



Heritage Road *Roundabout Evaluation*

Eagle Ridge Drive *Traffic Calming Evaluation*

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Bohannon  **Huston**

Engineering
Spatial Data
Advanced Technologies

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INTRODUCTION



A. OVERVIEW

Bohannon Huston was contracted by the City of Golden to complete an independent review of the existing configuration and operations of Heritage Road (Rd) between Eagle Ridge Drive (Dr) and Colfax Avenue (Ave), and the connecting section of Eagle Ridge Rd to the west just beyond Somerset Dr. (Figure 1: Project Area) Along Heritage Road, the review included individual analysis of the operations and functionality of the three roundabouts – located at Eagle Ridge Dr, 4th Ave, and Kimball Ave., – as well as the integration and efficiency of the bicycle/pedestrian facilities. A broader analysis of the entire corridor was also completed to consider bicycle and pedestrian improvements, as well as overarching enhancements which could benefit the experience for all users along Heritage Rd. Along Eagle Ridge Dr the focus is on the operations and functionality of the existing traffic calming features.

Although the evaluation was completed under a comprehensive effort, the results are provided in independent sections of this report. The one exception is the discussion of bicycle and pedestrian facilities; because they also impact the entire Heritage Rd corridor there may be duplication in representation of recommendations under the Roundabout Analysis section with more detail in the Bicycle and Pedestrian Facilities Analysis section.

The purpose of the study is to evaluate the existing design of Heritage Rd and consider how well it aligns with the local, state, and federal guidelines for roundabouts. Both full-sized and mini-roundabout guidelines were considered. Results of the analysis indicate how features of the current configuration respond to those guidelines, as well as a set of recommendation to improve the conditions based on best management practices.

Mark Johnson with MTJ Engineering, a national roundabout expert, was also included in the creation of recommendations. Mark Johnson provided input and feedback on the set of recommendations included in this report, sharing his vast knowledge and experience on various roundabouts all around the country.

Respecting that the documentation and standards established for roundabouts are guidelines and not regulatory in nature, three responses are designated to provide the most appropriate direction to decision-makers on opportunities for modifications. Where roadway features were evaluated, it was determined whether the existing conditions are 1) *recommended*, 2) *acceptable*, or 3) *discouraged*, as they relate to the approved guidelines. This methodology and response system supports the messaging included in all roundabout manuals, that roundabout design often requires a level of prioritization and compromise, especially when integrated into a built environment.

Along Eagle Ridge Dr, the purpose of the study is to consider best management practices for traffic calming features with an emphasis on chicanes. Again, there are no regulatory requirements, so analysis and recommendations are based on professional judgement.

A summary of the scope and expected deliverables is provided below. It is anticipated that the results of the analysis will be shared with stakeholders and the public, prior to decision-making by the City of Golden on potential improvements.



Figure 1: Project Area

1. SUMMARY OF PROJECT SCOPE AND DELIVERABLES

a) *Collect Existing Conditions Data*

BHI was tasked with reviewing all existing conditions data regarding the current roadway configuration. This included operational and physical details from before and after the initial construction of the roundabouts, as well as after the subsequent improvements completed to further manage travel speeds. Documentation on the public input process surrounding the initial planning was also provided.

- Data and details provided by the City:
 - As-builts (in CAD and pdf) of the current roadway condition
 - Traffic counts (before and after improvements)
 - Accident data (before and after improvements)
 - Speed study results (before and after improvements)
 - Noise study results (before and after improvements)
 - All public input documentation (before and after improvements)
- Design conditions provided by the City
 - Design vehicle is single-unit truck
 - Design speed is 15 MPH
 - Maximum sized roundabout to fit within ROW was constructed

b) *Compare Current Design with Local, State, and Federal Standards*

BHI was tasked with comparing the current design with approved standards and guidelines, including consideration of all physical elements including height, width, radius, signage, sight distance, ADA compliance, lighting, and paint/texture.

The following guidelines were used to complete the comparison for roundabouts:

- City of Golden¹
- Jefferson County²
- Colorado Department of Transportation (CDOT)³
- Federal Highway Administration (FHWA)⁴

¹ City of Golden Street, Drainage, and Sidewalk Specifications

² Jefferson County Transportation Design and Construction Manual

³ Colorado Bicycling Manual. CDOT Roadway Design Guide

⁴ FHWA-SA-10-006: Intersection Safety Roundabouts. Manual on Uniform Traffic Control Devices (MUTCD). FHWA: Roundabouts: An informational Guide 1st/2nd Edition. FHWA: Mini-Roundabouts

- Federal-Level Guidance⁵

For Eagle Ridge, specific guidelines for review were not outlined in the scope of work, but BHI reviewed manuals from the following agencies to complete a comprehensive evaluation of best management practices.⁶

- FHWA
- Pennsylvania Department of Transportation
- Institute of Transportation Engineers (ITE)

c) *Deliverables*

BHI was tasked with creating a summary matrix to compare the existing configuration against appropriate features of the roadway from the various data sources listed above. BHI subsequently developed a summary of recommended improvements or modifications to better align with standards and guidelines; and provide conceptual level detail and magnitude of cost associated with each recommendation.

2. PUBLIC INPUT

Goals and objectives surrounding the improvements to Heritage Rd were established during extensive public and neighborhood outreach over the past 4+ years. The initial planning and design elements of the current roundabouts along Heritage Rd were shared with the public in 2013/2014. The roundabout improvements are aligned with the Transportation Goals identified in the City of Golden Comprehensive Plan, and were validated by the corridor-specific public input received. The following key criteria for initial roundabout improvements, were taken into consideration when prioritizing and creating recommendations during this post-construction analysis being done under this effort.

- Traffic calming
- Reduce traffic noise
- Improve safety for pedestrians, bicycles, and vehicles
- Reduce cut-through traffic

⁵ American Association of State Highway and Transportation Officials (AASHTO). National Association of City Transportation Official (NACTO). Institute of Transportation Engineers (ITE)

⁶ Federal Highway Administration Traffic Calming ePrimer. Pennsylvania's Traffic Calming Handbook, Pennsylvania DOT. Traffic Calming Handbook, City of San Antonio Public Works. ITE Canadian Guide to Neighbourhood Traffic Calming.

In order to ensure that a comprehensive picture of issues was established, a summary of the input collected over the past several years was compiled into six categories, with some level of detail under each category. This summary includes a variety of issues identified by the roadway users along both Heritage Rd and Eagle Ridge Dr, and was considered as recommendations were developed for both corridors.

a) *Safety*

- Roundabouts: Users indicate that the roundabouts cause safety concerns because they seem too small and narrow.
- Drainage Pond: Users indicate that the drainage pond located in the Eagle Ridge Dr roundabout is a safety concern because it has been the site of multiple crashes.
- Bicycle Lanes: Users indicate elevated bicycle lanes cause safety concerns due to the transition in and out of the roundabout.
- Chicanes: Users indicate that the chicanes on Eagle Ridge Dr are a safety hazard due to car accidents, unreported incidents, and damage done to vehicles, curbs, and nearby properties.

b) *Consistency*

- Roundabouts: Users indicate the three roundabouts each differ in size causing users to maneuver each one in a different manner.
- Bicycle Facilities: Users indicated concern regarding clarity on where bicycles should ride.

c) *Aesthetics*

- Drainage Pond: Users made requests to aesthetically improve the drainage pond in the roundabout located at Eagle Ridge. (note: may be prior to recent sign modifications by the City).
- Landscaping: Users indicate that weeds are growing excessively in the drainage pond. It is also requested that landscaping be added to all the roundabouts to make them more attractive.
- Signage: Users indicate that the signage placed near the roundabout approach is excessive, not helpful, and not legible. (note: may be prior to recent sign modifications by the City).
- Chicanes: Users indicate that the chicanes on Eagle Ridge are unattractive, unsightly, and embarrassing.

d) *Effectiveness*

- Bicycle Lanes: Users indicate that the elevated bicycle lanes are not used or desired by bicyclists and some requests were made to remove them. However, there is also consistent use by some riders, and the corridor benefits from bicycle facilities.
- Overall Effectiveness: While it is reported that noise, speed, and volumes are reduced, users are concerned that the overall benefit of traffic calming efforts may be compromised by the potential increase of accidents and incidents.

e) *Visibility*

- Sight Distance: Users have stated that sight distance is an issue, specifically approaching the Kimball roundabout from the south. This is caused by the grade at this location.
- Pedestrian: Users indicate that pedestrians are not always visible due to “hidden sidewalks.”
- Lighting: Users indicate that there is poor lighting at the roundabouts; however, this may be due to lights being out rather than the absence of light poles.

f) *Trust*

- City Credibility: Users indicate they are now concerned about the credibility of the City due to what they believe to be poor design of the roundabouts and chicanes.

Beyond this initial outreach, and to ensure a comprehensive perspective on how the corridor functions, additional field visits were held with various user groups. This included City staff, representatives from the Fire Department located on the south end of the corridor, and a group of interested members of the public. The supplemental information received from these site visits was helpful in understanding the overall goals and priorities of the users, and provided a foundation for the recommendations provided.

It is expected that the results provided in this report will also be shared with the public for additional input on potential future modifications to Heritage Rd and Eagle Ridge Dr.

ROUNDABOUT ANALYSIS



The purpose of the analysis is to consider potential improvements to the operations and functionality of the roundabouts along Heritage Rd, as directed by roundabout guidance. The focus was on evaluating how well the existing conditions aligned with current roundabout guidelines, and then providing recommendations to address any gaps. For this effort, specific details on the roadway configuration were collected and represented in the following section.

The supplemental field visits with key stakeholders provided additional data points on how the corridor functions and where issues occur, including observations on travel patterns and potential safety concerns. All of this information was used to complete the analysis and develop recommendations.

A. EXISTING CONDITIONS

1. HERITAGE ROAD CORRIDOR

All features of the existing roadway were collected at the same time and documented under one reference (Table 1). This was not only an efficient data collection process, it provides perspective on how the corridor and roundabout areas are integrated and support each other as part of the entire roadway system.

Existing conditions were determined through the use of as-builts, details provided by the City, and field visits. Table 1 below represents the existing conditions which were used to complete the analysis of the entire corridor as well as each individual roundabout. As-builts of the initial roundabout project were provided by the City, and then updated to denote subsequent improvements; further details can be found in the Appendix A.

Table 1: Corridor Existing Conditions (Heritage Rd)

Segment	Southbound Bicycle Infrastructure	Southbound Pedestrian Infrastructure	Southbound Travel Lanes	Northbound Bicycle Infrastructure	Northbound Pedestrian Infrastructure	Northbound Travel Lanes
North of Eagle Ridge Dr	None	8' - Attached	Two 11' travel lanes narrow to one at roundabout	None	5' - Detached; buffer width varies	Widens to two 11' travel lanes north of roundabout
4th Ave to Eagle Ridge Dr	4' - Raised bike lane	5' - Detached with ~10' buffer	11' single lane	4' - Raised bike lane	5' - Attached	11' single lane
Kimball Ave to 4th Ave	4' - Raised bike lane	8' - Detached - bike lane as buffer	11' single lane	6' - Raised bike lane	5' - Attached	11' single lane
South of 4th Ave	4' - Raised bike lane	8' - Detached - bike lane as buffer	11' single lane	None	None	11' single lane

2. ROUNDABOUTS

Analysis of roundabout elements was based on the roadway features in the FHWA document *Roundabouts: An Informational Guide*. The major geometric design elements included approach alignment, entry width, central island and apron, exit curves, splitter islands, sight distance (approach/circulatory/intersection sight distances), and central island landscaping.

Figure 2 (using Kimball Ave as an example) provides a visual to help identify the location of the above-listed design elements.



Figure 2: Design Elements

The evaluation process was initiated by establishing existing condition details for the roundabouts specifically, shown in Table 2. The following effort involved going through the checklist of geometric design elements established by FHWA for each roundabout and noting where configurations do not currently align with guidelines. This overall approach was applied to all documents reviewed, with some flexibility in element delineation as each

document had slightly different element references. A comprehensive summary of results, focused on FHWA guidelines as the most comprehensive, are shown in Table 2, with further discussion following the table. The results indicate whether the existing roadway features are *recommended*, *acceptable*, or *discouraged*, based on roundabout guidelines. This information provides the basis for potential modifications, described in subsequent sections.

Table 2: Design Elements Analysis (All Roundabouts)

	Design Speed	Approach Alignment	Entry Width (ft)	Central Island Apron		Exit Curves	Splitter Island		Landscaping
				Width (ft)	Cross Slope (%)	Radius (ft)	Length (ft)	Width (ft)	Type
Kimball Ave Roundabout	15	Left	11 (14-16 ft, typical)	7.5 (3-13 ft, typical)	N/A	32 (33-39 ft, min)	23, 27 (50 ft, typical)	4 (6 ft, min)	Tree
4th Ave Roundabout	15	Center	11 (14-16 ft, typical)	No separate apron	N/A	22 (33-39 ft, min)	13.5, 21 (50 ft, typical)	4 (6 ft, min)	None
Eagle Ridge Dr Roundabout	15	Center	11 14-16 ft, typical)	7.5 (3-13 ft, typical)	N/A	32 (33-39 ft, min)	20, 21 (50 ft, typical)	4 (6 ft, min)	Pond, boulders
	Recommended								
	Acceptable								
	Discouraged								

Guidelines

Reference: Roundabouts: An Informational Guide (FHWA)

A narrative summary of the issues contained in Table 2 is provided below, with a comprehensive matrix of the evaluation process contained in Appendix B. This analysis on existing physical conditions, traffic counts, accident data, and the relationship with guidelines, was used by the consultant team to determine final recommendations for the corridor. As part of this analysis process, previously established corridor-wide priorities are the basis for determining which of the deficiencies (gaps in alignment with the guidelines) are most critical to address, and which will provide the most benefit to the operations of the corridor.

- **Approach** alignment is recommended at Left or Center
- **Entry width** is recommended to be 14-16 feet for single-lane
 - Current entry width is *discouraged* at all three roundabouts
 - Entry width is largest determinant of capacity
- Central island **apron width** is recommended to be 3-13 feet
 - Eagle Ridge Dr and Kimball Ave have a *recommended* 7.5-foot apron
 - 4th Ave is entirely paved with no separate apron but still *acceptable*
- Central **island shape** is recommended to be circular
 - Eagle Ridge Dr roundabout is more of an oval shape but *acceptable*
 - Circular shapes promote constant speeds
 - Irregular shapes are more difficult to drive and promote higher speeds on the straight sections.
- **Apron slope** was not evaluated, since no surface data was available
- Exit **curve radii** minimum criteria guideline is 33-39 feet.
 - Eagle Ridge Dr and Kimball Ave are close to criteria so considered *acceptable* at 32-foot exit curve radii
 - With a 22-foot exit curve radii, 4th Ave dimensions are *discouraged*
 - Criteria specific to a single-lane roundabout, with pedestrian activity and little/no large semi-trailer activity
- **Splitter Island length** is recommended to be 50 feet
 - Splitter island length is *discouraged* at all three roundabouts with a length of less than 50 feet
 - Should include options for raised/painted specifically for a mini-roundabout
- **Splitter island width** is recommended to be 6-foot minimum
 - Average width was only 4 feet
 - Function is to provide pedestrian shelter and deter wrong-way movements so considered *acceptable* because it still provides appropriate function
- **Pedestrian crossing** locations are recommended to be as close to intersection as possible to minimize out-of-direction travel
 - Out-of-direction travel has not been a concern so pedestrian crossings locations behind splitter islands are *acceptable*
- Continuation of attached **sidewalk** through roundabouts creates a potential pedestrian conflict with truck overhangs
 - Sidewalk has some distance from roundabout travel lane in most locations

- **Apron vertical** lip is recommended to be a minimum of 1-2 inches in height
 - Apron at Kimball Ave is 3-inch high which is *discouraged*
- Large fixed **landscaping** like trees and rocks should be avoided and are discouraged but minimal landscaping is recommended for visual queues
 - Eagle Ridge Dr has boulders and pond which is *discouraged*
 - Kimball Ave has a small tree which is *recommended* for a visual queue
 - 4th Ave doesn't have any landscaping which is *acceptable*
- Inscribed **circle diameter** is recommended at 45-100 feet minimum for mini-roundabout or urban compact roundabout
 - Circle diameter at all roundabouts is recommended

a) *Additional Guidelines*

All the documents and guidelines referenced in the Introduction were reviewed for specific roundabout design recommendations. *FHWA's Roundabouts* provided the most detailed guidance; therefore, the results are focused on this manual. However, there are a few relevant comments on the complete list of documents presented below. The comprehensive matrix of the guideline evaluations and relevant information is included in Appendix B.

- Federal – Level Guidance (other than *FHWA: Roundabouts*)
 - No specific references to roundabouts
- CDOT's "Roadway Design Guide"
 - Primarily refers to *FHWA's Roundabouts*, except for reference to crosswalk placement (minimum 20 feet from roadway)
- City of Golden Street, Drainage & Sidewalk Specifications
 - No specific reference to roundabouts
- Jefferson County Transportation Design & Construction Manual
 - Roundabouts should be designed per *FHWA Roundabouts*.

b) *Mini-Roundabout Guidelines*

Mini-roundabouts are characterized by a small diameter and traversable islands (center and splitter islands). This is most directly related to 4th Ave; therefore, further analysis was done to compare the design elements at 4th Ave to mini-roundabout guidance in both the *FHWA's Roundabouts: An Informational Guide* and the specific guide *FHWA: Mini Roundabouts*. This analysis was done at the request of the City to ensure due diligence, but

the results don't replace those presented in Table 2, they are supplemental and were also considered during development of recommendations.

The results of the evaluation with the more specific mini-roundabout guidance are shown below in Table 3. Although 4th Ave meets most criteria for being a mini-roundabout, there are still some design features which are identified as *discouraged*, such as the entry/exit land width and curve radii as well as the pedestrian splitter islands length and width.

Table 3: Design Element Analysis of Mini-Roundabouts (4th Ave)

Reference	Design Vehicle	Max. Entry Design Speed (mph)	Approach Alignment	Entry Width (ft)	Central Island	Inscribed Circle Diameter (ft)	Exit Curves Radius (ft)	Splitter Island		
								Type	Length (ft)	Width (ft)
Roundabouts: An Informational Guide (FHWA) (1)	Single-Unit Truck (SU-30)	15	Center (Center, Left)	11 (14-16 ft, typical)	Raised w/mountable curb (Domed or raised w/mountable curb. Domed 2.5-3% cross slope, max. 5" height.)	60 (45-80 ft)	22 (33-39 ft, min)	Mountable/painted combination (Raised or painted)	34 (50 ft, typical)	4 (6 ft, min)
Mini-Roundabouts (FHWA) (2)	Passenger Car and larger vehicle (bus, truck)	Design should promote reduced speeds.			Raised w/mountable curb (Domed or raised w/mountable curb. Domed 5-6% cross slope, max. 5" height.)	60 (<90 ft)		Mountable/painted combination (Raised, mountable, or flush)	34 (45 ft)	4 (6 ft, min)
Roundabouts: An Informational Guide, 2nd Edition (NCHRP) (3)	SU-30	20		11 (14-18 ft, typical)	Raised w/mountable curb (Domed or raised w/mountable curb. Domed 5-6% cross slope, max. 5" height.)	60 (45-90 ft)	22 (50 ft, min)	Mountable/painted combination (Raised, mountable, or flush)	34 (50 ft, min)	4 (6 ft, min)
	Mini-Roundabout				Mini-Roundabout	Mini-Roundabout		Mini-Roundabout		

	Recommended
	Acceptable
	Discouraged

Guidelines

3. VEHICLE TRACKING ANALYSIS

To fully analyze the operations and vehicle travel ability at each of the roundabout locations, AutoCAD layout and vehicle tracking software was utilized to evaluate speed and travel patterns. Vehicles tracked included fire truck, school bus, and the stated design vehicle which was the single-unit truck (SU-30). The passenger car analysis was later added at the request of the City. For each roundabout, vehicles were tracked on two alignments traveling south to north: 1) right-turn or through movement and 2) left turn movement. The

analysis assumed a design speed of 15 MPH and that the curb type for the circulatory path of roundabouts is flexible.

The vehicle tracking results indicate that the existing design does not allow travel at 15 MPH for any vehicle within the curb lane, including passenger vehicles. All three roundabout geometries would require reconfiguration to accommodate the design vehicle (SU-30) at 15 MPH speed. That said, this information indicates merely what is recommended; the decision to accept a certain vehicle tracking speed, and the mounting of curbs, is at the discretion of the City and the public. Consideration of public input and issues identified should be taken into consideration before design speed through the roundabout is determined a priority for the corridor.

Overall, the average speed for all vehicles evaluated was less than 5 MPH, and requires inevitable mounting of the curb for some vehicles. In response to these results, some reconstruction is recommended at all three roundabouts to potentially increase speeds and minimize contact with the vertical curbs. Full results of the vehicle tracking analysis are shown in Appendix C, with further discussion on infrastructure recommendations included in the Recommendations section.

4. SIGHT DISTANCE TRIANGLES

One of the roadway features which does not align with the roundabout guidance provided is maintaining a clear zone within the sight distance triangles at all three roundabouts. In order to better understand the limitation of the sight distance triangle at each location, the US DOT methodology on sight distance triangles was followed (*Chapter 6.3.10.1: Length of approach leg of sight triangle, Chapter 6.3.10.2 Length of conflicting leg of sight triangle*). Figures representing the recommended sight triangles that should remain clear of objects were created for each roundabout (see Appendix D).

The sight triangles were established with the following assumptions:

- Length of the approach leg of the sight triangle should be limited to 49 feet
- Conflicting approach speed of 15 MPH
- Intersection sight distance should be no more than 143 feet on each approach
- “Entering Stream Distance” and “Circulating Stream Distance” should be the same on each approach.

Although the sight distance triangle is compromised at each of the three roundabouts, this issue has not been identified as critical, nor is it assumed to be causing any of the common concerns. However, it is noteworthy and should be considered and addressed overtime. Most objects within the sight distance triangles are moveable (landscaping and signs), with the exception of the northwest corner of 4th Ave and Kimball Ave where there is a wooden backyard fence. Relocation of this fence will be challenging to address; additional signage to raise awareness may be an interim solution.

B. RECOMMENDATIONS

After the analysis of existing conditions and comparison with current guidelines for roundabouts (including mini roundabouts), a comprehensive set of recommendations was created for each of the three roundabouts, as well as some corridor-wide recommendations. Due to the integration of users along the corridor, recommendations involving the bicycle and pedestrian facilities are included in this Roundabout Analysis section, with repetition and further detail provided in the Bicycle and Pedestrian Facilities Analysis section.

A series of Comprehensive Analysis Matrices were developed for each roundabout as well as the corridor, and are included in Appendix E. These matrices document the overall process, including coordination with MTJ Engineering (Mark Johnson). Mark Johnson provided input on existing conditions, shared suggestions on how to address deficiency, while also providing caution regarding the secondary impact of some modifications. The Comprehensive Analysis Matrices also touch on magnitude of costs, design considerations, and additional recommendations which were considered but not chosen and why.



Figure 3: Green-Painted Curb for Bicycle Lane

1. MAGNITUDE OF COST

Respecting the constant struggle with limited public funds, recommendations were divided into high-cost and low-cost categories. The delineation between these ranges is fluid, but the high-cost recommendations require some level of reconstruction and further analysis to determine the level of effort and cost required; the low-cost options can be implemented directly with little or no further analysis.

2. DESIGN CONSIDERATIONS

The Comprehensive Analysis Matrices, in Appendix E, also provide detail on some design considerations which are critical to consider when retrofitting an existing roadway. Design considerations represent the potential impacts which occur when you implement a modification to improve one issue and end up causing or aggravating others. Mark Johnson was valuable in helping to determine where and when this might be a problem. The most critical design consideration identified (several times) and carefully weighted in our analysis was the concern that some of the modifications could increase speed along the entire corridor. Addressing speed and safety were high priorities identified during the initial project development process; therefore, it is prudent to prevent increasing speeds to a similar level as previously experienced.

3. RECOMMENDATIONS

Many of the **low-cost recommendations** include additional striping and pavement markings at strategic locations, as well as a more long-term low-cost recommendation to initiate the removal of structures within the sight distance triangles at each roundabout.

The **high-cost recommendations** generally include infrastructure modifications, such as reconstruction of the aprons at Eagle Ridge Dr and Kimball Ave, with curb relocations recommended at 4th Ave and Kimball Ave (*identified in red in Figures 5-7*). The high-cost infrastructure recommendations were carefully considered with regard to potential secondary impacts (i.e. design considerations), as well as a



Figure 4: Green-Painted Bicycle Ramp Entrance

qualitative cost-benefit analysis to ensure the expenditure of public funds will bring tangible improvements to the operations of the corridor. With all high-cost infrastructure recommendations, the need for further analysis is required to determine any drainage impacts and ROW needs, at the very least.

In order to best summarize the recommendations, a set of tables with associated figures were created (see Figure 5-8 and Tables 4-7). Further detail on the recommendations are shown in the Comprehensive Analysis Matrices found in Appendix E.

Table 4: Eagle Ridge Dr – Final Recommendations

Eagle Ridge Dr – Final Recommendations	
High Cost*	Reduction of width/vertical on apron is recommended but will require further analysis on potential design, drainage, and reconstruction issues.
Low Cost	Remove boulders - Add tall grass within center island.
	Further refine single lane on the southbound approach with sharrows/striping.
	Strive to remove structures within sight distance triangles.
	Place consistent signage/pavement markings before, during, after roundabouts.
	Where applicable, paint markings delineate the bicycle entrance/exit from the roadway.
	Utilize sharrow pavement markings within the roundabout.



Figure 5: Eagle Ridge Dr – Final Recommendations

Table 5: 4th Ave – Final Recommendations

4th Ave – Final Recommendations	
High Cost*	Relocate the outside curb line at the 3 corners where the sidewalk has been relocated, and also consider possibility of relocating sidewalk at the remaining corner as well. May require further analysis on potential design, drainage, and ROW issues.
Low Cost	Strive to remove structures within sight distance triangles.
	Place consistent signage/pavement markings before, during, after roundabouts.
	Where applicable, use pavement markings to delineate the bicycle entrance/exit from the roadway.
	Utilize sharrow pavement markings within the roundabout.

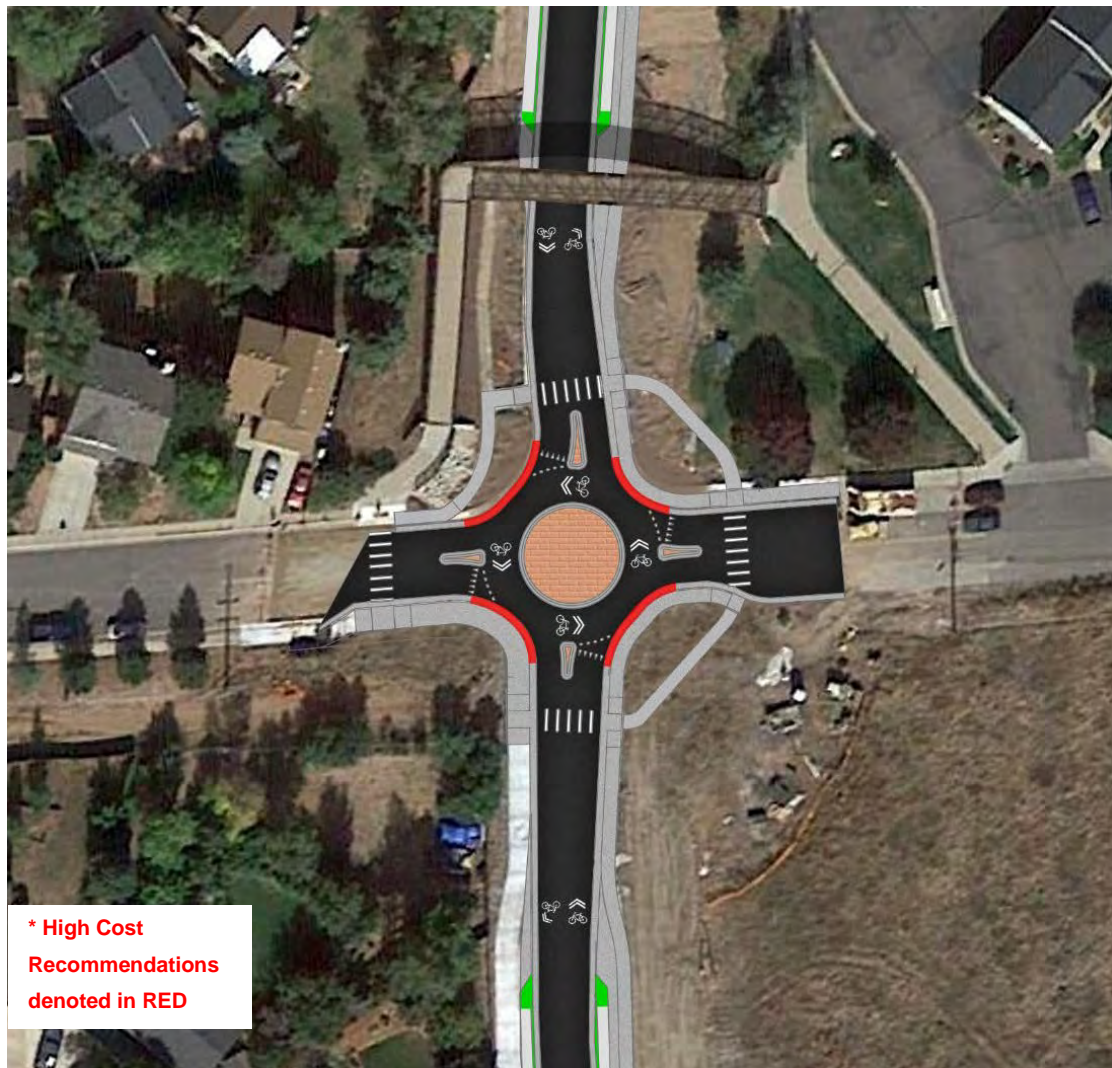
Figure 6: 4th Ave – Final Recommendations

Table 6: Kimball Ave – Final Recommendations

Kimball Ave – Final Recommendations	
High Cost*	Curb relocation recommended at the NB exit location but will require further analysis on potential design and ROW issues.
	Reduction of width/vertical of apron is recommended but will require further analysis on potential design, drainage, and reconstruction issues.
Low Cost	Place consistent signage/pavement markings before, during, after roundabouts.
	Where applicable, use pavement markings to delineate the bicycle entrance/exit from the roadway.
	Strive to remove structures within sight distance triangles.
	Utilize sharrow pavement markings within the roundabout.

**Figure 7: Kimball Ave – Final Recommendations**

Table 7: Corridor-Wide – Final Recommendations

Corridor-Wide – Final Recommendations	
Low Cost	Consolidate signage along corridor to improve sightlines and promote consistency at each roundabout.
	Green paint and pavement markings at decision points - enter/exit - and along bicycle facilities. Sharrow markings through the roundabout.
	Enhance existing crosswalk markings with enhanced paint and additional hashmarks in crosswalks.
	Add sharrow pavement markings north of Eagle Ridge Dr.
	Place low landscaping options between sidewalks and bicycle lanes and/or traffic lanes, where applicable.
	Recommend lane narrowing in the northbound direction and addition of sharrow pavement markings.

**Figure 8: Recommended Use of Sharrows**

4. CONCLUSIONS

As a conclusion to this study, a comprehensive analysis of potential roundabout and corridor-wide recommendations was completed. Ultimately the consultant team determined that the collection of recommendations previously presented are expected to bring the most benefit to the roadway network, with the anticipated outcome of improving operations and safety along the corridor.

A qualitative cost-benefit analysis was created for all potential modifications to ensure recommended changes result in value-based and sustainable benefits. The consistent messaging and selected infrastructure improvements should result in a tangible improvement for users along the corridor. Given funding availability, incremental value can be obtained by implementing the low-cost improvements initially, followed by the high-cost improvements over time.

The results provided encourage some level of acceptance surrounding the limitations of urban roundabouts, which often means speeds slow through the roundabout and drivers utilize the mountable aprons with larger vehicles. Mark Johnson fully supports the recommendations provided and reiterated that priorities and choices have to be made when working within a built environment and introducing a series of roundabouts with limited ROW.



Figure 9: Corridor-Wide – Final Recommendations

BICYCLE AND PEDESTRIAN ANALYSIS



The purpose of the bicycle and pedestrian analysis is to evaluate the existing conditions along the Heritage Rd project area against national standards and best practices. In addition to a review of existing conditions, this section contains recommendations that provide a range of options that the City of Golden could employ to address identified issues. Each element of this contains analysis of two sets of locations: along the linear path of the corridor and through the three roundabouts along Heritage Rd.

The majority of the feedback and discussion provided by stakeholders and members of the general public revolves around the current bicycle infrastructure and the means by which bicyclists must navigate the roundabouts along the corridor. While this evaluation discusses pedestrian infrastructure, most of the analysis focuses on bicycle infrastructure-related considerations.

A. EXISTING CONDITIONS

Table 1 summarizes the entire roadway conditions including bicycle and pedestrian infrastructure type and widths for various roadway segments along Heritage Rd, including segments to the north and south of the project area. Heritage Rd contains sidewalks that range from 5' to 8' in width and are detached from the roadway in most places. Between Kimball Ave and Eagle Ridge Dr, there are 4' wide raised bicycle lanes on both sides of the street, though there is no bicycle infrastructure through the roundabouts. There is one 11' wide general purpose travel lane in each direction. Analysis of these conditions against design standards are provided below.

1. CORRIDOR ANALYSIS

a) *Pedestrian Infrastructure*

The pedestrian facilities along Heritage Rd meet local and national design standards. The sidewalks are 5' or greater in width, which matches the City standard drawings and other local design guidance, and conforms to PROWAG standards. Sidewalks are generally detached, as indicated in the Jefferson County Transportation Design and Construction Manual and the City of Golden. The raised bicycle lane serves as the buffer – rather than a landscaping strip – along most stretches of the project area. A landscaping buffer is present between Eagle Ridge Dr and 4th Ave in the southbound direction along Heritage Rd.

The sidewalks along Heritage Rd are in generally good condition, and no major issues were raised from the public regarding the quality of the pedestrian infrastructure. The

exception is the segment to the south of Kimball Ave, where sidewalks and bicycle facilities are not present in the northbound direction.

b) *Bicycle Infrastructure*

Conformity with local and national design guidelines depends on the guideline source and how general bicycle lane standards are applied to the raised bicycle facilities along Heritage Rd. The raised bicycle lanes along Heritage Rd between Eagle Ridge Dr and Kimball Ave are 4' wide, which meets the minimum bicycle lane width guidance provided in local and some national standards; Jefferson County, CDOT, and AASHTO all indicate a 4' minimum width. However, ITE and NACTO both indicate a minimum lane width of 5', and national design standards generally recommend wider bicycle lanes than the minimum.

Heritage Rd contains pavement markings along the raised bicycle lanes, including bicycle stencils with green paint outline, that is consistent with MUTCD standards. However, it may not be clear to some users that the raised facility along Heritage Rd constitutes a bicycle lane.

(1) *Raised Bicycle Lanes*

Among the primary national design manuals, the *NACTO Urban Bikeway Design Guide* is the only document that provides standards related to raised bicycle lanes. Referred to by NACTO as raised cycle tracks, raised bicycle lanes are dedicated bicycle infrastructure vertically separated from the adjacent roadway that are frequently at an intermediate level between the roadway and a sidewalk. The vertical separation offered in raised bicycle lanes serves as a form of protection for bicyclists that keeps motorists from using the bicycle lane and encourages cyclists to use the dedicated bicycle facilities rather than the sidewalk. An additional benefit is the limited right-of-way required to protect bicyclists, compared to more traditional buffers.

Raised bicycle lanes are most appropriate along streets with high traffic volumes and/or high speeds where physical separation between cyclists and motorists is desirable. Corridors with few driveways, such as Heritage Rd, are most suitable for raised bicycle lanes. NACTO suggests that raised bicycle lanes be used in combination with effective signage, including situations where intersection conflicts can be mitigated through bicycle markings and other signage/signals. Raise bicycle lanes can be dropped at intersections to continue at street-level, as appropriate.

From a design perspective, the raised bicycle lanes are narrower than the minimum recommended width; NACTO suggest that raised bicycle lanes should be 6.5', with 5' width

acceptable under constrained situations. The facilities along Heritage Rd meet the guidance related to the vertical separation between motorists and cyclist as they are constructed at an intermediate level between the roadway and the sidewalk. This design provides additional vertical separation between cyclists and pedestrians. The raised bicycle lanes also feature a mountable curb to allow bicyclists to enter and exit the facility. However, the slope along the curb-line is steeper than the suggested ratio provided by NACTO (4:1 or 25% incline). This is not an issue at the entrance/exit ramps between the roadway and the bicycle lane.

Although raised bicycle lanes are a somewhat unique feature, the application along Heritage Rd is generally consistent with guidance on this facility type by location provided in the NACTO *Urban Bikeway Design Guide*. The most critical issue along the linear path of the corridor is the narrow width of the facility compared to recommended conditions. Additional recommendations are provided in the following section.

Recommended features for raised bike lanes, NACTO *Urban Bikeway Design Guide*

- Recommend width of 6.5', with a minimum 5' in constrained locations
- Mountable curb should be 1' wide, depending on height of curb
- Mountable curb should have 4:1 slope edge (the sloped edge is not considered a rideable surface or counted as part of the width)
- Vertical separation should be 1-6" from roadway to raised bicycle lane
- Vertical separation between bicycle lane and sidewalk should be 0-5", with 3" or greater separation discouraging conflicts with pedestrians
- Most appropriate when there are few conflicts with driveways
- Drainage should slope to the street

(2) Regional Connectivity

Heritage Rd is identified on the Jefferson County Bicycle Plan as a bicycle facility that provides a regional connection between US 6 and US 40. However, dedicated bicycle facilities are not provided to the north of Eagle Ridge Dr or in the northbound direction to the south of Kimball Ave. A Bike Route sign is provided to the north of Eagle Ridge Dr. To ensure regional connectivity and overall safety and comfort for bicyclists along Heritage Rd, infrastructure improvements could be considered to the north and south of the project area.

2. ROUNDABOUT ANALYSIS

a) General Guidance for Bicyclists

The movement of bicyclists through roundabouts must be considered from both a design and operations perspective. Design guides explicitly state that bicycle lanes are not to be provided through roundabouts (i.e. CDOT, AASHTO, and FHWA); rather, bicycle lanes must terminate 100' before the crosswalk or yield line at the entrance to the roundabouts, as indicated by the MUTCD.⁷

However, pathways should be provided for cyclists to navigate these intersections. According to the FHWA manual *Roundabouts: An Informational Guide*, bicyclists should have the option of traveling through the roundabout in the same manner as a vehicle or by dismounting and proceeding along the pedestrian route (i.e. the sidewalk).⁸ To aid bicyclists and inform motorists, shared lane markings may be provided at the entrances to roundabouts and path options for cyclists should be clearly indicated through signage and/or pavement markings.⁹



(1) Bicycle Ramps and Sidewalk Access

To allow bicyclists to access sidewalks, ramps may be provided from the road surface to allow cyclists to access the sidewalk in a location other than the formal crosswalk. FHWA and CDOT indicate that sidewalks should be widened at roundabouts so that cyclists and pedestrians may use sidewalks

⁷ Per the MUTCD, "Bicycle lanes shall not be provided on the circular roadway of a roundabout...Bicycle lane markings should stop at least 100 feet before the crosswalk, or if no crosswalk is provided, at least 100 feet before the yield line, or if no yield line is provided, then at least 100 feet before the edge of the circulatory roadway" (MUTCD 809).

⁸ Image on safely walking and biking through a roundabout is taken from the FHWA pamphlet "Roundabouts: A Safe Choice."

⁹ "The Bicycles May Use Full Lane sign may be used on roadways where no bicycle lanes or adjacent shoulders usable by bicyclists are present and where travel lanes are too narrow for bicyclists and motor vehicles to operate side by side.... The Bicycles May Use Full Lane sign may be used in locations where it is important to inform road users that bicyclists might occupy the travel lane" (MUTCD 794).

simultaneously (AASHTO asserts that this is only necessary depending on the level of pedestrian activity).

Where cyclists are encouraged to use pedestrian facilities through the roundabout intersection, FHWA recommends a 10' wide sidewalk with a 2-5' setback or buffer between the curb and the sidewalk to encourage pedestrians (and bicyclists) to stay on the designated sidewalks.

b) *Current Conditions and Compliance*

The sidewalks and pedestrian-oriented signage at the roundabouts along Heritage Rd appears to meet design standards and MUTCD requirements.

The bicycle lanes end prior to the entrance to the roundabouts, as directed by MUTCD, and bicyclists are expected to navigate roundabouts with flow of traffic. However, there are no signs or pavement markings, such as sharrows, to indicate that bicyclists may use the travel lane.

(1) *Bicycle Ramps and Sidewalk Access*

The ramps between the street and the raised bicycle lanes and between the sidewalks and the raised bicycle lanes are not clearly indicated. Many roundabout designs include bicycle ramps that enable bicyclists to easily access the sidewalk without having to utilize the crosswalk. Such ramps are present at most, but not all, roundabout approaches along the corridor. Where present, the raised bike lane exit ramps along Heritage Rd generally serve the function of providing a place for cyclists traveling with the flow of traffic to exit the roadway and access the sidewalk.

Although there are buffers and detached sidewalks along the majority of the corridor, most sidewalks at the roundabouts are attached (i.e. do not have a landscape buffer). The sidewalks through the roundabouts at Kimball Ave are of sufficient width to accommodate dismounted bicyclists and pedestrians; however, the sidewalks at the other roundabouts are of standard width and lack sufficient space to allow bicyclists to navigate along the sidewalk.

Table 8: Condition of Bicycle-specific Ramps and Connections from Bicycle Lanes to Sidewalks at Roundabouts along Heritage Rd

	Bicycle Ramps Present	Bicycle Ramps Not Present
Northbound	<ul style="list-style-type: none"> • Exit from Kimball Ave roundabout • Entrance to 4th Ave roundabout • Exit from 4th Ave roundabout • Entrance to Eagle Ridge Dr roundabout 	<ul style="list-style-type: none"> • Entrance to Kimball Ave roundabout • Exit from Eagle Ridge Dr roundabout
Southbound	<ul style="list-style-type: none"> • Exit from 4th Ave roundabout • Entrance to Kimball Ave roundabout • Exit from Kimball Ave roundabout 	<ul style="list-style-type: none"> • Entrance to Eagle Ridge Dr roundabout • Connection from sidewalk to bicycle lane south of Eagle Ridge Dr roundabout • Entrance to 4th Ave roundabout

B. RECOMMENDATIONS

Table 9 below provides a comprehensive list of recommendations for bicycle infrastructure along Heritage Rd; pedestrian infrastructure meets design standards and is in good condition and does not require improvements except for updated and enhanced pavement markings at existing crosswalks. The recommendations are organized by infrastructure type (i.e. raised bicycle lanes versus roundabouts) and by category (i.e. low cost/low impact and high cost/high impact). These same recommendations are duplicated in a cumulative fashion in the Roundabout Analysis Section, but additional details are provided here with a direct focus on the bicycle/pedestrian facilities.

Low-cost options reflect improvements that could be applied to the existing design configuration of Heritage Rd. A common theme among the low cost/low impact recommendations is the desire for increased information and improved awareness for motorists and cyclists at the entrance to each roundabout. Pavement markings and signage are desirable to indicate the options available to cyclists and inform motorists that cyclists may be present and may share the roadway space. High-cost options contain design changes and other improvements that require a greater level of investment and some level of physical change to the corridor. Some of the options in each column may be combined for added benefit, such as adding striping along roadway edges along with green paint along the raised bicycle lanes to distinguish the bicycle lanes from the roadway and the sidewalk. Low- and high-cost options may also be combined.

Table 9: Recommendations by Infrastructure Type and Level of Impact

	Low Cost/Low Impact	High Cost/High Impact
Raised Bicycle Lanes	<ul style="list-style-type: none"> • Green paint or color treatment along raised bicycle lanes to distinguish from roadway and at entrance/exit ramps • Additional bicycle stencils along raised bicycle lanes • Uniform use of Bike Lane signage 	<ul style="list-style-type: none"> • Widen raised bicycle lanes to conform with NACTO standards • Redesign to provide bicycle lanes at-grade or at same level as sidewalks
Roundabouts	<ul style="list-style-type: none"> • Add signage and/or pavement markings, including sharrows and Bicycles May Use Full Lane signs • Add bicycle ramps, where appropriate from street to sidewalks 	<ul style="list-style-type: none"> • Add landscaping buffers to sidewalks at roundabouts • Widen sidewalks at roundabouts to accommodate pedestrians and cyclists at the same time

EAGLE RIDGE DR TRAFFIC CALMING EVALUATION



Eagle Ridge Dr is a local road that has been treated with a series of traffic calming measures in response to observed speeds well above the posted limit. This analysis considers the design and performance of a series of chicanes and road narrowing medians installed along an approximately 800' stretch of the corridor. The five sets of chicanes are located on opposite side of the street with no off-set and the apexes are located from approximately 120' to 220' apart, depending on the location. Several road-narrowing medians are located in between the sets of chicanes. Eagle Ridge Dr is 44' wide through the project area.

Prior to the installation of traffic calming features, the average observed speed was approximately 35 MPH, compared to a posted speed limit of 25 MPH. Following the installation of traffic calming features, the average speed was observed at 26 MPH and the 85th percentile speed was 29 MPH. These latter data suggest traffic calming measures have been effective at reducing speeds, though observed speeds remain above desired levels.

Table 10: Observed Conditions along Eagle Ridge Rd Before and After Traffic Calming

	Before Traffic Calming (October 2006)	After some Traffic Calming (December 2014)	After Full Traffic Calming (March 2015)
Traffic Volume	1,632	1,541	1,603
Average Speed	35 MPH	27 MPH	26 MPH
Speeds (85th Percentile)	N/A	31 MPH	29 MPH

A. TRAFFIC CALMING FEATURES ALONG EAGLE RIDGE DR

Chicanes are alternating curves or lane shifts that are located in a position to force a motorist to steer back and forth out of a straight travel path. The curvilinear path is intended to reduce the speed at which a motorist is comfortable travelling through the feature. The chicane curves can be created with a curb extension that alternates from one side of the street to the other.¹⁰

Lateral shifts comprise a realignment of an otherwise straight street that causes travel lanes to shift in one direction. The primary purpose of a lateral shift is to reduce motor vehicle speed along the street. A typical lateral shift separates opposing traffic through the

¹⁰ Source: Federal Highway Administration Traffic Calming ePrimer

shift with the aid of a median island. Without the island, a motorist could cross the centerline in order to drive the straightest path possible, thereby reducing the speed reduction effectiveness of the lateral shift. In addition, a median island reduces the likelihood a motorist will veer into the path of opposing traffic, further improving the safety of the roadway for motorists.¹¹

Both traffic calming techniques are intended to narrow the width of the roadway, force motorists to reduce their speed, and create safer conditions for bicyclists and pedestrians. Bicyclists are expected to travel with the flow of traffic. Chicanes and lateral shifts should consider emergency access as some designs may cause challenges for large vehicles. Curb aprons or mountable curbs may be added to either feature to allow for emergency vehicles to pass through, while creating additional obstacles for single-occupancy vehicles.

