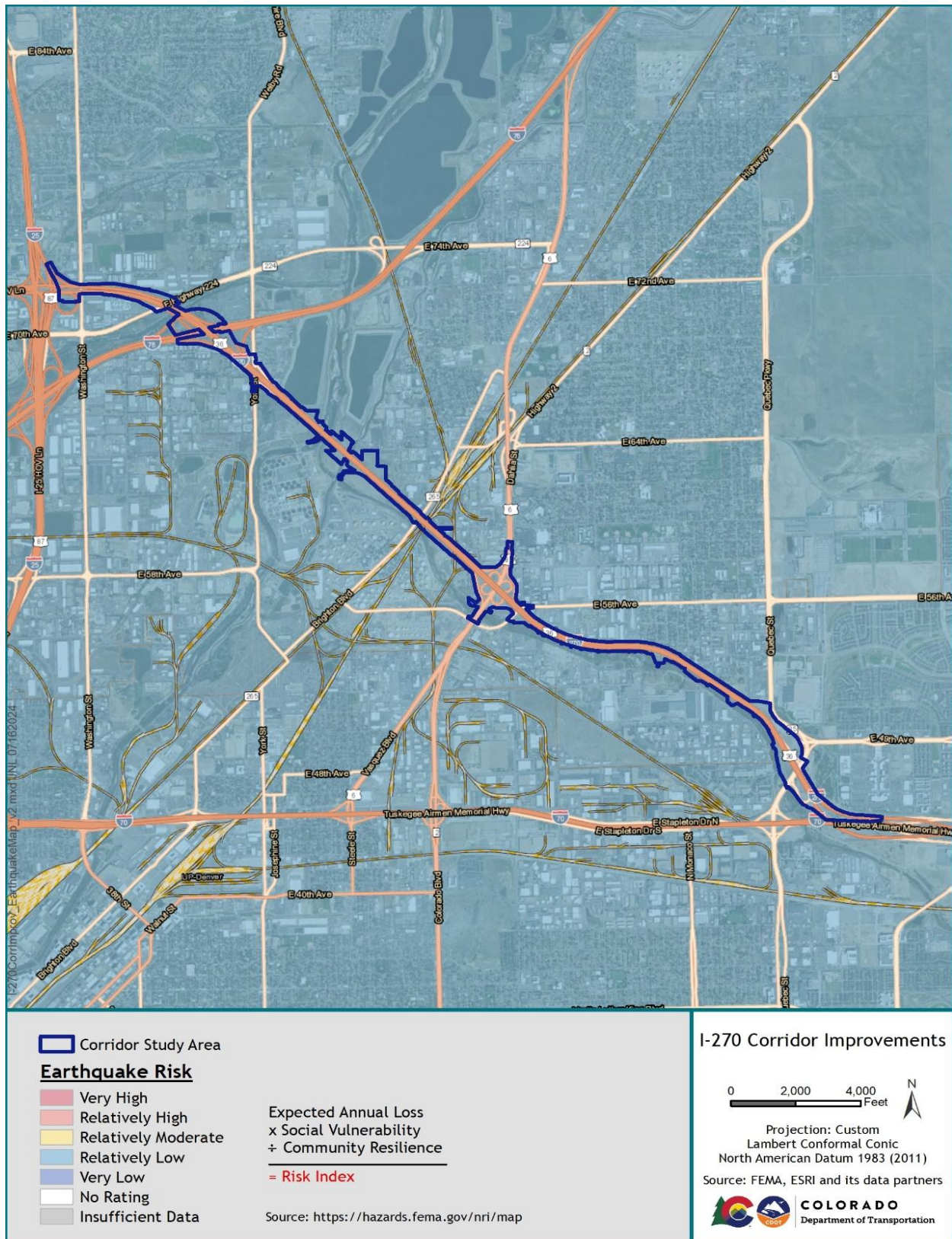
5.4 Regional Hydrology

Water table conditions in the project area are predominantly in unconsolidated alluvial deposits and depth to groundwater is assumed to be between 5 feet and 20 feet below ground surface (bgs) (Hillier, et. al., 1983). Soil borings completed in support of various investigations within the vicinity have confirmed groundwater elevation of shallow groundwater in the project area occurs between 5 feet to 30 feet bgs. Typically, shallow groundwater flow direction mimics topography and is influenced by adjacent waterways. In general, groundwater flow in the project area is north, but may locally be to the northeast or northwest. Sand Creek, which runs adjacent to the south of the majority of the project area, is classified as a perennial stream. Sand Creek does not act as a hydrological barrier for groundwater movement, and groundwater has been shown to transport contaminants from the southside of Sand Creek across Sand Creek to the north. See the I-270 Corridor Improvements Modified Environmental Site Assessment tech report for additional detail regarding groundwater and contamination movement.

