ATKINS

Member of the SNC-Lavalin Group

(U) Buckley Parking Lot Study

Findings and Recommendations

United States Government

15 October 2019

(U) Notice

(U) This document and its contents have been prepared and are intended solely as information for the United States Government to use in relation to the Buckley Parking Lot Study Report.

(U) Atkins North America, Inc. assumes no responsibility to any other party in respect of, arising from, or in connection with this document and/or its contents.

(U) This document has 122 pages including the cover.

(U) Document history

Revision	Purpose description	Originated	Checked	Reviewed	Authorized	Date
Rev 1.0	Draft					8/27/19
Rev 2.0	95%					9/5/19
Rev 3.0	Final Draft					9/18/19
Rev 4.0	100%					10/15/19

(b)(3)

(U) Client signoff

Client	United States Government
Project	(U) Buckley Parking Lot Study
Job number	100067080
Client signature / date	

(U) Contents

(U) Chapter Page

(U) Tables

(U) Figures

(U) Executive Summary

(U) The Site has numerous parking areas inside and outside of the perimeter fence, which results in many locations where pedestrians and vehicles interact. The United States Government (USG) has identified a need to improve pedestrian and vehicular traffic safety within the parking areas, along sidewalks/walkways, and at access points to the Site.

(U) The purpose of this study was to evaluate the existing signing, striping, lighting, and circulation patterns for pedestrians and vehicles within the study area and to develop a list of solutions to improve safe access and circulation for vehicles and pedestrians.

(U) The project goals included:

- Determine if there are pedestrian and vehicle safety deficiencies related to Site access and circulation.
- Identify opportunities to introduce state-of-the-art solutions that include the use of technology.
- Focus on solutions that improve the safe movement of pedestrians across and through the parking areas, while also addressing safety for vehicles that are entering, exiting, and circulating within the parking areas.
- Develop conceptual-level drawings of the recommended solutions.
- Create estimated costs to implement the recommended solutions.
- Provide a list of possible projects that can be implemented in phases based on future budgets.

(U) Observations made during the Site visits helped identify several issues that were considered contributing factors to the safety of pedestrians and vehicles within the study area. The issues were divided into four categories: Signage, Lighting, Pedestrian Access, and Vehicle Circulation/Parking.

(U) Based on the identified issues, a research effort was completed to identify solutions that, when implemented, would provide the best benefits for improving safety and address the observed issues. The list of solutions includes:

- Signing enhancements related to reflectivity, conspicuity, spacing, and placement.
- Lighting improvements, such as pedestrian-oriented lights to highlight pedestrian movements, high-mast lights to fill in the gaps in the existing parking area coverage patterns, and motion-activated pedestrian adaptive lighting systems at crosswalks and along walkways/sidewalks.
- Pedestrian access upgrades in and across the study area to add more walkways, use raised crosswalks, implement bulb outs, use high-visibility striping, install safety-oriented technology devices at crosswalks, and possibly consider the use of 3-D paint.
- Vehicle circulation and parking modifications, such as (1) using raised end-of-aisle islands, one-way frontage roads, wheel stops, informational signage regarding gate hours of operations, improved pavement markings, and curbs to restrict movements/better define intersections, and (2) restricting certain sized vehicles in parking spots at the end of rows and (3) reconfiguring the parking lot aisles and spaces.

(U) As a result of the data collection, Site observations, and research efforts into current state-of-the-practice solutions, the study makes recommendations focused on achieving the study goals. Recommendations are presented as projects; the study identified a total of 16 projects that will help improve safety by addressing the observed concerns/issues. The projects (see (U) Figure ES-1) are presented in order of top priority based on how well each would have an impact to both pedestrian and vehicular safety regardless of project costs. The USG should evaluate the list of projects based on available funding/budget allocations to create a package of project(s) for implementation. This would include consideration for optional features within the conceptual designs provided in this report.

(U) Figure ES-1: Identified Project Areas with Safety Issues

(b)(3)

(U) A summary of the recommended projects (ranked from highest to lowest priority), the issues that would be addressed, the recommended safety enhancement solutions, the estimated costs to implement, and a scoring summary of how well each project would benefit vehicular and pedestrian safety is shown in (U) Table ES-1.

(U) In addition, the projects identified in this report are generally large in nature and would require additional engineering study and design before improvements could be implemented. However, within the projects themselves there are certain items that could be completed under USG issued work orders (WO). These WOs are intended to address maintenance activities and corrections to deficiencies that can be accomplished while larger projects are being considered for implementation. (U) Table ES-2 provides a description of immediate action items that could be considered for USG WOs. These items are small in nature and would not require large funding sources to accomplish.

(U) Table ES-1: Recommended Projects to Address Safety Issues

Project Rank/Name	Issues	Solutions	Cost	Mode	Score	Sum
Project 1: Parking Lot Configuration	• One-way aisles with angled parking create safety issues • Drivers do not use the main entry and exit roads where they must weave around barricades	Convert parking to 90-degree parking spots, two-way aisles, and add raised pedestrian walkways	(b)(4) (b)(3)	Vehicle	2	7
				Pedestrian	5	
Project 2: Gate 410 Entrance/ Pedestrian Walkway	• Long crossing distances for pedestrians • Too many vehicle movements • Poor lighting for pedestrians	Add curbing to restrict vehicle movements, enhanced mountable pedestrian crossing, and adaptive pedestrian lighting		Vehicle	4	7
				Pedestrian	3	
Project 3: VCC Pedestrian Walkway	• Long crossing distances for pedestrians • Poor lighting for pedestrians	Add bulb outs, enhance mountable pedestrian crossing, and adaptive pedestrian lighting		Vehicle	7	8
				Pedestrian	1	
Project 4: Gate 498 Entrance/ Pedestrian Walkway	• Long crossing distances for pedestrians • Too many vehicle movements • Poor lighting for pedestrians	Add curbing to restrict vehicle movements, enhanced mountable pedestrian crossing, and adaptive pedestrian lighting		Vehicle	8	10
				Pedestrian	2	
Project 5: One-Way Frontage Road	• Vehicle speeds • Roadway combines one-way and two-way traffic • Width of crossing for pedestrians	Add bollards to make one-way, signing, and pavement markings		Vehicle	3	10
				Pedestrian	7	
Project 6: Parking Area Lighting	• Existing lighting has gaps • Hard for drivers to see pedestrians • Poor lighting for pedestrians	Add additional parking area solar-powered lighting		Vehicle	1	10
				Pedestrian	9	
Project 7: Pedestrian-Oriented Lighting	• Lack of lighting on sidewalks and walkways	Add pedestrian lighting		Vehicle	9	13
				Pedestrian	4	
Project 8: Parking Area 1	• Pedestrians and vehicles share aisles • Vehicle speeds	Add Sidewalks, pedestrian walkways, and pavement markings		Vehicle	11	17
				Pedestrian	6	
Project 9: Signing and Markings	• Signs not in compliance with standards • Vehicle speeds while circulating	Upgrade signs and pavement markings		Vehicle	6	18
				Pedestrian	12	
Project 10: End-of-Aisle Raised Islands	• Illegal parking that can block aisle and create sight distance obstructions	Add raised concrete islands		Vehicle	5	18
				Pedestrian	13	
Project 11: Pedestrian Turnstile Crossing	• Pedestrian traffic not using existing crossing • Vehicle speeds • Poor lighting for pedestrians	Add sidewalks, enhanced mountable pedestrian crossing, adaptive pedestrian lighting, and pavement markings		Vehicle	10	20
				Pedestrian	10	
Project 12: Parking Area 5 Pedestrian Crossing	• No signs or lighting for crossing • Crosswalk in parking space	Add enhanced mountable pedestrian crossing and adaptive pedestrian lighting		Vehicle	12	20
				Pedestrian	8	
Project 13: Motorcycle Parking Pedestrian Crossing	• No pedestrian crossing • Vehicle speeds • Poor lighting for pedestrians	Add sidewalks, enhanced mountable pedestrian crossing, and adaptive pedestrian lighting		Vehicle	13	24
				Pedestrian	11	
Project 14: Wheel Stops	• Irregular parking that can block aisles and create sight distance obstructions	Add concrete wheel stops		Vehicle	15	29
				Pedestrian	14	
Project 15: Parking Space Size Restriction	• Large vehicles at the end of the parking rows create sight obstructions	Add signs and pavement markings to restrict end parking spaces for compact cars		Vehicle	14	30
				Pedestrian	16	
Project 16: Gate Hour Signs	• Extra circulation by vehicles	Install information signs		Vehicle	16	31
				Pedestrian	15	

* Safety benefit of solutions for each mode were scored from 1 (highest) to 16 (lowest) and then summed; the lowest sum is project #1.

(U) Table ES-2: Work Orders for Consideration

#	Page	Section	Area	Project Key Elements	Work Order (s) for Consideration
1	58	5.1	East parking lots.	Change parking lot configuration.	There is an on-going parking lot re-surfacing and re-striping effort. Change orders to this contract can be investigated.
2	63	5.2.	Gate 410 pedestrian walkway	Upgrade 300 feet of pedestrian walkway from gate 410 to east side of building A. Includes raised crosswalks, pavement paint/markings, pedestrian lighting, sign upgrades, sidewalk modifications, etc.	Replace faded/damaged signs and modify sign placements based on guidance in the MUTCD.
3	64	5.3.	Visitor Control Center pedestrian	Upgrade 300 feet of pedestrian walkway from VCC to east side of building C. Includes raised crosswalks, pavement paint/markings, pedestrian lighting, sign upgrades, sidewalk modifications, etc.	Replace faded/damaged signs and modify sign placements based on guidance in the MUTCD.
4	65	5.4.	Gate 498 pedestrian walkway	Upgrade 300 feet of pedestrian walkway from gate 498 to east side of building D. Includes raised crosswalks, pavement paint/markings, pedestrian lighting, sign upgrades, sidewalk modifications, etc.	Replace faded/damaged signs and modify sign placements based on guidance in the MUTCD.
5	66	5.5.	North-south road running along east face of buildings A to E.	Narrow road through installation of bollards. Install one-way signs and pavement arrow markings.	Install signs and pavement markings.
6	67	5.6.	East parking lots.	Install high mast lighting to central areas of parking lots.	N/A
7	68	5.7.	New crosswalk west of building E, along the pedestrian walkway in east parking lots, and along east face of buildings A to E.	Install pedestrian-oriented lighting.	N/A
8	69	5.8.	Building E parking lot.	Add new north-south pedestrian walkways to connect to new east-west sidewalks. Add pavement markings and upgrade signing.	Replace stop sign in the northeast corner of the parking area and move it out of traffic flow area based on guidance in the MUTCD. Add pedestrian crossing sign for southbound approach to marked crosswalk.
9	70	5.9.	East parking lots.	Replace damaged and faded signs, add flashing beacons to stop signs, and fix location/placement of signs per the MUTCD. Install pavement markings to include YIELD and Speed Limit signs.	Use work orders to address signing and pavement markings.
10	71	5.10.	End of all parking aisles.	Create raised concreate islands at the end of parking aisles.	N/A
11	72	5.11.	Crosswalk at northeast corner of building E.	Upgrade pedestrian walkway at northeast corner of building E. Includes raised crosswalks, pavement paint/markings, pedestrian lighting, sign upgrades, sidewalk modifications, etc.	Modify crosswalk sign placements based on guidance in the MUTCD. Add Stop sign (red beacon) for westbound traffic. Fix broken eastbound flashing beacon and make red. Install temporary fencing to encourage pedestrians not to cut the corner and avoid the marked crossing location.
12	73	5.12.	Crosswalk near southeast small parking lot.	Upgrade 30 feet of pedestrian walkway from southeast most parking lot. Includes raised crosswalks, pavement paint/markings, pedestrian lighting, sign upgrades, sidewalk modifications, etc.	Install crosswalk signing (maybe stop signs and beacons also) based on guidance in the MUTCD.
13	74	5.13.	Motorcycle parking area for building E.	Add raised crosswalk, sidewalks, and lighting to allow motorcyclists to cross from building E to the parking area.	Install crosswalk pavement markings and signing based on guidance in the MUTCD.
14	75	5.14.	All parking lots.	Install wheel stops in all parking spots.	N/A
15	76	5.15.	All parking lots.	Install "compact car only" signs and/or pavement markings.	Install signs and/or pavement markings in select areas or end spot only along frontage road in front of buildings A to E.
16	77	5.16.	Along Aspen Street outside of Site fence.	Install signs on Aspen Street to identify which gates are open.	N/A

(U) 1. Introduction

(U) The Site has numerous parking areas inside the perimeter fence and large quantities of parking outside the fenced perimeter. Visitors to the Site must park outside the fence line and be escorted (walked) into the facility and across the inner parking lots to reach the Site buildings. Many of the U.S. Government (USG) employees choose to park outside the fence line, or park outside the fence line after the inner lots fill up, and then also must walk across the inner parking areas to reach the Site buildings. As a result, there are many locations where pedestrians and vehicles interact with each other and these interactions lead to conflicts. The USG has identified a need to improve pedestrian and vehicular traffic safety within the fenced area of the Site.

(U) 1.1. Project Purpose

(U) The purpose of the study was to evaluate the existing signing, striping, lighting, and circulation patterns for pedestrians and vehicles within the fenced perimeter and develop a list of possible solutions that will promote safe access to and from the Site buildings and at locations where there are interactions between pedestrians and vehicles. The study took a "snap shot" of existing conditions and makes recommendations for improvements that can be implemented in the short-term but provide long-term benefits.

(U) 1.2. Project Goals

(U) Based on discussions with USG staff, the goals of the project included:

- Determine if there are pedestrian and vehicle safety deficiencies related to Site access and circulation.
- Identify opportunities to introduce state-of-the-art solutions that include the use of technology.
- Focus on solutions that improve the safe movement of pedestrians across and through the parking areas, while also addressing safety for vehicles that are entering, exiting, and circulating within the parking areas.
- Develop conceptual-level drawings of the recommended solutions.
- Create estimated costs to implement the recommended solutions.
- Provide a list of possible projects that can be implemented in phases based on future budgets.

(U) 1.3. Project Location and Description

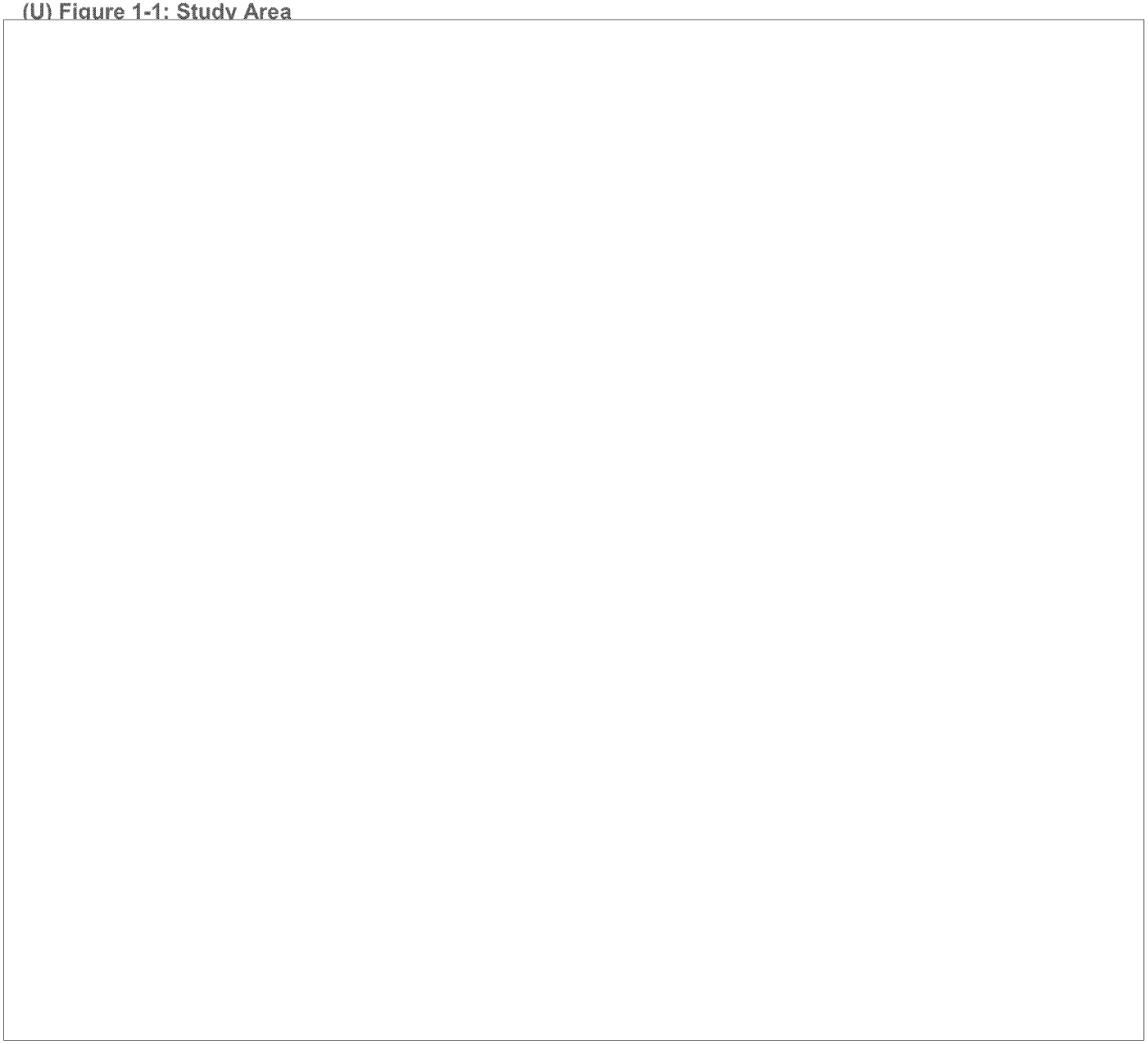
(U) Refer to (U) Figure 1-1 for an overview of the study area. The existing parking lots are located along the east side and in the northwest corner of the Site. The study area has the following access conditions:

- Gate 410 (along the east edge of the Site, near the southern limits of the study area):
  - Allows vehicle access (in and out) between 06:00 and 09:00 hours and allows vehicles to exit between 14:30 and 16:00 hours.
  - Badged pedestrian access is allowed during the same hours as vehicle access.
- Visitor Control Center (VCC) (along the east edge of the Site, near the center of the study area):
  - Allows badged pedestrian access through a security-controlled turnstile entrance 24 hours a day, 7 days a week.
  - Allows non-badged pedestrian-visitor access between 06:00 and 15:30 hours during the week.
- Gate 498 (along the east edge of the Site, closer to the northern limits of the study area):
  - Allows vehicle access (in and out) 24 hours a day, 7 days a week.
  - Allows pedestrian-visitor access outside of the VCC hours.
- Pedestrian turnstile gate through the fence line on the north edge of the Site.

(U) The primary entrances used by employees to enter/exit the Site buildings are shown in (U) Figure 1-1. The Site buildings contain several other entrance/exit points that are no longer in use or are used for emergency purposes only. Additional smaller access points are used by employees to access outdoor eating areas or smoking areas, but these locations are not used for primary access to/from the buildings and are not identified in the figure.

(U) Figure 1-1: Study Area

(b)(3)



(U) 1.4. Report Layout

(U) The following sections contain a description of the steps and procedures used to complete this study. They include:

- Methodology—How, when, and what data were collected.
- Existing Conditions—A summary of the data collected and observations of pedestrian/vehicle activities, patterns, and behaviors.
- Issues and Solutions—A discussion of the identified deficiencies or areas of needed improvements along with possible solutions.
- Recommendations—A description of specific locations with identified deficiencies and a recommended approach to fix the issues.

(U) 2. Methodology

(U) The primary focus of this study was to assess (1) vehicle and pedestrian patterns/interactions within the fenced perimeter of the Site at different times of the day, (2) different levels of employee activities in/out of the Site buildings, and (3) the full range of lighting conditions, including dawn, daylight, dusk, and night. Based on the data collected and observations made during these times, the study identified recommendations for solutions aimed at improving pedestrian and vehicular safety. Assessment of the Site included observations of the following:

- Vehicle movements and activities coming into, circulating within, and traveling out of the study area.
- Pedestrian movements and activities while moving between the Site buildings and the areas where vehicles are parked.
- Overall condition and location of pavement markings, road side signing, and lighting.

(U) 2.1. Data Collection Efforts

(U) Data collection efforts on the Site were completed on the following dates and times:

- 31 July 2019 between 12:00 and 14:30 hours (daylight conditions with heavy exiting activities for pedestrians and vehicles)
- 7 August 2019 between 20:00 and 22:00 hours (dusk and nighttime conditions with moderate entry and exit activities for pedestrians and vehicles)
- 8 August 2019 between 05:00 and 07:00 hours (dawn and early morning conditions with heavy entry activities for pedestrians and vehicles)
- 8 August 2019 between 14:00 and 16:00 hours (daylight conditions with heavy exiting activities for pedestrians and vehicles)

(U) Based on the data collection efforts, a list of observed issues/locations that may impact pedestrian/vehicle safety was developed for evaluation. Each of the issues was researched to develop a list of possible solutions based on current state-of-the-art practices, including the use of technology when applicable. Conceptual-level designs (lines on paper) were developed to illustrate how and where the solution(s) could best be implemented to address the issues. In some cases, there were multiple solutions for a single issue, and, in many cases, the same solution(s) could be applied at multiple locations. This information was used to develop cost estimates for each solution. Finally, a list of recommended projects, each of which was made up of one or more of the identified solutions, and their associated costs was created to provide the USG with options for how to best spend available funds to achieve the desired goals of the study.

(U) This page left blank intentionally.

(U) 3. Existing Conditions

(U) The following sections discuss the Site's existing conditions and the observations made during the data collection efforts.

(U) 3.1. Parking Areas

(U) The parking areas within the study area are shown in (U) Figure 3-1. The parking areas provide a combination of regular vehicle parking, reserved parking, motorcycle parking, and accessible parking. The parking lots include a mix of 90-degree head-in parking spots and 45-degree angled parking spots. The following sections provide a brief description of the typical characteristics of the different parking areas.

(U) Figure 3-1: Parking Areas and Marked Pedestrian Crossings

(b)(3)

(U) 3.1.1. Parking Area 1

(U) This parking area is in the northwest corner of the study area. The individuals that park in this area use Entrances #1 and #2 to enter/exit the Site buildings. The major characteristics of this parking area are shown in (U) Table 3-1.

(U) Table 3-1: Major Characteristics of Parking Area 1

Element	Feature	Description
Parking Space Count	Total	
	Regular	
	Motorcycle	
	Accessible	
Parking Space Size	Width x Depth (feet)	8 x 18
Parking Spots	Type	90-degree (perpendicular)
Circulating Roadway	Width (feet)	24
	Travel Direction	Two-way
Pedestrian Walking Areas	Description	Pedestrians share circulating roadways with vehicles

(b)(3)

(U) 3.1.2. Parking Area 2

(U) This parking area is along the east side of the Site buildings and north of Gate 498. The individuals that park in this area use Entrance #3 to enter/exit the Site buildings. The major characteristics of this parking area are shown in (U) Table 3-2.

(U) Table 3-2: Major Characteristics of Parking Area 2

Element	Feature	Description
Parking Space Count	Total	
	Regular	
	Motorcycle	
	Accessible	
Parking Space Size	Width x Depth (feet)	10 x 18
Parking Space Type	Type	45-degree (angled)
Circulating Roadway	Width (feet)	18
	Travel Direction	One-way
Pedestrian Walking Areas	Description	Pedestrians share circulating roadways with vehicles

(b)(3)

(U) 3.1.3. Parking Area 3

(U) This parking area is along the east side of the Site buildings between Gate 498 and the VCC. The individuals that park in this area use Entrances #3 and #4 to enter/exit the Site buildings. The major characteristics of this parking area are shown in (U) Table 3-3.

(U) Table 3-3: Major Characteristics of Parking Area 3

Element	Feature	Description
Parking Space Count	Total	
	Regular	
	Motorcycle	
	Accessible	
Parking Space Size	Width x Depth (feet)	10 x 18
Parking Space Type	Type	45-degree (angled)
Circulating Roadway	Width (feet)	18
	Travel Direction	One-way
Pedestrian Walking Areas	Description	Pedestrians share circulating roadways with vehicles

(b)(3)

(U) 3.1.4. Parking Area 4

(U) This parking area is along the east side of the Site buildings between the VCC and Gate 410. The individuals that park in this area use Entrance #4 to enter/exit the Site buildings. The major characteristics of this parking area are shown in (U) Table 3-4.