B. APPROPRIATENESS

Traffic calming guides indicate that chicanes and lateral shifts (i.e. road narrowing medians) are most appropriate under the following conditions:

- along local roads and collectors with higher speeds than intended¹²
- streets with fewer than 3,500 vehicles per day¹³
- speed limits of 30 MPH or below and operating speeds of 35 MPH or above.¹⁴

Eagle Ridge Dr is a suitable candidate for traffic calming measures, as the roadway meets the guidance based on facility type, volumes, and observed speeds. Eagle Ridge Dr is also particularly wide for a local road, with of curb-to-curb width of 44'. The elements that are currently utilized – chicanes and road narrowing medians – are appropriate based on the criteria outlined in traffic calming design guides.

1. DESIGN CONSIDERATIONS

Though the chicanes and lateral shifts are appropriate measures on Eagle Ridge Dr and have had some effect on reducing traffic speeds, there are minor issues associated with current design configuration. Chicanes are intended to create an s-curve driving motion; however, the chicanes are not currently off-set, allowing motorists to pass through them in a straight line, which encourages higher speeds. This effect is mitigated by the presence of

¹¹ Source: Federal Highway Administration Traffic Calming ePrimer

¹² Federal Highway Administration Traffic Calming ePrimer

¹³ *Pennsylvania's Traffic Calming Handbook*, Pennsylvania DOT, July 2012, p. 29

¹⁴ Traffic Calming Handbook, City of San Antonio Public Works, 2013, p. 19

road narrowing medians; however, the length between the medians allows motorists to achieve higher speeds than desirable.

Design guides assert that chicanes should be located in an offset pattern.

Pennsylvania's Traffic Calming Handbook calls for there to be 50-80' between the peaks of the chicanes (i.e. the most protruding point), with peaks extending at least 4' from the curb. The *Canadian Guide to Neighborhood Traffic Calming* calls for a 23' (7m) gap between chicane features located along the angled portion of the offset chicanes.¹⁵ This is comparable to the gaps between the chicanes along Eagle Ridge Dr; however, the paired design of the chicanes allows for higher speeds than other designs. The gap between the chicanes along Eagle Ridge Dr is also considerably longer than the recommended designs.

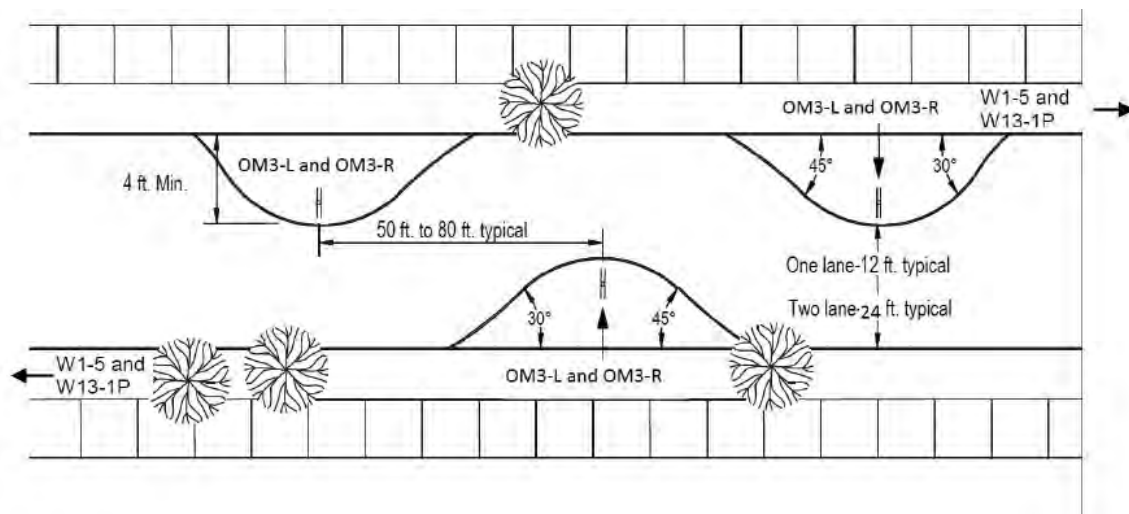


Figure 8: Design Considerations for Chicanes, *Pennsylvania's Traffic Calming Handbook*

C. RECOMMENDATIONS

Both low-cost and high-cost recommendations are provided, with choices for implementation being dependent on the amount of funds and effort available to update Eagle Ridge Dr.

¹⁵ ITE Canadian Guide to Neighbourhood Traffic Calming, December 1998, p. 4-9

Low-cost options

- Increased vertical elements (e.g. public art, landscaping) along medians to discourage motorists to speed up between traffic calming features

High-cost options

- Additional road narrowing median features to limit motorists' ability to accelerate between traffic calming features
- Relocate chicanes and increase size of traffic calming features to create greater offset
- Add curb aprons to road narrowing medians to create additional traffic calming features while allowing emergency vehicles to traverse the corridors

On-street parking option

Striping for on-street parking could be added in small sections of the corridor if such a feature is desired. Medians would need to be narrowed and could be replaced with center striping, though center striping is discouraged in various guides where chicanes are applied.

Any of these options would benefit the corridor, with the low-cost option of adding vertical elements a logical starting point. If greater traffic calming is desired, the high-cost options with incremental infrastructure modifications could be considered.

APPENDICES

APPENDIX A – AS-BUILTS

CONSTRUCTION PLANS FOR 2015 HERITAGE ROAD IMPROVEMENTS EAGLERIDGE DRIVE TO BERTHOUD WAY GOLDEN, COLORADO JANUARY 2015

Design Vehicle: 10,000 GVW Single-Unit Truck
Design Speed: 15 mph
Heritage Road Classification: Local Collector

EROSION CONTROL NOTES

1. THE CONTRACTOR SHALL ENSURE STORM WATER QUALITY BEST MANAGEMENT PRACTICES SHALL BE IMPLEMENTED TO MINIMIZE SOIL EROSION, SEDIMENTATION, INCREASED POLLUTANT LOADS AND CHANGED WATER FLOW CHARACTERISTICS RESULTING FROM LAND DISTURBING ACTIVITY, TO THE MAXIMUM EXTENT PRACTICABLE, SO AS TO MINIMIZE POLLUTION OF RECEIVING WATERS.
2. THE CONTRACTOR IS RESPONSIBLE FOR IMPLEMENTING AND MAINTAINING EROSION AND SEDIMENT CONTROL MEASURES AT ALL TIMES BEFORE, DURING AND AFTER CONSTRUCTION TO PREVENT DAMAGING FLOWS ON THE SITE AND ADJACENT PROPERTY.
3. TO THE EXTENT PRACTICABLE, EROSION AND SEDIMENT CONTROL MEASURES SHALL BE INSTALLED PRIOR TO GRADING ACTIVITIES. FOLLOWING INITIAL GRADING ACTIVITIES, EROSION AND SEDIMENT CONTROL DEVICES SHALL BE PLACED AS CONSTRUCTION SEQUENCING AND ACCESS DICTATES.
4. AT A MINIMUM, ALL BEST MANAGEMENT PRACTICES (BMPs) OUTLINED IN THE DRAWINGS MUST BE CORRECTLY INSTALLED AND FUNCTIONING, IN ACCORDANCE WITH THE CITY OF GOLDEN STORM WATER QUALITY CONTROL DESIGN GUIDANCE MANUAL. AT ALL TIMES DURING THE PROJECT CONSTRUCTION, ALL TEMPORARY AND PERMANENT EROSION AND SEDIMENT CONTROL MEASURES SHALL BE MAINTAINED AND REPAIRED AS NEEDED TO PREVENT ACCELERATED EROSION AND SEDIMENTATION, OR AS REQUESTED BY THE CITY, UNTIL A TIME WHEN THE CITY DETERMINES THEY ARE NO LONGER NEEDED.
5. NATURAL VEGETATION SHALL BE RETAINED AND PROTECTED WHEREVER POSSIBLE. EXPOSURE OF SOIL TO WATER AND WIND BY REMOVAL OR DISTURBANCE OF VEGETATION SHALL BE LIMITED TO THE AREA REQUIRED FOR IMMEDIATE CONSTRUCTION OPERATIONS AND FOR THE SHORTEST PRACTICABLE PERIOD OF TIME.
6. ALL TOPSOIL, WHERE PHYSICALLY PRACTICABLE, SHALL BE SALVAGED AND ON TOPSOIL SHALL BE REMOVED FROM THE SITE EXCEPT AS SET FORTH IN THE APPROVED PLANS. TOPSOIL AND OVERBURDEN SHALL BE SEGREGATED AND STOCKPILED SEPARATELY. TOPSOIL AND OVERBURDEN SHALL BE REDISTRIBUTED WITHIN THE GRADED AREA AFTER A ROUGH GRADING TO PROVIDE A SUITABLE BASE FOR THE AREAS THAT WILL BE SEEDED AND PLANTED.
7. ANY CONSTRUCTION DEBRIS OR MUD TRACKING IN THE PUBLIC RIGHT-OF-WAY RESULTING FROM THE CONSTRUCTION SHALL BE REMOVED IMMEDIATELY BY THE CONTRACTOR.
8. FUGITIVE DUST EMISSIONS RESULTING FROM GRADING ACTIVITIES AND/OR WIND SHALL BE CONTROLLED USING THE BEST AVAILABLE TECHNOLOGY. A WATER TRUCK SHALL BE USED WITHIN TWENTY-FOUR (24) HOURS OF THE CITY'S REQUEST FOR DUST CONTROL ON SITE.
9. RUNOFF FROM STOCKPILES SHALL BE CONTROLLED TO PREVENT EROSION AND RESULTANT SEDIMENTATION OF RECEIVING WATERS OR ADJACENT PROPERTY. SOILS STOCKPILED FOR MORE THAN THIRTY (30) DAYS SHALL BE SEEDED WITH A TEMPORARY OR PERMANENT GRASS COVER WITHIN FOURTEEN (14) DAYS AFTER COMPLETION OF THE STOCKPILE CONSTRUCTION.
10. IF STOCKPILES ARE LOCATED WITHIN CLOSE PROXIMITY TO A DRAINAGEWAY, ADDITIONAL SEDIMENT CONTROL MEASURES, SUCH AS TEMPORARY DIVERSION DIKE OR SILT FENCE, SHALL BE PROVIDED.
11. PERMANENT SOIL STABILIZATION MEASURES SHALL BE APPLIED WITHIN FOURTEEN (14) DAYS TO DISTURBED AREAS IN WHICH FINAL GRADE IS COMPLETED.
12. TEMPORARY SOIL STABILIZATION MEASURES SHALL BE APPLIED WITHIN FOURTEEN (14) DAYS, TO AREAS THAT ARE NOT AT FINAL GRADE BUT WILL REMAIN DORMANT (UNDISTURBED) FOR LONGER THAN THIRTY (30) DAYS, PER THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT VOLUME 3.
13. HYDRAULIC SEEDING MAY BE SUBSTITUTED FOR DRILLING ONLY WHERE SLOPES STEEPER THAN THREE TO ONE (3:1) OR WHERE ACCESS LIMITATIONS EXIST. WHEN HYDRAULIC MULCHING SHOULD BE DONE AS A SEPARATE OPERATION IMMEDIATELY FOLLOWING SEEDING, TO PREVENT SEEDS FROM BEING ENCAPSULATED IN THE MULCH. HYDRAULIC MULCH MUST CONTAIN A TACKIFYING AGENT AT A RATE OF FIFTEEN HUNDRED (1500) POUNDS PER ACRE (CITY OF GOLDEN STORM WATER QUALITY CONTROL DESIGN GUIDANCE MANUAL, APPENDIX C 3.2).
14. FOR SLOPES GREATER THAN THREE TO ONE (3:1) AND OTHER SPECIAL SITUATIONS, EROSION CONTROL BLANKETS, ANCHORED WITH STAPLES, MAY BE REQUIRED IN STEAD OF MULCH.
15. SEEDING RATES FOR BROADCAST APPLICATION SHOULD BE INCREASED AT LEAST TWICE THAT OF DRILLED RATES.
16. STRAW MULCH RATES SHOULD BE A MINIMUM OF TWO (2) TONS/ACRE AND SHOULD BE CRIMPED, OR ANCHORED WITH THE AID OF TACKIFIERS.
17. INSPECTION AND MAINTENANCE PROCEDURES. INSPECTIONS SHALL BE PERFORMED EVERY FOURTEEN (14) DAYS, OR FOLLOWING A STORM WATER EVENT. AN INSPECTION FORM (PROVIDED BY THE CITY) SHALL BE COMPLETED FOR EACH INSPECTION PERFORMED. THE COMPLETED INSPECTION FORM SHALL BE PROVIDED TO THE CITY. INSPECTION REPORTS MUST BE KEPT ON SITE. MAINTENANCE AND REPAIRS SHALL BE PERFORMED AS SOON AS POSSIBLE ON ITEMS OR AREAS IDENTIFIED IN THE INSPECTION REPORT. MAINTENANCE SHOULD BE PERFORMED AS INDICATED IN THE CITY OF GOLDEN STORMWATER QUALITY CONTROL DESIGN GUIDANCE MANUAL, PER MANUFACTURER'S SPECIFICATIONS, OR OTHER SOURCES DETERMINED TO BE ACCEPTABLE.
18. ALL EROSION CONTROL MEASURES MUST REMAIN IN A FUNCTIONAL CONDITION UNTIL A Viable VEGETATIVE COVER HAS BEEN ESTABLISHED.
19. A Viable VEGETATIVE COVER SHOULD BE ESTABLISHED WITHIN ONE (1) YEAR ON ALL DISTURBED AREAS AND SOIL STOCKPILES NOT OTHERWISE PERMANENTLY STABILIZED. VEGETATION IS NOT CONSIDERED ESTABLISHED UNTIL A GROUND COVER IS ACHIEVED WHICH, IN THE OPINION OF THE CITY, IS SUFFICIENTLY MATURE TO CONTROL SOIL EROSION AND CAN SURVIVE SEVERE WEATHER CONDITIONS. "ESTABLISHED" IS DEFINED AS A MINIMUM OF SEVENTY (70) PERCENT COVER OF DESIRED SPECIES.
20. THE CITY OF GOLDEN MAY MODIFY THE EROSION AND SEDIMENT CONTROL PLAN AS FIELD CONDITIONS WARRANT.
21. CONTRACTOR SHALL BE RESPONSIBLE FOR STATE AND LOCAL STORMWATER PERMITS. CITY OF GOLDEN STORM WATER PERMIT WILL REQUIRE CONTRACTOR TO SUBMIT STORMWATER MANAGEMENT PLAN. GRADING, EROSION, AND SEDIMENT CONTROL PLANS SHALL BE THE MINIMUM MEASURES EMPLOYED BY THE CONTRACTOR FOR STORMWATER MANAGEMENT.
22. EROSION CONTROL MEASURES FOR THIS PROJECT SHALL BE, AT A MINIMUM:
 - INLET PROTECTION FOR EXISTING DOWNSTREAM INLETS AND AFTER THE INSTALLATION OF NEW INLETS.
 - CURB SOCKS PLACED IN THE CURB AND GUTTER AT ONE HUNDRED FOOT (100') MAXIMUM SPACING, EACH SIDE OF STREET.
 - WATTLES PLACED ON THE NORTHERLY EDGE OF THE PROJECT AND DOWNHILL SIDE OF ALL STOCKPILES.
 - VEHICLE TRACKING CONTROL AT ANY ACCESS TO OPENED SUBGRADE.
 - A STABILIZED STAGING AREA. LOCATION SHOWN ON PLAN IS FOR REFERENCE. CONTRACTOR SHALL ESTABLISH LOCATION OF STABILIZED STAGING AREA.
 - ALL AREAS THAT INDICATE REVEGETATION (RV) SHALL BE SEEDED AND COVERED IN AN EROSION CONTROL BLANKET, BY THE CITY. FOR THESE AREAS NOT SLATED TO BE HARDESCAPED, THE CONTRACTOR SHALL BE RESPONSIBLE TO SET SUBGRADE, SIX INCHES (6") BELOW FINAL GRADE AS SHOWN. THE CITY WILL PROVIDE TOPSOIL AND REVEGETATION EFFORTS.



AGENCIES

CITY OF GOLDEN, COLORADO
1445 TENTH STREET
GOLDEN, COLORADO 80401

TTG ENGINEERS, INC.
9222 TEDDY LANE
LOVE TREE, COLORADO 80124

UTILITY NOTIFICATION CENTER OF COLORADO
DIAL 811 OR 1-800-922-1987
www.unc2.org

DAN HARTMAN, P.E., DIRECTOR OF PUBLIC WORKS
VINCE AUREMMA, P.E., DEPUTY DIRECTOR
(303) 384-8156

WARD MAHANKA, P.E., PROJECT MANAGER
(303) 792-0557

Field Order No. 01 (04-20-15): Curb
Section A and 2-Foot Rollover
Gutter details used for Raised Bike
Lane revised.

Field Order No. 02 (05-26-15):
Alternative - Raised Bike Lanes Street
Section, Single 6" white stripe deleted
as follows:
East side striping Sta 8+50 to 25+00
West side striping Sta 8+50 to 33+75.

Changes authorized by COG (Word Doc
06-30-15):

1. Sawcut raised bike lane instead of sidewalk as specified.
2. Add inlet and pipe west side north of Berthoud in place of sidewalk chase.
3. Added curb at east side south end.
4. Added demo of old curb west side Eagle Ridge to 4th instead of pouring new over pan.
5. Added backfill topsoil back of walk.

ALL MATERIALS, WORKMANSHIP AND DIMENSIONS OF PROJECT IMPROVEMENTS SHALL MEET OR EXCEED THE STANDARDS AND SPECIFICATIONS, AND APPLICABLE STATE AND FEDERAL REGULATIONS, OR ANY APPLICABLE STANDARDS, AND APPROVED BY THE CITY.

VISION OF SAID STANDARD, UNLESS

ONE (1) COPY OF THE APPROPRIATE
MENTS NEEDED FOR THE JOB, ONSITE AT ALL

LOCATION OF EXISTING UTILITIES, AS SHOWN ON
HERE POSSIBLE, MEASUREMENTS TAKEN IN
COMPLETE. THE CONTRACTOR MUST CALL THE
EXCAVATION OR REQUEST TO EXACT FIELD
VERIFY PERTINENT LOCATIONS AND

ELEVATIONS, ESPECIALLY AT CONNECTION POINTS AND AT POTENTIAL UTILITY CONFLICTS.

WORK AREAS WITH

EXCAVATION,

PRIVATE
ITIES WITHIN, OR
TRAFFIC CONTROL

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ON THAT IS NOT

N DEBRIS AND DIRT

DIMENSIONS ARE
THE AS-BUILT

FOR STORM WATER

FOR TO ANY OTHER
GROUND-DISTURBING ACTIVITY. ALL EROSION CONTROL MEASURES SHALL BE MAINTAINED IN GOOD REPAIR BY THE
CONTRACTOR, UNTIL SUCH TIME AS THE ENTIRE DISTURBED AREAS IS STABILIZED WITH HARD SURFACE LANDSCAPING. THE CITY
MAINTAINS THE RIGHT TO REQUIRE ADDITIONAL EROSION CONTROL MEASURES IF NECESSARY DURING CONSTRUCTION.

14. ALL EXISTING STRUCTURES, FENCES, SIGNS, AND IMPROVEMENTS DESTROYED, DAMAGED, OR REMOVED DUE TO THE
CONSTRUCTION OF THIS PROJECT SHALL BE REPLACED OR RESTORED IN LIKE AND KIND AT THE CONTRACTOR'S EXPENSE,
UNLESS OTHERWISE INDICATED ON THE DRAWINGS.

15. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING A DISPOSAL SITE FOR ALL UNUSABLE MATERIAL REMOVED FROM THE
PROJECT.

16. THERE SHALL BE NO SITE CONSTRUCTION ACTIVITIES ON SATURDAYS, UNLESS SPECIFICALLY APPROVED BY THE CITY, AND NO
SITE CONSTRUCTION ACTIVITIES ON SUNDAYS OR HOLIDAYS, UNLESS THERE IS PRIOR WRITTEN APPROVAL BY THE PUBLIC WORKS
DIRECTOR.

17. THE CONTRACTOR SHALL BE RESPONSIBLE FOR RECORDING AS-BUILT INFORMATION ON A SET OF RECORD DRAWINGS KEPT ON
THE CONSTRUCTION SITE, AND AVAILABLE TO THE CITY AT ALL TIMES.

18. TYPE R INLETS (GREATER THAN FIVE FEET (5')) SHALL HAVE TWO ACCESS COVERS AND STEPS.

19. GRATES FOR TYPE C AND 13C INLETS SHALL BE INSTALLED IN 2' X 2' SECTIONS.

20. CONTRACTOR SHALL, FOR ALL AREAS NOT SLATED TO BE HARDESCAPED, BE RESPONSIBLE TO SET SUBGRADE, SIX INCHES (6")
BELOW FINAL GRADE AS SHOWN. THE CITY WILL PROVIDE TOPSOIL AND REVEGETATION EFFORTS.

21. ALL ELEVATIONS ARE ON NAVD29.



SHEET INDEX

- | | |
|-------|-------------------------------------|
| 1 | COVER SHEET |
| 2 | TYPICAL SECTIONS |
| 3 | ALTERNATE SECTIONS |
| 4-7 | DEMOLITION PLAN |
| 8-11 | ROUNDBOUTS |
| 12-14 | HERITAGE ROAD |
| 15-16 | STORM SEWER |
| 17-19 | STRIPING AND CONDUIT PLAN |
| 20 | DETAILS AND WATER LINE PLAN |
| 21-23 | HERITAGE ROAD - ALTERNATIVE SECTION |
| 24 | STORM WATER MANAGEMENT PLAN |

CITY OF GOLDEN
2015 HERITAGE ROAD IMPROVEMENTS
COVER SHEET



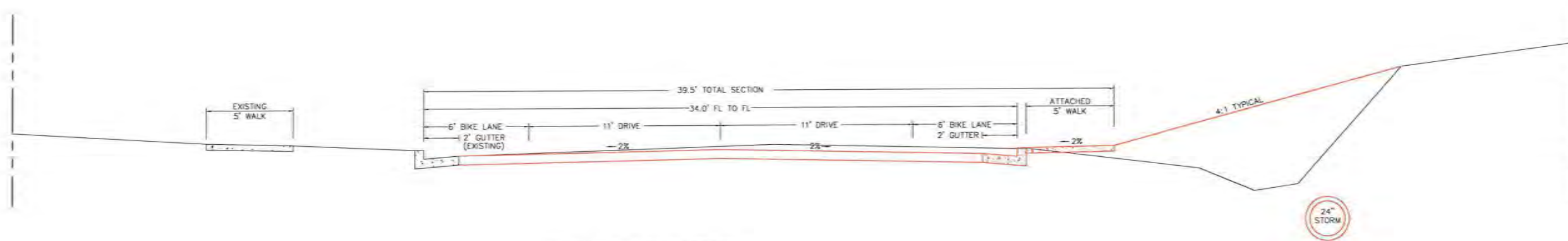
JOB NO.
592-401

SCALE
N.T.S.

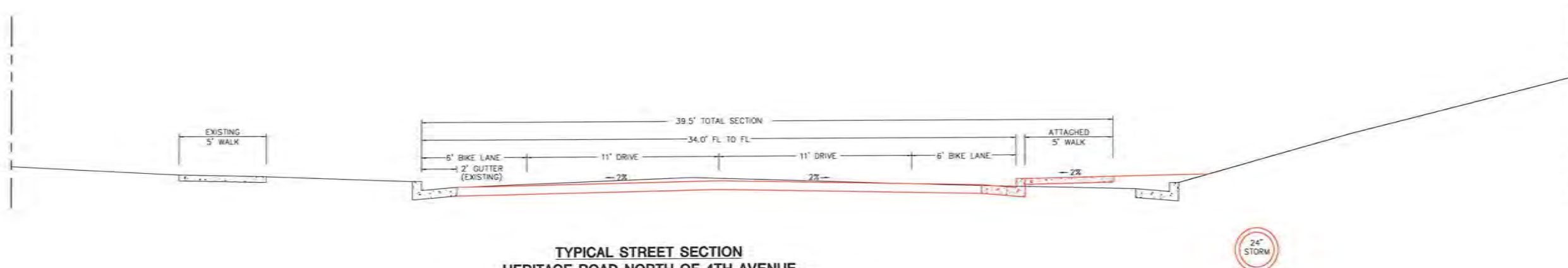
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SHEETS
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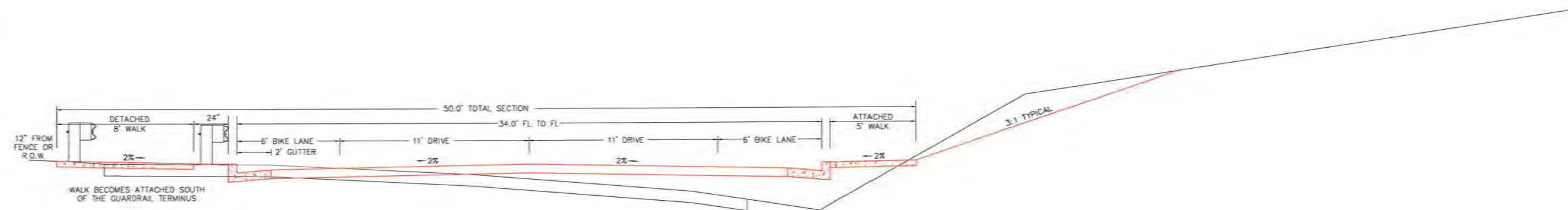
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TYPICAL STREET SECTION
HERITAGE ROAD SOUTH OF EAGLE RIDGE
CL STA 8+97
LANE GEOMETRY BASED ON WEST FLOWLINE

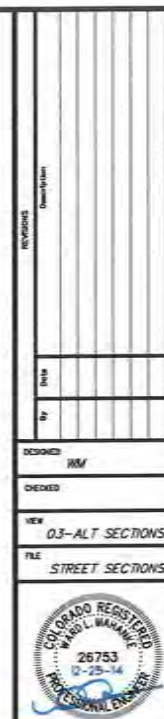
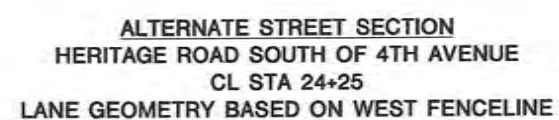
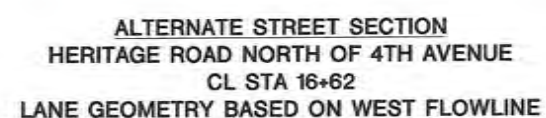
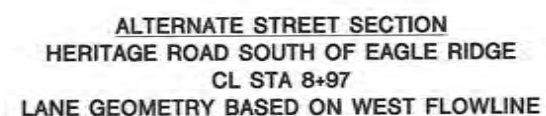


TYPICAL STREET SECTION
HERITAGE ROAD NORTH OF 4TH AVENUE
CL STA 16+62
LANE GEOMETRY BASED ON WEST FLOWLINE



TYPICAL STREET SECTION
HERITAGE ROAD SOUTH OF 4TH AVENUE
CL STA 24+25
LANE GEOMETRY BASED ON WEST FENCELINE

REVISIONS	
NO.	DESCRIPTION
DESIGNED	MM
CHECKED	
VIEW	02-SECTIONS
FILE	STREET SECTIONS
CITY OF GOLDEN 2015 HERITAGE ROAD IMPROVEMENTS TYPICAL STREET SECTIONS ON-STREET BIKE LANES	
TTG ENGINEERS, INC. <small>Consulting Engineers</small>	
JOB NO. 592-401	
SCALE N.T.S.	
2014-12-25	
SHEETS	SHEET
24	2



CITY OF GOLDEN
2015 HERITAGE ROAD IMPROVEMENTS
ALTERNATE STREET SECTIONS
RAISED BIKEWAY AND SIDEWALK



TTG
TTG ENGINEERS, INC.
 Consulting Engineers

JOB NO. 592-401

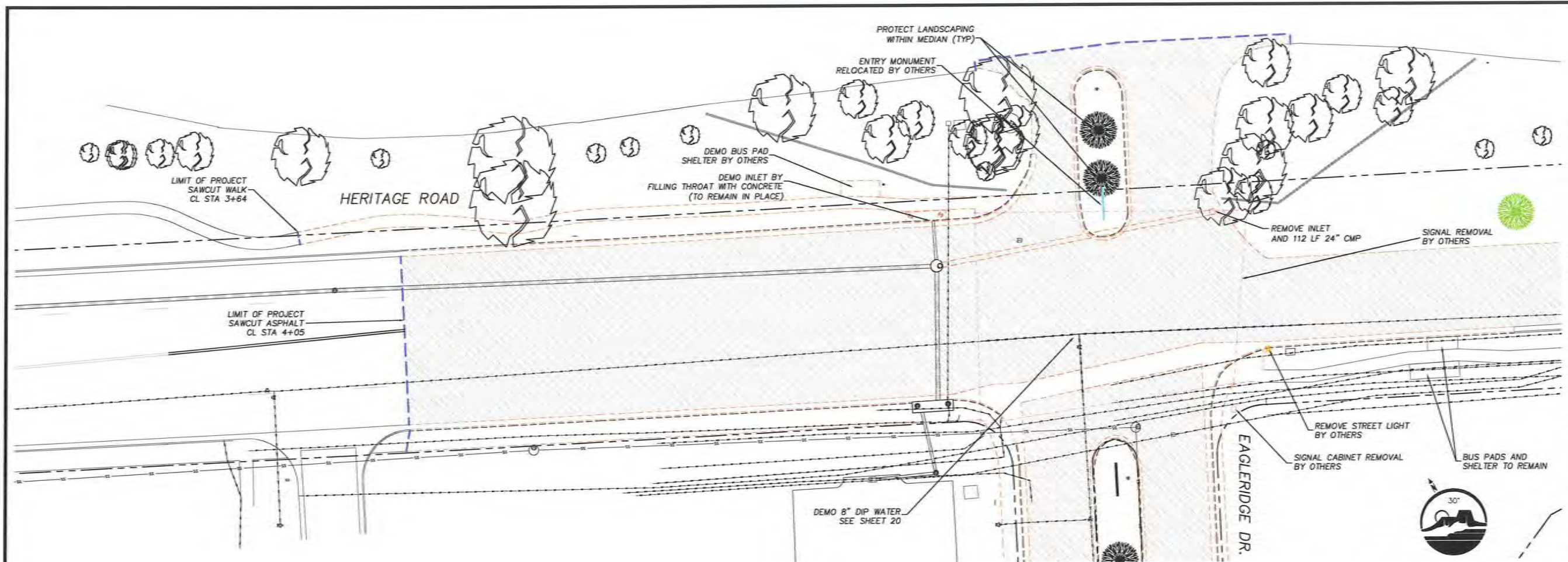
SCALE *N.T.S.*

2014-12-25

SMITH	SMITH
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24

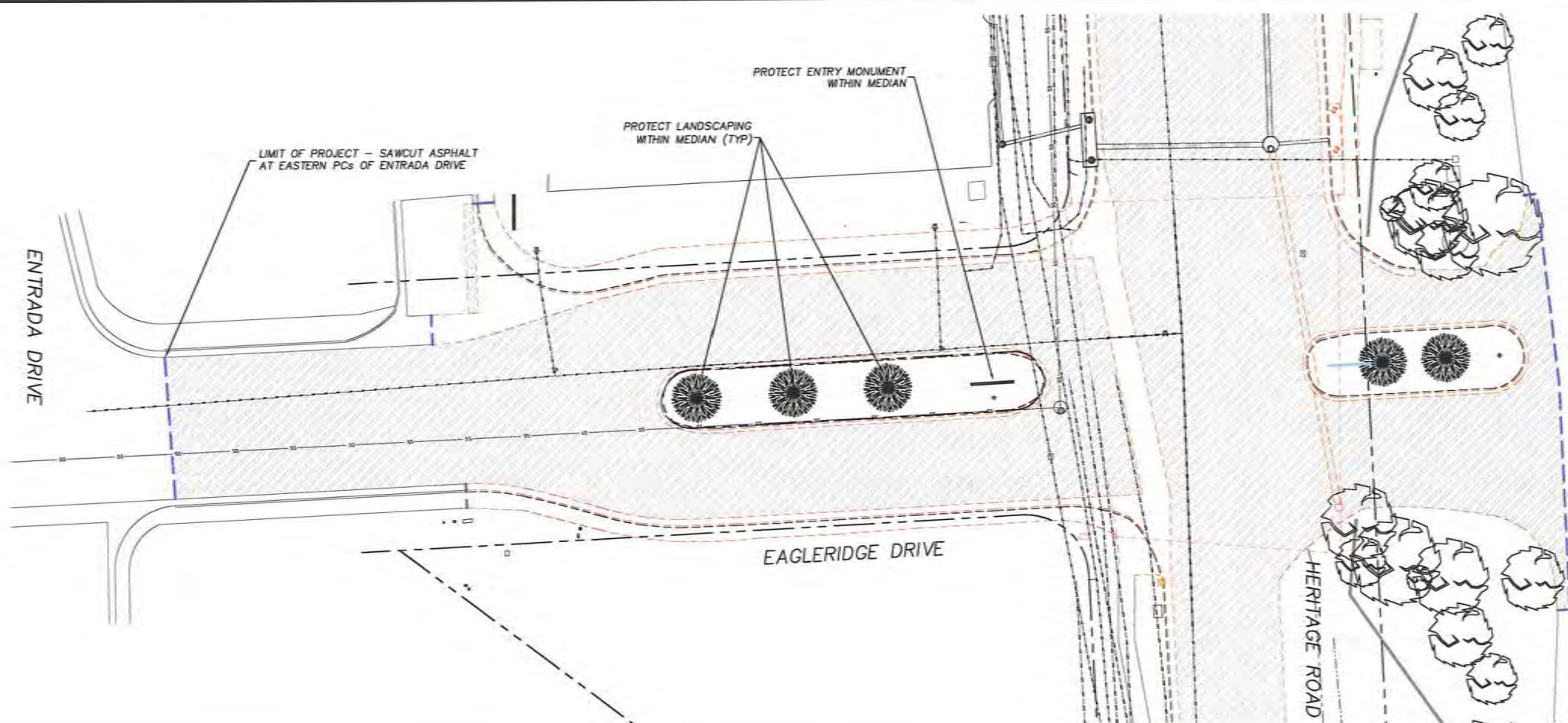
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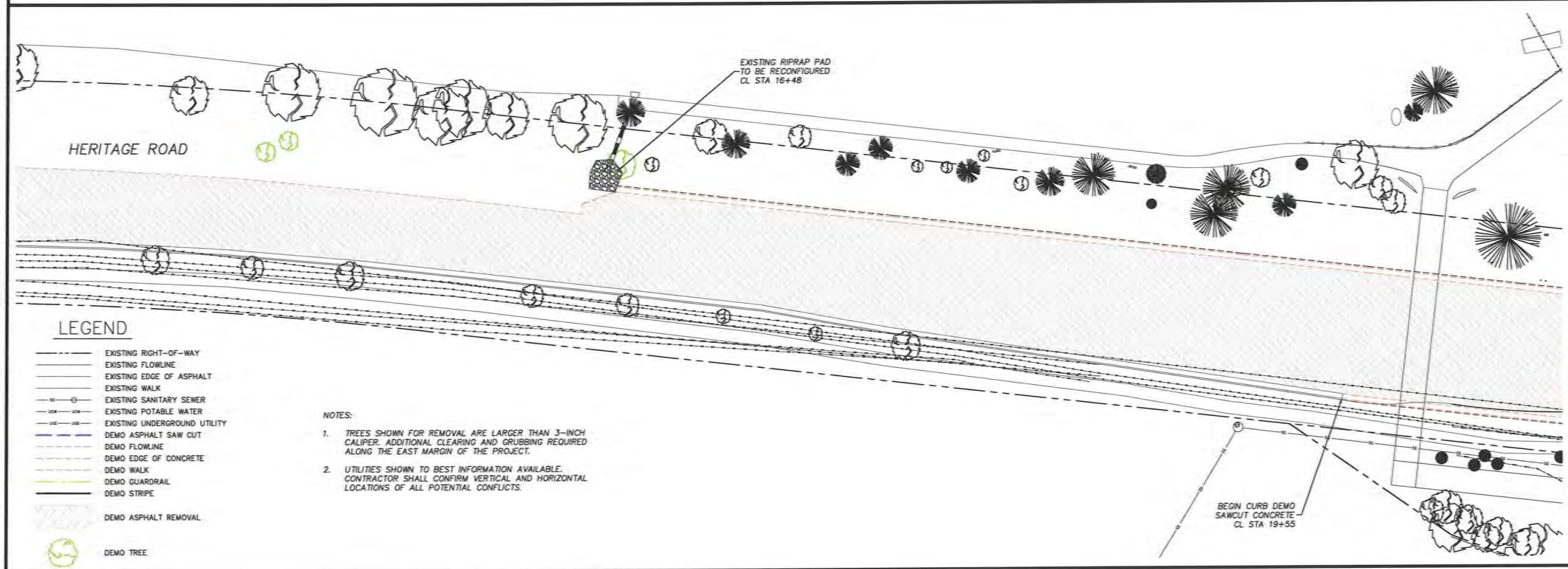
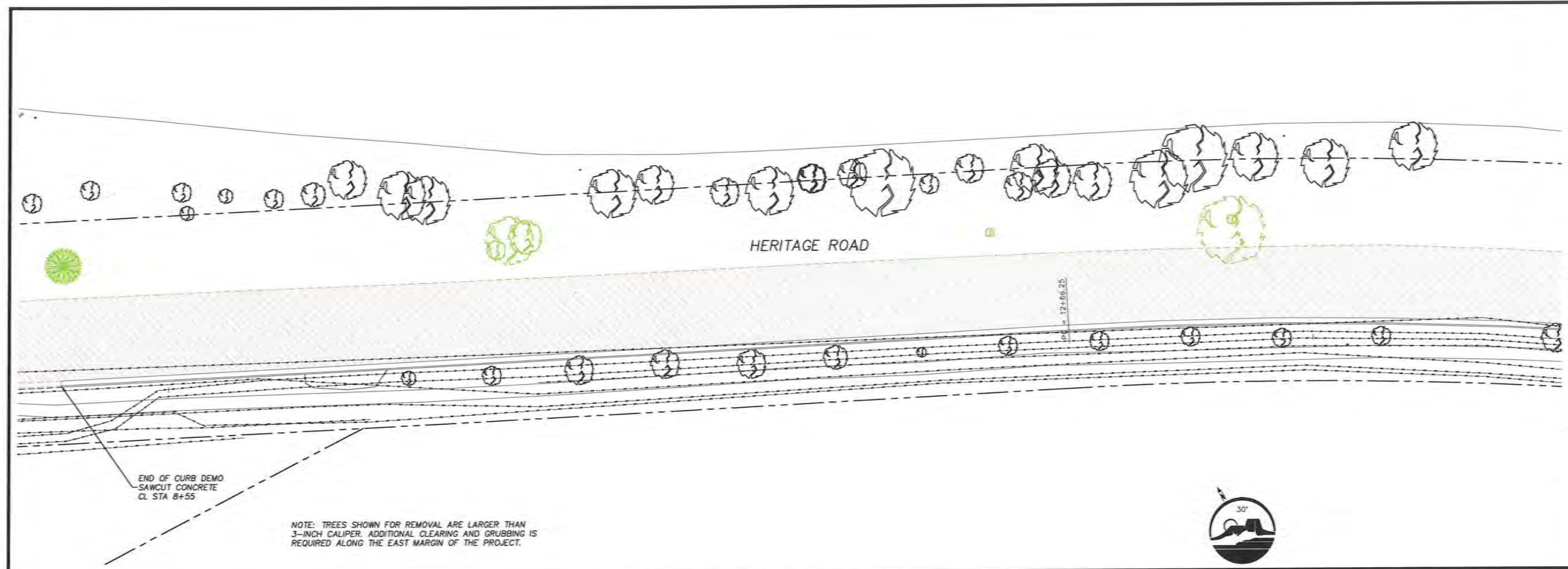


- | | |
|---|------------------------------|
|  | EXISTING RIGHT-OF-WAY |
|  | EXISTING FLOWLINE |
|  | EXISTING EDGE OF ASPHALT |
|  | EXISTING WALK |
|  | EXISTING SANITARY SEWER |
|  | EXISTING POTABLE WATER |
|  | EXISTING UNDERGROUND UTILITY |
|  | DEMO ASPHALT SAW CUT |
|  | DEMO FLOWLINE |
|  | DEMO EDGE OF CONCRETE |
|  | DEMO WALK |
|  | DEMO GUARDRAIL |
|  | DEMO STRIPE |
|  | DEMO ASPHALT REMOVAL |
|  | DEMO TREE |

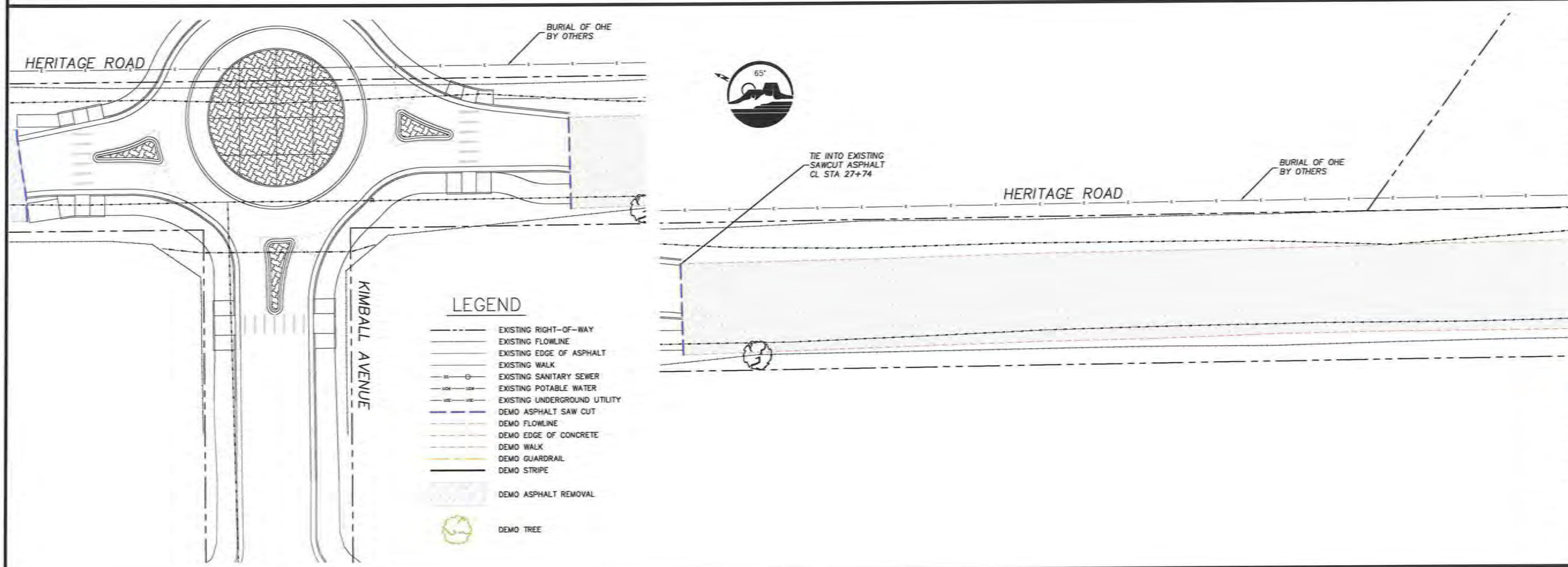
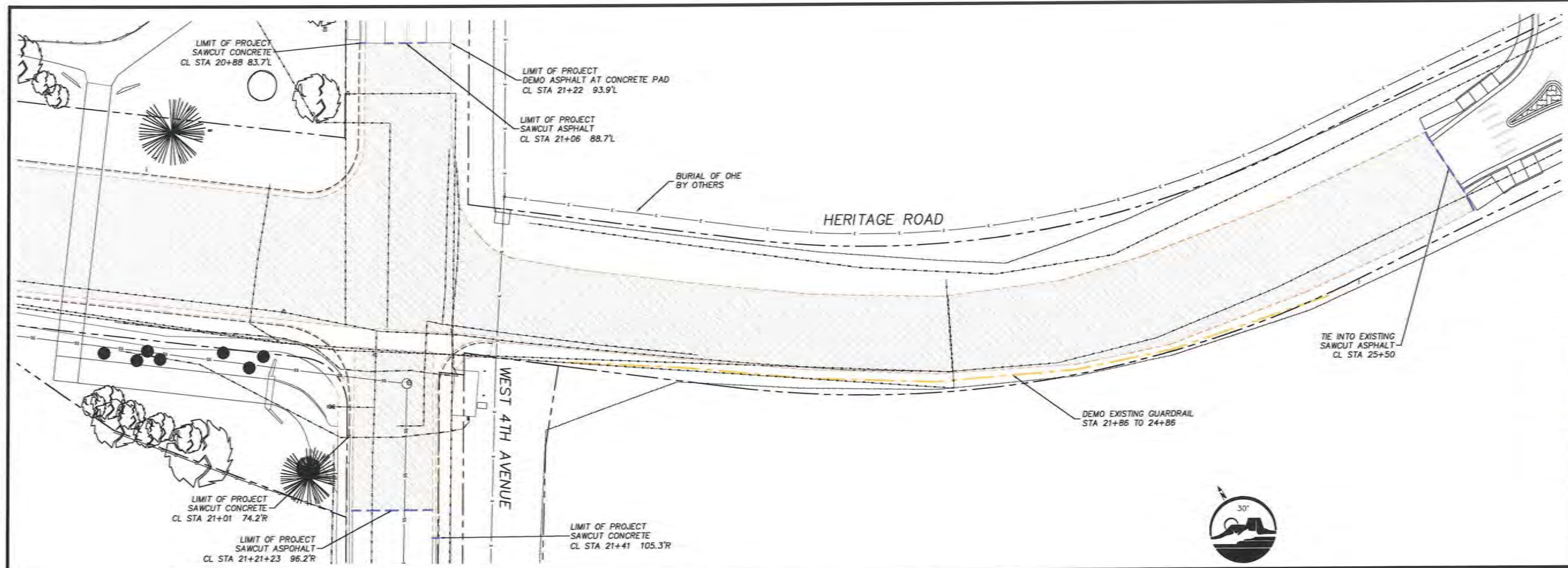
NOTES:

1. TREES SHOWN FOR REMOVAL ARE LARGER THAN 3-INCH CALIPER. ADDITIONAL CLEARING AND GRUBBING REQUIRED ALONG THE EAST MARGIN OF THE PROJECT.
2. UTILITIES SHOWN TO BEST INFORMATION AVAILABLE. CONTRACTOR SHALL CONFIRM VERTICAL AND HORIZONTAL LOCATIONS OF ALL POTENTIAL CONFLICTS.





