## 5.17 Geology and Soils

*This section discusses the geologic and soil resources in the study area. The impacts of the project alternatives on these resources also are evaluated and proposed mitigation measures are discussed to offset any potential adverse effects.*

### 5.17.1 What are geology and soil resources and why are they important to this project?

Geology includes complex and varied soil and ground conditions in the study area. The analysis of a geologic resource must include:

- Reviewing the stability of geologic features
- Researching earthquake history in the area
- Identifying any areas of high groundwater levels
- Examining the erosion potential
- Identifying possible excavation problems

Soil considerations and potential hazards include slope stability, expansive soils, differential settlement, erosion, presence of bedrock, high groundwater levels, and flooding.

These resources are important to consider during the planning of projects since they may require design changes.

### 5.17.2 Have there been any changes to geology and soils in the study area or to the analysis process since the release of the 2008 Draft EIS?

The geology and soil resources and the analysis process for these resources have not changed since the release of the 2008 Draft EIS. Geologic characteristics and soil types in the study area have not changed and are described in the 2008 Draft EIS. The impacts with the No-Action Alternative and the Revised Viaduct Alternative remain the same as discussed in the 2008 Draft EIS. The Partial Cover Lowered Alternative, which was not discussed in the 2008 Draft EIS, may create new impacts to geology and soil resources, and is discussed in this document.

### 5.17.3 What study area and process was used to analyze impacts to geology and soil resources?

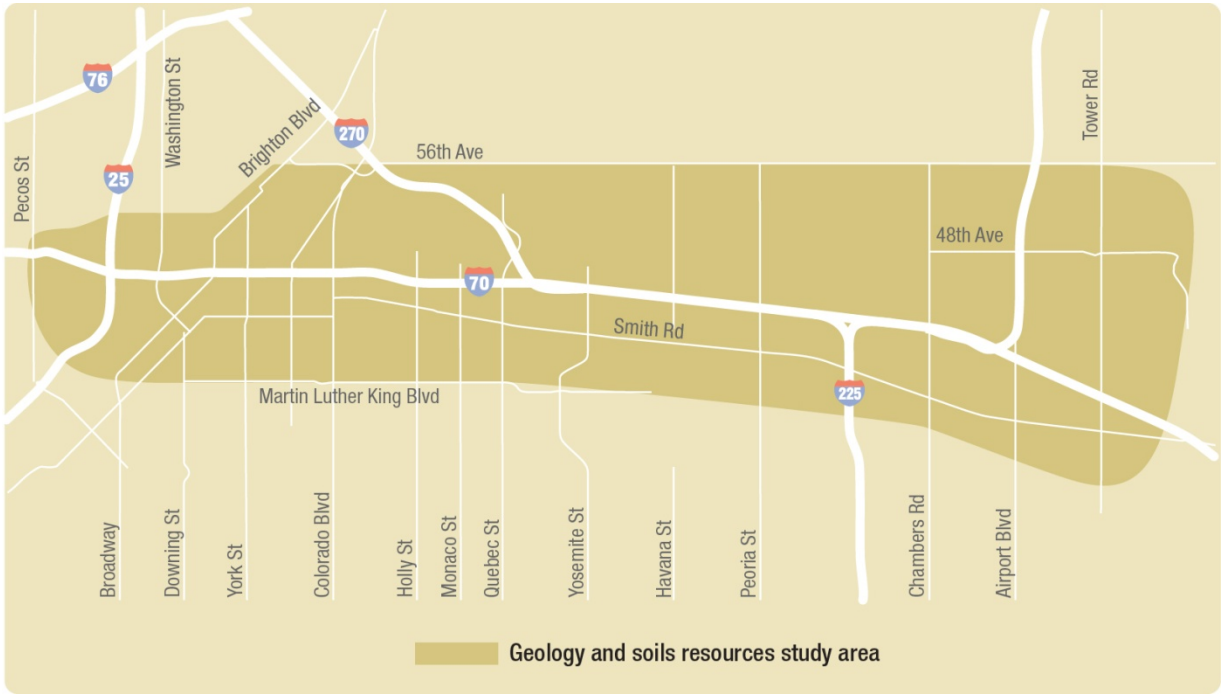
The study area for geology and soil resources is shown in Exhibit 5.17-1.

