Memo - 4910.23.1 Group 3 Red Butte Creek South Foothill Underpass

March 30th 2023
To: Lynn Jacobs
From: Group 3

The following submission is the revised final design of the Red Butte Crossing, located south of Wakara Way. There are several smaller changes we made to the overall design following comments and suggestions made previously. There is room for refinements and changes as needed.

Our focus going forward is to refine the design for presentation, develop a public outreach plan, and determine any additional adjustments that can be feasibly and realistically done to promote CPTED quality, add additional value, and community support for the project.

Provided below are design briefs, which contain information regarding design effectiveness and methodology, parameters and constraints, project summaries, and other general information. We have also provided a drawing plan set to review and show the work done up to this point.

Group three and Group six have combined drawing sets due to both projects being proposed as one package. This change reflects the overall master plan to have two underpasses for this proposed concept. This report will primarily focus on Foothill Drive and the connecting landscape areas to the east and west.

As always, please feel free to reach out. Contact information is provided on the signature of the drawing set and design brief.

Regards,

Group 3

RED BUTTE CROSSING

LOCATED AT THE SE CORNER OF SECTION 4 AND THE SW CORNER OF SECTION 3
T1S. R1E. SLB&M
SALT LAKE CITY, SALT LAKE COUNTY, UTAH

Department of
Civil & Environmental Engineering
THE UNIVERSITY OF UTAH

RED BUTTE CROSSING

LOCATED AT THE SE CORNER OF SECTION 4 AND THE SW CORNER OF SECTION 3
T1S. R1E. SLB&M
SALT LAKE CITY, SALT LAKE COUNTY, UTAH

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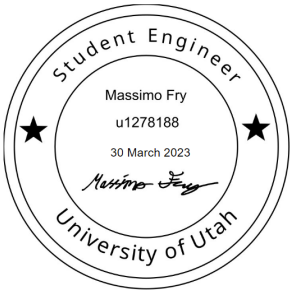
Disclaimer: The study described herein is associated with the courses CvEEN 4900 and 4910 Professional Practice & Design conducted at the University of Utah, 2022-23. As such, it is intended for academic use only. Engineering opinions and descriptions provided are likewise only for academic use



Acknowledgments

We would like to thank the support we received from the 4900 and 4910 instructiona team, Dr. Douglas Schmucker, Dr. Stephen Bartlett, Cyrus and HR. We also like to express gratitude towards our mentors from Parametrix, Cody Salisbury and Adam Pocock, for their advice and support. We also would like to thank the other mentors from Contech and AGEC for the help and information they provided. We also would like to thank the other engineers and professionals who helped give us feedback and support.

Executive Summary

The main goal for this project is to design a pedestrian underpass, in collaboration with group six, to cross both Foothill Drive and Wakara Way. This report is primarily focused on the underpass underneath Foothill Drive. For information on the Wakara Way underpass, see the group six report. Extensive engineering and safety analysis has been performed in order to design a pedestrian underpass that is:

- Both functional and appealing to the public
- Safe to use
- Efficiently designed

This document provides information on things such as:

- Cost estimation
- Existing site conditions
- Geotechnical analysis
- Hydrological analysis
- Design constraints and decision process
- Envision and EDIA impacts
- Structural calculations
- CPTED implementations
- Overall project summary and recommendations

Attached to this report is the revised final plan set which includes the following:

- Existing site conditions
- Site and Grading plans
- Utility plans
- Profile and cross sections
- Traffic management and construction plans
- Landscaping plans
- Drawing details

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1 Project Summary

1.1 Project Needs Statement

Foothill Drive is an essential arterial road that connects the University of Utah, Research Park, University hospital facilities, neighborhoods, and other businesses. Any new developments in the area will increase the volume of travelers on Foothill Drive. The primary solution to reduce traffic congestion is by increasing access to alternative routes of transportation. Since many vehicles are dedicated to short trips between locations, encouraging travelers to forego vehicular use and opt for walking, biking, and other non-vehicular modes of travel is the best approach. The Foothill and Wakara Way crossing is an important component to enable travelers and recreationists to safely and conveniently cross major streets while avoiding vehicular traffic.