REVISIONS	DESCRIPTION
DATE	
BY	
DESIGNED	MM
CHECKED	
NEW	05-DEMO
FILE	CD-MASTER
CITY OF GOLDEN 2015 HERITAGE ROAD IMPROVEMENTS DEMOLITION PLAN	
TTG TTG ENGINEERS, INC. Consulting Engineers	
JOB NO.	592-401
SCALE	1"=20'
2014-12-25	
SHEETS	SHEET
24	5



LEGEND

- EXISTING RIGHT-OF-WAY
- EXISTING FLOWLINE
- EXISTING EDGE OF ASPHALT
- EXISTING WALK
- EXISTING SANITARY SEWER
- EXISTING POTABLE WATER
- EXISTING UNDERGROUND UTILITY
- DEMO ASPHALT SAW CUT
- DEMO FLOWLINE
- DEMO EDGE OF CONCRETE
- DEMO WALK
- DEMO GUARDRAIL
- DEMO STRIPE
- DEMO ASPHALT REMOVAL
- DEMO TREE

CITY OF GOLDEN 2015 HERITAGE ROAD IMPROVEMENTS DEMOLITION PLAN

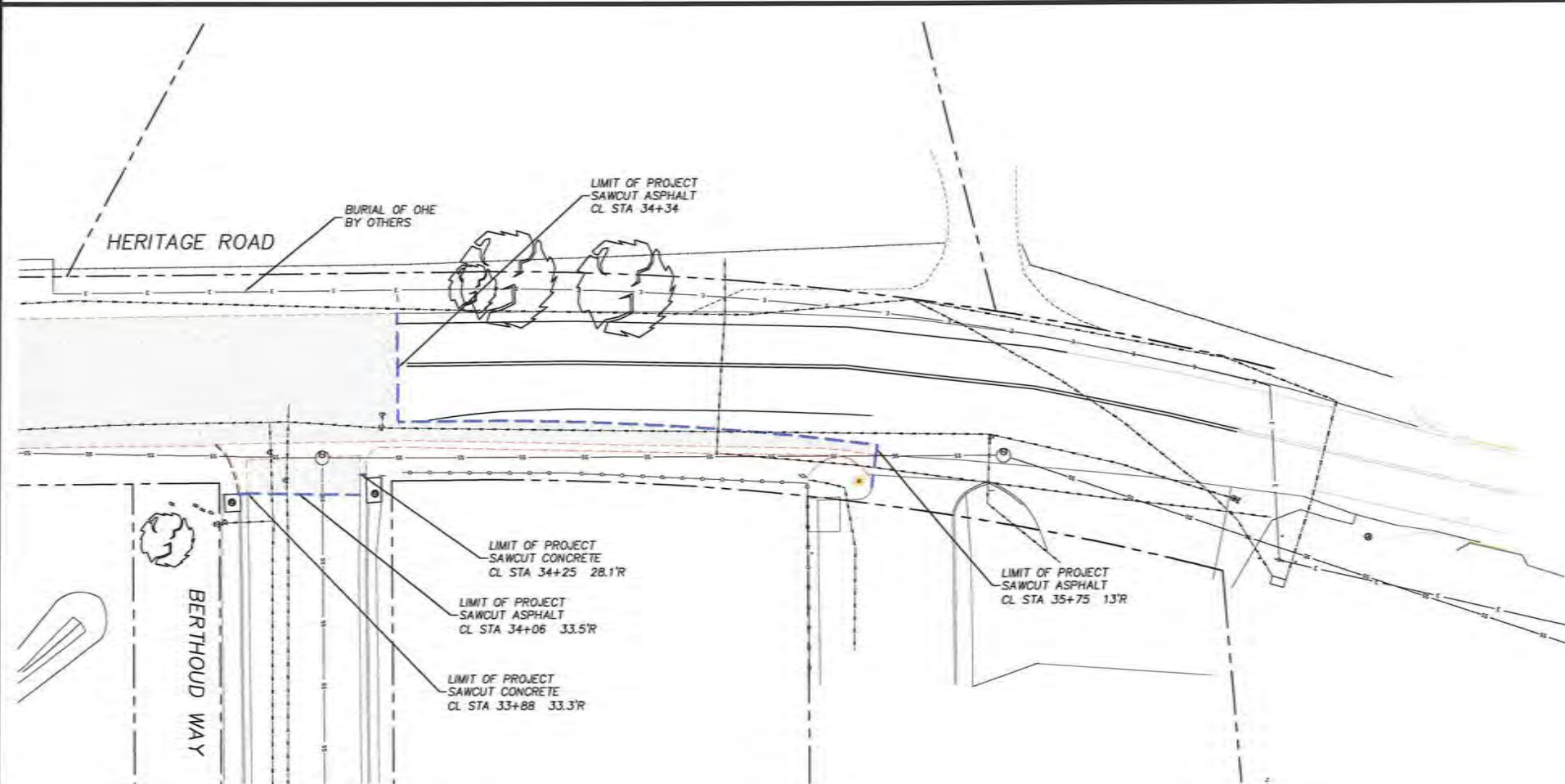
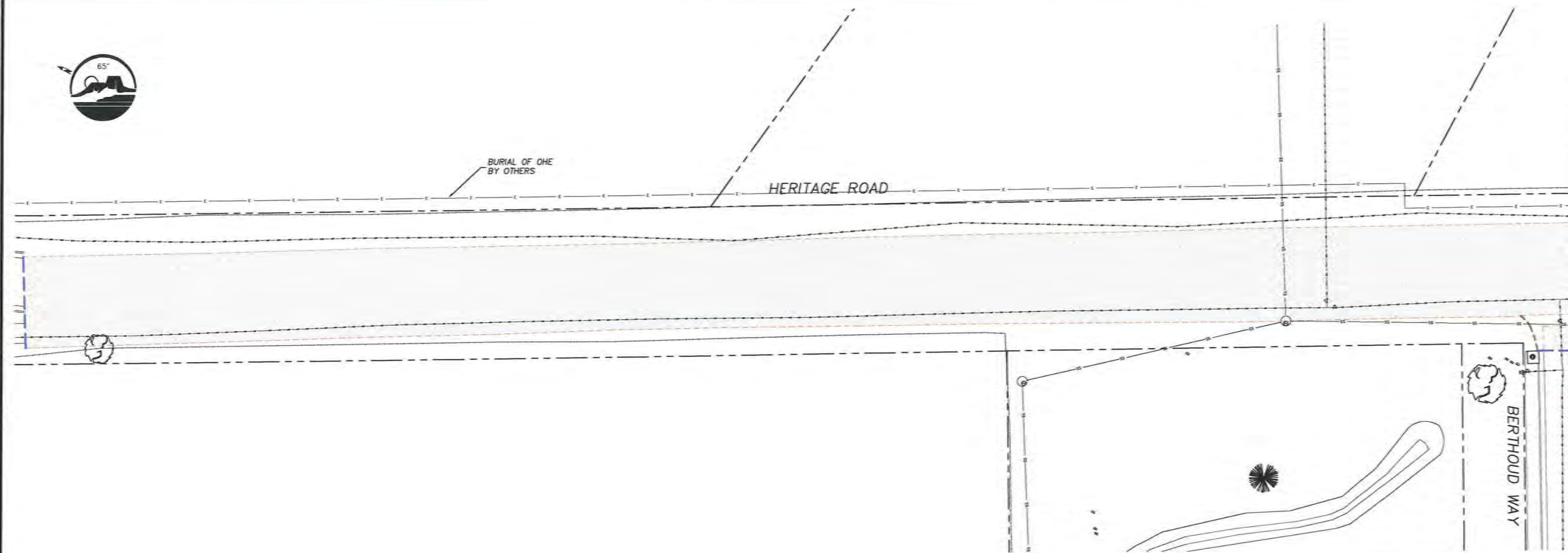


TTG
ENGINEERS, INC.
Consulting Engineers

JOB NO. 592-401
SCALE 1"=20'
2014-12-25
SHEETS 24 6



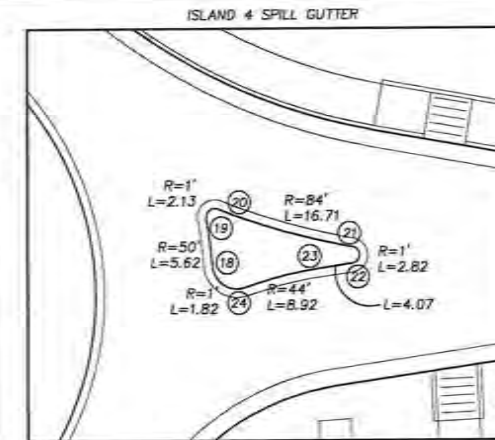
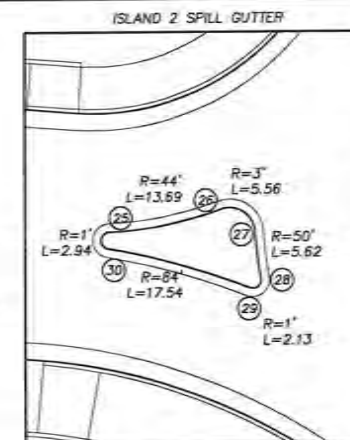
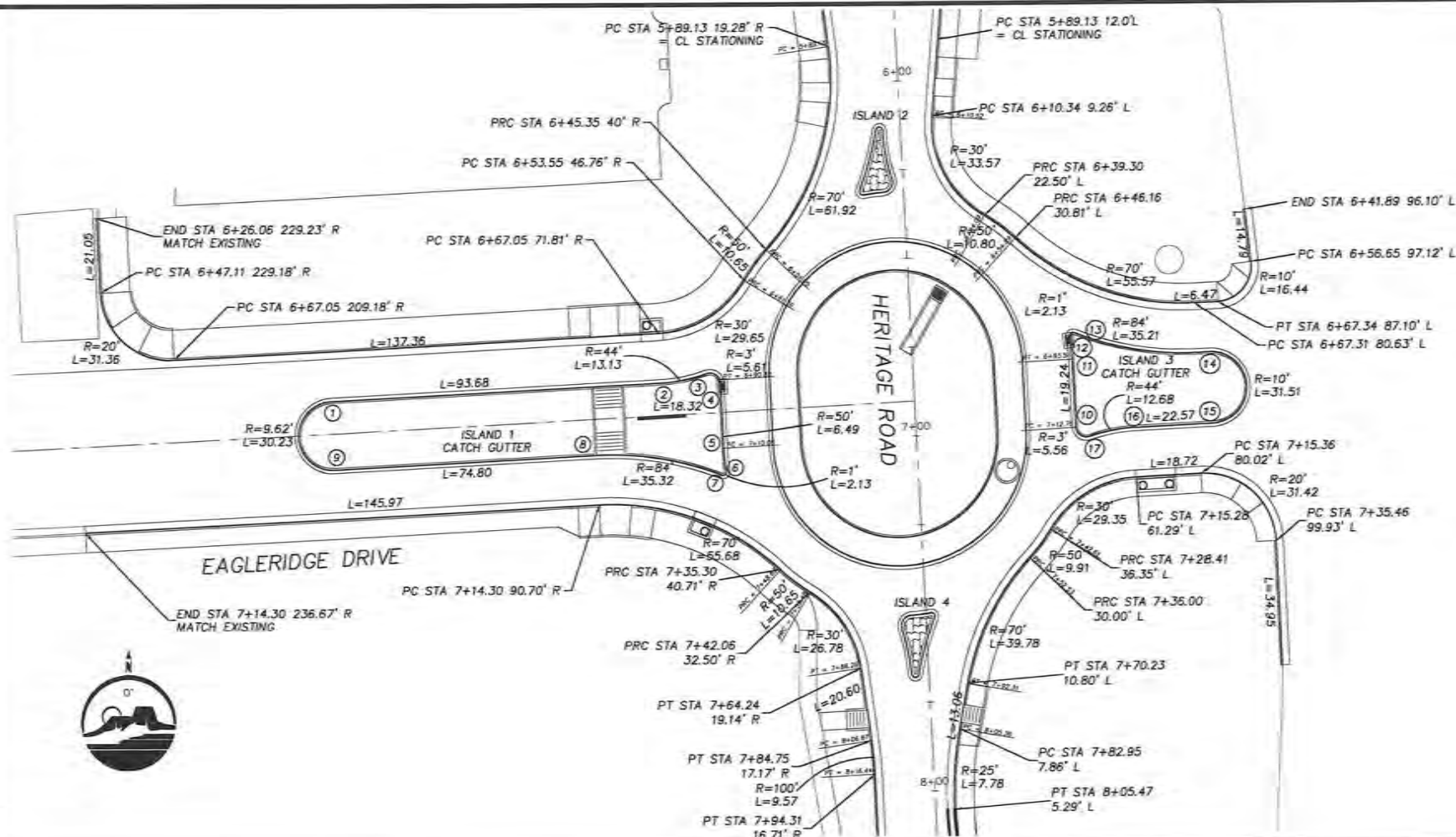
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LEGEND

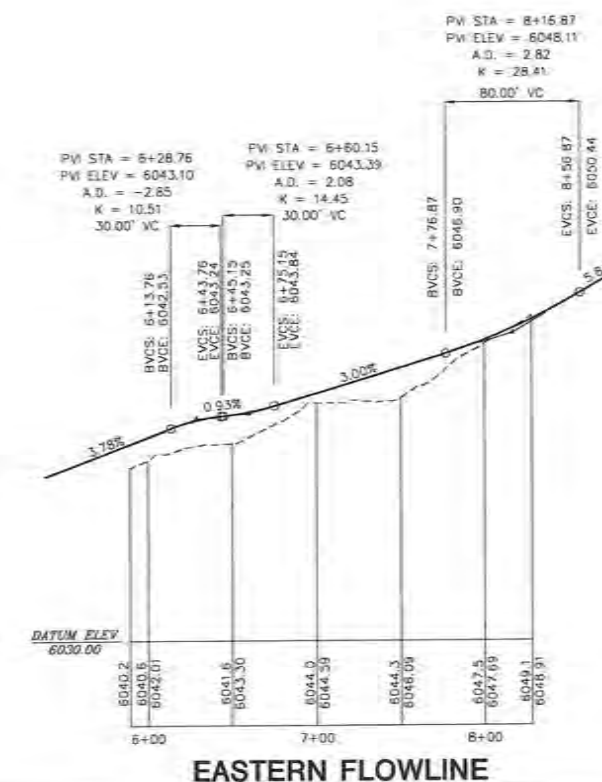
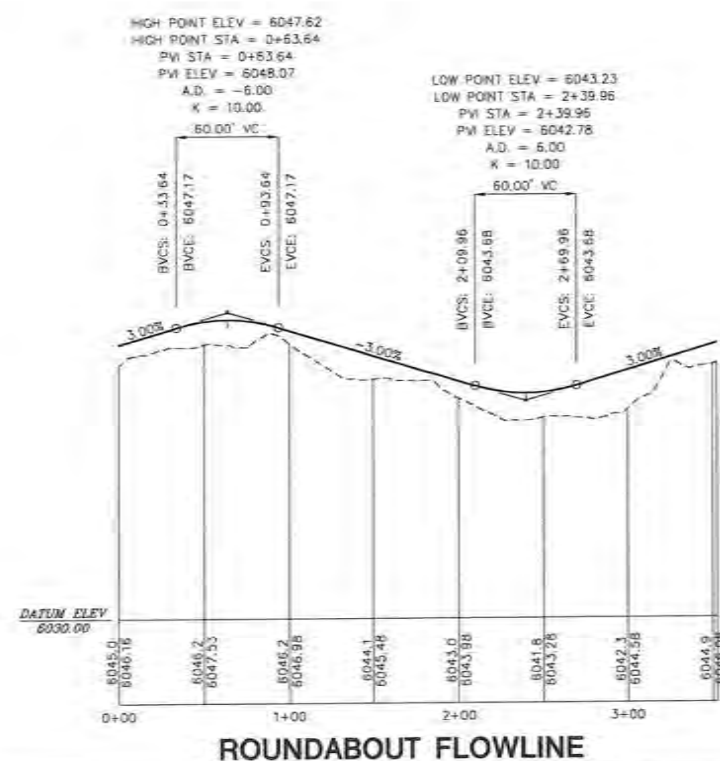
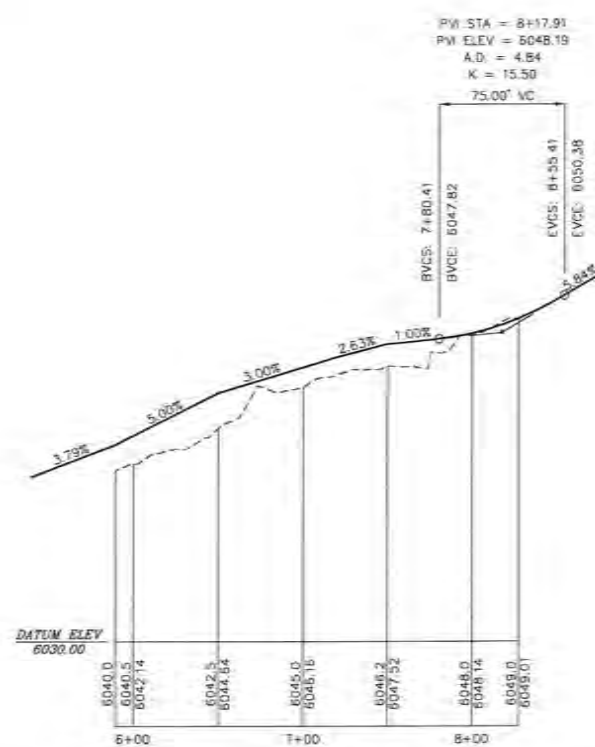
- EXISTING RIGHT-OF-WAY
- EXISTING FLOWLINE
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- EXISTING WALK
- EXISTING SANITARY SEWER
- EXISTING POTABLE WATER
- EXISTING UNDERGROUND UTILITY
- DEMO ASPHALT SAW CUT
- DEMO FLOWLINE
- DEMO EDGE OF CONCRETE
- DEMO WALK
- DEMO GUARDRAIL
- DEMO STRIPE
- DEMO ASPHALT REMOVAL
- DEMO TREE

REVISIONS	
By	Date
DESIGNED	AM
CHECKED	
NEW	07-DEMO
FILE	CD-MASTER
CITY OF GOLDEN	
2015 HERITAGE ROAD IMPROVEMENTS	
DEMOLITION PLAN	
TTG ENGINEERS, INC. Consulting Engineers	
JOB NO. 592-401	
SCALE 1"=20'	
2014-12-25	
SHEETS	SHEET
24	7



POINT	STATION	OFFSET	ELEVATION
1	6+81.05	165.50' R	51.23
2	6+81.05	71.81' R	48.53
3	6+79.11	58.89' R	48.59
4	6+81.88	45.00' R	48.51
5	7+00.30	55.00' R	48.46
6	7+06.75	54.58' R	48.66
7	7+07.80	53.58' R	48.70
8	7+00.30	80.70' R	48.15
9	7+00.30	165.30' R	51.38
10	7+00.30	45.00' L	44.98
11	6+81.14	45.00' L	44.39
12	6+74.73	44.60' L	44.20
13	6+73.88	46.41' L	44.20
14	6+81.19	80.56' L	45.70
15	7+01.28	61.36' L	45.32
16	7+03.04	48.84' L	45.07
17	7+50.29	41.3' R	47.74
18	7+49.88	1.47' L	47.52
19	7+51.28	2.51' L	47.52
20	7+46.08	4.81' R	47.18
21	7+46.83	4.81' R	47.18
22	7+42.90	5.20' R	48.03
23	7+54.17	6.95' R	48.02
24	6+13.68	5.00' R	43.01
25	6+29.18	3.05' R	43.32
26	6+31.06	5.87' R	43.36
27	6+30.47	11.47' R	43.47
28	6+13.46	6.97' R	43.14

NOTE:
ON THIS SHEET, STATIONING FOR:
FOR PLAN VIEW - IS CENTERLINE STATIONING.
FOR PROFILES - FLOWLINE STATIONING.

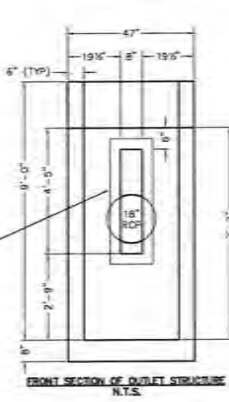
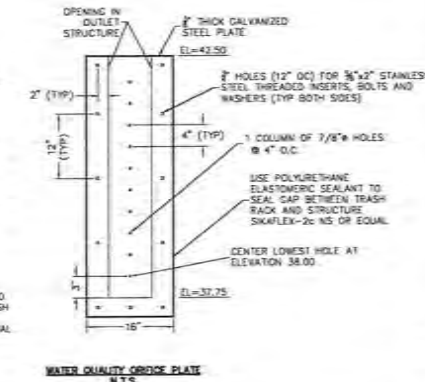
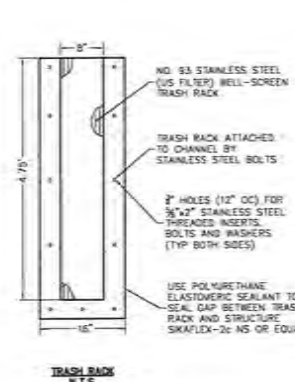
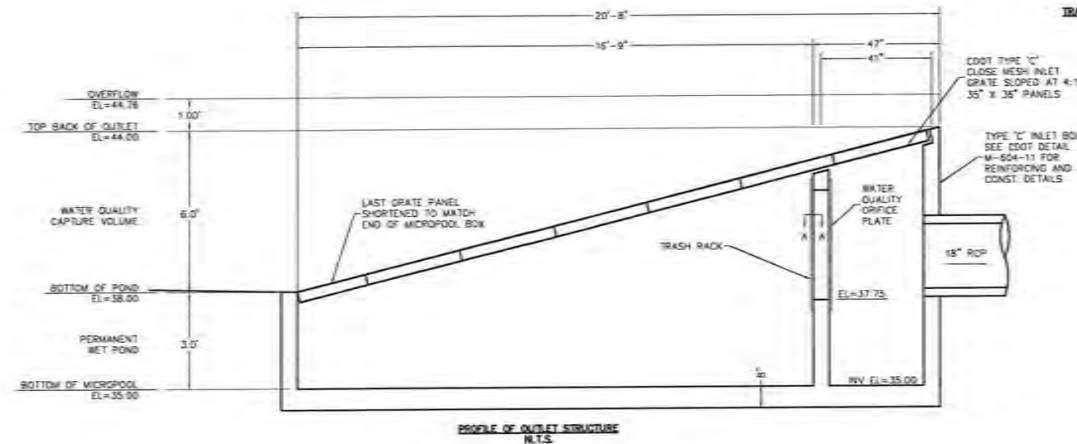
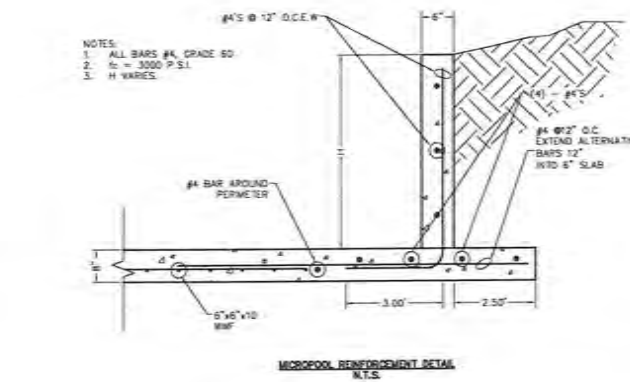
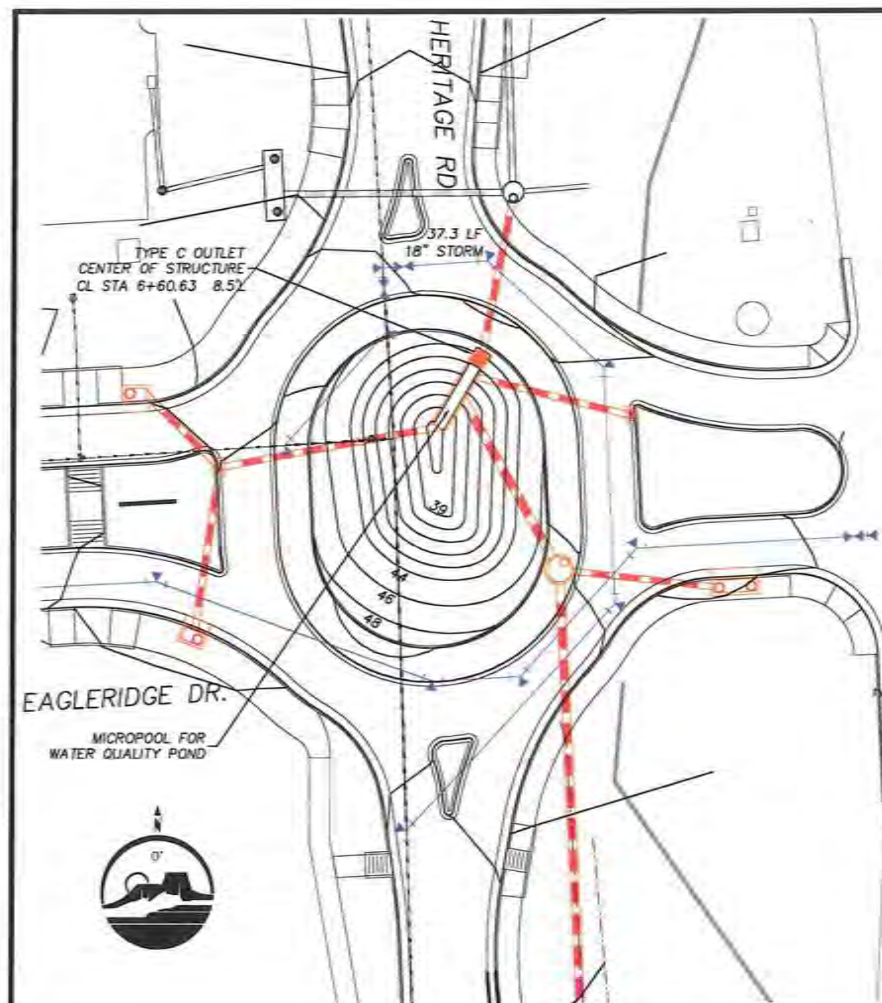


CITY OF GOLDEN
2015 HERITAGE ROAD IMPROVEMENTS
EAGLE RIDGE ROUNDABOUT

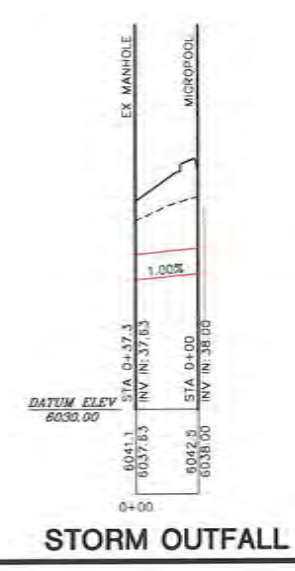
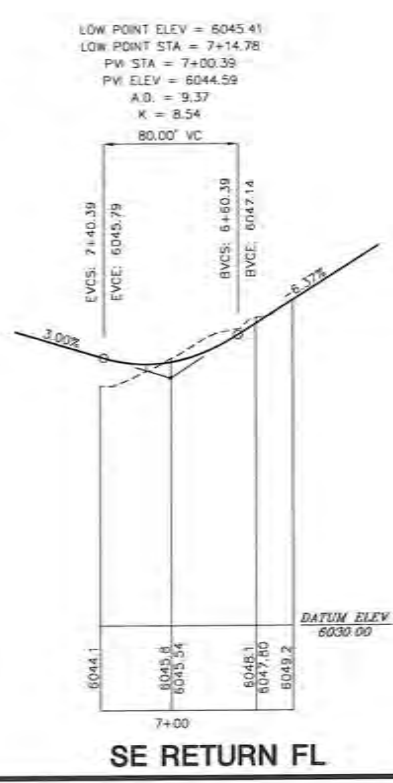
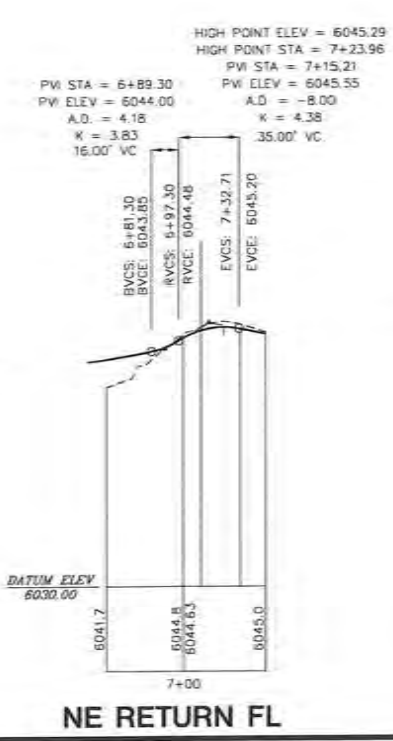
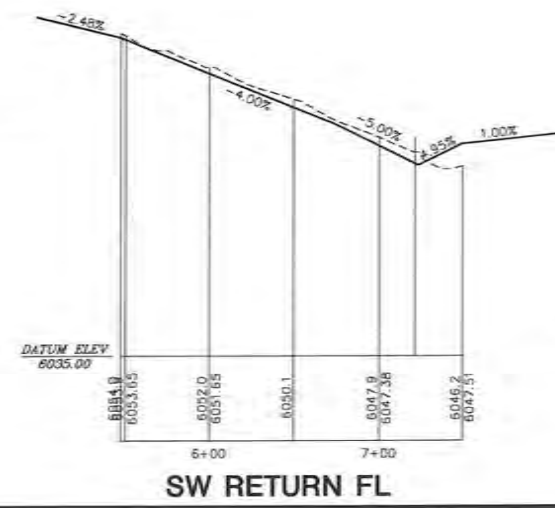
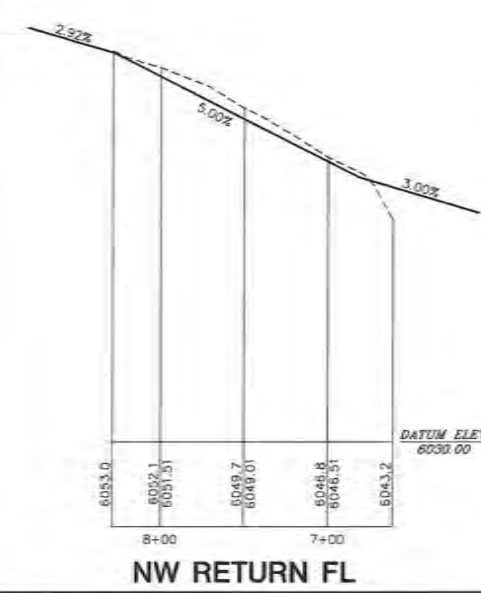


TTG
ENGINEERS, INC.
Consulting Engineers

ISS NO: 592-401
SCALE: 1"=20'
DATE: 2014-12-23
SHEET: 24 OF 8



RETURN PROFILES FOR EAGLE RIDGE - SEE SHEET 8

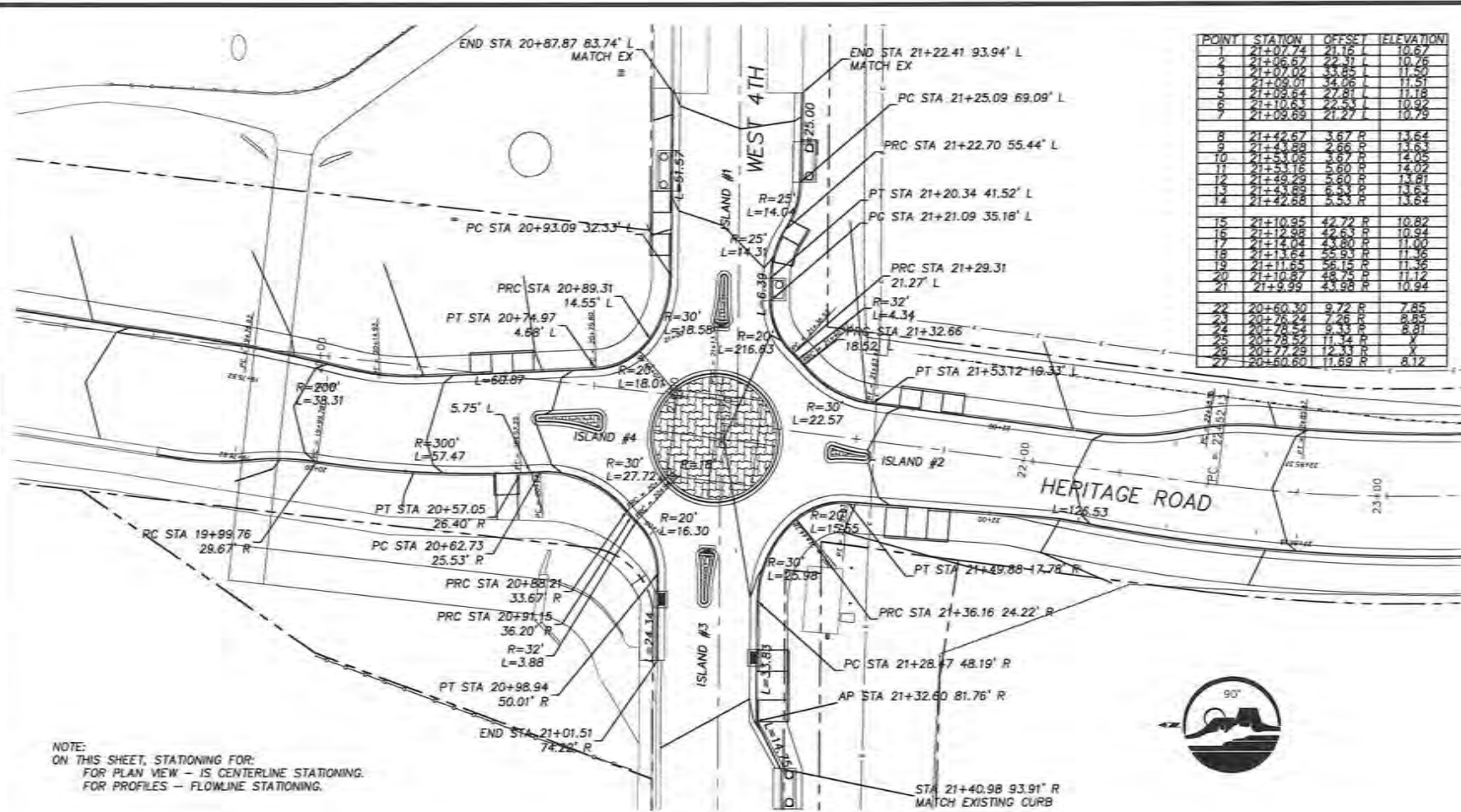


CITY OF GOLDEN
2015 HERITAGE ROAD IMPROVEMENTS
EAGLE RIDGE ROUNDABOUT

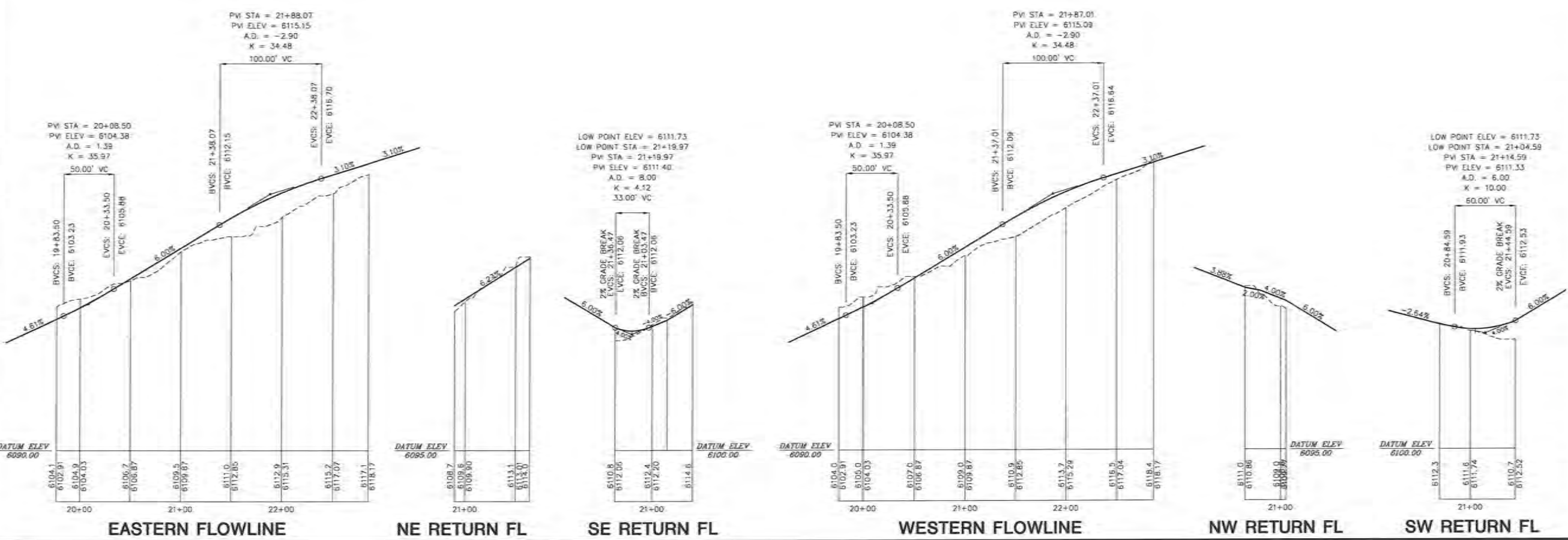
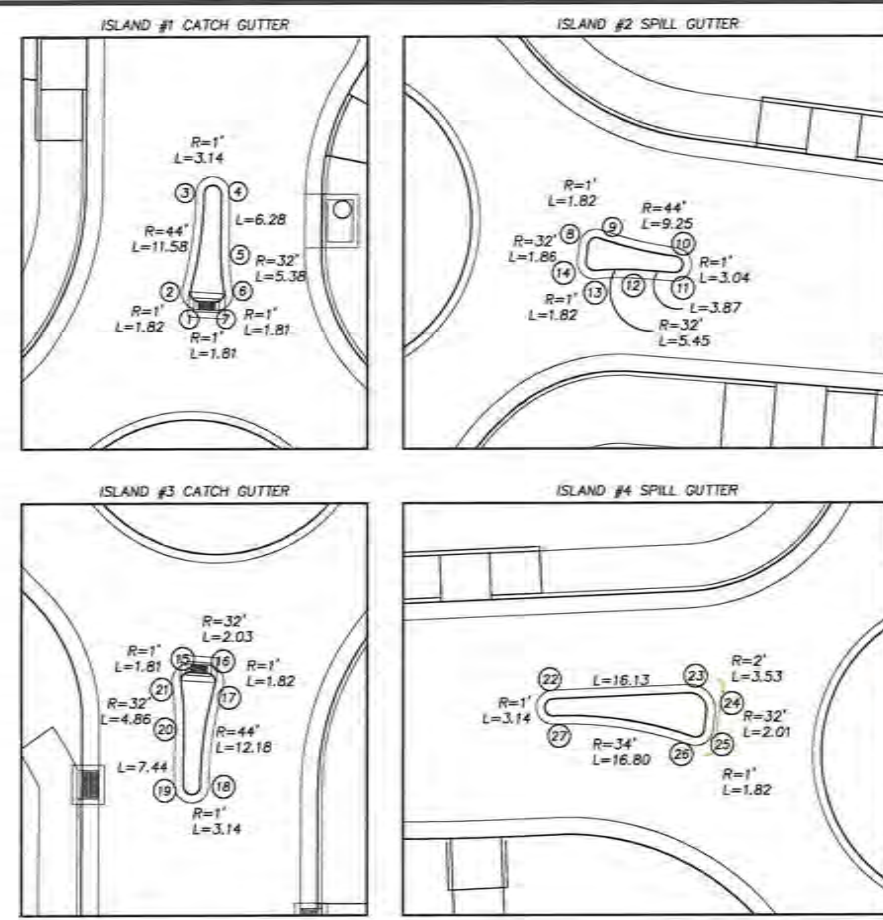


TTG
TTG ENGINEERS, INC.
Consulting Engineers

JOB NO. 592-401
SCALE 1"=20'
2014-12-25
SHEET 24 OF 9



POINT	STATION	OFFSET	ELEVATION
1	21+07.74	21.16	10.67
2	21+06.57	22.31	10.76
3	21+02.02	33.65	11.51
4	21+02.02	33.65	11.51
5	21+03.64	27.81	11.18
6	21+10.63	22.53	10.92
7	21+09.69	21.27	10.79
8	21+42.67	3.67	13.64
9	21+43.88	2.86	13.63
10	21+43.18	2.87	14.09
11	21+49.29	5.80	14.02
12	21+49.29	5.80	13.81
13	21+43.88	6.53	13.63
14	21+42.68	5.53	13.64
15	21+10.35	42.72	10.82
16	21+12.88	42.63	10.94
17	21+14.04	43.80	11.00
18	21+13.64	55.93	11.36
19	21+11.55	56.15	11.48
20	21+10.87	48.75	11.12
21	21+9.99	43.98	10.94
22	20+60.30	9.72	7.85
23	20+76.24	7.26	8.85
24	20+78.54	6.31	8.81
25	20+78.54	11.34	8.81
26	20+77.28	12.31	8.7
27	20+60.60	11.69	8.12



DESIGNED

DATE

BY

CHECKED

DATE

BY

VIEW

FILE

CD-MASTER

COLORADO REGISTERED

26753

2-25-14

PAUL W. MANNING

CIVIL ENGINEER

CITY OF GOLDEN

2015 HERITAGE ROAD IMPROVEMENTS

4TH ROUNDABOUT

TTG

TTG ENGINEERS, INC.

Consulting Engineers

JOB NO.

