SEPARATED GRADE CROSSING OF FOOTHILL DRIVE AT RED BUTTE CREEK FOR PEDESTRIANS AND CYCLISTS

Final Design of Underpass near Red Butte Creek

Final Design

Pedestrian Underpass near Red Butte Creek

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The study described herein is associated with the courses CvEEN 4900 and 4910 Professional Practice & Design conducted at the University of Utah, 2022-23. As such, it is intended for academic use only. Engineering opinions and descriptions provided are likewise only for academic use.

Acknowledgments

We would like to thank the generous actions displayed by Lynn Jacobs, the instructional staff, and the mentors who made this project happen. Without their devotion to furthering our education, we would be lacking critical skills and experience preparing us for practice.

We would also like to dedicate this work to the future University of Utah students with hopes of creating a safer and more active commuter-friendly campus

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Executive Summary

In an effort to provide a safer alternative for pedestrians crossing Foothill Drive, our team has designed an underpass as a potential solution. The all-ability underpass will begin and end in view of Red Butte Creek, incorporate existing walkways, and connect to the future Red Butte Creek Trail. This will create an enjoyable user experience while improving pedestrian accessibility in a highly trafficked area.

The underpass will have an interior width of sixteen feet to allow for pedestrian and cyclist traffic in both directions. The interior height will be ten feet to ensure a welcoming option for travel. The box culvert will be placed two feet below the existing roadway and has outer dimensions of 12’x18’, for a total concrete thickness of 2’. The approach design will include both stairs and ramps for pedestrians and cyclists, in addition to trail connections for the general public.

The design’s effectiveness is measured by pedestrian and cyclist comfort. In order to discourage vandalism, this design incorporates Crime Prevention Through Environmental Design (CPTED) by including aesthetic design elements in and around the underpass.

The accompanying plan set is a concept-level design. Limitations and challenges include assumed utility locations, a non-existent trail system, and interference with the Veterans Affairs (VA) property. These constraints must be addressed in a construction-level design. The cost estimate included in the report addresses this.

This underpass’s close proximity to Red Butte Creek will also be an exellent addition to the Salt Lake City trail system. Red Butte Creek Trail users will be able to effortlessly continue on their walk beneath Foothill Drive without having to cross at grade, promoting utilization. The underpass will also be used for active transportation by commuters to the University of Utah, Research Park, and the Veterans’ Affairs Hospital. Public transportation users will also benefit by having the option to avoid the at-grade crossings near Mario Capecchi Drive and Wakara Way.

Section 1. Project Summary

Section 1.1 Project Needs Statement

The pedestrian crossing experience across Foothill Drive between Mario Capecchi Drive and Wakara Way is dangerous and uncomfortable. The proposed underpass will serve both as a connection to the Red Butte Creek trail system beneath Foothill Drive and as a safe means of crossing. Additionally, this underpass will allow people of all ages and abilities to recreate and enjoy the ecology of Red Butte Creek.

As Salt Lake City continues its rapid growth, more people are choosing active modes of transportation. There are several destinations in this area, including the University of Utah, Research Park, and the VA Hospital. If nothing is done to improve the safety at these crossings of Foothill Drive, then more people are susceptible to accidents, injury, and death.

Section 1.2 Project Goals and Vision

The project will focus on creating an inclusive underpass for all modes of active transportation to the south of Red Butte Creek without altering the existing under-road creek culvert. The design will include a wide, tall tunnel with maintenance plans. It will aim to have minimal construction interruption with the traffic and buildings around the perimeter.

Section 1.3 Project Participants and Organization

Michael Jones with Parametrix has been the lead mentor for the project team. He met with the team on a biweekly basis and provided feedback on the work completed. He also reviewed drafts highlighting what was done well and mistakes to be improved.

Lynn Jacobs, a transportation engineer with Salt Lake City, was the sitting client for the project. He provided vision and direction throughout the project as the project needs evolving. Mr. Jacobs also reviewed the preliminary draft and provided feedback.

Section 1.4 Stakeholders

See Table 1 at the bottom of this section for the stakeholder engagement matrix.

Stakeholders are listed and their interests are defined below.

- Salt Lake City Engineering
  - Reduce likelihood of pedestrian fatalities
  - Connect trails to Bonneville Shoreline Trail
  - Design for low cost and maintenance
  - Minimize construction impacts to surrounding area
  - Promote usage and create an appealing final product
  - Design for ease of constructability
  - Impact utilities minimally
- Salt Lake City Trails
  - Universal accessibility

    - Trail connections
    - Two-way passage
    - Low cost
    - Elevation change minimization
- Sunnyside Neighborhood Community
    - Pedestrians
        - Wheelchair accessible
        - No impact on parking
        - Direct connection to other side of Foothill Drive
    - Cyclists
        - No requirement to dismount bike
        - Direct connection to other side of Foothill Drive
        - No construction debris
    - Hikers
        - Direct connection to other side of Foothill Drive
        - Little to no impact with surrounding area
        - Direct connection to future trails
- US Army Corp of Engineers
    - Reduce impact to the environment
    - Provide increased opportunity for outdoor recreation
- Salt Lake City Ordinance Riparian Corridor Overlay District (RCO)
    - Preserve riparian corridors
- Utah Division of Forestry, Fire & State Lands
    - Protect sovereign lands
    - Protect threatened species
- Utah State Engineer's Office
    - Low cost
    - Impact on channel and stream banks minimized
    - Low difficulty construction
    - Low utility impact
- Salt Lake County Engineering and Flood Control
    - No increase in the probability of a flood
    - No impact within 20 feet from the top of the channel bank
- Salt Lake County Watershed Planning and Restoration
    - No impact to downstream ecosystem and facilities
- Utah Department of Transportation (UDOT)
    - Promote active transportation
    - Improve traffic flow
    - Low disruption to traffic during construction
    - No change to Foothill Drive width and volume

  - Foothill Drive is a UDOT roadway
- Utah Transit Authority (UTA)
  - Improve access to bus stops
- US Federal Government
  - No effect on right-of-way
  - Ability to retain secure access points
  - Little to no impact on VA facilities
  - Lockdown plan
- University of Utah
  - Promote active transportation
  - Easy access to research park
  - Reduce vehicular traffic
  - Pedestrian safety
- Red Butte Creek Steering Committee
  - Balance nature and people
  - Retain access to Red Butte Creek
  - Provide passage to species living in and around the creek

A stakeholder engagement matrix is provided below to describe the level of engagement as unaware, resistant, neutral, supportive, or leading as shown in Table 1. This matrix will also include a power/interest assessment which will be rated low, medium, or high. Table 1 denotes a 'D' for desired engagement or a 'C' for current engagement on the project [1].

Table 1. Stakeholder Engagement Matrix with Power / Interest Assessment [1].

Stakeholder	Power / Interset	Unaware	Resistant	Neutral	Supporting	Leading
Salt Lake City Engineering	High / High					D-C
Salt Lake City Trails	Low / Medium			C	D	
Sunnyside Neighborhood Community	Low / High				D-C	
US Army Corp of Engineers	High / Low	C		D		
Salt Lake City Ordinance Riparian Corridor Overlay District	Medium / Low		C	D		
Utah Division of Forestry, Fire, and State Lands	Medium / Low		C	D		
Utah State Engineer's Office	High / High					D-C
Salt Lake County Engineering and Flood Control	Medium / Medium		C	D		
Salt Lake County Watershed Planning and Restoration	Medium / Low		C	D		
Utah Department of Transportation (UDOT)	High / High					D-C
US Federal Government	High / Medium			C	D	
Utah Transit Authority (UTA)	High / Medium			C	D	
University of Utah	Medium / High					D-C
Red Butte Creek Steering Committee	Low / Medium				D-C	

Section 2. Site Description and Analysis

Section 2.1 Location and General Usage

The area of focus for this study is a portion of Foothill Drive between the intersection of Wakara Way and Mario Capecchi Drive. Specifically, the underpass will be located approximately 10 feet South of Red Butte Creek.

The land owners of this area include the VA Hospital, the Fort Douglas military base, public land just southwest of the University of Utah Health Orthopedic Center, and a UDOT easement along Foothill Drive. Sidewalks along the VA Hospital are only a few feet from the road, while sidewalks near the Orthopedic Center are much further from the road. The pedestrian crossing over Wakara Way is located about 150 feet from its intersection with Foothill Drive.

