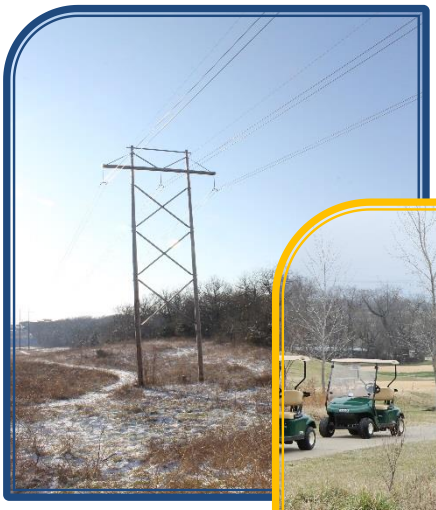
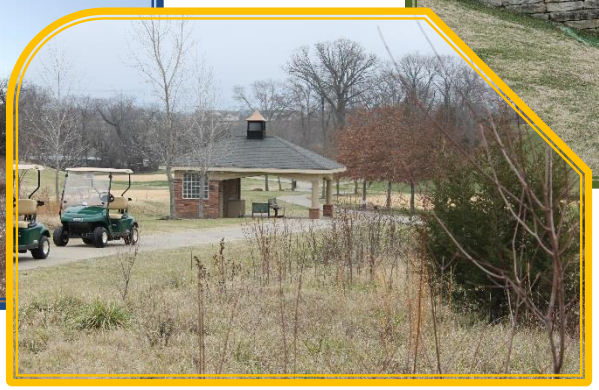
CONCEPT STUDY AND REPORT

Clear Creek Parkway Improvements

From Clare Road to K-7 Highway

City of Shawnee, Johnson County, Kansas
Shawnee Project No. 3413





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1. EXECUTIVE SUMMARY

This Concept Study and Report of the Clear Creek Parkway extension to Clare Road is for the City of Shawnee. The existing conditions of the proposed alignment go through mostly undeveloped land and the Shawnee Golf & Country Club, with the alignment influenced by future developments planned along the corridor.

1.1 Project Overview

This study and report analyzes alternatives for the extension of Clear Creek Parkway from approximately 3000 feet south of the 55th Street intersection with Clare Road and proceeds east to the existing termini of Clear Creek Parkway just west of the K-7 overpass. The study has considered alignment options for the roadway as well as the future intersection of Clear Creek Parkway with Gleason Road and the interaction of the parkway with the existing golf course.

Additional considerations include the path of the parkway was determined using the existing topography, drainage, and property lines among other influences encountered. This roadway is classified as a major collector.

1.2 Existing Conditions

The proposed Clear Creek Parkway runs over undeveloped land, which has mainly been used for agriculture, and through the existing Shawnee Golf & Country Club Property. After the parkway has been completed, the land will begin to develop with single family and multi-family residential areas. A small portion of the project at the east end has no known development plans.

Right-of-way was established using existing property lines and aforementioned development plans, including those from the future subdivisions, Shawnee Golf & Country Club and right-of-ways for Gleason Road, Hedge Lane and Clare Road.

The terrain of the proposed area is generally rolling, sloping north to south. The proposed alignment follows this, making sure to stay even with the elevations of the existing pond dams. The soil of the area is generally topsoil and clay, although some bedrock was also found to be present.

There are two existing trail ends within the study corridor that will be tied together with this project. The first runs along the south side of the existing portion of Clear Creek Parkway. The second is approximately 875 feet south of Clear Creek Parkway, west of K-7 near Clear Creek that ends just east of the golf course.

Six basins make up the existing drainage area and were found to either collect into tributary streams that run south to Clear Creek or into existing agricultural ponds that will stay with the proposed developments. Few utilities exist, as land is undeveloped, but Westar does have some high-voltage electric power lines crossing the project.

1.3 Proposed Improvements

The proposed improvements of this project extend Clear Creek Parkway to Clare Road with a 3-lane typical section with curb and gutter and an enclosed stormwater system. While development of the area has dictated the roadway classification to be a major collector, many other factors played into the actual

alignment of Clear Creek Parkway, including the proposed Canyon Lakes Subdivision, existing overhead power lines, Shawnee Golf & Country Club and the existing pond dams. The existing power lines have proven to be the most limiting element in the study corridor as there is a tower structure close to one of the proposed alignments that would be covered in more fill than Westar allows. The second horizontal alignment takes the roadway further from the power poles to reduce the fill. Coordination with Westar has already begun regarding allowable impacts within their existing easement. According to their direction their allowable impacts within the easement include, relocation of the poles, relocation of the roadway alignment or constructing a retaining wall around the poles. Both asphalt and concrete paving options are also discussed, although the roundabout will be concrete with either option.

For the proposed trail connection, four alternatives were developed and analyzed to reconnect to the parkway trail. The recommended alternative is Option 2, as the length and slopes best meet the trail needs and requirements.

The drainage for each alignment alternative are relatively similar, with the main difference being the final intersection type selected where Clear Creek Parkway meets with Gleason Road.

The three intersection alternatives are based on the intersection types – stop control on Gleason Road, traffic signal, and roundabout. There are few differences among these alternatives, although the roundabout design will require more right-of-way and slightly affects the vertical profile.

1.4 Intersection Analysis/Traffic Study

This study examined three alternatives for the future intersection of Clear Creek Parkway and Gleason Road, stop-control, signalized, and a roundabout. Traffic counts were estimated using the zoning types in Shawnee's transportation plan with the Institute of Transportation Engineer's *Trip Generation* manuals. The estimated counts were compared to actual traffic counts at nearby similar intersections and were found to be reasonable and comparable.

Each alternative was preliminarily designed and evaluated with the assumption of the land being fully developed, using operations, safety, driver expectancy, sustainability, aesthetics and cost of construction as evaluation parameters.

The recommended intersection is Alternative 3 - roundabout as it will be able to handle traffic volumes acceptably, costs less than a traffic signal, increase safety, be the most sustainable, and has the most opportunity to be aesthetically pleasing.

1.5 Evaluation of Alternatives

The shifted alignment, which takes the roadway away from the power poles, is the recommended alignment. For the intersection with Gleason Road, alternative 3, a roundabout at Gleason Road, is the recommended intersection alternative as it provides the most benefits, safety and opportunity for aesthetic treatments, as well as fits the general character of the corridor.

The estimated construction costs of the recommended improvements is $5,475,773.30 for the asphalt pavement option and $6,013,085.50 for concrete pavement.

2. PROJECT OVERVIEW

This study and report is to understand and propose a preferred alternative to connect the existing Clear Creek Parkway just west of K-7 to Clare Road. This 5500' east-west road will be designated as a major collector by the City of Shawnee. The westerly half of the project is within the Canyon Lakes plat. The easterly half primarily traverses the Shawnee Golf & Country Club golf course. Vertical and horizontal alignments, typical sections, intersection configurations at Gleason Drive, and drainage issues have been considered during the study. A proposed intersection at the future location of Gleason Road has been studied using both a roundabout and a T intersection alternatives. Sidewalks and pedestrian/bicycle trails have been included, as well as a grade separated crossing for golf carts. The Clear Creek alignment is close to two existing pond dams, which poses special geotechnical concerns. Lastly, there is an existing high voltage power line with poles adjacent to the proposed alignment.

2.1 Project Limits

Approximately 3000 feet south of the 55th Street intersection with Clare Road is the proposed Clear Creek Parkway intersection with Clare Road and the western terminus of project. The eastern terminus will extend Clear Creek Parkway westerly from the existing intersection with Hedge Lane Terrace, which is approximately 400 feet west of the Clear Creek Parkway bridge over K-7. Existing topography, drainage, property lines, plats, as well as the golf course layout are all issues that affected the horizontal alignment layout.

2.2 Purpose and Need

Clear Creek Parkway is a major collector and is intended to be a low-to-moderate-capacity road which moves traffic from residential properties and minor collectors to the arterial street network. Two subdivisions, specifically Canyon Lakes Residential Subdivision and the Shawnee Golf & Country 2nd Plat, have been platted and are working their way through the City of Shawnee's approval process. These subdivisions are proposed at full build-out to include multiple residential lots and apartment units, generating additional trips daily. In response to that forthcoming traffic load, Clear Creek Parkway is proposed to provide an efficient means to safely deliver those motorists to Clare Road, Hedge Lane Terrace, and Silverheel Street. From there, traffic can proceed to Shawnee Mission Parkway, Johnson Drive or Kansas State Highway 7.

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3. EXISTING CONDITIONS

Clear Creek Parkway is proposed to traverse undeveloped land which is generally former agricultural fields and light forest. The existing terrain along the corridor generally consists of rolling hills, with the westerly portion more rolling and the easterly portion generally flatter. Drainage patterns generally flow from north to the south before joining with Clear Creek stream, approximately ¾ of a mile south of the roadway corridor. Existing soil conditions within the project corridor vary and are discussed later in this report.

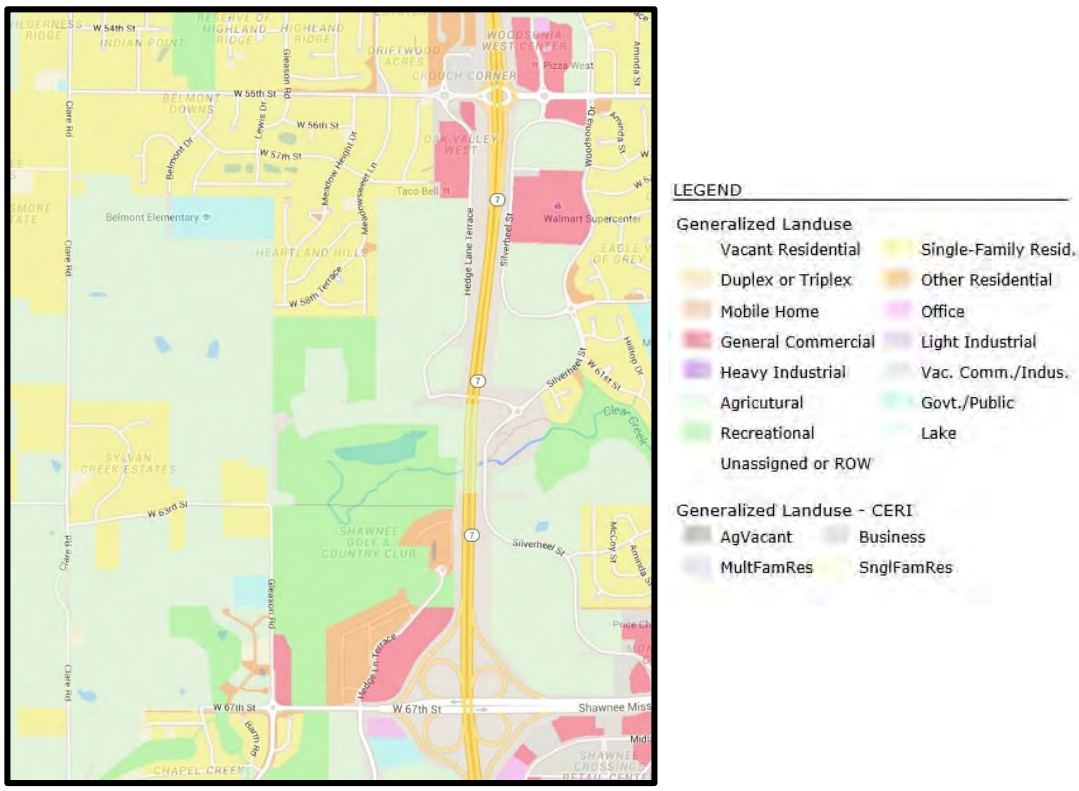
3.1 Land Use

The existing and proposed land use are described below.

3.1.1 Existing Land Use

The existing land use varies between the westerly 3000 feet of alignment and the easterly 2000 feet of alignment. On the west end, the latest use of the land continues to be undeveloped and agricultural in nature. The eastern side of the proposed project winds through property acquired by the Shawnee Golf & Country Club. The alignment is not anticipated to impact any of the golf course infrastructure. See Figure 3.1 - Existing Land Use for an illustration of existing land use as shown on Johnson County AIMS.

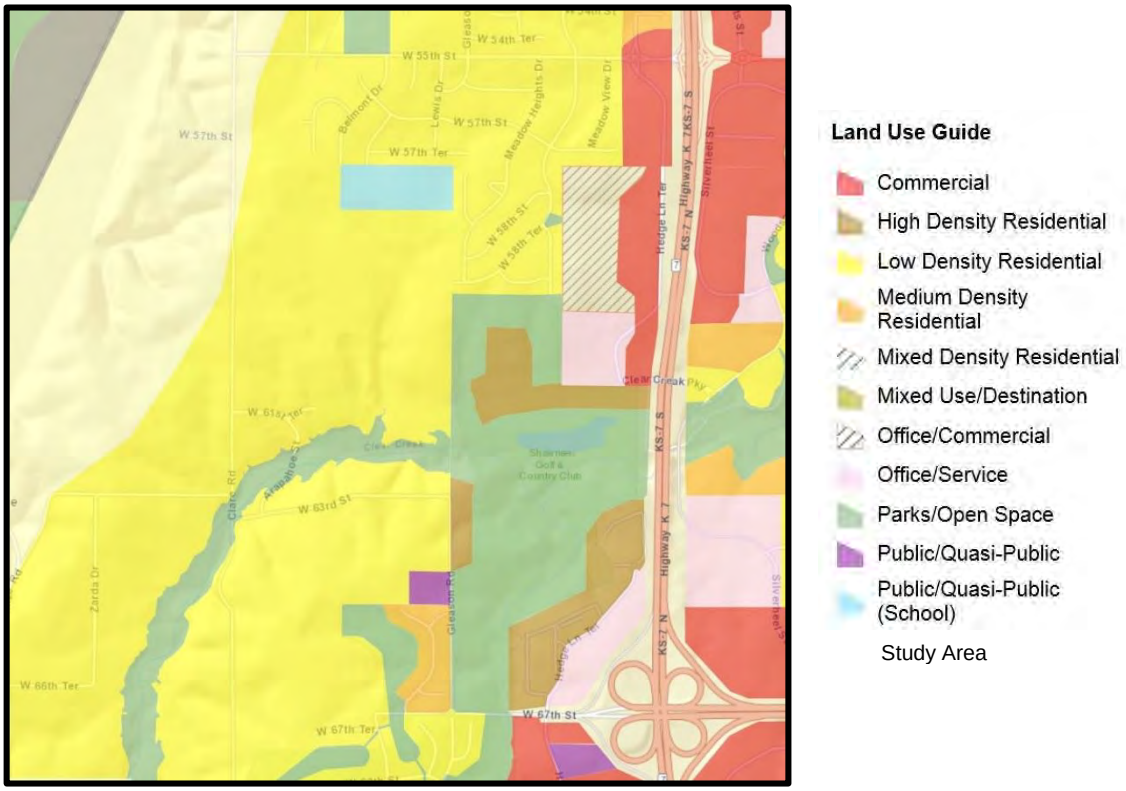
Figure 3.1 - Existing Land Use



3.1.2 Future Land Use

The future land use also varies between the westerly 3000 feet of alignment and the easterly 2000 feet of alignment. On the west end, the future use of the land will be single family residential. The eastern side of the project winds through property that will remain as the Shawnee Golf & Country Club, other property designated as multi-family residential, and one property designated for future office and commercial use. See Figure 3.2 - Future Land Use and Zoning for an illustration of future land use based on zoning as shown on Shawnee's Land Use Guide.