1.2 Project Goals and Vision

The goal of this project is to:

- Elicit use for travelers from residential areas to and from the University, research park, and other businesses, therefore reducing the volume of short vehicular trips on Foothill Drive.
- Developing a separate grade crossing is specifically aimed at eliminating the existing at-grade crosswalk, which is neither comfortable nor safe to use.
- Non-vehicular travelers should have a convenient, expedient, and safe path of travel, and vehicles traveling along Foothill should experience a similar amount, or a reduction, in traffic volume.
- This project is part of a grander vision to make Foothill Drive a “complete street”, which facilitates users of all modes and abilities to travel functionally and safely. The master plan will be to integrate a future red Butte Creek trail, which allows recreationists and travelers to travel along Red Butte Creek from Liberty Park to the Bonneville Shoreline trail.

1.3 Project Participants and Organization

UDOT is the primary organization that provides oversight of engineering, construction, and impacts on traffic. The CVEEN 4910 capstone class performs all necessary design work and calculations, with immediate feedback from instructors and Salt Lake City. Additionally, mentorship and design resources are being provided by firms Parametrix, Conetec, and AGEC.

1.4 Stakeholders

While the majority of the stakeholders share common goals, the methods and approaches to reach these goals slightly vary. The stakeholders that have the ability to impart the greatest influence on the project are analyzed below in terms of their goals and what can be done to satisfy them.

- The City of Salt Lake - Includes the city engineers and planning committees. The city has priority in the time frame and major design decisions for this project. Their main priority is to create a crossing that provides the greatest impact on the community in terms of usage and safety.
- UDOT - The Utah Division of Transportation has authority over any activities within the boundaries of the Right-Of-Way of Foothill Drive. Their main priority is to improve pedestrian safety in the area as well as reduce or maintain the current traffic flow.
- The University of Utah - The group includes university leadership, students, and other community members that will utilize the crossing to access facilities located on the University of Utah campus. Their goal is to increase the safety of students by connecting the new housing to Research Park and the main campus.
- Red Butte Creek Steering Committee - The group created a project called the Red Butte Vision which lays out goals of providing more access to the creek while also protecting it. Maintaining a balance between nature and people is their goal. They want some spaces near the creek to remain wild in order to provide space for wildlife.

2 Site Description and Analysis

2.1 Location and General Usage

Property ownership in the project area is difficult to determine since the majority of the land is owned by the University of Utah and the Federal Government. UDOT has a ROW easement on Foothill Drive. The project will require a new boundary survey to determine the exact boundaries and easements. Official documents can be obtained from the city that will allow for clarification on this issue.

Based on an initial site visit, one of the main challenges for construction would be the management of preexisting utilities. It is important to ensure that there is no loss of function during the construction process, which would require rerouting the underground lines (storm drains and sanitary sewer are particular concerns). There are above-ground power lines on both sides of Foothill Drive as well. Access to the sewer and storm drain must be maintained, as well as several underground electrical units.

2.2 Geologic and Geotechnical Summary

Based on the field testing done in October of 2022, the soil near the creek's east side of Foothill drive consists of a large amount of fill dirt (approximately 9’-28’). This is likely from the construction of Foothill Drive and surrounding landscape. Any sort of foundation would be supported by the soils that exist in the area.

Footings may be designed with an allowable net bearing pressure of 2500 psf. The following fluid weights are also recommended for the design of the underpass walls and retaining walls:

Table 1: Geotechnical Pressures for Walls
Active: 40 pcf
At Rest: 55 pcf
Passive: 300 pcf

For seismic conditions, active pressures should be increased by 44 pcf, at rest pressures increased by 29 pcf, and passive pressures decreased by 44 pcf. This is based on a 50-year event.

The lab report generated by AGEC indicated that the soil chemical makeup is acceptable to prevent corrosion and that it would be difficult to build anything right next to the creek. For our project, we are assuming that the soil pressures are the same just not next to the creek. The design will meet the criteria for the required capacity.

Table 2: Cut Fill Summary
Total: 47418 cu yd cut
Group six landscaping area: 11,855 cu yd
Underpasses: 1,784 cu yd
Remaining landscaping area: 33,779 cu yd

2.3 Hydrologic Summary

Our initial calculations were determined for the landscaped area to the southeast of the intersection of Wakara Way and Foothill Drive. The following calculation shows we need to hold at least 2,200 CU FT. The site has the space for a few 2' detention ponds and has the capacity for an underground storage system if required.