5.5 Geologic Hazards

Colorado is in a region that has minimal earthquake activity. The only major earthquake recorded in Colorado occurred in 1882. Since the 1882 earthquake, there has been little seismic activity within the 200-mile radius around Denver. Tremors occurred in Denver between 1962 and 1967 within the vicinity of the Rocky Mountain Arsenal National Wildlife Refuge, and a minor earthquake occurred in 1994 south of Castle Rock. Tremors at the arsenal refuge have been attributed to pumping fluid into a deep injection well (van Poolen and Hoover, 1970). FEMA has determined the risk of earthquakes in the study area as relatively low risk (Figure). FEMA defines exposure to earthquakes as “the representative value of buildings (in dollars), population (in both people and population equivalence dollars), or agriculture (in dollars) potentially exposed to a natural hazard occurrence.”

Figure 8. Earthquake Risk Index



5.6 Landfills

Numerous areas along the corridor were identified as historic landfill/solid waste disposal areas. These artificial fill areas may impact the geotechnical aspect of the project through differential settling or other geotechnically compromised subgrade materials. See the I-270 Corridor Improvements Modified Environmental Site Assessment for more information on the landfills identified.

5.7 Underlying Geology

The entire study area lies within the USGS Commerce City map quadrangle, and the corresponding 7.5-minute geologic map was used to review the geological context of the project. The study area is heavily urban and previously disturbed from prior construction efforts, with appropriate landscaping on slopes. Therefore, exposed bedrock is not common throughout the study area. The study area is underlain by the following units (Figure and Figure).

5.7.1 Artificial Fill

Artificial fill includes clay, silt, sand, gravel, and a variety of debris consisting of concrete, brick, wood, metal, plastic, glass, vegetation, and other trash. It includes engineered and compacted fill for highways, buildings, and bridge abutments; engineered and semi-engineered fill for dams, canals, and railway embankments; stream channelization dikes; some sanitary landfills; and uncompacted materials in local dumps. The thickness is generally between 5 feet and 20 feet, but some dams and embankments are as much as 30 feet thick.

In this area, the permeability of artificial fill deposits is variable; it is generally low in dams and highway fills, commonly high in trash dumps, and probably high laterally in sanitary landfills. The water table is generally low in highway and railway embankments, variable in dams, dikes, and canal embankments, and generally high in dumps and landfills in Clear Creek, Sand Creek, and the South Platte River valleys. Excavation using equipment varies from easy to difficult. Foundation stability conditions may be poor in landfill areas; concrete piers extending to suitable underlying material or bedrock are probably necessary for heavy structures. Resistance to erosion by running water is moderate on slopes, consisting of compacted fills protected by vegetation, but very poor where slopes are unprotected (Lindvall, 1980).

5.7.2 Holocene Piney Creek Alluvium

This alluvium consists of brown, light brown, light- to dark-gray interbedded sand, silt, and clay. It is generally well-stratified, humic material common in the upper 1 foot to 2 feet with interbedded gravel in the lower part. The upper part is generally finer grained than the lower part. The thickness is generally between 5 feet and 10 feet.

Permeability is mainly low but may be somewhat higher in the sandy portion of the alluvium. The water table generally is 5 feet to 15 feet bgs, but may be deeper, especially during the fall and winter. Excavation is easy by using equipment. Foundation stability conditions are fair to poor, and clayey parts of this unit may swell moderately when wet. Cut slopes may stand vertically for extended periods if dry, but eventually will slump to stable slopes of

approximately 3:1 to 6:1. The deposits are subject to moderate erosion, particularly along streambanks and to gully erosion on terrace surfaces (Lindvall, 1980).

5.7.3 Post-Piney Creek Alluvium

This alluvium is light to dark grayish-brown clay, silt, sand, and small amounts of gravel. Dark brown and dark bluish-black, humic bog clays are interbedded in places with sand and silt. These are deposits forming floodplains in the majority of streams, with a high proportion of silt and sand. It is mapped primarily in Clear Creek and Sand Creek, but thin deposits are present in most minor tributary stream valleys. The thickness can be up to 5 feet.