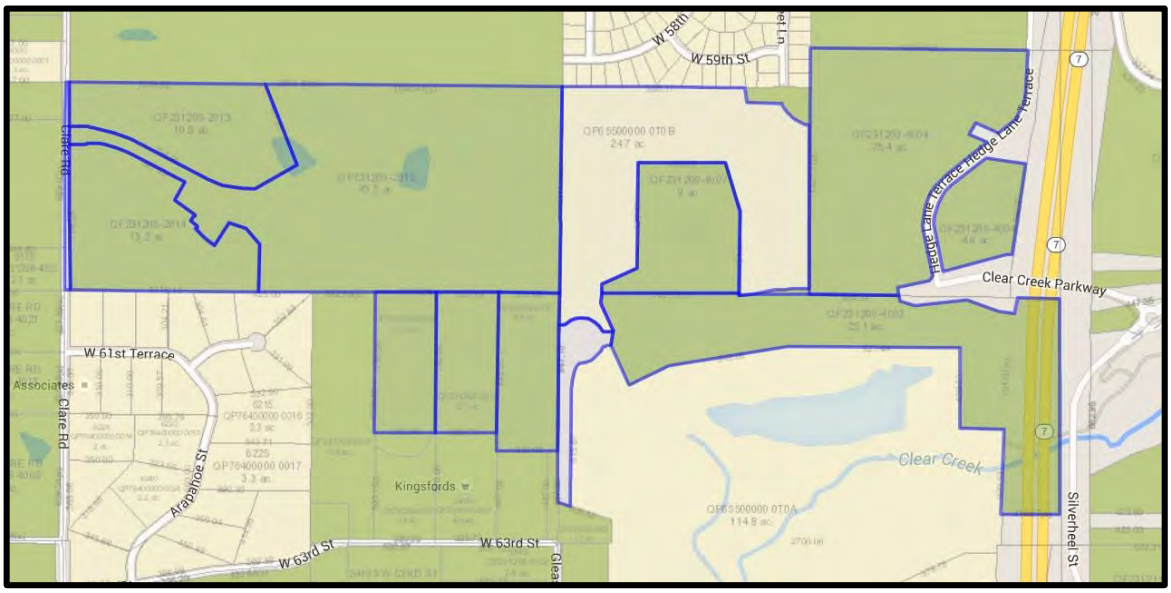
Figure 3.2 - Future Land Use and Zoning



3.2 Established Right-Of-Way and Property Lines

There are several established right-of-way lines and property lines within the project corridor. The right-of-way depicted in the preliminary plats for the Canyon Lakes residential subdivision and Shawnee Golf and Country Club were used to develop the horizontal alignment of Clear Creek Parkway. Additionally, the right-of-way already dedicated for Gleason Road was considered. See Figure 3.3 - Established Property Lines for established property lines as shown on Johnson County AIMS.

Figure 3.3 - Established Property Lines



3.2.1 Clare Road Right-Of-Way

Clare Road, at the western end of the corridor, is a north-south road that is shown on the City of Shawnee's Circulation Plan with a future classification as a minor arterial with 2 to 4 lanes. See Figure 3.4 - Circulation Plan in Vicinity of Project for a portion of the Circulation Plan relating to this project. The existing roadway is a rural design consisting of a narrow two-lane roadway and roadside ditches. The existing right-of-way width is 20 feet on the west side and 20 to 30 feet on the east side. The future right-of-way width will be 80 to 120 feet as shown in the City of Shawnee street design standards for this class of roadway.

Figure 3.4 - Circulation Plan in Vicinity of Project

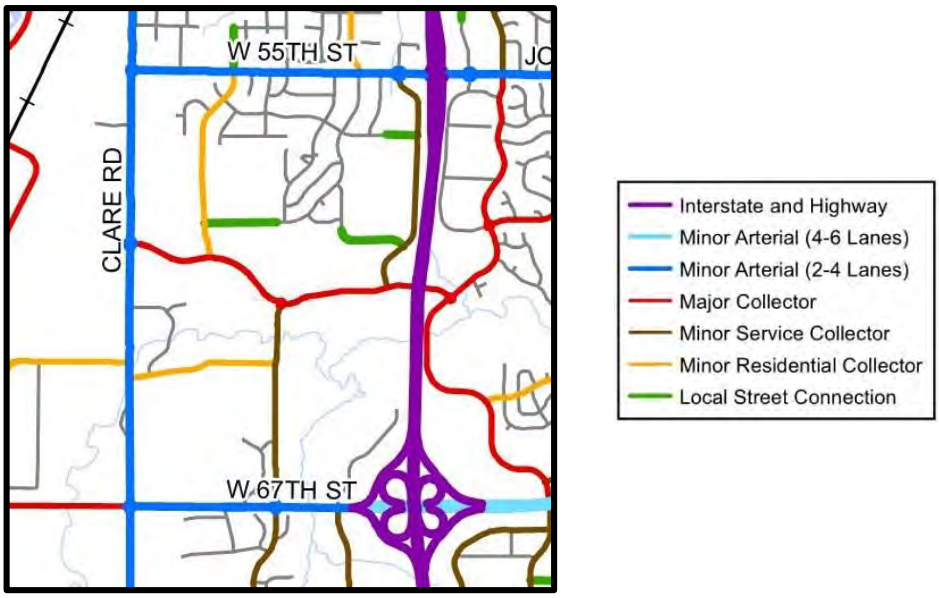


Figure 3.5 - View of Existing Clare Road

3.2.2 Canyon Lakes Residential Subdivision

Canyon Lakes is a proposed residential subdivision being developed by Prieb Homes, Inc. A preliminary plat has been submitted for approval to the City of Shawnee. This plat depicts a 70 foot wide right-of-way corridor for Clear Creek Parkway. There are proposed access points from the platted subdivision onto the parkway at several locations. These access points limit the potential vertical grade of Clear Creek in order to create safe and workable intersections with the planned subdivision.

3.2.3 Gleason Road Intersection Right-Of-Way

The intersection of Clear Creek Parkway and Gleason Road is located along the western edge of Shawnee Golf and Country Club. Gleason Road is planned as a future roadway to the south of Clear Creek Parkway and is shown as a minor service collector with 2 lanes on the City's Circulation Plan. Gleason Road has been constructed approximately a quarter mile south of the intersection with Clear Creek Parkway and will be extended in the future as land adjacent to the golf course develops. Within this quarter mile, right-of-way has already been dedicated for a width of 70 feet with the section line being the western edge of Gleason's right-of-way. Gleason Road is not planned to continue north of Clear Creek Parkway.

3.2.4 Shawnee Golf & Country Club

Shawnee Golf & Country Club was built in 2004. The golf course design reserved a corridor between the 6th hole on the south and the 12th thru 16th holes on the north for Clear Creek Parkway. The 12th thru 16th holes also form an inverted "U" shape, the middle of which is platted for future apartments. Those apartments will have access onto Clear Creek Parkway.

3.2.5 Hedge Lane Terrace Right-Of-Way

Hedge Lane Terrace intersects with Clear Creek Parkway at the eastern end of the project and extends to the north. The established right-of-way has a width of 60 feet. Hedge Lane Terrace is not shown to be extended south of Clear Creek Parkway in the future on the City's Circulation Plan.

3.2.6 Other Established Property Lines or Plats

The eastern 600 feet of the corridor is owned on the north side by Knight Development LLC and its current land use and zoning are agricultural.

East of hedge Lane Terrace, the right-of-way varies from 70 feet at Hedge Lane Terrace to 220 feet at the existing bridge over Kansas State Highway 7.

3.3 Existing Terrain and Features

The existing terrain generally slopes from north to south within the project area. The existing ground is generally rolling with the highest elevations near the eastern and western termini of the project. From east to west the area is divided into six drainage basins between ridges and valleys. Within the basins sheet flow drains southeasterly and southwesterly to the valleys and then flows southerly into local streams and tributaries. The existing land features consist of open pasture areas, heavily wooded areas, and the golf course area.

The ground along the proposed alignment starts at an elevation of approximately 927 at Station 10+00 and generally decreases for the first 1,200 feet to an elevation of 891 near Station 22+00 (36 feet vertically for an average grade of 3%). The surrounding ground is pasture land in which some trees have grown around and upstream of the western pond. The next 1,000 feet takes the proposed road just south of two dams which are located at existing farm ponds. The western dam top is approximately elevation 886. Also significant at Station 24+00 is a high-tension line which crosses above the first pond and dam and has three poles 50 feet south of project centerline. The eastern pond's dam top is approximately elevation 873 at Station 29+00. Each draw downstream of dam is approximately twenty feet tall at the proposed centerline of road. Stations 25+00 to Station 34+00 also constitutes the most densely wooded stretch of proposed alignment. Between Stations 31+50 and Station 39+00 the ground crests one last time near Station 33+00 at elevation 888 and then heads downward towards the east. The existing hill along centerline bottoms out at approximately Station 41+00 at elevation 845. This marks the point where a streambed, which drains much of the ground north of Stations 40+00 to 45+00, crosses the proposed roadway corridor. Finally, the eastern 2,000 feet is generally flat. The proposed centerline is just south and parallel to a ridge. The low ground has a drainage ditch which flows to the east. The proposed centerline transitions easterly and northeasterly through an established tree line between stations 52+00 and the eastern terminus.

3.3.1 Existing Trail

The City of Shawnee has an extensive trail system east of the proposed improvements. There is an existing 10 foot trail on the south side of Clear Creek Parkway, east of the proposed project eastern terminus. This path continues easterly over the Clear Creek Parkway bridge of K-7 and on to the existing roundabout at Silverheel Street. From there it heads south and intersects another trail. This intersected trail generally runs east-west. Easterly it eventually winds over to Monticello Road. Westerly, the path runs along the north bank of the Clear Creek and crosses under Silverheel Street. It also crosses under both K-7 bridges at Clear Creek. The path then terminates just west of the

KDOT right-of-way of K-7. This terminus is just east of the 5th green of Shawnee Golf & Country Club. This is approximately 900 feet south of the Clear Creek Parkway bridge over K-7.

3.3.2 Geotechnical Engineering Report

Terracon Consultants, Inc. provided the geotechnical investigations for the project corridor. Twelve soil borings were taken along the centerline of the preliminary alignment. The borings varied in depth from 3 to 25 feet below existing ground surface. The report, which is included in Appendix A, provides an analysis of the existing subsurface soil, bedrock, and groundwater conditions. In addition, the report provides recommendations for earthwork and preparation of pavement subgrades.

The analysis of the subsurface conditions shows that the materials encountered varied between the borings, and other variations could occur between borings or across the site. Generally, the borings consisted of four distinct stratums. Stratum 1 consists of topsoil for the first 1 to 4 inches in depth. Stratum 2 consists of lean clay for 2 feet of depth. Stratum 3 consists of moderately to highly plastic lean and fat clays from 2 to 23.5 feet of depth, and Stratum 4 consists Bedrock from 0.5 to 14.5 feet of depth. Groundwater was only present at two of the boring locations, B-8 and B-11.

3.4 Existing Drainage

The existing drainage areas form six distinct drainage basins within the project limits. The limits of the drainage areas extends to the centerline of Clare Road on the west, the centerline of Hedge Lane Terrace on the east, and 200 north of Belmont school for the northern limit. Storm water generally flows from the north to the south and is collected in small streams and tributaries which continue south until merging with Clear Creek approximately ¼ miles to the south. Clear Creek then flows easterly and crosses under State Highway K-7.

Within the drainage areas are three existing agricultural ponds, all located in the western two drainage basins. Two of the ponds will be immediately adjacent to the proposed roadway alignment and are planned to remain with the development of the Canyon Lakes residential subdivision. Canyon Lakes will improve and expand the ponds as permanent water features for use by its residence. The proposed Clear Creek Parkway alignment will cutoff the existing drainage patterns at the roadway, and cross road pipes will be required to maintain the flow within existing basins.

3.5 Existing Utilities

3.5.1 Existing Utilities

Since the project is crossing currently undeveloped green fields, there are relatively few existing utilities. However, there is an existing water line owned by the golf course which provides irrigation for the holes in the northeast quadrant of the project and will be crossed by the proposed alignment.

The major utility concern is Westar's high-voltage electric power which crosses the proposed centerline at approximately Station 24+00 in an existing utility easement. There are 2 poles within approximately 50 feet of the proposed centerline. Vertically, there is no concern of conflict with the wires, which will still be 50 feet above the proposed road, even though the proposed road is in 20 feet of fill. SKW has begun to coordinate this condition with representatives of Westar Energy. Options for handling the fill around the poles is discussed in Section 4.4 – Overhead Power Line Mitigation.

The only other utility in an existing utility easement is WaterOne running parallel to and immediately east of Clare Road.

Figure 3.6 – View of Existing Power Lines

3.5.2 Utility Contacts

A Kansas One-Call field utility location request was not completed at this stage of the project. Per Johnson County Automated Information Mapping System (AIMS) mapping, the area is served by the following utilities:

- **Electric** – Westar Energy
- **Gas** - Provided by Kansas Gas Service
- **Cable** - Provided by Time Warner Cable, CCI, and Google Fiber
- **Telephone** - Provided by Time Warner Cable and AT&T
- **Water** - Provided by WaterOne
- **Sanitary Sewer** - Provided by Johnson County Wastewater
- **Storm Sewer** - Provided by the City of Shawnee

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4. PROPOSED IMPROVEMENTS

This section presents the common features and alternatives considered for the design of the proposed improvements. Multiple improvement options were laid out, reviewed, discussed, and analyzed during the concept phase of the project. These included various horizontal and vertical alignments, as well as various intersection configurations at the intersection of Clear Creek Parkway and Gleason Road. In addition, various alternatives were studied for the recreational trail connection

The proposed improvements will extend Clear Creek Parkway from its terminus just west of the K-7 bridge, westerly approximately 5,050 feet to an intersection with Clare Road. The drainage will be enclosed system of inlets and pipes, and street lights will be located along the north side of the roadway. At the western terminus, Clear Creek Parkway will be widened at the intersection with Clare Road to provide a dedicated left-turn lane and raised island. Westbound traffic will have separate left and right turn lanes, and for eastbound traffic the one entering lane will be widened to 16 feet due to the adjacent raised island and curb. The various alternatives for the roadway alignment, slopes, and materials are discussed in Section 4.

4.1 Classification

Based on the City of Shawnee's Circulation Plan, Clear Creek Parkway is classified as a Major Collector roadway. Clare Road is classified as a Minor Arterial (2-4-lanes). Gleason Road is classified as a Minor Service Collector as is Hedge Lane Terrace.

4.2 Key Factors Influencing the Design

This project was initiated by the City of Shawnee in response to proposed development of the Canyon Lakes residential subdivision, and eventual development of single and multi-family residential units adjacent to the Shawnee Golf & Country Club. A Transportation Improvement District (TID) has been created and approved by Shawnee's City Council. Those developments will create a traffic burden which is discussed in the Section 5 – Intersection Analysis/Traffic Study. The traffic will govern the type and size of facility, but other factors will affect the alignment, both vertically and horizontally. Key issues influencing the design include the following:

- Coordination with Canyon Lakes Subdivision (Prieb Homes), including alignment, existing pond dams, drainage, and intersections.
- Coordination with the high-voltage, overhead power lines (Westar), including an alternative horizontal alignment or a retaining wall to eliminate fill impacts.
- Coordination with Shawnee Golf & Country Club (Lindsey Management Company), including golf cart path and underpass, side slopes/retaining walls, aesthetics and landscape screening, drainage, and planned intersections at Clear Creek Parkway.

4.3 Special Considerations at Ponds/Dams

There are two existing ponds near the proposed alignment, both of which the developer has expressed an interest in keeping and using. One is at proposed Station 23+00 and the second is at proposed Station 29+00. For both aesthetic and practical coordination with the existing dams, it is preferred to maintain

a roadway elevation consistent with the top of dam elevation. See Figure 4.1 - View of Existing Pond Dam.