2.4 General Topography

The project area mostly consists of Foothill Drive running through the project with landscape fill on either side. Both hills slope down to the west at varying slopes. Foothill Drive is relatively flat in our project area and the intersection of the road and Wakara Way serves as a grade break for the road. Wakara Way slopes upward towards Research Park along with the landscape fill. Red Butte Creek is located further north away from the project area and would not be significantly impacted by the construction of the project.

The property to the east is part of Research Park and university housing. The property to the southwest is university housing. The property to the northwest is Corner Bakery and part of the VA property.

3 Summary of Criteria

3.1 Project Criteria

The main objective for the design is to:

- Provide a safer alternative for pedestrians and cyclists of all ages, abilities, and backgrounds,
- To cross Foothill Drive without installing an at-grade crossing.
- Provide a potential connection to a future trail system along Red Butte Creek.
- Help deter general crime through smart design and environmental systems.
- Add value to the area and be desirable enough to use.

3.2 Basis of Design

- Integration of Stakeholder Priorities and Values
  - Address stakeholders' wants in the project by accurately communicating plans for the project by including their input into the final design.
  - Make sure stakeholders are included in deciding what alternatives should be selected and design features they would like included in the project.

- Integration of Sustainability
  - Envision sustainability analysis was done for this project to evaluate if the project was being designed in a sustainable way. From the analysis it was found that overall the project can be done somewhat sustainably if sustainable materials were selected and the project would help the quality of life in the surrounding area. However, this project does not do much in helping the natural world around the area and helping the climate.
  - Make sure when possible sustainable designs/materials will be selected and considered throughout the project
  - Give detailed information to shareholders about why and how sustainable designs/materials should be implemented into the project.

- Integration of Equity, Diversity, Inclusion, and Access
  - Structure is designed so that everyone of all physical abilities is able to safely cross Foothill drive.
  - ADA-compliant grades for the ramps and tunnel are followed to ensure everyone can safely use the pedestrian underpass
  - Designed so bikers can safely and efficiently use the pedestrian underpass

3.3 Decision Criteria

From the initial site visit and analysis of existing conditions, the following items need to be addressed for an underpass design to be implemented:

- All underground utilities running through Foothill and Wakara need to be relocated. We don't know the extent to which utilities are impacted, but the design is built with the contingency that all lines are affected.
- In order to be ADA compliant, all path slopes need to be under 8.33% with landings, or under 5% without landings.
- As a result of excavation, a method of detention, or retention, of stormwater will need to be addressed. City requirements typically plan for an analysis of a 100-year storm event.
- The location was determined to avoid disturbing the existing VA property (including Corner Bakery)
- The design needs to avoid areas that could impact parking
- The underpass has to be at least 12' wide and 10' tall to maintain the UDOT code. The paths have to be at least 12' wide to be maintained as a trail
- Any methods to help reduce costs will be preferred such as reducing excavation costs via retaining walls or minimizing road closures during construction.
- All designs are to meet UDOT, Salt Lake County, and Salt Lake City codes where applicable.
- It has to connect to another underpass to be located in Wakara Way to connect back towards the creek.
- Design must have CPTED (Crime Prevention Through Environmental Design) elements to add additional safety and value.

3.4 Design Criteria

The project was designed with the following design criteria in mind:

- Safety: The design of the underpass should ensure that pedestrians and cyclists can move safely without risk of accidents or injury. A successful underpass will provide a safer option for travelers to avoid crossing a dangerous intersection.

- Accessibility: The underpass should be accessible to people of all abilities and any non-vehicular mode of travel. The design should facilitate easy travel for all, including those with disabilities. Handrails, gently sloped paths, and adequate signage and visibility are key.
- Aesthetics: Making the pedestrian underpass inviting to use for the general public. This goal can be achieved through things such as light, murals, open space, etc.
- Structurally Sound: Designing the project to ensure that it can handle the design loads for the given area to ensure that it stays intact even in some of the worst of conditions.
- Cost-effectiveness: Creating a design that helps save money for the client while also meeting the requirements for the project and being structurally safe.