Permeability of the alluvium is medium to low, particularly in clay and silt. The water table is commonly high in the Clear Creek, Sand Creek, and the South Platte River valleys, particularly in spring and early summer. Excavation is easy by using equipment. Foundation stability conditions are fair to good, except on bog clay or near stream channels where conditions are extremely poor. Cut slopes may stand vertically for short periods of time after excavation or when dry but will eventually slump to slopes of approximately 3:1. The alluvium is moderately resistant to erosion, particularly if protected by vegetation (Lindvall, 1980).

5.7.4 Holocene and Pleistocene Eolian Sand

This sand contains light-brown fine sand, sandy silt, and clay. In some localities, it contains large amounts of clay and silty clay. The thickness is generally less than 10 feet but locally may be as much as 30 feet thick.

Deposits are very permeable, and surface drainage is generally good. The water table is usually low. Sand deposits are easily excavated by using hand tools. For short periods after excavation, when the moisture content is moderately high, eolian sand may stand in vertical walls as high as 10 feet. Walls of trenches may collapse if not supported with shoring. Eolian sand is not subject to swelling when wet. Natural slopes as much as 3:1 are usually stable. Resistance to erosion is low on steep slopes and cut banks and is moderate to high in flat areas, owing to high permeability (Lindvall, 1980).

5.7.5 Pleistocene Broadway Alluvium

The Pleistocene Broadway Alluvium is pink to light brown, generally well-stratified sand and gravel in well-defined terraces on the eastside of the South Platte River valley. The upper 2 feet to 3 feet is commonly a clayey to pebbly silt. The thickness can be as much as 15 feet.

Permeability of the alluvium is moderate to high. The water table is usually 10 feet or more bgs. Excavation is generally easy by using light equipment; in places, hand tools are sufficient. Foundation stability conditions are good to excellent. Slope stability is reasonably good. Cut slopes 5 feet to 10 feet high may stand vertically for short periods after excavation, but shoring is mandatory in construction operations. Natural slopes of 2:1 are generally stable and are moderately resistant to erosion, particularly when protected by vegetation (Lindvall, 1980).

5.7.6 Pleistocene Louviers Alluvium

The Pleistocene Louviers Alluvium is reddish to yellowish-brown pebbly arkosic sand, coarse sand, cobble gravel, and a few boulders. It includes lenticular masses of silt and clay. The coarse granular materials are stained and cemented locally by manganese and iron oxides, contain abundant mica, and generally are cross bedded. Many exposures are in pits, excavated in younger alluvial deposits. The thickness is commonly 15 feet to 20 feet in terrace deposits along the South Platte River; and the thickness can be as much as 25 feet to 35 feet in the Clear Creek and South Platte River valleys.

Permeability is generally very high, and the water table generally is within 10 feet to 15 feet of the surface in the Clear Creek and South Platte River valleys. The alluvium is easily excavated by using equipment. Foundation stability conditions are good. Cut slopes may stand vertically for short periods of time following excavation but will eventually slump to stable slopes of approximately 3:1 to 4:1. Shoring is usually necessary in trenches and excavations. The alluvium is moderately resistant to erosion on gentle slopes but is subject to undercutting of banks by running water (Lindvall, 1980).

5.7.7 Pleistocene Slocum Alluvium

The Pleistocene Slocum Alluvium is brown to reddish-brown, well-stratified pebbly clay, silt, sand, and gravel, with a few scattered cobbles and boulders. The deposits generally grade transitionally downward from clay to silt and sand to gravel. A strongly developed calcium carbonate-enriched zone occurs in the upper part. This alluvium occurs primarily on the terrace south of Clear Creek and west of the South Platte River. The thickness is generally 10 feet to 15 feet.

Permeability is high in sand and gravel, but generally low in silty and clayey sand. The water table is usually between 10 feet and 20 feet bgs in the gravelly part of the alluvium. Excavation is usually easy with equipment. Foundation stability conditions are good to excellent; however, moderate swelling is possible in the clayey upper part, and such swelling pressures may be sufficient to crack concrete slabs, sidewalks, and driveways. Vertical cuts of 8 feet to 10 feet high are generally stable for several months after excavation but subsequently may slump to slopes from 2:1 to 4:1. It is moderately resistant to erosion, particularly when the slopes are protected by vegetation (Lindvall, 1980).