In addition, due to the probability that the dams will have seepage, special consideration of drainage and fill materials will be required in these areas to ensure that the roadway fill and subgrade do not become saturated during large rain events. The easiest way to prevent this is to separate the dam structures from the roadway fill with a roadside ditch that carries any storm water to the cross road pipes.

Figure 4.1 - View of Existing Pond Dam

4.4 Overhead Power Line Mitigation

Near the western end of the project corridor and near the first pond, there is an existing set of overhead, high-voltage power lines owned by Westar Energy (see Figure 4.2 - View of Existing Power Lines). The nearest support structure, which is a wooden H-pole with "X"-bracing is only 50 feet south of the proposed roadway centerline. During conversations with Westar representatives, the project's construction has no issues with the vertical clearance, but the fill slopes cannot add more than one foot of fill on the existing, wooden, transmission poles. Westar's' concerns about filling around the power poles is based on the soil contact deteriorating their poles. The established alignment with a 4:1 fill slope shows a 15 foot embankment on the existing poles. With a 3:1 fill slope there would still be a 14 foot embankment on the

Figure 4.2 - View of Existing Power Lines

poles. See Appendix B for illustrations of these conditions.

Three options for mitigating the embankment placed on the existing poles were considered:

- Relocate the poles outside the limits of embankment.
- Construct retaining walls to limit the embankment around the poles to no more than one foot.
- Relocate the alignment of Clear Creek Parkway to the North.

Each of these options are further discussed below.

4.4.1 Relocate Poles

The existing power poles could be relocated further away from the alignment and outside of the planned fill slope. This would alleviate Westar Energy's concerns since no soil or additional loading would be placed on the poles. However, there is a cost associated with relocating the poles. The relocation costs are estimated at $200,000. This is the least desired option due to the time frame and cost required for relocation.

4.4.2 Construct Retaining Walls Around Poles

A retaining wall could be constructed along the right-of-way of Clear Creek Parkway in the vicinity of the existing power poles. This would eliminate the fill slopes around the poles. The width of the wall would need to allow truck maneuvering room around the poles so Westar Energy could maintain their facilities. This wall would not require the same level of aesthetic treatments as other retaining walls associated with the project. While this option has the highest costs, it requires the least coordination during construction. It also has a lower probability of impacting the schedule of roadway construction than pole relocation. The estimated cost associated with this option is $150,000.

4.4.3 Relocate the Roadway Alignment

The horizontal alignment of Clear Creek Parkway could be relocated to the north in the vicinity of the power poles so that the fill slopes would be shifted off of the existing poles. While this would eliminate the need for any other protective measures for the poles, this alignment would increase the impacts to the existing pond and dam, and it would affect the lot layout of Canyon Lakes. While this option has no additional construction costs, it may require a revision to the Canyon Lakes Plat. This is the recommended mitigation option.

4.5 Golf Cart Underpass

The horizontal alignment for the underpass was based on keeping the cart path deviation to a minimum and also minimizing the length of the underpass. The cart path also needs to remain outside of the right-of-way of the roundabout option. The vertical alignment was based on having minimal excavation for the underpass, maximum desired golf cart grades, and drainage considerations. The cart path on the north side of the intersection with Gleason Road must get over the planned cross road pipe, which is a 54" Reinforced Concrete Pipe (RCP). These walls will also present opportunities for landscaping and aesthetic treatments.

The typical section for the cart path is a 10 foot wide concrete path with a 1.50% cross-slope. The path has a 2 foot clear zone on each side which continues at the same cross-slope. Beyond that the side slopes are generally 4:1 but may 3:1 maximum to reduce impacts on the golf course as requested by the owner.

The size of the proposed underpass is a 10' x 10' Reinforced Concrete Box (RCB), which is consistent with the existing cart underpasses that exist on the course. During a site visit our team measured the size of the existing golf cart underpass. Adjacent to the roadway, and at the cart underpass, retaining walls are planned to reduce the fill slopes and impacts to the golf course. These walls will also present opportunities for landscaping and aesthetic treatments. Refer to Figure 4.3 - Existing Arch Golf Cart Underpass and Figure 4.4 - Existing RCB Golf Cart Underpass or photographs of the existing underpasses and their associated retaining walls.

Figure 4.3 - Existing Arch Golf Cart Underpass

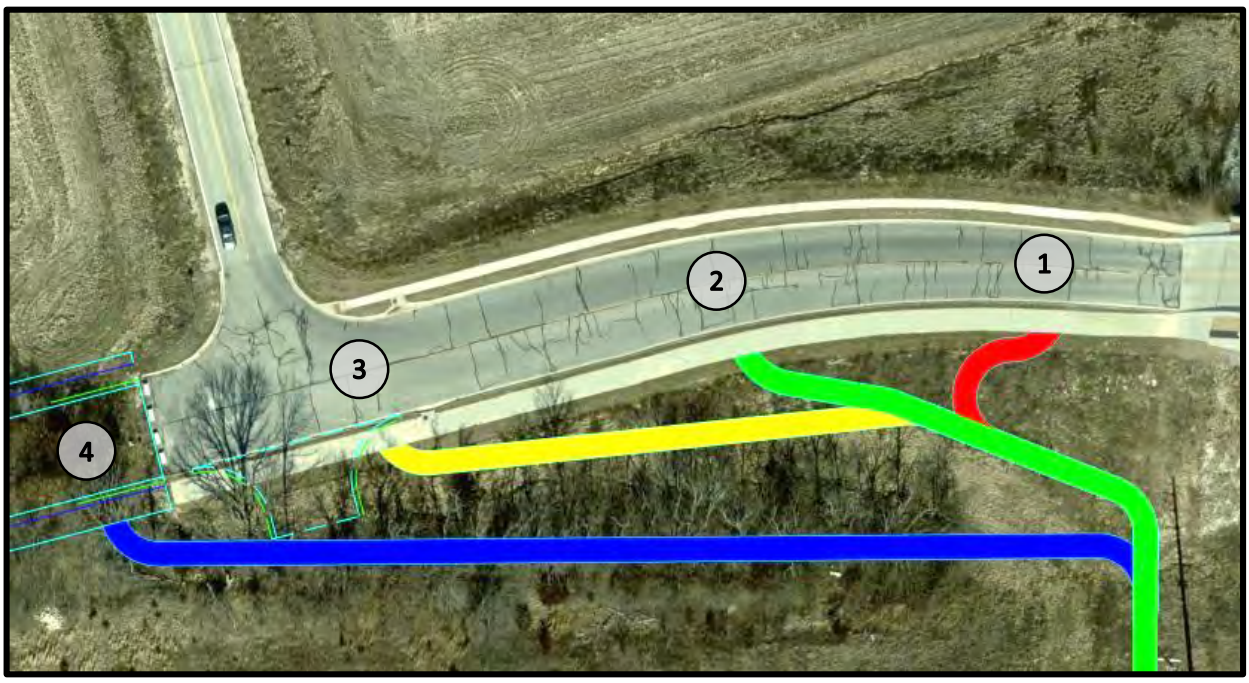
Figure 4.4 - Existing RCB Golf Cart Underpass

4.6 Recreational Trail Connection

A preliminary analysis of the alignment of the path connecting the two existing trails has been completed. The connection on the south end will turn north to minimize impact to the golf course and run parallel to the KDOT right-of-way. The path will have a cross slope of 1.5% to maintain the current drainage pattern in the area, which presently drains into the KDOT ditch along K-7. As the path continues north, it will go between two lines of power poles, one that is on KDOT right-of-way and the other that is on land owned by the golf course. After coordinating with the Shawnee Golf & Country Club, It has been determined that no fence will be required to separate the trail from the golf course to the west.

Several alternative paths were initially considered for the trail connection, which are shown in Figure 4.5 - Recreational Trail Connection Alternatives. The path has several options to reach Clear Creek Parkway. It could go over an existing ditch to meet up with the existing Clear Creek Parkway, as shown in trail alternatives 1 through 3, or follow along the south side of the ditch and meet up with the new extension of Clear Creek Parkway, shown in trail alternative 4.

Figure 4.5 - Recreational Trail Connection Alternatives



Trail alternatives 1 through 3 will cross a ditch that carries approximately 268 cfs during the 100yr storm to the K-7 ditch during rainfall events. An RCB or small pedestrian bridge will be required to allow the safe passage of pedestrians over the ditch during these events. Once the trail passes the ditch, it will need to climb up the side slope of Clear Creek Parkway bridge embankment to meet with the existing path. Depending on where the trail meets with Clear Creek Parkway, the trail may need to wrap around or switch back, as trail alternative 1 demonstrates. The switch back is needed in order to keep the vertical profile of the path under a 5% slope, which is the maximum allowed by ADA guidelines. Trail alternatives 2 and 3 will not need the switch backs as there is less change in elevation between the base of the side slope and the existing roadway trail.

Trail alternative 4 will meet with the new Clear Creek Parkway trail and will be flatter compared to the other alternatives and bring trail users out close to the intersection with Hedge Lane Terrace. However, this will also cause the trail to be longer before it's able to meet with the new Clear Creek Parkway path.

After evaluating each trail option based on the costs, construction issues, advantages and disadvantages of each, trail alternative 2 is the recommended alternative. A summary of the alternatives studied and the advantages and disadvantages of each is presented in Table 4.1 - Summary of Recreational Trail Connection Alternatives below.

Table 4.1 - Summary of Recreational Trail Connection Alternatives

Alternative No. (Alignment Color)	Advantages	Disadvantages
1 (Red)	Ties closest to Clear Creek Parkway bridge over K-7. Shortest additional length = 175 feet.	Requires RCB or pedestrian bridge over ditch. Requires switch back. Highest impact to existing bridge fill slope. Highest construction costs.
2 (Green) *Recommended	2nd shortest distance from bridge to tie-in. 2nd shortest additional length = 220 feet. Cheapest construction costs of alternatives 1, 2 or 3.	Requires RCB or pedestrian bridge over ditch. Medium impact to existing bridge fill slope.
3 (Yellow)	Ties near Hedge lane Terrace Intersection where curb ramps will be present. Least impact to existing bridge fill slope.	Requires RCB or pedestrian bridge over ditch. Small impact to existing bridge fill slope. 2nd longest additional length = 365 feet.
4 (Blue)	Doesn't cross ditch. Cheapest construction costs of all alternatives. Flattest path. No impact to bridge fill slope.	Farthest distance from bridge to tie-in. Longest additional length = 455 feet. Alignment has highest impact to future land to be developed. Trail becomes isolated behind grove of trees.

4.7 Retaining Walls

To reduce the impacts of the roadway corridor and its associated fill slopes on adjacent properties, retaining walls will be needed at some locations. This is especially true at the golf cart underpass. On both sides of Clear Creek Parkway retaining walls will be used at the golf cart underpass. These walls will extend up a minimum of 2 feet above the grade at the right-of-way. A decorative pedestrian rail will be placed on top of the walls to protect against falls. Multiple wall options were examined and are discussed below. See Appendix C for catalog cut sheets and photographs of the wall option studied.

4.7.1 Large Block Wall

Manufactured concrete modular units larger than one square foot per unit. Typical cross section includes a geogrid reinforced backfill zone behind face blocks. Face stones can range from smooth face concrete, textured form liner, to rock face form liner. Colors can include natural concrete, stained concrete or integral coloring. The products selected for this project must meet the two sided configuration at the top of the wall. The wall will be capped with a natural or manufactured stone capstone.

4.7.2 Natural Stone Block Wall

Manufactured concrete modular units typically smaller than one square foot face per unit. Typical cross section includes a geogrid reinforced backfill zone behind face blocks. Face stones can range from uniform split face concrete, multi-piece, to tumbled natural stone look. Colors can include natural concrete, stained concrete or integral coloring. The products selected for this project must meet the two sided configuration at the top of the wall.

4.7.3 Cast in Place Concrete Wall with Form Liner Facade

Cast in place concrete cantilever retaining wall reinforced with rebar. Foundations typically extend into the retained soil. A mortared stone façade added to the concrete substrate gives the feel of natural stone. This product would be similar to artistic elements on the Clear Creek Parkway bridge over K-7 highway. An alternative to a natural stone is to use a form liner to mimic the stone pattern. The wall would be faced on both sides where the wall extends above grade. The top of the wall would be capped with a cast in place concrete or manufactured stone capstone.

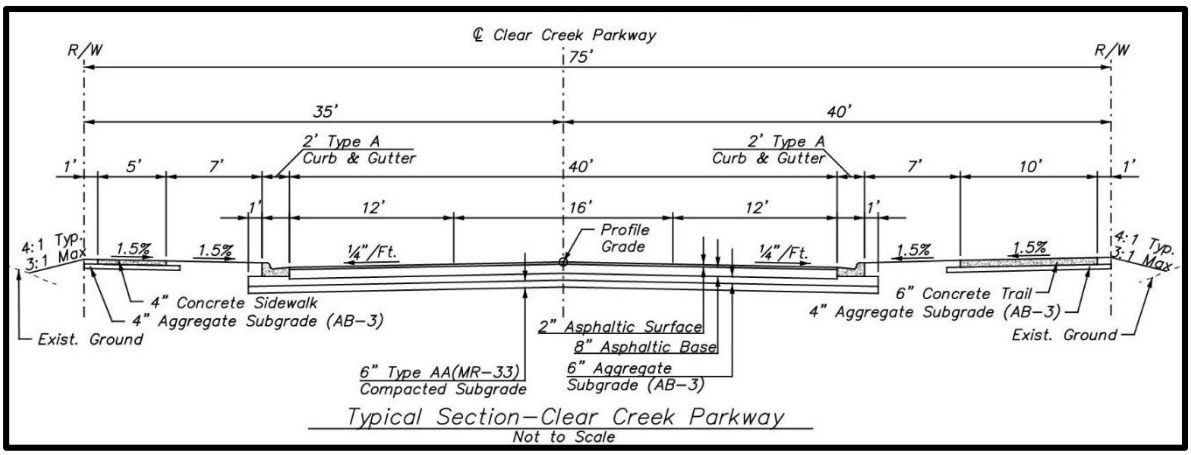
4.8 Typical Sections

The typical section for each roadway and for the trail/cart path are discussed below. See Appendix D.1 for additional typical sections.

4.8.1 Clear Creek Parkway Typical Section

The typical section for Clear Creek Parkway will be a 40 foot (12’-16’-12’) three lane section with two foot concrete curb and gutters on both sides, a five foot sidewalk on the north side and a 10 foot trail on the south side (see Figure 4.6 - Typical Section - Clear Creek Parkway). At Clare Road the section widens out for a raised island and a dedicated left-turn lane. The section also widens out at the approaches to the roundabout option to allow for the splitter islands.