4 Summary of Alternative Selection Process

4.1 Alternative Analysis

The preliminary design phase of this project involved analysis of different locations along the Foothill Drive between Sunnyside Avenue and Wakara Way, and different underpass types and dimensions. These alternatives create a matrix of combinations to select from. Four equidistant locations were analyzed for proximity to the intended user, ease of integration with the existing area, and the available space to build the structure.

Utilities were also an important topic of consideration, but relocations of interfering utilities were considered a feasible and likely possibility. Location was analyzed based on physical constraints, while the type and dimensions of the underpass were analyzed on a more qualitative basis. The engineering team analyzed how underpass shapes including arches and boxes, or combinations of the two, influence the comfort of users and the aesthetic appeal of the design. Once the design was chosen, the engineering team discussed additional value options such as sunken plazas and expanded pathing that could be added but not necessarily change the project in a major way.

4.2 Alternative Selection

Upon in-depth analysis of the locations and types for an underpass, the engineering team determined the optimal design that minimized travel distance, simplified right of way and property lines, and left room for future developments to integrate seamlessly into the proposed design. The design location just south of the intersection of Wakara way was an appropriate middle ground between the incoming residential developments on Sunnyside Avenue and the existing foot traffic on the nearby Crosswalks which are used to access public transport. This location was also chosen for its ample property area on the intersection corner

owned by the University of Utah. The box shape was chosen to minimize the depth of the tunnel to shorten the pathing required to return to grade. The shallower underpass also gives more space for the proposed utilities including the new storm drain lines and relocated sewer lines. The 18’ width was chosen to allow a large passing space between travelers to enhance safety and comfort of use. To finalize the design, a sunken plaza is proposed to add value to the immediate area and make the underpass an attractive alternative. This area included subtle and natural landscaping, seating, and pathing.

5 Design Development Summary

5.1 Design Process

The design methodology began by determining the level of need for an underpass across Foothill Drive, and the types of users that such a project would serve. The project team decided to locate the underpass as close to the intersection with Wakara Way to minimize travel distance for users, and better integrate the underpass with the available space. The design of the underpass itself (width and height) was chosen with a focus on comfort in passing space. It was necessary to keep all the paths ADA (5% or lower) and keep the area below the road, letting the pathing maintain consistency for cyclists and providing several landscaping opportunities. This comes at the cost of needing to excavate more fill. The design also includes stairs for quicker access for those who don't want to walk along the entirety of the path. CPTED elements were implemented such as efficient well-lit underpasses, a skylight for natural lighting, security cameras, and other landscaping and park methods. The design also had a focus on simplicity in form and function but generate opportunities for community engagement

5.2 Design Data and Specification

For all figures and calculations, refer to Appendix II-V and the attached plan set.

5.3 Operations and Maintenance Summary

Operation and maintenance are expected to be minimal but will be necessary throughout the year. Areas with new sidewalks will need to be maintained throughout the season, including snow removal and maintenance of the proposed landscaping and vegetation. More importantly, the new drainage features that tie into the existing storm drain, will need to be cleaned out on a regular basis. Years of weathering always result in concrete cracking, requiring a built-in budget to seal these cracks in retaining walls and replace pavement slabs when necessary. The underpass structure itself is surrounded by soil, and groundwater may seep through cracks that form. Regular annual maintenance that mitigates seepage, should prevent any required overhaul of the structure.

6 Design Summary Effectiveness

6.1 Summary of Final Design

The design consists of two 16’-18’ wide concrete underpasses under each major road. There will be a 12-foot wide asphalt trail that connects the two structures and existing sidewalks. The paths will be landscaped with roundabouts, keystone retaining walls, 3:1 slopes, and other vegetation features. The Foothill drive underpass has a skylight to provide natural light to the structure. There is also a staircase option to increase options of travel.