(U) Table 3-4: Major Characteristics of Parking Area 4

Element	Feature	Description
Parking Space Count	Total	(b)(3)
	Regular	
	Motorcycle	
	Accessible	
Parking Space Size	Width x Depth (feet)	10 x 18
Parking Space Type	Type	45-degree (angled)
Circulating Roadway	Width (feet)	18
	Travel Direction	One-way
Pedestrian Walking Areas	Description	Pedestrians share circulating roadways with vehicles

(U) 3.1.5. Parking Area 5

(U) This parking area is along the east side of the Site buildings and south of Gate 410. The individuals that park in this area use Entrances #4 and #5 to enter/exit the Site buildings. The major characteristics of this parking area are shown in (U) Table 3-5.

(U) Table 3-5: Major Characteristics of Parking Area 5

Element	Feature	Description
Parking Space Count	Total	(b)(3)
	Regular	
	Motorcycle	
	Accessible	
Parking Space Size	Width x Depth (feet)	10 x 18
Parking Space Type	Type	45-degree (angled)
Circulating Roadway	Width (feet)	18
	Travel Direction	One-way
Pedestrian Walking Areas	Description	Pedestrians share circulating roadways with vehicles

(U) 3.2. Pedestrian Crossings

(U) Within the study area, there are 10 specific areas (refer to (U) Figure 3-1) designated with painted crosswalks where pedestrians are encouraged to cross the circulating roadways. At each of these locations, a potential for conflict between pedestrians and vehicles exists. (U) Table 3-6 provides a description of the location and some of the general characteristics of each crossing.

(U) Table 3-6: Pedestrian Crossing Location Characteristics

Location	Description	Characteristics
1	Provides connection between Parking Area 1 and Entrance #1	• One pedestrian crossing sign • Good lighting • Crosses a roadway that has very limited vehicle traffic (gated road)
2	Provides connection between Parking Area 1 and Entrance #2	• No pedestrian crossing signs or lighting • Crosses a roadway that has very limited vehicle traffic (gated road)
3	Provides connection between the turnstile gate in the fence and crosses the roadway between Parking Area 1 and Parking Area 2	• Fair lighting • Pedestrian crossing signs in both directions • Eastbound crossing traffic is controlled with a Stop sign and a flashing yellow beacon
4	Provides connection between Gate 498 and sidewalk between Parking Area 2 and Parking Area 3	• Both directions of the crossing roadway are controlled by Stop signs and pedestrian crossing signs • Good lighting
5	Provides connection between the sidewalk that separates Parking Area 2/Parking Area 3 and Entrance #3	• Southbound direction signed with Stop sign and pedestrian crossing sign • Northbound direction signed with pedestrian crossing sign • Good lighting
6	Provides connection between the VCC and sidewalk that separates Parking Area 3/Parking Area 4	• Both directions of the crossing roadway are controlled by Stop signs, pedestrian crossing signs, and flashing red beacons • East side of crossing is set back too far • Good lighting
7	Provides connection between the sidewalk that separates Parking Area 3/Parking Area 4 and the sidewalk along the east side of the Site buildings	• Northbound direction controlled by Stop sign and pedestrian crossing sign with flashing red beacon • Good lighting
8	Provides connection between Gate 410 and the sidewalk that separates Parking Area 4/Parking Area 5	• Both directions of the crossing roadway are controlled by Stop signs, pedestrian crossing signs, and flashing red beacons • Fair lighting
9	Provides two connections between the sidewalk that separates Parking Area 4/Parking Area 5 and the sidewalk along the east side of the Site buildings	• Good lighting • No warning signs or control of vehicle movements
10	Provides connection across the circulating roadway that passes between the two parts of Parking Area 5	• Good lighting • No warning signs or control of vehicle movements

(U) 3.3. Signing, Striping, and Lighting

(U) As part of the data collection efforts, the location and condition of the existing signing, striping, and lighting within the parking areas was documented. The following sections provide a discussion of the observations.

(U) 3.3.1. Signing

(U) The location of existing signs within the study area are shown in (U) Figure 3-2, (U) Figure 3-3, and (U) Figure 3-4. In general, the most common type of signs on the Site are Stop, Pedestrian Crossing, and Speed Limit (10 mph) signs. There are several locations where the Site uses flashing yellow or red beacons to supplement other signs to provide additional warning about a pedestrian crossing location or a desired stop location. (U) Table 3-7 is an inventory of the existing signs and provides information about the size, color, and condition of the sign installation. A condition of "Good" means the sign does not appear to meet current retro-reflectivity guidance in the MUTCD and should be considered for replacement. The table also contains some recommendations for upgrading the signs to better be in compliance with the guidance/recommendation in the MUTCD. Although the MUTCD does not specifically apply to parking lots, it is good state of the practice procedures to follow MUTCD guidance as much as possible in parking lots.

(U) Figure 3-2: Existing Signing (Sheet 1 of 3)

(b)(3)

(U) Table 3-7: Study Area Sign Inventory

Sign						
#	Sheet	Legend	Color	Size*	Condition	Comments (Possible changes to fix)
1	2	Stop	Red	30 x 30	Good	Bent post—sign not properly aligned (Replace and move)
2	2	Pedestrian Crossing	Yellow	30 x 30	Good	
3A	2	Radar Speed Panel	Black	36 x 30	Good	
3B	2	Speed Limit (10)	White	24 x 30	Good	
4A	2	Radar Speed Panel	Black	36 x 30	Good	
4B	2	Speed Limit (10)	White	24 x 30	Good	
5A	3	Stop	Red	30 x 30	Good	Flashing yellow beacon—not working (should be red)
5B	3	Pedestrian Crossing	Yellow	30 x 30	Good	Very low mounting height (move to separate post)
6	3	Pedestrian Crossing	Yellow	30 x 30	Good	Too far in advance of crosswalk (move closer – add missing stop sign on this approach)
7A	3	Speed Limit (10)	White	24 x 30	Good	Assembly creates a visibility obstruction (move sign higher)
7B	3	Speed Limit (10)	White	24 x 30	Good	
8A	4	Speed Limit (10)	White	24 x 30	Good	Assembly creates a visibility obstruction (move sign higher)
8B	4	Speed Limit (10)	White	24 x 30	Good	
9A	4	Speed Limit (10)	White	24 x 30	Good	Assembly creates a visibility obstruction (move sign higher)
9B	4	Speed Limit (10)	White	24 x 30	Good	
10	4	Speed Limit (10)	White	24 x 30	Good	
11A	4	Stop	Red	30 x 30	Good	Sign should be higher above ground.
11B	4	3 Way	Red	6 x 12	Good	
11C	4	Pedestrian Crossing	Yellow	30 x 30	Good	Very low mounting height, too far in advance of crosswalk (move sign to new post closer to crossing and make higher)
12A	4	Stop	Red	30 x 30	Good	Assembly creates a visibility obstruction (use taller post)
12B	4	Pedestrian Crossing	Yellow	30 x 30	Good	Very low mounting height, too far in advance of crosswalk (move sign to new post closer to crossing and make higher)
13	4	Solid Red/Flashing Yellow Beacon	N/A	12 x 24	Fair	Intended for vehicles, but no sign to clarify meaning
14	4	Solid Red/Flashing Yellow Beacon	N/A	12 x 24	Fair	Intended for vehicles, but no sign to clarify meaning
15	5	Stop	Red	30 x 30	Good	At gate exit with guard
16	5	Stop	Red	30 x 30	Good	At gate exit with guard
17A	5	Stop	Red	30 x 30	Poor	Sign is very faded, low mounting height creates visibility obstruction (raise sign to taller post and replace panels)
17B	5	3 Way	Red	6 x 12	Good	
17C	5	Pedestrian Crossing	Yellow	30 x 30	Good	Very low mounting height, too far in advance of crosswalk (move sign to new post closer to crossing and make higher)
18A	5	Stop	Red	30 x 30	Good	Assembly creates a visibility obstruction (raise sign to taller post and replace panels)
18B	5	3 Way	Red	6 x 12	Good	
18C	5	Pedestrian Crossing	Yellow	30 x 30	Good	Very low mounting height, too far in advance of crosswalk (move sign to new post closer to crossing and make higher)
19A	5	Speed Limit (10)	White	24 x 30	Good	Assembly creates a visibility obstruction (move sign higher)
19B	5	Speed Limit (10)	White	24 x 30	Good	
20A	5	Speed Limit (10)	White	24 x 30	Good	Assembly creates a visibility obstruction (move sign higher)
20B	5	Speed Limit (10)	White	24 x 30	Good	
21	5	One Way (Right Arrow)	White	24 x 30	Good	
22	5	One Way (Right Arrow)	White	24 x 30	Good	

Sign						
#	Sheet	Legend	Color	Size*	Condition	Comments (Possible changes to fix)
23A	5	Stop	Red	30 x 30	Good	Assembly too close to crossing and creates visibility obstruction—has flashing red beacon (raise sign to taller post and replace panels)
23B	5	Pedestrian Crossing	Yellow	30 x 30	Poor	Damaged from vehicle hit, very low mounting height (replace sign, move sign to new post closer to crossing and make higher)
24A	5	Stop	Red	30 x 30	Good	Assembly too close to crossing and creates visibility obstruction—has flashing red beacon (raise sign to taller post and replace panels)
24B	5	Pedestrian Crossing	Yellow	30 x 30	Good	Very low mounting height (move to separate post)
25A	5	Stop	Red	30 x 30	Good	Assembly too close to crossing and creates visibility obstruction—has flashing red beacon (raise sign to taller post and replace panels)
25B	5	Pedestrian Crossing	Yellow	30 x 30	Good	Very low mounting height (place sign on new post)
26	5	One Way (Right Arrow)	White	24 x 30	Good	
27	6	One Way (Right Arrow)	White	24 x 30	Good	
28	6	One Way (Right Arrow)	White	24 x 30	Good	
29	6	Speed Limit (10)	White	24 x 30	Good	
30A	6	Stop	Red	30 x 30	Good	Assembly creates a visibility obstruction (raise sign to taller post and replace panels)
30B	6	Pedestrian Crossing	Yellow	30 x 30	Good	Very low mounting height, too far in advance of crosswalk (move sign to new post closer to crossing and make higher)
31	6	One Way (Right Arrow)	White	24 x 30	Good	
32	6	Stop	Red	30 x 30	Good	At gate exit with guard
33	6	Stop	Red	30 x 30	Poor	At gate exit with guard, sign has brown letters (install red/white stop sign)
34	6	Solid Red/Flashing Yellow Beacon	Black	12 x 24	Good	Intended for vehicles, but no sign to clarify meaning
35	6	Solid Red/Flashing Yellow Beacon	Black	12 x 24	Good	Intended for vehicles, but no sign to clarify meaning
36	6	One Way (Left Arrow)	White	24 x 30	Good	
37A	6	Stop	Red	30 x 30	Good	Assembly creates a visibility obstruction (raise sign to taller post and replace panels)
37B	6	Pedestrian Crossing	Yellow	30 x 30	Good	Very low mounting height, too far in advance of crosswalk (move sign to new post closer to crossing and make higher)
38	6	One Way (Left Arrow)	White	24 x 30	Good	
39A	6	Speed Limit (10)	White	24 x 30	Good	Assembly creates a visibility obstruction (move sign higher)
39B	6	Speed Limit (10)	White	24 x 30	Good	
40A	6	Speed Limit (10)	White	24 x 30	Good	Assembly creates a visibility obstruction (move sign higher)
40B	6	Speed Limit (10)	White	24 x 30	Good	
41	6	One Way (Left Arrow)	White	18 x 6	Good	Very small and hard to see due to location (change to be same size as other one-way signs)

* Sign sizes are approximately and in inches (width x height)

(U) 3.3.2. Striping

(U) A summary of some of the typical existing pavement markings (not parking spots) that exist within the study area is provided in (U) Table 3-8. In general, the Site uses standard waterborne paint to mark the parking spots, crosswalks, vehicle movement arrows, and end-of-parking-aisle islands. The striping is not high intensity, which means it does not have high reflective qualities. Many of the striping features were showing signs of fading and were difficult to see. (U) Figure 3-5, (U) Figure 3-6, and (U) Figure 3-7 show the location of pavement markings (anything that is not a parking spot) within the study area.

(U) Table 3-8: Typical Striping Characteristics

Number	Sheet	Feature	Description
1	1	Oblong oval-shaped end-of-aisle island	Typical for Parking Area 1 with an approximate size of 9 feet wide by 36 feet long
2	1, 2, and 3	Standard crosswalk (continental style)	Each block is 1 foot wide by 6 feet long
3	1 and 2	Zebra-style crosswalk	Diagonal 1-foot-wide by 12-foot-long blocks outlined by 1-foot-wide bars—observed on the roadway on the north side of the Site buildings
4	2 and 3	Triangular-shaped end-of-aisle island	Typical for Parking Areas 2, 3, 4, and 5 at the end of each aisle
5	2 and 3	Directional arrow	Typical for Parking Areas 2, 3, 4 and 5 to help identify travel direction for vehicles

(U) Figure 3-5: Existing Striping (Sheet 1 of 3)

(b)(3)

(U) 3.3.3. Lighting

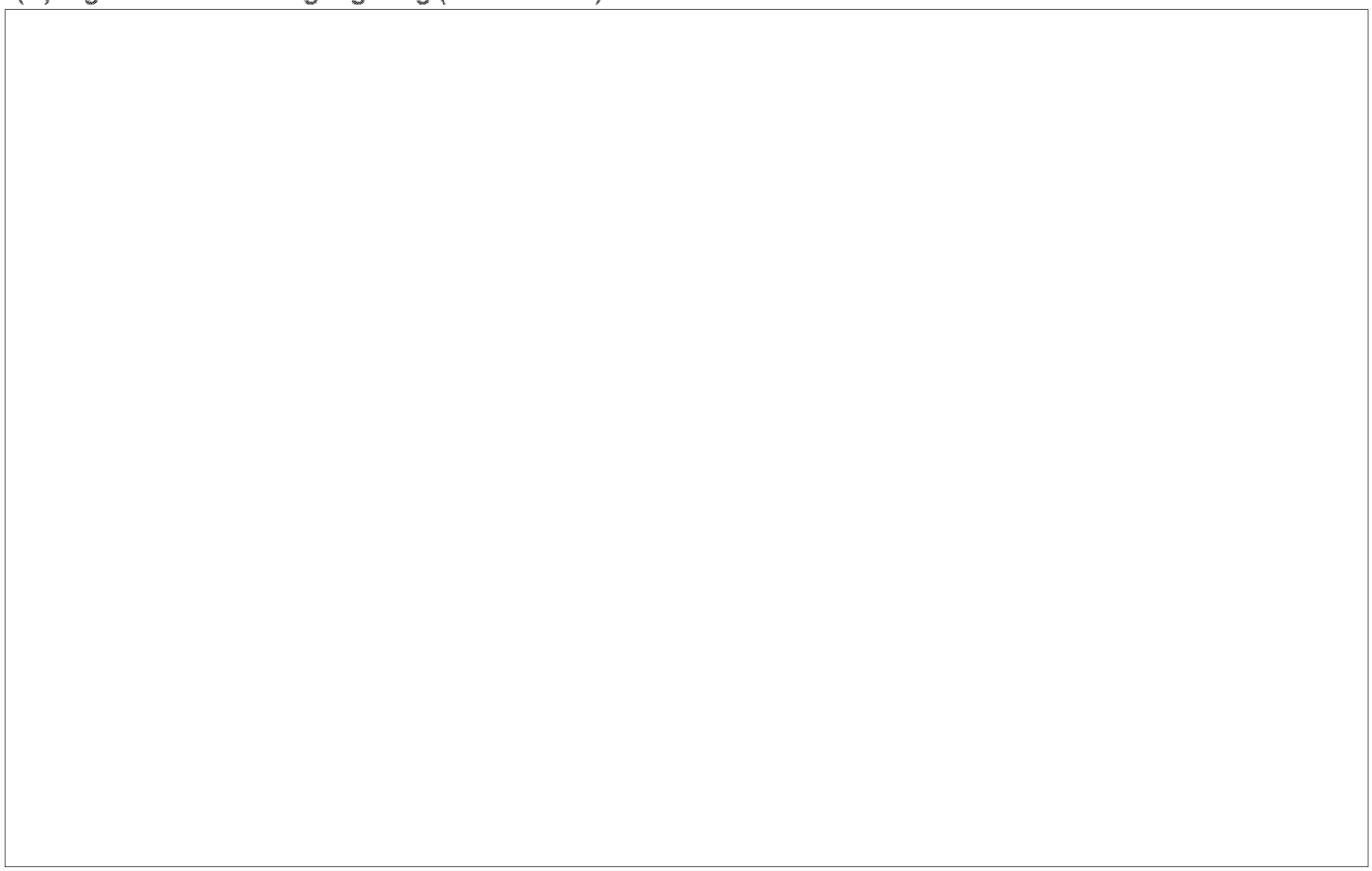
(U) A summary of some of the typical existing lighting elements found in the study area is provided in (U) Table 3-9. In general, the Site has high-mast (approximately 25 feet above ground) single-/double-headed LED lights within the parking areas and low-level (approximately 15 feet tall) single-headed LED lights along the roadway on the north side of the Site buildings The parking area in the northwest corner of the Site (Parking Area 1) has three rows of high-mast lights (one row of single-headed lights on each edge of the lot and one row of double-headed lights down the center of the lot), while the parking areas along the east side of the Site buildings (Parking Areas 2, 3, 4, and 5) have two rows of high-mast lights (one row of double-headed lights along each end of the parking aisles). Additional single-headed high-mast lighting was found near Gate 498 (since it is open 24/7) and along the pedestrian walkways between the Site buildings and Gate 498, the VCC, and Gate 401. The Site also has emergency lighting (activated only in case of power outages) that is spaced around the perimeter of the parking areas. (U) Figure 3-8, (U) Figure 3-9, and (U) Figure 3-10 show the location of non-emergency lighting and a depiction of the illumination pattern these lights were observed to create within the study area.

(U) Table 3-9: Typical Lighting Characteristics

Number	Sheet	Feature	Description
1	1	High-mast double-headed LED	Typical for Parking Area 1—equipped with solar cell for power
2	1	High-mast single-headed LED	Typical for Parking Area 1—equipped with solar cell for power
3	1 and 2	Low-level single-headed LED	Typical for the walkways and along the roadway on the north side of the buildings—equipped with solar cell for power
4	2 and 3	High-mast double-headed LED	Typical for Parking Areas 2, 3, 4, and 5—not equipped with solar cell
5	2 and 3	High-mast single-headed LED	Typical along the pedestrian walkways between the parking areas and in the areas directly around Gate 498, Gate 410, and the VCC—not equipped with solar cell
6	1, 2, and 3	Emergency lights	Typical around perimeter of parking areas—not equipped with solar cell

(U) Figure 3-10: Existing Lighting (Sheet 3 of 3)

(b)(3)



(U) 3.4. Observed Vehicle and Pedestrian Flows

(U) Observations of pedestrian and vehicle flows and behaviors were collected during each visit to the Site (refer to (U) Figure 3-11, (U) Figure 3-12, and (U) Figure 3-13). The observations focused on volume of movements at the different access locations, behaviors when inside the fence line, and typical interactions between vehicles and pedestrians at conflict areas. The observations were broken down into three main time periods:

- Early morning when it was still dark outside (lighting was on) and most activity was related to vehicles and pedestrians entering the Site.
- Early afternoon when most activity was related to pedestrians and vehicles exiting the Site.
- Late evening when it was dark outside (lighting was on) and the activity by pedestrians and vehicles was split equally between entering and exiting the Site.

(U) The following sections summarize the observations for the different modes of transportation.

(U) 3.4.1. Vehicles

(U) In general:

- Parking Area 2 (northeast corner of study area) and Parking Area 5 (southeast corner of the study area) have the highest overnight vehicle occupancy.
- Vehicles appeared to use both gates equally to enter and exit the Site when both gates were open.
- When inside the fence line, vehicles tended to fill up the parking areas on the east side of the Site buildings (Parking Areas 2, 3, 4, and 5) from the north to the south.
- Parking Area 1 saw more activity after Parking Areas 2 and 3 were nearly full.

- Vehicle speeds during the early morning and late evening hours, when the parking areas were relatively empty, were observed to be higher than other times of the day.
- Most vehicles made an immediate right turn or left turn after entering the gates and very few vehicles continued straight on the entry roadways up to the frontage road along the east side of the Site buildings.
- Very few vehicles were observed to park outside the fence line prior to sunrise.
- Vehicles did not drive diagonally through the parking aisles, even when the lots were empty.
- Queues outside the gates in the morning hours and inside the gates in the afternoon hours typically were short (no more than 4 to 5 vehicles) and did not create congestion on the circulating roadways in the area.

(U) 3.4.2. Pedestrians

(U) In general:

- After parking, most pedestrians were observed to walk down the parking aisles and then cross the frontage roadways to enter the Site buildings.
- Very few pedestrians were observed to walk diagonally through the parking aisles between the gates/parked vehicles and the Site buildings.
- Pedestrians entering from Gate 498, Gate 410, and the VCC were observed to use the crosswalks and the walkways to cross through the parking areas.
- When parking outside the fence line, most pedestrians entered through the VCC.
- Pedestrians exiting the buildings tended to use the sidewalks on the east side of the buildings to move north-south along the frontage road and did not cut diagonally across the frontage road until they were close to their desired parking aisle.

(U) Figure 3-11: Observed Vehicle and Pedestrian Flow Patterns (Sheet 1 of 3)

(b)(3)

(U) This page left blank intentionally.

(U) 4. Issues and Solutions

(U) Observations made during the Site visits helped identify several opportunities to improve the safety of pedestrians and vehicles within the study area. The issues can be divided into four categories: Signage, Lighting, Pedestrian Access, and Vehicle Circulation/Parking. The following sections contain discussions of the observed issues and some of the possible solutions.

(U) 4.1. Signage

(U) The use of roadside signing is intended to help convey messages with clear meanings to promote the safe movement of vehicles and pedestrians on, along, and across roadways. This also applies within parking areas. The *2009 Manual on Uniform Traffic Control Devices* (MUTCD) provides guidance and requirements for the proper placement and use of signs and is the industry standard that should be followed in all cases where roadside signing is used.

(U) 4.1.1. Reflectivity

(U) Faded or poorly illuminated signs can be difficult for drivers to observe, especially when there is sun glare or night lighting conditions. This can lead to drivers failing to obey the messages being conveyed by the signs. Per the MUTCD, *"Regulatory, warning, and guide signs and object markers shall be retroreflective or illuminated to show the same shape and similar color by both day and night."* The best way to achieve this requirement is to install new signs that are made with materials that are retroreflective under all conditions. Existing signage within the parking areas showed a range of reflective quality and most appeared to need replacement. (U) Figure 4-1 shows an example of a sign that has poor reflectivity that is located within the study area.

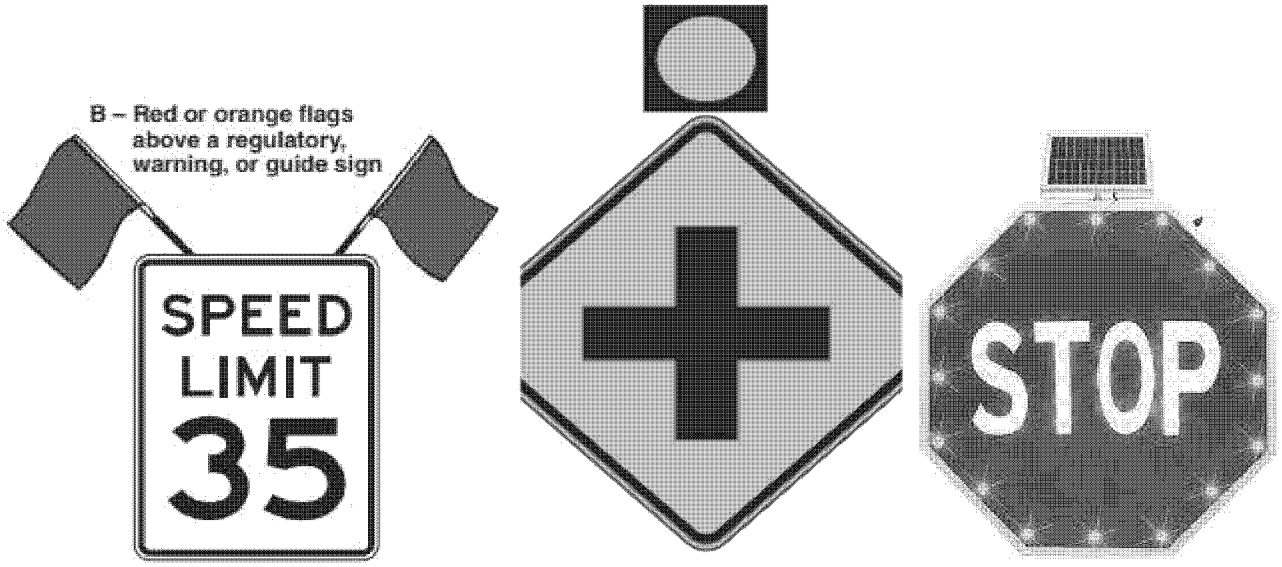
(U) In addition to using signs made with reflective materials, the signs should be replaced approximately every 10 to 15 years (expected life cycle of a sign), as soon as a sign begins to show evidence of fading, or when a sign shows evidence of any damage (vehicle impact) that reduces the overall sign reflectivity.