Section 2.2 Geologic and Geotechnical

According to the Utah Geological Survey, the project area is within the Wasatch and West Valley Fault Zones and is part of the Surface-Fault-Rupture Hazard Special Study Zone [2]. Therefore, it is important to look at the soil in the site area and design the bridge or underpass to withstand an earthquake of high magnitude. The Utah Geological Survey also provides the types of soils in the project area. These soils consist of alluvium, alluvial fan, and debris fan deposits, as well as sand and gravel deposits from the regressive phase of Lake Bonneville [2].

Figure 1 shows a map of these soils in the project area. The lightest portion of the map along Red Butte Creek is alluvium with a maximum thickness of 3 meters. Alluvial fan and debris fan deposits with a maximum thickness of 10 meters make up the northern project area. The southern portion of the project area is composed of sand and gravel deposits of the regressive phase of Bonneville Lake with a thickness ranging from 1 meter to 4 meters [2].

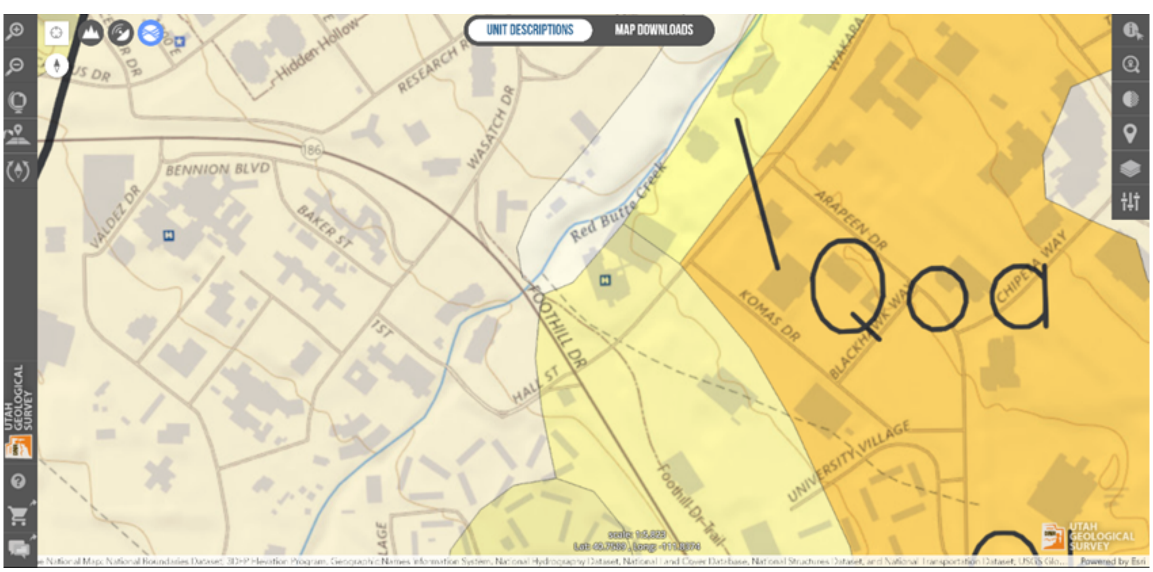


Figure 1. Geologic Map [3].

In addition to these soils, the National Resources Conservation Service (NRCS) with the United States Department of Agriculture classifies the soils in the site area as Bingham gravelly loam (BhB) and parleys silt loam (PeB). Figure 2 shows a layout of these soils concerning the project area. The shaded yellow represents BhB and the shaded white represents PeB. Table 2 provides a rating for soil susceptibility to compaction [3].

Figure 2. Soil Map for Compaction [4].

Table 2. Soil Susceptibility to Compaction [4].

Summary by Map Unit — Salt Lake Area, Utah (UT612)

Summary by Map Unit — Salt Lake Area, Utah (UT612)

Map unit symbol	Map unit name	Rating	Component name (percent)	Rating reasons (numeric values)	Acres in AOI	Percent of AOI
BhB	Bingham gravelly loam, 3 to 6 percent slopes	Medium	Bingham (95%)	Soil texture, 0-12 inches (1.00)	134.6	71.6%
				Rock fragments, 0-12 inches (1.00)		
				Soil structure grade, 0-12 inches (1.00)		
				Bulk density-compactibility to 30cm (1.00)		
				Subaerial (1.00)		
PeB	Parleys silt loam, 3 to 6 percent slopes	Medium	Parleys (85%)	Soil texture, 0-12 inches (1.00)	35.2	18.7%
				Rock fragments, 0-12 inches (1.00)		
				Soil structure grade, 0-12 inches (1.00)		
				Bulk density-compactibility to 30cm (1.00)		
				Subaerial (1.00)		
SP	Stony terrace escarpments	Not rated	Stony terrace escarpments (100%)		18.1	9.6%
Totals for Area of Interest					**187.8**	**100.0%**

These soils are also susceptible to flooding and may liquefy during a high-magnitude seismic event. The next step in the geotechnical process is to bore into the soil as this will provide a higher understanding of what kinds of soils are present in the site area.

Section 2.3 Hydrologic and Hydraulic

To prevent flooding in the underpass, the 100-year floodplain and flow rates were analyzed. The floodplain is shown below in Figure 3. It was determined that flooding could be prevented at the project location by implementing stormwater drainage on both sides of the walkway. It was calculated that each drainage area should be 2 feet wide and 1.5 feet deep to allow any floodwater from a 100-year storm event to be kept off of the walkway. All calculations can be found in Appendix 1.

Figure 4 shows the StreamStats report and peak flow statistics, which was the source used to determine the approximate flow for a 100-year storm (1-percent AEP flood) in the Appendix 1 calculations. The StreamStats report also shows the watershed characteristics for this location, but that information was not used in the report.

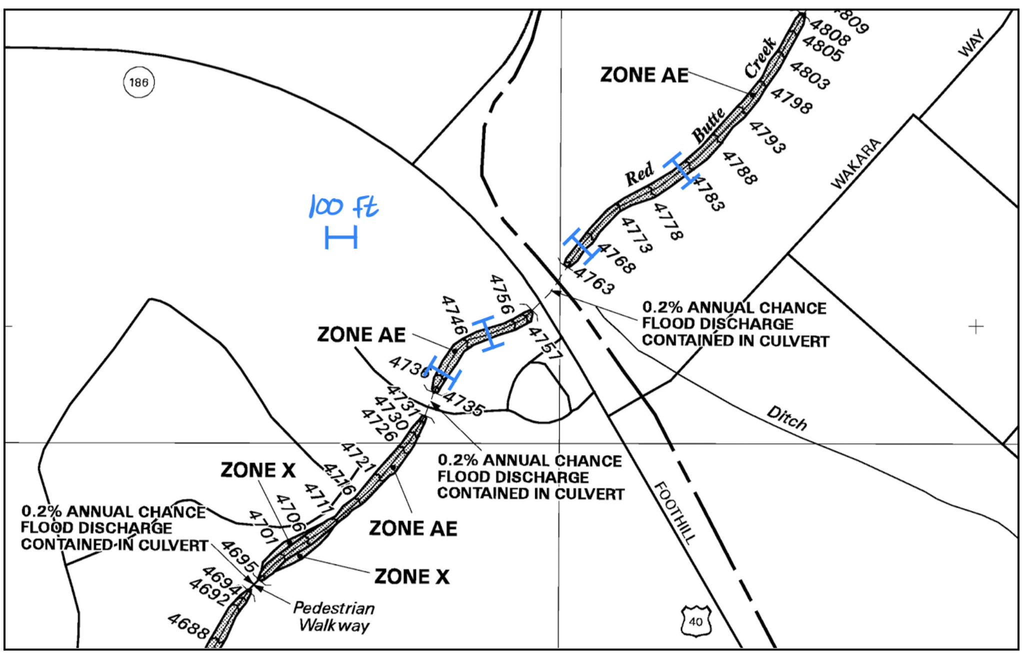
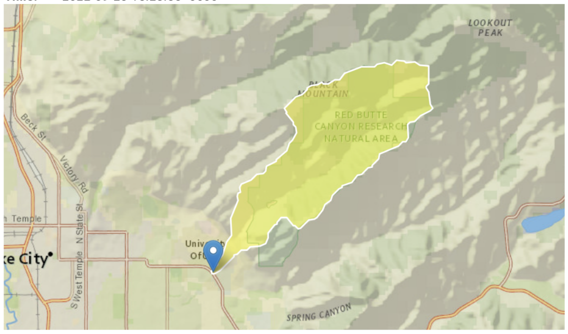