6.2 Final Design Effectiveness

The intent of the project will provide a safe and efficient alternative to the existing at-grade crosswalk for users of all abilities. An effective design is classified as one that serves a utilitarian purpose and is attractive to use. It adds value to the area from a standpoint of both usability and aesthetics. Ultimately, the design is part of a broader plan to increase options for travel to minimize short vehicular trips in the area. The proposed design is located in an area anticipated to see a high number of short-distance trips between the future residential developments, the research park, the University of Utah, the VA, and the surrounding trail systems. The underpasses are designed to be integrated with existing sidewalks and bus routes, while a trail system may be added at a later date. The design itself is to be wide enough for users to safely pass by one another, and a proposed light well adds natural lighting to enhance comfort for the users. The surrounding landscaping ensures that the design does not detract from the pre-existing aesthetic, architectural, and environmental value of the area. In conjunction with the underpass of Wakara way, future residents of the residential developments on Foothill Drive can access a key UTA bus route without crossing a busy intersection, and travelers to and from Research Park or the University of Utah have two less busy streets to cross.

7 Cost Estimate

The cost estimation below breaks down the different components that are needed in order to complete the pedestrian underpass that crosses Foothill Drive. Since the project is a part of the overall project with group six design, a connected underpass will cross Wakara Way. Note, below is not a complete cost estimation for what the total cost of this project will be.

Table 3: Cost Estimate Calculations

Item	Units	Number	Cost/Number	Total Cost
Excavation	yd^3	36000	$50	$1,800,000
Concrete	yd^3	732	$1,500	$1,098,000
Repaving Road	mile	0.01	$980,000	$9,800
Construction and Traffic Management Plan	N/A	N/A	N/A	$1,248,322
Labor	N/A	N/A	N/A	$1,248,322
Sewer Line Relocation Cost	ft	420	$250	$105,000
Curb Relocation	ft	300	$21	$6,300
Asphalt Walkways	ft	540	$35	$18,900
Drain Water Line Relocation Cost	ft	77	$250	$19,250
Equipment Cost	N/A	N/A	N/A	$60,000
Median w/ Skylight	ft^2	255	$8.00	$2,040.00
Pavement Markings	ft	495	$3.06	$1,514.70
Contingency	%	10	N/A	$624,161
Total Cost				$6,241,609

8 Work Summary

The design team first conducted a need analysis to determine the scope and extent of the project. Site visits and research-informed decision-making determined the optimal location of the project. Multiple alternatives were generated in the preliminary design phase. These options were narrowed down to 4 potential locations and a set range of possible dimensions. The final design was chosen based on the outlined design criteria and satisfies the criteria to the fullest. The work then transitioned to integrate the design into the existing space, with regard to the right of way, property lines, and existing utilities. This stage culminated the schematic design phase and initiated the engineering from quantitative data to determine the technical requirements for the underpass, retaining walls, and drainage features. Time was dedicated to designing optimal trail design to connect to the existing sidewalk, landscaping to match or improve the existing area, and other details to maximize the use of the project, increase safety and accessibility, and create a sustainable positive impact for the community and environment.

Appendix I - Existing Site Conditions

Legal Description of Properties Affected by Project

Parcel Number: 16092260010000

Legal Description:
BEG S 42^15’30” E 9160.378 FT & S 89^59’50” W 1801.0333 FT & N 0^02’01” W 800 FT FR NW COR SEC 4, T 1S, R 1E, SLM; S 89^59’50” W 254.96 FT; N 30^05’ E 231.97 FT; N 71^29’ E 130.01 FT; N 43^59’ E534.97 FT; S 57^36’ E 250.01 FT; S 75^26’E 165 FT; N 71^44’ E 202.01 FT; N 57^29’ E 125 FT; S 30^31’ E 279.7 FT; S 73^42’ W 1215 FT TO BEG. 9.44 AC M OR L. 2412-334

Parcel Number: 16092260040000

Legal Description:
COM S 42^15’30” E 9160.378 FT FR NW COR SEC 4 T 1S R 1E SL MER S 89^59’50” W 1801.033 FT N 0^02’01” W 800 FT N 73^42’E1215 FT S 30^31’E 1122.614 FT SWAY ALG CURVE TO RIGHT 181.51 FT TO BEG 34.68 AC