552-401

SCALE

1"=20'

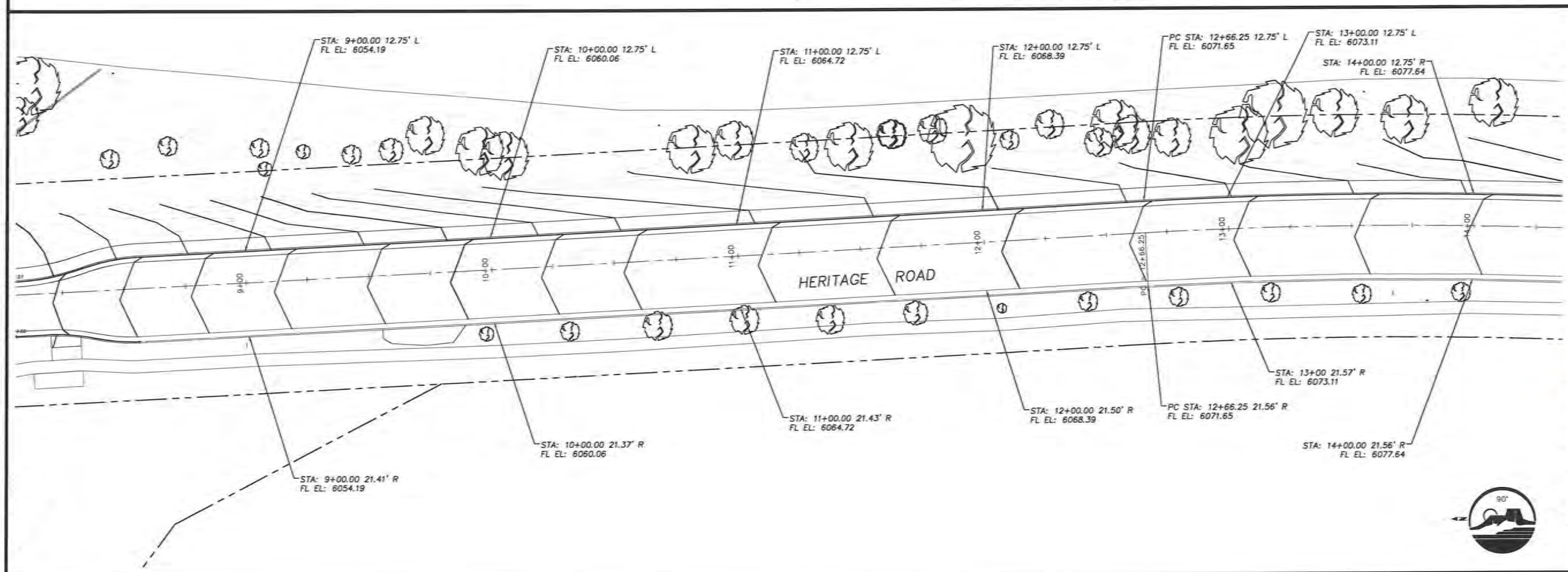
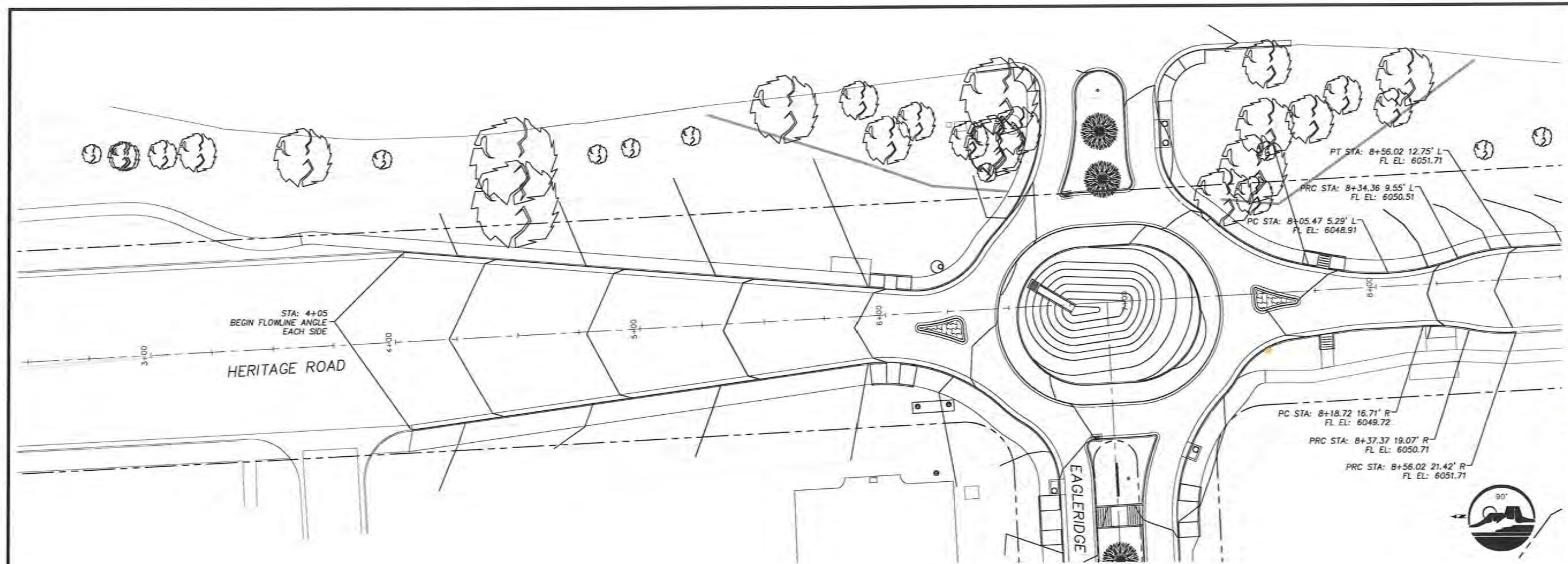
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2014-12-25

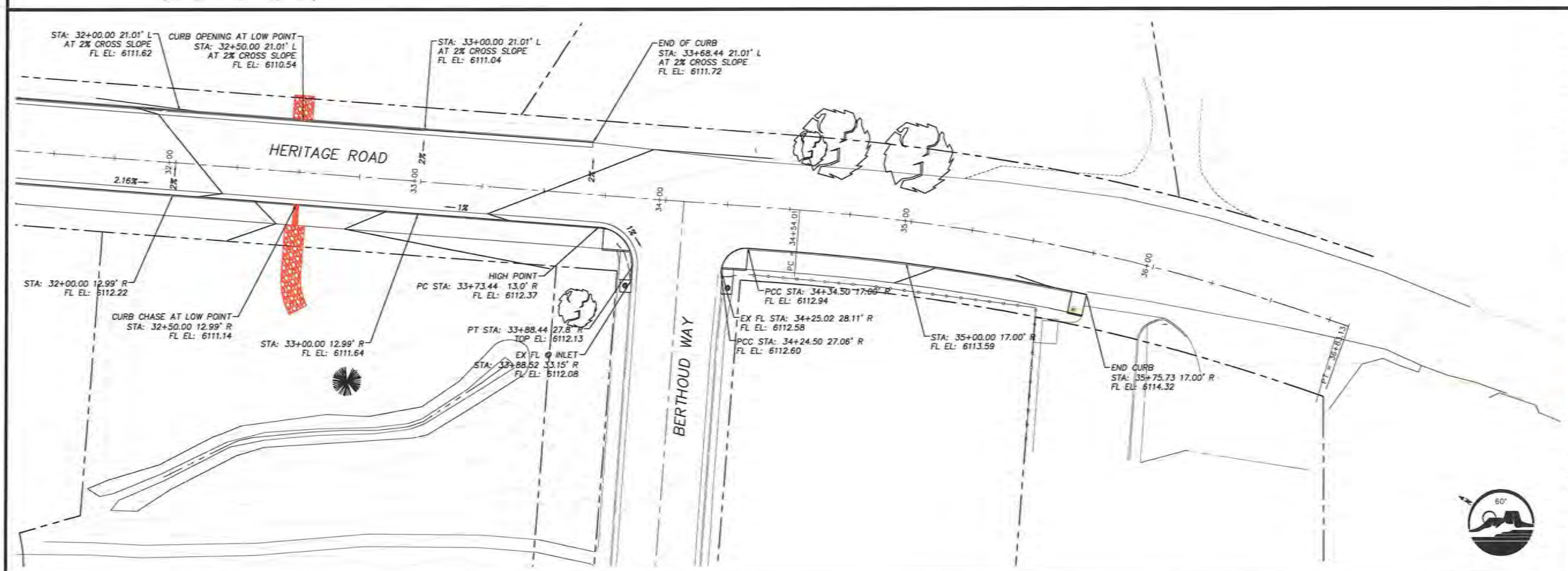
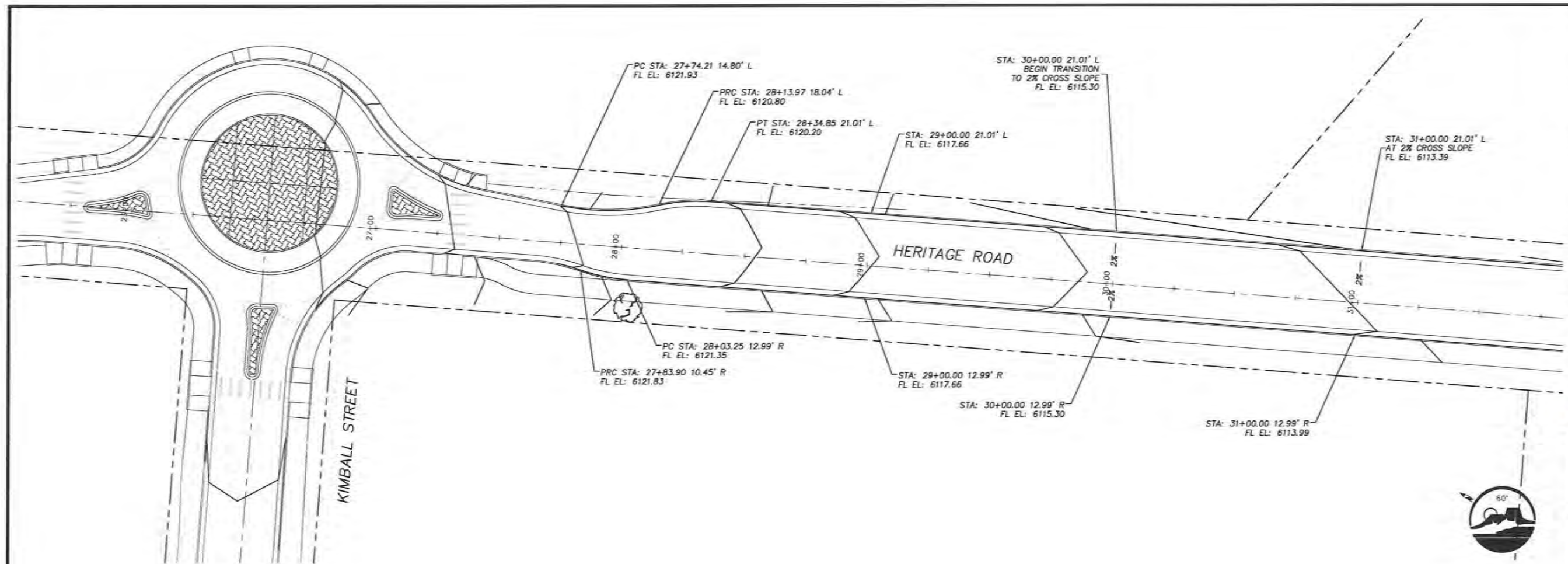
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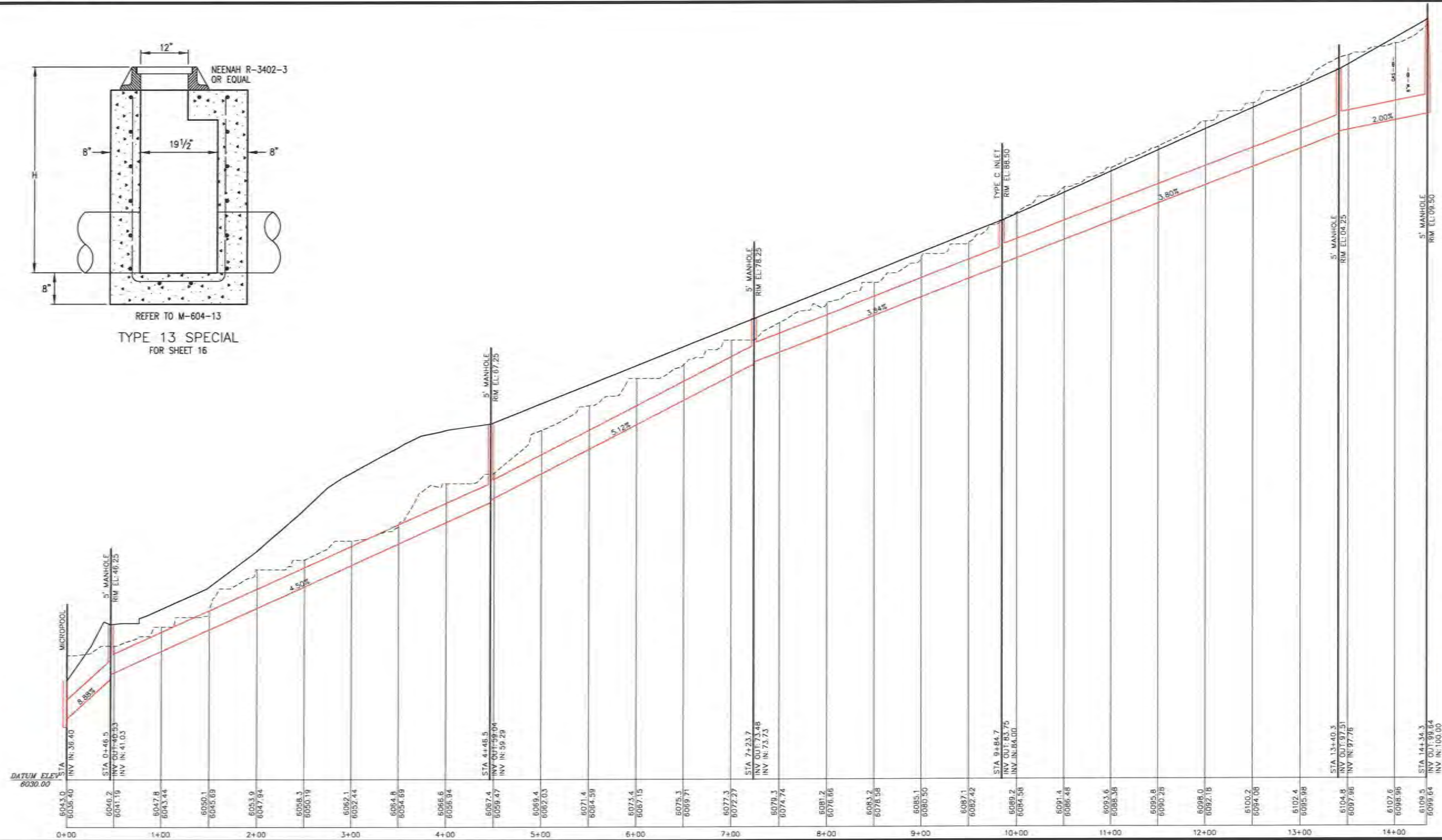
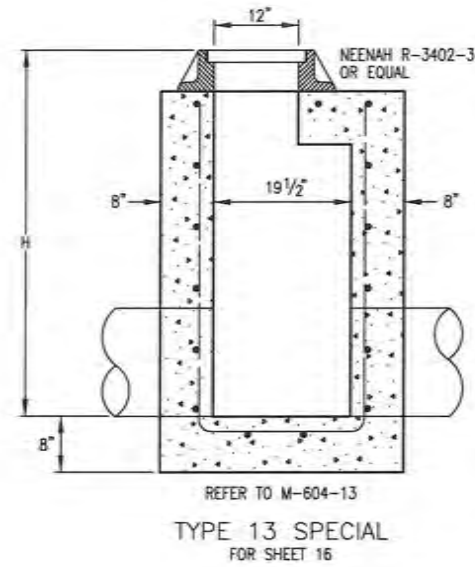
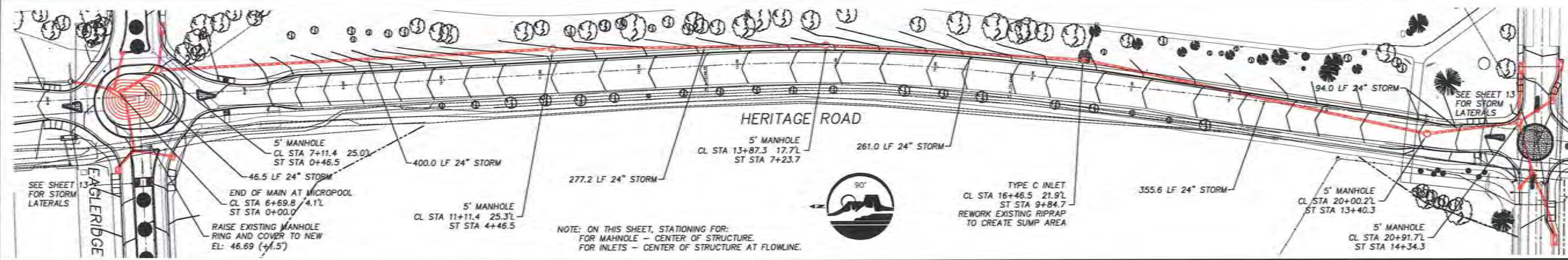
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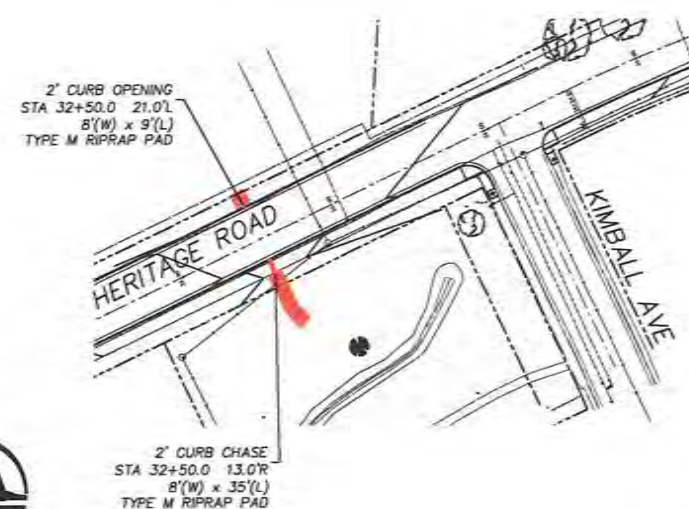
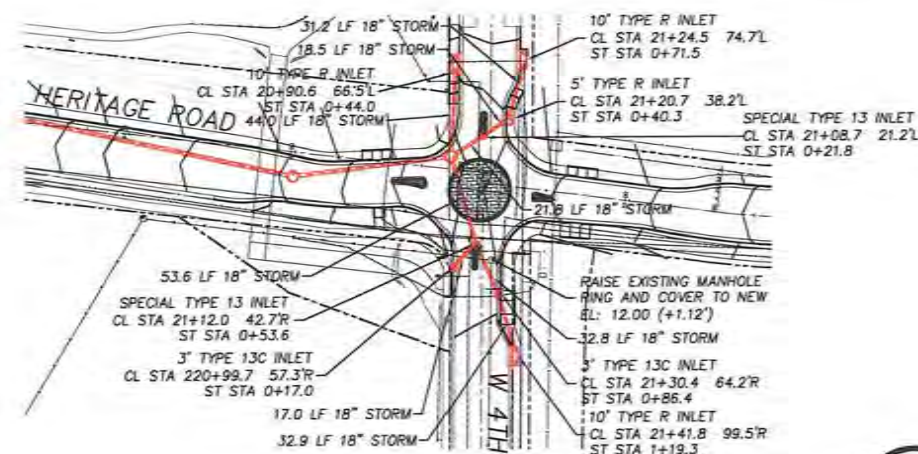
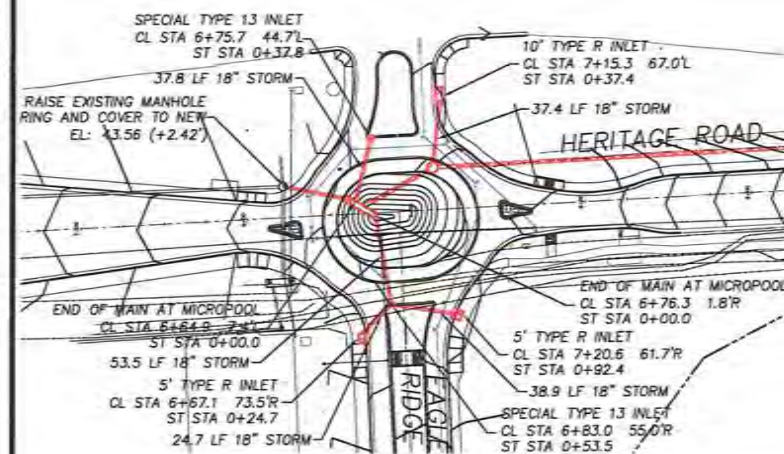
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FILE	CD-MASTER
CITY OF GOLDEN 2015 HERITAGE ROAD IMPROVEMENTS HERITAGE ROAD - STRIPED BIKE LANES	
TTG ENGINEERS, INC. Consulting Engineers	
JOB NO.	592-401
SCALE	1"=20'
2014-12-25	
SHEET NO.	24
SHEET	12



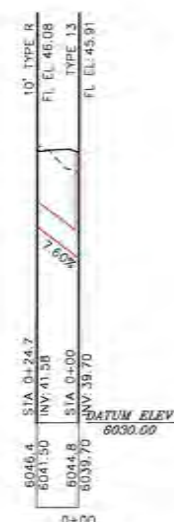
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CITY OF GOLDEN 2015 HERITAGE ROAD IMPROVEMENTS HERITAGE ROAD - STRIPED BIKE LANES		
 TTG TTG ENGINEERS, INC. Consulting Engineers		
JOB NO: 592-401 SCALE: 1"=20' 2014-12-25 SHEET: 24 OF 14		



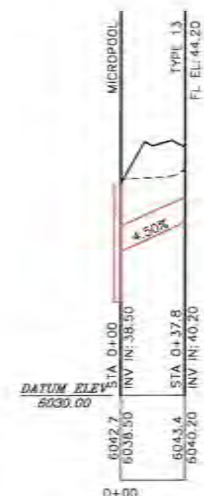
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FILE: CD-MASTER	
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 TTG ENGINEERS, INC. Consulting Engineers	
JOB NO: 592-401 SCALE: 1"=50' DATE: 2014-12-25	
SHEETS: 24	SHEET: 15



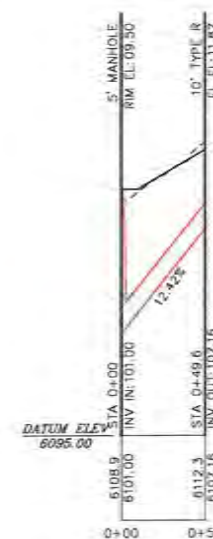
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FOR MANHOLE - CENTER OF STRUCTURE
FOR INLETS - CENTER OF STRUCTURE AT FLOWLINE



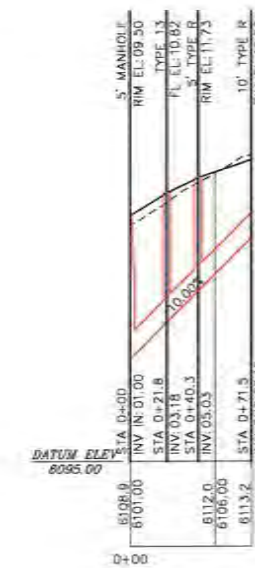
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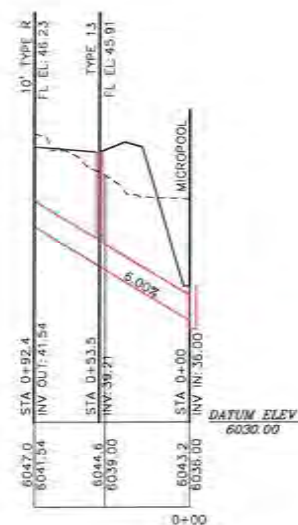
NE EAGLE RIDGE



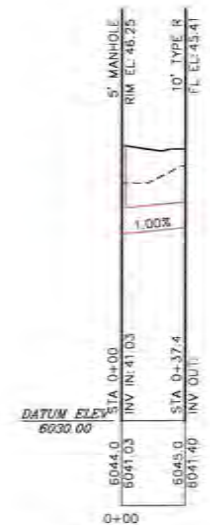
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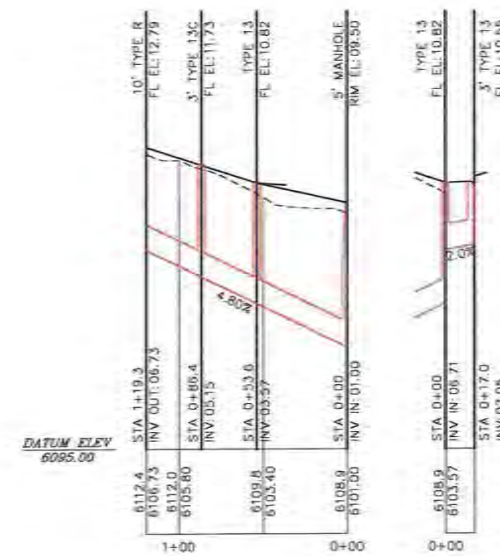
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SW EAGLE RIDGE



SE EAGLE RIDGE



SW 4TH

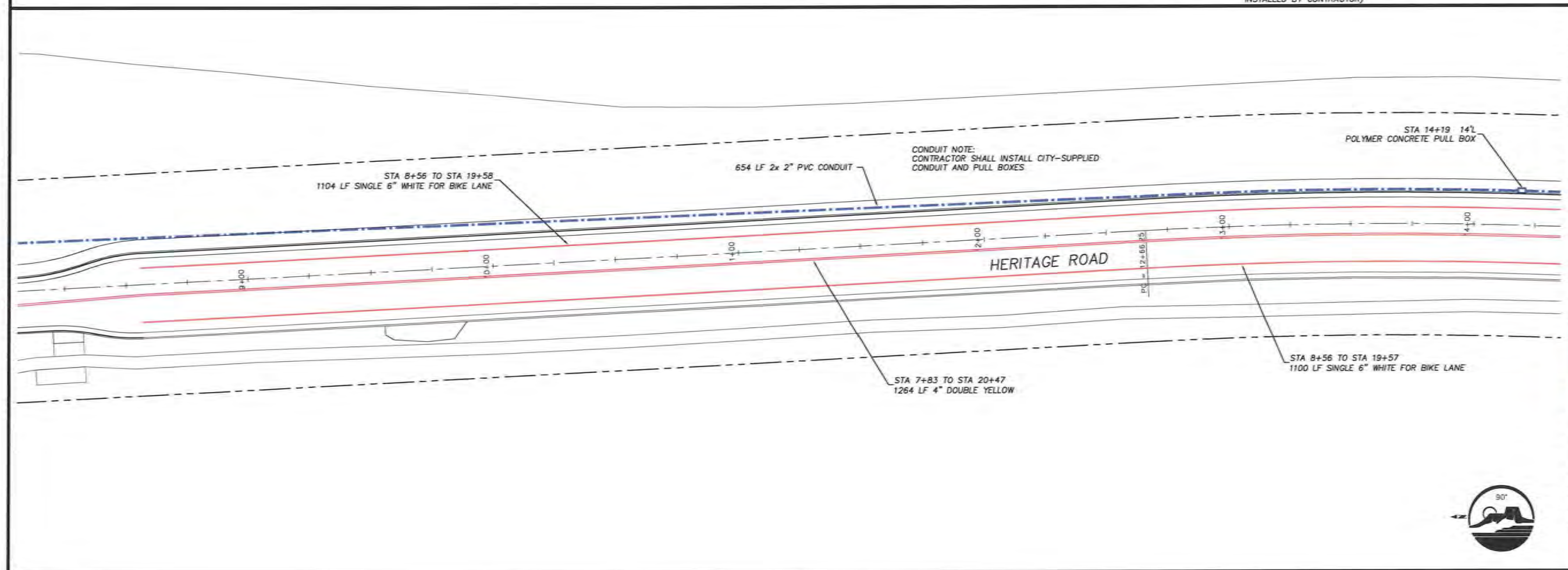
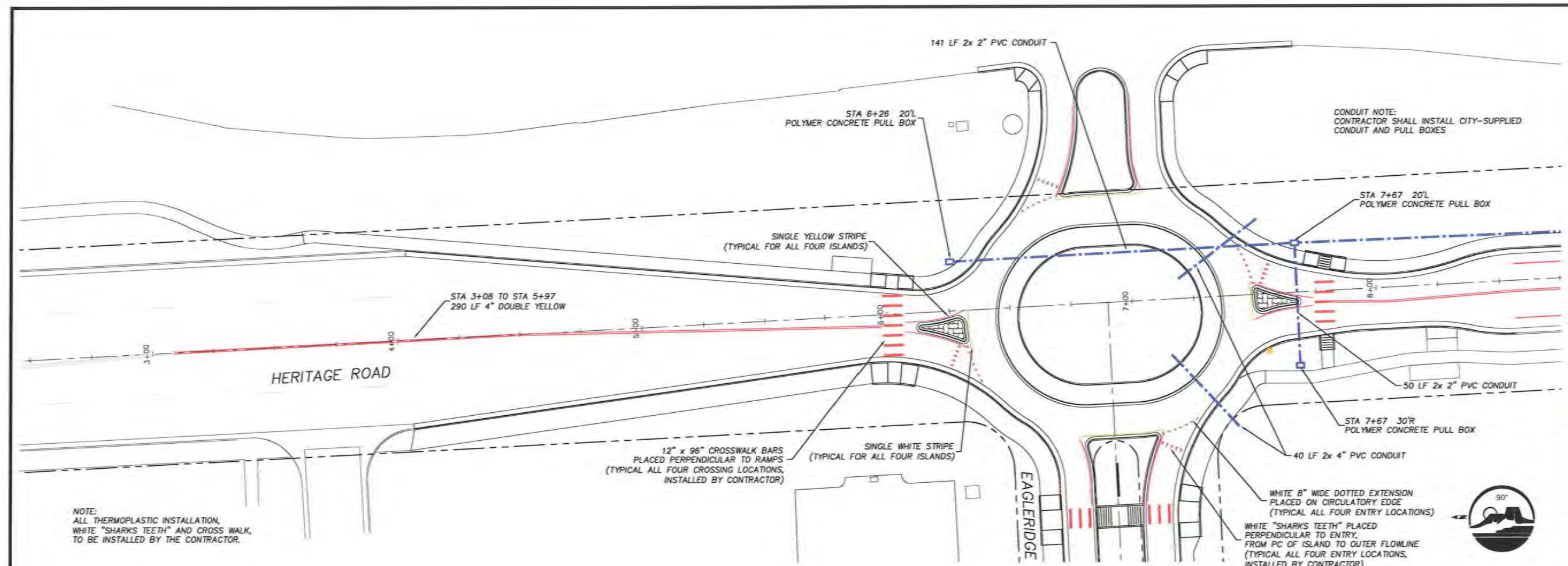


CITY OF GOLDEN
2015 HERITAGE ROAD IMPROVEMENTS
STORM SEWER LATERALS

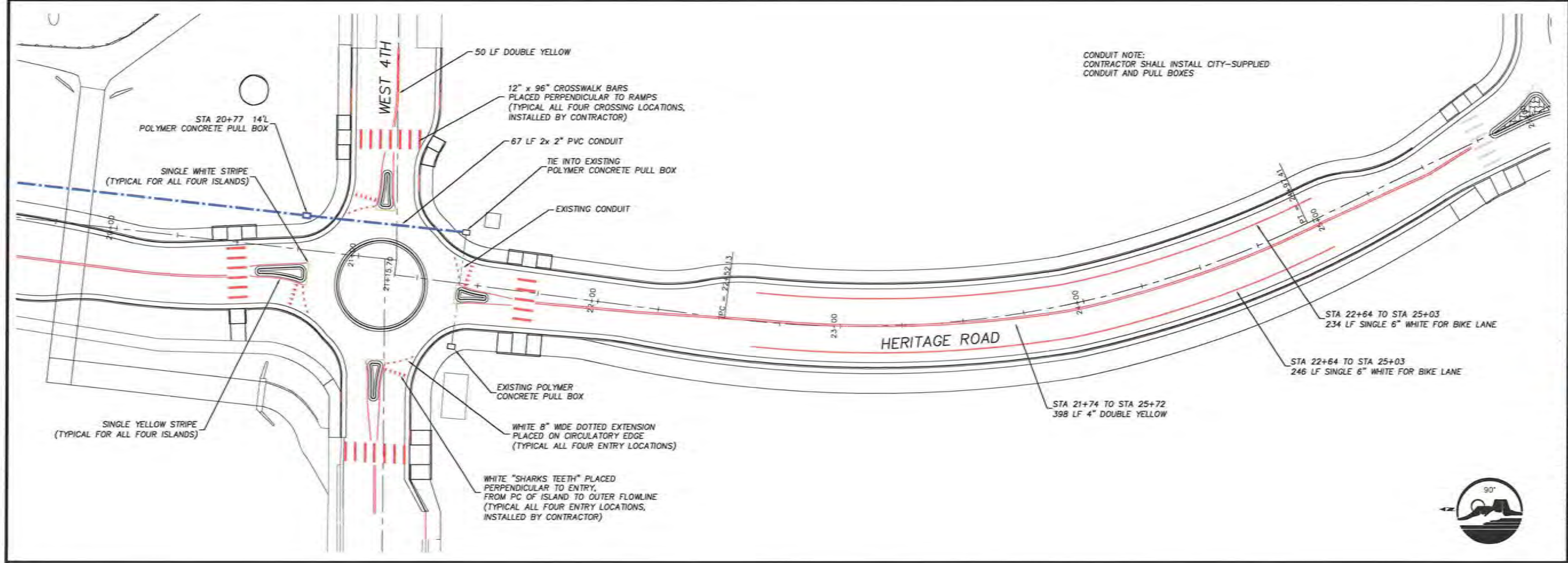
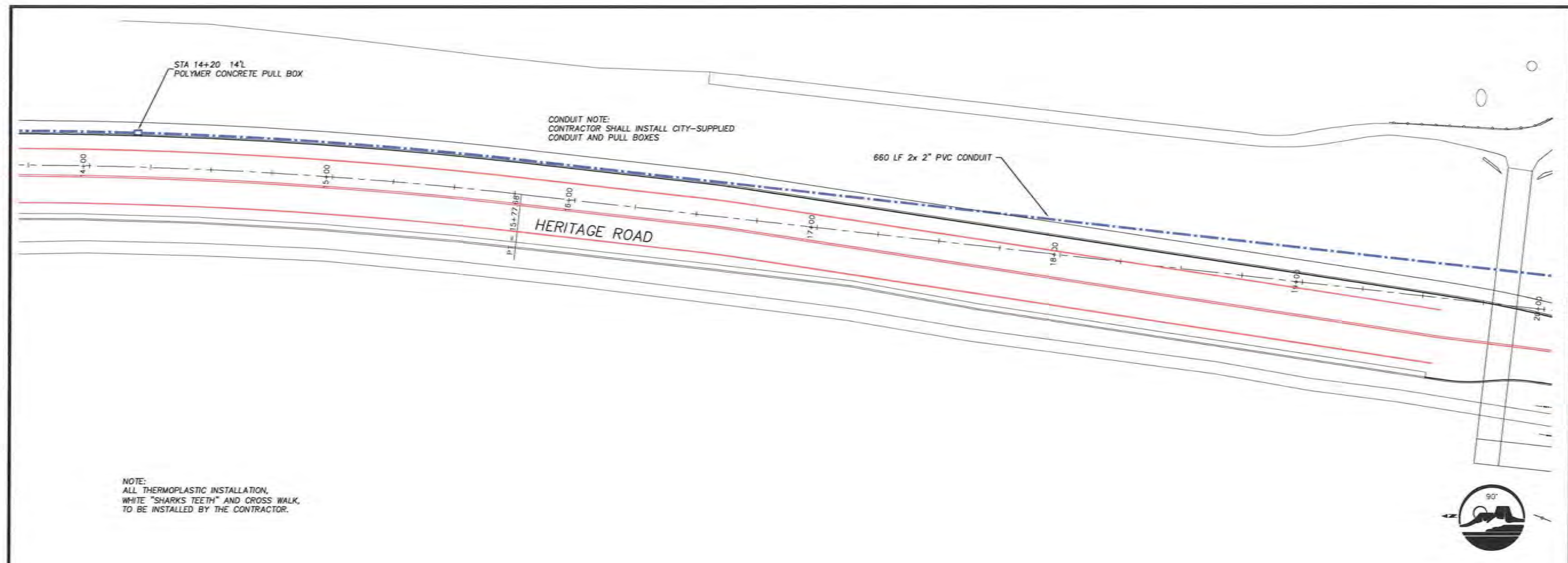


TTG
TTG ENGINEERS, INC.
Consulting Engineers

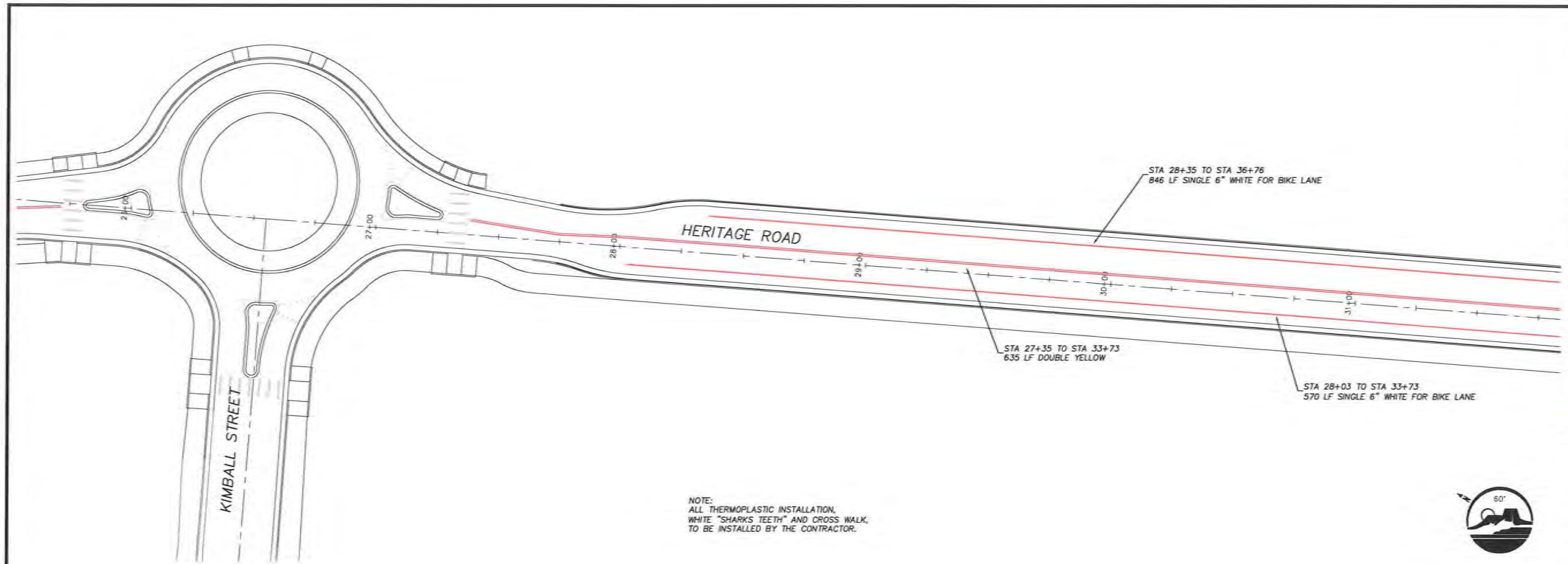
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DATE	2014-12-25
SHEET	24
TOTAL SHEETS	16



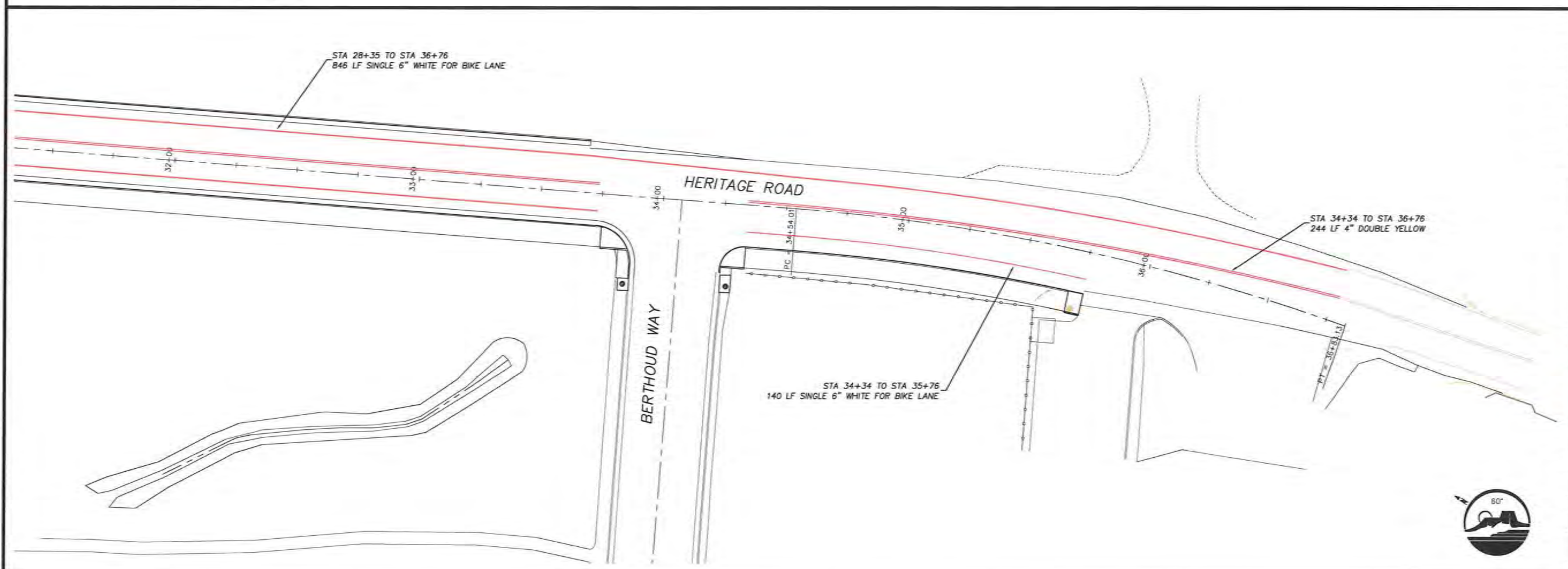
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<p>TTG ENGINEERS, INC. Consulting Engineers</p>	
JOB NO.	592-401
SCALE	1"=20'
2014-12-25	
SHEETS	SHEET
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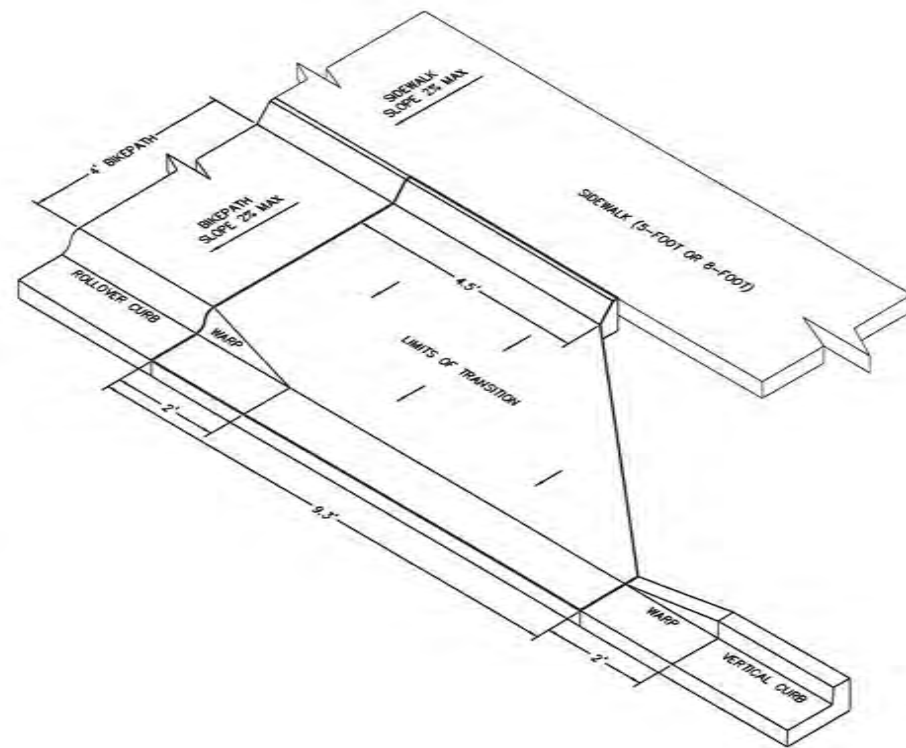
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TTG TTG ENGINEERS, INC. Consulting Engineers	
JOB NO.	592-401
SCALE	1"=20'
2014-12-25	
SHEETS	SHEET
24	18



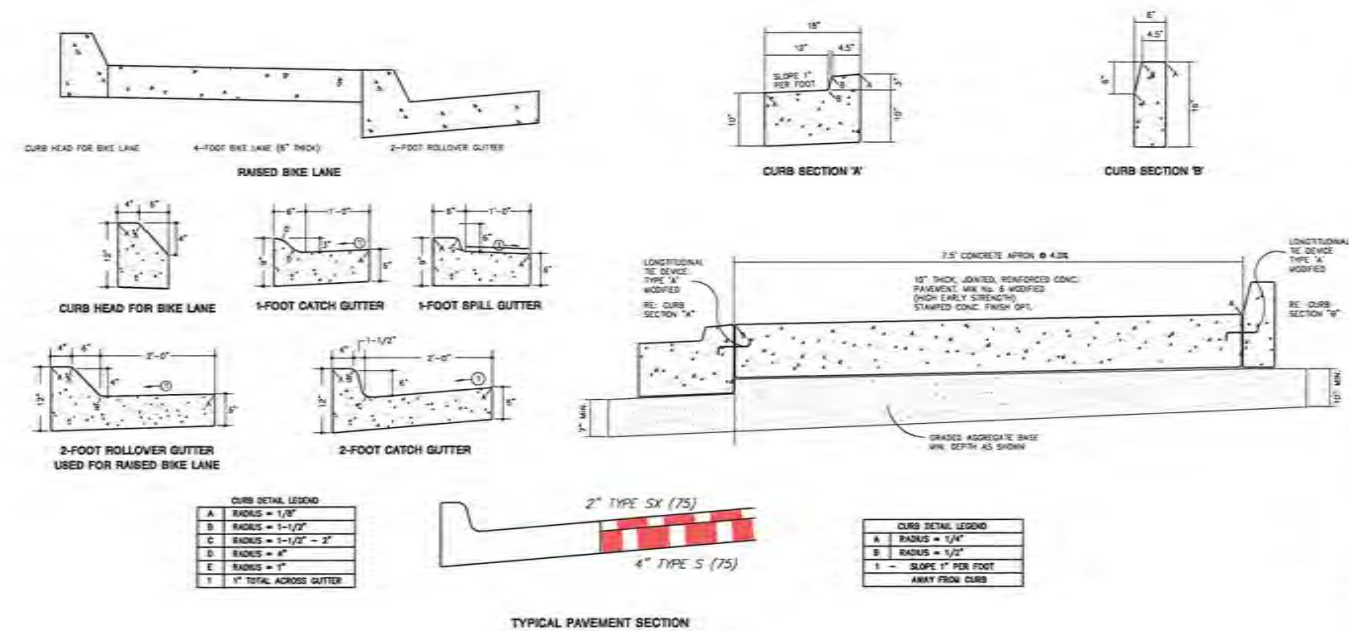
NOTE:
ALL THERMOPLASTIC INSTALLATION,
WHITE "SHARKS TEETH" AND CROSS WALK,
TO BE INSTALLED BY THE CONTRACTOR.