(U) 4.1.2. Enhanced Sign Conspicuity

(U) At critical locations, such as pedestrian crosswalks or major intersections within the parking area, signs can be modified to add additional conspicuity to emphasize a sign's message and meaning. The MUTCD provides many methods to achieve this goal, including:

- Increasing the size of signs
    - Sign sizes—usually speed limit signs, Stop signs, or Pedestrian Crossing warning signs—can be upsized to add additional emphasis and increase sign visibility.
- Adding red or orange flags above a sign panel (see (U) Figure 4-2)
    - This approach usually is used on speed limit signs in areas where vehicle speeds are observed to exceed desired levels.
- Adding flashing beacons above warning or Stop signs (see (U) Figure 4-2)
    - The beacon above a Stop sign is required to be a flashing red light, whereas the beacons above warning signs are required to be a flashing yellow light. These beacons can be solar powered, which would reduce the installation and yearly operational costs.
- Adding light emitting diodes (LEDs) within the legend or border of regulatory or warning signs (see (U) Figure 4-2)
    - To emphasize signs at critical or safety-sensitive locations, such as crosswalks, an LED border on a regulatory or warning sign can be added. This topic is covered in more detail later in *Section 4.3.3.1, High-Visibility Crosswalks Enhanced by Technology*.

(U) Figure 4-2: Examples of Enhanced Sign Conspicuity



Source: MUTCD and amazon.com

(U) 4.1.3. Sign Spacing

(U) Per the MUTCD, *"Signs requiring separate decisions by the road user shall be spaced sufficiently far apart for the appropriate decisions to be made."* Based on this requirement, regulatory and warning signs should not be placed on the same sign post but should be placed on separate posts and separated by a distance that ensures the signs do not block each other and allows drivers enough time to see the sign and perform a required reaction if necessary.

(U) The Site's parking areas have numerous locations where there are Stop signs (regulatory) and Pedestrian Crossing signs (warning) on the same post (see (U) Figure 4-3). These locations create the following issues:

- They convey two different messages to the driver at the exact same location, which can be confusing to the driver and does not comply with the MUTCD standards.
- Drivers may stop at the Stop sign and then forget that they also were warned to look for pedestrians.
- Stop signs at mid-block crossing locations—such as the one shown in (U) Figure 4-3 (at the crossing in front of the VCC)—tend to cause drivers to perform a rolling stop. The driver knows there are no vehicle conflicts at this location and, unless there is a pedestrian present, the driver is likely to slow and then proceed through without fully stopping. Due to the infrequent encounters with pedestrians, the driver becomes used to rolling through the intersection even if a pedestrian is present. Furthermore, if the driver becomes used to rolling through one location, the driver may exhibit similar behavior at all Stop locations in the area.

(U) There are a few options to solve this issue, including:

- Keep the Stop sign and flashing red beacon at these locations but remove the Pedestrian Crossing sign.
- Remove the Stop sign and flashing red beacon while using a concept discussed in *Section 4.3.3.1, High-Visibility Crosswalks Enhanced by Technology* to warn the drivers that pedestrians may cross at this location.
- Place the Pedestrian Crossing sign approximately 30 feet in advance of the crossing on a separate post and then keep the Stop sign and flashing red beacon at the crossing location.
- Move the Stop sign and flashing red beacon about 15 feet in advance of the crosswalk and place the Pedestrian Crossing sign at the crosswalk.

(U) Figure 4-3: Example of Flashing Beacons and Multiple Messages on a Shared Post

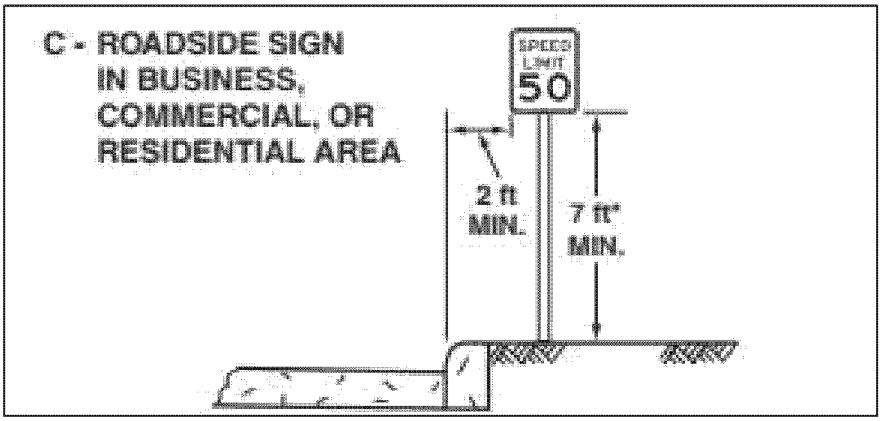
(U) 4.1.4. Sign Placements

(U) The MUTCD contains guidance on the mounting height and lateral placement of signs near locations where vehicles are parking or pedestrian activity is expected to occur (see (U) Figure 4-4). Signs should be located at least 2 feet behind a curb (or edge of the travel way) and signs should be mounted at a minimum height (to the bottom of the sign panel) of 7 feet above the sidewalk or pavement. These requirements help to improve the visibility of the sign for approaching vehicles, especially in the situation where there is a vehicle stopped in front of the sign. In addition, signs that are too low to the ground create sight distance obstructions that prevent a driver from seeing a pedestrian that is waiting to enter the crosswalk (the pedestrian may not be able to see the vehicle either). Finally, placement of the signs too close to the travel way tend to result in vehicles hitting the signs, especially at intersections where vehicles are turning.

(U) There are options the USG can use to address sign placement, including:

- Place signs behind raised curbing or move them up to two feet away from the edge of the roadways to reduce the risk of vehicles hitting the sign assembly.
- Use taller sign posts to raise signs to a minimum of 7 feet above ground to improve sign visibility, reduce sight obstructions, and reduce the risk of pedestrians hitting their heads on the sign panels while walking past the sign assembly.
- When signs are attached to light poles, place the signs at a height that is at least 7 feet above ground to prevent the signs from being blocked by parked vehicles and to eliminate possible sight distance obstruction for vehicles exiting the aisles.

(U) Figure 4-4: MUTCD Recommended Sign Placements



* Minimum height to bottom of panel.
Source: MUTCD

(U) 4.2. Lighting

(U) Inconsistent lighting coverage, or lack of lighting, often is a factor in crashes in low-light or dark conditions where the transitions between light and dark areas make it hard for the different users to see each other. Lighting uniformity is also a factor in pedestrians feeling safe when traversing a parking lot. For more details on the standards for lighting illumination the USG is directed to the following publications:

- *Interior and Exterior Lighting Systems and Controls*, Department of Defense, UFC 3-530-01, June 2016.
- *The Lighting Handbook, 10th Editions*, Illuminating Engineering Society of North America, 2011.

(U) 4.2.1. Parking Areas

(U) A demonstration done by Rensselaer Polytechnic Institute in Troy, New York, tested two uniformity conditions, 10:1 (standard) and 3:1 (improved), for perceptions of good lighting and safety and found that lighting levels matter less than uniformity.[1] (U) Figure 4-5 illustrates the difference in uniformity conditions. This has implications for energy usage as well as human comfort, allowing the focus to be on coverage, not brightness. As seen in (U) Figure 4-6, there are gaps in the existing lighting coverage within the study area, especially in Parking Areas 2, 3, 4, and 5 along the east side of the Site buildings.

(U) Lighting uniformity has implications for pedestrians as well, allowing them to better avoid hazards on the ground. The type of lighting also has been found to matter. Soft reflected light can help with the perception of faces whereas harsh, bright light can cast shadows, making it harder to discern a threat. Another related issue that can be mitigated with proper design is disability glare. Disability glare is defined as "… *very high luminance (measured 'brightness') that is close to the line of sight that affects the viewer's ability to resolve details because it superimposes a veil of light, washing out the contrast in the visual image*." This has implications for drivers and pedestrians seeing each other in parking lots.

(U) As noted, lighting has numerous safety implications. Proper lighting can improve safety by minimizing the opportunity to trip and fall, can help pedestrians avoid being struck by vehicles, and can improve personal security. While the parking lots at the Site were observed to have good overall lighting, the following are general recommendations that could make the parking lots safer for both pedestrians and drivers:[2]

- Illumination within parking lots—All points across the interior of the parking lot should be illuminated, including the low-traffic areas.
- Illumination level in high-traffic areas—Illumination levels at entrances, exits, loading zones, and collector lanes of parking areas should be greater than the illumination of the adjacent parking area or the adjoining street, whichever is greater.

---

[1] https://www.lrc.rpi.edu/programs/solidstate/parkingLotUniformity.asp
[2] Illuminating Engineering Society of North America (IESNA) requirements, to the International Dark-Sky Association (IDA) recommendations

(U) 4.2.2. Pedestrian Oriented Lighting

(U) In high pedestrian traffic areas, such as walkways, pedestrian-scale lighting should be considered. Pedestrian-scale lighting typically is shorter than vehicle-scale lighting and should be more frequent. The *Seattle Streets Design Guide* recommends a 12-foot to 14-foot height for pedestrian-scale lighting.[3] The Site has this type of lighting along the sidewalk adjacent to the roadway that is located along the north edge of the Site buildings (between Parking Areas 1 and 2). The Site does not have similar lighting along the other pedestrian walkways that connect the buildings to Gate 498, Gate 410, and the VCC, or along the sidewalk along the frontage road on the east side of the Site buildings.

(U) 4.2.3. Adaptive or Smart Lighting

(U) In addition to the improvements to coverage and brightness, new technologies are available that could be considered to improve lighting conditions in the parking lots. Adaptive lighting is increasingly in use around the country. Some examples include:

- Bi-level LED lighting (smart lighting)4. Bi-level lighting is lighting that responds to the presence of pedestrians and becomes brighter as someone walks along the walkway.
- Adaptive control system for exterior lighting5. UC Davis is pioneering experiments with adaptive lighting systems6 that are both energy efficient and responsive to user needs. Some highlights of the system include:
    - Light-emitting diode (LED) lights: LEDs give off bright white light but use little electricity.
    - Motion sensors: Sensors detect the motion of a person or vehicle within about 35 feet. When no motion is detected for a designated period (30 seconds to 30 minutes), the sensor switches the LED light from its high level to a low level that uses half the energy or it can even be turned off. And the switch from low brightness to high signals to people using the area that there is another car or person moving nearby—and can give that information to security personnel, too.

(U) 4.3. Pedestrian Access

(U) The use of clearly marked and designed pedestrian walkways and crosswalks is the best way to facilitate safer pedestrian movement through the parking lots. Options for materials, locations, and enhancements are discussed below.

(U) 4.3.1. Pedestrian Walkways between Parking Aisles

(U) Walkways that clearly identify the pedestrian walk path should be considered (see (U) Figure 4-7). These designated spaces facilitate safe movement through the parking lots because they let drivers know where to expect pedestrians, minimizing the opportunity for surprises. These concepts are easier to implement in parking lots where 90-degree parking spots are used (such as Parking Area 1), but the Site uses angled parking in Parking Areas 2, 3, 4, and 5.

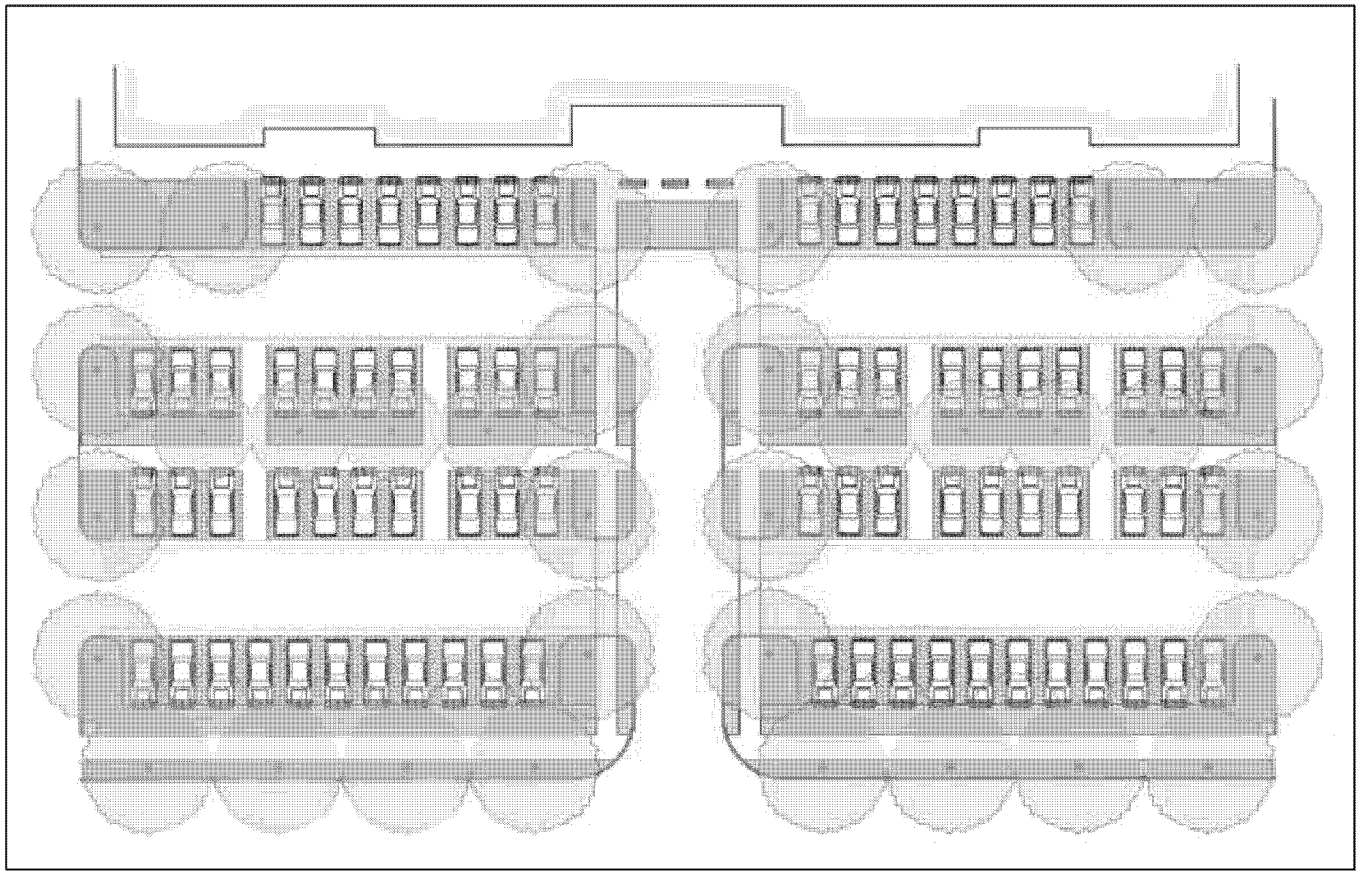
(U) Solutions to this walkway issue can be accomplished by the following approaches:

- Painted walkways (at least 5 to 6 feet in width) between parking aisles. The use of concrete parking wheel stops, especially if vehicles are found to be encroaching on the walkways, add an additional feature that can help preserve the needed width for the pedestrians to walk.
- Sidewalks with vertical curbing that is constructed between the aisles to provide the most direct routes to doors/buildings or where walking is being encouraged.

---

[3] https://streetsillustrated.seattle.gov/design-standards/lighting/
[4] https://www.bdcnetwork.com/uc-davis-demonstrates-smart-lighting-parking-lots
[5] http://cltc.ucdavis.edu/sites/default/files/files/publication/uc-davis-spec-networked-adaptive-controls-system.pdf
[6] https://www.ucdavis.edu/news/new-smart-lighting-makes-parking-greener-and-safer

(U) Figure 4-7: Example of Pedestrian Walkway Concept



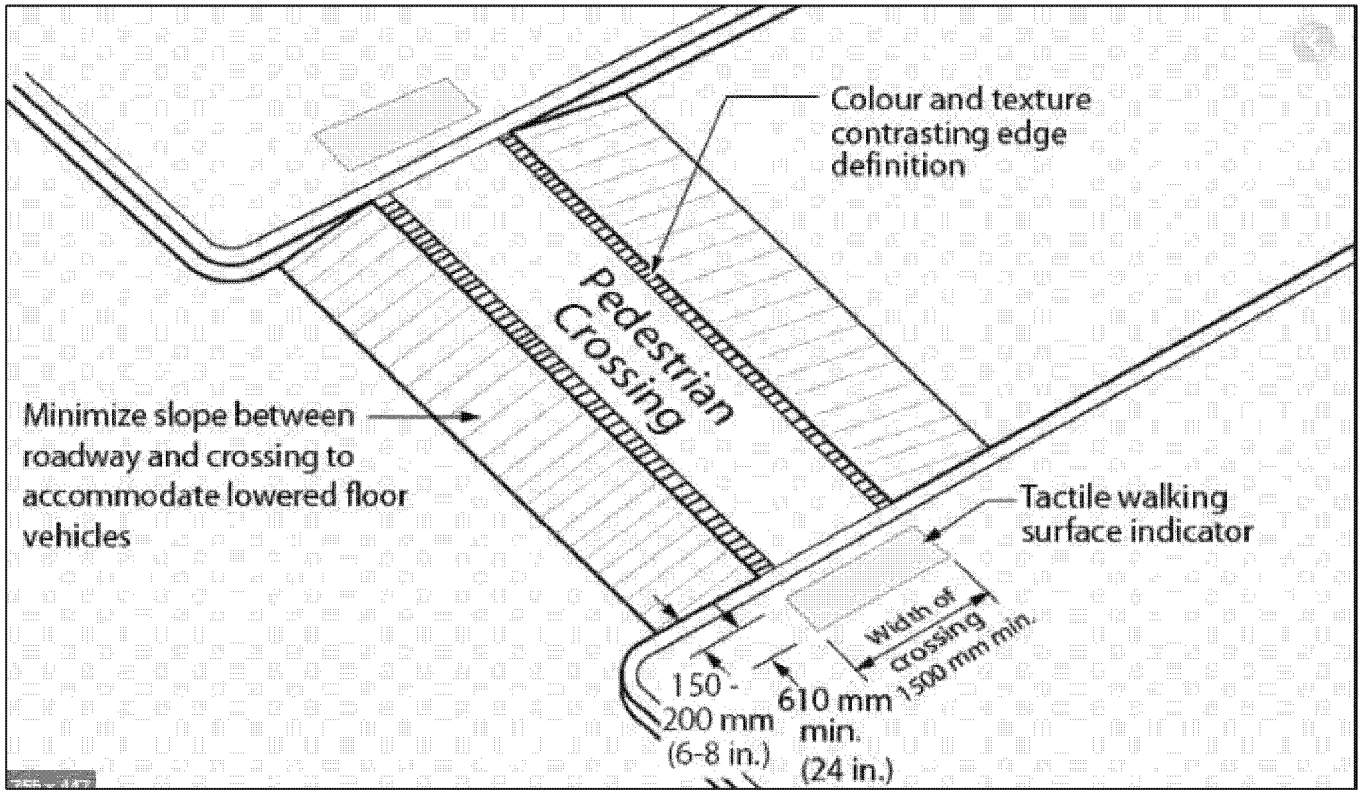
Source: *San Mateo County Sustainable Green Streets and Parking Lots Design Guidebook*

(U) 4.3.2. Raised Crosswalks

(U) Raised crosswalks allow better visibility of and by pedestrians before they enter and while they are crossing a roadway. While they are not the same as speed bumps, approach ramps for raised crosswalks have been shown to reduce speeds, improve motorist yielding rates, and reduce pedestrian crashes by 45 percent.[7] Raised crosswalks can be constructed (see (U) Figure 4-8) with either mountable or non-mountable curbs. Mountable curbs allow vehicles to drive over them, making them less safe for pedestrians but more accessible to emergency vehicles, and have no impact to vehicle circulation patterns in the parking areas. Non-mountable curbs, basically an extension of a sidewalk, are the most safe for pedestrians, but they can slow emergency vehicle access and would result in a change in the circulation pattern of vehicles in the parking area (the raised pedestrian crossing basically closes the road to vehicles). (U) Figure 4-9 illustrates a mountable raised crosswalk design and highlights the features that make it effective. In the case of a non-mountable design, the ramps on either side of the crossing are replaced with additional sidewalk space or landscaping and raised curbs are extended along the length of the crossing to prevent vehicles from driving over the crossing area.

[7] http://www.pedbikesafe.org/pedsafe/countermeasures_detail.cfm?CM_NUM=7

(U) Figure 4-8: Example of a Raised Crosswalk Detail



Source: Pedbikesafety.org

(U) Figure 4-9: Example of a Mountable Raised Crosswalk

Source: Pedbikesafety.org

(U) 4.3.3. Curb Extensions

(U) Sidewalk/curb extensions also can help reduce the distance a pedestrian has to cross over a roadway, reducing the pedestrian's exposure time to vehicles. Also, the use of raised curbs helps to make sure that pedestrians begin to cross the roadway from the edge of the travel way instead of moving out from behind parked vehicles or starting from a unexpected position on which a driver's attention is not focused. For example, (U) Figure 4-10 shows the pedestrian crossing at the VCC. The pedestrians exiting the VCC begin their crossing where the crosswalk starts, which is at least 10 feet away from the travel lanes. Pedestrians were observed to stop at the edge of the sidewalk and wait for vehicles to stop, but from this location they are partially behind parked cars, partially behind the signs, and not at the edge of the travel way where drivers expect pedestrians to be waiting to cross the road. (U) Figure 4-11 shows an example of how raised curbs, or bulb outs, are used to narrow the width of roadway that a pedestrian must cross, but also allow the pedestrians to start a crossing from a point that is directly adjacent to the travel lanes. At this location, the pedestrian is more visible to the vehicle driver, making the crossing a safer movement.

(U) Figure 4-10: Example of an Existing Pedestrian Crossing at the VCC

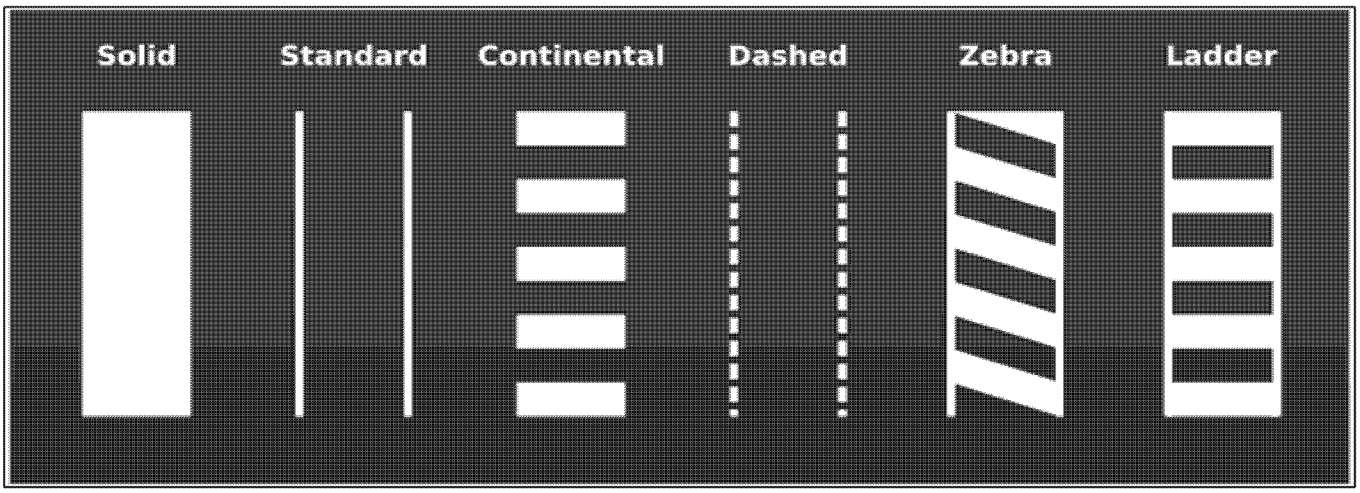
(U) Figure 4-11: Example of Curb Extension/Bulb Outs at Pedestrian Crossing

Source: mainstreetbeverly.wordpress.com

(U) 4.3.4. Enhanced (High-Visibility) Crosswalks

(U) Crosswalks are used to identify specific locations for pedestrian crossing. There are several options for the type of striping that can be used to mark a crosswalk. The Site currently uses two different styles of crosswalk striping: continental and zebra style striping (refer to (U) Figure 4-12). Continental crosswalks using high-visibility pavement marking materials have been found to be the most visible to approaching vehicles and to improve yielding behavior.