Parcel Number: 16101260056003

Legal Description:
PRIVILEGE TAX ON 3.35 AC OF THE FOLLOWING DESCRIPTION: BEG N89^59’50” E 58.16 FT & N 58.2 FT & N 89^59’50” E 168.16 FT FR CITY MONUMENT OF THE INTERSECTION OF 2100 E ST & SUNNYSIDE AVE SITUATED IN NW ¼ OF SEC 10, T1S, R1E, SLM; N89^58’04” E 921.17 FT; N 1320 FT; E 1320 FT; S 910.7 FT; N 62^18’30” E 2311.71 FT; W 5183.904 FT M OR L; S 30^27’24” W 8.57 FT M OR L; S 8^46’48” E 96.35 FT; S 27^39’15” E 200.25 FT; S 30^31’ E 1292.51 FT; S 56^20’43” E 163.57 FT M OR L TOBEG. ALSO, BEG N 1968.54 FT & W 276.30 FT FR SLC SUR MONUMENT AT THE INTERSECTION OF SUNNYSIDE AVE & PADLEY ST, SD MONUMENT BEING S 65^48’24” W 3622.62 FT; E 97 FT; S 58.20 FTFR SE COR OF SEC 3, T1S, R1E, SLM; S41^00’ W 392 FT; N 49^00’ W 178 FT; N 41^ E 492 FT: S 49^00’ E 178 FT TO BEG. FEWER STREETS. 52.19 AC M OR L. 2708-0515 2813-316 4193-0144 9780-5761

All of the properties are considered university owned. No existing buildings or parking is to be impacted. The existing sidewalk east of Foothill drive is anticipated to be removed and integrated into the new design. All the existing landscaping is anticipated to be removed and replaced as desired by the community and the city.

Appendix II - Hydrology and Drainage Calculations

Table 4: Drainage Calcs for Sunken Plaza Area

Pre-Development Area Analysis						
Area		sq. ft.	Acres		C	
Building		0	0.00		0.85	
Improvements		10,000	0.23		0.90	
Landscape		81,491	1.87		0.15	
Total		91,491	2.10		0.23	
Post-Development Area Analysis						
Area		sq. ft.	Acres		C	
Building		0	0.00		0.85	
Improvements		14,233	0.33		0.90	
Landscape		77,358	1.78		0.15	
Total		91,591	2.10		0.27	
100 Year Storage Analysis						
NOAA Precipitation Frequency Data Server						
Latitude: 40.7546°		**Longitude: -111.8328°**				
Allowable Runoff		0.20	cfs/acre			
Time	I	Runoff	Allowable Runoff		Storage	
(min.)	in./hr	ft3	ft3		ft3	
5	6.740	1,133	126		1,007	
10	5.130	1,725	252		1,473	
15	4.240	2,139	378		1,760	
30	2.850	2,875	757	>	2,118	<
60	1.770	3,571	1,514		2,057	
120	0.993	4,007	3,028		979	
180	0.679	4,110	4,542		0	
360	0.370	4,479	9,083		0	
720	0.226	5,472	18,167		0	
1440	0.133	6,440	36,334		0	
			Required Detention		**2,118**	

Storage calculations determined by the following method (Storage=Curve number*Intensity*Area*Time (hours) - allowable runoff)

Appendix III - Structural Calculations

Table 5: Structural Calculations for Underpass

Top/Bottom of Underpass Reinforcement		
Live Load	485	psf
Dead Load	405	psf
f'c	4000	psi
fy	60000	psi
h	12	in
b	12	in
d	10.5	in
Length	18	ft
Beta	0.85	
Ultimate Moment		
Wu	1262	plf
Mu	51111	lb*ft
Mu/4d	1.22	(guess for As)
Nominal Moment		Good
#9 @ 10" o.c.	1	in^2
As	1.2	in^2
a	1.76	in^2
Mn	51935.29	lb*ft
Tensile Strain		Good
c	2.08	in
ety	0.005	
et	0.012	
Minimum Area of Steel		Good
As(min)1	0.26	
As(min)2	0.20	
Maximum Bar Spacing		Good
fs	40000	psi
Cc	0.94	in
s1	12.66	in
s2	12	in
Transverse Reinforcement		
As(min)	0.26	in
#4 Bars	0.2	in^2
Spacing	9	in
Summary		
Top Flexural	#9 @ 10" o.c.	
Top Transverse	#4 @ 9" o.c.	
Bottom Flexural	#4 @ 9" o.c.	
Bottom Transverse	#4 @ 9" o.c.	

Our calculations show that the underpass can handle the loads present in Foothill and would be safe as currently designed. By using standard UDOT wall designs with terracing, the retaining walls should be up to code as well.