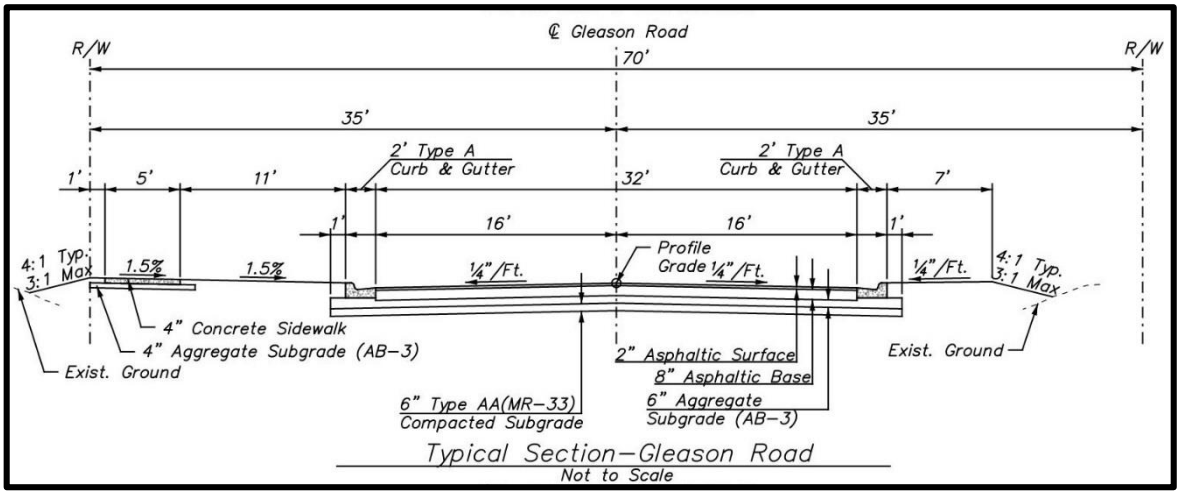
Figure 4.6 - Typical Section - Clear Creek Parkway



4.8.2 Gleason Road Typical Section

The typical section for Gleason Road will be a 32 foot (16'-16') two lane section with two foot concrete curb and gutters on both sides and a five foot sidewalk on the west side (see Figure 4.7 - Typical Section - Gleason Road). The sidewalk is separated from the curb by a seven foot grass parkway. One foot behind the sidewalk, the typical section hinges down to a 4:1 foreslope. On the east side, in order to minimize impact to the golf course, a seven foot grass parkway will angle up from the curb and gutter. At the seven foot line, the slope will hinge down to a 3:1 slope to minimize the impacts to the course.

Figure 4.7 - Typical Section - Gleason Road



At Clear Creek Parkway the section widens out to 36 foot (12'-12'-12') three lanes for a dedicated left-turn lane (one southbound lane, one northbound left turn lane, and one northbound right turn lane). The curb return radii will be 35 feet. The section also widens out at the approaches to the roundabout option to allow for the splitter islands.

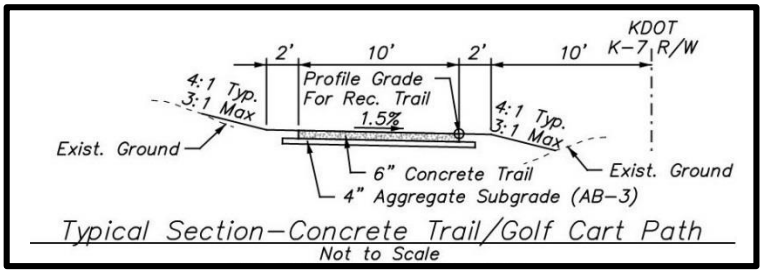
4.8.3 Roundabout Option Typical Section

The typical section for the roundabout intersection option will be a 150 foot "inscribed circle" for the diameter which will allow additional green space for landscaping and aesthetics treatments. The single lane circulatory roadway will be concrete pavement and a standard 16 feet wide, with an eight foot truck apron. Each approach leg to the roundabout widens out to allow for the splitter islands separating traffic entering and exiting the roundabout.

4.8.4 Recreational Trail/Cart Path Typical Section

This typical section is a 10 wide paved section with 2 foot clear zones on each side of the trail/path. Beyond the clear zone the grades vary from 2% minimum to 4:1 maximum. The typical section is the same for both the recreational trail and the golf cart path. See Figure 4.8 - Typical Section - Trail/Cart Path.

Figure 4.8 - Typical Section - Trail/Cart Path



4.8.5 Roadway Side Slopes

The side slopes from the cut and fill limits associated with the roadway are generally 4:1 maximum. Exceptions include using 3:1 side slopes along the golf course and Lindsey Management properties as requested by the property owner, and 3:1 slopes at the overhead power line crossing.

4.9 Pavement Types

The City of Shawnee requested that the study include options for both asphalt and concrete paving materials for the project and a cost comparison of each pavement type. All three intersection alternatives studied include the costs for both paving types. The roundabout will be concrete for both mainline pavement options to a logical point beyond the raised splitter islands. While the pavement area is the same for both pavement types, recent unit prices for bid tabulations on similar roadway projects suggest the asphalt option would currently be more economical.

4.9.1 Asphalt Pavement Option

Recent bid tabulations for similar sized projects have averaged $8.00 per square yard of 2" asphalt surfacing and $30.00 per square yard for 8" asphalt base. Using these unit prices, an estimated construction cost of $902,361.30 is anticipated for only the asphalt pavement of the T intersection alternative.

Since the roundabout will be concrete for both pavement options, the roundabout option's asphalt pavement area is less than the T intersection. An estimated construction cost of $1,201,050.80 is anticipated for only the asphalt pavement of the roundabout intersection alternative.

4.9.2 Concrete Pavement Option

Recent bid tabulations for similar sized projects have averaged $55.00 per square yard of 8" concrete pavement. Using these unit prices, an estimated construction cost of $1,306,049.25 is anticipated for the concrete pavement of the T intersection alternative.

Since the roundabout will be concrete for both pavement options, the roundabout option's concrete pavement area is more than the T intersection. An estimated construction cost of $1,738,363.00 is anticipated for the concrete pavement option of the roundabout intersection alternative.

4.10 Proposed Alignments

During the analysis two horizontal and one vertical alignment of Clear Creek Parkway satisfied the desires of the property owners/developers along the corridor.

4.10.1 Horizontal Alignments

Clear Creek Parkway's horizontal alignment is very similar for both the roundabout and T intersection types. The difference being that the roundabout has a deflection at the intersection while the T intersection has a large radius curve.

Though the intent is to align Gleason with the section line, as the side street approaches Clear Creek Parkway, Gleason curves to the right in order to line up perpendicularly to the through street. This will increase safety for motorists attempting to turn onto Clear Creek Parkway by minimizing the approach angle. A minimal radius of 425 feet was used for the curve since Gleason will always be approaching a stopping condition. Gleason ultimately will run between an existing drainage stream on the west and the 11th fairway of the golf course, which will be to the east of the road.

As discussed in Section 4.4 – Overhead Power Line Mitigation, at Westar's overhead power lines, an alternative horizontal alignment was developed as an option to mitigate the fill on the existing power poles. This alignment sweeps Clear Creek Parkway's alignment to the north to be closer to and parallel with the existing dam alignments. This shift allows the fill on the poles to be eliminated.

4.10.2 Vertical Alignments

Clear Creek Parkway is spanning over a golf cart tunnel at approximately proposed Station 42+50. The Gleason Road intersection is at approximately proposed Station 41+40. Therefore Gleason must be in approximately 13 feet of fill at its northern terminus solely as a function of the Clear Creek Parkway profile. Heading southerly (down station) from the intersection at the 2% grade which defines the cross-slope of Clear Creek Parkway, the vertical profile of Gleason Roads breaks down to an 8% grade as quickly as is appropriate given the crest curve sight distance constraints. As the proposed Gleason Road approaches the existing ground line it transitions back to the general grade of the existing ground while maintaining the City's-mandated minimum grade. Reducing the fill height, and therefore the resultant width of the fill slopes as quickly as possible is important because of the constraints caused by the proximity of the stream and fairway.

The vertical alignment is generally the same as the T intersection, however the diameter of the roundabout will relocate the actual intersection point of Gleason further to the south. This implies

the tie-down point where Gleason returns to the existing ground will be approximately 100 feet further south than the T intersection.

4.11 Gleason Road Intersection Alternatives

Additionally, three alternatives were considered for the future Clear Creek Parkway intersection with Gleason Road:

- Alternative 1 – T Intersection with Stop Control on Gleason.
- Alternative 2 – T Intersection with Traffic Signal.
- Alternative 3 – Roundabout

A detailed intersection analysis and traffic study was performed to analyze each alternative. The analysis is presented in Section 5 – Intersection Analysis/Traffic Study.

4.11.1 Alternative 1 – T Intersection with Stop Control on Gleason

The first alternative considers a traditional T intersection assuming a stop sign will be posted on Gleason. Clear Creek Parkway would have no restrictions to traffic movements. The mainline (Clear Creek Parkway) traffic operationally will be unaffected by the presence of the Gleason intersection. As traffic travels westerly on Clear Creek, Gleason will be a transition point from a segment with relatively few side street access points into a stretch which is residential in character with relatively more access points. Operationally, Gleason traffic entering Clear Creek will need to find gaps in the traffic to enter. This may particularly difficult for cars turning from the south to the west. The conceptual plans are illustrated in Appendix D.1.

4.11.2 Alternative 2 – T Intersection with Traffic Signal

The second alternative was developed using a traffic signal to regulate the intersection. Though a signal is out of character with much of the Clear Creek Parkway corridor, the signal would provide an acceptable LOS. The downside is the significant initial capital cost and continuing maintenance required. Motorists traveling westerly on Clear Creek Parkway and encountering a green light might enter a more residential area without fully recognizing the change in character. The traffic signal will enable traffic from Gleason to make left turns onto Clear Creek Parkway with relative ease. The signal, when it stops westbound traffic will also provide traffic calming component to motorists entering the residential area west of Gleason. The conceptual plans are illustrated in Appendix D.2.

4.11.3 Alternative 3 – Roundabout

The third alternative considered for the Clear Creek Parkway proposes a roundabout with the Gleason Road intersection. The existing Clear Creek Parkway corridor east of K-7 utilizes roundabouts throughout its length, so introduction roundabout would be in character with the road. Secondly, the roundabout would impart a traffic calming effect, and would create a visual transition as westbound motorists enter the residential area west of Gleason Road. Gleason traffic will be able to enter the roundabout circulation easily, and a roundabout eliminates the cost of a signal and the subsequent maintenance. The conceptual plans are illustrated in Appendix D.3.

4.12 Proposed Drainage

The storm drainage for each alternative has many things in common, such as the location of major cross road pipes and most of the curb inlet locations. The horizontal and vertical alignments are generally the same for each alternative, as well as the locations of the side road and entrance connections. The only difference is at the intersection with Gleason Road. Depending on the selected alternative, the number of curb inlets and pipe routing would differ for a T intersection and a roundabout. The following analyses provides a summary of the major storm drainage items. See Appendix E for the Drainage Area Map and additional Drainage Calculations. See below for additional discussion about the drainage analysis.

4.12.1 Cross Road Pipes

The 179.4 acres north of the proposed roadway, east of Clair Road and west of Hedge Lane, were divided into six smaller drainage areas based on existing Johnson County AIMS contours. These contours helped determine the extent of each drainage area, ranging from 5.6 acres to 76.8 acres. Proposed flow quantities for the 50-year storm and 100-year storm scenarios were determined based on these areas as well as future zoning plans. Each drainage area has a cross road pipe sized to convey stormwater to the south, beneath the proposed Clear Creek Parkway corridor. These culvert locations were decided based on existing low points and channels along the proposed roadway within each of the drainage areas. The culverts were sized according to their calculated incoming flows, while taking into account other key factors such as outlet velocity, overtopping elevations and pipe cover. A summary of these calculations and final pipe sizes is shown below in Table 4.2 - Summary of Drainage Analysis.

Table 4.2 - Summary of Drainage Analysis

	Description	DA 1	DA 2	DA 3	DA 4	DA 5	DA 6
Hydrology	Area (ac)	33.00	76.80	24.40	5.60	20.50	19.10
	Cn (#)	82	82	79	88	80	93
	Equivalent C Value (#)	0.51	0.51	0.44	0.66	0.45	0.78
	Composite Tc (min)	15.18	17.70	15.36	12.24	15.00	16.92
	50 yr Flow (cfs)	187.19	409.80	129.76	37.92	112.29	122.66
	100 yr Flow (cfs)	215.09	471.14	150.30	42.98	129.72	137.78
Hydraulics	Pipe/Box Size	54" RCP	72" RCP	54" RCP	2-30" RCP	8'X4' RCB	6'X3' RCB
	Pipe/Box Location (sta)	24+56	29+80	41+22	47+56	52+33	60+30
	Pipe/Box Length (ft)	152	140	335	232	133	93
	Approximate Cover (ft)	14.00	10.00	11.50	2.88	2.71	2.50
	100 yr Over Top Elevation (ft)	883.85	873.98	854.70	849.62	842.40	833.60
	100 yr Headwater Elevation (ft)	882.27	873.74	851.54	849.07	842.31	833.37
	Slope (%)	1.00	1.00	1.40	0.50	0.50	0.50
	100 yr Outlet Velocity (fps)	14.08	17.16	15.28	6.59	9.17	9.69
	Flow Line Upstream (ft)	872.00	858.70	845.00	846.49	838.58	828.76
	Flow Line Downstream (ft)	870.00	857.00	841.00	846.00	838.00	828.38

4.12.2 Gutter and Inlet Capacity

Gutter capacity was calculated at various roadway slopes with a target spread of 12 feet using APWA 5604.3. Inlet spacing could then be calculated from these flows for each corresponding slope using the Rational method with an additional 1.1 factor (City of Shawnee Standards) adopted into the design in addition to the 1.1 factor "k" used for the 25-year storm. A right-of-way width of 70 feet was used in the calculations. Table 4.3 - Summary of Inlet Spacing presents these findings.

Table 4.3 - Summary of Inlet Spacing

Description	Slope = 2%	Slope = 4%	Slope = 6%
Q (cfs)	5.79	8.21	10.06
Area (ac)	0.70	1.00	1.22
Spacing (ft)	872	1,237	1,516

4.13 Proposed Utilities

During the design phase, utility corridors should be identified for future utilities to occupy to serve the proposed developments adjacent to Clear Creek Parkway, therefore minimizing conflicts with the proposed roadway. If possible, utility sleeves should be provided for future utility crossings under Clear Creek Parkway. The additional green space added between the curb and trail will provide additional area for placement of future utilities.

4.14 Street Lighting

The street lighting criteria for minor arterial roadway was used for the analysis, with a 44 feet road width, and lighting on the north side of the road. The City and IES has set a standard of 1.4 foot-candles minimum and a maximum average to min fc level of 3:1. Depending on the fixture selected, it is anticipated lighting will consist of approximately 30 to 31 LED fixtures. The approximate pole spacing is 195 feet apart, and the spacing decreases at intersections to increase light levels at these locations. The costs for the lighting fixtures studied range from $1,125 to $1,640 each, and poles range from $825 to $1,017 for 30' straight, square steel poles. Quantities for bases, conduit, wiring, etc. have not been established, but lump sum costs have been estimated.

The two options for light fixtures reviewed are the Razar, a US Architectural Lighting product and the Ventus, a McGraw-Edison product. Both are LED fixtures, and both can meet the average 1.4 fc at a spacing of 195 feet. At that spacing, the average to min for the Razor is 3.5:1, whereas the Ventus is better at only 2.3:1. The razor is more efficient because it uses only 174 Watts versus the 259 Watts needed for the Ventus. The Razor is also less expensive than the Ventus and depending on the final layout may require less poles and fixtures. See Appendix F for catalog cut sheets of the fixtures studied and concept level street lighting calculations.

4.15 Aesthetics and Landscaping

The overall aesthetic impression of this intersection considers two primary conditions: the future context of this intersection when the adjacent properties are fully built out, and resident and golf course patron expectations.

The neighborhood context that includes an existing golf course and planned higher end, residential properties sets an elevated level of expectations for aesthetic treatments, not only for this intersection but the entire Clear Creek Parkway corridor. The roundabouts design offer the best opportunity to provide this level of expectation due to the multiple opportunities to place aesthetic enhancements.

Designing with the future in mind, the key entities of this area include the golf course, the parkway trail, and future multi-family and single family developments. The landscape design for the roundabout intersection takes on components from the nearby established intersections at Monticello Road, Clear Creek Parkway and 67th at Gleason. Each of these intersections include various aesthetic elements such as landscaped roundabouts, hardscaping, water features, and pedestrian and bike crossings. This design will include a low landscape wall in the roundabout and masonry columns similar to the CCP bridge over K-7. Groupings of ornamental trees, shrubs, grasses and ground-covers will soften the perimeter and provide texture and color. In addition, evergreen trees and shrubs will be used for screening in special view corridors. Green solutions at the parkway will include BMP's and plants with low water needs. Concept landscape plans for both intersection options, and a concept rendering of the roundabout option is presented in Appendix G.