Figure 3. 100-year Floodplain

StreamStats Report

Region ID: UT
Workspace ID: UT20220925212334575000
Clicked Point (Latitude, Longitude): 40.75628, -111.83473
Time: 2022-09-25 15:23:55 -0600



Collapse All

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	8.81	square miles
ELEV	Mean Basin Elevation	6590	feet
PRECIP	Mean Annual Precipitation	33.9	inches

Peak-Flow Statistics Flow Report [Region 2]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	ASEp	Equiv. Yrs.
50-percent AEP flood	41.6	ft^3/s	71	71	0.9
20-percent AEP flood	71.4	ft^3/s	58	58	1.6
10-percent AEP flood	94.9	ft^3/s	53	53	2.5
4-percent AEP flood	118	ft^3/s	51	51	3.7
2-percent AEP flood	149	ft^3/s	50	50	4.6
1-percent AEP flood	172	ft^3/s	50	50	5.4
0.5-percent AEP flood	196	ft^3/s	51	51	6.1
0.2-percent AEP flood	239	ft^3/s	52	52	6.8

Figure 4. StreamStats Report and Peak Flow Statistics [4]

Section 2.4 Topographic

The site has a uniform cross slope of ~1% across Foothill Drive. The underpass will have a 2% slope underneath the roadway and will end on the west side of Foothill Drive about 10 feet south of the existing circular culvert shown in Figure 5. The underpass is to end here with the expectation that a future trailway will connect to the bottom of the stairs on the VA side. On the east side, the underpass will start ten feet south of the existing culvert shown in Figures 6 and 7. The future trail system will stretch east from this location and connect with the Bonneville Shoreline Trail to ensure extended trail access. The underpass will not cross the Red Butte Creek at any point, so it will be left unobstructed. The topographic map in Figure 5 illustrates the slopes near the creek and across Foothill Drive. Figure 8 describes the cross slopes across Foothill Drive with relation to the planned elevations of the future underpass.

Figure 5. Topographic Map Near Red Butte Creek

Figure 6. West of Foothill Drive Culvert

Figure 7. East of Foothill Drive Culvert

FOOTHILL DRIVE UNDERPASS PROFILE

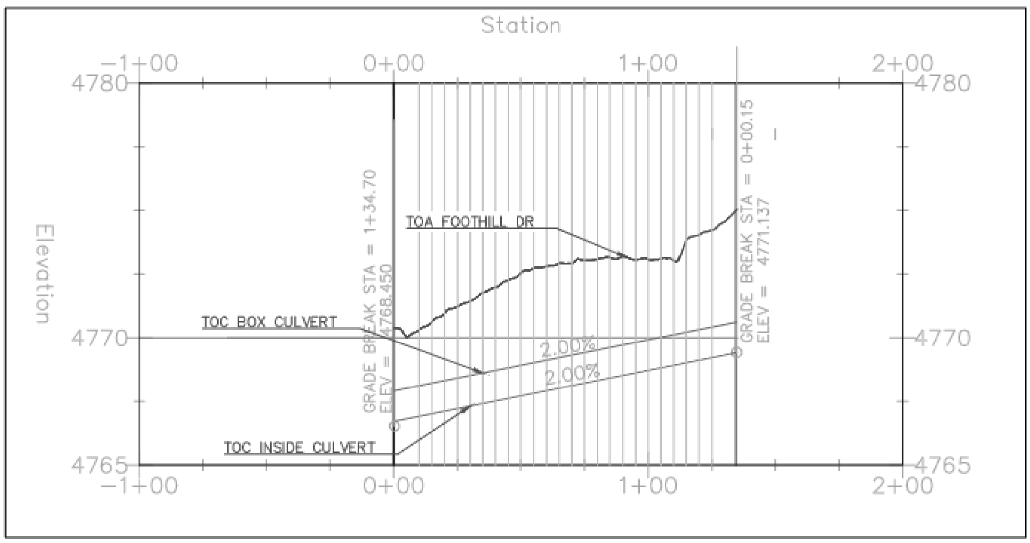


Figure 8. Pedestrian Underpass Plan and Profile

Section 3. Summary of Criteria

Section 3.1 Project Criteria

Complete Streets

Foothill Drive is considered a collector road, as it connects local roads and streets with arterials. It has a speed limit of 40 miles per hour and strives to balance mobility with land access. Foothill Drive has been making improvements to become a complete street by adding a bus route that comes to each stop every 15 minutes, ensuring that it has walkable sidewalks and bike paths with adequate lighting, and modifying curb ramps to make sure the sidewalks are accessible. The frequently-used pedestrian crossings at Wakara Way and Mario Capecchi Drive do not promote pedestrian comfort, as they must cross nine lanes of traffic, or 120', in a 25-second time limit. Adding an underpass in between these intersections will contribute to Foothill Drive's plan to become a complete street, as exemplified in Figure 9.

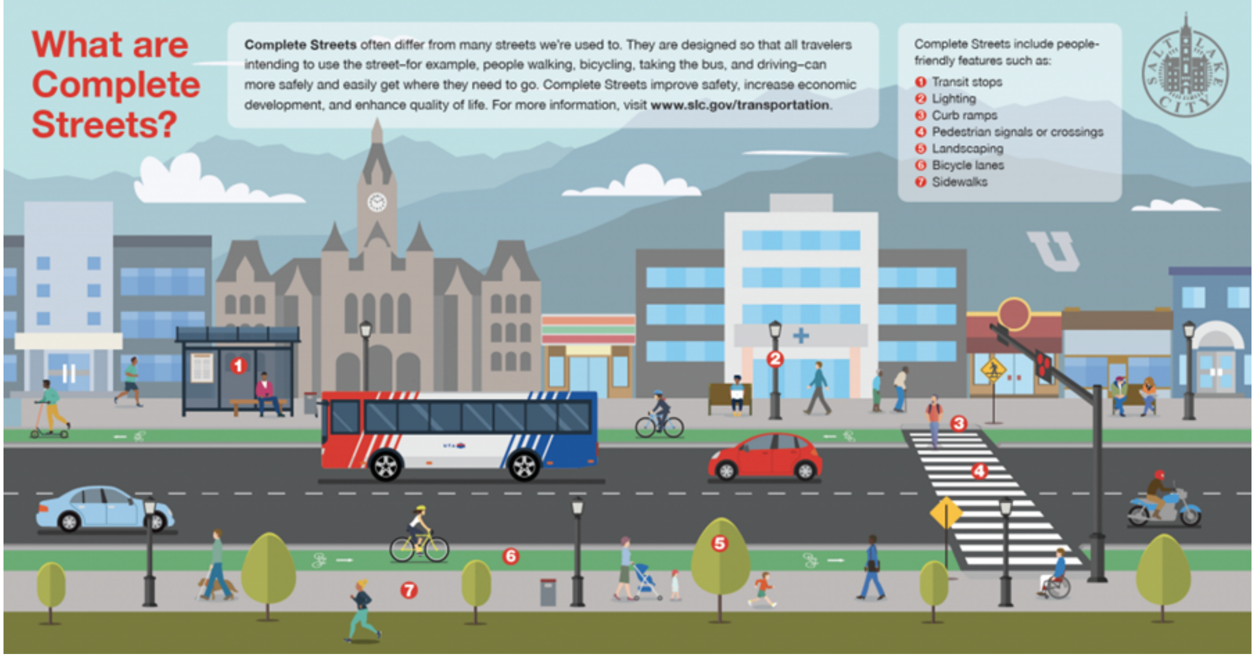


Figure 9. Complete Streets

Design Methodology and Constraints

The underpass was designed with safety, trail connectivity, and accessibility as key factors. The location of the underpass had significant consideration for all three of these factors, but the utilities made this a challenge. Possible existing utilities include electrical, stormwater, and sewer. Assumptions were often made on how to accommodate them. Adjustments to the location may need to be made if new utility information is discovered.