5.7.8 Paleocene and Upper Cretaceous Denver and Arapahoe Formations

The Upper Cretaceous Denver and Arapahoe formations are brown, yellowish-brown, gray, and bluish-gray interbedded sandstone, claystone, siltstone, shale, and conglomerate. Cross bedded and lenticular units are common throughout the formations. Olive-brown andesitic sandstone beds are diagnostic of the Denver Formation. The lower conglomerate member of the Arapahoe Formation is generally water bearing. Note that, it can be difficult to predict the exact depth at which the Denver Formation occurs below the surface, because its contact with overlying more recent units tends to be extremely variable. Depth can be estimated from geotechnical surveys or existing well data, but an exact depth often cannot be given until excavation reaches the unit. The thickness was 785 feet as reported in a well log from northeastern Commerce City.

Permeability is moderately high in sandstone and conglomerate beds and very low in shale, siltstone, and claystone beds. The depth to the water table is variable; the conglomerate at the base of the Arapahoe Formation is usually water bearing and a fair source of water for small wells. Equipment is necessary for excavating in sandstone and conglomerate and locally may require the use of explosives. Foundation stability conditions are generally good in sandstone and conglomerate, but groundwater seepage may be a problem locally; some of the shale, claystone, and siltstone units have very high swelling properties. Where the units contain high-swelling clays, concrete foundation piers supporting houses and other buildings should extend down through the near-surface zone of fluctuating groundwater saturation and penetrate several feet into the zone of permanent groundwater saturation. There, wet clays are permanently swollen to their maximum expansion. The water table generally reaches its highest level in early summer and is at its lowest level in October. Slope stability is good to excellent; excavations in sandstone and conglomerate beds generally stand in vertical walls, but excavations in shale, siltstone, and claystone beds typically weather after a few months and slump to 1:1 or 2:1 slopes. Resistance to erosion by running water is moderate to excellent (Lindvall, 1980).

Figure 9. Local Geologic Units (West Section of I-270 Corridor)