(U) Figure 4-12: Examples of High-Visibility Crosswalks



Source: sfbetterstreets.org

(U) As part of the data collection effort, it was observed that the pedestrian crossing at the northeast corner of the Site buildings (the turnstile entrance through the fence line) appears to be misplaced. (U) Figure 4-13 shows the existing crossing is located near the frontage road along the east side of the buildings but there is clear evidence as seen by the worn path in the dirt that a high number of pedestrians using this sidewalk are going to and coming from the building entrance near the northwest part of the Site. The pedestrians that are using this dirt trail do not benefit from the signing and pavement markings at the existing crossing location.

(U) Figure 4-13: Example of Misplaced Crosswalk

(b)(3)

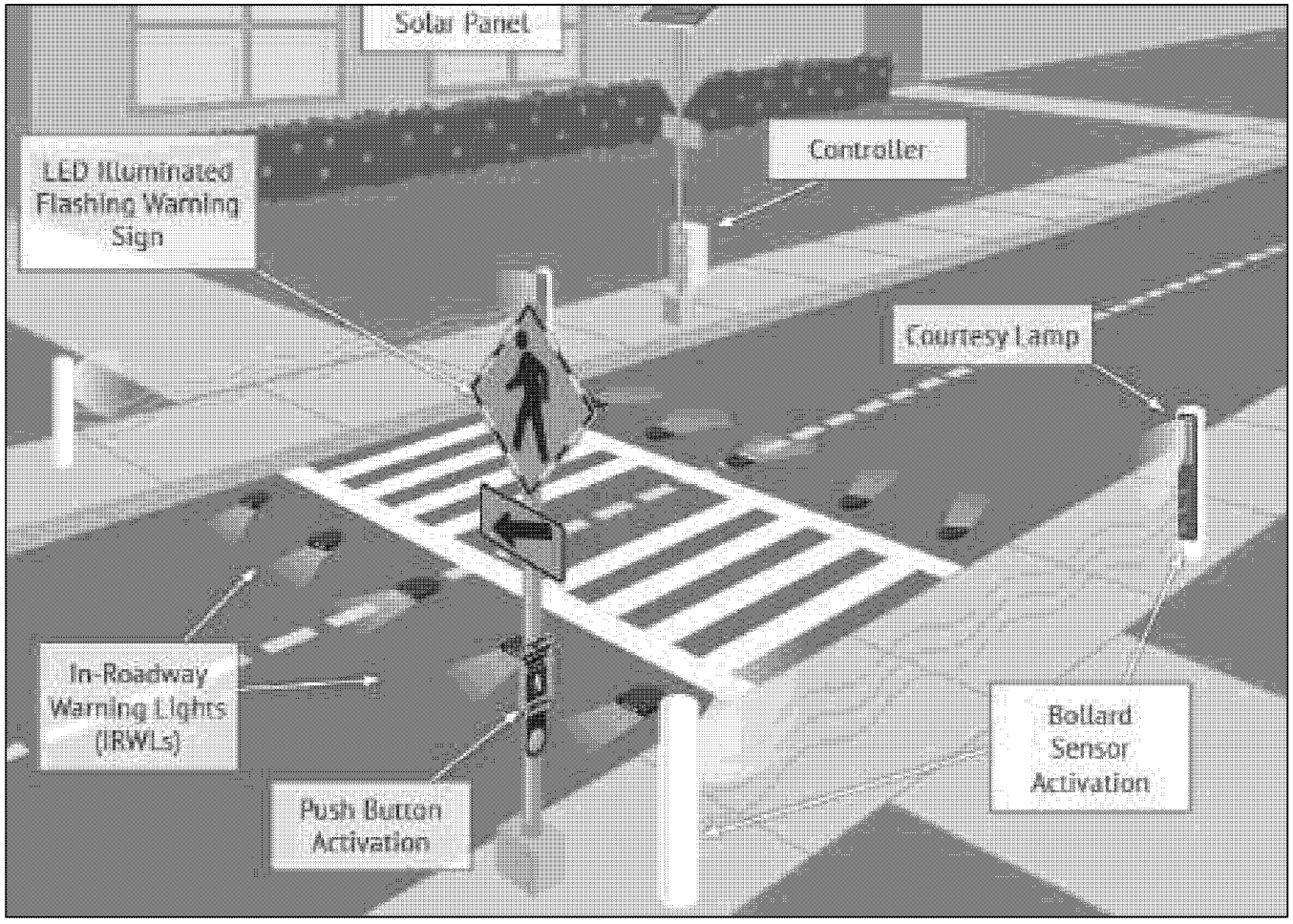
(U) 4.3.5. High-Visibility Crosswalks Enhanced by Technology

(U) The following items illustrate a "complete" crosswalk treatment (refer to (U) Figure 4-14). This includes:

- Motion-sensitive bollards that, when walked between, activate in-roadway lighting and/or flashing warning beacons
- Solar-powered LED Pedestrian Crossing signs
- Pedestrian-activated crossing beacons

(U) The illustration below shows how the components work together. This type of approach is appropriate at locations where high pedestrian and vehicle activities occur, resulting in an increase in the potential for conflicts. The LED signing requires pedestrians to push a button or it may be connected into the motion-activated system. The in-pavement lighting may become blocked by dirt or snow, which would decrease its effectiveness, but modern advancements in the technology have resulted in better design of the lighting units that make it more difficult to become obscured by dirt or snow. Also, there is a potential for false positive activations, which are activations when no pedestrian is crossing. This can lead to drivers ignoring the warning. The system also can be subject to failed activations, which occur when the motion-activated sensors fail to detect a crossing pedestrian, and this can result in increased conflicts.

(U) Figure 4-14: Example of Using Technology to Create a Complete Crosswalk



Source: lightguardsystems.com

(U) 4.3.6. 3-D Painted Crosswalks

(U) A new approach to painted pedestrian crossings includes the use of three-dimensional (3-D) painting. The intention of the design is to get drivers to slow down when approaching the crosswalk and generally they seem to, although no long-term studies on the efficacy of such designs have been completed. The concept, as shown in (U) Figure 4-15, is to make the crossing appear to float above the pavement (3-D effect) and make the driver pay more attention on the approach to the area. It is important to note that this concept does not comply with the MUTCD.

(U) As a result of demonstrated safety concerns, the Federal Highway Administration (FHWA) is no longer considering field experimentation with 3-D crosswalk designs. The FHWA had previously approved field experimentation with 3-D markings until one such experiment showed unintended—and potentially dangerous—effects. A significant percentage of drivers swerved upon seeing the markings, perhaps perceiving them to be real raised objects on the roadway. While this type of driver reaction did decrease over time, the experiment showed that more than 1 in 10 drivers might make an evasive or erratic maneuver upon experiencing this or similar installations for the first time. The results suggest that a 3-D marking design can result in unsafe behavior by drivers. If the design is effective at portraying a 3-D object and drivers believe there are real raised objects on the roadway, it is a reasonable expectation that drivers will take evasive action, such as braking abruptly, in fear of colliding with the perceived obstruction. This type of driver reaction is, in fact, what the experiment showed. The potential for a significant percentage of drivers to react unpredictably is too great a risk to allow further field experimentation.[8]

(U) Figure 4-15: Example of a 3-D Painted Crosswalk

Source: WDAF

(U) 4.4. Vehicle Circulation and Parking

(U) The current parking area has other elements that could be changed to help with overall safety related to vehicle circulation and parking. The following sections discuss these issues and possible solutions to address them.

[8] https://mutcd.fhwa.dot.gov/knowledge/faqs/faq_part3.htm#cwq4

(U) 4.4.1. Raised Islands at the End of Parking Aisles

(U) The islands at the end of parking aisles are there to reserve space at the end of the aisle to create adequate sight distance and line of sight to assist vehicles entering and exiting the aisles. The space, when sized appropriately, also helps pedestrians and drivers see each other to reduce the risk of conflict. The use of paint to delineate the islands at the end of the parking aisles as shown in (U) Figure 4-16, as opposed to using concrete to create raised islands, can create issues, including:

- Paint does not prevent vehicles from parking on the island area and potentially sticking out into the circulating roadway or parking aisles.
- Vehicles parking on the island area reduce the sight distance for vehicles and pedestrians.
- The parking lot light pole assemblies are located within the painted areas and are subject to vehicles hitting the base.

(U) One solution is to use concrete to make raised islands (see (U) Figure 4-17) at the end of each parking aisle. This would help to clearly indicate where vehicles are not to park so that adequate sight distance is preserved at the intersections. The raised nature of these islands allows the light pole bases to be protected and eliminates the possibility of vehicles striking them. Also, the raised islands can provide opportunity to introduce landscaping into the parking areas.

(U) Figure 4-16: Example of Vehicles Parked on Painted Islands

(b)(3)

(U) Figure 4-17: Example of a Raised Concrete End-of-Aisle Island

Source: hort.ifas.ufl.edu

(U) 4.4.2. One-Way Building Frontage Road

(U) The Site has a parking lot frontage road (road between the parking spots and the buildings) along the east side of the buildings (see (U) Figure 4-18). The roadway varies in width and has a combination of one-way and two-way traffic movements. The roadway is currently one-way southbound south of Gate 410, one way northbound from Gate 410 to a location halfway between Gate 498 and the VCC, and it then has two-way traffic from this location to the north end of the road.

(U) Changing the frontage road to be one-way the entire length of the parking areas has benefits that include:

- Eliminating driver confusion and the possibility of vehicles driving the wrong direction at the point where the road changes from two way to one way.
- Reducing the distance pedestrians must cross and interact with vehicles, since a one-way road can be narrower than a two-way road.
- Requiring pedestrians to cross only one lane of traffic, which means they only need to look in one direction to see on-coming vehicles.

(U) Figure 4-18: Existing Frontage Road Along East Side of Buildings

(b)(3)

(U) 4.4.3. Wheel Stops

(U) The aisles in the Site parking areas do not have wheel stops but rely on striping to delineate the front end of the parking spaces. This creates several issues, including:

- Drivers are not sure how far to pull in before they pass the front of the parking spots, which can lead to fender benders or irregular parking depths so that vehicles protrude into the aisles, as shown in (U) Figure 4-19 and (U) Figure 4-20.
- Pulling into the parking spaces in an uneven manner results in narrowing of the aisle, making it difficult for vehicles to travel down the aisle.
- Pedestrians also must weave around the vehicles as they walk in the aisles, which increases the risk for conflicts with moving vehicles.

(U) The use of wheel stops (as shown in (U) Figure 4-21) helps drivers know when they are fully in the spaces, prevents vehicles from opposing aisles from contacting each other, and reduces the degree to which vehicles protrude in the aisle. The use of wheel stops can help create walkways for pedestrians (painted or raised) in the area in between parking aisles, which is easier to do in parking lots with 90-degree parking spots.

(U) Figure 4-19: Example of Existing Parking Without Wheel Stops

(b)(3)

(U) Figure 4-20: Example of Vehicle Parking Depths Without Wheel Stops

(b)(3)

(U) Figure 4-21: Example Use of Parking Wheel Stops

Source: Centurygrp.com

(U) 4.4.4. Signing for Gate Hours

(U) The USG staff identified an issue (outside of the fence line) with drivers/visitors not knowing the hours of operation for Gate 498, Gate 410, and the VCC. As a result, drivers arriving at the Site using Aspen Street were unsure which entrance to use and ended up having to circulate around within the parking areas outside the fence line. The USG is concerned about the safety of the pedestrians in the outer parking areas and would like to reduce the amount of circulating by vehicles that are trying to enter the inner parking areas but arrive at Gate 410 when it is closed and then must circulate to Gate 498. This also applies to visitors that arrive at the VCC after it closes and then must circulate back to Gate 498.

(U) One solution is to install informational signs along Aspen Street that contain digital insert displays that can be manually set to read "OPEN" or "CLOSED" based on the hours of operation for the gates and the VCC. The signs would be hardwired back to the gates and VCC to allow staff the ability to change the messages between "OPEN" or "CLOSED." These signs could help reduce unnecessary circulating by vehicles and reduce the number of conflicts with pedestrians in the outer parking areas.

(U) 4.4.5. Other Pavement Markings

(U) The MUTCD identifies pavement markings that are allowed that can help influence driver behaviors to improve safety, and some of these can be applied to parking areas. In locations where speed is a concern or a recurring issue, speed limit pavement markings (see (U) Figure 4-22) can be used to supplement posted speed limit signs. A few locations where these markings would provide benefit include:

- Areas where vehicles first enter a safety sensitive area, such as at gates or driveways
- Areas where vehicle speeds are known to exceed the desired speed limits

(U) One issue that was observed in the parking areas was at the end of the parking aisles, where vehicles were observed to pull out of the aisles and into the circulating roadways or frontage road without slowing or stopping. Vehicles exiting a parking aisle should yield to vehicles on the circulating or frontage roads. Installation of YIELD pavement markings (see (U) Figure 4-22) at the end of each parking aisle will reinforce the need for drivers to slow in this area and to warn the drivers that they have reached the end of the row and are entering a roadway where drivers are not required to yield. The YIELD markings also can be used at crosswalk locations.

(U) Figure 4-22: Example of Other Pavement Markings

Source: topslab.wisc.edu and pplsok.com

(U) 4.4.6. Use of Curbing to Define Intersections

(U) Large intersections that are not well defined with curbing result in vehicles being able to travel through the intersections along various paths that overlap pedestrian crossings. These intersections also create long distances that pedestrians must cross, which increases the time the pedestrians are exposed to vehicles and increases the potential for conflicts to occur. The addition of curbing can help to better define the intersections and restrict vehicle movements to smaller areas. This will reduce the distance that pedestrians must cross, reduce the time

pedestrians are exposed to vehicles, and confine the area in which pedestrians must watch for approaching/ crossing vehicles. Although this concept could be accomplished with striping, this approach is not as effective as curbing because vehicles can simply drive over the striping. Curbing is more expensive to install, but it would have better safety benefits by keeping vehicles in desired travel areas.

(U) 4.4.7. Add Control to Intersections

(U) With a focus on pedestrian safety, all pedestrian crossing locations should have signing to control vehicle movements. Vehicles should not have the ability to approach and cross (straight movement or turning movement) over a pedestrian crossing without at least warning signs and/or other traffic control devices, such as Stop signs. At uncontrolled crossing locations, the driver may assume the right of way and fail to yield to pedestrians. Lack of traffic control also can lead to confusion and possible conflict between vehicle movements.

(U) 4.4.8. Parking Size Restrictions

(U) Parking lots often have a wide variability in the size of vehicles that park in the parking areas. If larger vehicles (vehicles longer than a typical sedan), such as pickup trucks, park in the spots at the end of the aisles (see (U) Figure 4-23), these vehicles tend to extend beyond the parking spot and block part of the aisles, which creates sight distance issues for vehicles attempting to enter or exit the aisle, causing safety concerns for both vehicles and pedestrians.

(U) One possible solution would be the implementation of restrictions that prohibit large vehicles from parking in the last couple of parking spots in each aisle. This could be accomplished by using signs or pavement markings that indicate the last few spots are reserved for compact vehicles only (see (U) Figure 4-24). The implementation of this concept requires investment in the resources to enforce the rule or relying on drivers to follow the honor system and adhere to the rule.

(U) Figure 4-23: Example of a Large Vehicle at the End of a Parking Row

(b)(3)

(U) Figure 4-24: Example Compact Car Parking Sign and Pavement Marking

Source: myparkingsign.com and thebluebook.com

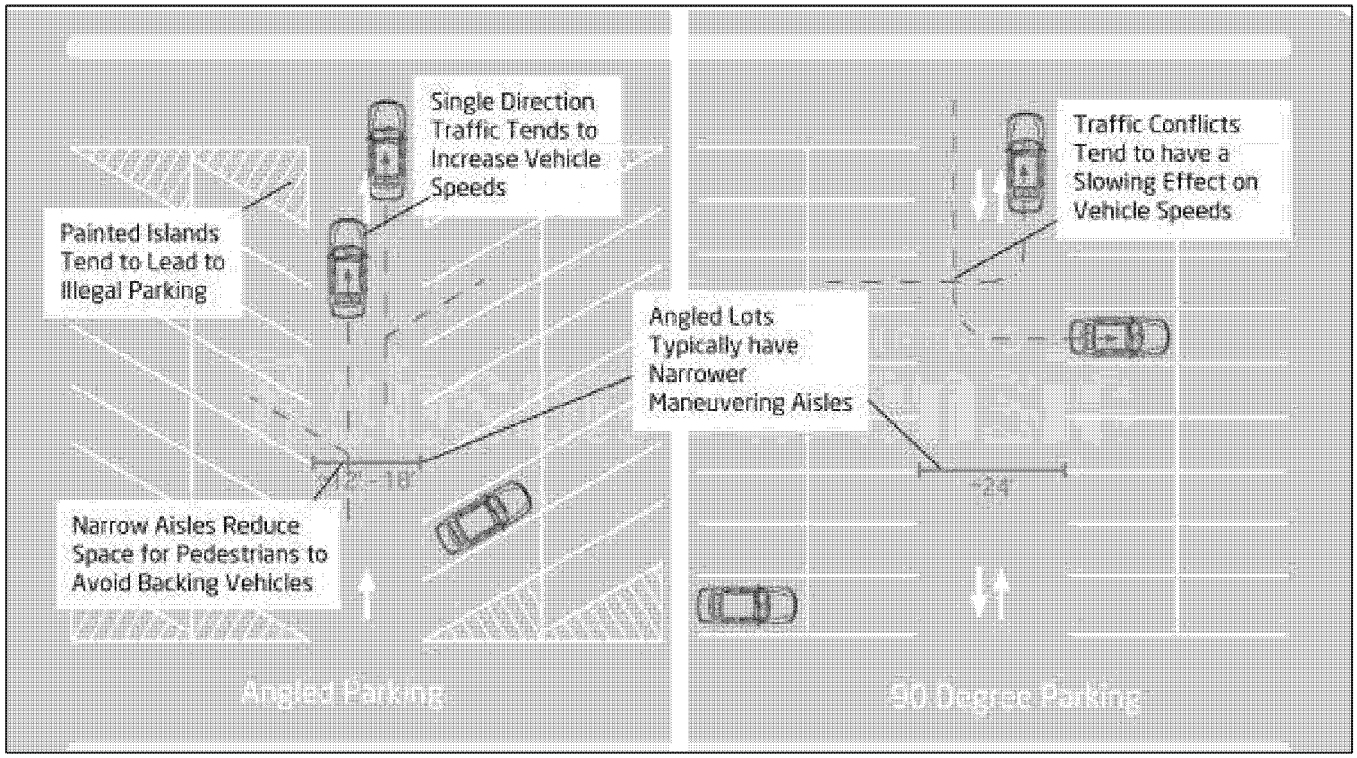
(U) 4.4.9. Parking Lot Configuration

(U) The layout of parking spots and aisles can lead to issues and can make it difficult to implement some of the other identified solutions (see (U) Figure 4-25). Restriping a parking lot is a major undertaking that requires closing the lot. Depending on the level of changes being made (grouping multiple solutions into one work project), the regular users of the lot could be displaced for long durations. Careful consideration is needed to ensure a new striping concept does not create new issues, and a more detailed analysis should be completed before restriping a parking lot.

(U) The current parking lot configuration (Parking Areas 2, 3, 4, and 5) is shown in (U) Figure 4-26, (U) Figure 4-27, and (U) Figure 4-28. The parking lots use angled spots with one-way aisles. The current layout creates issues that include:

- Lack of walking aisles between the parking aisles
- Narrow one-way aisles that must be shared by pedestrians and vehicles
- Difficulty for drivers to know when the front of their vehicles has reached the front of the spot—leads to vehicles not pulling in far enough and blocking part of the aisles or pulling in too far and encroaching beyond the front of the space
- Higher speeds pulling into and backing out of spots
- Vehicles tending to circulate more because aisles are only one way
- Drivers entering at the gates and using the first parallel aisles to avoid weaving around the barricades on the main entry roads (see (U) Figure 4-29). By avoiding the barricades, these vehicles travel at higher speeds in these aisles.

(U) Figure 4-25: Example of Angled Parking versus 90-Degree Parking



Source: trafficsafetystore.com

(U) Figure 4-26: Existing Parking and Circulation (Sheet 1 of 3)

(b)(3)

(U) 4.5. Summary of Solution Pros and Cons

(U) A summary of the solutions identified to address the issues and includes a list of the primary pros and cons for each solution is provided in (U) Table 4-1.

(U) Table 4-1: Solution Pros and Cons

Issue	Solution	Pros/Cons
Signage	Reflectivity	Pros—convey clear message to drivers Cons—none
	Conspicuity	Pros—add emphasis to sign messages and increase awareness at safety-sensitive areas Cons—additional costs
	Spacing	Pros—prevent driver confusion Cons—more signs may create sign pollution
	Placement	Pros—reduce potential for sight obstructions and vehicle strikes to signs Cons—costs to add curbing to protect sign posts
Lighting	Pedestrian Oriented	Pros—enhances visibility of pedestrians Cons—cost
	Adaptive	Pros—enhances pedestrian walkway lighting, responds to motion, energy saving Cons—cost and increased maintenance needs
	Parking Area	Pros—enhances parking lot visibility at night Cons—cost
Pedestrian Access	Pedestrian Walkways	Pros—creates safe spaces by which pedestrians can move through the parking lot Cons—may mean the loss of parking spaces
	Raised Crosswalks	Pros—creates a safer place for pedestrians to cross and slows down drivers Cons—impacts to drainage, vehicle circulation, snow removal, and emergency response
	Curb Extension (Bulb Outs)	Pros—better pedestrian visibility of crossing and slows vehicles down Cons—impacts to drainage and snow removal
	High-Visibility Striping	Pros—creates a safer place for pedestrians to cross and slows vehicles down Cons—increase in costs to install
	Crosswalks Enhanced by Technology	Pros—creates a safer place for pedestrians to cross and slows vehicles down Cons—costs and maintenance requirements
	3-D Painted Crosswalks	Pros—may help slow drivers down Cons—not MUTCD compliant and possible negative impact on drivers
Vehicle Circulation and Parking	Raised-End Aisle Islands	Pros—creates safe spaces by which pedestrians can move through the parking lot Cons—may mean the loss of parking spaces
	One-Way Frontage Road	Pros—creates safe spaces by which pedestrians can move through the parking lot Cons—may mean the loss of parking spaces
	Wheel Stops	Pros—creates safe spaces by which pedestrians can move through the parking lot Cons—may mean the loss of parking spaces
	Signing for Gate Hours	Pros—creates safe spaces by which pedestrians can move through the parking lot Cons—may mean the loss of parking spaces
	Other Pavement Markings	Pros—creates safe spaces by which pedestrians can move through the parking lot Cons—may mean the loss of parking spaces
	Use of Curbing to Define Intersections	Pros—creates safe spaces by which pedestrians can move through the parking lot Cons—may mean the loss of parking spaces
	Add Control to Intersections	Pros—creates safe spaces by which pedestrians can move through the parking lot Cons—may mean the loss of parking spaces
	Parking Size Restrictions	Pros—creates better sight distance at the end of all parking aisles Cons—requires resources to enforce or rely on honor system
	Parking Configuration Change	Pros—would facilitate the implementation of more solutions Cons—very costly and long duration impact to Site operations during implementation

(U) 4.6. Evaluation of Solutions

(U) After identifying solutions that could be implemented to address the various safety issues within the study area, the next step was to evaluate the possible solutions to identify how well each one satisfies the project purpose and goals. To complete this evaluation, several factors were considered, including complexity to implement, cost to build, degree of maintenance costs/activities, and the overall benefit that the solution would provide to either pedestrian or vehicle traffic. The evaluation of each solution was done on a very high level and in many cases the results are based on engineering judgement. The following sections describe the evaluation process in more detail.

(U) 4.6.1. Evaluation Criteria

(U) Each solution was evaluated against four criteria (complexity to implement, cost to build, maintenance costs/activities, and benefit to safety) and provided a score of low, medium, or high. The following sections provide more discussion of the criteria and how they were applied to evaluate the solutions.