Access to this public amenity would be limited if it was not designed with safety in mind. Muggings, robberies, and assaults must be prevented to ensure safe passage, so security measures such as adequate lighting and cameras were implemented. For adequate lighting, a skylight near the middle of the tunnel has been proposed. It may also be beneficial to utilize more reflective materials for the walls and/or floor of the underpass. This would allow natural light to coruscate throughout the underpass during the day, and artificial light would be utilized at times of minimal natural light. It important that users of the underpass feel safe at all times. If safety was not properly addressed, community members will discontinue their use of the underpass, and the project would be a waste of time and money for all those involved.

Trail connectivity is important for those who will be using the underpass while out biking or running. Performing these activities in nature is more enjoyable, and waiting at traffic signals to continue a workout can be frustrating. For this reason, the underpass needs to connect to the trail system and allow easier access to those using it. The trail system that the underpass will connect to does not yet exist, so assumptions were made about where the trail would connect.

Accessibility for all users is an important part of the design process that will improve the chances of the project's success. To achieve this, our design includes stairs for quick access for runners, at grade ramps for people in wheelchairs or on crutches, benches for anyone needing a rest or a place to relax, and excess headspace for individuals riding bikes. Constraints with accessibility include where to put stairs and how to connect ramps to the existing sidewalk without interfering with the VA property. The best proposed alternative can be seen in the "Drawings" section of this report.

Section 3.2 Basis of Design

The existing land near Foothill Drive is characterized as a destination district and a neighborhood. The University of Utah, the VA Hospital, and Research Park are considered destination districts. To the southwest of Foothill Drive, the land is residential. The zoning of the area between Mario Capecchi Drive and Wakara Way is classified as RP (Research Park) for the east side of Foothill Drive and I (institutional) for the west side of Foothill Drive. This grade-separated crossing will provide a safer path from west to east (or vice versa) across Foothill Drive. The crossing will connect Research Park, Red Butte Gardens, the University of Utah, city trails, and the Natural History Museum of Utah to residents, in addition to VA Hospital patients to employees from the University of Utah Health campus.

Salt Lake City's 2015-2040 Long-Range Transportation Plan [5] is to decrease pedestrian, bike, and auto accidents by making transportation accessible within ¼ mile of all residents. The #5 initiative is "Make walking and cycling viable, safe, and convenient transportation options in all areas of the city." The project area includes neighborhood byways, pedestrian crossings, and priority east-west corridors. This area also has a high comfort rating from the bikeway map, but will help to minimize the nearby "extra caution" areas in the Salt Lake City & County Bike Map, 2019 [5]. Foothill Drive has an existing Frequent Transit Network (FTN) level of service, which is a great step closer to becoming a complete street. The area's master plan includes a goal for the East Bench Area to chart a course for future growth, provide policy direction, and create a framework to measure future achievements. The specified goal for Foothill Drive is to improve the pedestrian experience, according to the initiative MC-1.4, which recommends that the sidewalks be leveled and widened with a buffer provided between the sidewalk and curb. The buffer may include trees, street and sidewalk lighting, low landscape walls, and other elements.

The Envision Estimate gives projects a ranking for sustainable infrastructure. Many assumptions were made during the scoring of this design due to the project's conceptual nature. For example, the companies and materials utilized in the project are yet undermined, and therefore, some assumptions were made considering the location of the project and the availability of sustainable companies and materials at close distances. The Envision Estimate categories are explained below. A full explanation and scoring of the Envision Estimate can be found in Appendix 3.

- This project will improve the quality of life for residents, commuters, and recreational pedestrians looking for a safer way to reach nearby trails. The score given to this section is an 8/10, given that all requests can meet at least a basic opportunity for improvement.
- An 8/12 was rewarded in the Leadership category, as there are many sustainability options nearby. Additionally, the University of Utah, UDOT, and residents are incredibly involved in the development of this crossing.
- The Resource Allocation score was lower than other sections at 5/10. Reducing the carbon footprint on projects of this size with limited space and time will not always be easier and more cost-efficient. It is still believed there can be effort put into this initiative by including some reusable energy present throughout construction.
- The Natural World section was given an 8/12 score. There must be a major focus on protecting and managing Red Butte Creek, the neighboring source of water. The design of the project will need to take into consideration storm water, hydrology functions, the protection of water quality, and the protection of the area's ecological value.
- The final section is Climate and Resilience, and its score was 5/10. Once again, making sure sustainable practices are being used throughout the development of this project is hard to grasp without thinking about the extra cost to the overall production. There is a basic opportunity to improve the carbon footprint left by construction, however, it will take more time and money to implement these practices.
- The overall score for the ISI Envision Rankings is a 60%, which falls under Platinum. This score is exceedingly high; however, there is reason to believe that there is a basic opportunity for all categories. Some categories may even have a chance to go above and beyond with little cost. A more conclusive analysis can be made once the project has chosen materials, partnering companies, and the level of prioritized sustainability.

The underground pedestrian tunnel's location has features that meet the requirements of the surrounding area. The demographic includes families with young children, university students, faculty, athletes, and VA Hospital patrons. For this community, inclusion is a must. One of the main criteria for this design is to make it accessible to all pedestrians, making ADA-approved access non-negotiable. The project will also heavily rely on the integration of the community and their thoughts on how to make the underground crossing better for their daily commutes and outdoor activities.

Section 3.3 Decision Criteria

The existing site conditions create restraints for the design. The roadway can not feasibly be raised and the creek creates a depth restraint in order to reduce flooding, therefore, the underpass must be above the creek elevation but below the roadway elevation.

Permit Requirements are a necessary step in a project's completion. Salt Lake County provides a list of permits regarding watershed planning and restoration. Red Butte Creek comes from one of the closest watersheds to Salt Lake City proper, meaning that there are many permits to consider. Below is a detailed list of all considered permits with a brief description.

Table 3. Permit Requirements

Permit Name	Permit Description	Jurisdiction
Salt Lake County Flood Control Permit	Any work within 20 feet of the top of the channel back of any “flood control facility”.	Salt Lake County Engineering and Flood Control
State Stream Alteration Permit	Any work altering the bed or banks of a natural stream. May need additional permitting from the U.S. Army Corps of Engineers.	Government of Utah U.S. Army Corps of Engineers
Salt Lake City Riparian Permit	A riparian zone is considered the interface between land and stream. Red Butte Creek is a riparian, so this permit is needed.	Salt Lake City Development Review

Section 3.4 Design Criteria

Table 4. Design Criteria

Design Criteria	Description
Minimum height	The minimum height for an underground pedestrian tunnel with accessibility to walking pedestrians and cyclists is 8 feet. The design chosen to accommodate the demographic is 12 ft.
Minimum width	The minimum width for underground pedestrian tunnels with accessibility to walking and riding pedestrians is 10 ft. The design chosen to accommodate the demographic is 16 ft.
Entrance direct connection to trails	The clients made it a priority for the design to have a direct connection to the new trails implemented into the area. The existing sidewalk connections will be revised at a later time.
Skylight	The client requested the addition of a skylight in the middle of the tunnel to add another source of natural light to make the underground crossing more friendly during day hours. The natural light will create a better sense of safety and will lead pedestrians to feel more comfortable using this path.
Aesthetic	Case studies show that pedestrians feel more comfortable crossing an underground tunnel when it is very well-lit, the entrance and exit are seen from opposite sides, it is wider than 6 ft, and lively designs are incorporated inside the tunnel.

Section 4. Summary of Process for Alternative Development, Analysis, and Selection

As mentioned previously, the basis of design for this project is a pedestrian underpass. Alternative 1 has been chosen as the design to move forward with. Two other designs were analyzed in order to find the best choice for the community, stakeholders, and clients, as well as the environment and economy.

Table 5. Alternative Development

Number	Alternatives	Description	Analysis
1	Skylight, lane shifts	This design includes a skylight in the middle of the road to provide natural light into the tunnel. This cut in the pavement and the roof of the tunnel will shift the lanes to the East into the existing sidewalk. The Northbound lanes will be reduced to 11 ft lanes to accommodate a smaller curve radius added to the lanes and have a minimal adjustment to the alignment of the road.	The client gave the suggestion for adding the skylight. Having a source of natural light in the middle of the tunnel will provide a safer passage for pedestrians and create a better ambiance in the tunnel. The tunnel will also connect directly to the new trail heads.
2	No skylight, no lane shift	This design will just include the underground tunnel and the entrances will connect the trails immediately to the tunnel.	The purpose of this design is to connect the tunnel entrances with the new trailheads. This design will ignore the existing sidewalks and in a later revision with the city, the implementation will be discussed.
3	Inclusion of sidewalk to trail	This design will connect the existing sidewalk to the entrances of the tunnel and it will also connect the trials on the East and West side.	This was the first design created with a large entrance on the East side of the tunnel to incorporate the sidewalk and trailhead and create a seamless route for pedestrians.