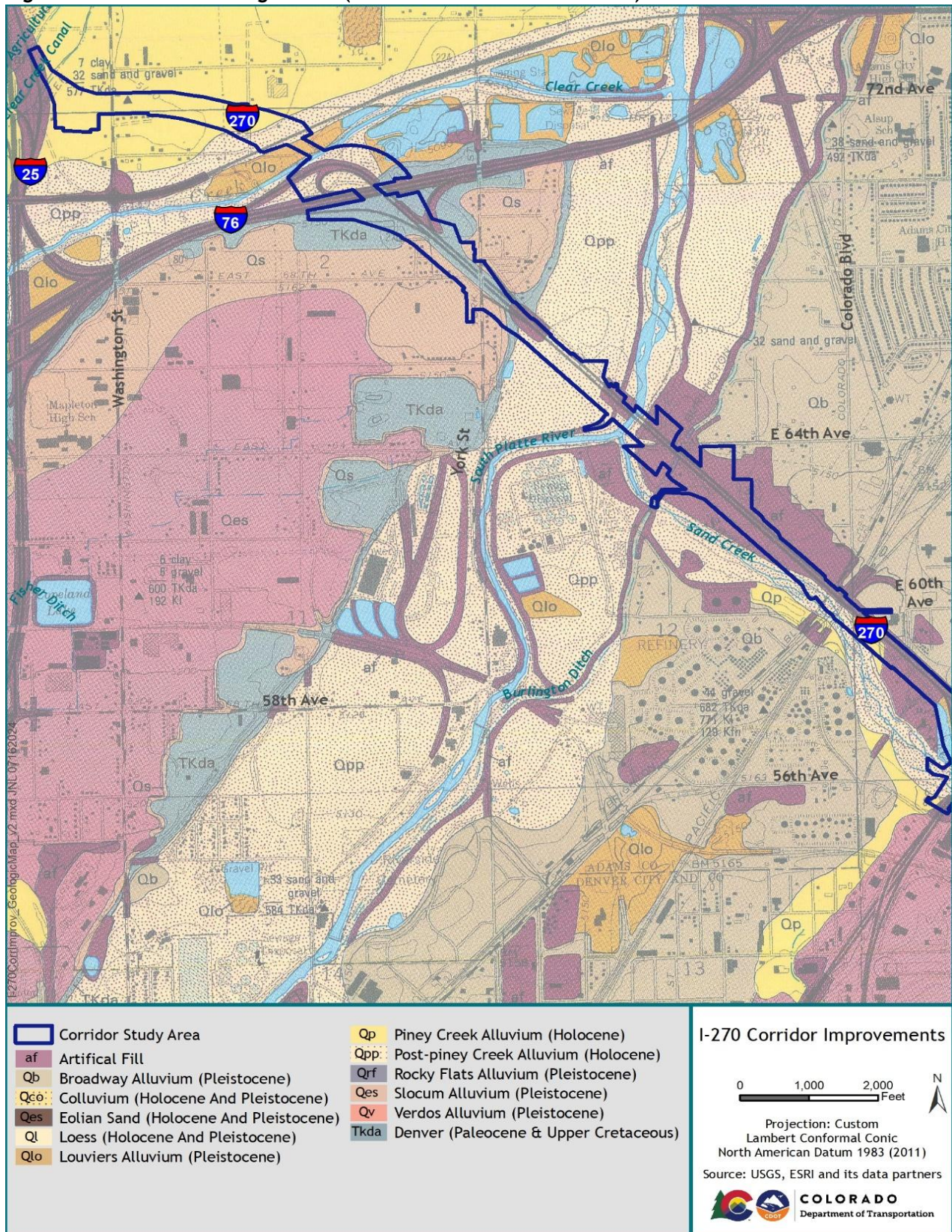
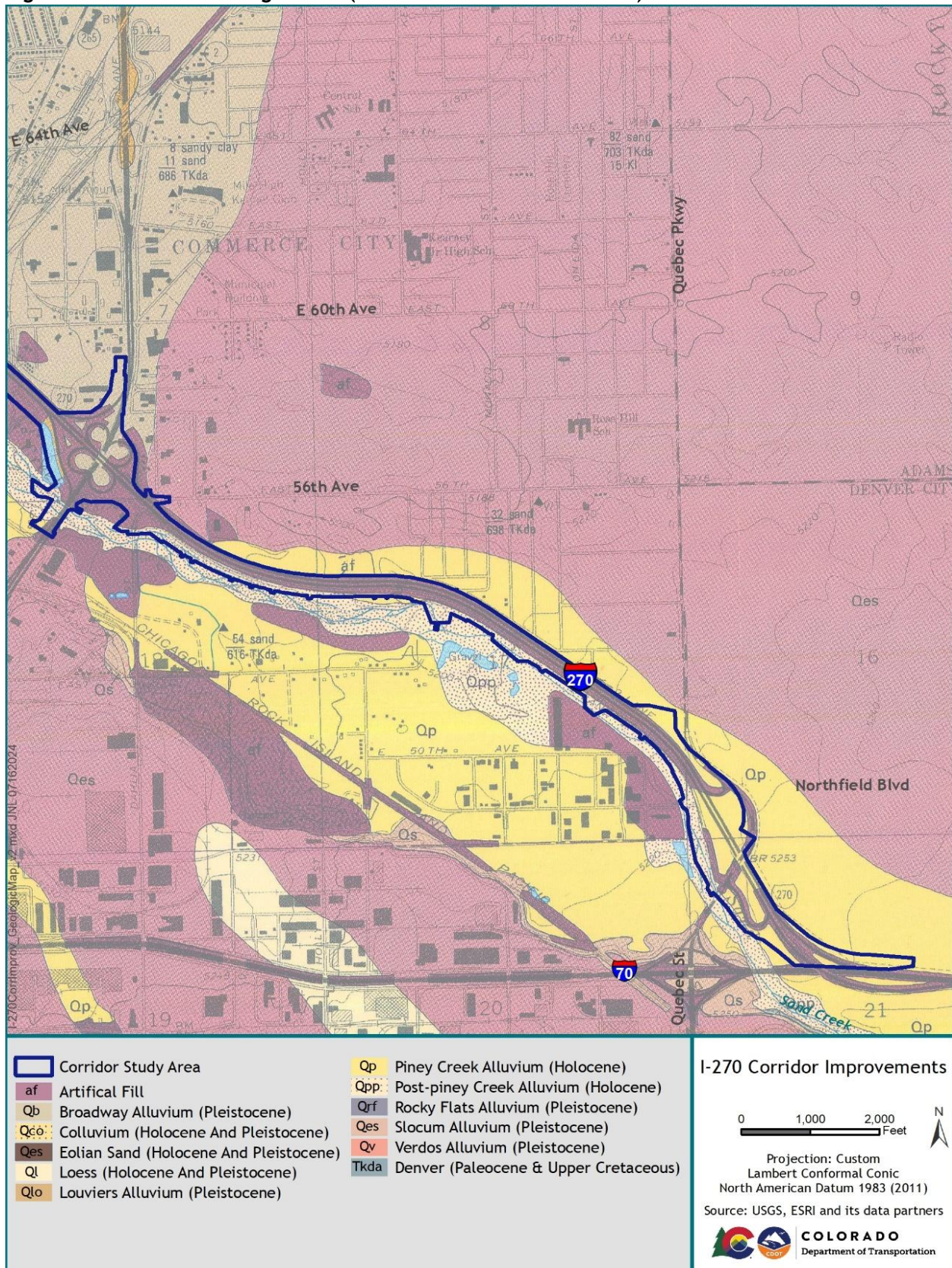