Appendix IV - Structural Calculations for Typical Retaining Walls

Landscaping Retaining Wall:

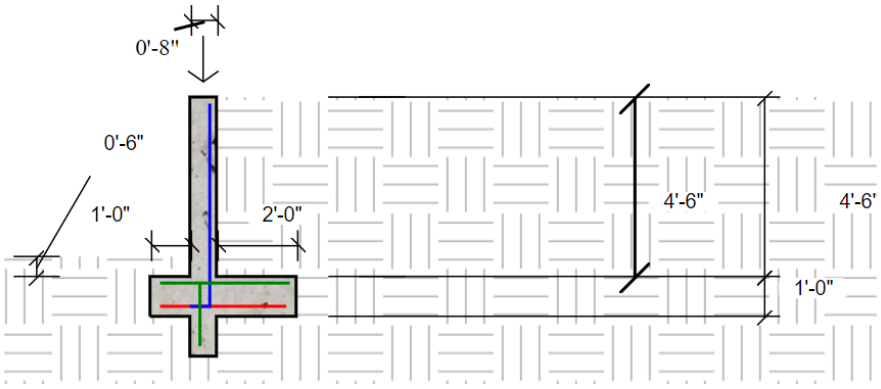

Figure 1. Landscape Retaining Wall Design

Table 6. Landscape Retaining Wall Structural Calculations

Global Values		Factors
Overturning		
Overturning Moment	1.11 k-ft	4.41
Resisting Moment	4.90 k-ft	
Sliding		
Sliding	605.00 lb	3.09
Resistance to Sliding	1872 lb	
Bearing Pressure		
Allowable Bearing Pressure	2500 psf	2.91
Required Bearing Pressure	858 psf	
Concrete Elements		
Stem		
Moment Capacity Ratio	0.33	OK
As Min Ratio	0.86	
Heel		
Moment Capacity Ratio	0.08	OK
As Min Ratio	0.84	
Toe		
Moment Capacity Ratio	0.05	OK
As Min Ratio	0.84	

Appendix V - Foothill Drive Retaining Wall

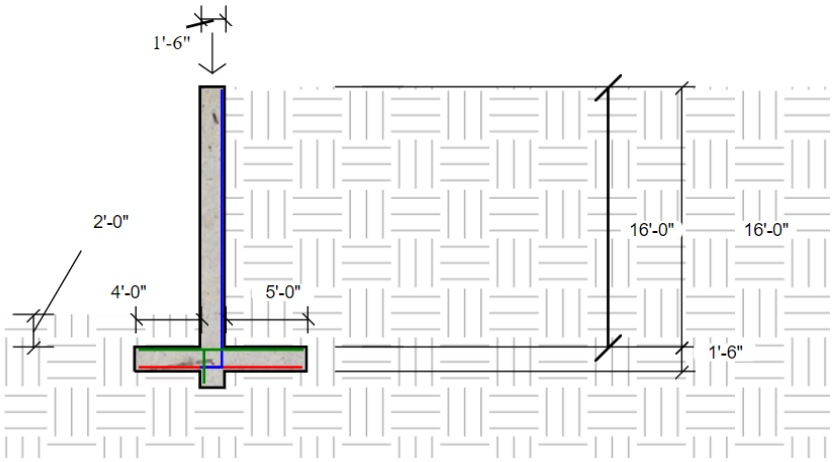

Figure 2. Foothill Drive Retaining Wall Design

Table 7. Foothill Drive Retaining Wall Structural Calculations

Global Values		Factors
Overturning		
Overturning Moment	35.73 k-ft	3.24
Resisting Moment	115.85 k-ft	
Sliding		
Sliding	6125.00 lb	1.65
Resistance to Sliding	10089 lb	
Bearing Pressure		
Allowable Bearing Pressure	2500 psf	1.06
Required Bearing Pressure	2355 psf	
Concrete Elements		
Stem		
Moment Capacity Ratio	0.84	OK
As Min Ratio	0.33	
Heel		
Moment Capacity Ratio	0.35	OK
As Min Ratio	0.33	
Toe		
Moment Capacity Ratio	0.37	OK
As Min Ratio	0.33	

Design follows IBC 2018. Concrete density is assumed to be 150 pcf and strength is required to be 3000 psi minimum.