Alternative 1 was chosen due to its closeness to the client's preferences. The client specified that a skylight in the middle of the tunnel would give the tunnel a better sense of security and safety. The addition of the skylight added an extra 7 feet to the width of the road. To accommodate for this widening and have minimal impact on the east right-of-way, the northbound lanes will be reduced from 12 feet to 11 feet. This can be done by requesting a permit from the city and providing reasoning for the adjustment. The client also requested that the integration of the existing sidewalk was not included in the chosen design, as their first priority is to connect the tunnel to the new trailhead, not the sidewalk. All of these requests from the client led to the design of Alternative 1.

Section 5. Design Development Summary

Section 5.1 Process

The final chosen design went through multiple alterations and alternatives. At first, the client wanted two alternatives designed, one that included Red Butte Creek and another that was adjacent to the creek. After presenting basic designs, the client asked the team to move forward with an underground tunnel which did not include the creek. The next variations of this design included different types of entrances on both the east and west side. The priority for these designs was to make the slope of the entrance at a <5% grade, to abide by ADA regulations, the designs also included different alternatives for connecting the entrance to the sidewalks and the trails. These designs were put on hold to work on a more simple entrance with the priority of having a direct connection to the future trails. Given this suggestion, the design moved towards finding the most direct way to connect to the trails, which included shorter and straighter trail entrances. The client then suggested adding a skylight in the middle of the tunnel to incorporate more natural light into the tunnel. Measurements and inspiration were taken from the underground pedestrian tunnel in Sugar House Park. The final design has all the factors the client identified as a priority.

Section 5.2 Design Data and Specification Summary

The specification sheet from UDOT's 2023 Standard Specifications for Road and Bridge Construction may be found in Appendix 2, which contains any information that the contractor may need for the completion of this project. It also contains information pertaining to excavation, compaction, and concrete placement. Appendix 2 should not be treated as a full and complete specification sheet, but is useful for certain aspects pertaining to this project.

Section 5.3 Operations and Maintenance Summary

Table 6. Frequency and Type of Inspections [6]

SOILS CONSTRUCTION (IBC 1705.6)

Item			*Detailed Instructions and Frequencies*
Verify subgrade is adequate to achieve design bearing capacity	☐ Continuous	☒ Periodic	Prior to placement of concrete.
Verify excavations extend to proper depth and material	☐ Continuous	☒ Periodic	Prior to placement of compacted fill or concrete.
Verify that subgrade has been appropriately prepared prior to placing compacted fill	☐ Continuous	☒ Periodic	Prior to placement of compacted fill.
Perform classification and testing of compacted fill materials	☐ Continuous	☒ Periodic	All materials shall be checked at each lift for proper classifications and gradations not less than once for each 10,000ft² of surface area.
Verify proper materials, densities and lift thicknesses during placement and compaction.	☒ Continuous	☐ Periodic	

CONCRETE CONSTRUCTION (IBC 1705.3 & 1705.12.1)

Item			*Detailed Instructions and Frequencies*
Reinforcing steel	☐ Continuous	☒ Periodic	Verify prior to placing concrete that reinforcing is of specified type, grade and size; that it is free of oil, dirt and rust; that it is located and spaced properly; that hooks, bends, ties, stirrups and supplemental reinforcement are placed correctly; that lap lengths, stagger and offsets are provided; and that all mechanical connections are installed per the manufacturer's instructions and/or evaluation report.
Welding of reinforcing steel	☐ Continuous	☒ Periodic	Visually inspect all welds and also verify weldability of reinforcing steel based upon carbon equivalent and in accordance with AWS D1.4.
Cast-in bolts & embeds	☐ Continuous	☒ Periodic	Inspection of anchors or embeds cast in concrete is required when allowable loads have been increased or where strength design is used.
Post-installed anchors or dowels	☐ Continuous	☒ Periodic	All post-installed anchors/dowels shall be specially inspected as required by the approved ICC-ES report. Horizontally or upwardly inclined anchors that resist sustained tension loads require continuous inspection and approved installers.
Use of required mix design	☐ Continuous	☒ Periodic	Verify that all mixes used comply with the approved construction documents; ACI 318: Ch. 19, 26.4.3, 26.4.4; and IBC 1904.1, 1904.2, 1908.2, 1908.3.
Concrete sampling for strength tests, slump, air content, and temperature	☒ Continuous	☐ Periodic	
Concrete & shotcrete placement	☒ Continuous	☐ Periodic	
Curing temperature and techniques	☐ Continuous	☒ Periodic	Verify that the ambient temperature for concrete is kept at > 50°F for at least 7 days after placement. High-early-strength concrete shall be kept at > 50°F for at least 3 days. Accelerated curing methods may be used (see ACI 318: 26.4.7-26.4.9). The ambient temperature for shotcrete shall be > 40°F for the same period of time as noted for concrete. Shotcrete shall be kept continuously moist for at least 24 hours after shotcreting. All concrete materials, reinforcement, forms, fillers, and ground shall be free from frost. In hot weather conditions ensure that appropriate measures are taken to avoid plastic shrinkage cracking and that the specified water/cement ratio is not exceeded.
Strength verification	☐ Continuous	☒ Periodic	Verify that adequate strength has been achieved prior to the removal of shores and forms or the stressing of post-tensioned tendons.
Formwork	☐ Continuous	☒ Periodic	Verify that the forms are placed plumb and conform to the shapes, lines, and dimensions of the members as required by the approved construction documents.

Table 7. Frequency of Component Replacement or Maintenance

Item	Estimated time of Replacement	Source
Precast Concrete Box Culvert	100 years	Columbia Precast Products
Asphalt Pavement	20 years	Empire Paving
Lighting	6 years	Portor Lighting
Snow Maintenance	As Needed	University of Utah

Section 5.4 Construction Needs and Phasing Summary

Construction Needs

Important features that a contractor should be made aware of:

- Overhead power lines are 20 feet high
- Vehicle width limited to 12 feet
- Close East sidewalk on Foothill Drive
- Salt Lake Valley prohibits construction equipment usage and construction activities outside the hours of 7:00 am to 10:00 pm unless a noise permit is issued (section 4.7.2) [7].
- Table 1a in "Community Noise Pollution Control" [7] shows that noise levels between the hours of 7:00 am and 10:00 pm should not exceed 70 dBA.
- Two staging areas have been considered for this construction, and they can be seen below in Figure 10. The area shown in blue would be closer to the construction, but it would impact the existing bus stop. For this reason, the area in red should be selected as the staging area. It will not impact any public transportation, it is still close enough to the construction to be feasible, and the wider shape allows for more flexibility with equipment storage.

Figure 10. Staging Area Location

Maintenance of Traffic Plan

During construction there can be two alternatives for a traffic plan:

- 1. Close section of Foothill Drive (between Wakara Way & Mario Capecchi). This alternative will reroute northbound traffic to go right on Wakara Way, take a left on Chipeta Way, take another left onto Pollock Road, turn right on Fort Douglas BLVD, then left on Hempstead Rd, another left on Mario Capecchi, and turn right on Foothill Drive to get back on the road. For southbound drivers they will have to take a left toward Mario Capecchi, a right on Hempstead Road, another right on Fort Douglas BLVD, a left on Pollock Rd, a right onto Chipeta Way, a right on Wakara Way, and lastly a left towards Foothill Drive. Figures X & X show the northbound route and the southbound route separately.
- 2. Close half of Foothill Drive at a time. The design calls for a skylight in the middle of the road, which can lead to having two precast concrete boxes for each section. This can help with the building of the tunnel and the minimizing of traffic disruption. The road can be split into southbound and northbound sections. While having the southbound lanes closed, the West side of the tunnel will be placed and repaved once it has been installed, the southbound traffic will be redirected as seen in figure X. The traffic will be moved to the new southbound lanes and the northbound lanes will be closed off to install the East section of the tunnel, the northbound traffic will be redirected as seen in figure X. Once this section is repaved and the new stripping is done, the entire road can be reopened.