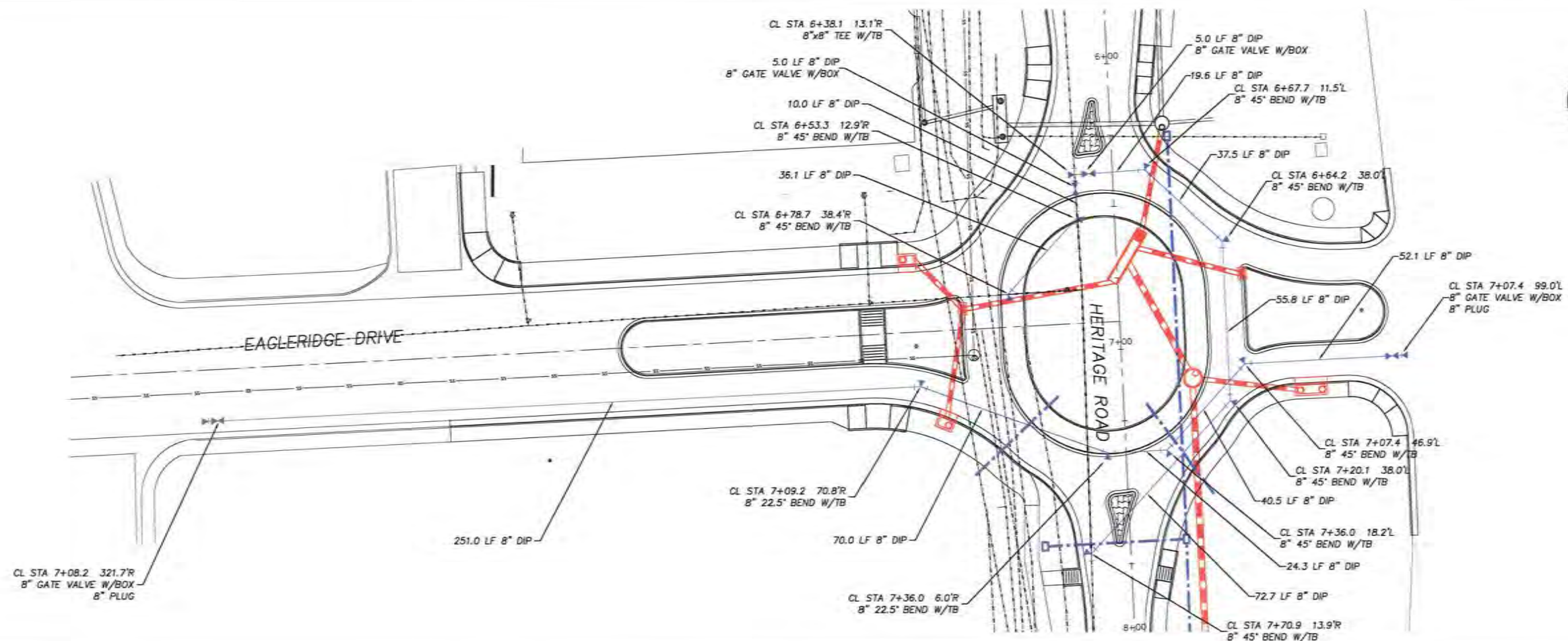
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FILE	CD-MASTER
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TTG ENGINEERS, INC. Consulting Engineers	
JOB NO. 592-401	
SCALE 1"=20'	
2014-12-25	
SHEETS 24	SHEET 19



ALTERNATE RAISED BIKE LANE TRANSITION DETAIL



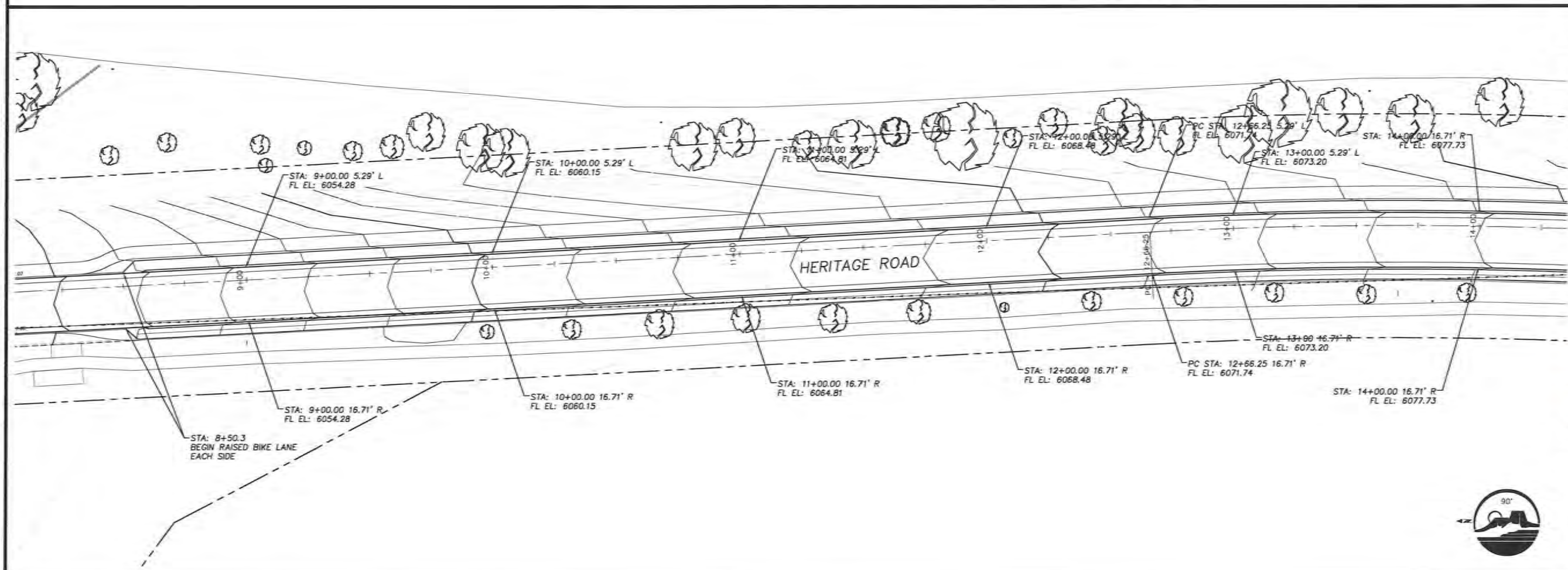
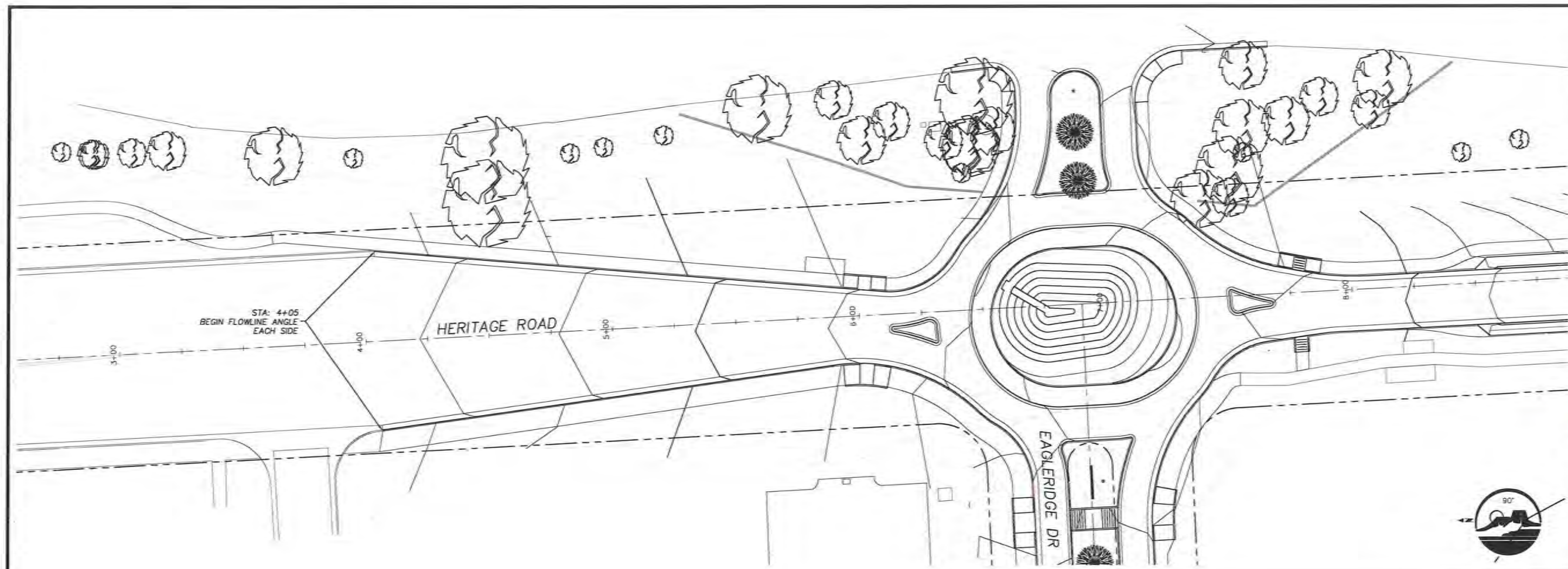
CURB, GUTTER, RAISED BIKE LANE AND APRON DETAIL



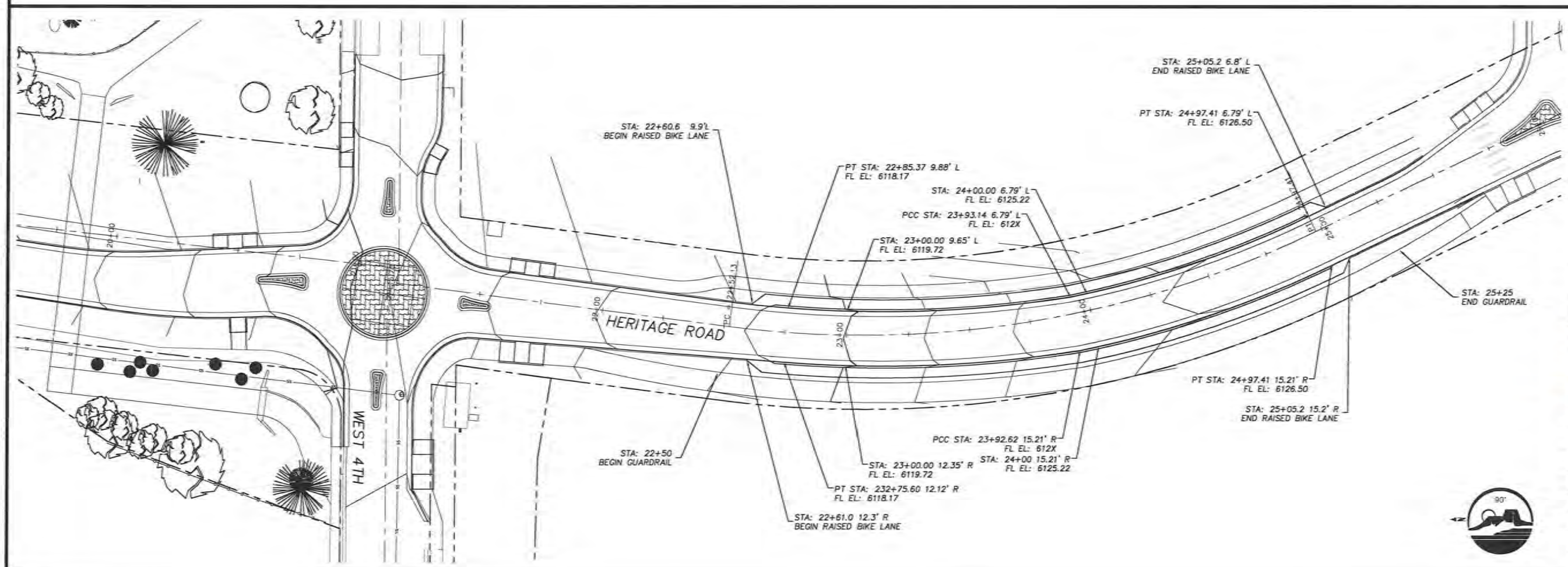
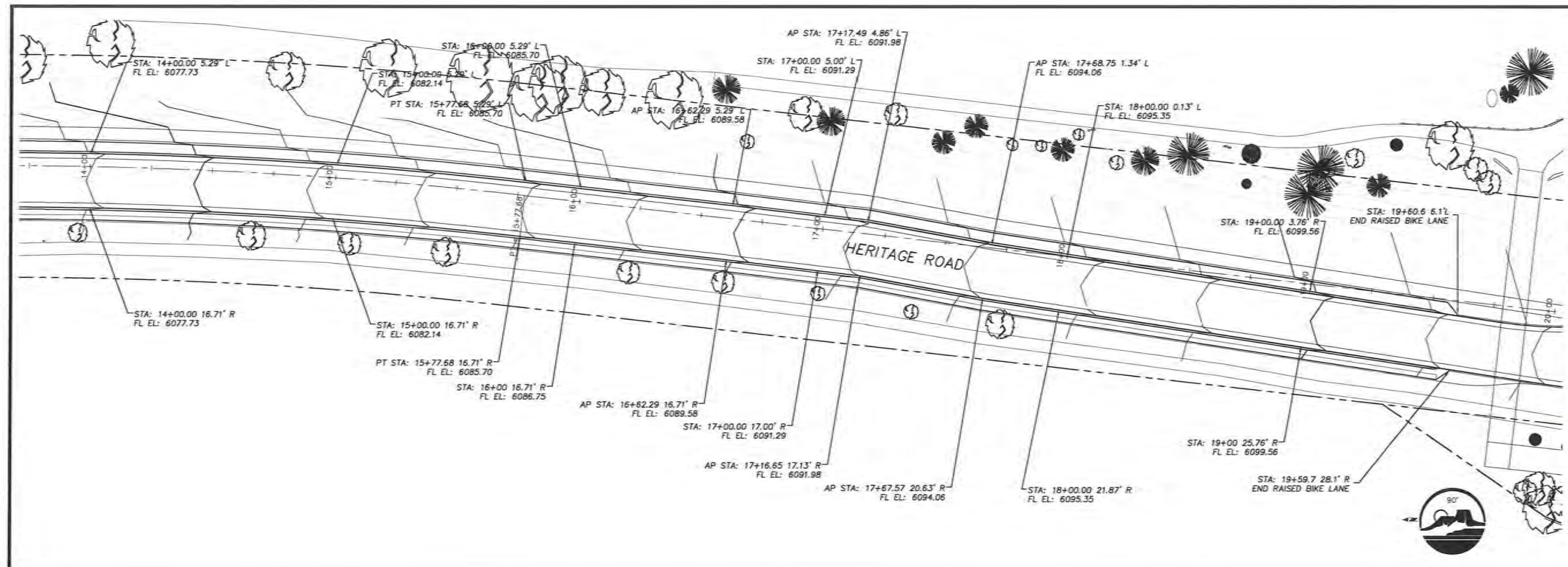
CITY OF GOLDEN
2015 HERITAGE ROAD IMPROVEMENTS
DETAILS AND WATERLINE



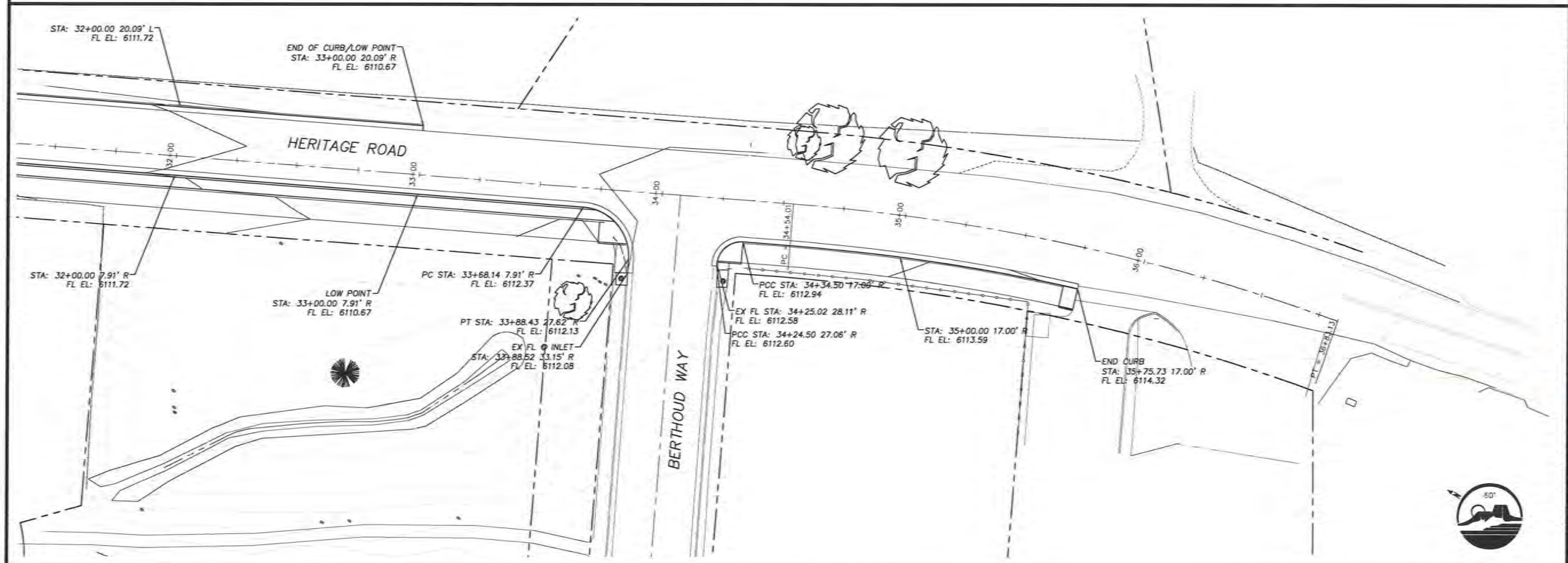
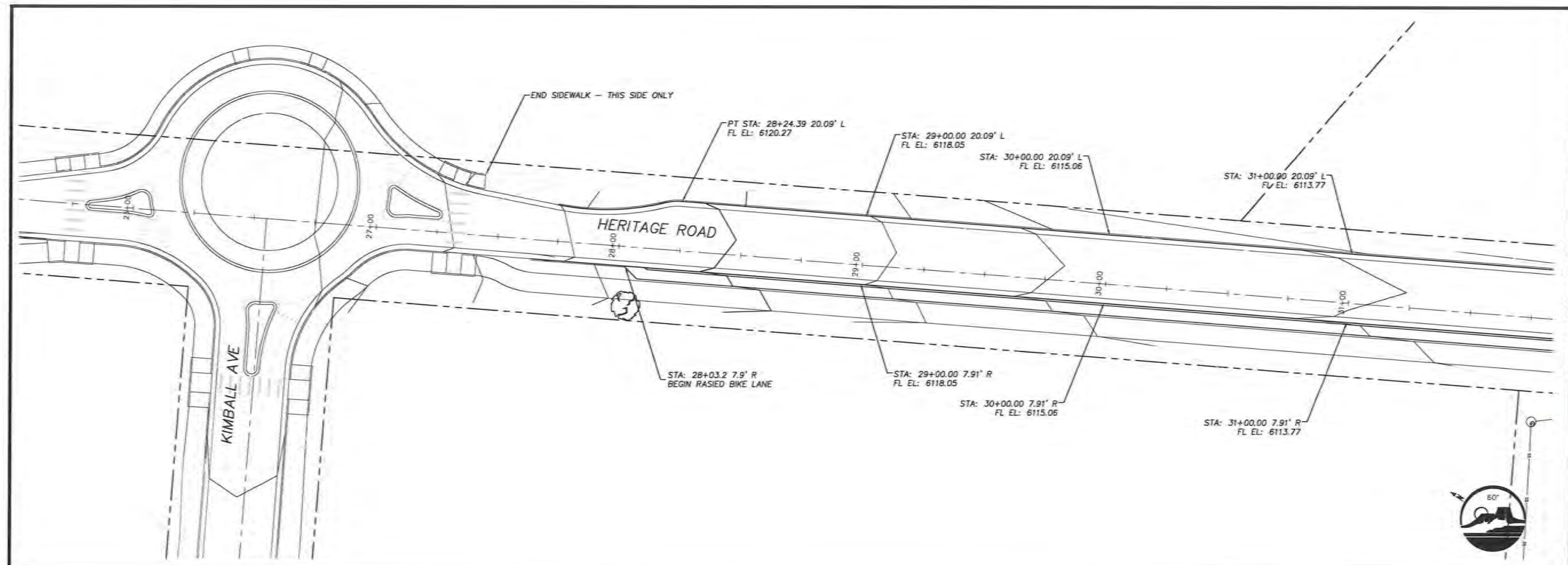
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2014-12-25
SHEETS 24 20



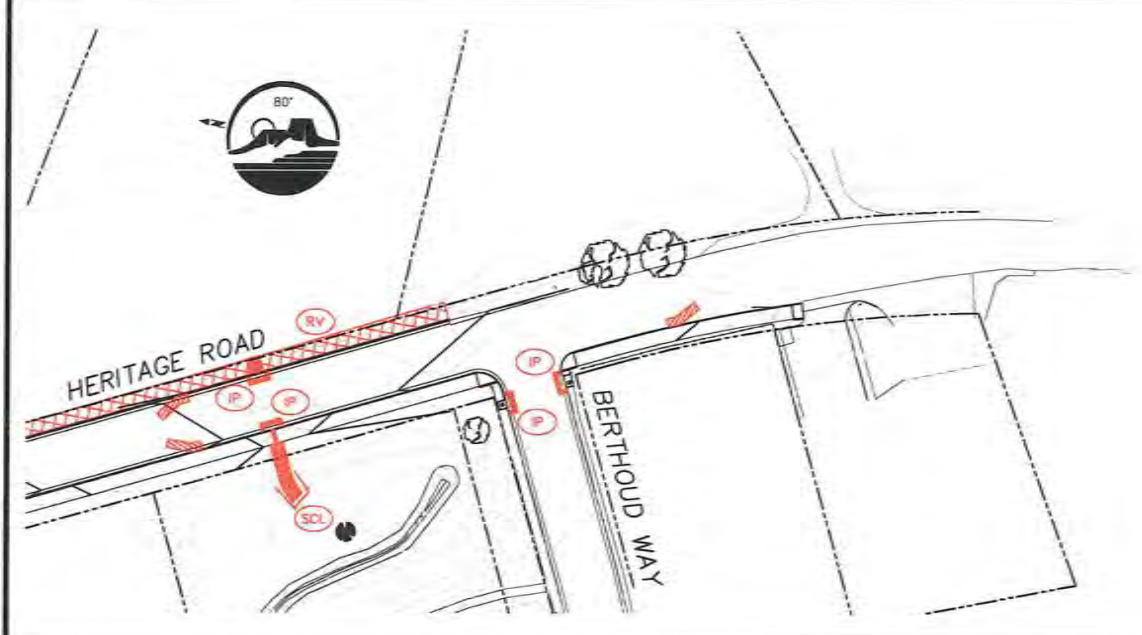
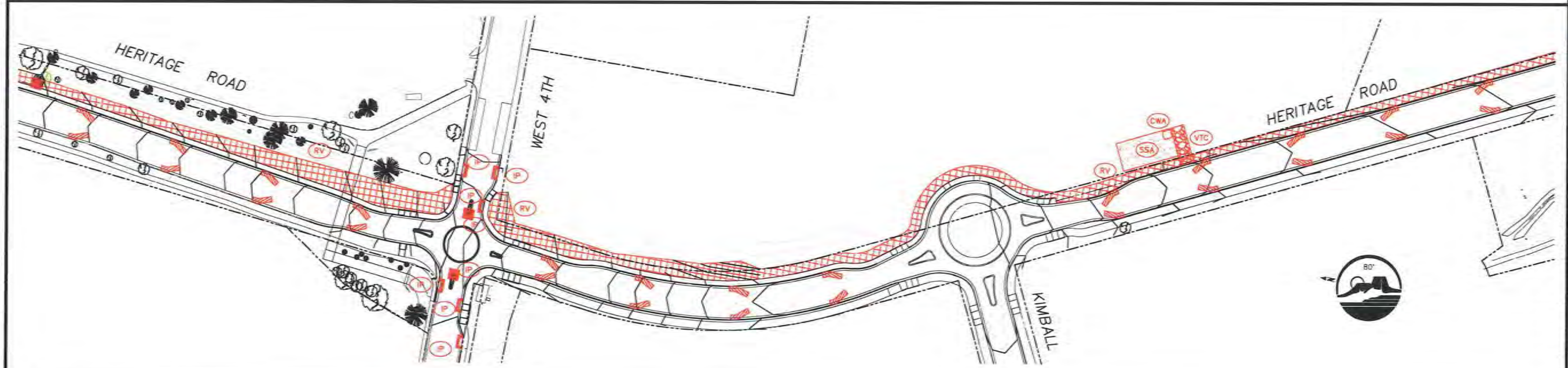
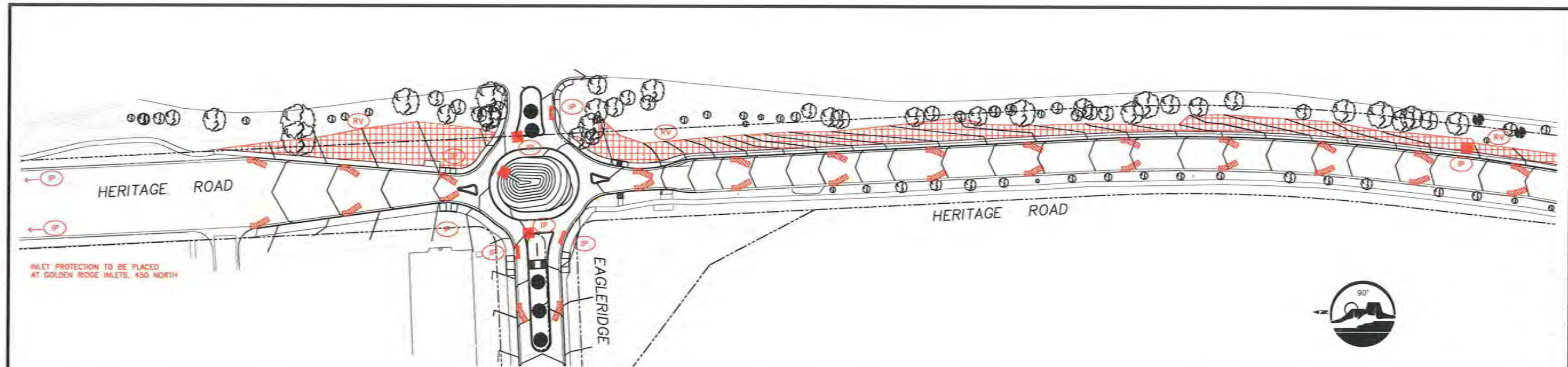
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DATE	
BY	
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CD-MASTER	
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TTG ENGINEERS, INC. Consulting Engineers	
JOB NO.	592-401
SCALE	1"=20'
2014-12-25	
SHEETS	SHEET
24	21



DESIGNED: MM	
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SSN NO: 592-401 SCALE: 1"=20' 2014-12-25	
SHEETS	SHEET
24	22



REVISIONS	
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DESIGNED	WJM
CHECKED	
VIEW	14-HERITAGE
FILE	CD-MASTER
CITY OF GOLDEN 2015 HERITAGE ROAD IMPROVEMENTS ALTERNATE - RAISED BIKE LANES	
JOB NO: 592-401 SCALE: 1"=20' 2014-12-25	
SHEETS	SHEET
24	23



1. THE CONTRACTOR SHALL ENSURE STORM WATER QUALITY BEST MANAGEMENT PRACTICES SHALL BE IMPLEMENTED TO MINIMIZE SOIL EROSION, SEDIMENTATION, INCREASED POLLUTANT LOADS AND CHANGED WATER FLOW CHARACTERISTICS RESULTING FROM LAND DISTURBING ACTIVITY, TO THE MAXIMUM EXTENT PRACTICABLE, SO AS TO MINIMIZE POLLUTION OF RECEIVING WATERS.
2. THE CONTRACTOR SHALL FOLLOW ALL OF THE NOTES ON THE COVER SHEET.
3. EROSION CONTROL MEASURES FOR THIS PROJECT SHALL BE, AT A MINIMUM:
 - INLET PROTECTION FOR EXISTING DOWNSTREAM INLETS AND AFTER THE INSTALLATION OF NEW INLETS.
 - CURB SOCKS PLACED IN THE CURB AND GUTTER AT ONE HUNDRED FOOT (100') MAXIMUM SPACING, EACH SIDE OF STREET.
 - WATTLES PLACED ON THE NORTHERLY EDGE OF THE PROJECT AND DOWNHILL SIDE OF ALL STOCKPILES.
 - VEHICLE TRACKING CONTROL AT ANY ACCESS TO OPENED SUBGRADE.
 - A STABILIZED STAGING AREA. LOCATION SHOWN ON PLAN IS FOR REFERENCE. CONTRACTOR SHALL ESTABLISH LOCATION OF STABILIZED STAGN AREA.
 - ALL AREAS THAT INDICATE REVEGETATION (RV) SHALL BE SEEDED AND COVERED IN AN EROSION CONTROL BLANKET, BY THE CITY. FOR THESE AREAS NOT SLATED TO BE HARDESCAPED, THE CONTRACTOR SHALL BE RESPONSIBLE TO SET SUBGRADE, SIX INCHES (6") BELOW FINAL GRADE AS SHOWN. THE CITY WILL PROVIDE TOPSOIL AND REVEGETATION EFFORTS.

BMP LEGEND

	CWA	CONCRETE WASHOUT AREA
	CS	CURB SOCK
	IP	INLET PROTECTION
	OP	OUTLET PROTECTION
	RV	REVEGETATION
	SCL	SEDIMENT CONTROL LOG
	SSA	STABILIZED STAGING AREA
	VTC	VEHICLE TRACKING CONTROL

DESIGNED: RM CHECKED: VER: 24-SWMP FILE: CD-MASTER	
CITY OF GOLDEN 2015 HERITAGE ROAD IMPROVEMENTS STORMWATER MANAGEMENT PLAN	
 TTG ENGINEERS, INC. Consulting Engineers	
JOB NO: 592-401 SCALE: 1"=50' 2014-12-25	
SHEETS: 24	SACS: 24

**APPENDIX B – ROUNDABOUT GUIDELINE
EVALUATION MATRIX**

REFERENCE	ROUNDAABOUT	ALIGNMENT	BEST MANAGEMENT PRACTICES	Initial DRAFT RECOMMENDATIONS - Initial - NOT NECESSARILY CHOSEN		IMPLICATIONS TO CONSIDER
				High Cost	Low Cost	
City of Golden						
City of Golden Street, Drainage, and Sidewalk Specifications	No guidance available from City of Golden.					
Jefferson County						
Jefferson County Transportation Design and Construction Manual	Jefferson County guidance references the FHWA "Roundabouts: An Informational Guide"	None of the three roundabouts met the criteria for the design vehicle (SU-30, Single-Unit Truck) or design speed of 15 mph.				
Colorado Department of Transportation (CDOT)						
Colorado Bicycling Manual						
CDOT Roadway Design Guide	Crosswalks should be placed a minimum of 20 feet back from circulatory roadway.	A minimum of 20 feet is provided between the circulatory roadway and the crosswalks.				
Federal Highway Administration						
FHWA-SA-10-006: Intersection Safety Roundabouts	Landscaping should be designed to minimize hazards.	The pond (as it exists) at the Eagle Ridge roundabout has proven to be a potential hazard.	No specific guidance found on ponds in the center of the RAB. But a pond would be considered "depressed" - benefits from some kind of natural barrier/identifiers along the transition from pond to apron.	Eagle Ridge: Reconfigure ponding to be located outside of center island in order to create a raised center island. This would likely require additional Storm Drain infrastucture and property acquisition downstream in order to relocate the water quality pond.	Eagle Ridge: Leave draingage pond in place but provide breakaway signs/markers. Also consider increased delineation at the back of the apron.	Internal landscaping options within the pond will provide visual queues and aesthetics.
Manual on Uniform Traffic Control Devices (MUTCD)						
Roundabouts: An Informational Guide	Design speed is 15 mph and Design vehicle is Single-unit Truck or Bus for Mini-Roundabout or Urban Compact.	Using Vehicle Tracking software, could not get design vehicle through roundabouts at design speed. Simulated speed was less than 5 mph in all cases.	If ROW is available, Roundabout should be designed such that design vehicle can complete through movement at design speed.	All Roundabouts: Reconfigure roundabout geometry to allow design vehicle to complete through movements. Options to address this are included under criteria below.		ROW restrictions limit the size of roundabouts. High Cost involved due to ROW acquisition.
	Preferred approach alignment is left or center.	Approach alignments provided are left and center.				
	Typical entry width is 14 to 16 feet for single-lane.	Entry width provided is 11 feet.		All Roundabouts: Increase entry widths as necessary to accommodate design vehicle and speed. Entry widths can be increased by revising geometry and moving curbing as necessary. Right-of-way acquisition or utility relocation may be required.	All Roundabouts: Increase entry widths, where possible, to accommodate design vehicle and speed.	Increasing entry widths could potentially increase speeds.
	Minimum inscribed circle diameter ranges from 45 to 100 feet for Mini-Roundabout or Urban Compact single-lane.	Minimum diameter is provided for all roundabouts.				
	Required circulatory roadway width for single-lane should be wide enough to accommodate design vehicle with 2-ft minimum clearance from outside edge of vehicle tire track to curb line.	Design vehicle could not "drive" through roundabouts at design speed. It is assumed that the required circulatory roadway width was not met.		All Roundabouts: Increase circulatory roadway widths in conjunction with entry widths to meet minimum criteria. Right-of-way acquisition or utility relocation may be required.	Eagle Ridge and Kimball: Increase circulatory roadway widths in conjunction with entry widths to meet minimum criteria by decreasing center island dimensions, if possible.	Kimball: Need to maintain apron slope recommended.
	Preferred central island shape is circular.	Eagle Ridge Dr. is more of an oval shape.	Circular shape helps promote constant speeds. Irregular shape is more difficult to drive and promotes higher speeds on the straight sections. Central islands are recommended to be raised and not depressed.	Eagle Ridge: Revise roundabout geometry in it's entire to meet design criteria, including circular center island. This may require right-of-way acquisition.	Eagle Ridge: Revise center island exclusively to be circular shape.	Eagle Ridge: Consider impacts to other design critera such as driving lane widths (too wide increases speed) and drainage requirements.
	Typical central island apron width is 3 to 13 feet. Cross slope is typically 3 to 4 percent away from center (not evaluated).	Apron width provided is 7.5 feet for Kimball Ave. and Eagle Ridge Dr. There is not a separate apron for 4th Ave.		Kimball Ave: The apron slope at Kimball Ave. appears to exceed the 4 percent maximum and should be flattened to meet criteria.	Kimball Ave: The apron slope at Kimball Ave. appears to exceed the 4 percent maximum and should be flattened to meet criteria.	
	Minimum apron vertical height is 1.2 inches.	Apron vertical height provided is 3 inches and seems excessive.	A vertical height of 2 inches is typical.	Eagle Ridge Dr. and Kimball Ave.: Remove and replace apron so that vertical height is 1.5-2 inches.	Eagle Ridge Dr. and Kimball Ave.: Remove and replace apron so that vertical height is 1.5-2 inches.	Could increase speeds.
	Minimum exit curve radius for Mini Roundabout or Urban Compact is typically no less than 50 feet for single-lane. However, guidance says at locations with pedestrian activity and no large semi-trailers, minimum 33 to 39 feet.	Exit curve radius of 32 feet provided at Kimball Ave. and Eagle Ridge Dr. At 4th Ave., exit curve radius is 22 feet.		Eagle Ridge Dr. and Kimball Ave.: Exit curve radii should be increased to meet minimum requirements. Right-of-way acquisition or utility relocation may be required.		Increase in exit curve radii may increase speeds.
	Typical splitter island length is 50 feet and width is 6 feet at pedestrian crossing. Guidance says splitter island can be raised or painted for Mini-Roundabout.	Splitter islands are a combination of raised and pavement markings. Typical island width provided along Heritage Rd. is 4 feet and length is less than 50 feet in all locations. The splitter islands on Eagle Ridge Dr. meet minimum requirements.		All Roundabouts: Increase length and width of splitter islands to meet minimum requirements. Taper rates would need to be adjusted as well. Right-of-way acquisition or utility relocation may be required.	ALL Roundabouts: Leave splitter islands as is but consider opportunities on a corridor-wide initiative to heighten awareness of pedestrian crossings.	Consider compromise required to leave or reduce splitter islands to allow for wider travel lanes, entry/exit widths.
	Pedestrian crossings should be as close to intersection as possible for convenience. Crossing should be placed a minimum of one vehicle-length (25 ft.) away from yield line. And should be located to take advantage of splitter island.	Pedestrian crossing/refuge located behind raised portion of island. This creates a potential vehicle-pedestrian conflict point.		All Roudabouts: By increasing the length/width of splitter islands, pedestrian crossing locations will meet requirements.		Consider compromise required to leave or reduce splitter islands to allow for wider travel lanes, entry/exit widths.
	Landscaping: large fixed landscaping such as trees, rocks, etc. should be avoided in areas prone to vehicle runoff.	Eagle Ridge Dr. provided large boulders and a water quality pond in the center. There is no landscaping present at Kimball Ave. or 4th Ave.	Consider barriers that are more forgiving upon impact to protect the entrance into the drainage pond.	Eagle Ridge: Remove boulders from perimeter of roundabout center island at Eagle Ridge and provide guardrail around the pond,	Eagle Ridge: Remove large boulders from perimeter of roundabout center island at Eagle Ridge.	Consider Landscaping improves aesthetics - consider other opportunities for landscaping outside of the sight zone.
	Sight distance is a concern at Kimball and 4th Ave. roundabouts.	Need to consider modifications to grade and signage (on-street and off-street) at these 2 locations to improve visibility.		All Roundabouts: Remove all sight obstructions from within sight triangles. See provided exhibits.	All Roundabouts: Remove as many sight obstructions from within sight triangles as possible. See provided exhibits.	If roadway signage is in clear zone - need to relocate to a more appropriate spot - not remove.
Federal-Level Guidance						
American Association of State Highway and Transportation Officials (AASHTO)	Central island not required to be circular in shape.	Criteria met for all roundabouts.				
	Splitter island should be cut to allow pedestrian pass through.	Only splitter island on west side of Eagle Ridge Dr. meets this criteria. All others do not meet criteria.				
National Association of City Transportation Officials (NACTO)	Only very general design guidance found.					
Institute of Transportation Engineers (ITE)	Recommended Practice for Modern Roundabouts: Mini-Rounabout - design vehicle, bus and single-unit truck drive over apron.	Criteria is met for Eagle Ridge Dr. and Kimball Ave. At 4th Ave., bus/SU truck cannot successfully maneuver through roundabout even while driving over apron.				

Design Guidelines Matrix

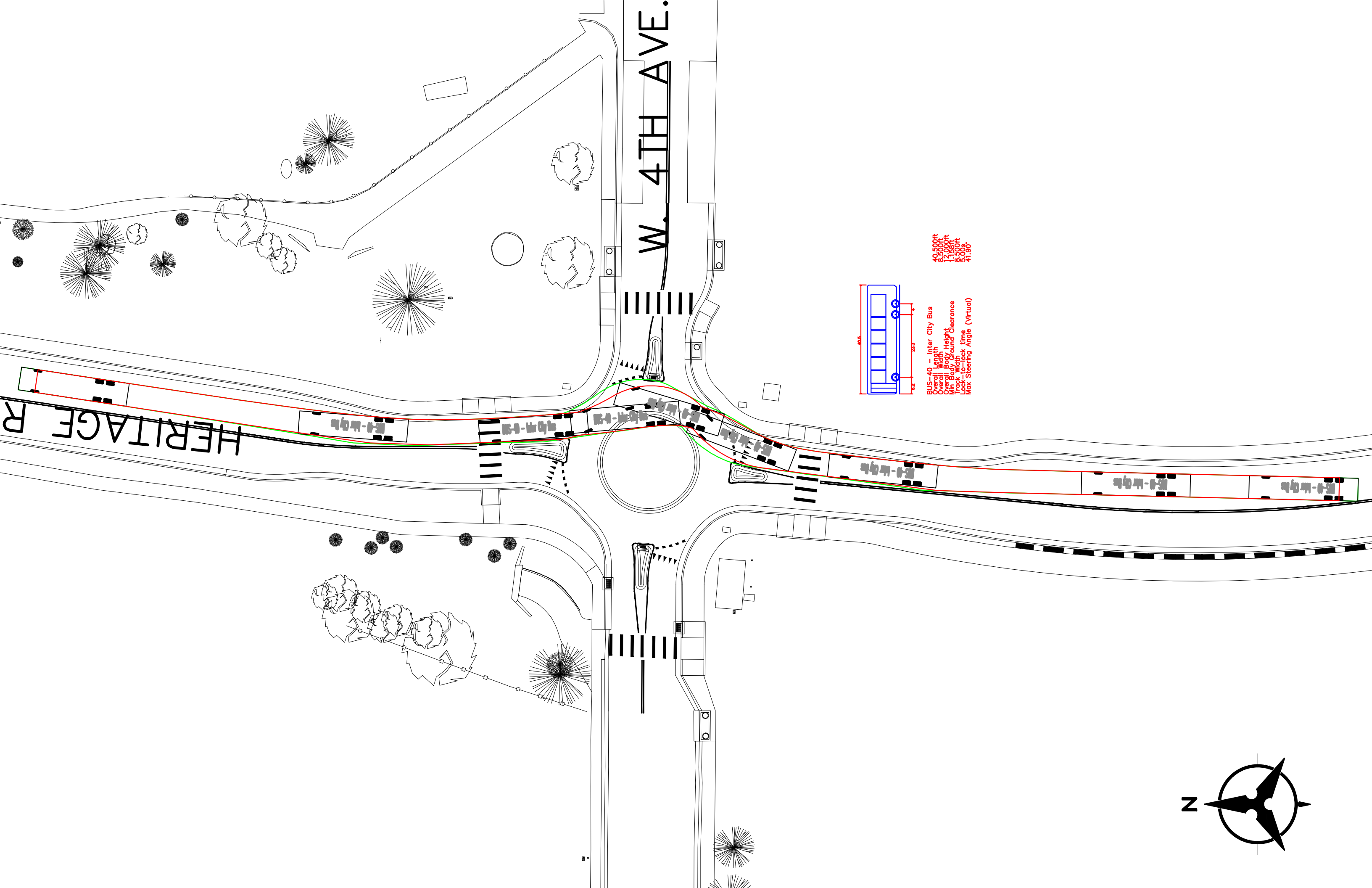
DRAFT April 2017

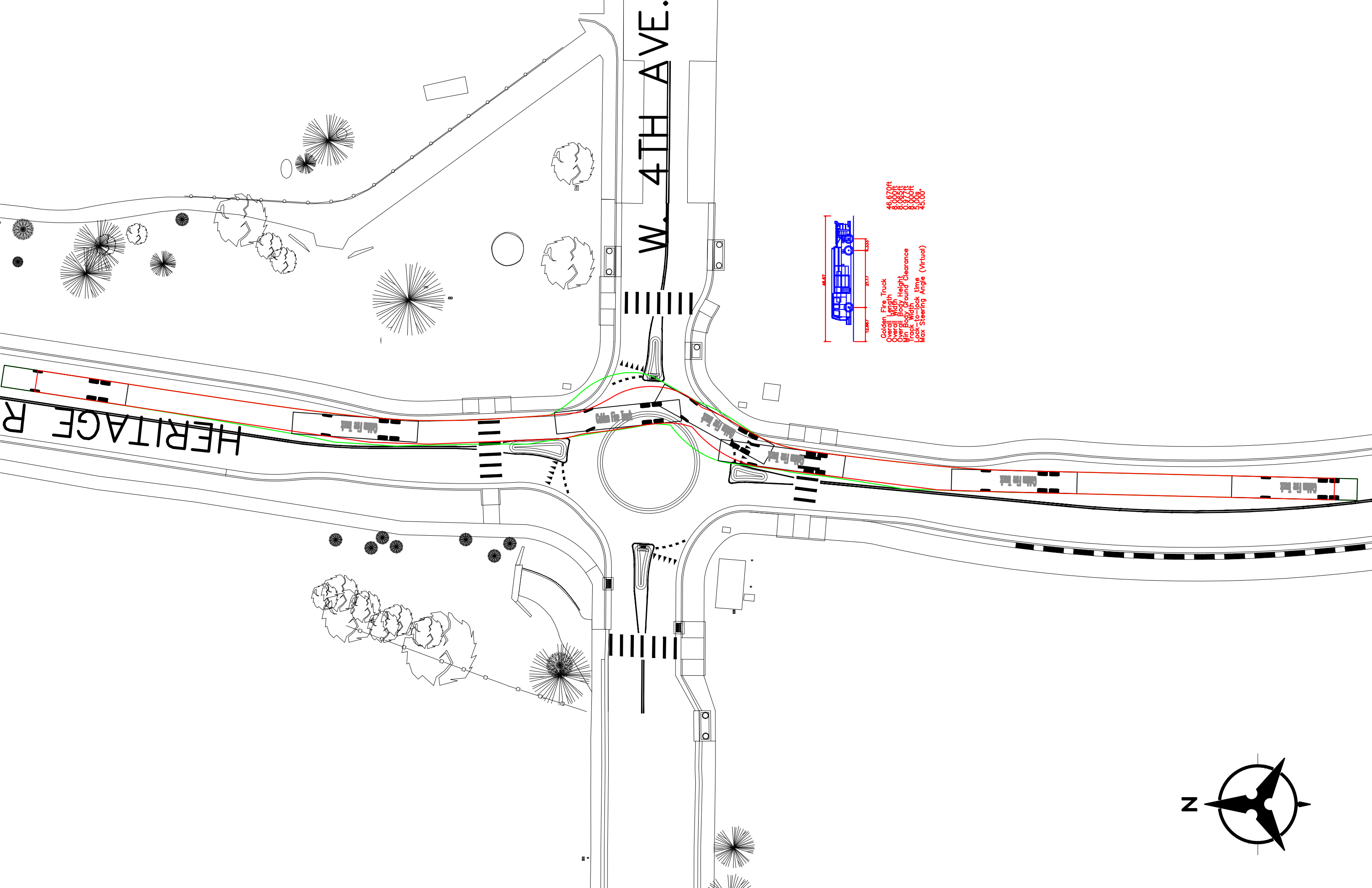
Heritage Rd - Bicycle/Pedestrian

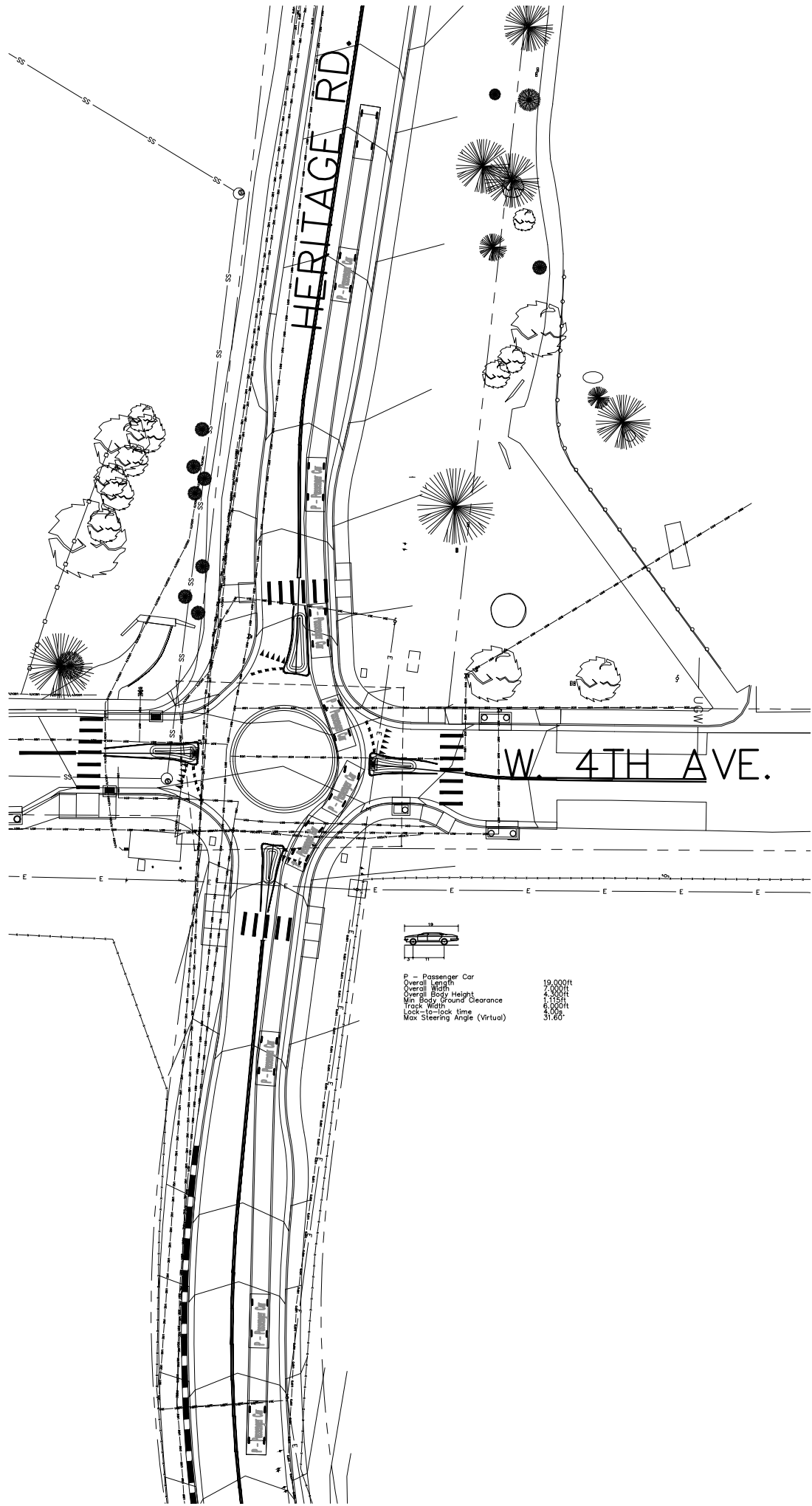
REFERENCE	BICYCLE/PEDESTRIAN	COMPLIANCE	BEST MANAGEMENT PRACTICES
City of Golden			
City of Golden Street, Drainage, and Sidewalk Specifications	Sidewalks - Minimum 5' in width; should be "detached. " Attached sidewalks should be at least 8' wide. All discussion on bicycle facilities refers to bike paths (10' facility). Standard drawings call for 8' bike lanes on arterials; no bike lanes are indicated on local roads or collectors.	Pedestrian infrastructure is in compliance along roadways. No guidance related to navigation of roundabouts.	Not applicable
Jefferson County			
Jefferson County Transportation Design and Construction Manual	Standard templates call for 4' bicycle lanes, 6' sidewalk with 5' buffer on collectors.	Pedestrian infrastructure is in compliance along roadways. No guidance related to navigation of roundabouts. Raised bicycle lanes are 4' wide, which complies with Jefferson County guidance.	Not applicable
Jefferson County Bicycle and Pedestrian Planning Purpose and Process / Bicycle Plan	Proposed bicycle lane between US 40 and US 6. Heritage Rd provides regional connection between proposed paved shoulders on US 40 to the south and shared use path along US 6 to the north of the study area.	Raised bicycle lane provided between Kimball Ave and Eagle Ridge Dr; other segments of corridor are lacking desired infrastructure.	Not applicable
Colorado Department of Transportation (CDOT)			
Colorado Bicycling Manual	Guidance on how cyclists should navigate roundabouts; appropriate signage and traffic control devices.	Not applicable.	A guide to safe bicycling practices - manual describes how pedestrians and cyclists should behave. Provides how-to information on navigating different intersection types, but does not provide design guidance.
CDOT Roadway Design Guide	Minimum bicycle lane width is 4'. "The needs of bicyclists and pedestrians shall be included in the planning, design, and operation of transportation facilities, as a matter of routine." Encourages context-sensitive bicycle and pedestrian accommodations (14-8).	Raised bicycle lanes are 4' wide, which complies with CDOT guidance, though CDOT does not provide guidance specific to raised bike lanes. "Alternating facilities, such as from bike lanes to sidepaths, can cause confusion for both bicyclists and motorists" (14-11). "Advanced signage should be provided to inform bicyclists that the improvement (e.g. bike lane) is coming to an end" (14-11).	CDOT defers to other guidance documents on separated bicycle lanes and navigating roundabouts. CDOT is silent on raised bike lanes. Supports used of innovative signing and marking, colored bike lanes.
Federal Highway Administration			
Manual on Uniform Traffic Control Devices (MUTCD)	Guidance related to signage and pavement markings for cyclists and pedestrians, including optional signage for pedestrians at roundabouts.	Bicycle lanes end as suggested prior to roundabouts. Heritage Rd does not provide suggested signage for bicyclists for navigating the roadway through the roundabout. Pedestrian signage at roundabouts appears to be sufficient.	Sharrows or other guidance for cyclists to navigate the intersections.
Roundabouts: An Informational Guide (FHWA)*	Pedestrian accommodations must be located around the perimeter of the roundabout. Guidance related to pedestrian and bicycle travel through crosswalks at roundabouts. Bicyclists should be provided with options through roundabouts. Bicyclists may travel along roadway or on sidewalks through a roundabout. Bicyclists may be comfortable riding in the travel lane on low-volume roadways, but on the sidewalk through high-volume roundabouts.	Heritage Rd does not provide suggested sidewalk widths for bicycle and pedestrian travel through intersections. The only option for bicyclists when navigating the roundabouts is to travel with the flow of traffic.	Widened sidewalks (up to 10') to allow for bicyclists to traverse roundabout along pedestrian path if they do not wish to travel through roundabout with vehicle traffic. Roundabouts should include a 2-5' setback or buffer between the curb and the sidewalk to encourage pedestrians (and bicyclists) to stay on the designated sidewalks.
Federal-Level Guidance			
American Association of State Highway and Transportation Officials (AASHTO) - Guide for the Development of Bicycle Facilities	Preferred lane width is 5', while minimum width is 4'. "For roadways where the bike lane is immediately adjacent to a curb, guardrails, or other vertical surface, the minimum bike lane width is 5 feet" (4-15). There are exceptions for constrained right-of-way.	There is no guidance specific to raised bicycle lanes, but guidance on standard bike lanes calls for 5' width where the bike lane is adjacent to a curb or vertical surface. The bike lanes on Heritage Rd do not meet that standard.	Guidance provided on bicycle travel at roundabouts is less rigid in terms of bicycle ramps and widened sidewalks. These are considered desirable along higher speed roadways. AASHTO generally encourages travel with flow of traffic. Wider sidewalks are not necessary for places with low volumes of pedestrians.
National Association of City Transportation Officials (NACTO) - Urban Bikeway Design Guide	Provides guidance on raised cycle tracks (also referred to as raised bike lanes), which feature vertical separation from roadway. Facilities should be 5-6.5' wide with mountable curb with a 4:1 ratio slope edge.	The raised bike lanes on Heritage Rd are below the suggested width range. The raised bike lane is at an intermediate level above the roadway and below the sidewalk. The curb between the bike lane and the roadway is mountable.	The bike lane could be further delineated with paint and pavement markings at entrance ramps and/or along the mountable curb.
Institute of Transportation Engineers (ITE) - Designing Walkable Urban Thoroughfares: A Context Sensitive Approach	Bike lanes are desirable on major thoroughfares with design speeds of 30 MPH or greater and are a high priority when creating connected networks. Minimum lane width is 5' (may include gutter pan), and recommended lane width is 6'. ITE does not provide guidance on raised bike lanes.	Heritage Rd is an appropriate location for bicycle facilities and serves an important regional connection. Bicycle lane widths do not meet minimum standards.	Bicycle travel with flow of traffic is appropriate when design speeds are 25 MPH or below. One-lane roundabouts are designed to ensure speeds below 25 MPH.