**Why are geology and soil resources evaluated in this document?**

There are no federal or state laws that apply specifically to geologic or soil resources. However, the CDOT *NEPA Manual* (2013b) 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 geology or soils could have on the project
- 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

**Exhibit 5.17-1. Geology and soils resources study area**




A preliminary subsurface investigation was performed between Brighton Boulevard and Colorado Boulevard to include a determination of the depth to bedrock and groundwater. Section 5.18, Hazardous Materials, describes the investigation of soil and groundwater, including chemical analysis.

## 5.17.4 What are the existing geology and soils resources in the study area?

Bedrock is present at depths ranging from 31 feet to 79 feet below existing grade—an approximate elevation of 5,142 feet to 5,165 feet—except near Columbine Street, where bedrock was encountered at an elevation of 5,113 feet. The lower bedrock elevation appears to be associated with a paleo-channel created by the historic South Platte River. The bedrock consists of very hard claystone that contains interbedded, very hard sandstone.

The depth to groundwater ranges from approximately 27 feet to 72 feet below existing grade, an elevation of 5,155 feet to 5,166 feet. Variations in the groundwater levels can occur during different seasons, following precipitation events, after construction and site grading, and due to changes in surface and subsurface drainage characteristics of the surrounding area.

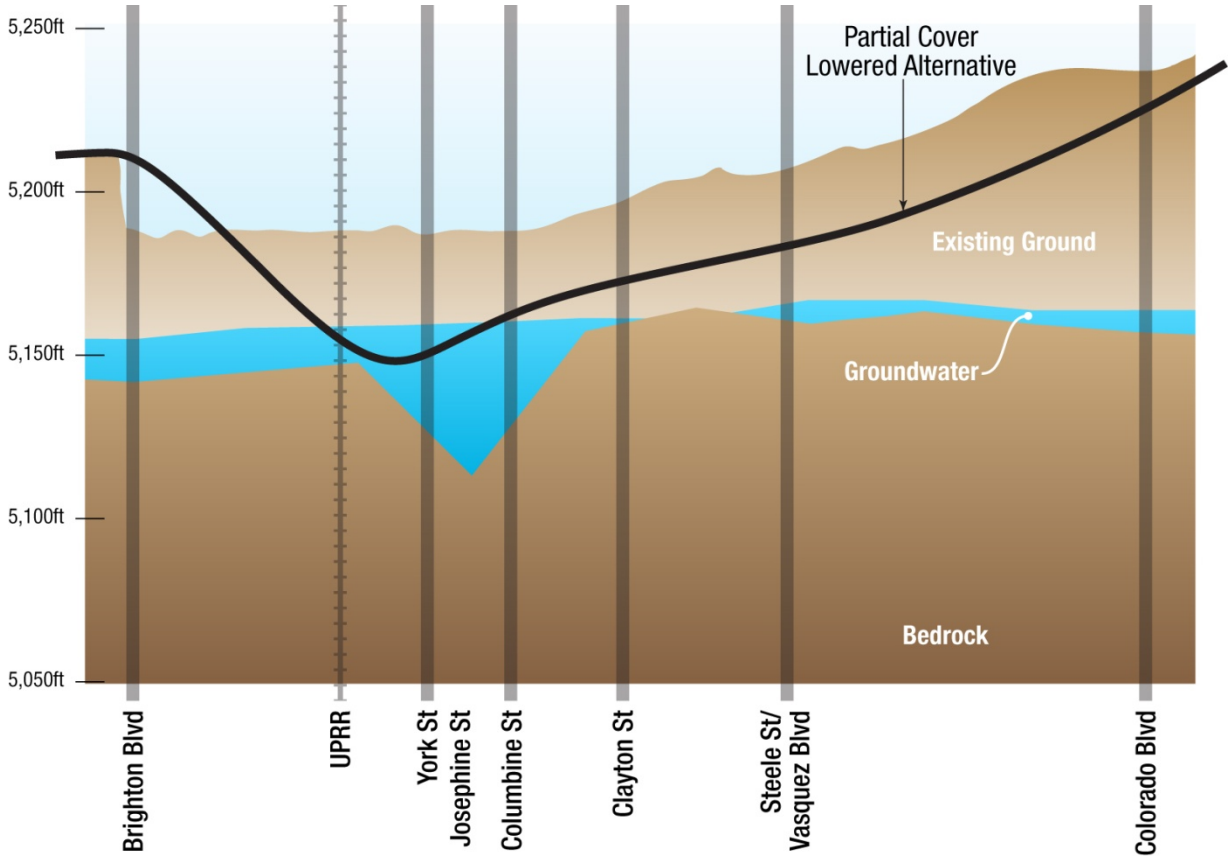
**Bedrock and groundwater excavation issues**