Figure 11. North and Southbound Traffic Alternatives

Landscaping Plan

The aesthetic look for this project has been explored with the client and the team. There has been initiatives from the city to keep as many trees as possible during construction. Given that this will be a large project, inevitable some trees will need to be taken down, as well as local vegetation. The plan after construction is finished is to replant the removed trees and add more as is seen needed through the perimeter. Around the tunnel entrances there will be benches as well as local flowers and bushes to increase bio diversity. The team hopes for the community to be involved in the design for the interior of the tunnel. Some of the ideas include a mural of the local flora and fauna with descriptions of how they effect and help their ecosystem for a more educational approach. The next idea is to create a community contest where locals will submit their mural design idea and later the same community will vote on the best one.

The following figures show an basic look into what the underground tunnel will look like after construction, both West and East entrances can be seen, as well as their respective trail connetions. This landscaping design can have future adjustments and additions regarding the layout of vegetation and miscellaneous infrastructure as the project is being constructed.

Figure 12. East Entrance Landscape Design

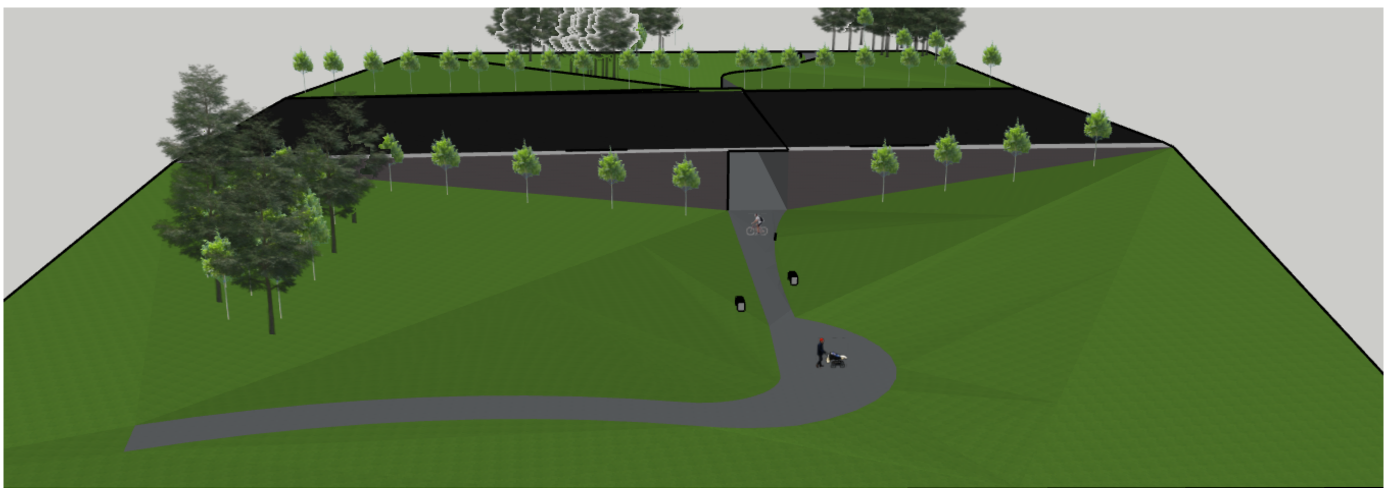


Figure 13. West Entrance Landscape Design

Section 6. Design Summary Effectiveness

The effectiveness of this design will be predominantly focused on safety and rate of utilization. This underpass will remove the risk of vehicle-pedestrian accidents, provided that it is utilized well. In addition to safety, the main goal of the underpass is to serve as a connection for Red Butte Creek Trail. In this design, the length of the culvert's outer wall lies 10 feet south of the length of the existing culvert for Red Butte Creek. Because of the location, this will benefit pedestrians of both Wakara Way and Mario Capecchi Drive. There will also be little to no deviation needed from the trail because it is such a direct route across Foothill Drive. Not only will the underpass function as a superb trail connection, but it will also be able to connect bus routes and active commuters to and from the VA and the University of Utah.

In order to improve utilization, the design will also focus on the aesthetics of the trail to ensure that the lengthy underpass is welcoming and safe. After analyzing several alternatives, our team decided upon a design that focuses on natural light via a skylight in a proposed median in the center of Foothill Drive. Because the length of the underpass is nearly 150 feet, artificial lighting is also required. Lighting the underpass may accentuate murals, wall finishes, and scientific or historical placards, in addition to benches and tables outside of the underpass for people to stop, rest and recreate. The underpass may also feature a gate and security cameras to ensure the safety of all users.

Maintenance of the traffic plan (MOT) will need to be developed extensively to prevent further congestion of Foothill Drive during construction. Another option for construction is the box push method, which may allow for limited to no disruption of the roadway. This option may prove difficult because it is a new process that contractors in the area may not be familiar with.

Overall, the conceptual effectiveness of the design is high, but it may lack details that would typically be seen in construction drawings. Details regarding foundations, soil pressures, and constructability are estimates and will be further established upon general design feedback and approval from the client.

Section 7. Cost Estimate

Concept level design, as well as unknown factors relating to utilities, prompted a 20% contingency. Another 20% is also included for further design and engineering because there is much more work to do.. The grand total for the project will be approximately $6.3 million. The majority of the cost stems from a custom concrete box culvert that is 12 feet high by 18 feet wide and spans approximately 150 feet. Several details are a part of the cost estimate. Construction, roadway alterations, and aesthetic finishes are all included in the cost estimate, these major categories are summarized in Table 8 below.

Many of the costs are estimates from comparing several websites and vendors. Others are educated inquiries and estimates from the instructional team or mentors. Construction costs include mobilization, excavation, and dust control. Material costs are also estimated for connecting the Red Butte Creek trail beneath Foothill Drive, as well as the box culvert and roadway alterations. In order to fit the skylight, a median must be constructed in the center of Foothill Drive. With the placement of a median Foothill Drive will be slightly altered to ensure that roadway lanes are not disrupted. Finally, finishing costs are also included to ensure that the underpass is approachable.

There are several minor costs that will be added to the final project by more experienced professionals, but the overall cost of this project should not exceed $8 million. The repavement of Foothill Drive after construction was not included, because the entire roadway will need to be repaved anyway in the next five to ten years. Another cost not included is repaving Red Butte Creek Trail with gravel or asphalt because the final path has yet to be determined. The entire trail is expected to be repaved once it is fully completed.

Table 8. Full Cost Estimate

Item Number	Description	Source	Quantity	Unit	Unit Price ($)	Total Cost ($)
1	Mobilization	The Constructor	1	NA	100,000	100,000
2	Water for Dust Control	GX Contractor	1	NA	5,000	5,000
3	Excavation	ProEst	2500	Cubic Yards	100	250,000
4	Box Culvert (18' x 14')	Several Vendor Estimates	1	Cubic Yards	3,500,000	3,500,000
5	Traffic Control	Columbus	1	NA	2,500	2,500
6	Granular Base	Dr. Bartlett	12.5	Cubic Yards	32	400
7	Roadway Alteration	N/A	1	NA	500,000	500,000
8	Median and Skylight	N/A	1	NA	50,000	50,000
9	LED Lights	Portor Lighting	25	Each	100	2,500
10	Mural	N/A	1	Each	5,000	5,000
11	Anti-Graffiti Finish	Exterior Coatings	1	NA	5,000	5,000
12	Finishing Vegetation	N/A	1	NA	10,000	10,000
13	Environmental Study	Lynn Jacobs	1	NA	100,000	100,000
					Total	4,530,400
					20% Contingency	906,080
					20% Design and Engineering	906,080
					Grand Total	**6,342,560**

Section 8. Work Summary

Work for this project began in the Fall semester of 2022 when students began preliminary design. This consisted of stakeholder analysis and scope identification, as well as learning about several factors of the project from guest speakers. These speakers spoke on topics related to the geotechnical, structural, and hydrologic fields of civil engineering. Case studies similar to the design of our underpass were also conducted. Students also researched Salt Lake City's master and city plans to connect this project to a larger goal. Overall, the goal of last semester was to prepare students for technical design in the spring semester.

Since last semester, there have been numerous changes to the goals of this project. Originally, the goal of this project was for the underpass to serve as a below-grade crossing for pedestrians to use instead of crossings at Mario Capecchi Drive and Wakara Way. This concept also focused on connecting to existing sidewalks on both sides of the underpass. However, the project evolved into focusing on the trail system near Red Butte Creek. The main focus of the project is to connect pedestrians to existing and future trails that run parallel to Red Butte Creek.