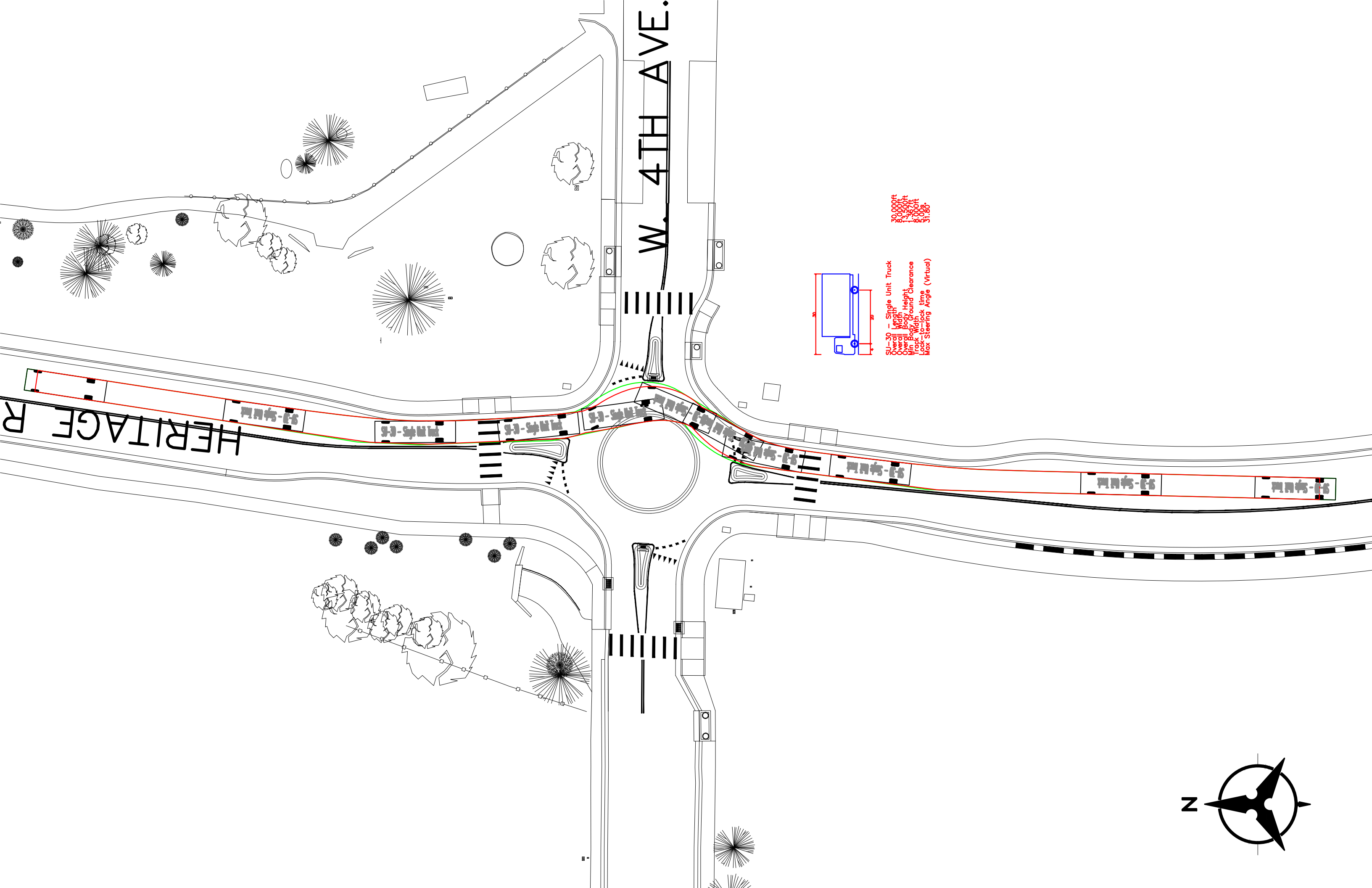
*Guidance in the FHWA manual on Intersection Safety and Roundabouts is essentially the same as in "Roundabouts: An Informational Guide"

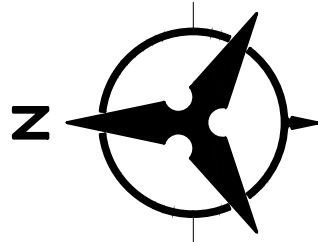
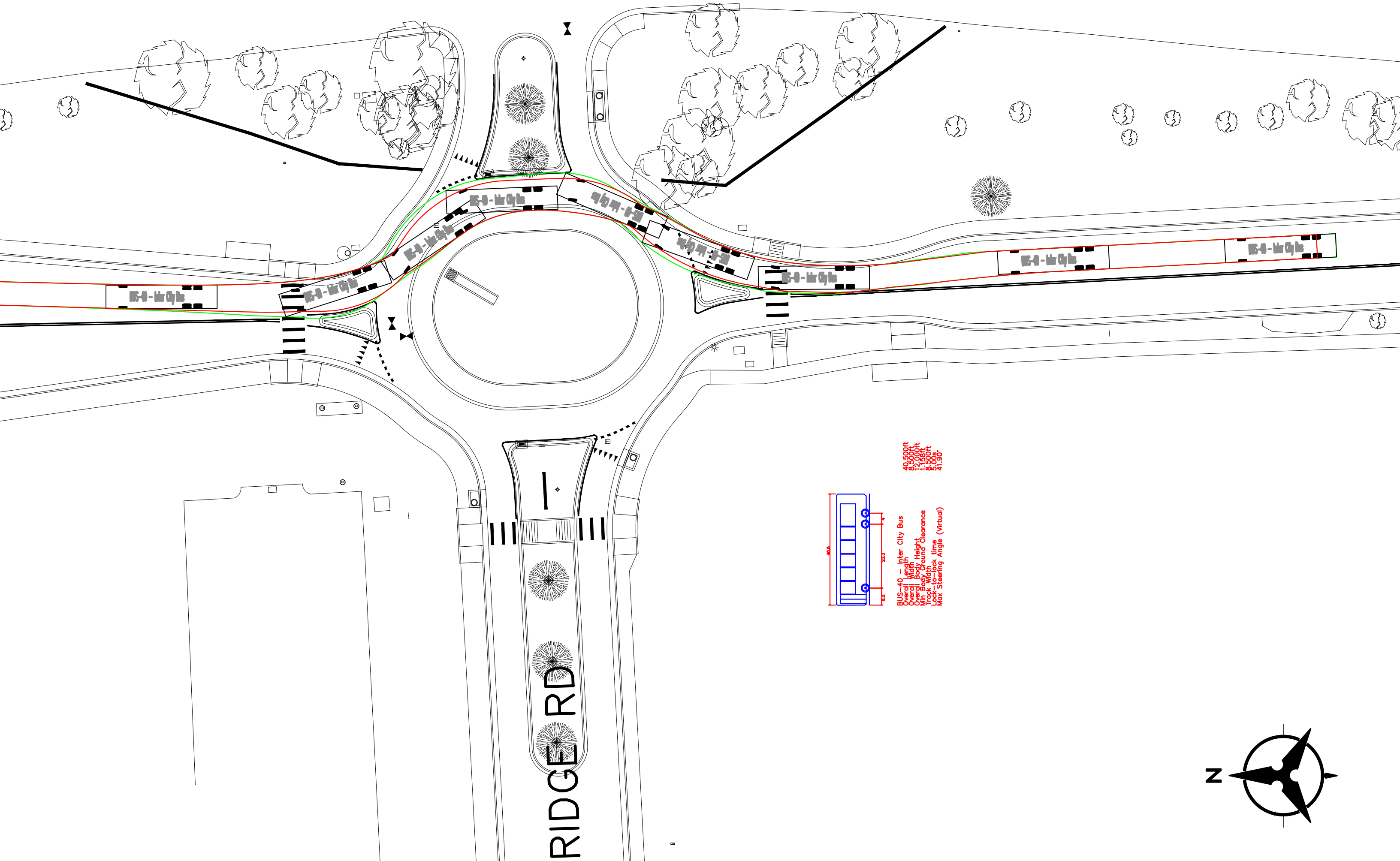
APPENDIX C – TURNING MOVEMENT

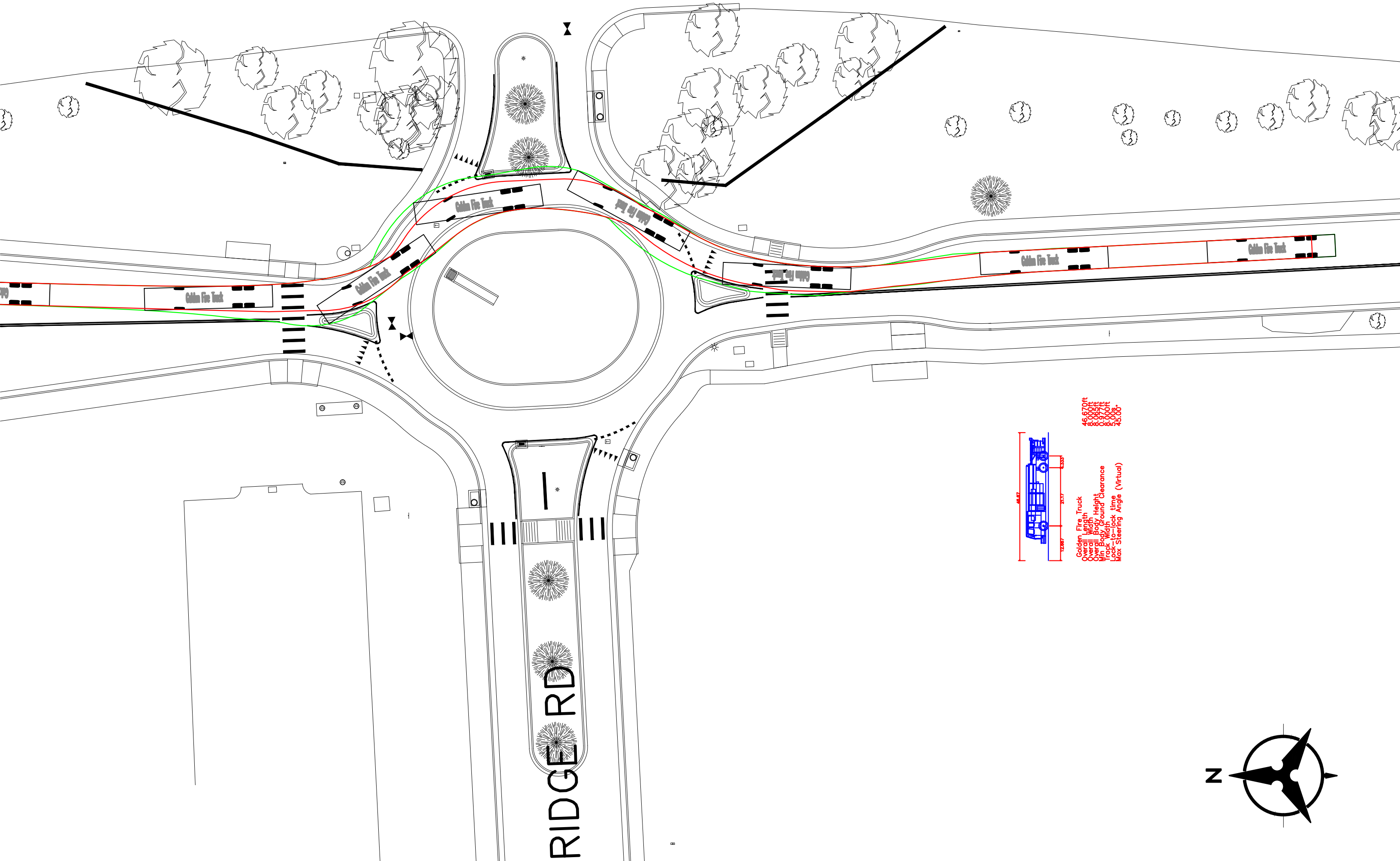




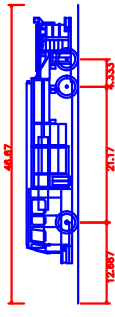




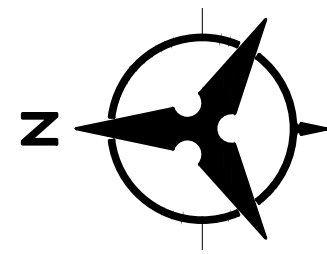


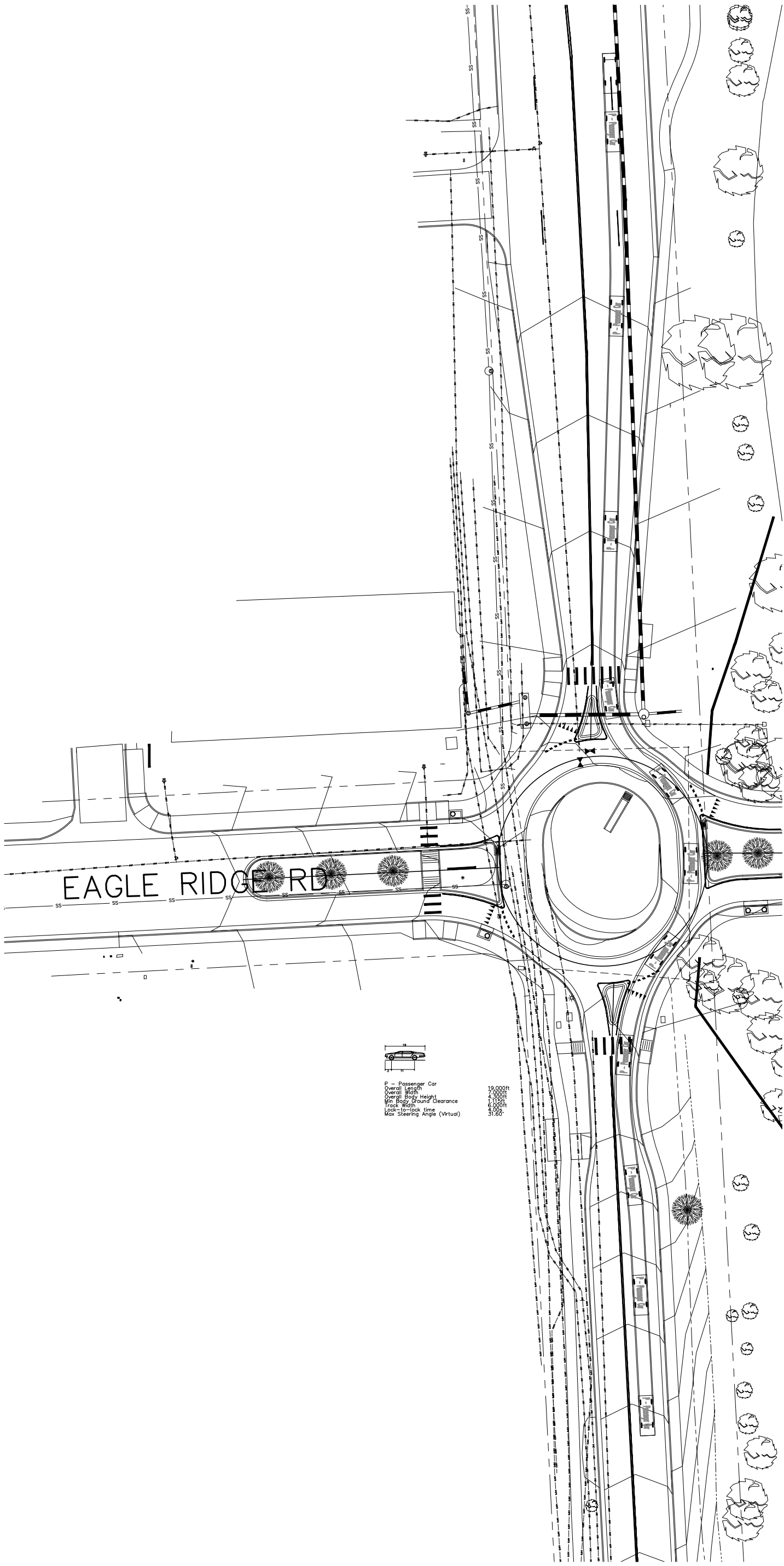


RIDGE RD



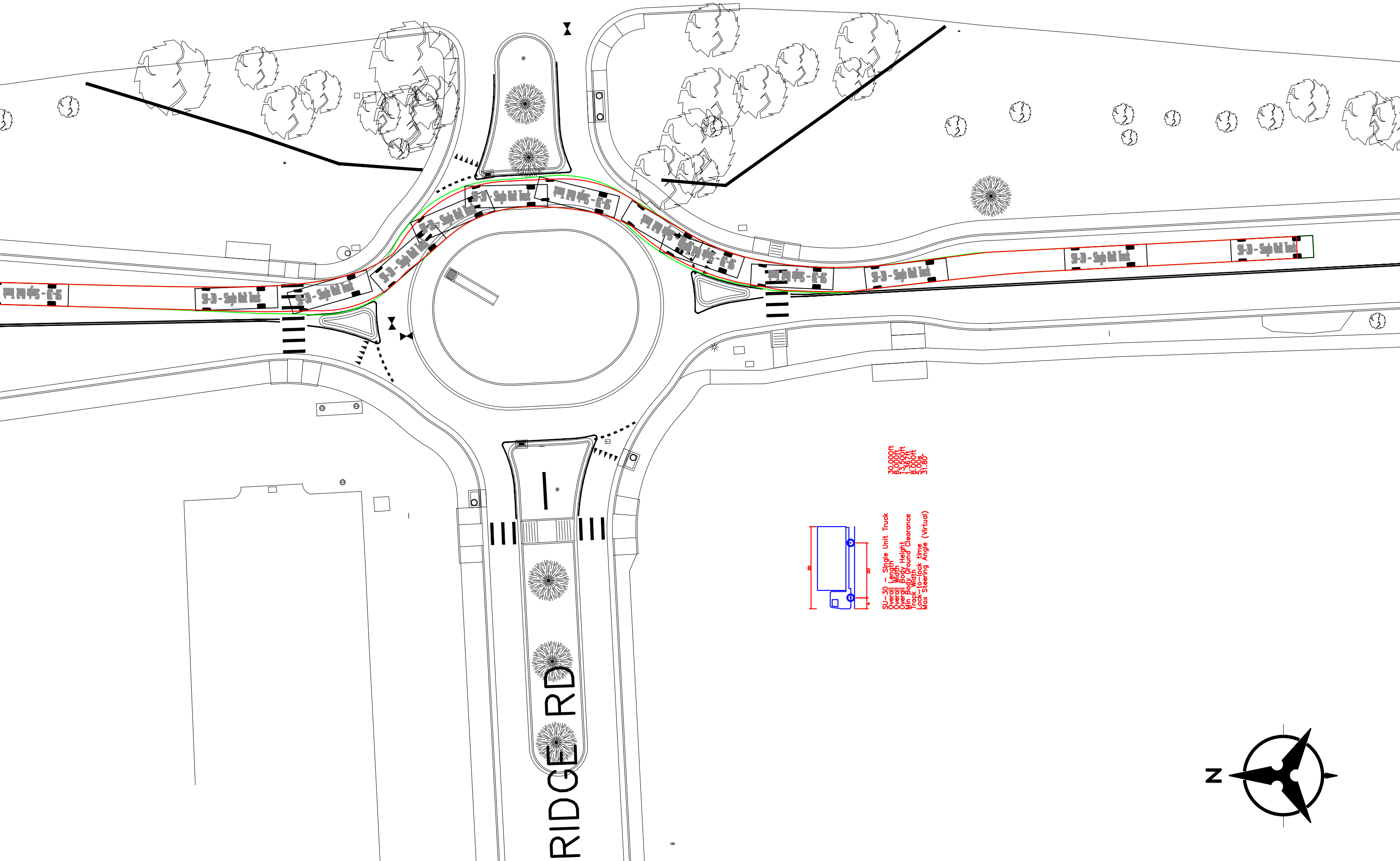
Golden Fire Truck
Overall Length 46.67ft
Overall Width 12.85ft
Overall Height 13.35ft
Max. Ground Clearance 21.17ft
Track Width 6.00ft
Lock-to-lock time 2.00s
Max Steering Angle (Virtual) 45.00°



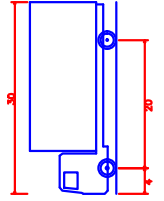


P - Passenger Car
Overall Length
Overall Width
Overall Body Height
Min Body Ground Clearance
Front Width
Lock-to-lock time
Max Steering Angle (Virtual)

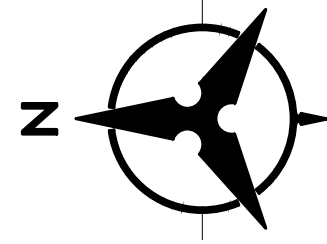
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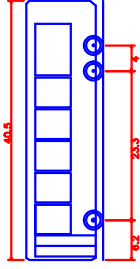
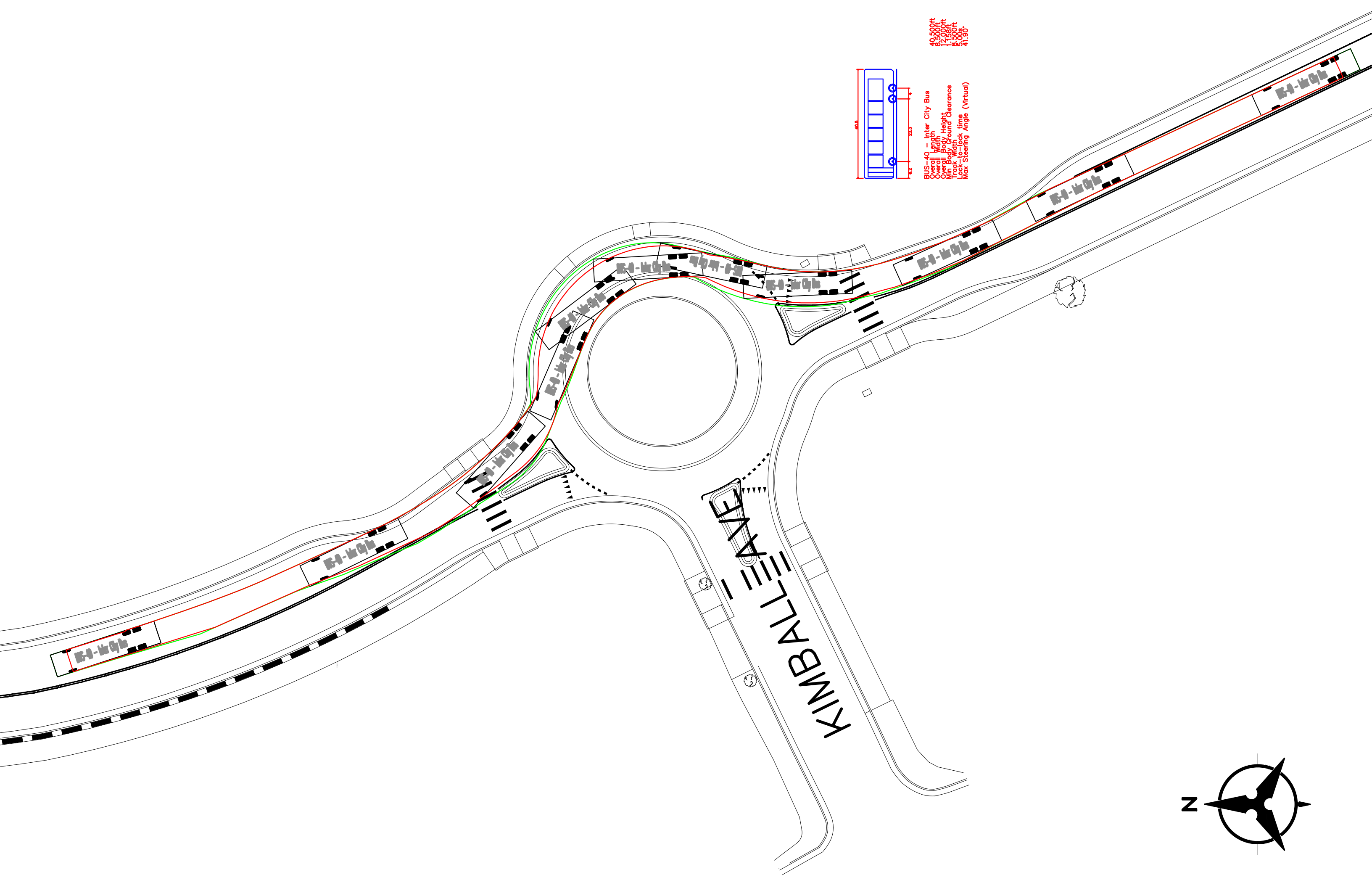


RIDGE RD

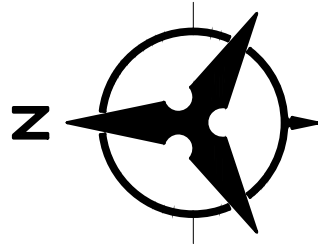


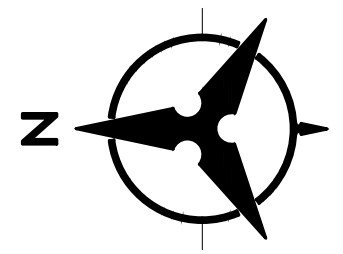
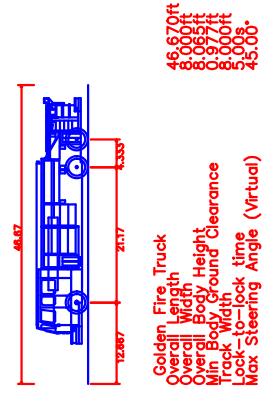
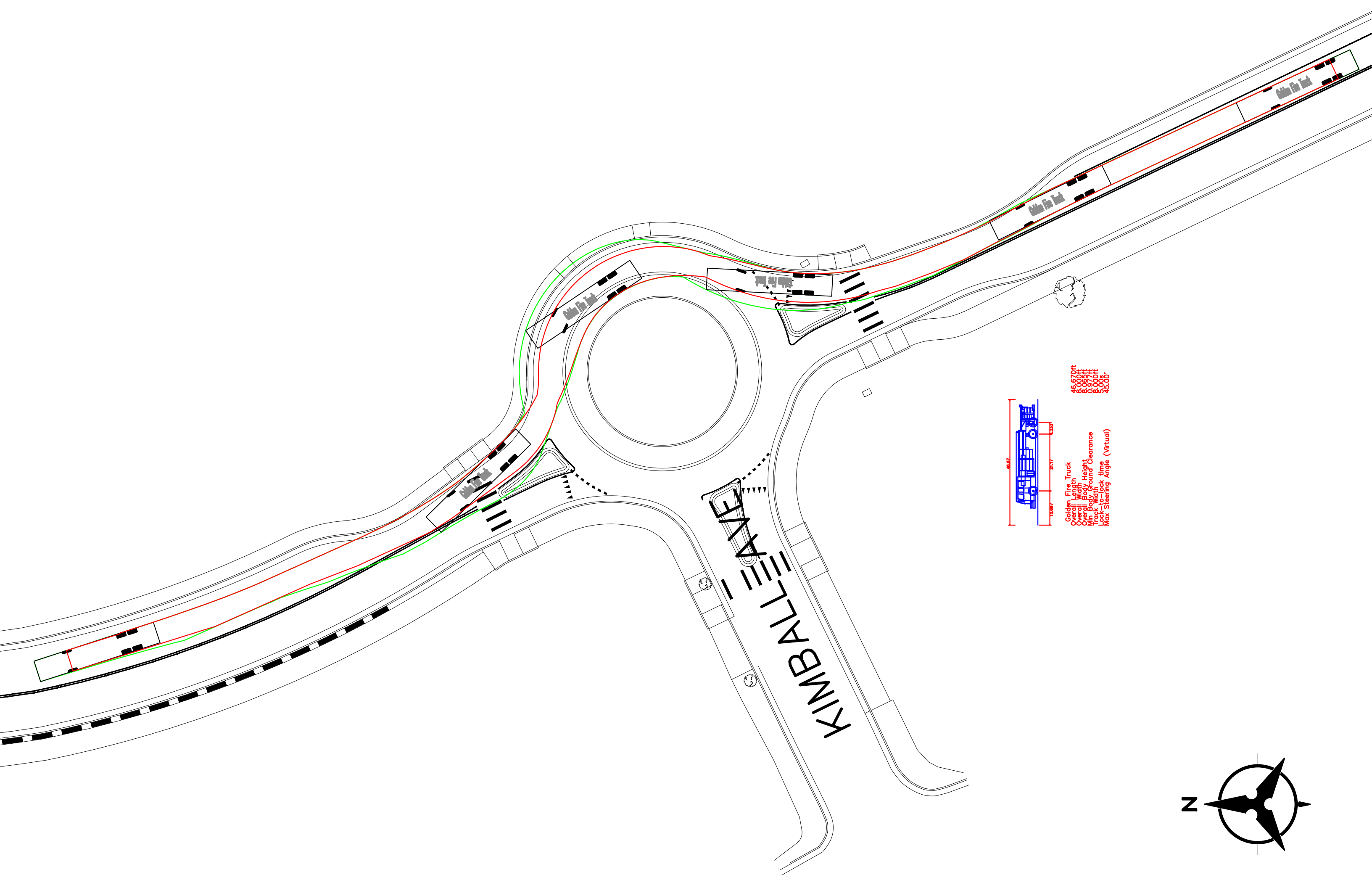
SU-30 - Single Unit Truck
Overall Length 30.000ft
Overall Width 8.500ft
Overall Height 13.500ft
Wheelbase 10.000ft
Ground Clearance 1.500ft
Track-to-lock time 31.80s
Max Steering Angle (Virtual)

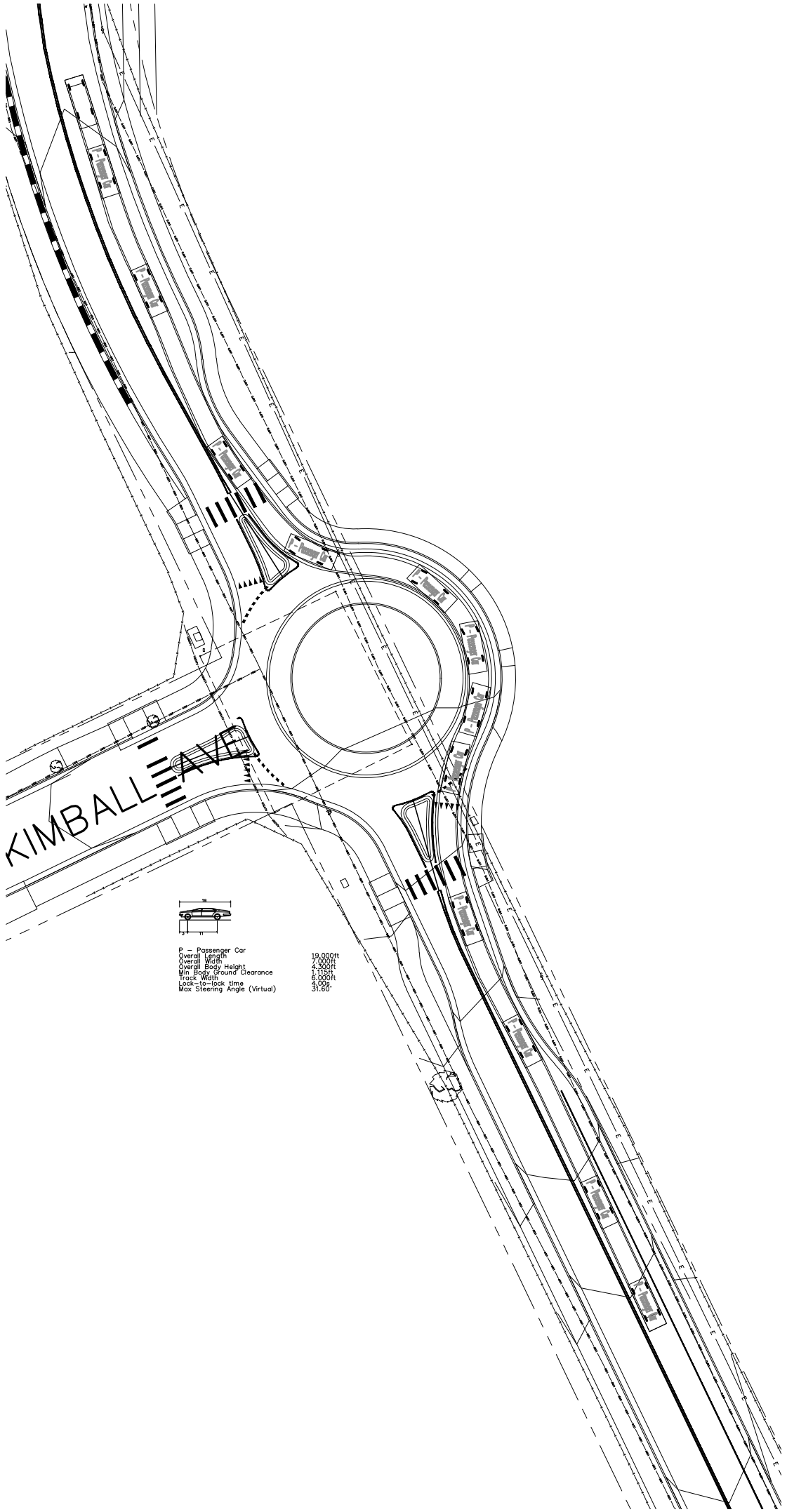




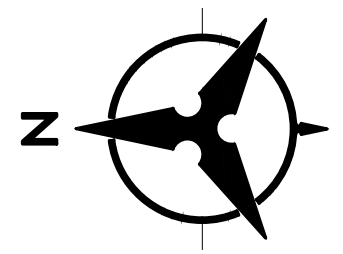
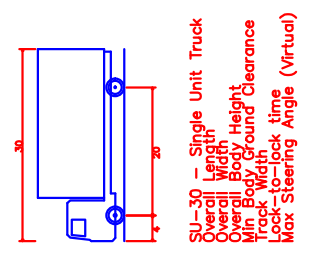
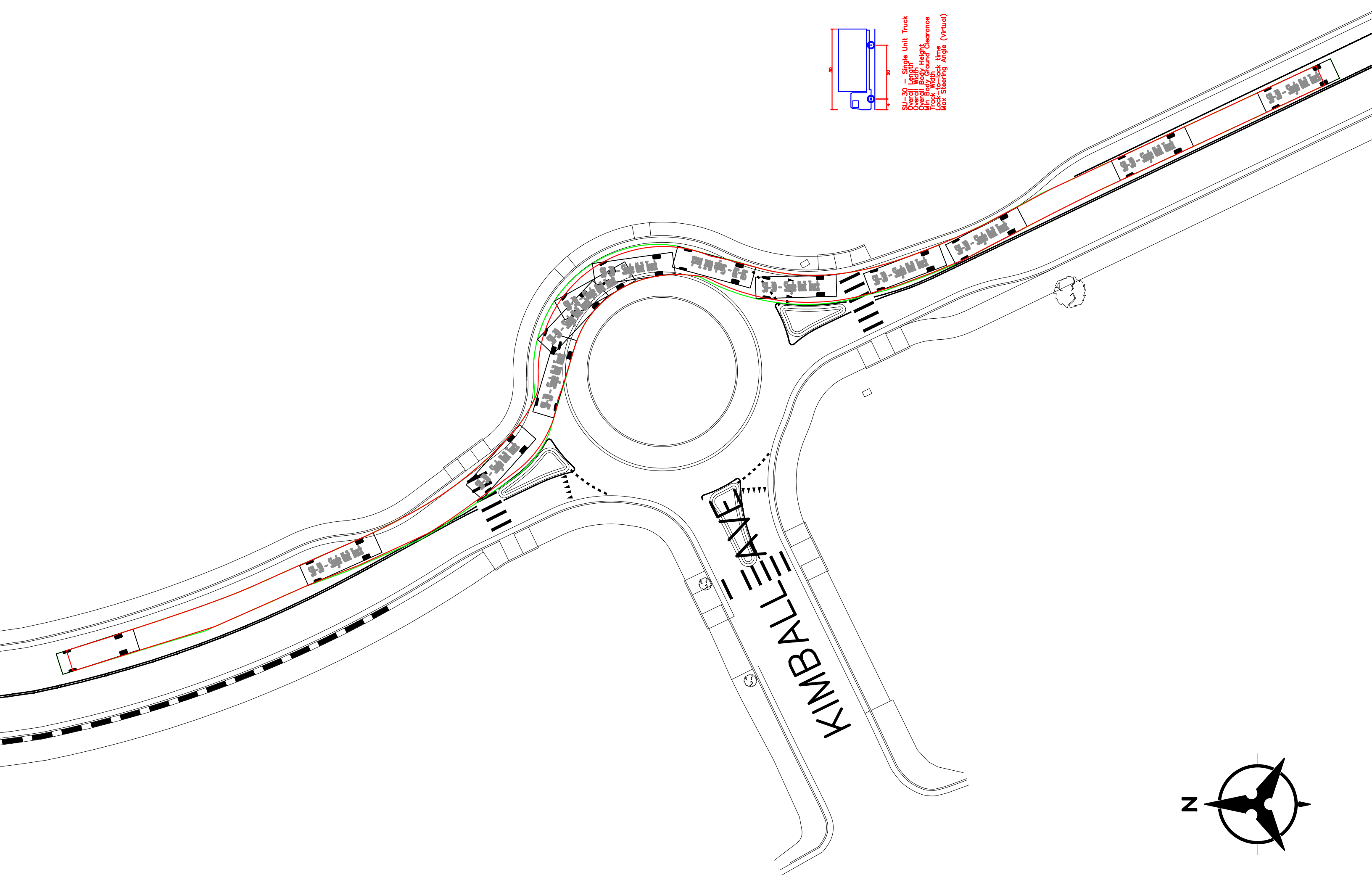
BUS-40 - Inter City Bus
Overall Length 46.1
Overall Width 8.2
Overall Height 12.3
Min. Body Clearance 1.5
Max. Wheel Lock-to-lock time 5.0
Max. Steering Angle (Virtual) 41.90°