(U) 4.6.1.1. Complexity to Implement

(U) This evaluation criterion considers how complex an effort a solution would require if it were to be implemented within the Site. The complexity of a solution considers the following items:

- Level of design services that would be needed to develop the concept to full construction-level plans.
- Whether the solution by itself would be beneficial or if the solution would be better if combined with other solutions. For example, the implementation of adaptive lighting would require installation of more lighting and most likely improvements to the sidewalks or walkways to be fully effective.
- Possibility that the solution would require significant efforts to implement, such as the need to install power sources or the need to perform significant construction activities.
- The potential that the solution may result in the need for other improvements. For example, the addition of raised crosswalks or adding curbing/sidewalks may impact drainage and the USG may have to invest in additional improvements.
- Technical solutions may require items such as sensors or other devices that would require expertise to install and maintain.

(U) 4.6.1.2. Cost to Build

(U) Applying this criterion was difficult when evaluating the solutions because it was not known how much of any one solution the USG may implement. For example, the Site has more than 60 signs that need replacement because of poor reflectivity, placement, or spacing, but the USG may choose to replace only some of the signs due to budget constraints. Therefore, the application of this criterion assumes the USG would implement a large-scale project and address as many locations as possible if the solution was implemented.

(U) 4.6.1.3. Maintenance Costs/Activities

(U) Each solution was evaluated to determine estimated costs to maintain the solution in future years and the potential impact that the solution would have to person-hour commitment from USG maintenance staff. Some of the considerations for this criterion include:

- The need to provide power—for example, if the solution requires direct electrical power or other direct communication that would incur a monthly cost.
- How often the improvement would need to be updated/replaced—in the case of a solution that involved paint, then the striping may need to be redone annually or over a longer duration depending on wear-and-tear and events, such as snow plows scraping over the surface. This also applies to items such as light bulbs, damaged wheel stops, and other items that are subject to lifecycle durations.
- If the solution may require additional maintenance activities in the form of additional person-hours for USG staff. For example, with solutions that include technology, such as adaptive lighting, maintenance staff may spend extra time ensuring the sensors are aligned properly or they may need to spend more time performing activities such as replacing bulbs or aligning wheel stops. There may be additional hours required for snow removal efforts due to changes in circulation in the parking areas.

(U) 4.6.1.4. Safety Benefits

(U) The USG is concerned with how to improve safety for both vehicle and pedestrian modes of transportation. Each of the solutions was evaluated to determine (based on engineering judgement) how much of a benefit would be experienced by vehicles (or their drivers) or pedestrians within the parking areas.

(U) 4.7. Prioritization of Solutions

(U) Based on the criteria evaluation process, each solution then was provided with an overall priority for each mode. A solution may receive a high priority for one mode (vehicle or pedestrian) and a low priority for the other. (U) Table 4-2 includes a summary of the criteria evaluation process as it was applied to each of the solutions. None of the evaluated solutions scored low in the benefit category for both vehicles and pedestrians, meaning that every solution would provide some degree of benefit if implemented within the study area. Solutions that are a priority for both vehicles and pedestrians include:

- High-visibility crosswalk striping, as well as other word and symbol striping in the parking areas
- Converting the frontage road on the east side of the buildings to a one-way roadway for its full length
- Adaptive lighting along the walkways, at crosswalks, and on sidewalks
- Use of raised crosswalks and/or curb extensions at all crosswalk locations

(U) Even though it is not recommended by FHWA and does not comply with the MUTCD, 3-D painted crosswalks may provide benefits to both vehicle and pedestrian safety. Implementation of this concept should be considered by the USG, but only after careful consideration of the potential impact to drivers. The USG should conduct some testing of this solution with employees in a non-critical location prior to implementing it more widely in the parking areas.

(U) Table 4-2: Prioritization of Solutions

Issue	Solution	Complexity	Cost	Maintenance	Mode	Safety Benefit	Overall Priority
Signage	Reflectivity	Low	Low	Low	Vehicle	High	High
					Pedestrian		
	Conspicuity	Low	Medium	Low	Vehicle	High	High
					Pedestrian		
	Spacing	Low	Low	Low	Vehicle	Medium	High
					Pedestrian		
	Placement	Low	Low	Low	Vehicle	High	High
					Pedestrian		
Lighting	Pedestrian Oriented	Medium	Medium		Vehicle		
					Pedestrian	High	Medium
	Adaptive			Low	Vehicle	Medium	
					Pedestrian	High	Medium
	Parking Area	Low	Medium	Low	Vehicle	High	High
					Pedestrian	Medium	Medium
Pedestrian Access	Pedestrian Walkways		Medium	Low	Vehicle		
					Pedestrian	High	Medium
	Raised Crosswalks	Medium	Low	Low	Vehicle		Medium
					Pedestrian	High	High
	Curb Extension (Bulb Outs)	Medium	Low	Low	Vehicle		Medium
					Pedestrian	High	High
	High-Visibility Striping	Low	Low	Low	Vehicle	Medium	High
					Pedestrian	High	High
	Crosswalks Enhanced by Technology		Medium	Medium	Vehicle	Medium	
					Pedestrian	High	Medium
	3-D Painted Crosswalks	Low	Low	Low	Vehicle	Medium	High
					Pedestrian	High	High
Vehicle Circulation and Parking	Raised-End Aisle Islands	Medium		Low	Vehicle	High	Medium
					Pedestrian		
	One-Way Frontage Road	Low		Low	Vehicle	High	High
					Pedestrian	High	High
	Wheel Stops	Medium	Medium	Medium	Vehicle	Medium	Medium
					Pedestrian		
	Signing for Gate Hours	Medium	Medium	Low	Vehicle	High	High
					Pedestrian		
	Other Pavement Markings	Low	Low	Low	Vehicle	Medium	High
					Pedestrian		
	Use of Curbing to Define Intersections	Medium	Medium	Low	Vehicle	High	High
					Pedestrian	Medium	Medium
	Add Control to Intersections	Low	Low	Low	Vehicle	Medium	Medium
					Pedestrian	Medium	Medium
	Parking Size Restrictions	Low		Low	Vehicle	High	High
					Pedestrian		
	Parking Configuration Change			Low	Vehicle	High	Medium
					Pedestrian	High	Medium

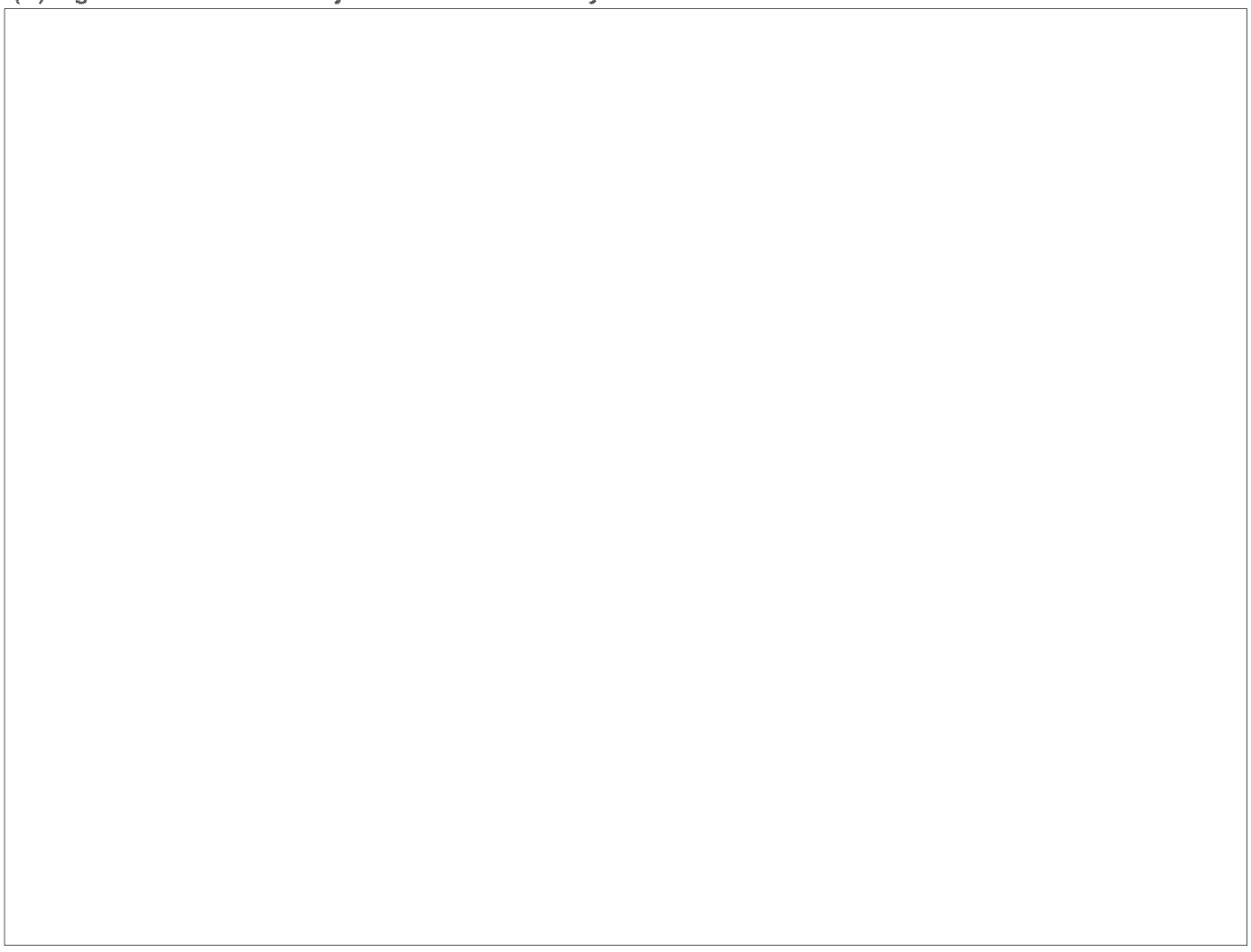
Note: For complexity, cost, and maintenance criteria, a low score is desired (green) and a high score is not (red). For safety benefit criterion, a low score is not desired (red) and a high score is desired (green). The overall priority is an engineering judgement based on the combination of the four criteria scores.

(U) 5. Recommendations

(U) The previous section of this report identified solutions that would improve safety for pedestrians and vehicles within the study area. This section of the document will present recommendations for 16 specific projects (figures provided in this section and larger figures provided in Appendix B: Project Figures) that should be completed to achieve the study goals (see (U) Figure 5-1). Each of the 16 project areas have issues that can be addressed through the implementation of one or more of the previously identified solutions. The following sections discuss each of these project areas, identify specific solutions, and estimate the costs to make the improvements (refer to Appendix A.1 and A.2 for details regarding the development of the cost estimates and the assumptions for each project item). Note that each project is considered as an independent improvement and does not include the solutions from other projects. If multiple projects are completed, then there could be overlap in the solutions, quantities, and costs. Note that the cost estimates do not include costs to conduct additional studies or gather topographic survey data, engineering costs to produce plans, or other miscellaneous construction costs (such as traffic control).

(U) Figure 5-1: Identified Projects to Address Safety Issues

(b)(3)



(U) Discussion with USG staff indicated a need to adjust typical cost estimates to account for what was described as the "Site effect." This includes adding several additional costs that include:

- [redacted] fee on top of the raw project costs to account for engineering/survey costs to develop construction plans.
- [redacted] fee for security escorts that are typically added to contractor bids since visitors and contractors must be escorted any time they are on Site.
- [redacted] fee that is typically added by contractors because work hours are typically only 6 hours a day instead of 8 hours, primarily due to gate wait times, escort wait times, and general lost time during the day associated with Site security. (b)(4) (b)(3)
- [redacted] fee that is related to market saturation because contractors shy away from projects on the Site due to the base access issues and the extra requirement for them to vet their employees.
- [redacted] management fee related to oversite by USG and other project management issues.

(U) These costs are included in the overall project cost estimates in the following sections and are shown in more detail in Appendix A.2.

(U) 5.1. Project 1—Parking Lot Configurations

(U) The USG has indicated that parking areas on the east side of the buildings (Parking Areas 2, 3, 4, and 5) are going to be resurfaced soon and this would provide the opportunity to restripe the parking areas and add other solution features. This study took a high-level look at the parking areas and has developed two possible options that would help address multiple safety issues:

- Option 1—Angled Parking: Option 1 shows how the parking lot could be reconfigured to keep the angled parking but address some circulation issues (refer to (U) Figure 5-2, (U) Figure 5-3, and (U) Figure 5-4).
- Option 2—90-Degree Parking: (U) Figure 5-5, (U) Figure 5-6, and (U) Figure 5-7 show an option for converting the parking lot to 90-degree parking and the addition of walking aisles for pedestrians. This option would address more issues and provide the best overall approach to addressing safety issues. However, this option also would require significant effort to implement and would have much higher costs.

(U) For purposes of this study, it is recommended that the USG implement Option 2, but there would need to be a much larger, more in-depth parking study and design effort to better determine costs and evaluate other possible impacts to elements such as drainage, emergency response, Site safety protocols/measures, and general access to the facility. Note that the Site currently has approximately one-half of Parking Area 1 closed to parking and being used to store building materials. This means that there are about 300 parking spots in Parking Area 1 that are currently blocked off. Based on a count of parking lot occupancy (counting the number of spaces occupied by a vehicle from the aerial images), approximately 98 percent of the available parking spaces in Parking Areas 2, 3, 4, and 5 are occupied by vehicles. The two options for new layouts reduce the parking spots by less than 80 spots (refer to (U) Table 5-1), even with the addition of pedestrian walking aisles. If the USG made a change to its parking layout, there would be more than enough parking spaces (including the spots currently closed in Parking Area 1) to accommodate the typical daily demand for parking inside the perimeter fence.

[redacted] (b)(3)

(U) Project 16 encompasses Parking Areas 2, 3, 4, and 5 and addresses issues related to parking aisle configuration, parking space design, curbing to help define intersections, and the addition of sidewalks to enhance pedestrian safety while also improving circulation for vehicles. Refer to (U) Figure 4-26, (U) Figure 4-27, and (U) Figure 4-28 for the option to replace the existing striping as is, without any changes. The recommended solutions for parking configuration design Option 1 (see (U) Figure 5-2, (U) Figure 5-3, and (U) Figure 5-4 or Appendix B.1.1, B.1.2 and B.1.3) and for Option 2 (see (U) Figure 5-5, (U) Figure 5-6, and (U) Figure 5-7 or Appendix B.1.4, B.1.5, and B.1.6) include:

- Existing
  - Restripe all spaces to match the existing parking lot configuration without any changes.
- Option 1
  - Restripe (item 1A) the parking areas to address observed circulation issues, while maintaining the basic parking aisle and space design as existing conditions.
  - Add curbing (item 1B) to define intersections and restrict vehicle movements.
  - Add sidewalks, bulb outs, or walkways (item 1C) for pedestrian safety.
- Option 2
  - Restripe (item 1D) the parking areas to convert to two-way aisles and 90-degree parking spaces.
  - Add curbing (item 1E) to define intersections and restrict vehicle movements.
  - Add sidewalks, bulb outs, or walkways (item 1F) for pedestrian safety.

(U) The estimated costs to complete the options for Project 1 are included in (U) Table 5-2.

(U) Table 5-2: Project 1 Estimated Costs

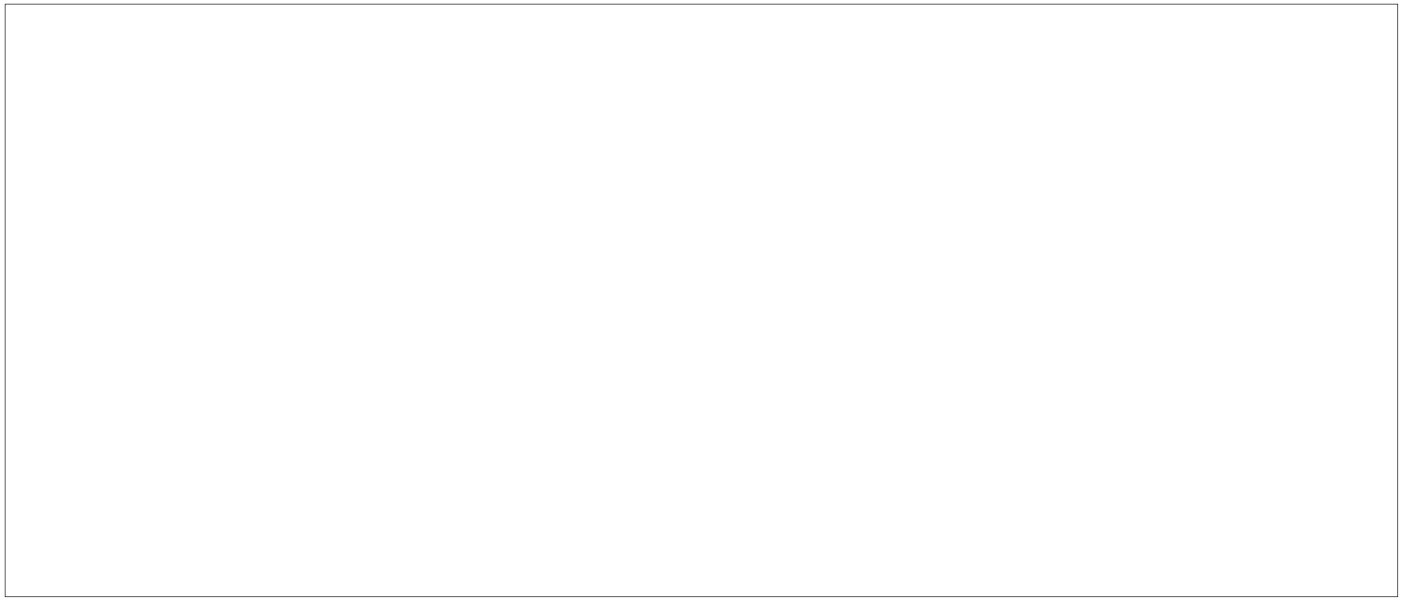
Option	Item	Description	Costs
Existing	N/A	Replace existing striping	(b)(4) (b)(3)
1 (Angled)	1A	Striping	
	1B	Curbing	
	1C	Sidewalks, bulb outs, and walkways	
	Project Total Cost (including engineering, security escort, lost labor, market saturation, and management)		
2 (90-Degree)	1D	Striping	
	1E	Curbing	
	1F	Sidewalks, bulb outs, and walkways	
	Project Total Cost (including engineering, security escort, lost labor, market saturation, and management)		

(U) 5.2. Project 2—Gate 410 Entrance and Pedestrian Walkway

(U) Project 2 is located at the pedestrian crossing that provides access between Gate 410 and the Site buildings. The solutions that are recommended to best address the issues in this area (see (U) Figure 5-8 or Appendix B.2) include:

- Install mountable raised crosswalks (item 2A) with high-visibility striping. This also would act as a traffic-calming method to slow vehicles at the crossings.
- Install pedestrian-activated LED-enhanced crossing signs (item 2B).
- Install motion-activated pedestrian adaptive lighting systems (item 2C).
- Install bulb outs/sidewalks (item 2D) to restrict vehicle circulation options and to create safer walkways for pedestrians.
- Upgrade Stop signs (item 2E) to be MUTCD compliant.
- Add curbing (item 2F) to help define the intersection.
- Install YIELD pavement markings (item 2G) at the crosswalk.

(U) Figure 5-8: Project 2 Recommended Solutions



(b)(3)

(U) The estimated costs to complete the recommended solutions for Project 2 are listed in (U) Table 5-3. The table also shows the optional costs to include motion-activated in-pavement lighting (item 2H) to further enhance the visibility of the crossing.

(U) Table 5-3: Project 2 Cost Estimates

Item	Description	Total Cost
2A	Mountable raised crosswalk	(b)(4) (b)(3)
2B	Pedestrian-activated LED-enhanced crossing signs	
2C	Adaptive pedestrian lighting system	
2D	Sidewalk	
2E	Upgrade signs (stop signs)	
2F	Curbing	
2G	Yield pavement marking	
Project Total Cost (including engineering, security escort, lost labor, market saturation, and management)		
Project Costs with Optional Approaches		
2H	Motion-activated in-pavement lighting	

(U) 5.3. Project 3—Visitor Control Center Pedestrian Walkway

(U) Project 3 is located at the pedestrian crossing that provides access between the VCC and the Site buildings. The solutions that are recommended to best address the issues in this area (see (U) Figure 5-9 or Appendix B.3) include:

- Install bulb outs/sidewalks (item 3A) to restrict vehicle circulation options and to create safer walkways for the pedestrians.
- Install motion-activated pedestrian adaptive lighting systems (item 3B).
- Install pedestrian-activated LED-enhanced crossing signs (item 3C).
- Install YIELD pavement markings (item 3D) at the crosswalk to eliminate the need for Stop signs.
- Install a mountable raised crosswalk (item 3E) with high-visibility striping. This also would act as a traffic-calming method to slow vehicles at the crossing.
- Add striping (item 3F) to preventing parking in the vicinity of the walkways or in undesired areas.

(U) Figure 5-9: Project 3 Recommended Solutions

(b)(3)

(U) The estimated costs to complete the recommended solutions for Project 3 are shown in (U) Table 5-4. The table also shows the optional costs to include motion-activated in-pavement lighting (item 3G) to further enhance the visibility of the crossing.

(U) Table 5-4: Project 3 Cost Estimates

Item	Description	Total Cost
3A	Bulb outs or sidewalks	
3B	Adaptive pedestrian lighting system	
3C	Pedestrian-activated LED-enhanced crossing signs	
3D	Yield pavement markings	
3E	Mountable raised crosswalk	
3F	Striping to identify no parking areas	
Project Total Cost (including engineering, security escort, lost labor, market saturation, and management)		
Project Costs with Optional Approaches		
3G	Motion-activated in-pavement lighting	

(b)(4)
(b)(3)

(U) 5.4. Project 4—Gate 498 Entrance and Pedestrian Walkway

(U) Project 4 is located at the pedestrian crossing that provides access between Gate 498 and the Site buildings. The solutions that are recommended to best address the issues in this area (see (U) Figure 5-10 or Appendix B.4) include:

- Install mountable raised crosswalks (item 4A) with high-visibility striping. This also would act as a traffic-calming method to slow vehicles along the entire length of the roadway.
- Install YIELD pavement markings (item 4B) at the crosswalk to eliminate the need for Stop signs.
- Install pedestrian-activated LED-enhanced crossing signs (item 4C).
- Install motion-activated pedestrian adaptive lighting systems (item 4D).
- Upgrade signs in the area to be consistent with MUTCD (item 4E) and add signs, such as No Left Turn, to address the change in circulation patterns.
- Install bulb outs/sidewalks (item 4F) to restrict vehicle circulation options and to create safer walkways for pedestrians.

(U) Figure 5-10: Project 4 Recommended Solutions

(b)(3)

(U) The estimated costs to complete the recommended solutions for Project 4 are shown in (U) Table 5-5. The table also shows the optional costs to include motion-activated in-pavement lighting (item 4G) to further enhance the visibility of the crossing.

(U) Table 5-5: Project 4 Cost Estimates

Item	Description	Total Cost
4A	Mountable raised crosswalk	
4B	Yield pavement markings	
4C	Pedestrian-activated LED-enhanced crossing signs	
4D	Adaptive pedestrian lighting system	
4E	Signing upgrades (stop signs)	
4F	Bulb outs/sidewalk s	
Project Total Cost (including engineering, security escort, lost labor, market saturation, and management)		
Project Costs with Optional Approaches		
4G	Motion-activated in-pavement lighting	

(b)(4)
(b)(3)

(U) 5.5. Project 5—One-Way Frontage Road

(U) Project 5 addresses the frontage road along the east side of the Site buildings. The solutions that are recommended to best address the issues at this location (see (U) Figure 5-11 or Appendix B.5) include:

- Narrow the width of the frontage road by adding bollards (item 5A) for the entire length of the frontage road in front of the Site buildings. This will reduce the width of the roadway to slow vehicles, narrow the width pedestrians must cross, and make it so pedestrians must look in just one direction for approaching vehicles.
- Install one-way signing (item 5B) at the end of the parking aisles and at the end of the main entry roads to direct traffic flows in the appropriate directions. Install additional signs, such as a No Right Turn sign (item 5B) at the far north end of the frontage road, to prevent vehicles at this intersection from making an eastbound to southbound turn.
- Install pavement marking arrows (item 5C) to reinforce to drivers what movements are allowed on the frontage road.

(U) Figure 5-11: Project 5 Recommended Solutions

(b)(3)

(U) A breakdown of the estimated costs to complete the recommended solutions for Project 5 is shown in (U) Table 5-6.