Pedestrian railing has not been proposed for the decorative walls at the golf cart underpass because there is a plant buffer proposed to separate pedestrians from the fall hazard. The current design allows for a 6-8 foot planting bed between the edge of sidewalk and face of the retaining wall which is elevated 24” above grade. This planting bed will consist of shrubs the entire length of the wall as indicated on the planting plan. This plant bed provides a barrier and separation that technically meets code compliance and therefor does not requiring a railing in addition to the top of wall. This allows for a clearer view of the surrounding landscape which is primarily made up of tree groves and the golf course.

If an additional barrier is deemed necessary, then a decorative railing is recommended as depicted in Figure 4.9 - Example Pedestrian Rail below (sample image provided by ornamental gate-fence.com). This design, or something similar, would blend with the curvilinear nature of the parkway and golf-course setting versus standard railing details that to not reflect these aspects.

Figure 4.9 - Example Pedestrian Rail

4.16 Right-of-Way and Easements

For Clear Creek Parkway the right-of-way will generally be 75 feet wide, with variations at each end. At the west end of the project as the alignment approaches Clare Road, the right-of-way flares out to 95 feet wide to accommodate a left-turn lane and a raised island at the intersection. The right-of-way is 35 feet on the north and 40 feet on the south side of the roadway to allow more green space between the trail and roadway for pedestrian safety. At the east end where the alignment ties to Hedge Lane Terrace, the existing KDOT right-of-way is 110 feet wide and widens to over 300 feet near the bridge over K-7. For Gleason Road the right-of-way will be 70 wide throughout its corridor. All of the required right-of-way will have to be obtained with the design of this project.

Permanent easements will be required around the planned cross-road pipes at six locations. Temporary construction easements will be required adjacent to both sides of the roadways to accommodate construction activities and provide access for equipment. All of the required easements will have to be obtained with the design of this project.

8.2 acres of right-of-way will be required for the T intersection. In addition, 0.6 acres of permanent easement and 10.5 acres of temporary easement will be required for this alternative.

For the roundabout alternative, the right-of-way required is very similar to the T intersection except for the additional right-of-way needed to accommodate the roundabout. At the roundabout the right-of-way circle has a diameter of 240 feet. Due to the roundabout size, the area required for temporary easements will be greater. 9.5 acres of right-of-way will be required for the roundabout alternative. In addition, 0.3 acres of permanent easement and 9.9 acres of temporary easement will be required.

4.17 Conformance with Current Design Standards

The Gleason Road typical section deviates from the City of Shawnee minor collector because the sections and slopes outside the curbs have been reduces in order to minimize impact to the golf course and stream. All other design standards, both horizontally and vertically, have been maintained for the proposed improvements.

4.18 Coordination with Stakeholders

Stakeholders considered for the project study include adjacent property owners, surrounding neighborhood developments, and the travelling public. There are three land owners adjacent to the proposed roadway who are considered major stakeholders:

- Prieb Homes, Inc. – Developer of the Canyon Lakes Subdivision.
- Lindsey Management Co., Inc. – Owner of Shawnee Golf & Country Club and Developer of multi-family housing adjacent to the golf course.
- Kimball Development, LLC – Owner of the tracts of land adjacent to Hedge Lane Terrace on the north side of Clear Creek Parkway.

The alternatives considered for this study and report have been coordinated with both Prieb Homes and Lindsey Management. The concepts of the study were first presented at the project kick-off meeting, where both owners were present. In addition, each iteration of the horizontal and vertical alignments was presented to the property owners, and the comments received were incorporated into the layouts.

The adjacent property owners and other surrounding stakeholders will be invited to attend an open-house style, public meeting to view the results of the study and report and ask questions related to their concerns about the project.

4.19 Effects on Surrounding Cities/Counties

All improvements proposed with this study and report impact only the City of Shawnee and are only of benefit to the City of Shawnee. No other cities or counties are impacted or receive benefit from this project.

4.20 Opinion of Probable Costs

Concept level quantities were used to prepare an opinion of probable construction costs for both the asphalt and concrete pavement options. A concept level contingency of 15% has been added to the cost estimate. Costs are presented for the base bid and each pavement option. The costs for acquisition of the right-of-way and easements, and the costs for engineering design and City administration are not included.

A detailed cost estimate for each alternative is included in Appendix H. The total construction cost of each alternative is summarized as follows:

Alternative 1 – T Intersection with Stop Control on Gleason

- Base Bid = $4,033,748.05
- Asphalt Pavement Option = $902,361.30
- Concrete Pavement Option = $1,306,049.25

- Total Cost of Alternative 1 with Asphalt = $4,936,109.35
- Total Cost of Alternative 1 with Concrete = $5,339,797.30

Alternative 2 – T Intersection with Traffic Signal

- Base Bid = $4,304,826.05
- Asphalt Pavement Option = $902,361.30
- Concrete Pavement Option = $1,306,049.25

- Total Cost of Alternative 2 with Asphalt = $5,207,187.35
- Total Cost of Alternative 2 with Concrete = $5,610,875.30

Alternative 3 – Roundabout

- Base Bid = $4,274,722.50
- Asphalt Pavement Option = $1,201,050.80
- Concrete Pavement Option = $1,738,363.00

- Total Cost of Alternative 3 with Asphalt = $5,475,773.30
- Total Cost of Alternative 3 with Concrete = $6,013,085.50

5. INTERSECTION ANALYSIS/TRAFFIC STUDY

As part of the Concept Study and Report a traffic study and intersection analysis were performed at the intersection of Gleason Road and Clear Creek Parkway. Traffic counts were estimated to determine how much traffic would be going through the intersection and directional movements throughout the day and during peak hours. Using this information, an operational analysis was able to be completed. The operations along with several other parameters, including safety and aesthetics, were then rated to compare three alternative designs of the intersection. The results of the analysis are described below.

5.1 Study Area Overview

The proposed intersection of Gleason Road and Clear Creek Parkway is located in the northwest corner of Shawnee, west of K-7, east of Clare Road and between W 67th and W 55th Streets. The surrounding land is largely undeveloped, with the majority of the land zoned for low density housing and the remaining land zoned for commercial, office/service, and office/commercial. There is also some high density residential zoning for existing and planned apartments at the Shawnee Golf & Country Club. Clear Creek Parkway is classified as a major collector, and opens up connectivity to future developments. Figure 5.1 - Shawnee's Future Land Use Guide for Study Area shows the study area.

5.2 Traffic Projections

Initially, the design team consulted with representatives of the Mid America Regional Council (MARC) to determine if the metro wide transportation planning model maintained by MARC would have relevant data regarding future year traffic volumes on Clear Creek Parkway or on Gleason Road. Unfortunately, the Traffic Analysis Zones (TAZs) in this area of the model were very large in size (thus limiting their coding of specific land uses) and the roadway system within the study area, as currently shown on Shawnee's Transportation Plan, was not completely represented within MARC's model. Thus MARC was unable to provide any information helpful to creating meaningful traffic projections.

Utilizing an aerial photo of the study area, from 55th Street on the north, to 67th Street on the south and from K-7 on the east to the Kansas River on the west. Two traffic counts were estimated. The first estimated the traffic when Clear Creek Parkway opens in 2017. This consisted of taking the study area and counting existing homes and estimating the number of trips the current households would make using Clear Creek Parkway. The second traffic count estimated the traffic when the study area is fully developed. The study area was divided by a grid into areas measuring 660 feet square, each grid consisting of 10 acres. All undeveloped areas within the study area were assigned a development type, based on the zoning contained within the City's master plan, which can be seen in Figure 5.1 - Shawnee's Future Land Use Guide for Study Area. Traffic generation numbers were developed for each grid for daily, peak AM hour, and peak PM hour time periods. These trip estimates for both traffic counts were developed using information contained in the Institute of Transportation Engineers (ITE) report document entitled *Trip Generation 9th Edition*. In total, trip estimates were made for 37 different land grids. The grids were then combined into 5 different area groupings for distribution to the roadway system and specifically to the intersection of Clear Creek Parkway and Gleason Road. These groups include the future development around Belmont Drive, the land east of Clare Road, existing developments around 63rd Street and Gleason Road, future Shawnee Golf Course & Country Club developments, and future commercial development on Hedge Lane. The inbound and outbound trips were split 50-50 for daily trips, but residential areas had larger amount of outbound trips in the morning

and more inbound trips in the evening, while the commercial areas had more inbound trips in the morning and outbound trips in the evening. The final peak hour and daily traffic estimates for when Clear Creek Parkway opens and when the area has reached full build-out are summarized in Table 5.1 - Projected Traffic Flows - Opening Day (2017) and Table 5.2 - Projected Traffic Flows - Full Build-Out.

Figure 5.1 - Shawnee's Future Land Use Guide for Study Area

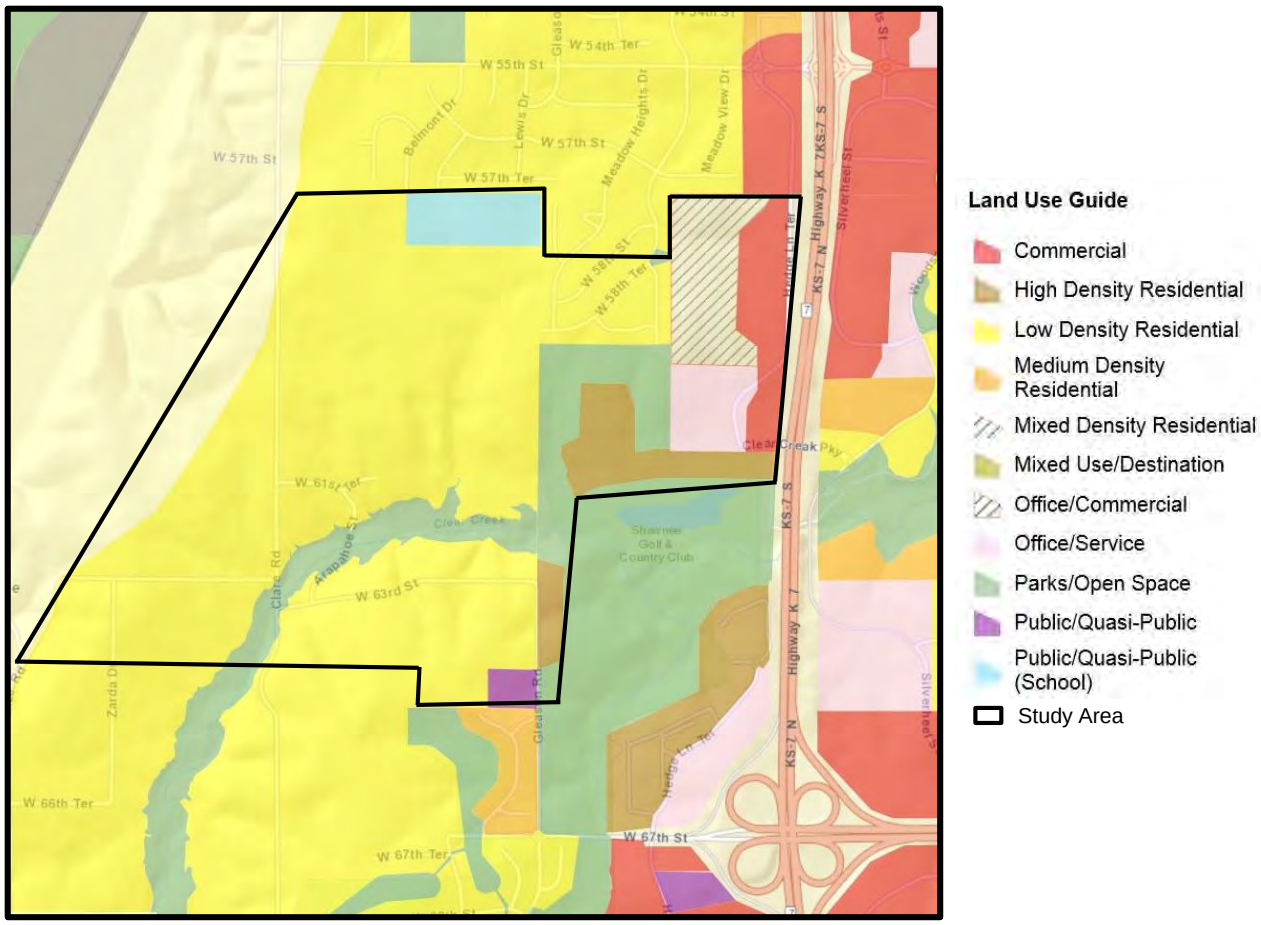


Table 5.1 - Projected Traffic Flows - Opening Day (2017)

	Eastbound		Westbound		Northbound	
	Thru	Right	Left	Thru	Left	Right
Daily	158	-	-	158	-	-
Am Peak	18	-	-	8	-	-
Pm Peak	12	-	-	22	-	-

Table 5.2 - Projected Traffic Flows - Full Build-Out

	Eastbound		Westbound		Northbound	
	Thru	Right	Left	Thru	Left	Right
Daily	1999	1608	2389	1999	1608	2389
Am Peak	220	177	173	96	77	232
Pm Peak	144	116	399	277	222	337

There were two opportunities to corroborate the methodology and predicted generated trips. The first opportunity was in comparing this study to the Belmont Elementary School Traffic Study. The methodology used in the Belmont Study was comparable to the one documented here. While their predicted trips generated had a different focus area, they were found to reasonably fit into those on Clear Creek Parkway. Actual traffic counts were also conducted by SKW on 55th Street, east of Meadowsweet Lane/Old K-7, and on 67th Street at Hedge Lane, and the traffic estimates were found to reasonably match the existing traffic counts. See Appendix I for estimates of future traffic volumes and LOS.

5.3 Alternative Descriptions

Three alternatives for the intersection of Clear Creek Parkway and Gleason Road were considered. Concept designs of the alternatives can be seen in Appendix D. These were:

- **Alternative 1 – Minor Leg Stop-Control**: The minor-leg stop controlled intersection would have a stop sign on Gleason Road and traffic would not stop along Clear Creek Parkway.
- **Alternative 2 – Traffic Signal**: A signalized intersection would be laid out similarly to the minor-leg stop controlled intersection but would have a traffic signal controlling traffic. This intersection could run as a minor-leg stop controlled intersection until more land is developed and a signal is warranted at the intersection.
- **Alternative 3 – Roundabout**: The roundabout would have one lane for traffic to circulate through.

5.4 Alternative Analysis

The three intersection alternatives were analyzed considering six factors, which can be seen in Table 5.3 - Alternative Analysis Summary. Further explanation of the analyses are following the summary table.

5.4.1 Operations

The capacity and delay of vehicles during peak morning and evening hours were analyzed using the traffic estimations and the corresponding software to the *Highway Capacity Manual*. A 3-leg intersection with stop control on Gleason Road was found to have a Level of Service (LOS) F in the evening hours due to a delay of 17 minutes for vehicles turning left from Gleason Road onto Clear Creek Parkway. Improving the intersection from stop-control to a traffic signal improved the evening peak hour LOS to B, with the longest delays close to 30 seconds for both left-turn movements, northbound on Gleason Road to westbound on Clear Creek Parkway and westbound on Clear Creek Parkway to southbound on Gleason Road. A single lane roundabout has a LOS C in the evenings, with the longest delay being 39 seconds for westbound vehicles. A summary of the intersection operations can be seen in Table 5.4 - Intersection Design LOS.