Appendix VI - Construction/Traffic Management Plans

For this project, a Construction and Traffic Management Plan must be followed to ensure that the project is efficiently built while normal traffic can get through the area. Below are simplistic explanations of what the construction and traffic management plans are. The figure below shows the traffic will be controlled during construction.

Construction Management Plan

- Will be constructed using the Cut and Cover method for construction of the pedestrian underpass
- The underpass will be built as two different sections (West and East) with each section having two parts (Center and Edge pieces)
- Each section will be built starting from the center and building up to the Edge

Traffic Management Plan

- First phase will involve the closure of the West side lanes
- A temporary road will be built into the east side of the road to allow cars to pass through while heading northbound
- Phase Two is the East side of the road closing down with a temporary road being built on the east side so cars can head northward

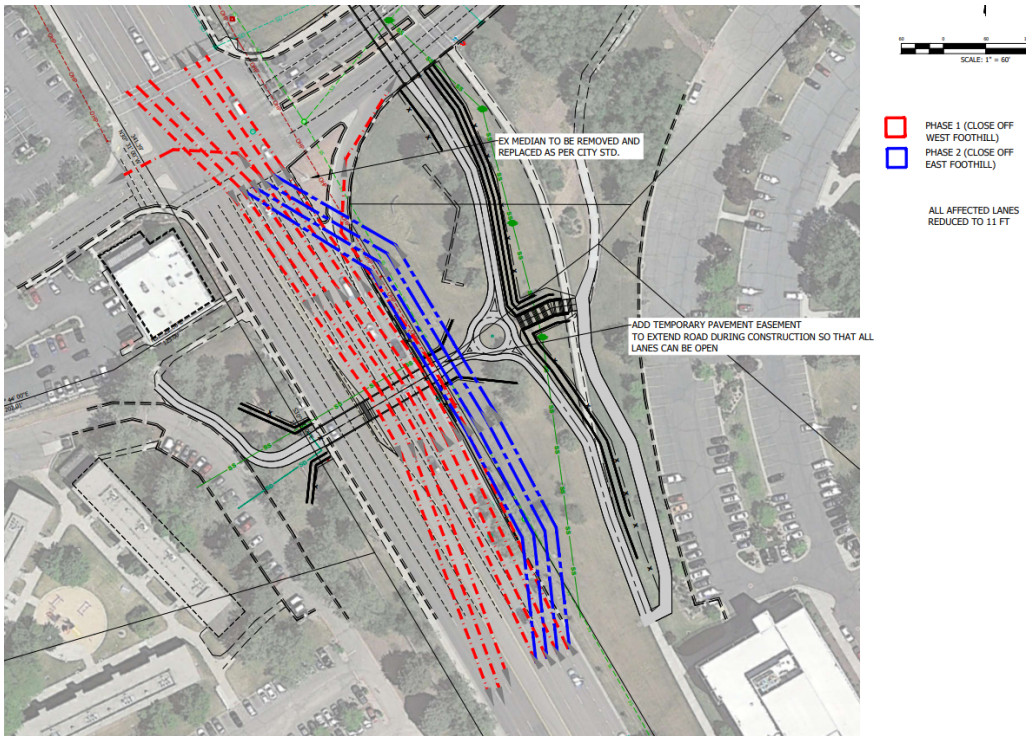

Figure 3. Transportation Traffic Plan

Appendix VII - Security Plans (CPTED Section) and AADT

Safety and crime prevention is a large priority for the underpass at Foothill Drive. CPTED sets standards for the physical space to meet the needs of the users and predict the behavior of the users in the space. To uphold CPTED, the design will incorporate:

- Skylight added in the median for additional lighting to feel safer
- Community outreach to draw murals on the surface of the walls to try and prevent vandalism
- Surface of walls coated so it is easier to clean surfaces if vandalism occurs
- Wider Pedestrian tunnel so people feel safer using it
- Installed lights to improve safety
- Security cameras at the entrances
- Benches with armrests if required.

Table 8: AADT pre development

	AADT Data	
	Average	2019
Foothill Drive	40000	51000

Table 9: Traffic Patterns For Foothill Drive

89.5 % Cars
10.5 % Trucks