(U) Table 5-6: Project 5 Cost Estimates

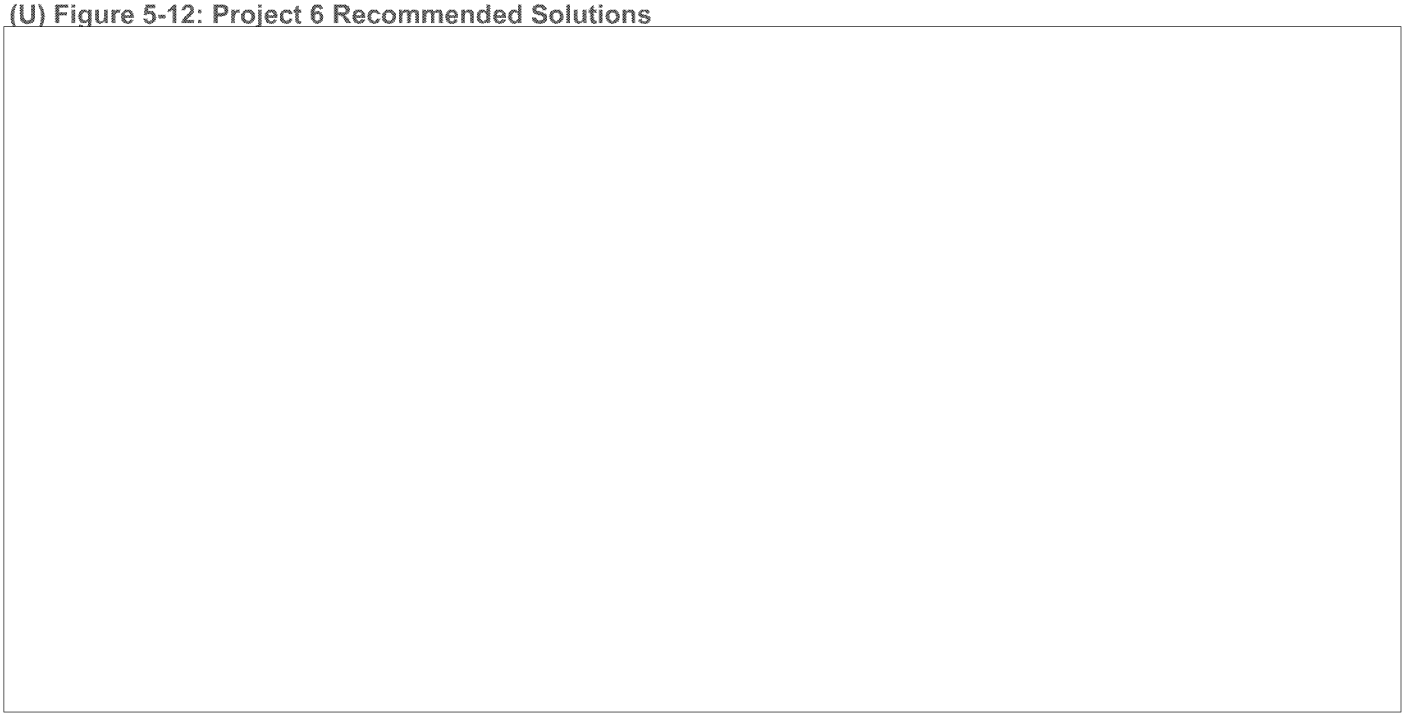
Item	Description	Total Cost
5A	Bollards (with lights)	(b)(4) (b)(3)
5B	Signing	
5C	Pavement markings (directional arrows)	
Project Total Cost (including engineering, security escort, lost labor, market saturation, and management)		

(U) 5.6. Project 6—Parking Area Lighting

(U) Project 6 addresses the gaps in lighting created by the existing distribution of high-mast lighting in the parking areas on the east side of the Site buildings (Parking Areas 2, 3, 4, and 5). Since these parking areas do not use solar-powered light units, the first option is to add additional non-solar powered lights, but another option is to install solar-powered lights. The solutions that are recommended to best address the issues in these areas (see (U) Figure 5-12 or Appendix B.6) include:

- Install a row of double-headed LED solar-powered lights (item 6A) within the parking aisles to fill in the gaps in the existing lighting.
- Install single-headed LED solar-powered lights (item 6B) along the pedestrian walkways at Gate 498 and the VCC.

(U) Figure 5-12: Project 6 Recommended Solutions



(b)(3)

(U) The estimated costs to complete the recommended solutions for Project 6 are shown in (U) Table 5-7. The table also shows the optional costs to install lighting units that use solar cells/batteries for power.

(U) Table 5-7: Project 6 Cost Estimates

Item	Description	Total Cost
6A	High mast double-headed LED solar-powered light	(b)(4) (b)(3)
6B	High mast single-headed LED solar-powered light	
Project Total Cost (including engineering, security escort, lost labor, market saturation, and management)		
Project Costs with Optional Approaches		
6A + 6B	High mast double-headed and single-headed LED lights (non-solar powered)	

(U) For more details on the standards for lighting illumination the USG is directed to the following publications:

- *Interior and Exterior Lighting Systems and Controls*, Department of Defense, UFC 3-530-01, June 2016.
- *The Lighting Handbook, 10th Editions*, Illuminating Engineering Society of North America, 2011.

(U) 5.7. Project 7—Pedestrian-Oriented Lighting

(U) Project 7 deals with the gaps in pedestrian-oriented lighting (as with the type of lighting that currently exists along the sidewalk on the north side of the Site buildings). Since this type of lighting is aimed to provide proper lighting for pedestrians specifically to help illuminate pedestrian walking areas (sidewalks and walkways), there are several areas that would benefit from the addition of more of these lights. The recommended solutions to best address this issue (see (U) Figure 5-13 or Appendix B.7) include:

- Install pedestrian-oriented lighting (item 7A) along the sidewalk on the east side of the Site buildings.
- Add a light for the crosswalk in the northwest corner of the buildings.
- Add additional lights along the walkways between Gate 498, Gate 410, and the VCC and the buildings.
- An optional approach would be to make all the existing and recommended new locations use adaptive pedestrian lighting technology.

(U) Figure 5-13: Project 7 Recommended Solutions

(b)(3)

(U) The estimated costs to complete the recommended solutions for Project 7 are included in (U) Table 5-8.

(U) Table 5-8: Project 7 Cost Estimates

Item	Description	Total Cost
7A	Pedestrian-oriented lights	(b)(4)
Project Total Cost (including engineering, security escort, lost labor, market saturation, and management)		(b)(3)
Project Costs with Optional Approaches		
N/A	Adaptive pedestrian lighting system (old and new)	

(U) For more details on the standards for lighting illumination the USG is directed to the following publications:

- *Interior and Exterior Lighting Systems and Controls*, Department of Defense, UFC 3-530-01, June 2016.
- *The Lighting Handbook, 10th Editions*, Illuminating Engineering Society of North America, 2011.

(U) 5.8. Project 8—Parking Area 1

(U) Project 8 focuses on Parking Area 1. Note that this area currently uses 90-degree parking with two-way aisles, which generally is safer than angled parking with one-way aisles. However, there are a few safety concerns in this area. To address the issues in this section, the following solutions (see (U) Figure 5-14 or Appendix B.8) are recommended:

- Add sidewalks (item 8A) along the edge of the parking lot to provide pedestrians with a safe walkway so that they do not have to share the aisles with vehicles.
- Add pedestrian walkways (item 8B) across the parking area at the end of aisles and in the middle of the aisles to assist pedestrians with safely reaching the sidewalks. This also breaks up the long, straight aisles, which tend to result in vehicles traveling at higher speeds.
- Install YIELD pavement markings (item 8C) at the end of all aisles and at all crosswalks to slow vehicles in these areas.
- Fix the Stop sign placement (item 8D) to prevent vehicles from hitting the sign assembly.
- The walkways can be marked with paint, a combination of paint and raised islands (item 8E), or a combination of raised islands and mountable raised crosswalks (item 8F).

(U) Figure 5-14: Project 8 Recommended Solutions

(b)(3)

(U) The estimated costs to complete the recommended solutions for Project 8 is shown in (U) Table 5-9. The table also shows the optional costs to include raised islands (item 8E) at the end of the parking aisles or mountable raised crosswalks (item 8F) instead of paint.

(U) Table 5-9: Project 8 Cost Estimates

Item	Description	Total Cost
8A	Sidewalk	(b)(4) (b)(3)
8B	Painted pedestrian crossing	
8C	YIELD pavement markings	
8D	Sign placement (just move sign)	
Project Total Cost (including engineering, security escort, lost labor, market saturation, and management)		
Project Costs with Optional Approaches		
8B + 8E	Raised islands and painted crosswalks*	
8E + 8F	Raised islands and mountable raised crosswalks**	

* The entire length of the walkways would be a combination of raised islands and painted crosswalks.
** The entire length of the walkways would be a combination of raised islands and mountable raised crosswalks.

(U) 5.9. Project 9—Signing/Pavement Marking Upgrades

(U) Project 9 addresses the general issue of signing and pavement markings within the entire study area. As previously discussed, many of the signs in the parking areas do not meet current MUTCD requirements, which can create safety issues for both drivers and pedestrians. Also, many of the signs are creating sight distance issues at the pedestrian crossing areas. It is recommended that all sign locations in the study area be reviewed and, when necessary, replaced to make all sign locations conform with MUTCD requirements. In addition, the USG identified concerns about overall speeding that occurs in the study area. It is recommended that Speed Limit pavement markings be installed on the circulating roadways to reinforce the speed limit signing. This project also includes adding YIELD pavement markings at the end of each parking aisle in all parking areas. The solutions that are recommended to best address these issues (see (U) Figure 5-15 or Appendix B.9) include:

- Install YIELD pavement markings (item 9A) at the end of all parking aisles.
- Install Speed Limit 10 (item 9B) pavement markings.
- Upgrade signs (item 9C) to address reflectivity, placement, and spacing requirements of the MUTCD.
- Upgrade sign locations (item 9D) where flashing beacons are used to meet the MUTCD requirements, including conspicuity standards.

(U) Figure 5-15: Project 9 Recommended Solutions

(b)(3)

Note: This figure shows example locations for signing issues, but the USG should conduct a thorough sign study to identify all locations that should be upgraded.

(U) The estimated costs to complete the recommended solutions for Project 9 are shown in (U) Table 5-10.

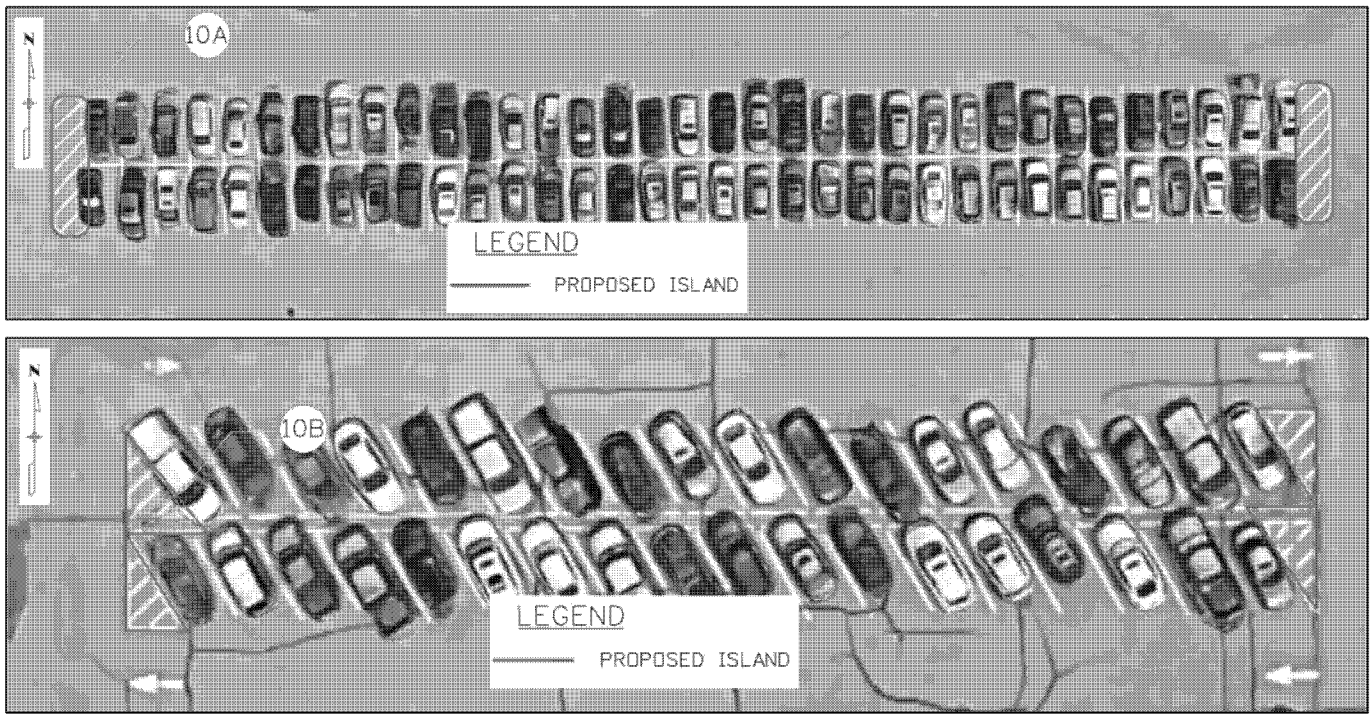
(U) Table 5-10: Project 9 Cost Estimates

Item	Description	Total Cost
9A	Yield pavement markings	(b)(4) (b)(3)
9B	Speed Limit sign pavement markings	
9C	Sign upgrade (reflectivity, placement, and spacing)	
9D	Sign upgrade (conspicuity)	
Project Total Cost (including engineering, security escort, lost labor, market saturation, and management)		

(U) 5.10. Project 10—End-of-Parking-Aisle Raised Islands

(U) Project 10 is located throughout all parking areas in the study area. The existing parking areas have painted islands at the end of the parking aisles, which create safety issues as previously discussed. The recommended solution (see (U) Figure 5-16 or Appendix B.10) to address the safety issues caused by painted islands is to use concrete to create raised islands at the end of the parking aisles. The islands in Parking Area 1 would be oblong ovals (item 10A) and the islands in Parking Areas 2, 3, 4, and 5 would be triangular (item 10B).

(U) Figure 5-16: Project 10 Recommended Solutions



(U) The estimated costs to complete the recommended solutions for Project 10 are shown in (U) Table 5-11.

(U) Table 5-11: Project 10 Cost Estimates

Item	Description	Total Cost
10A	Raised islands (Parking Area 1) ovals	(b)(4) (b)(3)
10B	Raised islands (Parking Areas 2, 3, 4, and 5) triangles	
Project Total Cost (including engineering, security escort, lost labor, market saturation, and management)		

(U) 5.11. Project 11—Pedestrian Turnstile Crossing

(U) Project 11 is located at the pedestrian crossing that provides access between the buildings and the turnstile gate in the fence line along the north side of the study area. The solutions that are recommended to best address the issues in this area (see (U) Figure 5-17 or Appendix B.11) include:

- Install mountable raised crosswalks (item 11A) with high-visibility striping at the existing crossing and at a new crossing location. This also would act as a traffic-calming method to slow vehicles along the entire length of the roadway.
- Install motion-activated pedestrian adaptive lighting systems (item 11B).
- Install a sidewalk (item 11C) that follows the dirt trail and then extends to the west along the north side of the roadway to the new crossing location that is closer to the building entrance/exit point.
- Install pedestrian-activated LED-enhanced crossing signs (item 11D) at both crossings.
- Install YIELD pavement markings (item 11E) at the crosswalk to slow vehicles in these areas and eliminate the need for Stop signs.

(U) Figure 5-17: Project 11 Recommended Solutions

(b)(3)

(U) A breakdown of the individual items, their costs, the quantity of items that are needed, and a total cost to complete the recommended solutions for Project 11 is shown in (U) Table 5-12. The table also shows the optional costs to include motion-activated in-pavement lighting (item 11F) to further enhance the visibility of the crossing.

(U) Table 5-12: Project 11 Cost Estimates

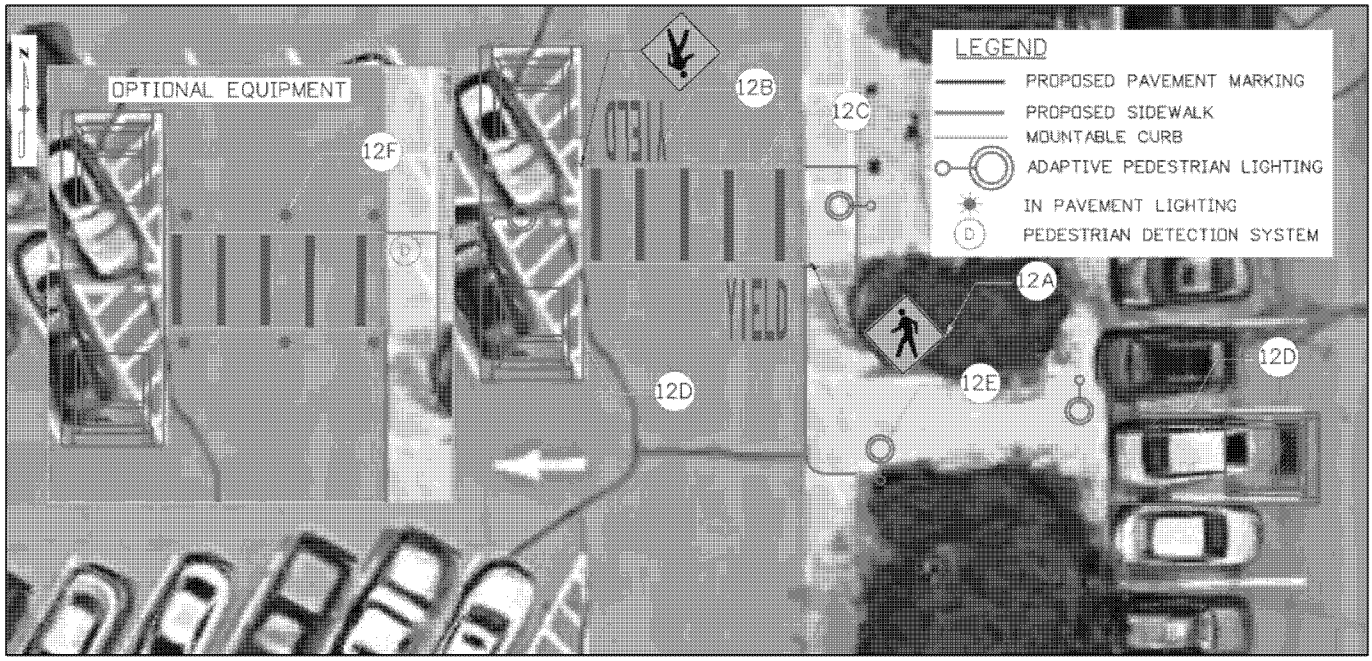
Item	Description	Total Cost
11A	Mountable raised crosswalk	(b)(4) (b)(3)
11B	Adaptive pedestrian lighting system	
11C	Sidewalk	
11D	Pedestrian-activated LED-enhanced crossing signs	
11E	Yield pavement markings	
Project Total Cost (including engineering, security escort, lost labor, market saturation, and management)		
Project Costs with Optional Approaches		
11F	Motion-activated in-pavement lighting	

(U) 5.12. Project 12—Parking Area 5 Pedestrian Crossing

(U) Project 12 is located at the pedestrian crossing that provides access between the VCC and the Site buildings. The solutions that are recommended to best address the issues in this area (see (U) Figure 5-18 or Appendix B.12) include:

- Install pedestrian-activated LED-enhanced crossing signs (item 12A).
- Install YIELD pavement markings (item 12B) at the crosswalk.
- Install mountable raised crosswalks (item 12C) with high-visibility striping. This also would act as a traffic-calming method to slow vehicles at the crossings.
- Install sidewalks (item 12D) to restrict vehicle circulation options and to create safer walkways for pedestrians.
- Install motion-activated pedestrian adaptive lighting systems (item 12E).
- Add striping to show no parking areas (item 12F).

(U) Figure 5-18: Project 12 Recommended Solutions



(U) The estimated costs to complete the recommended solutions for Project 12 are shown in (U) Table 5-13. The table also shows the optional costs to include motion-activated in-pavement lighting (item 12G) to further enhance the visibility of the crossing.

(U) Table 5-13: Project 12 Cost Estimates

Item	Description	Total Cost
12A	Pedestrian-activated LED-enhanced crossing signs	(b)(4) (b)(3)
12B	YIELD pavement markings	
12C	Mountable raised crosswalk	
12D	Sidewalk	
12E	Adaptive pedestrian lighting system	
12F	Striping to identify no parking areas	
Project Total Cost (including engineering, security escort, lost labor, market saturation, and management)		
Project Costs with Optional Approaches		
12G	Motion activated in-pavement lighting	

(U) 5.13. Project 13—Motorcycle Parking Pedestrian Crosswalk

(U) Project 13 is in the area where motorcycles park in the northwest corner of the Site buildings. To address the safety issues at this location, the following solutions (see (U) Figure 5-19 or Appendix B.13) are recommended:

- Provide a sidewalk (item 13A) along the east edge of the motorcycle parking area to provide pedestrians a place to gather before crossing the roadway.
- Install a mountable raised crosswalk (item 13B) with high-visibility striping to provide a safer location for pedestrians to cross the roadway and to slow vehicle speeds in the area.
- Install pedestrian-activated LED-enhanced crossing signs (item 13C) on each approach to further enhance the visibility of the crossing location.
- Install YIELD pavement markings (item 13D) at the crosswalk to slow vehicles in these areas.
- Install motion-activated pedestrian adaptive lighting system (item 13E).

(U) Figure 5-19: Project 13 Recommended Solutions

(b)(3)

(U) A breakdown of the individual items, their costs, the quantity of items that are needed, and a total cost to complete the recommended solutions for Project 13 is shown in (U) Table 5-14. The table also shows the optional costs to include motion-activated in-pavement lighting (item 13F) to further enhance the visibility of the crossing.

(U) Table 5-14: Project 13 Cost Estimates

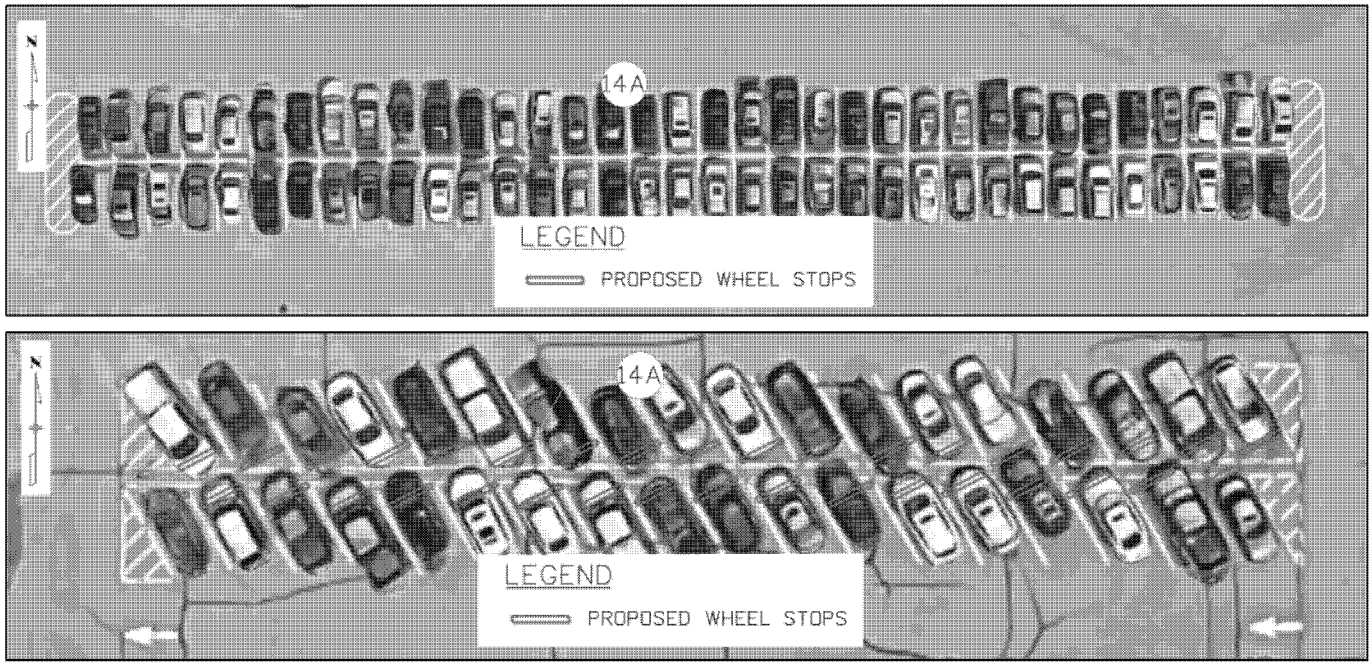
Item	Description	Total Cost
13A	Sidewalk	
13B	Mountable raised crosswalk	
13C	Pedestrian-activated LED-enhanced crossing signs	
13D	Yield pavement markings	
13E	Adaptive pedestrian lighting system	
Project Total Cost (including engineering, security escort, lost labor, market saturation, and management)		
Project Costs with Optional Approaches		
13F	Motion-activated in-pavement lighting	

(b)(4)
(b)(3)

(U) 5.14. Project 14—Wheel Stops

(U) Project 14 addresses the safety issues caused by the parking areas using paint to separate the head-to-head parking in the numerous parking rows. The recommended solution (see (U) Figure 5-20 or Appendix B.14) to address the safety issues caused by painted parking spots is to use wheel stops (item 14A) to help drivers know when they are properly pulled into the parking spots (far enough forward to be out of the aisle, but not too far forward to overlap into the parking spot in the adjacent aisle), especially since most of the parking rows involve head-to-head parking of vehicles. This solution applies to all parking areas regardless of 90-degree parking (Parking Area 1) or angled parking (Parking Areas 2, 3, 4, and 5) configurations, as shown in the figure.