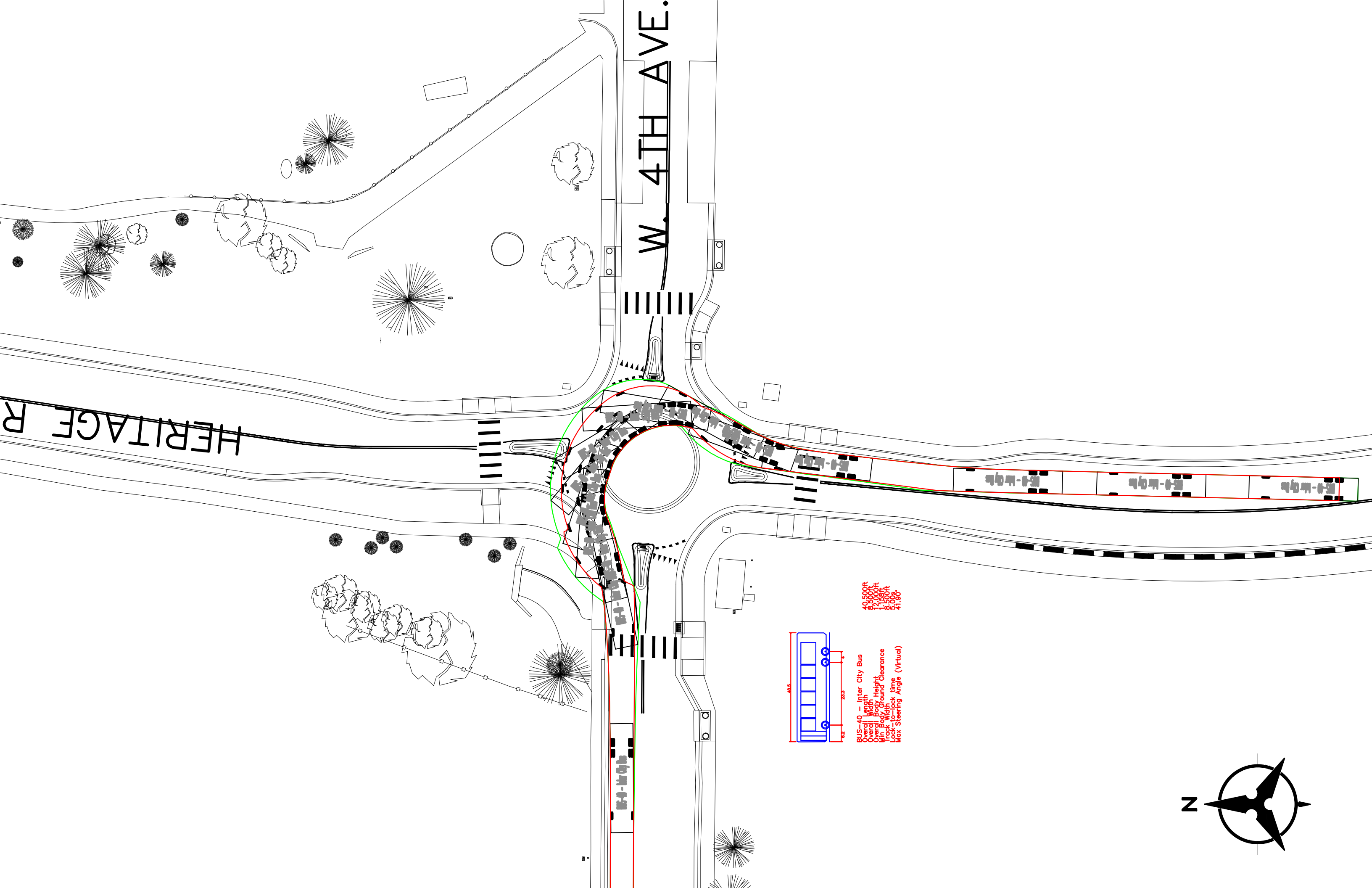


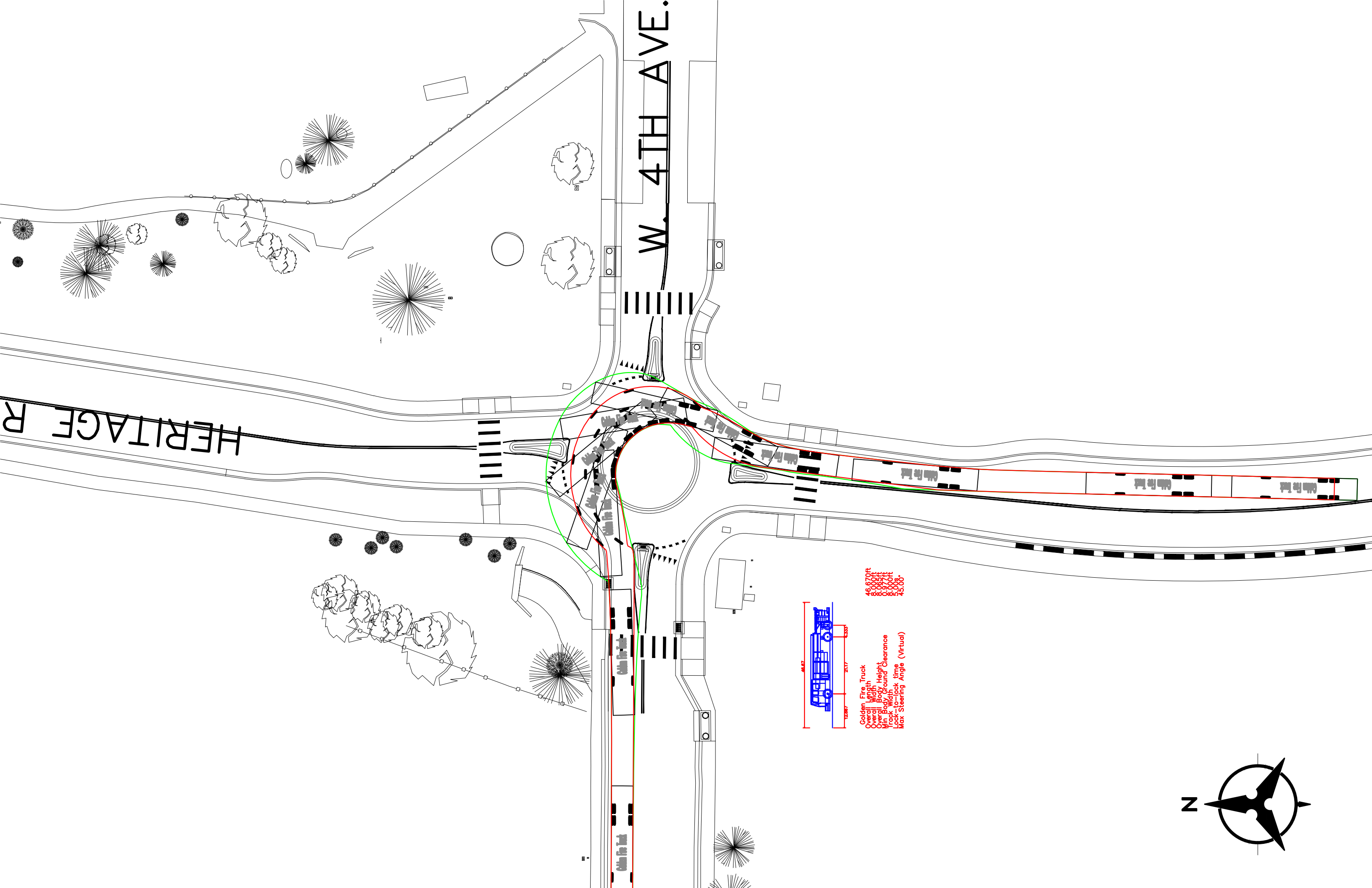


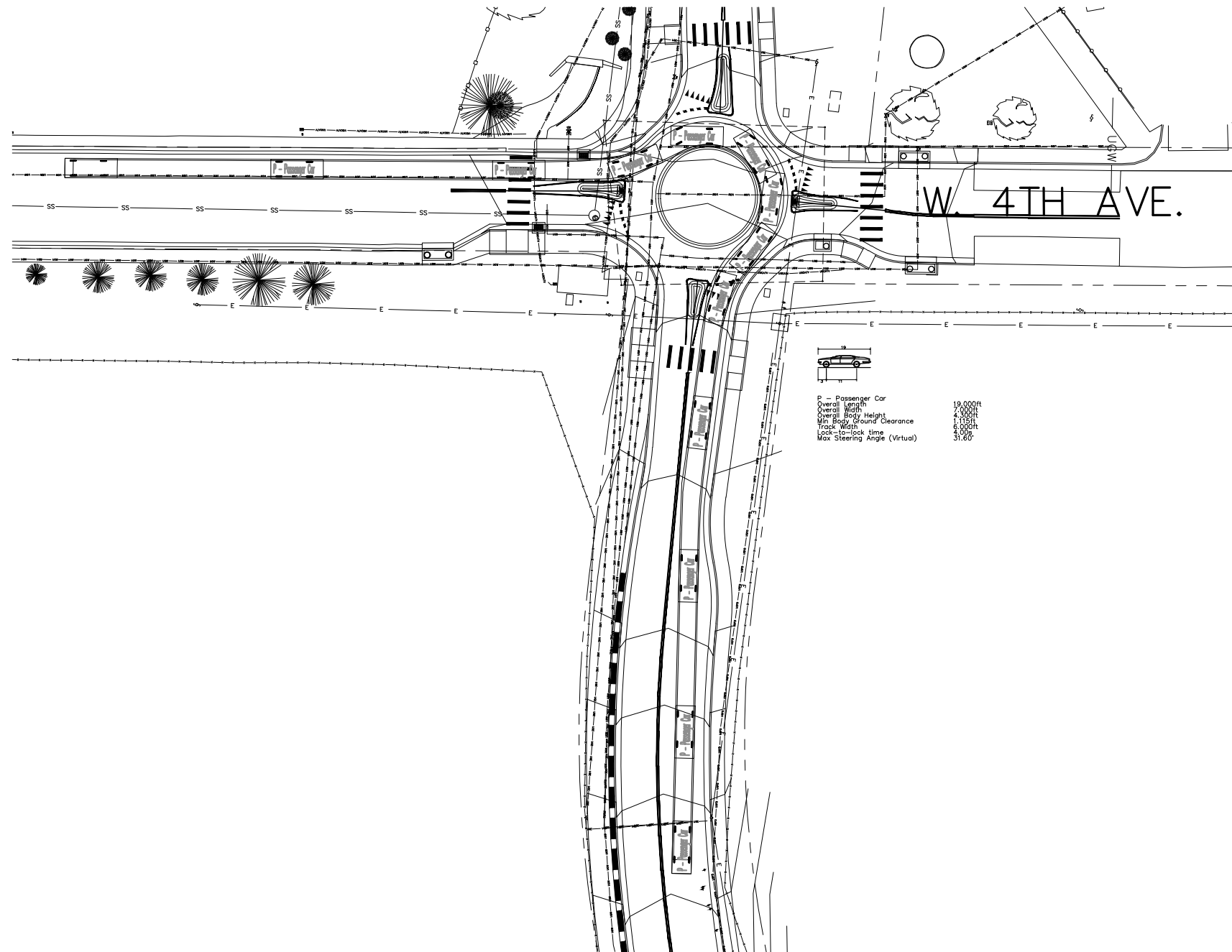


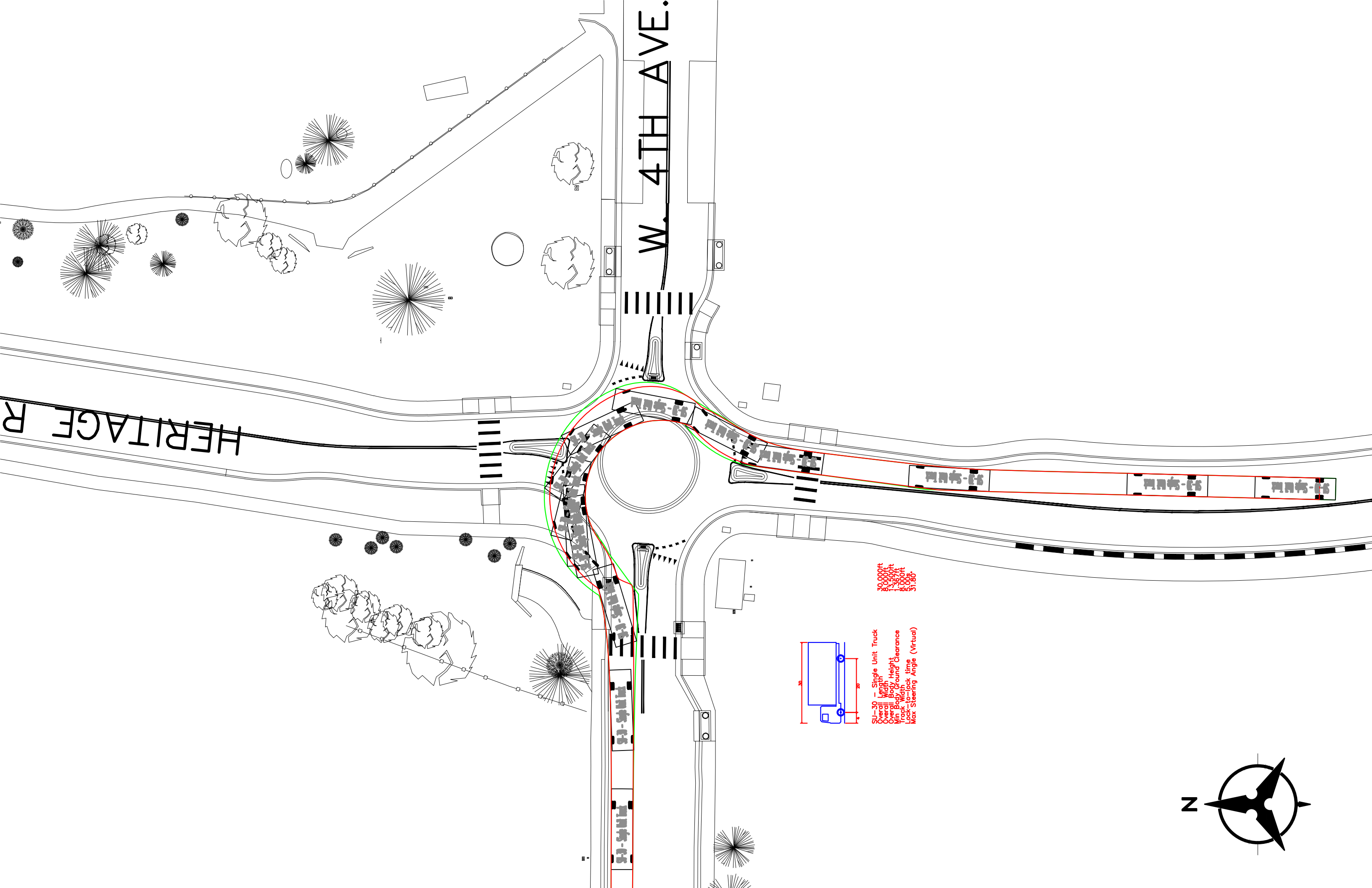
P - Passenger Car
Overall Length 19.000ft
Overall Width 7.000ft
Overall Body Height 4.115ft
Min Body Ground Clearance 4.000ft
Track Width 5.000ft
Lock-to-lock time 31.00s
Max Steering Angle (Virtual) 31.00°







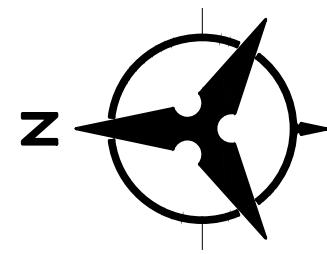
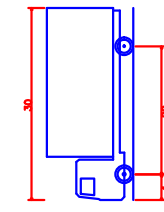


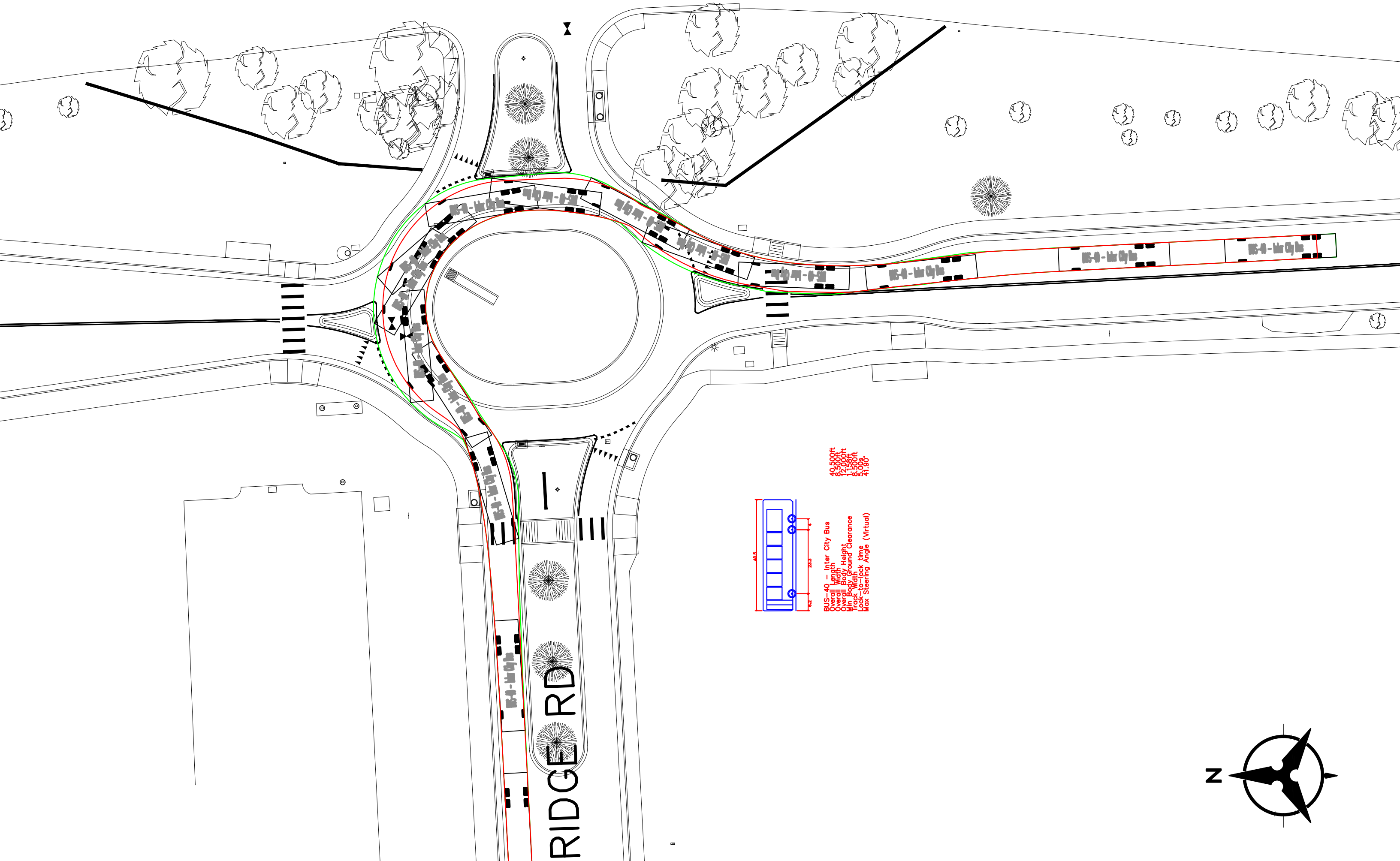


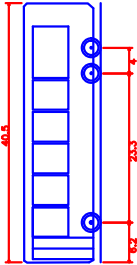
HERITAGE R

W 4TH AVE

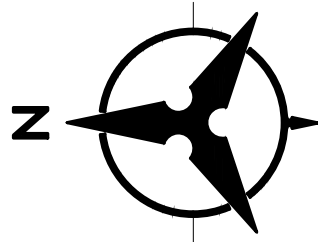
SU-30 - Single Unit Truck
Overall Length 30.000ft
Overall Width 8.000ft
Overall Height 13.67ft
Max Body Height 13.67ft
Max Body Width 8.000ft
Track Width 5.00ft
Lock-to-lock time 31.80s
Max Steering Angle (Virtual)

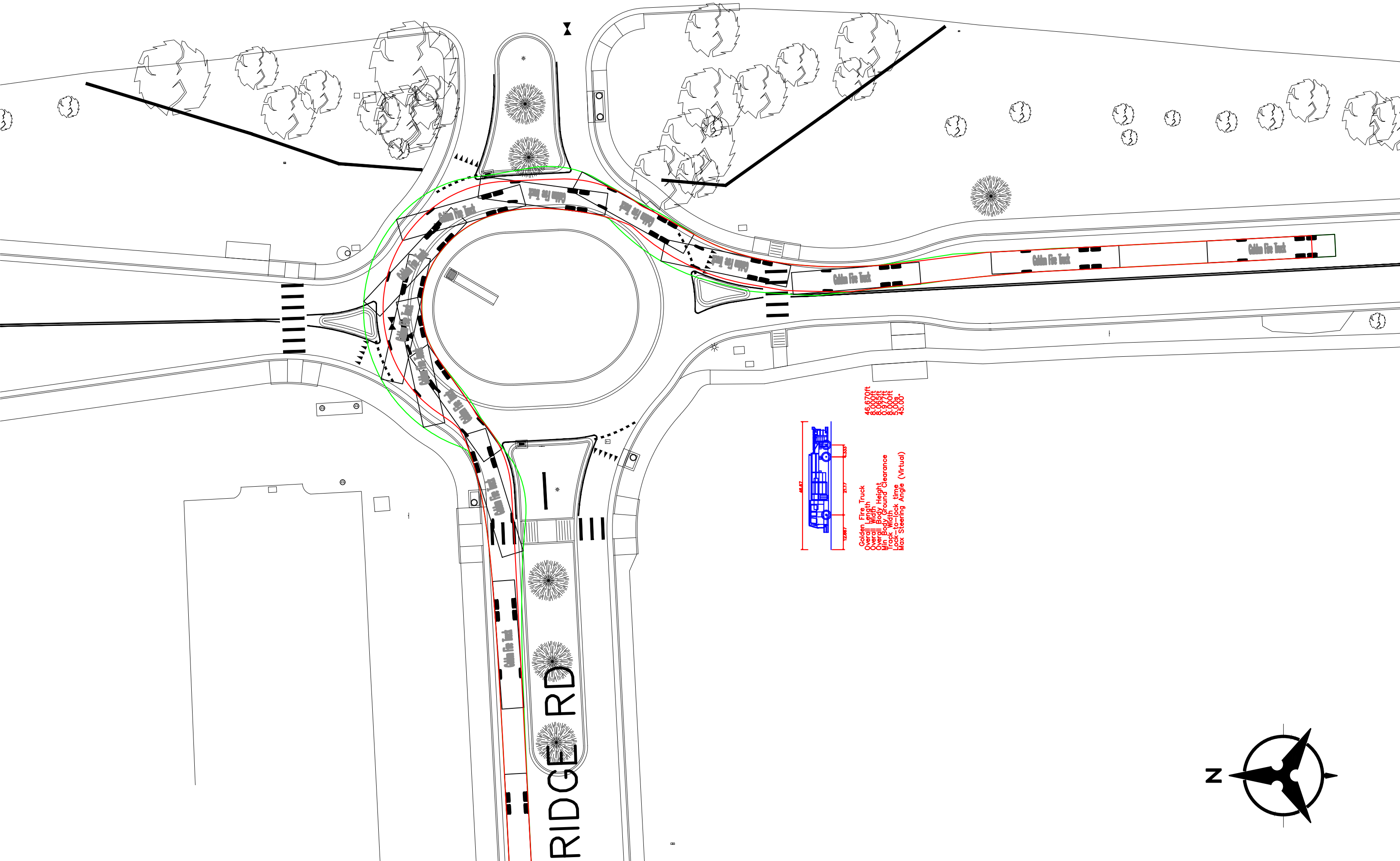




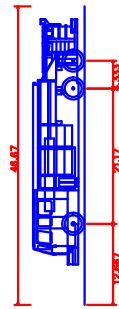


BUS-40 - Inter City Bus
Overall length 60.500ft
Overall width 23.300ft
Overall height 6.200ft
Min. Body Ground Clearance 1.156ft
Track Width 8.500ft
Lock-to-lock time 2.00s
Max Steering Angle (Virtual) 41.90°

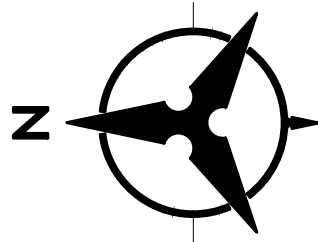


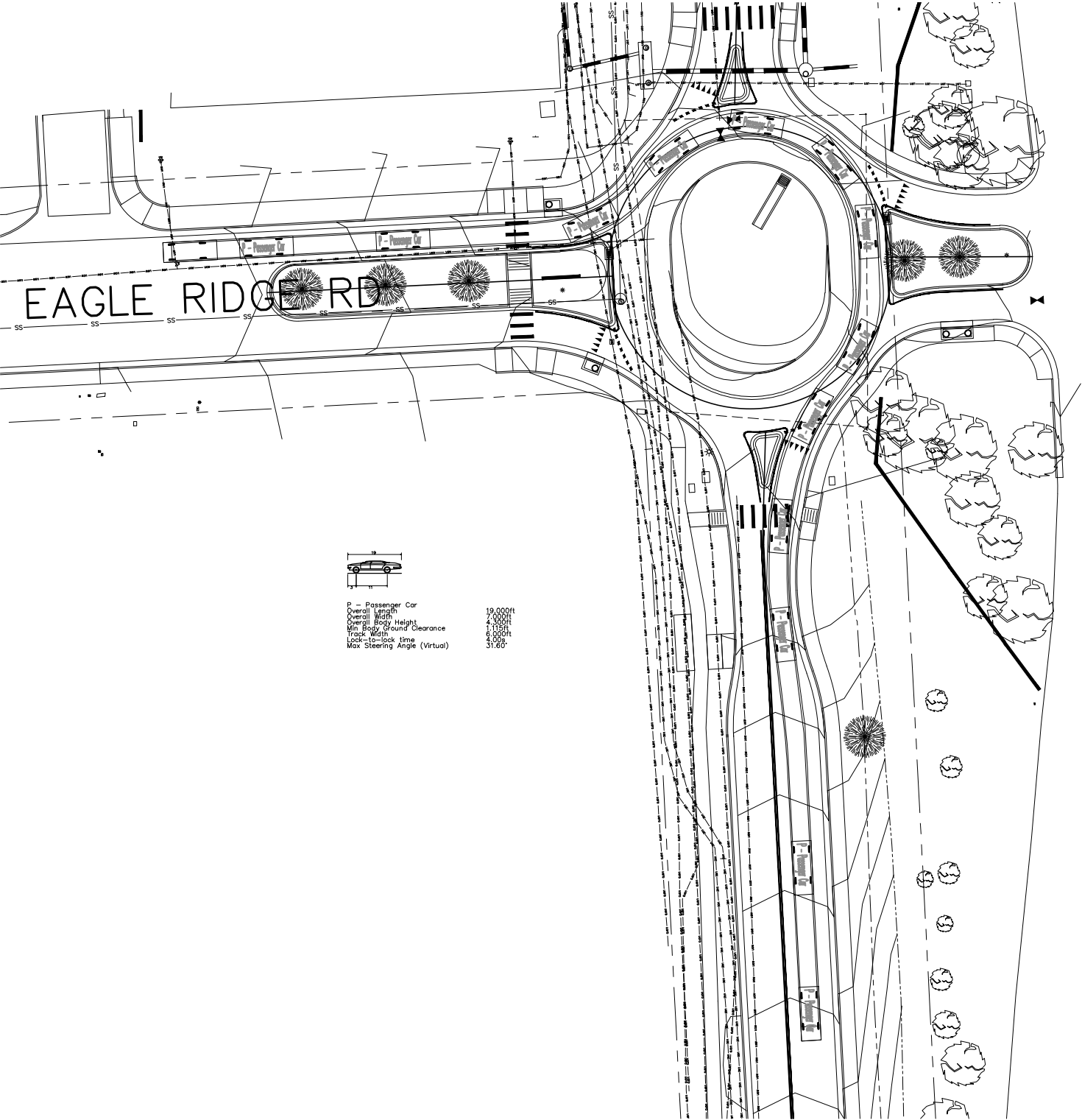


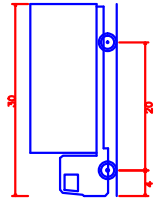
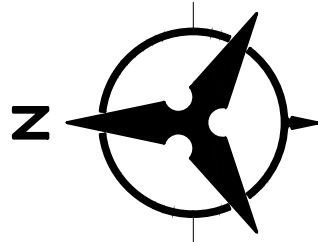
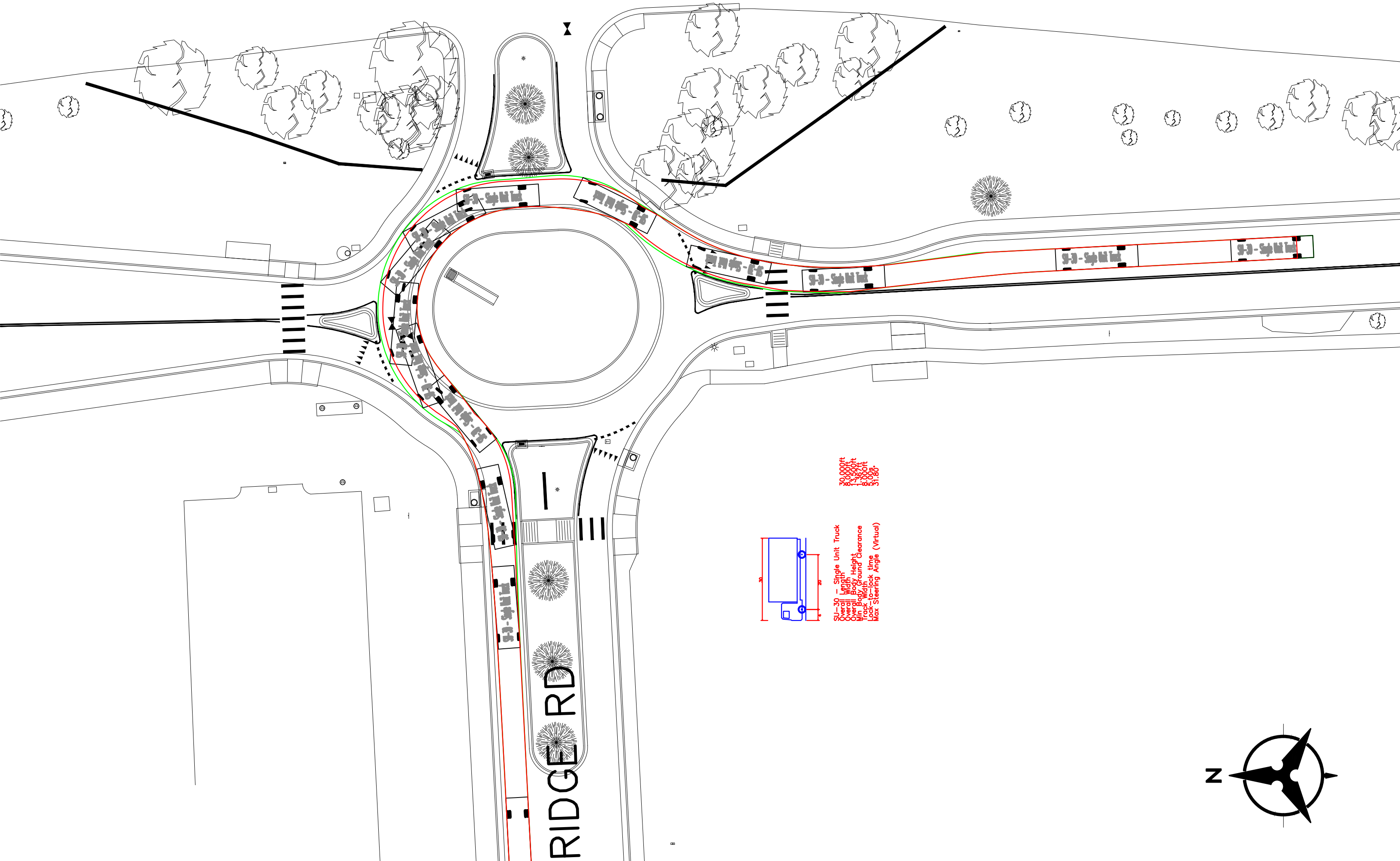
RIDGE RD



Golden Fire Truck
Overall Length 46.67ft
Overall Width 12.867ft
Overall Height 21.17ft
Overall Body Height 8.333ft
Min Body Ground Clearance 8.000ft
Track Width 3.000ft
Lock to-lock time (Virtual)
Max Steering Angle (Virtual)

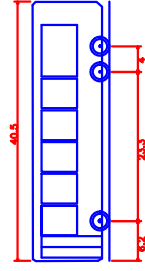
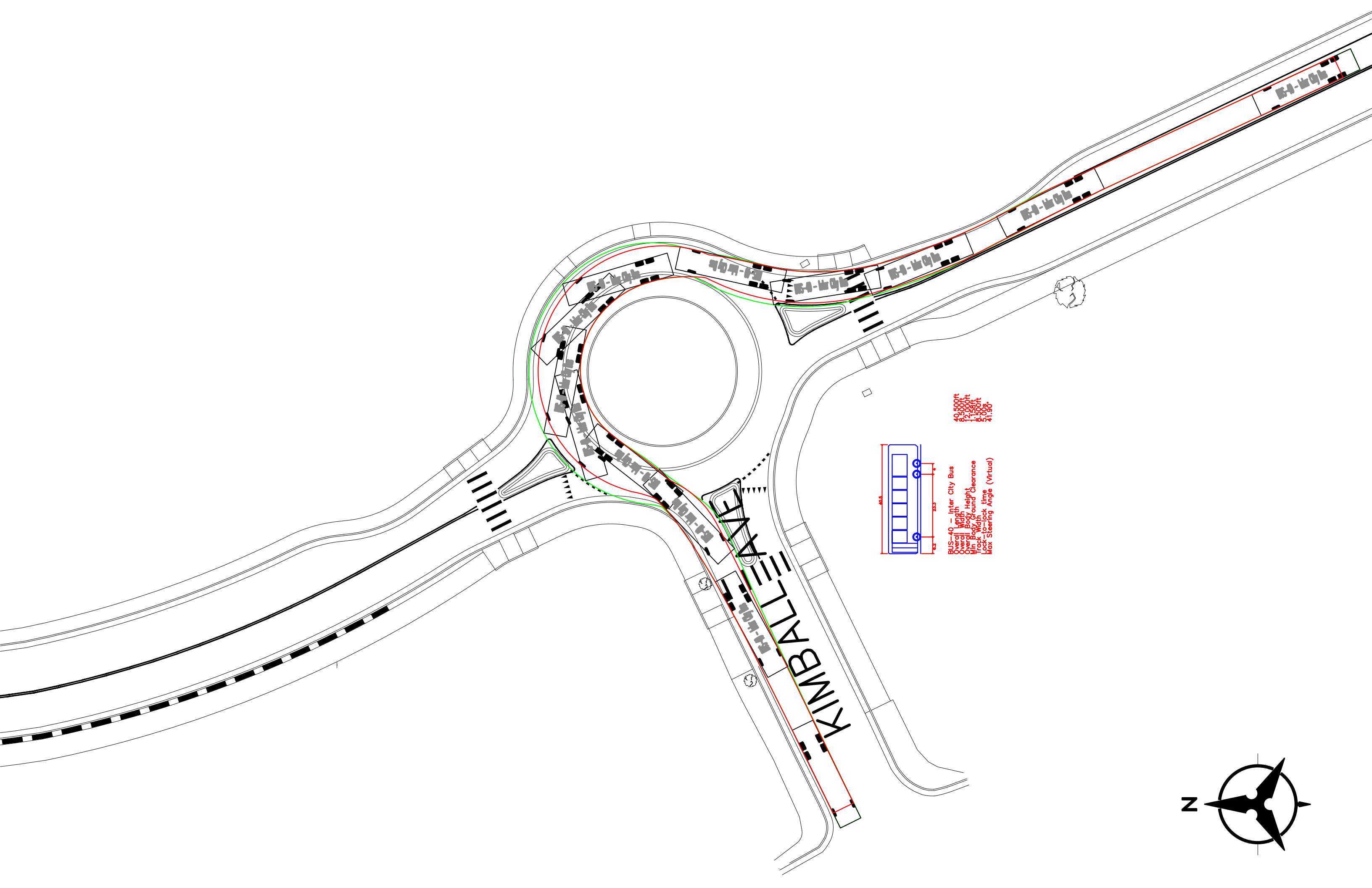




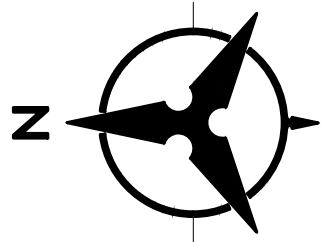


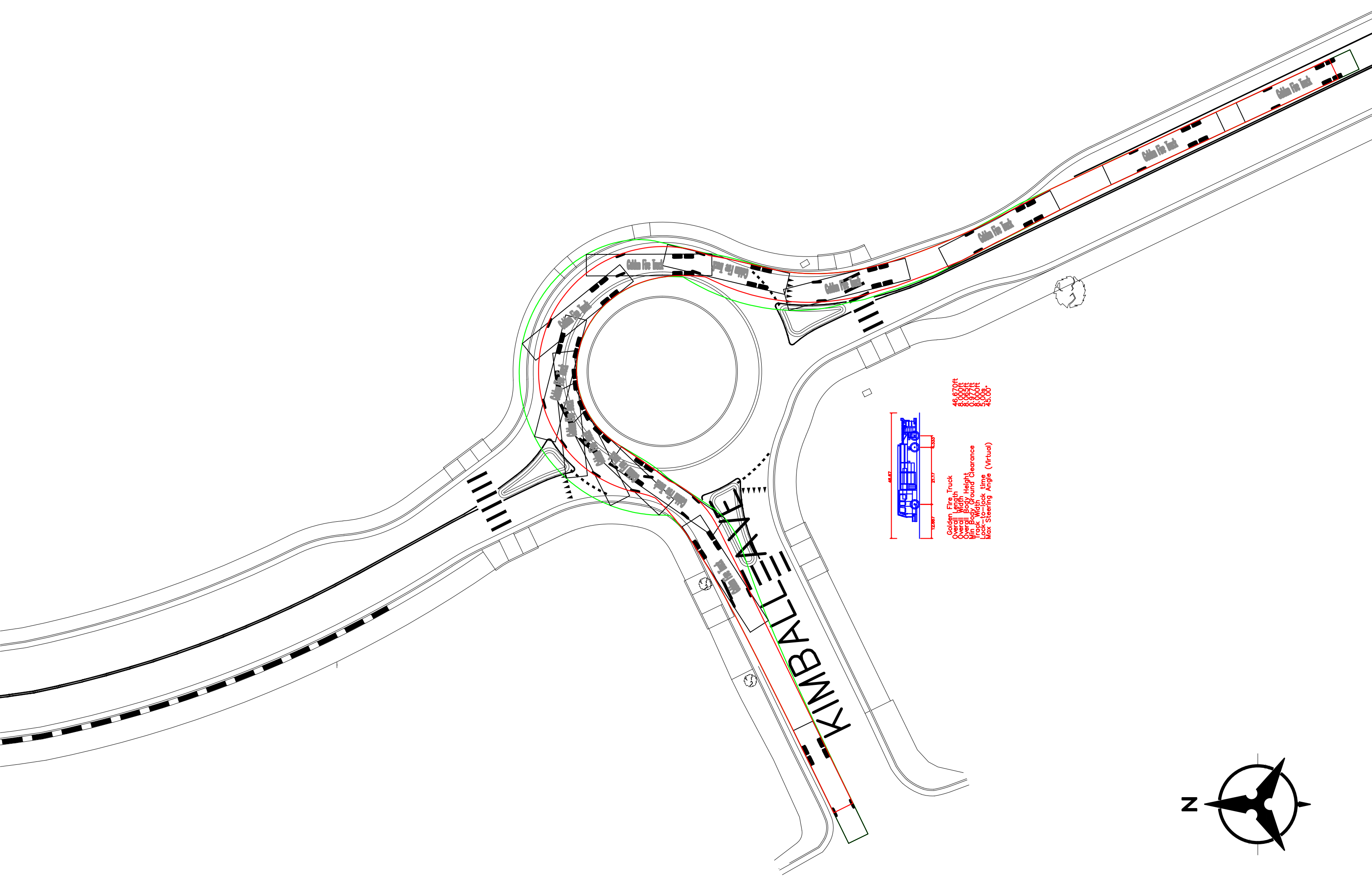
SU-30 - Single Unit Truck
 Overall Length 30.000ft
 Overall Width 8.000ft
 Overall Body Height 13.500ft
 Overall Ground Clearance 8.000ft
 Lock-to-lock time 5.00s
 Max Steering Angle (Virtual) 31.80°

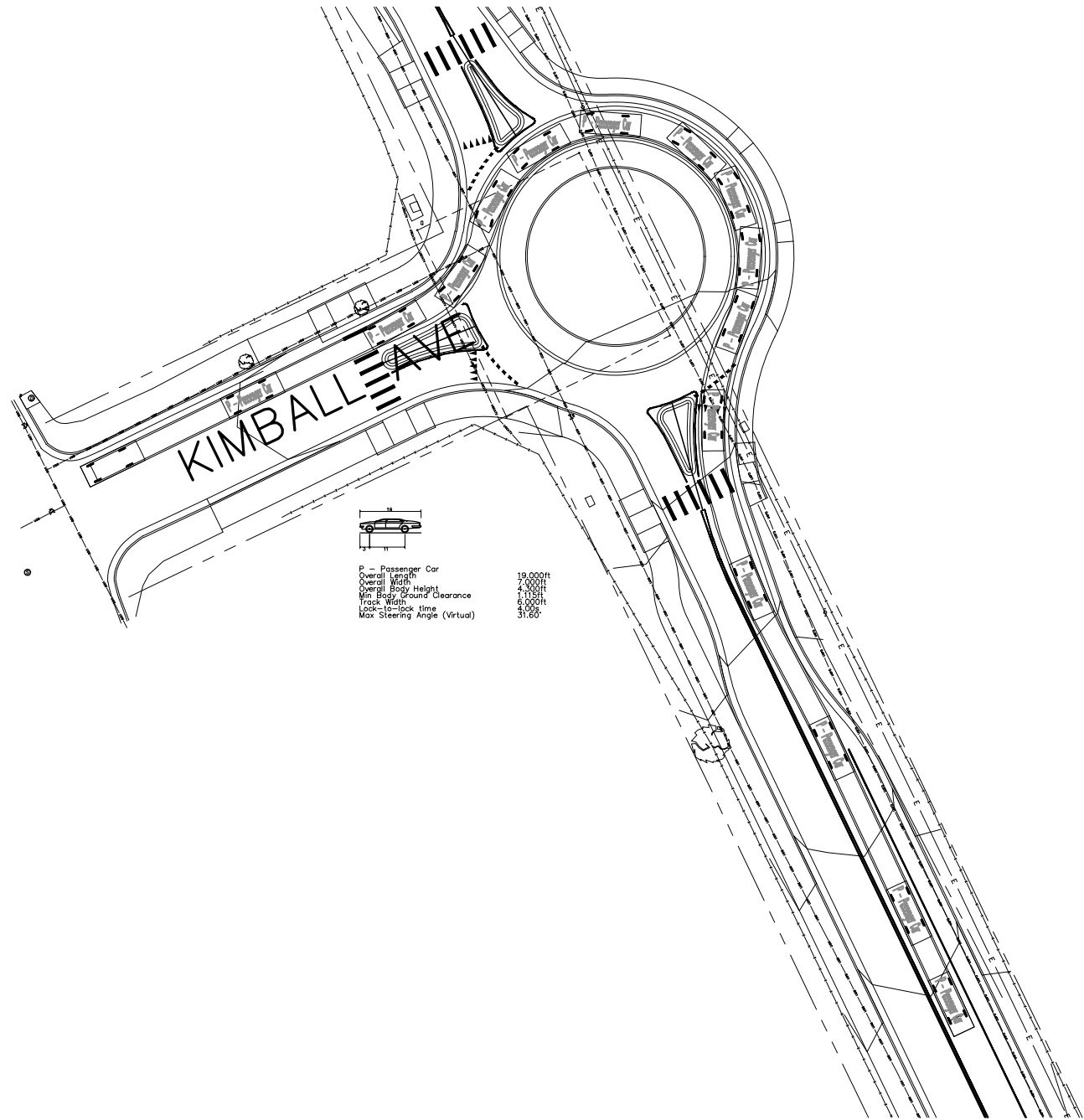
RIDGE RD

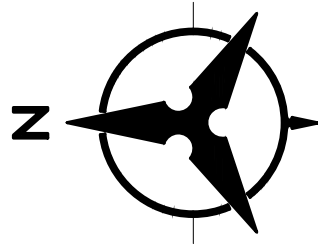
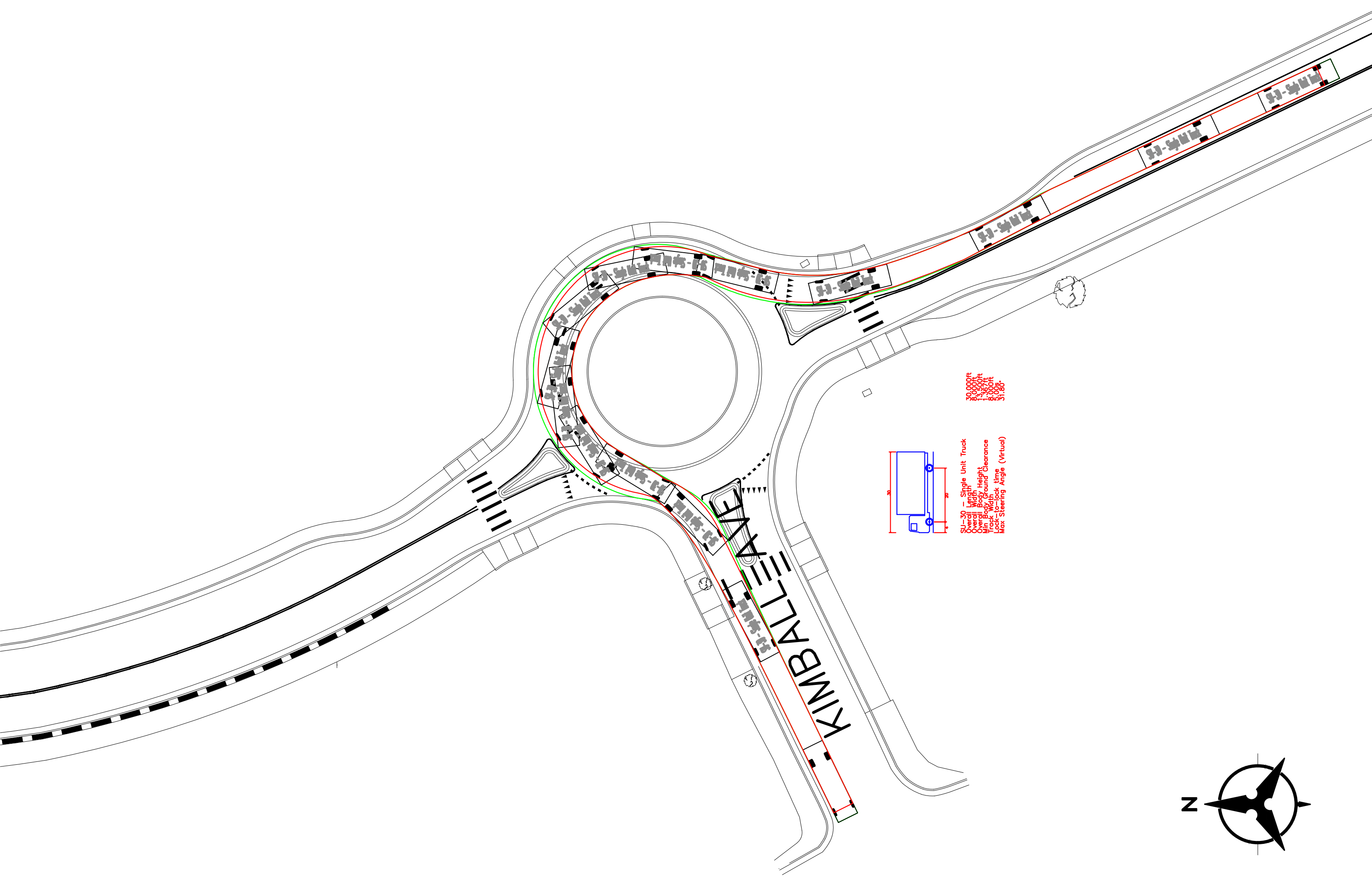


BUS-40 - Inter City Bus
Overall Length 40.500ft
Overall Width 6.200ft
Overall Height 9.200ft
Overall Body Height 1.158ft
Min Body Ground Clearance 8.500ft
Track Width 2.000ft
Lock-to-lock time (Virtual) 4.190s
Max Steering Angle (Virtual)