Although excavating at bedrock and groundwater depths is not impossible, the excavation at these depths is a lot more complicated and costly.

To minimize the construction cost and time, the highway is designed to be constructed with minimal groundwater and bedrock disturbance.

Exhibit 5.17-2 shows a profile of groundwater and bedrock depths relative to existing and proposed ground surfaces. Note that the proposed ground surface represents the lowest elevation being evaluated, which is the Partial Cover Lowered Alternative.

**Exhibit 5.17-2. Comparison of surface, groundwater, and bedrock elevations**




## 5.17.5 How do the project alternatives affect the geology and soil resources?

As mentioned previously, the impacts from the No-Action Alternative and the Revised Viaduct Alternative remain the same as discussed in the 2008 Draft EIS. The Partial Cover Lowered Alternative requires the largest excavation of the alternatives, so it has the greatest potential to affect, and be affected by, geologic conditions. The excavation is anticipated to extend below the depth of groundwater from approximately the UPRR to Columbine Street. It will be necessary to prevent the groundwater from entering the excavated trench for the lowered portion of I-70.

The lowest grade for the Partial Cover Lowered Alternative is located between the UPRR separation and York Street, where an approximate 40-foot cut is proposed. The excavation for the

roadway is located just above the bedrock, so minimal bedrock excavation is anticipated. Storm drain pipes and utilities could require bedrock excavation, but are not expected to be significant.

### 5.17.6 How are the impacts to the geological resources minimized and mitigated?

**Dewatering**

Dewatering is the removal or draining of groundwater or surface water from a construction area.

To minimize impacts to the lowered highway from the groundwater, the contractor can construct retaining walls to the depth of bedrock. This will cut off groundwater infiltration into the lowered section of the highway. Storm drain pipes below the pavement will drain any additional groundwater that still enters the lowered section. Extensive dewatering during the construction is anticipated for the Partial Cover Lowered Alternative. For the Revised Viaduct Alternative, the construction of structure foundations also will require dewatering. Water collected from dewatering will be treated according to regulations if contaminants are discovered.

**Secant caisson wall**

Secant caisson walls are formed by constructing a series of drilled shafts and a series of secondary overlapping shafts. These walls minimize deflection and keep groundwater from flowing into the facility.

The proposed retaining walls will be constructed using top-down construction techniques. This involves drilling a caisson or driving a pile first, followed by excavation in phases. The wall is constructed as the excavation progresses. Within the area of large excavations and below groundwater, a secant caisson wall is anticipated. The secant walls provide additional wall stiffness in deep excavation areas and can be designed to seal the portion of the I-70 highway that will be below the groundwater table elevation.

Exhibit 5.17-3 summarizes the impacts and mitigation measures pertaining to geologic and soil resources.

## Exhibit 5.17-3. Summary of geology and soils impacts and mitigations

| Alternative | Impacts and/or Benefits | Mitigation Measures Specific to Alternatives |
|---|---|---|
| No-Action Alternative | • Excavation below groundwater for construction of the viaduct structure foundations<br>• Temporary impacts to groundwater during excavation | • Dewater structure foundations during construction |
| Revised Viaduct Alternative | • Excavation below groundwater for construction of the viaduct structure foundations<br>• Temporary impacts to groundwater during excavation | |
| Partial Cover Lowered Alternative | • Excavation is anticipated to extend below the depth of groundwater from approximately the UPRR to Columbine Street<br>• Temporary impacts to groundwater during excavation | • Prevent groundwater infiltration into the lowered section of the highway<br>• Install storm drain pipes below the pavement to drain any additional groundwater that still enters the lowered section<br>• Dewater during the construction process |

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