(U) Figure 5-20: Project 14 Recommended Solutions



(U) The estimated costs to complete the recommended solutions for Project 14 are shown in (U) Table 5-15.

(U) Table 5-15: Project 14 Cost Estimates

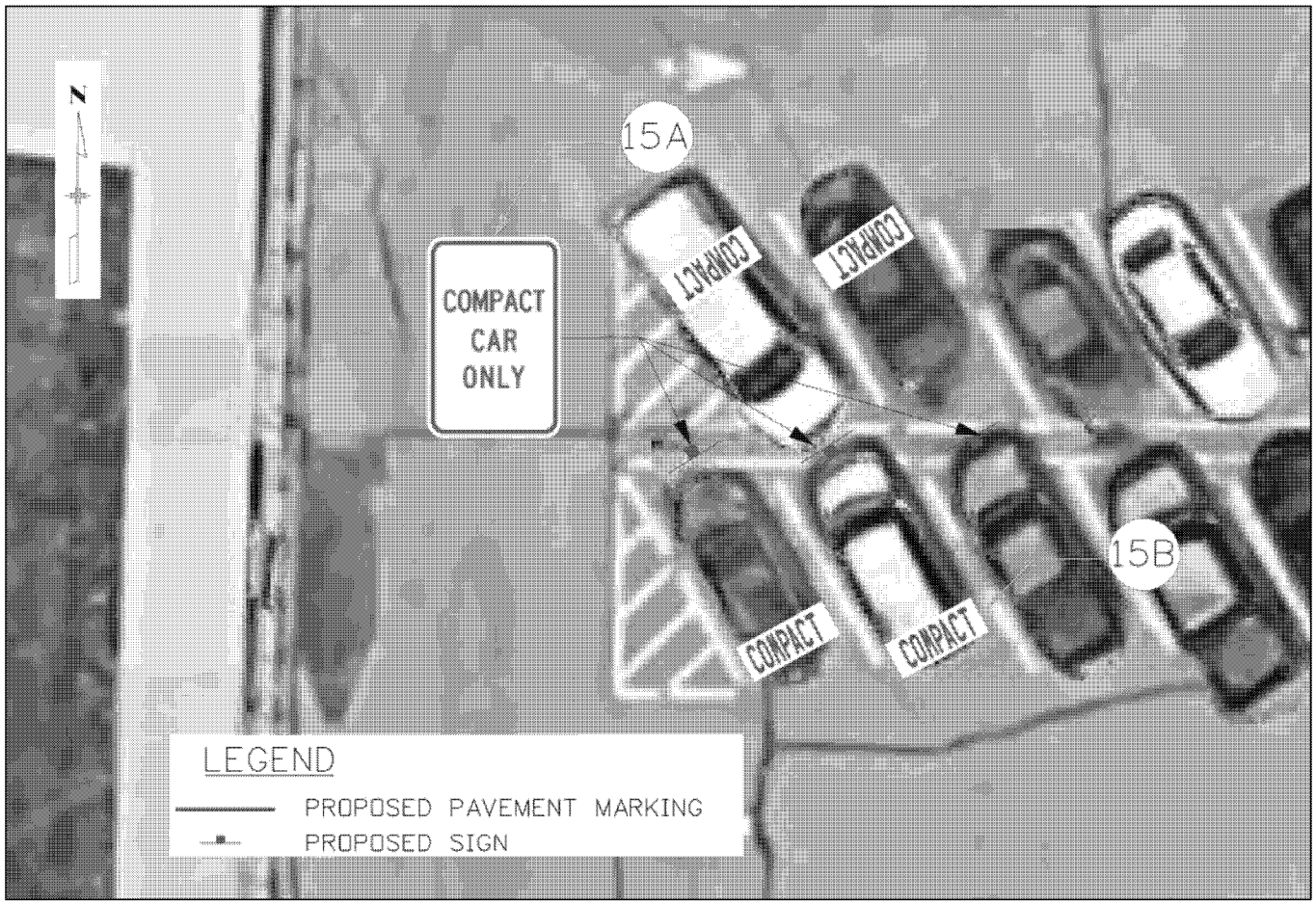
Item	Description	Total Cost
14A	Wheel stops	(b)(4) (b)(3)
Project Total Cost (including engineering, security escort, lost labor, market saturation, and management)		

(U) 5.15. Project 15—Parking Size Restrictions

(U) Project 15 addresses the safety issues that are created when large vehicles park in the last few spots of a parking row and create sight distance obstructions for vehicles entering and exiting the aisle. This can create sight distance issues for pedestrians as well. The solutions that are recommended to best address these issues (see (U) Figure 5-21 or Appendix B.15) include:

- Install Compact Car Only parking signs (item 15A) in the last two or three spots of each parking row.
- Install a COMPACT pavement marking (item 15B) within each of the spots designated to have the vehicle parking size restriction.

(U) Figure 5-21: Project 15 Recommended Solutions



(U) The estimated costs to complete the recommended solutions for Project 15 are listed in (U) Table 5-16.

(U) Table 5-16: Project 15 Cost Estimates

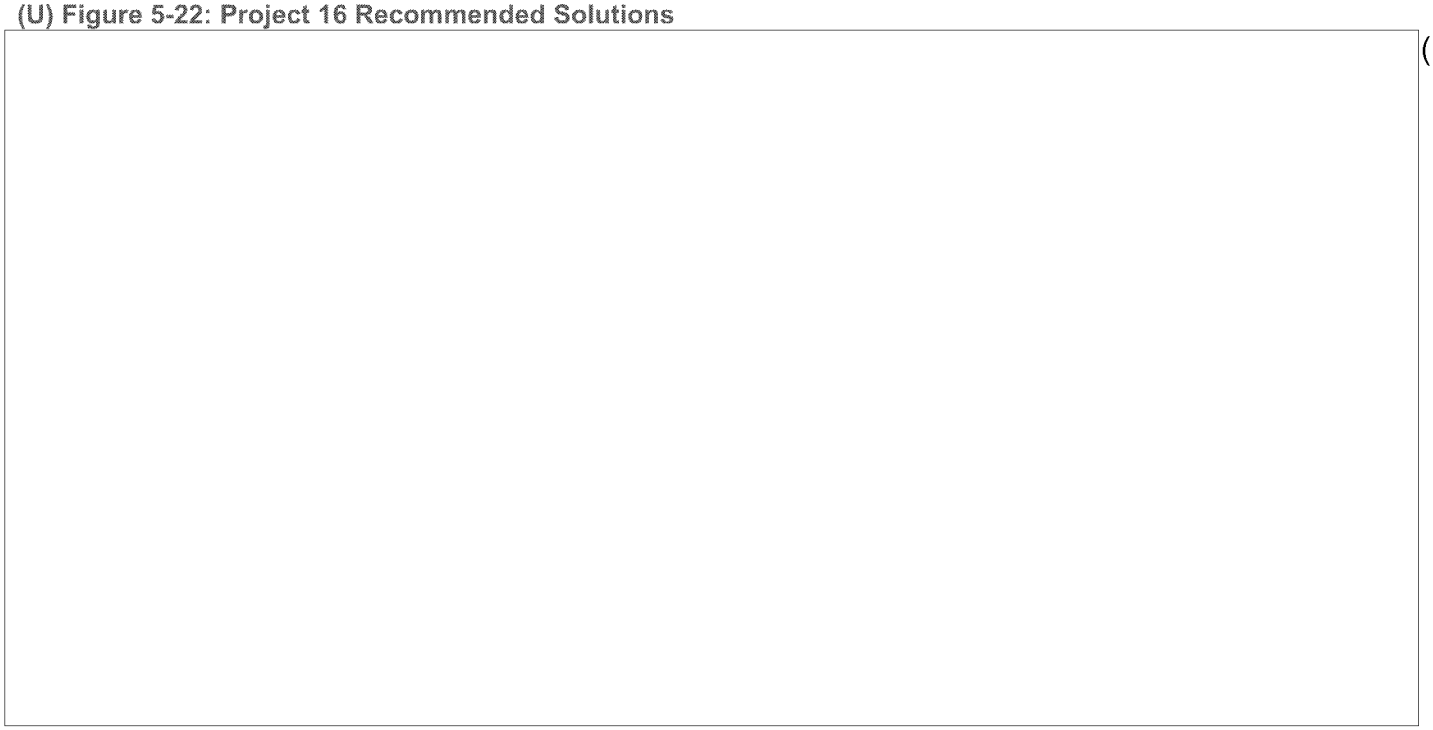
Item	Description	Total Cost
15A	Signs	(b)(4) (b)(3)
15B	Pavement marking (Compact)	
Project Total Cost (including engineering, security escort, lost labor, market saturation, and management)		

(U) 5.16. Project 16—Gate Hour Signing

(U) Project 16 is located outside the actual project study area but was an issue that was raised by USG staff. There was concern regarding conveying messages to arriving vehicles about which access points are open/closed. This type of signing would help cut down on unnecessary circulation in the parking areas outside the fence line and reduce the number of potential conflicts between pedestrians/vehicles. The solutions that are recommended to best address the issues related to the gate hour signing issue (see (U) Figure 5-22 or Appendix B.16) include:

- Install a series of signs (item 16A) along Aspen Street that provide information to drivers about which access points are open and which are closed. The signs also would provide directional information regarding desired location for vehicles to turn off Aspen Street. Refer to Appendix A.3 for more detail on the size and layout of the informational signs.
- Install power/communication system (item 16B) between all signs and Gate 498. The signs would include digital inserts that can convey an OPEN or CLOSED message, but the messages would have to be manually turned on by individuals at Gate 498 (since this is the only location that is staffed full time). It may be possible for the signs to be operated remotely with a radio signal or other devices (cell phone application), but this approach to controlling the signs would need to be cleared by the USG for use on the site.

(U) Figure 5-22: Project 16 Recommended Solutions



(b)(3)

(U) The estimated costs to complete the recommended solutions for Project 16 are shown in (U) Table 5-17.

(U) Table 5-17: Project 16 Cost Estimates

Item	Description	Total Cost
16A	Signs with digital insert panels	(b)(4) (b)(3)
16B	Power/communication system	
Project Total Cost (including engineering, security escort, lost labor, market saturation, and management)		

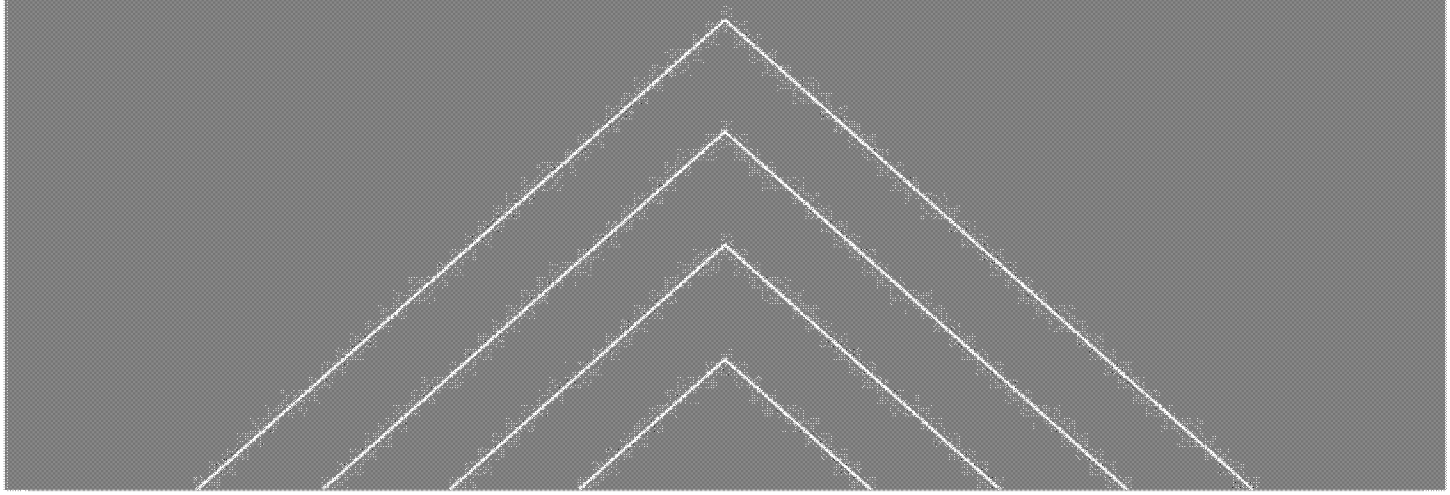
(U) 6. Other Considerations

(U) The USG identified an issue with speeding on the roadway that runs along the north edge of the buildings between Parking Area 1 and Parking Area 2. The previous section of this document provided some means to help reduce speed or encourage lower speeds on this roadway, and those solutions should be attempted before a large change is considered. One other option would be to close the roadway between Parking Area 1 and Parking Area 2 to vehicle traffic. This could be accomplished by placing gates at either end of the roadway. In addition, the USG could consider providing vehicle access to Parking Area 1 by opening the Security Gate along Telluride Street that is along the west fence line of the Site. Vehicles then would have access to Parking Area 1 from this gate. This gate could be open for limited hours of operations—for example, 0600 to 1800 hours. Outside of these hours, vehicles would use Gate 498 to access the Site and park in the lots along the east side of the Site. (U) Figure 6-1 shows this concept. Other roadways may require gates to prevent access to the facility and the parking area will need to be restriped at the access point, but these are less critical and costly issues to be addressed if this option is considered.

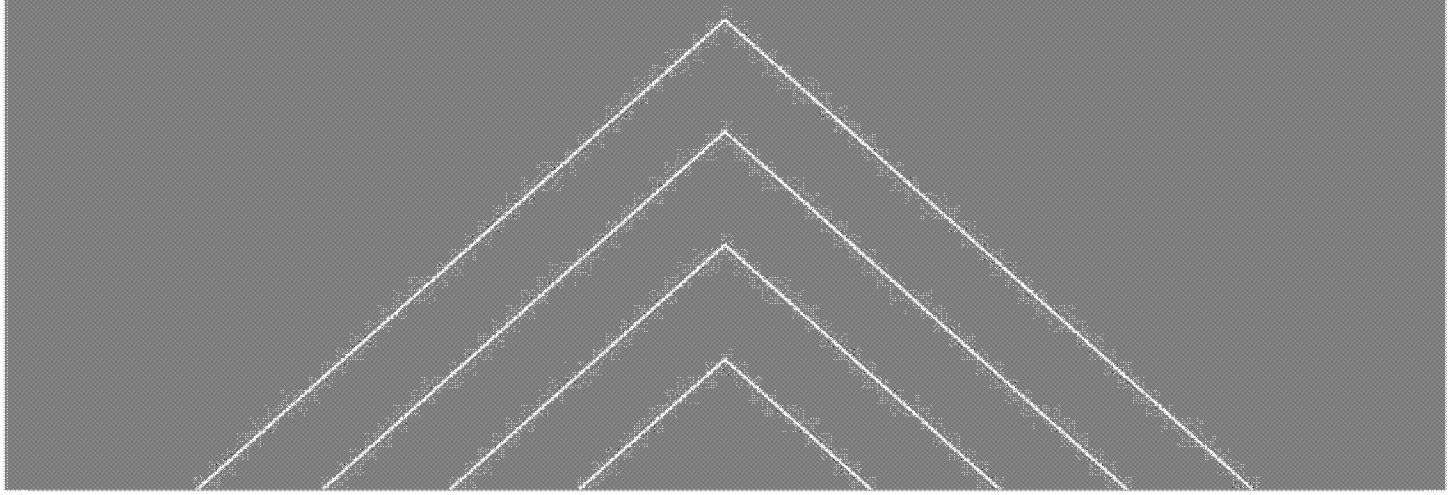
(U) Figure 6-1: New Gate Access from North Telluride Street

(b)(3)

(U) Appendices



(U) This page left blank intentionally.



(U) Appendix A. Support Data

(U) This page left blank intentionally.

(U) A.1. Item Unit Cost Data and Assumptions

BUCKELY AIRFORCE BASE - PARKING LOT IMPROVMENTS UNIT COSTS
ENGINEER'S ESTIMATE OF CONSTRUCTION COSTS (O&M)

CDOT ITEM NO.	ITEM DESCRIPTION	UNIT	UNIT PRICE	MAINTENANCE	ASSUMPTIONS
CURB COST OPTIONS					
412-00600	SPEED TABLE (10' WALK)	EA	[redacted]	No Maintenance	ASSUME: 24' Long, 10' Wide + 6' Ramps [redacted]
412	CURBED/RAISED SIDEWALK (10' WALK)	EA		No Maintenance	ASSUME: 24' Long, 10' Wide @ $110/SY + 1.5' Curb on both [redacted]
609-21010	CURB AND GUTTER TYPE 2 (SECTION I-B)	LF		No Maintenance	1.5' Spill Curb
609-21020	CURB AND GUTTER TYPE 2 (SECTION II-B)	LF		No Maintenance	2.5' Catch Curb
622-00540	WHEEL STOP (CONCRETE)	EA		Low Maintenance	[redacted]
622-00270	BOLLARD	EA		Low Maintenance	
RAISED ISLAND COST OPTIONS					
609	CURBED ISLAND WITHOUT MEDIAN COVER	SF			ASSUME: 10'X8' With 1.5' Curb [redacted]
207 & 212	TOPSOIL AND SEEDING (NATIVE)	SF		High Maintenance	=Topsoil 4"=[redacted]
213-00067	ROCK MULCH (WEED FREE)	SF		Low Maintenance	Rock Mulch = [redacted]
608-00000	CONCRETE SIDEWALK	SF		No Maintenance	Plain Concrete Island Cover = [redacted]
610-00020	MEDIAN COVER MATERIAL (PATTERNED CONCRETE)	SF		Low Maintenance	
LIGHTING COST OPTIONS					
613	BOLLARD WITH LIGHTS	EA		High Maintenance	[redacted]
613-32116	LIGHT STANDARD STEEL (10 FOOT) WITH FOUNDATION	EA		Low Maintenance	
613-32250	LIGHT STANDARD STEEL (25 FOOT) WITH FOUNDATION	EA		Low Maintenance	
613-35120	LIGHT STANDARD STEEL HIGH MAST (120 FOOT) WITH 6 LIGHTS	EA		Low Maintenance	
TRAFFIC CONTROL COST OPTIONS					
614	SIGN PANEL (CLASS I) WITH POST AND SOCKET	EA		No Maintenance	[redacted]
614	SIGN WITH LED LIGHTS (POWERED)	EA		Low Maintenance	
614	SIGN WITH LED LIGHTS (SOLAR)	EA		High Maintenance	
614	IN PAVEMENT LIGHTING	EA		High Maintenance	
614	PEDESTRIAN DETECTION SYSTEM	EA		High Maintenance	
614	LARGE SIGN WITH VMS INSERT	EA		High Maintenance	
614	SOLAR POWERED RECTANGULAR RAPID FLASHING BEACON SYSTEM	EA		Low Maintenance	
PAVEMENT MARKING COST OPTIONS					
627-00001	PAVEMENT MARKING PAINT	SF		High Maintenance	Waterbourn Paint @ 110sf/gal
627-00008	MODIFIED EPOXY PAVEMENT MARKING	SF		Low Maintenance	Traffic paint that meets reflectivity requirements @ 110sf/Gal
627-30405	PREFORMED THERMOPLASTIC PAVEMENT MARKING (WORD-SYMBOL)	SF		Low Maintenance	
627-30410	PREFORMED THERMOPLASTIC PAVEMENT MARKING (XWALK-STOPLINE)	SF		Low Maintenance	
627	3D PAVEMENT MARKING	SF		High Maintenance	

(b)(4)
(b)(3)

(b)(4)
(b)(3)

ATKINS
Member of the SNC-Lavalin Group

UNCLASSIFIED//FOR OFFICIAL USE ONLY (U//FOUO)
Approved for Release: 2021/01/11 C05129207

(U) This page left blank intentionally.

(U) A.2. Project Cost Estimates with Assumptions

(U) Values in the tables are rounded to whole dollars.

Project 1 - Parking Lot Restriping						
Improvement #	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Cost**	**Assumptions**
N/A	Replace existing parking lot striping	GAL	123			Assumed all striping to be 4" wide.
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees
Option 1:						
1A	Striping	GAL	123			Assumed all striping to be 4" wide.
1B	Curbing	LF	964			
1C	Sidewalk	SF	6664			
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees
Option 2:						
1D	Striping	GAL	80			Assumed all striping to be 4" wide.
1E	Curbing	LF	13980			
1F	Sidewalk	SF	61066			
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees

(b)(4)
(b)(3)

(U) Values in the tables are rounded to whole dollars.

Project 2 - Gate 410 Entrance and Pedestrian Walkway						
Improvement #	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Cost**	**Assumptions**
2A	Mountable Raised Crosswalk	EA	5.5			Assumed 1 regular , 1 being 3 times the regular size, and the last 1.5 times regular size
2B	Pedestrian activated LED enhanced crossing signs	EA	2			
2C	Adaptive pedestrian lighting system	EA	9			
2D	Sidewalk	SF	1800			
2E	Upgrade signs (stop signs)	EA	3			
2F	Curbing	LF	346			
2G	Yield pavement markings	SF	138			
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees
Optional:						
2H	Motion activated in-pavement lighting	EA	2			
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees

(b)(4)
(b)(3)

(U) Values in the tables are rounded to whole dollars.

Project 3 - V.C.C. Pedestrian Walkway						
Improvement #	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Cost**	**Assumptions**
3A	Sidewalk	SF	1324			
3B	Adaptive pedestrian lighting system	EA	8			
3C	Pedestrian activated LED enhanced crossing signs	EA	2			
3D	Yield pavement markings	SF	46			
3E	Mountable Raised Crosswalk	EA	1			
3F	Striping	GAL	2			
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees
Optional:						
3G	Motion activated in-pavement lighting	EA	1			
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees

(b)(4)
(b)(3)

(U) Values in the tables are rounded to whole dollars.

Project 4 - Gate 498 Entrance and Pedestrian Walkway						
Improvement #	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Cost**	**Assumptions**
4A	Mountable Raised Crosswalk	EA	2			
4B	Yield pavement markings	SF	46			
4C	Pedestrian activated LED enhanced crossing signs	EA	4			
4D	Adaptive pedestrian lighting system	EA	7			
4E	Signing upgrades (stop signs)	EA	2			
4F	Sidewalk	SF	1142			
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees
Optional:						
4G	Motion activated in-pavement lighting	EA	1			(b)(4) (b)(3)
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees

Project 5 - One-way Frontage Road						
Improvement #	**Description**	**Unit**	**Quantity**		**Cost**	**Assumptions**
5A	Bollards with Lights	EA	210			
5B	Signing	EA	14			
5C	Pavement Markings (directional arrows)	EA	7			
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees

(U) Values in the tables are rounded to whole dollars.

Project 6 - Parking Area Lighting						
Improvement #	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Cost**	**Assumptions**
6A	High mast double head LED solar powered light	EA	14			assume to include pole, foundation, 2 luminaires, and solar equipment
6B	High mast single head LED solar powered light	EA	4			assume to include pole, foundation, luminaire, and solar equipment
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees
Optional:						
6A	High mast double head LED light (non solar)	EA	14			assume to include pole, foundation, 2 luminaires, and trenching and wiring
6B	High mast single head LED light (non-solar)	EA	4			assume to include pole, foundation, luminaire, and trenching and wiring
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees

Project 7 - Pedestrian Lighting						
Improvement #	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Cost**	**Assumptions**
7A	Pedestrian oriented lights	EA	38			Assumed these to be 10 foot lights
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees
Optional:						
N/A	Adaptive pedestrian lighting system (old and new)	EA	62			Assumed (b)(4) per light to convert to adaptive
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees

(b)(4)
(b)(3)

(U) Values in the tables are rounded to whole dollars.