Table 5.3 - Alternative Analysis Summary

	Alternative 1 Stop-Control	Alternative 2 Signal	Alternative 3 Roundabout
Operations	○	●	◎
Safety	◎	◎	●
Driver Expectancy	●	○	●
Sustainability	◎	○	●
Aesthetics	◎	◎	●
Construction Cost	●	○	◎

Legend: ● Greater ◎ Average ○ Lesser

The intersection will operate effectively with either a signal or roundabout when the surrounding area is fully built out as a LOS B or C respectively, which will meet driver expectations during the peak hour. As it will take some time for the area to develop, if the signalized intersection is selected, it would be best that the intersection be designed to be able to operate with a signal, but begin with the minor leg stop-control intersection until a signal is warranted.

Determining signal warrants using the *Manual on Uniform Traffic Control Design* (MUTCD) can be a challenge for new intersections as there are no existing traffic counts or travel patterns established. The traffic count estimations for when the intersection opens (see Table 5.1 - Projected Traffic Flows - Opening Day (2017)) are very low and therefore, do not meet any signal warrants. However, a signal will be warranted as the area develops. Using the traffic estimations for PM peak hour, warrant three, peak hour, will be met due to the heavy left-turn movements from Gleason Road to Clear Creek Parkway. However, another traffic study will need to be completed after Clear Creek Parkway is built and the area has developed to confirm that a signal is warranted.

Table 5.4 - Intersection Design LOS

	Level Of Service (LOS)
Alternative 1 - Stop-Control	F
Alternative 2 - Traffic Signal	B
Alternative 3 - Roundabout	C

If a LOS C is determined to be unacceptable to the City, there are additions to the roundabout, such as adding a lane for westbound left-turn movements, and further, adding a bypass lane for northbound right- turns, which will improve the LOS to B and A respectively. If this is desired, further study would be needed to make sure the extra space required for these lanes would fit into the design constraints.

5.4.2 Safety

In general, roundabouts have been found to be safer due to removing left turns and therefore greatly reducing left-turn collisions. Intersections that were stop-control and converted to a roundabout see a 44% reduction in all crashes and a 78% reduction in fatal/injury crashes. Intersections that were transitioned from a traffic signal to a roundabout were also found to have a 48% reduction in all crashes and a 60% reduction in fatal/injury crashes. Roundabouts do sometimes see an increase in property damage only (PDO) collisions, but the increase in these are usually offset by the reduction in fatal/injury collisions and result in an overall lower intersection crash rate.

5.4.3 Driver Expectancy

Intersections throughout the project area are primarily stop-control or roundabouts. There are a few traffic signals at the higher volume intersections along the arterial roads. The predominant layout for Clear Creek Parkway between Hedge Lane Terrace and Woodland Drive is that higher order intersecting streets join at roundabouts while lower order streets have stop-control. The locations where Clear Creek Parkway currently end have stop-control as well. Based on the analysis of similar, adjacent intersections, either the stop-control or roundabout option would be most consistent with driver expectation in the final build-out condition. A traffic signal would be inconsistent with driver expectation at this location. Figure 5.2 - Intersections in the Area of Clear Creek Parkway and Gleason Road shows the existing intersection types near Clear Creek Parkway and Gleason Road as well as the roadway classifications.

The interim condition presents an interesting case for driver expectancy. The interim straight section of road for both the strop-control and signal option would not impact the driver's performance in any way. The issue with this is that there would be only a single access point for the 0.6 of a mile coming westbound from Silverheel Street. Given the rarity of that condition in developed areas it could lead to drivers speeding up through this stretch. With no treatment at Gleason Road, westbound vehicles would then enter a dense residential area with potentially no queue to slow down. A roundabout in this application would serve as a traffic calming device to slow traffic entering the residential area as roundabouts force people to slow down as they follow the dividing islands on the approach and yield to look for any vehicles already present in the roundabout. Other traffic calming devices, including speed humps, could serve the same purpose in the stop-control or signalized options.

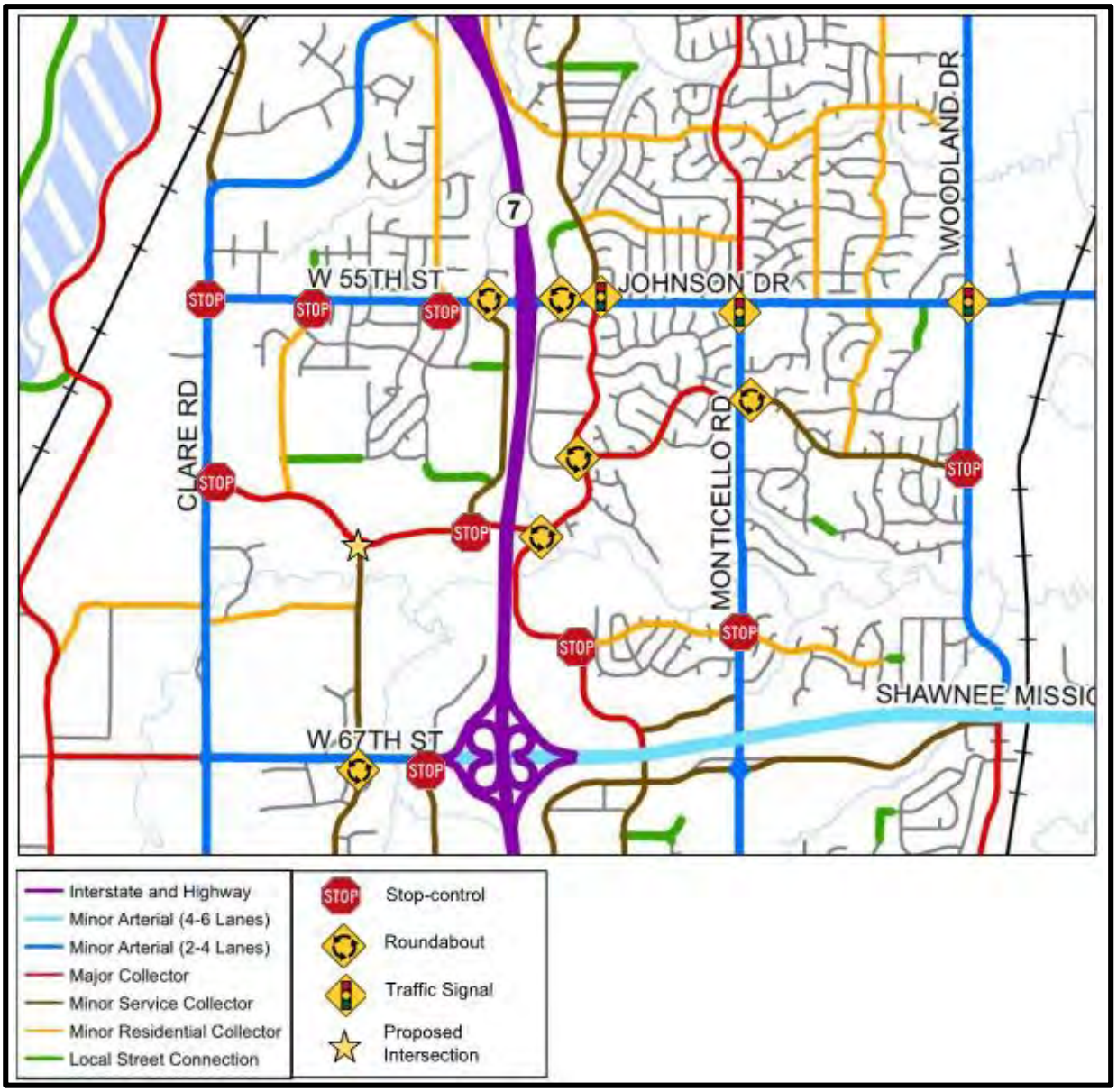
5.4.4 Sustainability

Green solutions can be provided at any intersection configuration, however roundabouts have proven scientific findings that make them superior green solutions to stop-control and signalized intersections. The most prominent fact is vehicles use less fuel at roundabouts as they do not sit idle waiting for a signal to change. Another advantage is vehicles generate less air pollution by not having to stop and wait for a signal, or expend added pollution by accelerating after a stop.

5.4.5 Aesthetics

The overall aesthetic impression of this intersection should analyze two primary considerations. What the future context of this intersection will eventually emulate when the adjacent properties are fully built-out, and resident and golf course patron expectations.

Figure 5.2 - Intersections in the Area of Clear Creek Parkway and Gleason Road



5.4.5.1 Future Area Context

The key entities of this area include the golf course, the Parkway trail, and future multi-family and single family developments. The new intersection will be most similar to two established intersections in Shawnee. These intersections are Monticello Road at Clear Creek Parkway and

67th Street at Gleason Road. Each of these sample intersections include various aesthetic elements such as landscaped roundabouts, hardscaping, water features, and pedestrian and bike crossings. In contrast, the similarly established intersection at 53rd Street and Monticello Road is a stop sign intersection with far less appeal due to the limited area for aesthetic enhancements.

5.4.5.2 Resident and Golf Course Patron Expectations

The neighborhood context that includes an existing golf course and planned higher end residential properties sets an elevated level of expectations for aesthetic treatments, not only for this intersection but the entire Clear Creek Parkway corridor. Roundabouts offer the best opportunity to provide this level of expectation due to the multiple opportunities to place aesthetic enhancements. Stop sign and signaled intersections simply do not offer as many opportunity areas, however available property at the corner of the intersections could provide aesthetic options.

5.4.6 Intersection Construction Cost

Preliminary construction costs using general cost estimates for intersections were determined to compare the alternatives, which can be seen in Table 5.5 - Concept Level Intersection Cost Estimates. As expected, the stop-controlled intersection is the most affordable intersection to construct, followed by the roundabout and traffic signal. However, constructing the roundabout now is more economical than adding it when Gleason Road is constructed. The extension of the tunnel for the golf course would be approximately the same length and cost for each alternative and therefore was not included in the estimates. Although not part of construction, it is also important to remember the maintenance costs of the alternatives. While a stop-control and roundabout will need routine maintenance for mowing and landscaping, the maintenance and electricity costs of a signal will be greater over time.

Table 5.5 - Concept Level Intersection Cost Estimates

	Concept Level Cost Estimate
Alternative 1 - Stop-Control	$168,000
Alternative 2 - Traffic Signal	$418,000
Alternative 3 - Roundabout	$337,000

5.5 Intersection Recommendation

Considering all the aspects reviewed in this study for each alternative of a stop-control, traffic signal or roundabout intersection, Alternative 3 - Roundabout is recommended for this location. This alternative will be able to match driver expectancy in the area while handling traffic volumes during peak hours when the area is fully developed. A stop-controlled intersection would not be able to handle traffic once the surrounding area is fully developed, and a traffic signal, while being able to successfully operate at peak hours, would look out of place in the context of the area. Roundabouts are also proven to be more sustainable and safer than the other intersection types as well as being more aesthetically pleasing, which is especially important in the context of its location.

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6. EVALUATION OF ALTERNATIVES

The advantages and disadvantages of each alternative presented in Section 4 and 5 are summarized below:

6.1 Alternatives Summary

6.1.1 Overhead Power Line Mitigation Options

The shifting the roadway alignment is recommended as the best mitigation option to reduce impacts to Westar Energy's existing power poles, and it is the best option for coordination with the planned roadway's construction.

6.1.2 Recreational Trail Connection

Option 2 is the recommended alignment for the recreational trail connection.

6.1.3 Retaining Walls Options

At the roundabout, the recommended retaining wall material is a large, segmental block, retaining wall. If a wall is needed at the power poles, a smaller, segmental block wall option that is less aesthetically pleasing and less costly is recommended.

6.1.4 Pavement Options

Recent unit prices for bid tabulations on similar roadway projects suggest that asphalt pavement will be more economical than concrete pavement by approximately 30%.

6.1.5 Alternative 1 – T Intersection at Gleason with Stop Control on Gleason

- Total Cost of Alternative 1 with Asphalt = $4,936,109.35
- Total Cost of Alternative 1 with Concrete = $5,339,797.30

The advantages and disadvantages of this alternative are summarized below:

Advantages:

- Least right-of-way and easement requirements.

Disadvantages:

- Left turns from Gleason will back up during peak hour traffic.

6.1.6 Alternative 2 – T Intersection with Traffic Signal

- Total Cost of Alternative 2 with Asphalt = $5,207,187.35
- Total Cost of Alternative 2 with Concrete = $5,610,875.30

The advantages and disadvantages of this alternative are summarized below:

Advantages:

- Least right-of-way and easement requirements.
- Traffic signal increases safety at the intersection for turning vehicles over stop sign.

Disadvantages:

- Traffic signal increases utility and maintenance costs.
- Green light reduces traffic calming effect.
- Higher construction costs over stop sign.

6.1.7 Alternative 3 – Roundabout

- Total Cost of Alternative 3 with Asphalt = $5,475,773.30
- Total Cost of Alternative 3 with Concrete = $6,013,085.50

The advantages and disadvantages of this alternative are summarized below:

Advantages:

- Roundabout provides natural traffic calming effect.
- Roundabout provides greatest opportunity for landscaping and aesthetic treatments.
- Roundabout serves as gateway to Canyon Lakes subdivision.
- Roundabout is the safest alternative for the travelling public.

Disadvantages:

- Highest right-of-way and easement requirements.
- Highest construction costs.

6.2 Recommended Alternative

After reviewing the advantages and disadvantages of each alternative, and comparing it with the project costs, **Alternative 3 with a roundabout is the recommended solution.** This alternative provides the most benefits, safety and opportunity for aesthetic treatments, and this alternative is the best fit for the character of the corridor.

7. PERMITS

The project will most likely require a Corps 401/404 permit for the stream at the golf course and adjacent to Gleason Road. For land disturbance on the project, a Notice of Intent must be filed with the Kansas Department of Health and Environment (KDHE) under the National Pollutant Discharge Elimination System (NPDES). Local permits from the City of Shawnee will be required to construct the project including right-of-way permits and land disturbance permits.

In the future, when Gleason Road is constructed between Clear Creek Parkway and 63dr Street, the existing stream running south of the Clear Creek Parkway and Gleason Road intersection will likely displace the current streambed. There will be significant 401/404 permitting requirements associated with the stream relocation or enclosure at that time.

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Appendix A

Geotechnical Engineering Report

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Geotechnical Engineering Report

Clear Creek Parkway Expansion
West of Intersection with Hedge Lane Terrace
Shawnee, Kansas

March 17, 2016
Terracon Project No. 02165011

Prepared for:
Shafer Kline & Warren, Inc.
Lenexa, Kansas

Prepared by:
Terracon Consultants, Inc.
Lenexa, Kansas

terracon.com
Terracon
Environmental ■ Facilities ■ Geotechnical ■ Materials

March 17, 2016

Shafer Kline & Warren, Inc.
11250 Corporate Ave
Lenexa, Kansas 66219-1392

Attn: Howard Lubliner, Ph.D., P.E.
howard.lubliner@skw-inc.com

Re: Geotechnical Engineering Report
Clear Creek Parkway Expansion
West of Intersection with Hedge Lane Terrace
Shawnee, Kansas
Terracon Project No. 02165011

Dear Dr. Lubliner:

Terracon Consultants, Inc. (Terracon) has performed the geotechnical engineering services described in our proposal P02165011 dated January 5, 2016 for the proposed Clear Creek Parkway Expansion planned in Shawnee, Kansas. This report presents the findings of our subsurface exploration and provides geotechnical recommendations concerning earthwork and preparation of pavement subgrades for the proposed alignment.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Sara J. Somsky, P.E.
Senior Project Manager
Kansas: 18855

Craig K. Denny, Ph.D., P.E.
Senior Consultant
Kansas: 10043

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EXECUTIVE SUMMARY

A geotechnical exploration has been performed for the proposed Clear Creek Parkway Expansion planned in Shawnee, Kansas. Samples recovered from the borings have been tested. Logs of borings with test data are appended to this geotechnical engineering report. Findings, professional opinions and recommendations presented in this report are summarized below.