In the Spring semester of 2023, students began working diligently toward the technical design of the underpass. A deeper analysis of last semester's work, in addition to developing drawings and evaluating several alternatives, was the focus of the last three months. Students developed in-depth drawings in plan, profile, and cross-sectional views. Red Butte Creek was also studied extensively to determine the impact of flooding in the underpass.

Appendices

Appendix 1: Stormwater Calculations

For the stormwater calculations, an impermeable rectangular channel was assumed. This will not be the case in reality due to the stormwater drainage system that will be in place, but this assumption ensures that stormwater will be able to flow through the underpass without spilling over into the walkway. It is designed for the 100-year storm with the assumption that 10% of the flow would travel through the underpass.

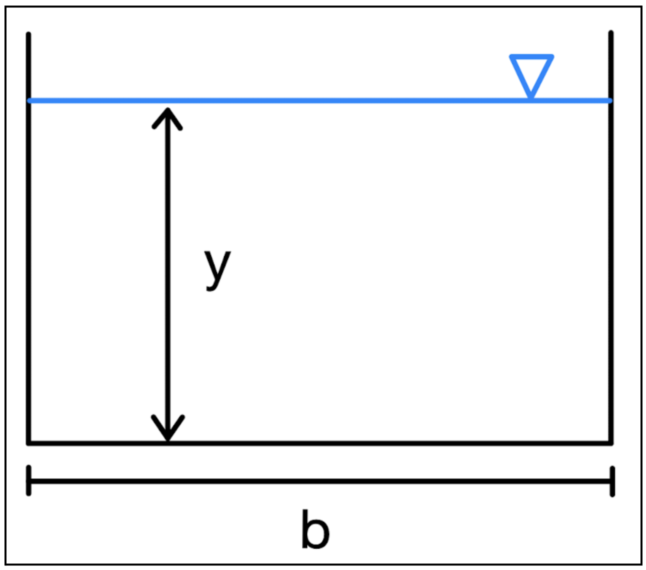


Figure 14. Rectangular Channel Cross Section.

Example Calculations for the stormwater drainage system in our underpass:

$$Q = 0.10 * 172\, ft^3/s = 17.2\, ft^3/s \;;\quad use\ 18\, ft^3/s\ to\ be\ conservative$$

$$Q = 18 = V * A$$

$$A = b * y$$

$$When\ b = 1\, ft,\ A = 1y$$

$$18 = V * y \ -> \ V = 18/y$$

$$Fr = \frac{V}{\sqrt{gy}}\ where\ the\ Froude\ Number\ (Fr)\ should\ be\ less\ than\ 1\ to\ ensure\ subcritical\ flow$$

$$1 > \frac{18/y}{\sqrt{gy}}$$

$$1 > \frac{18}{y^{1.5}\sqrt{32.2}}$$

$$y^{1.5} > \frac{18}{\sqrt{32.2}}$$

$$y > \sqrt[1.5]{3.17208}$$

$$y > 2.16\, ft\,;\ use\ 2.2\, ft\ to\ be\ conservative$$

For a rectangular channel with 18 ft^3/s of flow, a water depth of 2.2 ft is required to maintain subcritical flow. This situation is highly unlikely, as it would only occur in the event that a 100-year storm took place and the stormwater in the underpass was completely unable to drain. These calculations should ensure the walkways in the underpass never flood. A 50-year storm event was not considered for these calculations because a 50-year storm would not flood the underpass given its current proposed location and the existing floodplain.

Table 9 shows possible widths that can be used for the individual drainage areas and the corresponding flow depth that would need to be allowed. A drainage area that is 2 feet wide and 1.5 feet deep would be sufficient and would not drastically affect the current design.

Table 9. Stormwater Design Alternatives

Width of Drainage Area	Allowable Flow Depth to Ensure Subcritical Flow
1 ft	2.2 ft
1.5 ft	1.7 ft
2 ft	1.4 ft
2.5 ft	1.2 ft
3 ft	1.04 ft

Appendix 2. Specification Sheet

The following information is from UDOT's 2023 Specification Sheet for Road and Bridge Construction; resource 8:

BACKFILL AND RESTORATION

A. Backfill test-hole excavation according to utility owner's specifications when outside of the roadway prism.

1. Backfill according to the most restrictive of either the Department's or the utility owner's specifications if test-hole excavation is within the roadway prism.

2. Backfill within 24 hours or as otherwise determined.

B. Backfill test-hole excavation to the same depths and grades with equivalent or better materials of surrounding pavement or terrain. Remove and dispose of pieces over 1 ft2.

REMOVE CONCRETE SIDEWALK AND CONCRETE DRIVEWAY

A. Remove concrete to the nearest expansion joint or saw cut to provide proper grades and connections.

B. Make concrete cuts straight, vertical to the surface, full depth, and free from irregularities. Refer to Section 02705.

COMPACTION REQUIREMENTS

1. Borrow, Drainage Pipe Bedding, Embankment Material, Embankment for Bridge, Granular Backfill Borrow and Granular Borrow

a. Compact each lift to a minimum average of 96 percent of maximum laboratory density with no single determination lower than 92 percent.

1) Use AASHTO T 180 Method D for A-1 soils and AASHTO T 99 Method D for all other soils to establish maximum laboratory density.

2) Maintain appropriate moisture for compaction during Processing.

2. Drainage Pipe Backfill

a. Compact each lift to a minimum average of 92 percent maximum laboratory density with no single determination less than 90 percent.

1) Use AASHTO T 180 Method D for A-1 soils.

2) Maintain appropriate moisture for compaction during processing.

b. Meet the pavement section material density requirement for pipes that encroach into the pavement section or use flowable fill.

3. Material with more than 30 percent retained on the 3⁄4 inch sieve

a. Compact each lift to 100 percent of the developed field Density.

1) The Department develops a field density compaction curve according to UDOT Materials Manual of Instruction Section 989.

4. Free-Draining Granular Backfill

a. Compact each lift to 100 percent of the developed field density.

1) The Department develops a field density compaction curve according to UDOT Materials Manual of Instruction Section 989.

CONCRETE PLACEMENT

A. Dry Hole Placement

1. Place concrete immediately after placing the reinforcing steel cage.

a. Begin concrete placement within 16 hours of completion of drilling the shaft hole.

b. Place concrete in a continuous operation.

2. Use a tremie or spout to prevent concrete from striking the reinforcing steel cage.

a. Do not allow the free-fall of concrete to exceed 5 ft.

3. Vibrate the concrete within at least 10 ft from top of shaft.

4. Remove contaminated concrete from the top of the shaft.
    a. Remove and dispose of muck, laitance, and contaminated Concrete.

B. Water In Hole Placement

1. Place concrete immediately after placing the reinforcing steel cage.
    a. Begin concrete placement within 16 hours of completion of drilling the shaft hole.
    b. Place concrete in a continuous operation.
2. Use a tremie to place concrete.
    a. Purge the tremie pipe of water.
        1) Insert a sturdy plastic ball or equivalent into the top of the pump hose extension before connecting the hose from the concrete pump.
        2) The ball must fit snugly into the pump hose extension when the hose is filled. The hose must be strong enough to resist rupture.
        3) Prime the hose and pipe with cement slurry.
3. Lower a small diameter pole with an attached flat plate into the hole to determine the top surface of concrete.
    a. Mark both pole and tremie pipe so that the length of penetration can be immediately determined.
    b. Prevent the end of the tremie pipe from becoming plugged with soil from the bottom of the hole.
4. Begin pumping the concrete immediately after setting the reinforcing steel cage and tremie pipe in the hole.
    a. Do not begin raising the tremie pipe until the concrete surface is 10 ft above the bottom of the pipe.
5. Keep the bottom of the tremie pipe at least 5 ft below the top of the concrete until the placement is complete.
    a. Provide a positive hold down to maintain distance below top of concrete if the pipe floats.

6. Remove casing as the concrete is placed.
    a. Keep the bottom of the casing between 5 ft and 8 ft below the top of the concrete surface when withdrawing.
    b. Prevent concrete separation when withdrawing the casing.
7. Do the following if the tremie pipe plugs, equipment breaks down or loss of the seal at the end of the tremie pipe occurs:
    a. Pull the tremie pipe, reset it 2 ft below the top of the concrete, and purge it.
    b. Lower the tremie pipe to at least 5 ft below the top of the placement and continue pumping concrete until all contaminated concrete has lifted to the top of the shaft.
8. Continue pumping concrete until the water and contaminated concrete is expelled.
    a. Remove and dispose of muck, laitance, and contaminated concrete.