Project 8 - Parking Area 1						
Improvement #	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Cost**	**Assumptions**
8A	Sidewalk	SF	9210			assumed 1535 ft at 6 feet wide
8B	Painted Pedestrian Crossing	GAL	19			asssumed modifed epoxy pavement marking
8C	Yield Pavement Markings	SF	690			assumed preformed thermoplastic and 23 sf per word
8D	Sign Placement (just move sign)	EA	1			
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees
Optional:						
8B + 8E	Raised Islands and Painted Crosswalks	-	-	-		5 sections of sidewalk at 145'x10', 1 section of sidwalk at 134'x10', 12 Gal of Paint
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees
8E + 8F	Raised Islands and Mountable Raised Crosswalks	-	-	-		assumed 24 speed tables a sections of sidewalk at 145'x10', 1 section of sidwalk at 134'x10'
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees

(b)(4)
(b)(3)

(b)(4)
(b)(3)

(U) Values in the tables are rounded to whole dollars.

Project 9 - Signing Upgrades/Pavement Markings						
Improvement #	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Cost**	**Assumptions**
9A	Yield pavement markings	SF	1058			Assumed 46 markings at 23 SF each
9B	Speed limit pavement markings	SF	560			Assumed 16 markings at 35 SF each
9C	Replace existing signs	EA	50			Assumed replacing 50 ground signs, including posts and panels
9D	Replace existing signs with beacons	EA	8			Assume adding 8 signs including beacons for conspicuity, assumed [redacted] for solar flashing beacon
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees

(b)(4)
(b)(3)

Project 10 - End of Aisle Raised Islands						
Improvement #	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Cost**	**Assumptions**
10A	Raised Islands - Ovals	EA	12			Assumed 80 LF curb at [redacted] + 350 SF curbed island at [redacted]
10B	Raised Islands - Triangles	EA	57			Assumed 90 LF curb at [redacted] + 340 SF curbed island at [redacted]
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees

(b)(4)
(b)(3)

(U) Values in the tables are rounded to whole dollars.

Project 11 - Pedestrian Turnstile Walkway Crossing						
Improvement #	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Cost**	**Assumptions**
11A	Mountable Raised Crosswalk	EA	2			
11B	Adaptive pedestrian lighting system	EA	4			assumed [redacted] for adaptive light each, plus [redacted] for trenching wiring each
11C	Sidewalk	SF	2600			
11D	Pedestrian activated LED enhanced crossing signs	EA	4			
11E	Yield pavement markings	SF	92			
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees
Optional:						
11F	Motion activated in-pavement lighting	EA	2			
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees

(b)(4)
(b)(3)

(U) Values in the tables are rounded to whole dollars.

(b)(3)

Project 12 - Parking Area 5 Pedestrian Crossing						
Improvement #	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Cost**	**Assumptions**
12A	Pedestrian activated LED enhanced crossing signs	EA	2			
12B	Yield pavement markings	SF	46			
12C	Mountable Raised Crosswalk	EA	1			
12D	Sidewalk	SF	872			
12E	Adaptive pedestrian lighting system	EA	3			
12F	Striping	GAL	1			
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees
Optional:						
12G	Motion activated in-pavement lighting	EA	1			
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees

(b)(4)

(b)(3)

(U) Values in the tables are rounded to whole dollars.

Project 13 - Motorcycle Pedestrian Crossing						
Improvement #	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Cost**	**Assumptions**
13A	Sidewalk	SF	180			
13B	Mountable Raised Crosswalk	EA	1			
13C	Pedestrian activated LED enhanced crossing signs	EA	2			
13D	Yield pavement markings	SF	46			
13E	Adaptive pedestrian lighting system	EA	2			
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees
Optional:						
13F	Motion activated in-pavement lighting	EA	1	$3,550.00		
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees

(b)(4)
(b)(3)

Project 14 - Wheel Stops

(b)(3)
(b)(4)

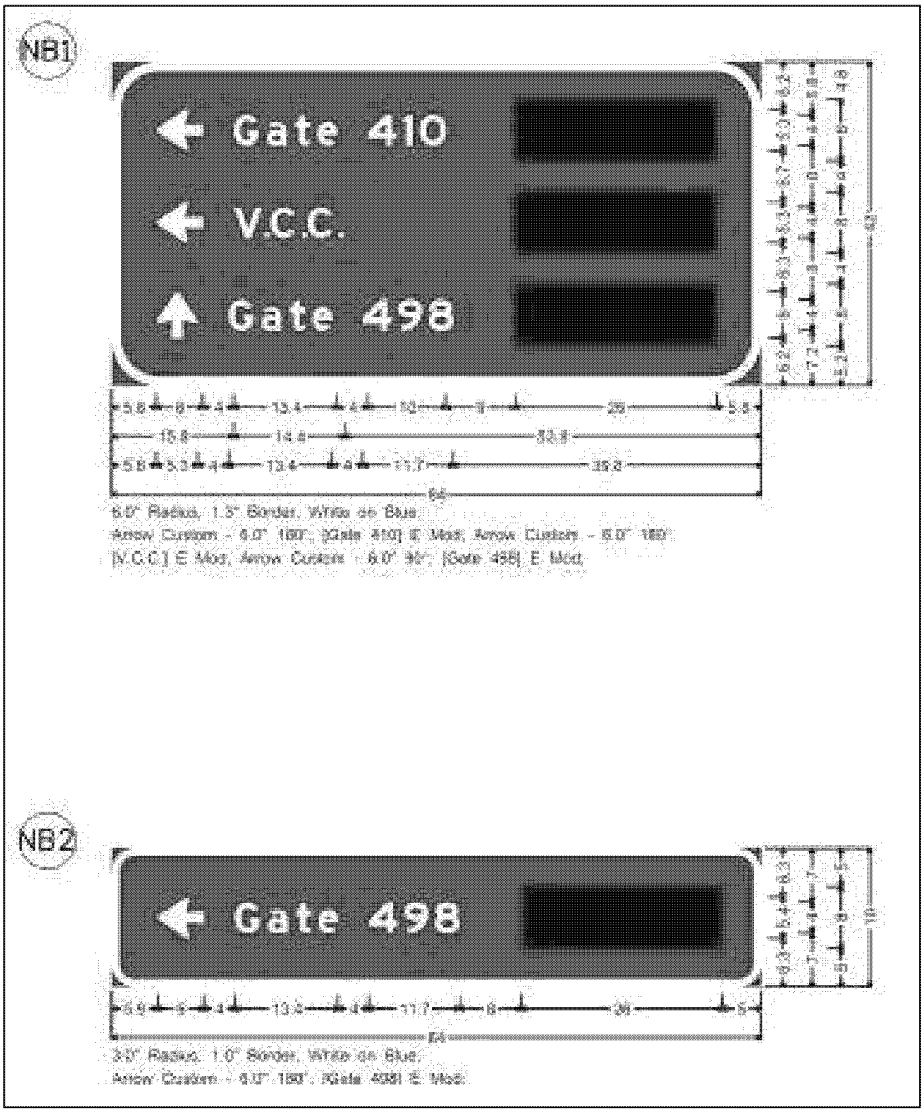
(U) Values in the tables are rounded to whole dollars.

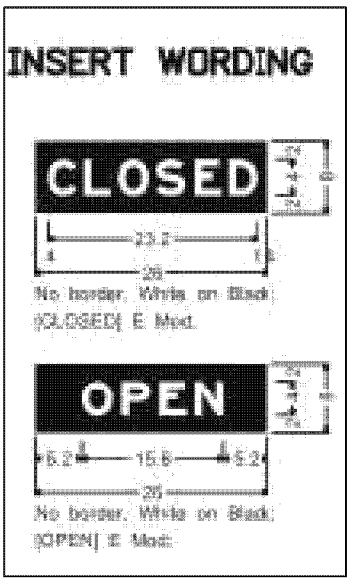
Project 15 - Parking Size Restrictions						
Improvement #	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Cost**	**Assumptions**
						(b)(3) (b)(4)

Project 16 - Gate Hour Signs						
Improvement #	**Description**	**Unit**	**Quantity**	**Unit Cost**	**Cost**	**Assumptions**
16A	Signs with digital insert panels	-	-	-		Assume for Class 3 Panels, 87.5 total, per DMS inserts at 10 total, posts/bases at
16B	Power/communication system	-	-	-		Assumed 9 pullboxes at each, asssumed 1290 LF of 3" conduit at LF and for wiring (b)(4) (b)(3)
				Raw Cost		Total from above
				Engineering Fee (20% of Raw)		20% of Raw
				Security Escorts (5% of Raw)		5% of Raw
				Lost Labor Factor (25% of labor)		25% of Labor -- 50-50 labor and materials
				Market Saturation Factor (25% of Raw)		25% or Raw
				Subtotal		Raw cost plus additional costs
				Management Fees (25% of subtotal)		25% or sutbtotal
				TOTAL		Subtotal plus management fees

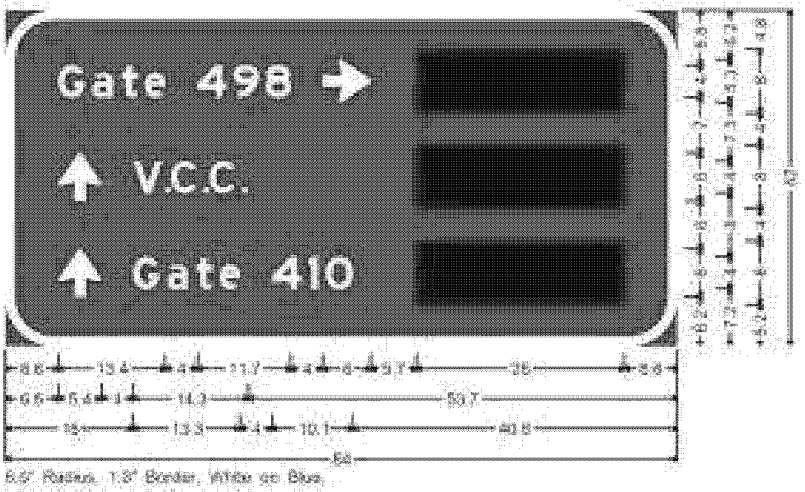
(U) This page left blank intentionally.

(U) A.3. Gate Hour Sign Panel Details



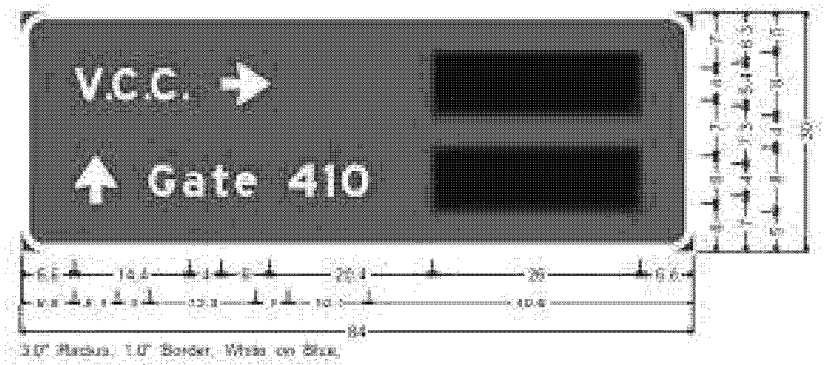


SB1



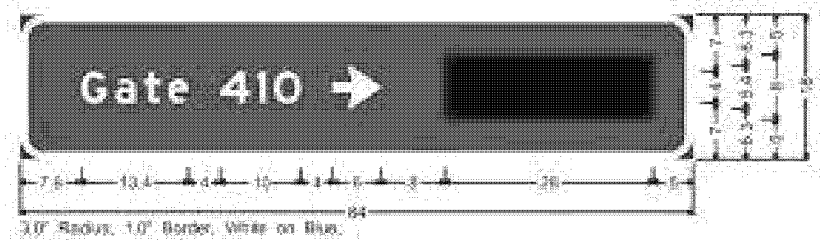
6.5" Radius, 1.5" Border, White on Blue.
[Gate 498] E Mod, Arrow Custom - 8.0" 0°, Arrow Custom - 8.0" 90°;
[V.C.C.] E Mod, Arrow Custom - 8.0" 90°, [Gate 410] E Mod.

SB2



3.0" Radius, 1.0" Border, White on Blue.
[V.C.C.] E Mod, Arrow Custom - 8.0" 0°, Arrow Custom - 8.0" 90°;
[Gate 410] E Mod.

SB3



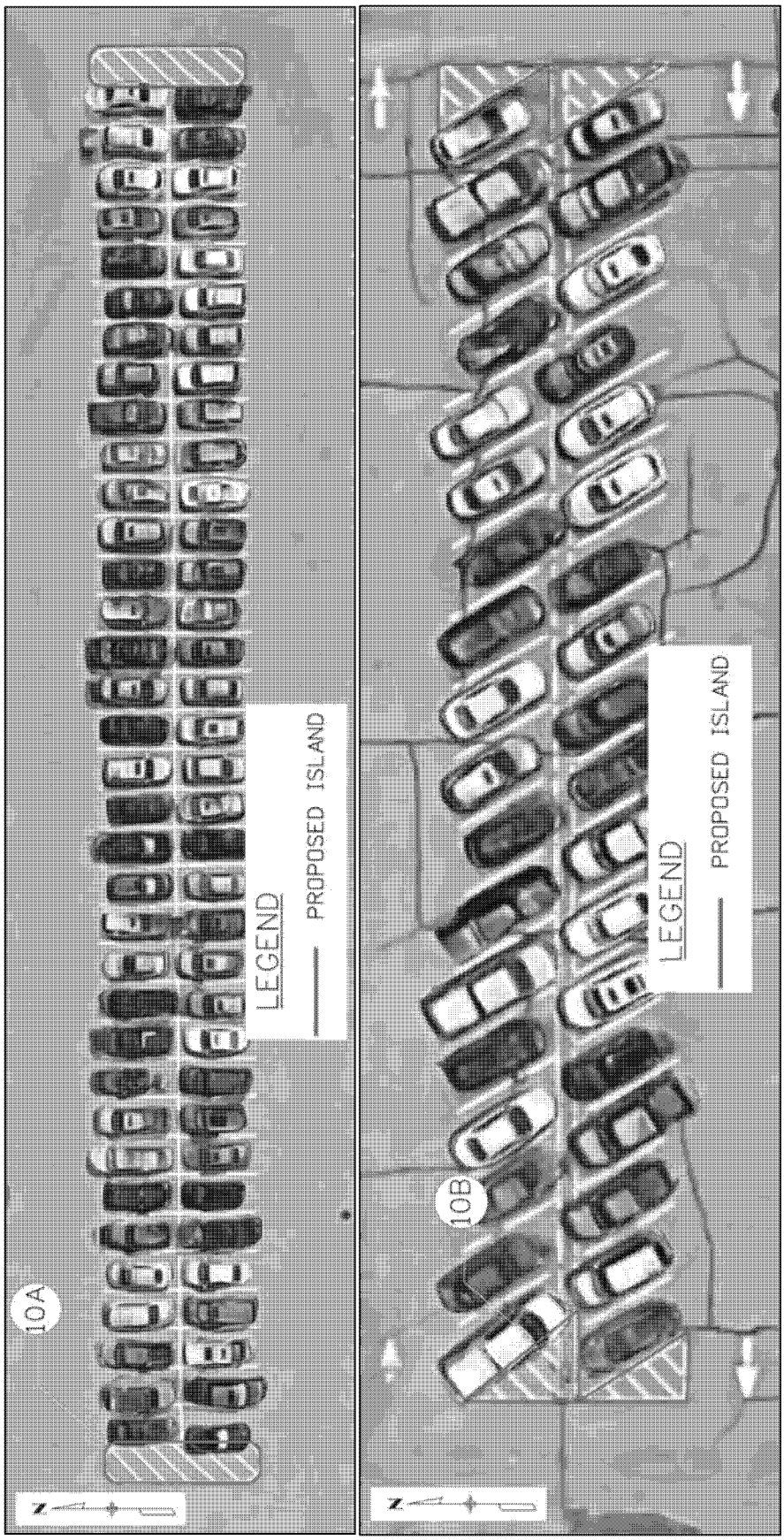
3.0" Radius, 1.0" Border, White on Blue.
[Gate 410] E Mod, Arrow Custom - 8.0" 0°;

(U) Appendix B. Project Figures

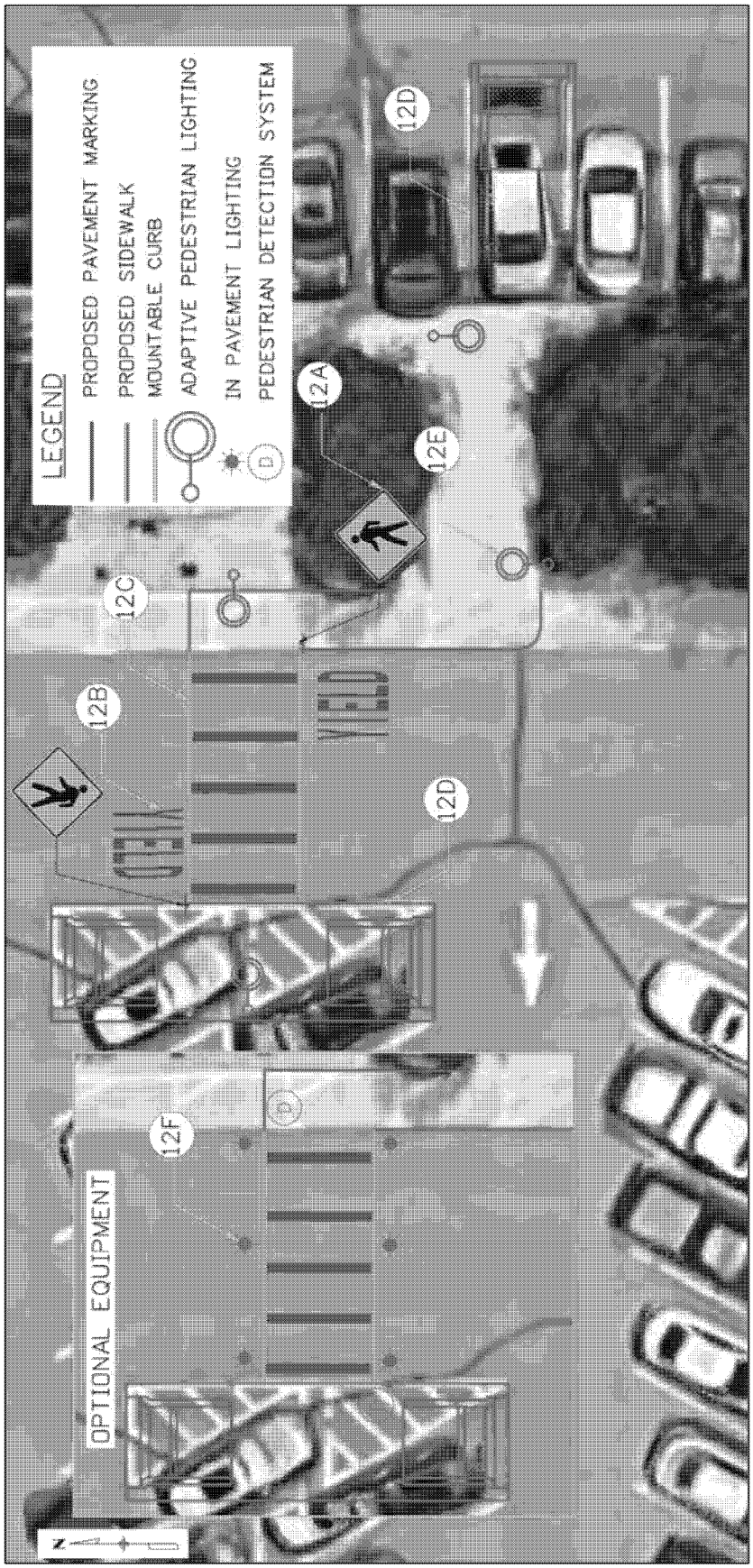
(U) B.1. Project 1—Parking Lot Configurations

(U) This page left blank intentionally.

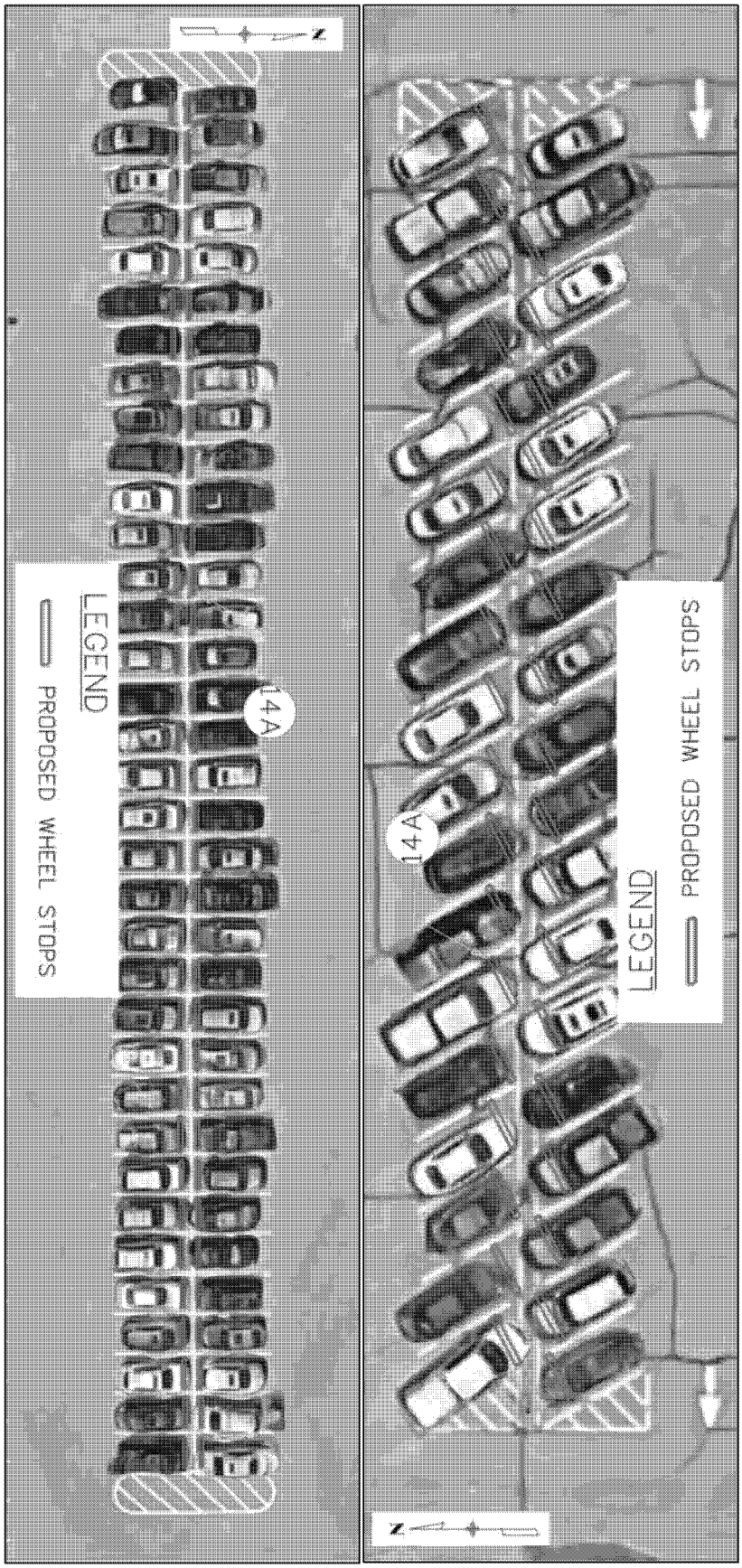
(U) B.10. Project 10—End of Aisle Raised Islands



(U) B.12. Project 12—Parking Area 5 Pedestrian Crossing



(U) B.14. Project 14—Wheel Stops



(U) B.15. Project 15—Parking Size Restrictions

ATKINS
Member of the SNC-Lavalin Group

[redacted] (b)(6)
Atkins North America, Inc.
7604 Technology Way
Suite 400
Denver, CO 80237
Tel: (b)(6)
Fax [redacted]