- At Boring B-11, fill was encountered to a depth of 2 feet. Existing fill materials could be encountered along the alignment. We recommend existing fill and unsuitable native soils be removed where encountered within the alignment and replaced with engineered fill.

- Bedrock strata were encountered at depths of ½ to 23½. Bedrock generally consisted of shale and limestone. Sandstone bedrock was encountered at Boring B-6. Based on the planned cut/fill along the centerline, excavation of bedrock may not be required to establish the vertical alignment, but excavation of bedrock may be required to install below-grade utilities. Conventional heavy duty excavation equipment such as large track-mounted hoes equipped with rock teeth or bulldozers equipped with ripping attachments are often used to excavate bedrock materials that were penetrated with flight augers in the exploratory borings. Excavation of rock formations that cannot be penetrated with flight augers is usually much more difficult and often requires the use of pneumatic breakers or other rock excavation techniques.

- Moderately plastic to highly plastic fat clay soils (liquid limits ranging from 54 to 70 and plastic indexes ranging from 34 to 26) were encountered at the borings. These soils are not ideal as subgrade material immediately below pavement sections. In this locale, clay soils with a liquid limit of greater than 40 and a PI greater than 25 are either undercut and replaced with low plasticity clay or crushed aggregate soils, or the highly plastic soils are chemically modified by incorporating lime, Portland cement or Class C fly ash.

The professional opinions and recommendations presented in this report are based on evaluation of data developed by testing discrete samples obtained from widely spaced borings. Site subsurface conditions have been inferred from available data, but actual subsurface conditions will only be revealed by excavation. We recommend Terracon be retained to observe excavation and perform tests during earthwork and subgrade construction phases of the project.

This executive summary should not be separated from or used apart from this report. This report presents recommendations and opinions based on our understanding of the project at the time the report was prepared. The report limitations are described in section **5.0 GENERAL COMMENTS**.

GEOTECHNICAL ENGINEERING REPORT
CLEAR CREEK PARKWAY EXPANSION
WEST OF INTERSECTION WITH HEDGE LANE TERRACE
SHAWNEE, KANSAS

Terracon Project No. 02165011
March 17, 2016

1.0 INTRODUCTION

Geotechnical exploration and engineering services have been performed for the proposed Clear Creek Parkway Expansion planned in Shawnee, Kansas. The borings extended to depths of approximately 3 to 25 feet below ground surface (BGS). An exploration plan and boring logs are included in Appendix A of this report. The purpose of this report is to provide information, professional opinions, and geotechnical engineering recommendations relative to:

- subsurface soil and bedrock conditions
- groundwater conditions
- earthwork
- preparation of pavement subgrades

2.0 PROJECT INFORMATION

This section of the report reflects our understanding of the project based on information provided by Shafer, Kline & Warren (SKW). If we have misunderstood any aspect, please contact us so we can review the recommendations presented herein.

2.1 Site Location

Item	Description
Location	Clear Creek Parkway will be continued approximately 5,100 feet west of its current terminus at Hedge Lane Road in Shawnee, Kansas. Latitude: 39.017654° Longitude: 94.863976°
Existing improvements	The eastern portion of the roadway extension will bisect the Shawnee Golf and Country Club golf course. A portion of the western half of the proposed alignment is located in a heavily wooded area, with the remaining portion of the planned roadway alignment located in undeveloped agricultural land.
Current ground cover	Grass, weeds, trees
Topography	Gently rolling; Johnson County AIMS indicated up to 100 feet of grade change along the proposed alignment.

2.2 Project Description

Clear Creek Parkway will extend approximately 5,100 feet west of its current terminus at Hedge Lane Road in Shawnee, Kansas, as indicated in Figure 1. The proposed roadway will include sidewalks, a recreational trail, a golf cart crossing (reinforced concrete box underpass), and new storm sewer(s). We understand that a City of Shawnee pavement section will be utilized.

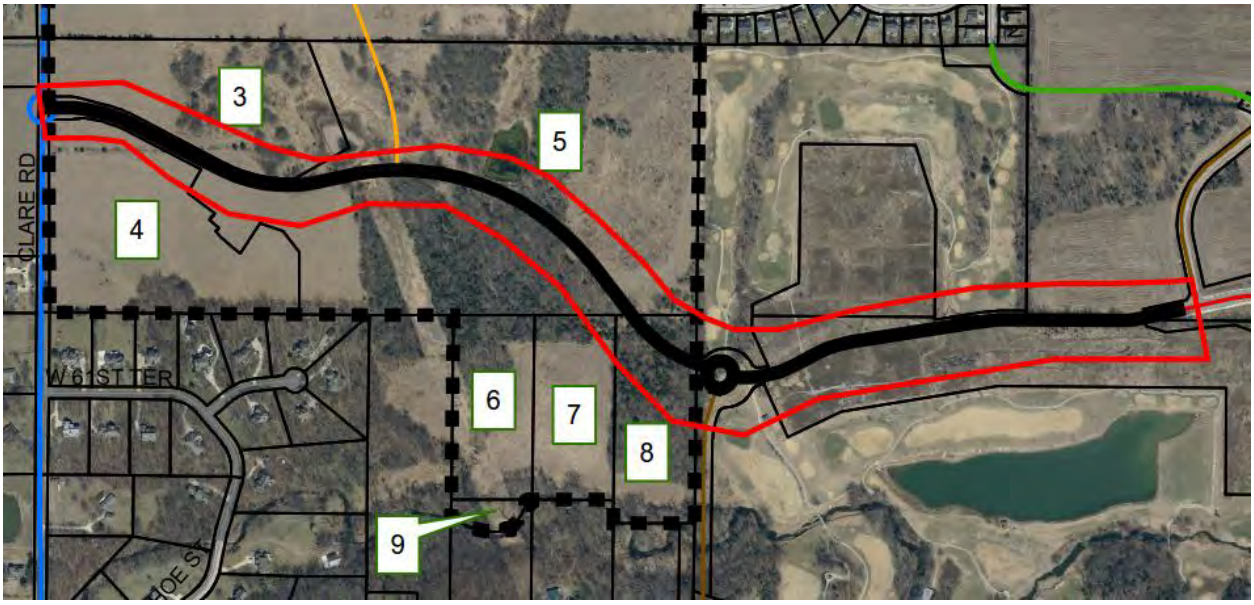


Figure 1. Proposed Alignment

3.0 SUBSURFACE CONDITIONS

3.1 Typical Profile

Conditions encountered at each boring location are indicated on the individual boring logs in Appendix A. Stratification boundaries on the boring logs represent the approximate location of changes in soil and bedrock types; in situ, the transition between materials may be gradual. The materials encountered varied between the borings, and other variations could occur between borings or across the site. Conditions at the borings are summarized in the following table.

Stratum	Approximate Depth of Bottom of Stratum	Material	Comments
1	1 to 4 inches	Topsoil	--
2	2 feet	Lean clay	Encountered at B-11, existing fill
3	2 to 23½ feet [1]	Lean clay and fat clay	Moderately to highly plastic, generally brown and gray, medium stiff to very stiff

4	½ to 14½ feet [1]	Bedrock	Shale, limestone and sandstone, brown to gray

1. Borings B-1, B-2, B-3, B-9, B-10, and B-12 were terminated in Stratum 3 at planned depths of 10 to 15 feet.
2. Borings B-4 through B-8 were terminated in Stratum 4 at depths of 3 to 8½ feet when auger refusal occurred. Boring B-8 and B-11 was terminated in Stratum 4 at a planned depth of 25 and 15 feet, respectively.

3.2 Groundwater

We monitored the boreholes for the presence and level of groundwater while drilling and after the completion of drilling. Groundwater conditions are indicated on the individual boring logs in Appendix A and in the following table.

Boring No.	Depth to groundwater while drilling	Depth to groundwater after drilling
B-1	Not noted	Not noted
B-2	Not noted	Not noted
B-3	Not noted	Not noted
B-4	Not noted	Not noted
B-5	Not noted	Not noted
B-6	Not noted	Not noted
B-7	Not noted	Not noted
B-8	24 feet	24 feet
B-9	Not noted	Not noted
B-10	Not noted	Not noted
B-11	8 feet	5 feet
B-12	Not noted	Not noted

Long-term observations in piezometers or observation wells sealed from the influence of surface water would be needed to develop groundwater information. Groundwater level fluctuations occur due to variations in rainfall, runoff and other factors not evident at the time we performed the borings. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

Bedrock was encountered at depths of ½ to 23½ feet. As the ground surface descends to the east, the bedrock strata that was encountered at higher elevations along the west part of the alignment have been removed by erosion and/or weathered to a clay-like consistency. Conditions

along the proposed roadway alignment are indicated on boring logs in Appendix A. For ease of reference, we have plotted the boring profiles in ascending order from west to east along the alignment (Figure 3).

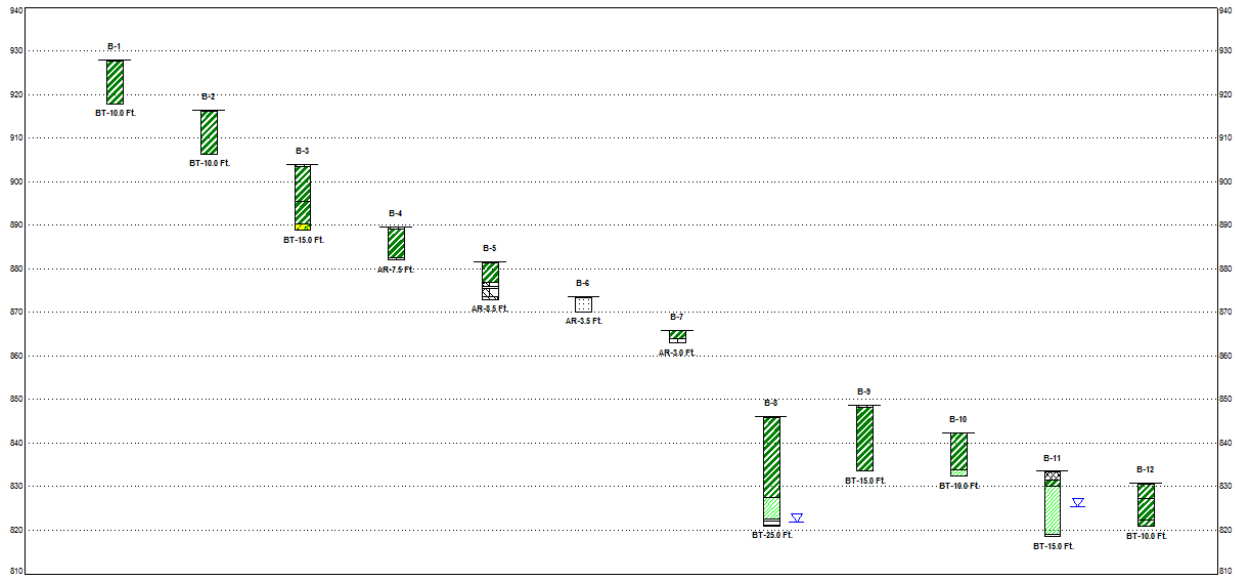


Figure 3. Subsurface Profile

The clay soils encountered at the boring locations exhibited medium to high plasticity. Based on our knowledge of geotechnical conditions in this locale, we expect similar conditions within the planned alignment corridor. At Boring B-1, very highly plastic fat clay soil (LL 70, PI 46) was encountered. Portions of the alignment corridor are heavily wooded, so the clay soils may be desiccated. Dry clay soils can have a very high swell potential.

Highly plastic clay soils are not an ideal subgrade material immediately below pavement sections. In this locale, clay soils with a liquid limit greater than 40 and a plastic index greater than 25 are either undercut and replaced with low plasticity clay or crushed aggregate or the highly plastic soils are chemically modified by incorporating lime, Portland cement or Class C fly ash to establish pavement subgrades.

Engineered fill should be placed according to the recommended compaction requirements in section **4.2 Earthwork**. Even with an overlying layer of engineered fill, some of the underlying native clay soils may shrink and swell with normal changes in moisture content. Some movements should be expected and anticipated in the improvement areas. Because weather related conditions (floods, droughts, sub-freezing temperatures, etc.) cannot be controlled, larger movements should still be expected if expansive soils become very wet or very dry.

Existing fill was observed at Boring B-11 to an approximate depth of 2 feet below existing ground surface elevations. Existing fill materials could be encountered in other portions along the

alignment. We recommend existing fill and unsuitable native soils be removed and replaced with engineered fill. Engineered fill should be placed according to the recommended compaction requirements in section **4.2 Earthwork**.

4.2 Earthwork

4.2.1 Site Preparation

Clearing, grubbing and other earthwork operations should comply with requirements described in Division 4100 of the latest edition of the Shawnee Design and Construction Manual and as otherwise described herein. Stripping operations should extend a minimum of one foot beyond the back of planned edge of shoulder limits. Tree root systems should be thoroughly grubbed to remove roots larger than ½ inch in diameter. Surface vegetation should be stripped and all organic topsoil should be removed from planned borrow source areas, cut areas, and areas to be filled. Existing fill should be undercut where encountered. Because portions of the alignment corridor are heavily wooded, desiccated clay soils may be encountered. Desiccated soils that are not removed with tree root systems during grubbing operations should be further undercut. If moisture conditioned and found to be otherwise suitable, materials from cut areas could be used to construct engineered fills.

Topsoil materials removed during stripping operations could be used to top graded ditches and embankment slopes to facilitate vegetation growth. These materials should be carefully separated to avoid incorporation of organic matter in controlled engineered fill sections.

4.2.2 Initial Proof-rolling

After the street subgrades have been cut to grade, but before fill is placed, the subgrades should be proof-rolled with a fully loaded, tandem-axle dump truck or other equipment providing an equivalent loading. The initial proof-rolling will aid in delineating soft, yielding, or otherwise unsuitable soils located at or just below the exposed subgrade level. Areas that rut, pump, or deflect during the initial proof-rolling should be overexcavated and replaced with engineered fill or stabilized. Proof-rolling is also recommended in areas left near existing grade after rough grading is completed. A minimum gross weight of 25 tons is recommended for the proof-rolling equipment.

In our opinion, experienced personnel should observe proof-rolling operations to help identify unstable subgrade material. Prior to placing any fill, the exposed subgrade should be scarified 6 inches and compacted with strict moisture and density control as recommended for fill soils.

4.2.3 Embankment Foundation Treatment

Portions of the planned alignment will involve construction of embankment fills. From the provided roadway plans, fill section heights could be up to approximately 18 feet in height above existing grades. Following stripping in new embankment areas, the exposed grade should evaluated to determine the extent of desiccated soils. If soils are not desiccated, the exposed subgrade should

be scarified to a minimum depth of 6 inches. Depending on the extent of desiccation and moisture content of the soils exposed, further undercutting and moisture conditioning of the exposed grade may be required prior to fill placement. The moisture content of the exposed grade should be adjusted to the moisture range recommended for the embankment fill and the scarified materials should be compacted in accordance with Shawnee's recommendations for embankment fill.

In areas where fill will be placed on existing slopes, any slopes steeper than 5:1 (H:V) should be benched prior to placement of embankment fill. Benching of the slope helps provide interlocking between the fill and native soils and helps facilitate proper compaction of the fill. The benches should have a minimum vertical face height of 1 foot and a maximum vertical face height of 3 feet and should be cut wide enough to accommodate compaction equipment.