Figure 10. Local Geologic Units (East Section of I-270 Corridor)


6.0 Impacts Assessment

6.1 No Action Alternative

The No Action Alternative is the condition where CDOT would not proceed with a build alternative. The No Action Alternative includes ongoing highway and bridge maintenance and isolated pavement reconstruction. Ongoing maintenance includes work CDOT routinely performs on I-270 as part of its maintenance program, such as mill and overlay, crack sealing, maintenance of bridge, drainage and water quality structures, and guardrail replacement or repair as warranted.

The No Action Alternative includes ongoing highway and bridge maintenance and isolated pavement reconstruction of I-270. Since the No Action Alternative will not address the structural integrity issues on I-270, differential settling will continue to occur.

6.2 Three General-Purpose Lanes Alternative

Construction of the I-270 Three General-Purpose Lanes Alternative would require excavation and subsurface drilling for potential bridge/overpass construction, noise walls, and/or signs, and lighting. Grading activities could range from 2 feet to 4 feet deep, while drilling activities could extend up to 60 feet to 80 feet deep. Groundwater may be encountered during bridge construction or in areas where deep foundations may be necessary (e.g., deep retaining wall and/or pedestrian bridge foundations). Depths to groundwater vary highly throughout the study area, but groundwater will likely be encountered during construction.

Construction would occur where existing differential settlement occurs due to the proximity to landfills. Additional activities in these areas may further exacerbate differential settling that exists on I-270.

6.3 Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative

The Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative will have the same impacts as the Three General-Purpose Lanes Alternative.

7.0 Mitigation Measures

Table 3 shows a summary of the impacts and mitigations for the Build Alternatives. No mitigation measures are recommended for the No Action Alternative.

Table 3. Summary of Impacts and Mitigation - Build Alternatives

Activity Triggering Mitigation	Location of Activity	Impact	Mitigation	Responsible Branch	Timing/Phase that Mitigation will be Implemented
Construction/excavation near landfills	All locations where existing differential settling occurs	Potential to exacerbate the issue	CDOT and the contractor will develop a mitigation plan to address differential settling that exists today and reduce the potential for it to occur in the future. If additional delineation of the landfill boundary is needed prior to developing the mitigation plan, consider including a full geophysical survey along the route in the post-NEPA design process using techniques such as seismic, ground penetrating radar, or other techniques.	CDOT Engineering and Contractor	Pre-Construction and Construction
Excavation and drilling activities	All locations where groundwater/ infiltration water is generated, and dewatering is required	Potential to encounter groundwater during construction	A Colorado Discharge Permit System - Construction Dewatering Permit will be obtained from the CDPHE - WQCD and requirements will be followed.	CDOT Engineering and Environmental, and Contractor	Pre-Construction and Construction

8.0 Required Permits and Coordination

Table 4 lists the permits and coordination required for soils and geology.

Table 4. Required Permits and Coordination by Agency and Project Phase

Agency	Permit/Coordination	Phase
Colorado Department of Public Health and Environment (CDPHE), Water Quality Control Division	Colorado Discharge Permit System Permit, Construction Dewatering Permit	Construction

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