C. Finishing

1. Remove scum, laitance, loose gravel, and sediment from the surface of the shaft concrete before finishing.
    a. Do not permanently cover or impede access to the top of the drilled shaft until authorization of integrity test report is received.
2. Level high spots from the surface of the shaft concrete that would make placement of steel reinforcing as shown more difficult.
3. Cure exposed concrete according to section 03390.

Appendix 3. ISI Envision Estimate

Quality of Life

Does the project:

1. Improve health and safety for the broader community? +2
2. Preserve and enhance cultural resources? +1
3. Meet the needs and goals of the community? +1
4. Minimize negative impact on the surrounding community? +1
5. Follow a fair, equitable, and inclusive development process? +1
6. Is the project located near public transportation? +2

Discuss:

The project for a non-grade crossing at Foothill drive next to Red Butte Creek would instantly make crossing safer than choosing to use the intersections on Mario Capecchi and/or Wakara Way. The crossing will be located next to bus stops on both sides of the street. The building process for either a tunnel or bridge would be invasive to the natural environment, however, this crossing will connect to trails, Research Park, Red Butte Gardens, and the Natural History Museum of Utah, which will enhance cultural resources to the public. There was an auto-pedestrian accident in Wakara Way and Foothill Drive in 2019 leaving a woman critically injured, this raised concerns about the safety of pedestrians in this area, which led to a discussion of different and safer alternatives for pedestrian crossings in the community and the state. The construction of this project might bring some negative impacts to the surrounding community with traffic due to closed lanes or materials/machinery being brought to the job site. However, the community will be positively impacted once the non-grade crossing is finished, given that the safety of all pedestrians will be guaranteed. This project is also design for the communities surrounding Foothill Drive, the developmental process will be inclusive to all pedestrians, given that the Veterans hospital is in the surrounding area and those patients will be a big part on the demographics.

For each question, speculate as to:

+0 not applicable or no opportunity

+1 basic opportunity

+2 chance to go above and beyond for little cost

SCORE: 8/12

Leadership

1. Are there sustainability commitments from the project developers? +1
2. Is there a sustainability management plan in place? +1
3. Are stakeholders engaged? +2
4. Will the project stimulate economic development? +1
5. Are local residents employed on the project? +1
6. Is the project located near public transportation? +2

Discuss:

This project has been discussed and some what analyzed for quite some time now. There is a great possibility for sustainability commitment from future project developers. Salt Lake City Engineers is one of the stakeholders in the project, they mentioned a list of different design considerations, for example, minimizing the invasion to existing property, minimizing the impacts to storm drainage, conveyance systems, and impacts to utilities, they would also like to preserve and protect Riparian Corridors, connect to historic heritage, and promote sustainable design, construction, and usage. The Salt Lake City Trails would like the trails surrounding the crossings be a natural walking path, preserving its original beauty. The process for this project will bring jobs to engineers, construction workers, and the purchasing of materials and machinery will stimulate the economy. Another great source for economic development could be for the surrounding companies to encourage their employees to use public transportation (there are bus stops around the area), bike, or walk to work. The Sunnyside neighborhood community is already considered a stakeholder, this will bring local residents to participate in the project and potentially they could be employed to work on it.

For each question, speculate as to:

+0 not applicable or no opportunity

+1 basic opportunity

+2 chance to go above and beyond for little cost

SCORE: 8/12

Resource Allocation

1. Is the project constructed from sustainable materials? +1
2. Does the project manage construction and operational waste? +1
3. Does the project reduce energy consumption and source renewable energy? +1
4. Does the project reduce water consumption and protect water resources? +1
5. Does the project monitor energy and water use? +1

Discuss:

If the project partners with sustainability committed companies like, Staker Parsons, their materials could potentially be sustainable. There must be a balance between where the material is being sourced from and if its safe for its purpose. This project will be managing all construction and their operational waste. By hiring the correct companies, the waste will hopefully be decreased, and the rest will be dealt in an environmentally friendly way. The stakeholders in the project will have a large say on how sustainable this project will be, the use of renewable energy will hopefully be considered, however, the job site is going to have very limited space for sources of renewable energy. One way to reduce energy consumption would be to make all machinery only run while its being used, no idling. Utah is going through a very dry year and water is scars, the project will hopefully take that into consideration and reduce their water consumption, the job site will have a creek adjacent to the building so protecting that water source is a must.

For each question, speculate as to:

+0 not applicable or no opportunity

+1 basic opportunity

+2 chance to go above and beyond for little cost

SCORE: 5/10

Natural World

Does the project:

1. Avoid sites of high ecological value? +1
2. Protect wetland and surface water quality? +2
3. Maintain hydrological functions? +1
4. Manage storm water? +2
5. Protect soil health? +1
6. Manage or eliminate invasive species? +1

Discuss:

The project will be located next to the Red Butte Creek. This body of water must be protected and cannot be altered during construction, there is a minimum of 20 feet of no impact from the top of channel bank. There will also have to be extensive research and design supporting storm water and potential flooding, especially if the crossing is underground. The soil must be maintained around the creek and the trails surrounding the pedestrian path. The project must take into consideration the protection and preservation of Riparian Corridors which lay all around the creek, specially at the entrance and exit of the creek culvert under Foothill Drive.

For each question, speculate as to:

+0 not applicable or no opportunity

+1 basic opportunity

+2 chance to go above and beyond for little cost

SCORE: 8/12

Climate and Resilience

Does or is the project:

1. Reduce greenhouse gas emissions? +1
2. Reduce air pollutant emissions? +1
3. Avoid unsuitable sites? +1
4. Reduce climate change vulnerability? +1
5. Resilient and adaptable? +1

Discuss:

The project could consist of two alternatives, a bridge or underground tunnel. Both alternatives will require extensive machinery that burns fossil fuels and add to the carbon emissions in the atmosphere. There could be an opportunity to reduce these emissions by encouraging the construction firms to avoid idling. There could be an opportunity to use some renewable energy on smaller machinery and maybe for night or underground construction the use of solar powered lights could be helpful. The site where this project will be based it will most likely be the parking lot to the south if the VA Salt Lake City Regional Office, here the site will be far away enough from the natural habitats on the east side of Foothill drive. This project will need to go above and beyond in the department of resilience. There has to be daily, if not hourly, weather updates, especially during spring or heavy rain season, to make sure the creek doesn't overflow. This project will need to anticipate any risks potential to the area, specially if the construction is underground.

For each question, speculate as to:

+0 not applicable or no opportunity

+1 basic opportunity

+2 chance to go above and beyond for little cost

SCORE: 5/10

Summary:

The main key opportunity for this project is the safety of pedestrians. The whole project is based on how to make this crossing better and safer to connect pedestrians from the west side to the east. The east side has many destinations to offer for the community, it has Research Park, the University of Utah, trails leading to Red Butte Garden and the mountain trails, and the Natural History Museum of Utah. Another piece to consider is the protection of Red Butte Creek and making sure construction doesn't damage the water flow and surrounding vegetation. The overall purpose of envision is to improve the sustainability performance of a project. Looking at the crossing there are many places where sustainability can be improved, the scoring given was mainly based on hypothetical circumstances and potential contractors involved in the project.

Overall Percentage: 60% (platinum)

Resources

[1] D. Schmucker, CVEEN 4900 Canvas Modules, University of Utah. Available: https://utah.instructure.com/courses/798316. [Accessed: 5-Oct-2022].

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[5] Master Plan Transportation Salt Lake City http://www.slcdocs.com/Planning/Projects/PlanSaltLake/final.pdf [Accessed: 12-Sep-2022].

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[7] “Salt Lake Valley Health Department - Salt Lake County, Utah,” Community Noise Pollution Control. [Online]. Available: https://slco.org/globalassets/1-site-files/health/regs/noise.pdf. [Accessed: 27-Mar-2023].

[8] UDOT, 2023 Specification Sheet for Road and Bridge Construction. Available: https://drive.google.com/drive/folders/1WUQNI_0zcbBPPAYqZTIe2dTwcJ-2IsqJ. [Accessed 30-Mar-2023].