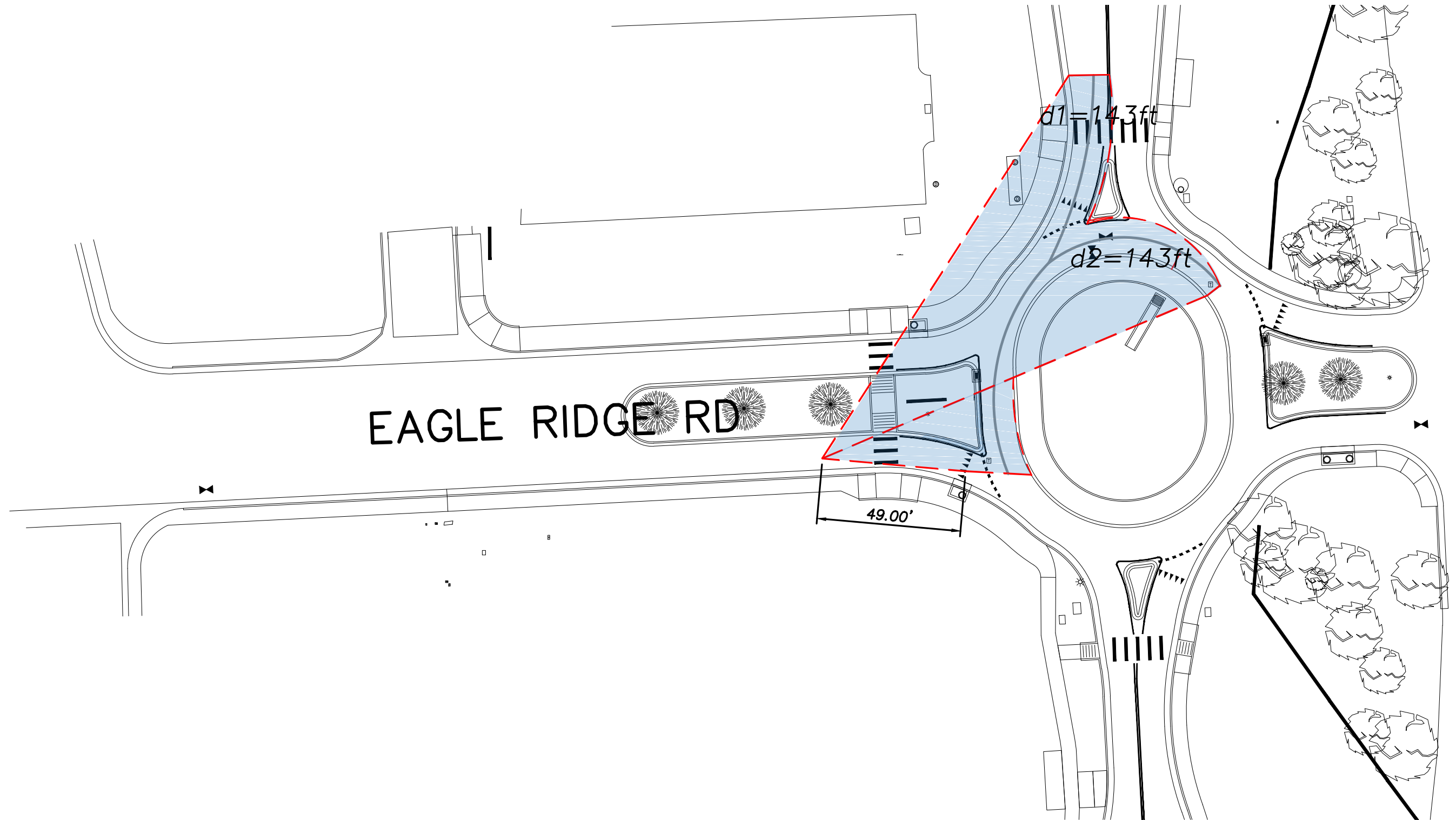


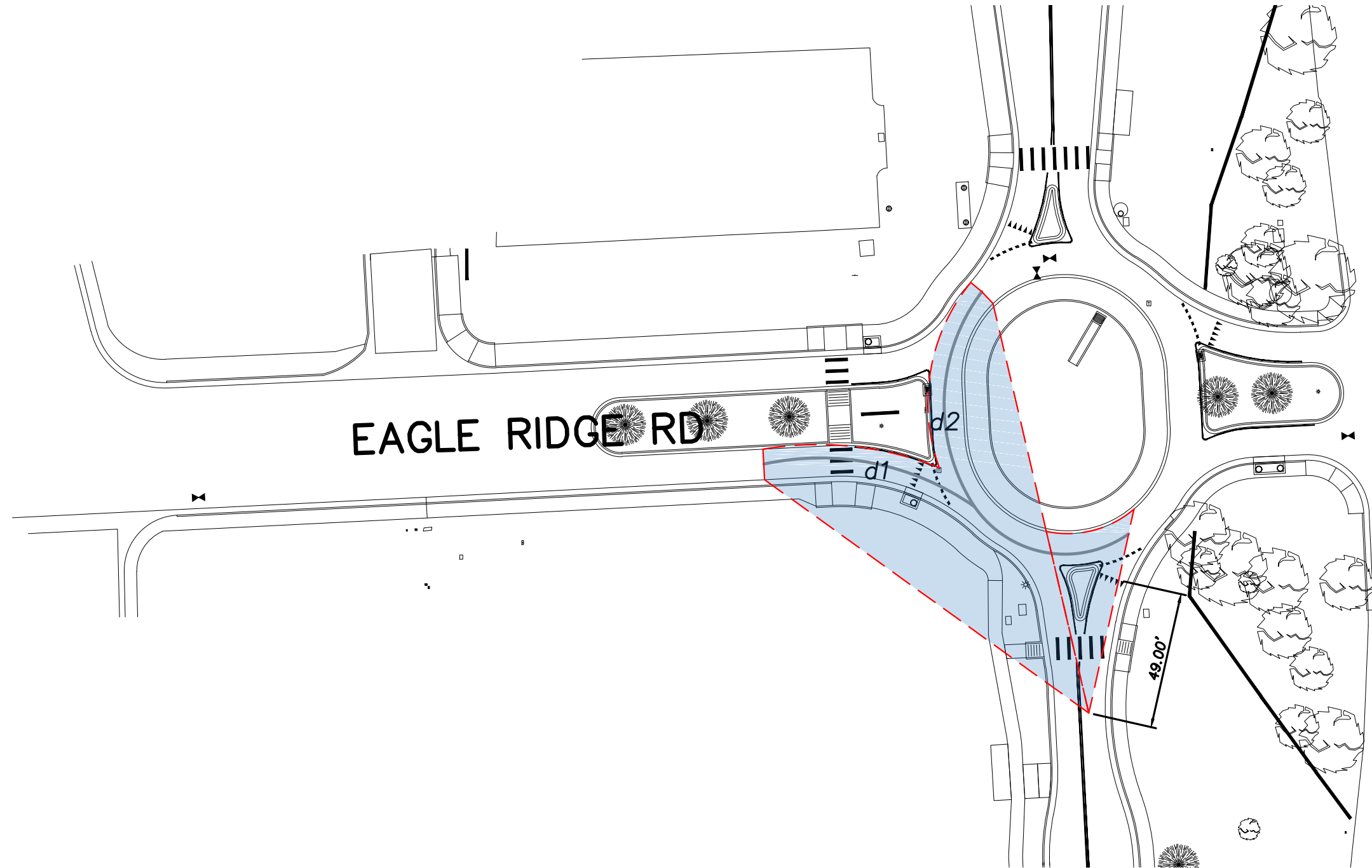


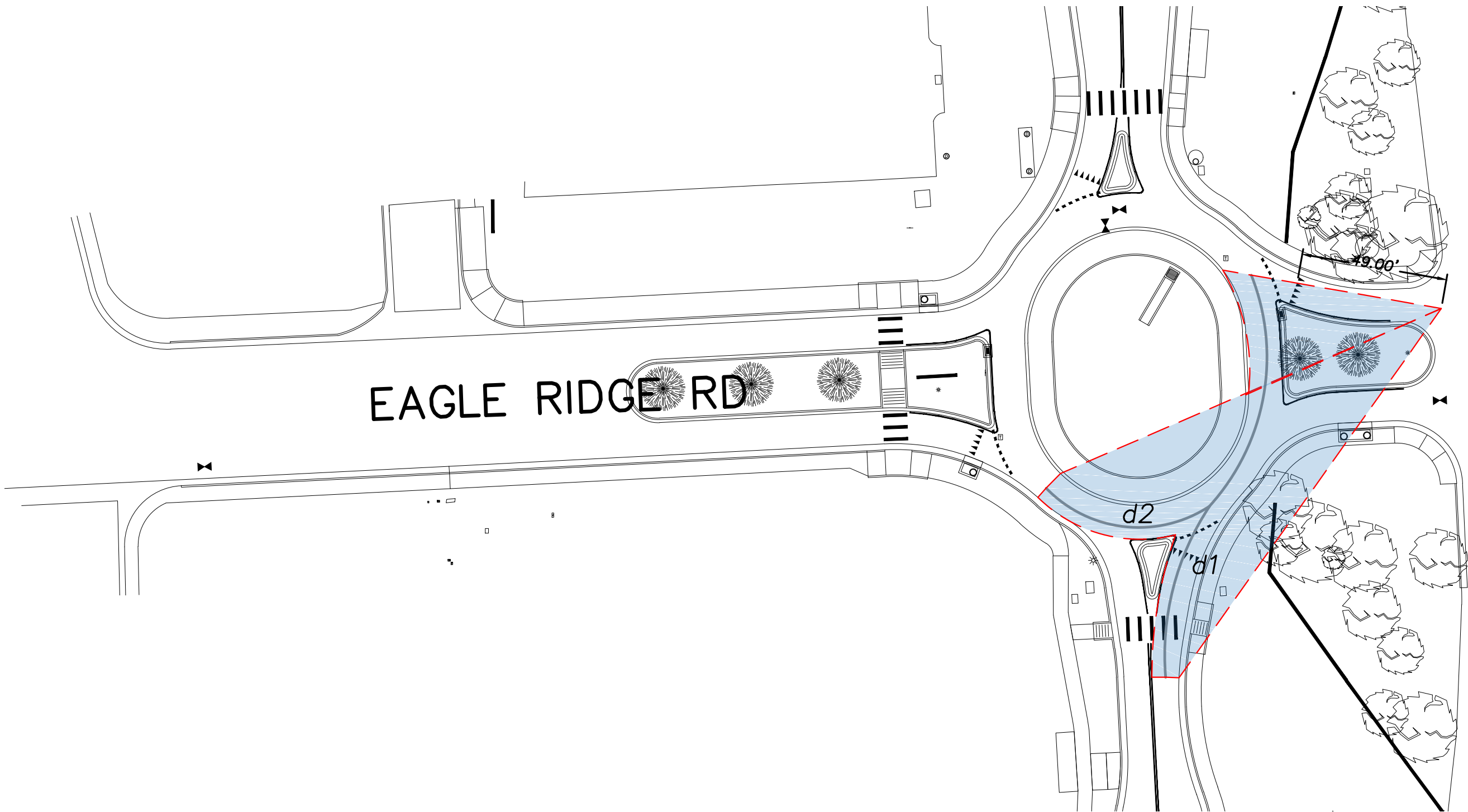


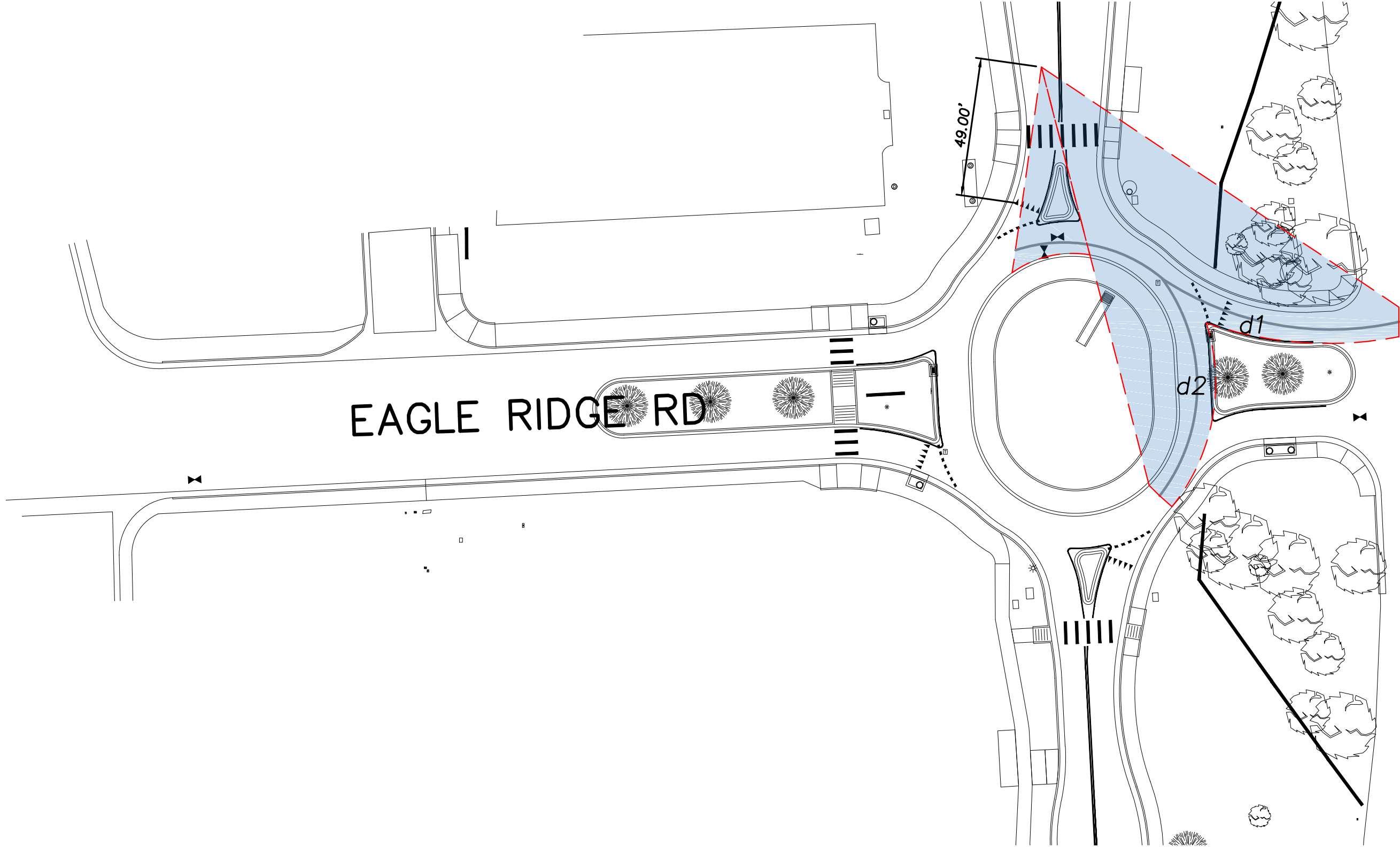


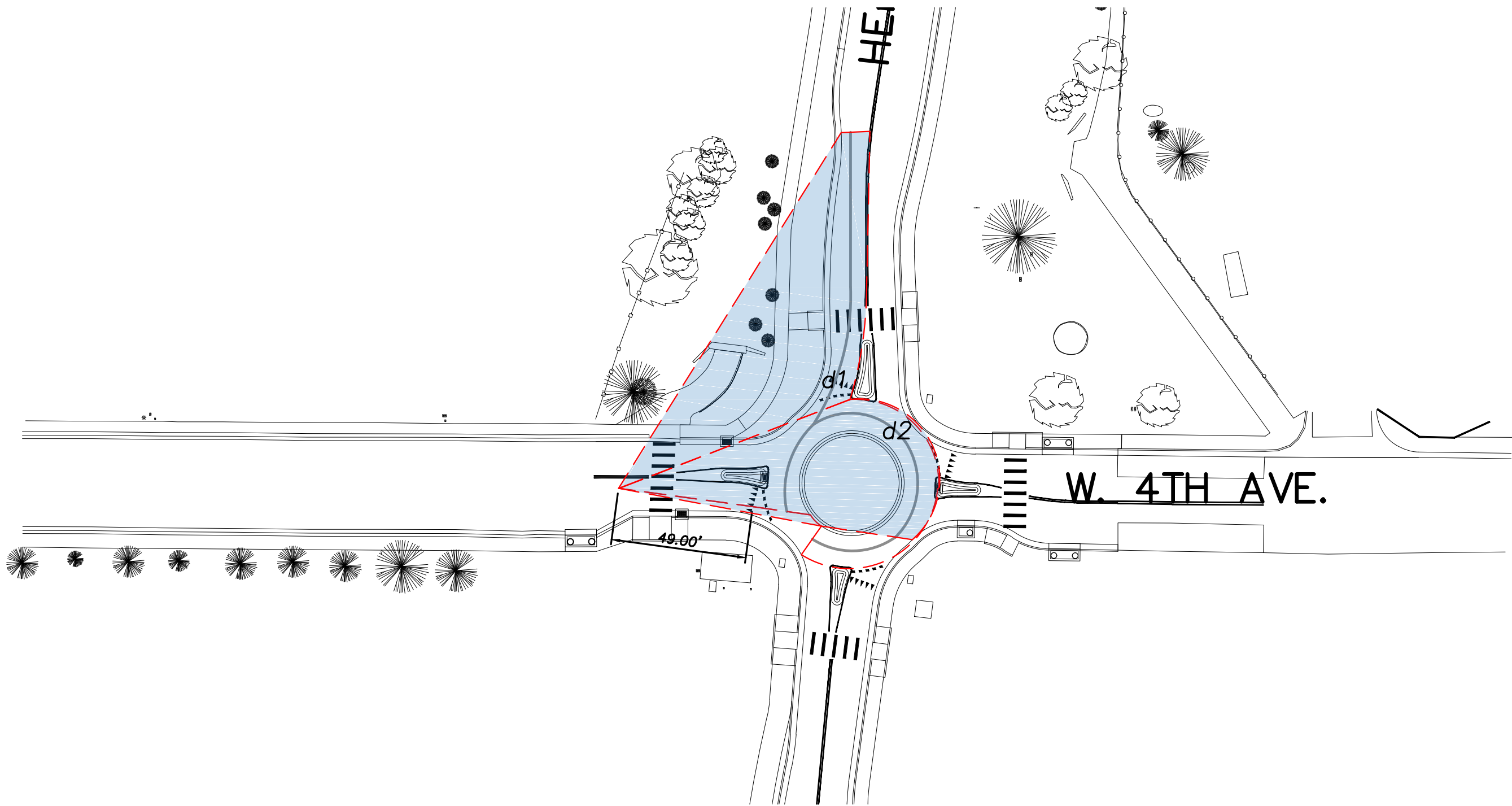
APPENDIX D – SIGHT DISTANCE TRIANGLES

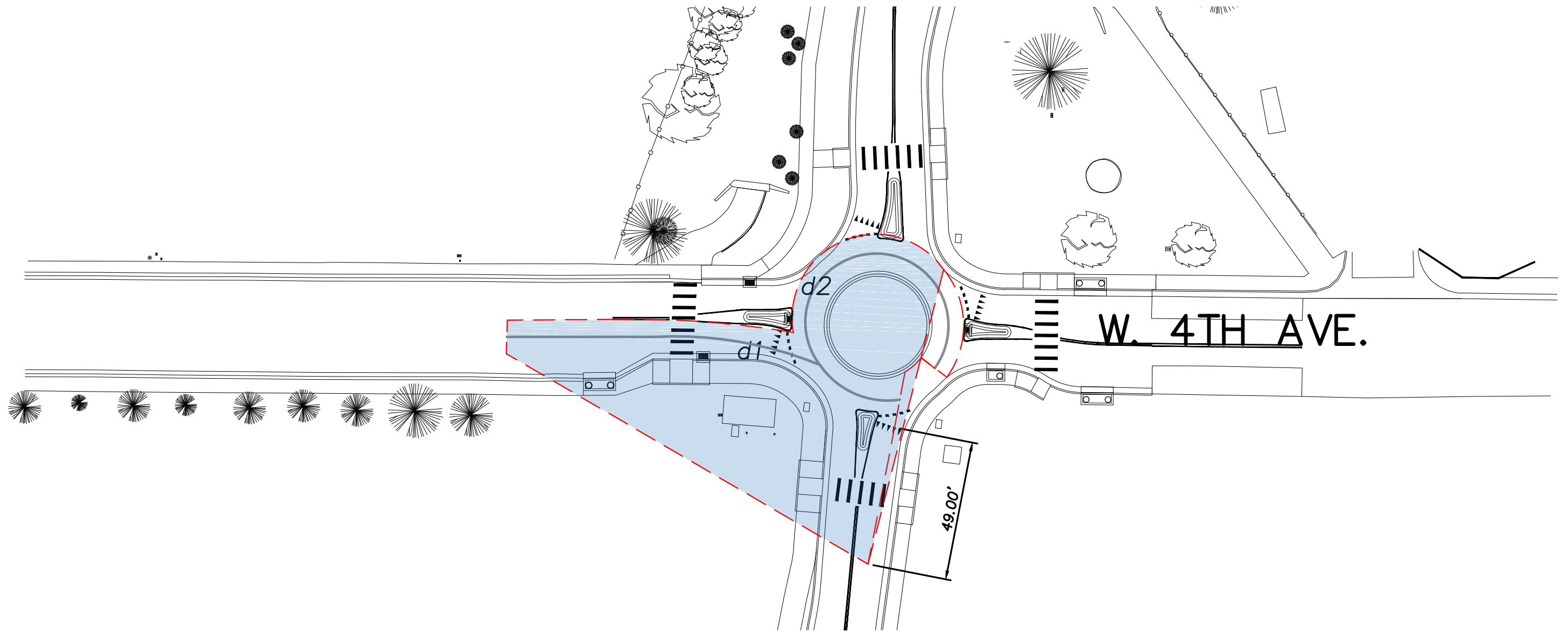


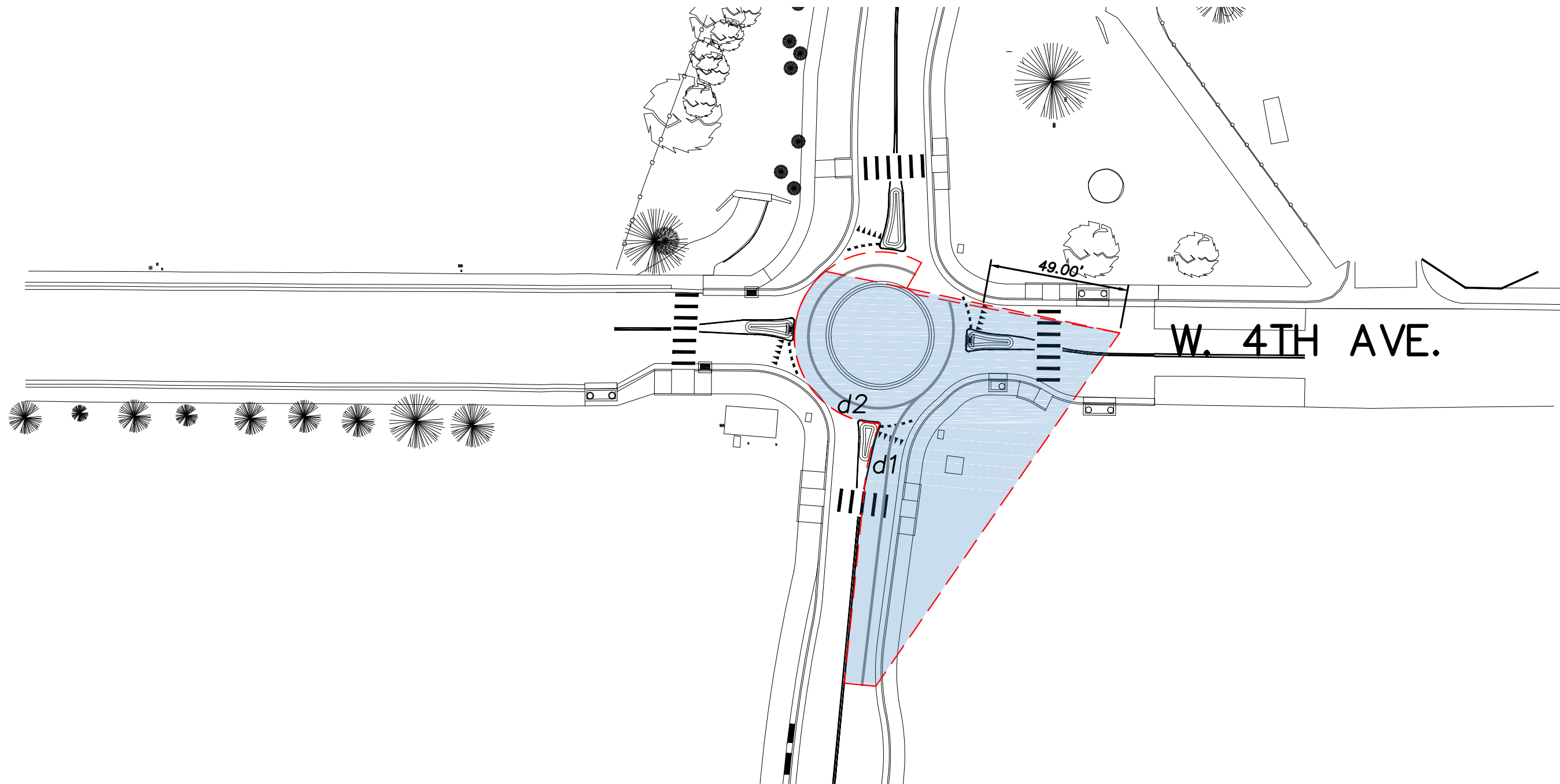


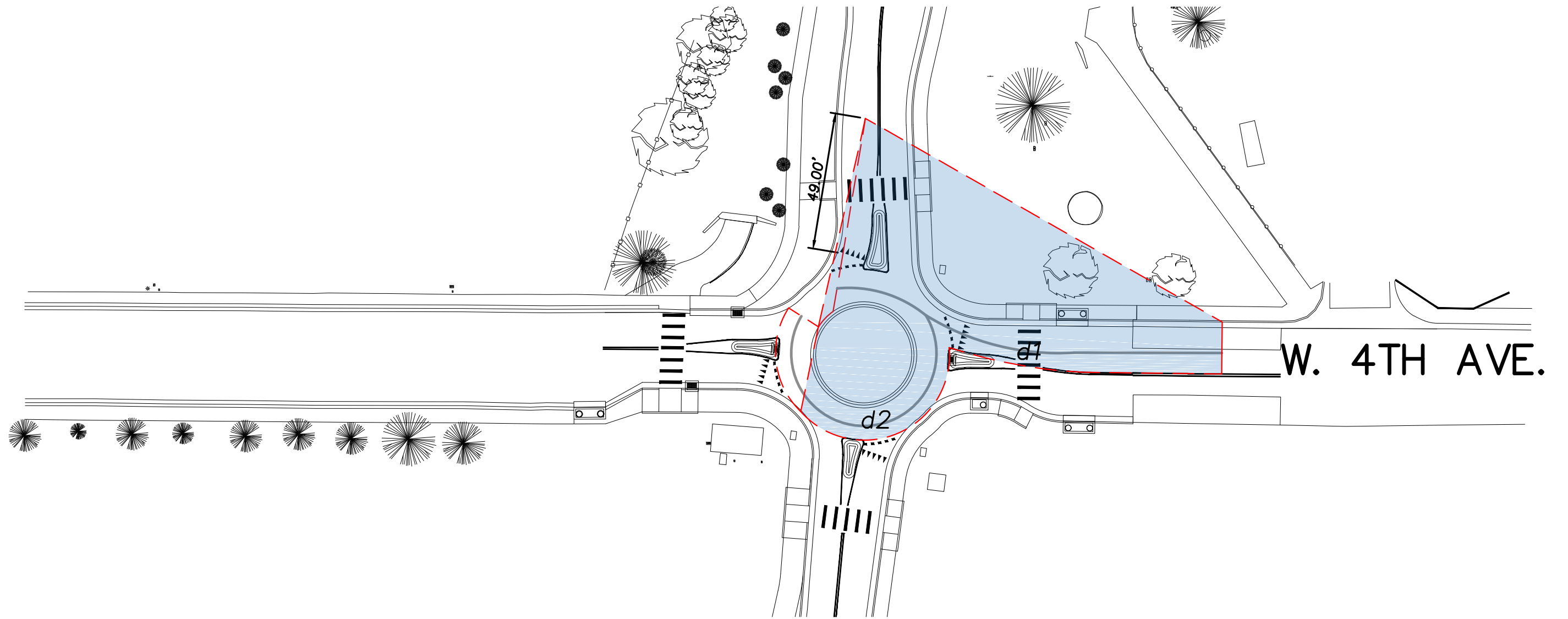


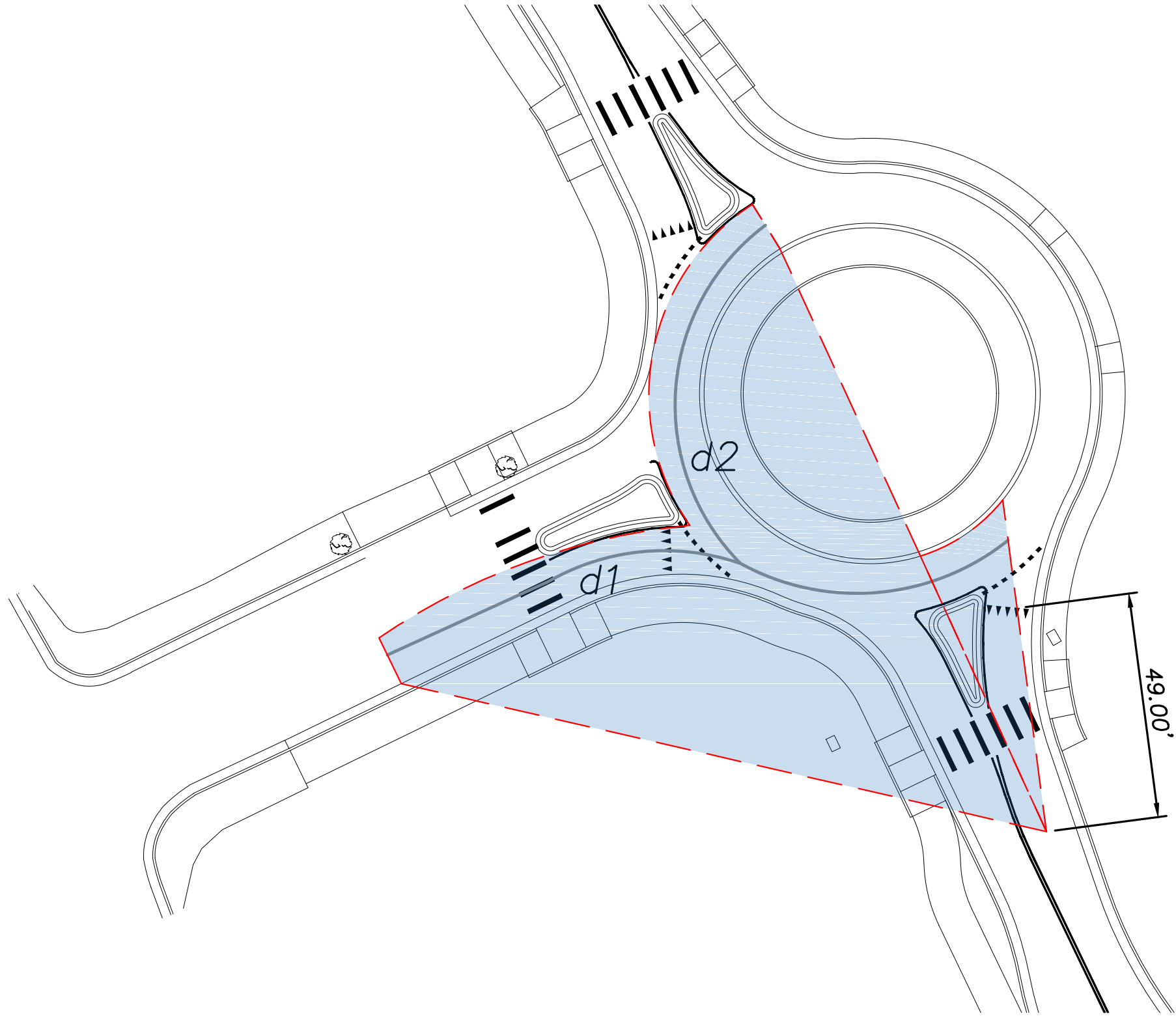


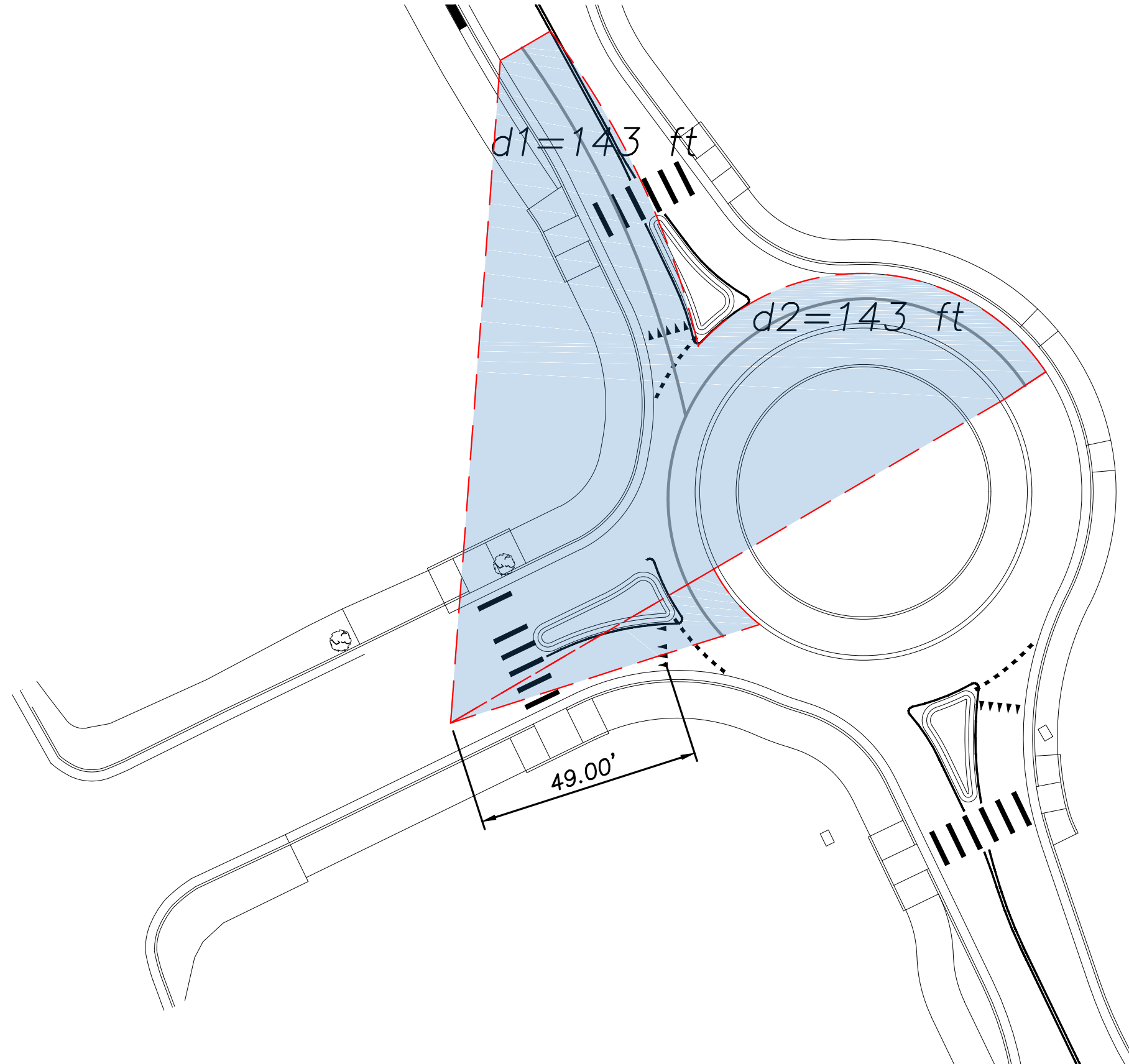


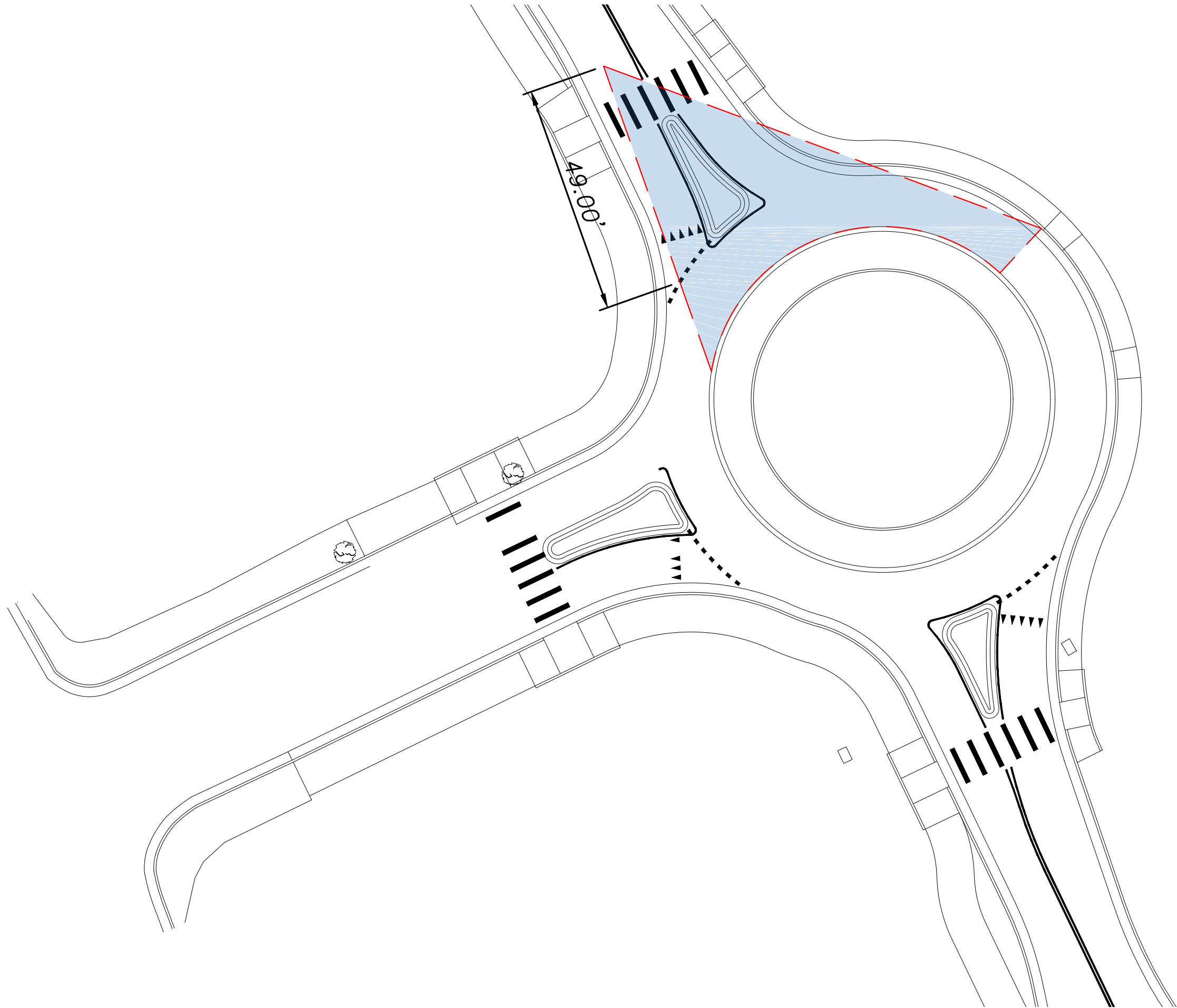












APPENDIX E – COMPREHENSIVE ANALYSIS MATRICES

Eagle Ridge Drive						
	Draft Recommendations	Design Implications	Pedestrian/Bicycle Considerations	Improvements Not Recommended - Why?	Discussion With MTJ (Mark Johnson)	Final Recommendation
High Cost	Convert oval center island to round.	May increase speeds.	Increased speeds affect other users.	Won't address entry/exit issues. Very costly.	Not necessary	
	Relocate drainage pond.	Will require relocation of pond area. Won't improve operations of the roundabout.		Won't prevent drivers from going through the middle. Very costly.	Would be ideal but not necessary. Recommend improve aesthetics and visual queues - remove boulders.	
	Relocate outside curb line to widen entry/exit lanes.	May increase speeds.	May require reduction of pedestrian/bicycle facilities due to ROW limitations. Increased speeds affect other users.	May be able to get similar results from adjusting apron. Very costly. May need ROW acquisition.	Recommend adjusting entry and exit - if ROW allows - but can get same result from apron adjustments.	
	Reduce width/vertical of apron to widen travel lane.	May increase speeds.	Increased speeds affect other users.		Work toward creating consistency amongst aprons - both width and vertical - with a goal to create mountable aprons for the larger trucks (fire trucks) when necessary.	Reduction of width/vertical on apron is recommended but will require further analysis on potential design, drainage, and reconstruction issues.
	Widen sidewalks to accommodate pedestrian and dismounted bicyclists.	Would require construction and may require additional ROW depending on design modifications.	Widening of sidewalks would improve safety and comfort for bicyclists and pedestrians.	Pedestrian facilities work well as is, modifications not recommended due to cost and impact to corridor.	Not needed and won't improve operations of the roundabout.	
Low Cost	Provide break away markers/signage/landscaping around edge of drainage pond.	Need to be considerate of not making it feel/look too chaotic. Consider aesthetics.			Encouraged removal of boulders - addition of more landscaping such as tall grasses.	Remove Boulders - Add tall grass
	Reduce splitter islands to widen entry/exit lanes.	May increase speeds.	Reducing splitter islands will result in a false sense of security for pedestrians.	Ideal scenario allows for wide and long splitter islands but the ROW won't allow it so recommend consistency with narrow splitter islands outside pedestrian access points.	Leave splitter islands in the current locations with the current widths .It is better to be consistent along the corridor.	
	Consider further refining the southbound approach - slowing traffic as much as possible as it enters the roundabout.	May continue to minimize drivers entering the pond/center area.	May provide improved opportunity for bicycle transition on Heritage Road north of Eagle Ridge.		Full support of any recommendation to slow down traffic as it approaches the roundabout.	Further refine single lane on the southbound approach with sharrows/striping.
	Consider sight distance triangle analysis - relocate signage/obstacles and manage vegetation growth.	Won't result in significant benefit but will improve perceived safety for all users.	Better visibility.		Yes. But agrees this is not causing any immediate concerns. It is just good practice and will allow for improved visibility along the entire corridor.	Strive to remove structures within sight distance triangles.
	Integrate consistent visuals (signage/striping/aesthetics) at each roundabout to create consistency and visual queues along the corridor.	Consistent visuals make all users more comfortable.	Consistent visuals make all users more comfortable.		Challenging because two roundabouts can't really accommodate art, but landscaping/pavement markings could be done along the entire corridor to improve consistency and aesthetics.	Place consistent signage/pavement markings before, during, after roundabouts.
	Create bicycle-specific ramps from street to sidewalk.	Applies to southbound direction entering and existing roundabout; applies to northbound direction exiting the roundabout only.	New curb ramps that separate bicyclists and pedestrians provide safety benefits and give bicyclists an additional option for navigating roundabouts.	The construction of bicycle-specific curb ramps at roundabouts is desirable but not required		Where applicable, paint markings delineate the bicycle entrance/exit from the roadway.
	Use sharrow pavement markings at approaches to roundabouts.	No design implications.	Improve awareness for motorists that bicyclists will utilize travel lanes through roundabouts.		Supports use of sharrows whenever possible.	Utilize sharrow pavement markings.

Priority Recommendation

4th Street						
	Draft Recommendations	Design Implications	Pedestrian/Bicycle Considerations	Improvements Not Recommended - Why?	Discussion with MTJ (Mark Johnson)	Final Recommendations
High Cost	Relocate outside curb line to widen travel lanes and entry/exit lanes.	May increase speeds.	Increased speeds affect other users.		Recommended if possible, but may increase speeds through roundabout.	Open up the outside curb line at the 3 corners where the sidewalk has been relocated, and also consider possibility of relocating sidewalk at the remaining corner as well. May require further analysis on potential design, drainage, and ROW issues.
	Widen radius of center circle.	Without moving curb line out, it will reduce opportunity for design vehicles to pass through successfully.		Center circle should remain the same, with a recommendation to relocate the outside curb line to widen travel lanes.	Will increase traffic on center circle, and will have to accept that heavy vehicles (fire trucks) will use mountable apron when necessary.	
	Increase vertical on the apron to prevent travel on the apron.	Without moving curb line out it will cause more conflict because vehicles NEED flat apron to manage current condition.		Not recommended because it won't improve the overall operations of this roundabout.	No. Just own that it is a mini roundabout. Keep mountable curb. Aim to create consistent curb height at all roundabouts.	
	Widen sidewalks to accommodate pedestrian and dismounted bicyclists.	Would require construction and may require additional ROW depending on design modifications.	Widening of sidewalks would improve safety and comfort for bicyclists and pedestrians.	Pedestrian facilities work well as is, modifications not recommended due to cost and impact to corridor.	Not needed and won't improve operations of the roundabout.	
Low Cost	Reduce splitter islands to widen entry/exit lanes.	May increase speeds.	Reducing splitter islands will result in a false sense of security for pedestrians.	Ideal scenario allows for wide and long splitter islands but the ROW won't allow it so recommend consistency with narrow splitter islands outside pedestrian access points.	Leave splitter islands in the current locations with the current widths .It is better to be consistent along the corridor.	
	Consider sight distance triangle analysis - relocate signage/obstacles and manage vegetation growth.	Won't result in significant benefit but will improve perceived safety for all users.	Better visibility.		Yes. But agrees this is not causing any immediate concerns. It is just good practice and will allow for improved visibility along the entire corridor.	Strive to remove structures within sight distance triangles.
	Integrate consistent visuals (signage/stripping/aesthetics) at each roundabout to create consistency and visual queues along the corridor.	No available space (outside the sight distance triangle) within the 4th Ave roundabout for art or landscaping.	Consistent visuals make all users more comfortable.		Challenging because two roundabouts can't really accommodate art, but landscaping/pavement markings could be done along the entire corridor to improve consistency and aesthetics.	Place consistent signage/pavement markings before, during, after roundabouts.
	Create bicycle-specific ramps from street to sidewalk.	In the southbound direction the only connection for bicyclists to sidewalks are at pedestrian crossings; Curb ramps exist in northbound direction to allow bicyclists to exit and enter street.	New curb ramps that separate bicyclists and pedestrians provide safety benefits and give bicyclists an additional option for navigating roundabouts.	The construction of bicycle-specific curb ramps at roundabouts is desirable but not required.	Supports this idea for delineation.	Where applicable, use pavement markings to delineate the bicycle entrance/exit from the roadway.
	Use sharrow pavement markings at approaches to roundabouts.	No design implications.	Improve awareness for motorists that bicyclists will utilize travel lanes through roundabouts.		Supports use of sharrows whenever possible.	Utilize sharrow pavement markings.
	Priority Recommendation					

Kimball Avenue						
	Draft Recommendations	Design Implications	Pedestrian/Bicycle Considerations	Improvements Not Recommended - Why?	Discussions with MTJ (Mark Johnson)	Final Recommendations
High Cost	Convert oval center island to round.	May increase speeds.	Increased speeds affect other users.	Won't address entry/exit issues. Very costly.	Not Necessary.	
	Relocate outside curb line to widen entry/exit lanes.	May increase speeds.	Increased speeds affect other users.	May be able to get similar results from adjusting apron. Very costly. May need ROW acquisition.	Recommend adjusting entry and exit - if ROW allows - but can get same result from apron adjustments.	Curb relocation recommended at the NB exit location but will require further analysis on potential design and ROW issues.
	Reduce width/vertical of apron to widen travel lane.	May increase speeds.	Increased speeds affect other users.		Work toward creating consistency amongst aprons - both width and vertical - with a goal to create mountable aprons for the larger trucks (fire trucks) when necessary.	Reduction of width/vertical of apron is recommended but will require further analysis on potential design, drainage, and reconstruction issues.
Low Cost	Reduce splitter islands to widen entry/exit lanes.	May increase speeds.	Reducing splitter islands will result in a false sense of security for pedestrians.	Ideal scenario allows for wide and long splitter islands but the ROW won't allow it so recommend consistency with narrow splitter islands outside pedestrian access points.	Leave splitter islands in the current locations with the current widths .It is better to be consistent along the corridor.	
	Consider sight distance triangle analysis - relocate signage/obstacles and manage vegetation growth.	Won't result in significant benefit but will improve perceived safety for all users.	Better visibility.		Yes. But agrees this is not causing any immediate concerns. It is just good practice and will allow for improved visibility along the entire corridor.	Strive to remove structures within sight distance triangles.
	Integrate consistent visuals (signage/stripping/aesthetics) at each roundabout to create consistency and visual queues along the corridor.	Consistent visuals make all users more comfortable.	Consistent visuals make all users more comfortable.		Challenging because two roundabouts can't really accommodate art, but landscaping/pavement markings could be done along the entire corridor to improve consistency and aesthetics.	Place consistent signage/pavement markings before, during, after roundabouts.
	Create bicycle-specific ramps from street to sidewalk	Applies to northbound direction entering the roundabout only; ramps are present exiting the roundabout in the northbound direction and both before and after the roundabout in the southbound direction	New curb ramps that separate bicyclists and pedestrians provide safety benefits and give bicyclists an additional option for navigating roundabouts.	The construction of bicycle-specific curb ramps at roundabouts is desirable but not required	Supports this idea for delineation.	Where applicable, use pavement markings to delineate the bicycle entrance/exit from the roadway.
	Use sharrow pavement markings at approaches to roundabouts.	No design implications.	Improve awareness for motorists that bicyclists will utilize travel lanes through roundabouts.		Supports use of sharrows whenever possible.	Utilize sharrow pavement markings.

Priority Recommendation

Heritage Road - Corridor						
	Draft Recommendations	Design Implications	Pedestrian/Bicycle Considerations	Improvements Not Recommended - Why?	Discussions with MTJ (Mark Johnson)	Final Recommendations
<u>High Cost</u>	Widen bicycle lanes between Eagle Ridge and Kimball; widen mountable curb to achieve 4:1 grade	Raised bike lanes could be widened to meet national design recommendations; mountable curbs could be redesigned to improve access to and from facilities for bicyclists	Wider bicycle lanes would improve bicyclist safety and comfort; mountable curbs are steeper than recommended	Though the current widths do not align with NACTO guidance for raised bicycle lanes, the costs of widening the existing facilities are considered greater than the value of the benefit.	Not necessary.	
<u>Low Cost</u>	Consolidate signage along corridor to improve sightlines and promote consistency at each roundabout.	Need to consider placement outside the sight distance triangle.	Consistency is good for all users.		Concerned about inconsistent and excessive signage at roundabouts.	Consolidate signage along corridor to improve sightlines and promote consistency at each roundabout.
	Clarify signage/markings related to bicyclists to manage expectations for motorists and cyclists		"Bike Lane Ends" signs are included approaching 4th St and Kimball Ave in the southbound direction and approaching 4th Ave and Eagle Ridge Dr in the northbound direction. No guidance is provided for bicyclists on how to navigate roundabouts.		Concerned about lack of identification for bicycle facilities. Supports broad use of sharrows and additional green paint.	Green paint and pavement markings at decision points - enter/exit - and along bicycle facilities. Sharrow markings through the roundabout.
	Improve pavement markings for pedestiran crossings.	Due to minimal pedestrian refuge points, cross walks need to be emphasized.	Pedestrians benefit with crosswalks are clearly marked for both the pedestrian and the vehicle.			Enchance exisitng crosswalk markings with enhanced paint and additional hashmarks in crosswalks.
	Add sharrows north of Eagle Ridge Dr	Heritage Rd is a designated bicycle facility from US 6 to US 40, but the only bicycle lanes are between Eagle Ridge Dr and Kimball Ave (and Berthoud Way in the southbound direction).	Sharrows would provide delineation to both bicyclists and motorists.		Concerneda bout bicycle connections in this area and supports suggestions for adding sharrows.	Add sharow pavement markings north of Eagle Ridge Dr.
	To improve aesthetics consider consistent landscaping/art along the side of the roadway instead of the roundabouts	Must be low so as not to impede sight triangle	Often provides additional buffer from vehicles		Suggested and supported this opportunity.	Place low landscaping options between sidewalks and bicycle lanes and/or traffic lanes, where applicable.
	Implement traffic calming between Kimball and south end of Heritage Road.	May improve awareness of roundabouts, slow traffic down before roundabout.	Improves environment for bicycle and pedestrian.		Suggested this as a way to make the speed along Heritage more consistent corridor-wide so the slow down at the roundabouts will feel less drastic.	Recommend lane narrowing in the northbound direction and addition of sharrow pavement markings.

Priority Recommendation