4.2.4 Material Requirements

The compaction requirements outlined in Section 4115 of the Shawnee Design and Construction Manual and in the City of Shawnee Standard Details (which references section 205.4.g of the Kansas Department of Transportation Manual) indicates soil placed below a depth of 18 inches in fill sections should be compacted to Type B compaction with a moisture range of MR-90, which is defined as "enough moisture to achieve compaction". Acceptable Type B compaction accomplished when the tamping feet of a sheepsfoot roller "walk out" of the soil and ride on top of the lift being compacted. In our opinion, the soils at the project site could achieve Type B compaction with lower than recommended moisture contents, which could result in lower in-place densities and moderate to high swell potential of on-site soils placed in this manner. As such, we recommend all fill placed within the street subgrades be placed as described below.

Materials that will be used as engineered fill to support pavements and other features that are movement sensitive should consist of approved materials. Approved materials should be free of organic matter and debris. Frozen materials should not be used, and fill should not be placed on a frozen subgrade. Engineered fill should be placed and compacted in lifts of 9 inches or less in loose thickness. Fill should be compacted to at least 95% of the material's maximum standard Proctor dry density (ASTM D698). The moisture contents of clay soils having a liquid limit greater than 45 should be within the range of 0 to 4% above the optimum moisture content value determined by the standard Proctor test at the time of placement and compaction. The moisture contents of clay soils having a liquid limit less than 45 should be within the range of -2% to +2% of optimum moisture content. Granular fills should be placed at workable moisture contents (sufficient to achieve compaction without pumping when proof-rolled).

To reduce the potential for future subgrade swell, the subgrade moisture should be maintained within the recommended range until the pavements are constructed. Grades should be sloped to provide rapid drainage of surface water away from the pavements.

4.2.5 Review of Pavement Subgrades Prior to Paving

We recommend pavement subgrades developed as recommended in section **4.2.1 Site Preparation** of this report be reviewed prior to placement of pavement sections. On most project sites, the site grading is accomplished relatively early in the construction phase. Fills are placed and compacted in a uniform manner. However, as construction proceeds, excavations are made into these areas, rainfall and surface water saturates some areas, heavy traffic from concrete trucks and other delivery vehicles disturbs the subgrade and many surface irregularities are filled in with loose soils to improve trafficability temporarily.

We recommend pavement subgrades be reviewed and evaluated as the time for pavement construction approaches. We recommend the subgrade be final proof-rolled within two days prior to commencement pavement operations. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing and replacing the materials with properly compacted fills. After proof-rolling and repairing deep subgrade deficiencies, subgrades can be stabilized.

4.3 Slope Considerations

In our opinion, all permanent and temporary embankment fill slopes and cut backslopes in native clay soils that are similar to those encountered at our borings should be no steeper than 3:1 (H:V). We recommend that permanent slopes be vegetated soon after completion to reduce erosion. Erosion control measures should be considered for the temporary slopes to reduce erosion.

4.4 Public Utilities

We understand that storm sewer facilities are planned along the alignment at typical depths of 3 to 5 feet below finished grades. Excavation of clay soils (native and fill) is not expected to be difficult. If bedrock is encountered, excavation of bedrock strata in these confined areas and particularly below auger refusal depths will be more difficult. Experience has indicated that conventional heavy duty excavation equipment such as backhoes equipped with rock teeth can sometimes excavate bedrock materials which we could penetrate with a flight auger fitted with a carbide finger tooth bit. Rock excavation methods, such as jackhammers, hoe-rams, or blasting could also be required to remove bedrock to required depths.

4.5 Box Culvert

Design recommendations for the proposed box culvert and wing wall foundations are presented in the following section. We considered that continuous footings would support wing walls and the culvert would be supported on a structural slab. We considered the wing walls and culvert will bear on native clay soils near existing grades.

4.5.1 Foundation Design Recommendations

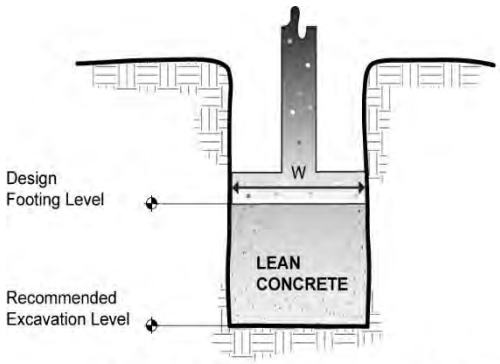
Description	Wall
Net allowable bearing pressure [1]	2,000 psf
Minimum width of wing wall footing	18 inches
Minimum embedment below finished grade	3 feet
Approximate total settlement	1 inch or less
Estimated differential settlement	1 inch or less between the center and end of the box culvert

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. The recommended bearing value considers the foundations bear on suitable clays soils below the scour depth.
2. The embedment depth is for frost protection and to reduce the effects of seasonal moisture variations in the subgrade soils. Minimum embedment depths may need to be increased for scour. Scour evaluation was not included in the scope of services for this project.

4.5.2 Foundation Construction Considerations

Water may be encountered near or above planned foundation bearing levels. The base of all foundation excavations should be free of water and loose/soft soil and rock prior to placing concrete. In order to develop a level surface to construct the culvert base and wing wall foundations, a lean concrete mud mat could be placed over the existing surface. The geotechnical engineer should be retained to observe and test the foundation bearing materials.

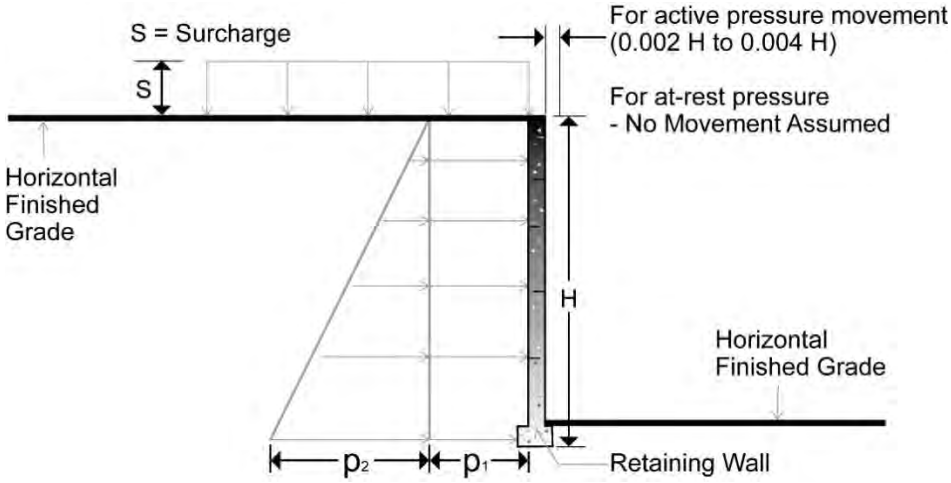
If unsuitable bearing materials are encountered in footing excavations, the excavations should be extended deeper to suitable strata. Footings could bear directly on the suitable materials at the lower level or on lean concrete backfill placed in the excavations as shown in the adjacent figure.



Lean Concrete Backfill

4.5.3 Lateral Earth Pressures

Culvert and wing walls with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to those indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown. Active earth pressure can be used if wall movement is permitted whereas, the "at-rest" condition considers no wall movement. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls. In our opinion, at-rest parameters should be used to design culvert walls. If wing walls will connect to culvert walls such that movement is restricted, at-rest parameters should also be used to design wing walls.



Earth Pressure Coefficients

Lateral Earth Pressure Parameters				
Pressure Conditions	**Coefficient For Backfill Type**	**Equivalent Fluid Unit Weight (pcf)**	**Surcharge Pressure, P_1 (psf)**	**Earth Pressure, P_2 (psf)**
At-Rest (K_o)	Granular - 0.47	60	(0.50)S	(60)H
	Cohesive - 0.63	75	(0.63)S	(75)H
Active (K_a)	Granular - 0.31	40	(0.50)S	(60)H
	Cohesive - 0.45	55	(0.45)S	(55)H
Passive (K_p)	Granular – 3.2	420	---	---
	Cohesive – 2.2	250	---	---

Applicable conditions to the above include:

- For active earth pressure, wall must rotate about base, with top lateral movements of approximately 0.002 **H** to 0.004 **H**, where **H** is wall height
- For passive earth pressure to develop, wall must move horizontally to mobilize resistance
- Uniform surcharge, where S is surcharge pressure
- Granular material backfill: unit weight = 130 pcf and Phi = 32 degrees
- Clay soil backfill: unit weight = 120 pcf and Phi = 27 degrees
- Horizontal backfill, compacted as recommended in the report
- Loading from heavy compaction equipment not included
- No hydrostatic pressures acting on wall
- No loading from nearby footing or slabs
- No dynamic loading
- No safety factor included in soil parameters
- Ignore passive pressure in frost zone

Wall backfill should consist of granular soils or lean clay soils. For the granular values for lateral earth pressures to be valid, the granular backfill must extend out from the base of the wall at an angle of at least 45 from vertical for the active case. To calculate the resistance to sliding, an ultimate coefficient of friction value of 0.30 should be used.

If there is concern that water may accumulate and free-draining backfill with a reliable drainage system is not placed behind the walls, which would result in application of hydrostatic loads on walls, then walls should be designed using the combined hydrostatic and lateral earth pressures of 100 pcf. This pressure does not include the influence of surcharge loads, which should be added. Heavy equipment should not operate within a distance closer than the exposed height of walls to prevent lateral pressures more than those provided.

5.0 GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction, and other earth-related construction phases of the project.

The professional opinions and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of geotechnical services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either expressed or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION

Field Exploration Description

The boring locations were selected by Terracon and were staked at the site by SKW. Ground surface elevations were provided by SKW. The borings were drilled with a track-mounted, rotary drill rig using solid-stem, continuous flight augers to advance the boreholes. Samples of the soil encountered in the borings were obtained using split-barrel sampling procedures, where a standard 2-inch outer diameter split-barrel sampling spoon is driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths.

The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. The drill crew backfilled the borings with auger cuttings after completion of drilling/sampling and prior to leaving the site.

The drill crew prepared a field log of each boring. These logs included visual classifications of the materials encountered during drilling as well as the driller's interpretation of the subsurface conditions between samples. The final boring logs included with this report represent the engineer's interpretation of the subsurface conditions at the borings based on field and laboratory data and observation of the samples.

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager: SJS	Project No. 02165011
Drawn by: SJS	Scale: AS SHOWN
Checked by: CKD	File Name:
Approved by: SJS	Date: 03/17/2016

Terracon
13910 W 96th Terrace
Lenexa, Kansas 66215-1228

EXPLORATION PLAN

Clear Creek Parkway
West of Intersection with Hedge Lane Terrace
Shawnee, Kansas

Exhibit
A-2

BORING LOG NO. B-1

PROJECT: Clear Creek Parkway Expansion

CLIENT: Shafer Kline & Warren, Inc.
Lenexa, Kansas

SITE: Clear Creek Parkway and Hedge Lane
Shawnee, Kansas

LOCATION See Exhibit A-3

Latitude: 39.0204865° Longitude: -94.8721185°
Northing: 265624.0426 Easting: 2201018.652
Station: 10+50

Surface Elev.: 927.909 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
0.3 **3" TOPSOIL**	927.5								
FAT CLAY (CH), brown, stiff									
				15	3-4-6 N=10	1	27		70-24-46
				18	3-5-5 N=10	2	26		
		5							
-reddish brown				16	2-4-5 N=9	3	23		
10.0	918	10							
Boring Terminated at 10 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
Continuous flight solid stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-1 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 West 96th Terrace
Lenexa, Kansas

Boring Started: 2/22/2016	Boring Completed: 2/22/2016
Drill Rig: 988	Driller: KP
Project No.: 02165011	Exhibit: A-4

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 02165011.GPJ TERRACON2015.GDT 3/17/16

BORING LOG NO. B-2

PROJECT: Clear Creek Parkway Expansion

CLIENT: Shafer Kline & Warren, Inc.
Lenexa, Kansas

SITE: Clear Creek Parkway and Hedge Lane
Shawnee, Kansas

LOCATION See Exhibit A-3

Latitude: 39.0201412° Longitude: -94.8706064°
Northing: 265504.4058 Easting: 2201444.303
Station: 15+50

Surface Elev.: 916.322 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
0.2	916								
2" TOPSOIL									
FAT CLAY, brown, gray, stiff									
				16	3-5-9 N=14	1	27		
-light gray, brown				18	3-4-5 N=9	2	25		
		5							
-with sand, reddish brown				18	3-5-5 N=10	3	20		
10.0	906.5	10							
Boring Terminated at 10 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
Continuous flight solid stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-1 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 West 96th Terrace
Lenexa, Kansas

Boring Started: 2/22/2016	Boring Completed: 2/22/2016
Drill Rig: 988	Driller: KP
Project No.: 02165011	Exhibit: A-5

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 02165011.GPJ TERRACON2015.GDT 3/17/16

BORING LOG NO. B-3

PROJECT: Clear Creek Parkway Expansion

CLIENT: Shafer Kline & Warren, Inc.
Lenexa, Kansas

SITE: Clear Creek Parkway and Hedge Lane
Shawnee, Kansas

LOCATION See Exhibit A-3

Latitude: 39.0196285° Longitude: -94.8691772°
Northing: 265338.4885 Easting: 2201840.338
Station: 19+50

Surface Elev.: 903.87 (Ft.)

DEPTH	ELEVATION (Ft.)	Description
0.3	903.5	**4" TOPSOIL**
		FAT CLAY (CH), brown, reddish brown, gray, stiff
		-medium stiff
8.5	895.5	
		FAT CLAY (CH), sandy, reddish brown, stiff
13.5	890.5	
		SANDY FAT CLAY (SC), fine to medium grained, reddish brown, medium dense
15.0	889	
		Boring Terminated at 15 Feet

DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
		18	2-4-6 N=10	1	29		
		18	2-3-4 N=7	2	22		
5							
		18	3-4-4 N=8	3	17		
10							
		18	4-7-7 N=14	4	22		
15							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
Continuous flight solid stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-1 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 West 96th Terrace
Lenexa, Kansas

Boring Started: 2/22/2016	Boring Completed: 2/22/2016
Drill Rig: 988	Driller: KP
Project No.: 02165011	Exhibit: A-6

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 02165011.GPJ TERRACON2015.GDT 3/17/16

BORING LOG NO. B-4

PROJECT: Clear Creek Parkway Expansion

CLIENT: Shafer Kline & Warren, Inc.
Lenexa, Kansas

SITE: Clear Creek Parkway and Hedge Lane
Shawnee, Kansas

LOCATION See Exhibit A-3

Latitude: 39.0196678° Longitude: -94.8681217°
Northing: 265358.779 Easting: 2202141.827
Station: 22+50

Surface Elev.: 889.502 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
0.3 **4" TOPSOIL**	889								
FAT CLAY (CH), reddish brown, stiff									
				14	2-5-6 N=11	1	25		
-trace gravel				15	3-2-4 N=6	2	22		
		5							
7.0	882.5								
7.5 **LIMESTONE**, gray	882								
Auger Refusal at 7.5 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic SPT Hammer

Advancement Method:
Continuous flight solid stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-1 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 West 96th Terrace
Lenexa, Kansas

Boring Started: 2/22/2016	Boring Completed: 2/22/2016
Drill Rig: 988	Driller: KP
Project No.: 02165011	Exhibit: A-7

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 02165011.GPJ TERRACON2015.GDT 3/17/16

BORING LOG NO. B-5

PROJECT: Clear Creek Parkway Expansion

CLIENT: Shafer Kline & Warren, Inc.
Lenexa, Kansas

SITE: Clear Creek Parkway and Hedge Lane
Shawnee, Kansas

LOCATION See Exhibit A-3

Latitude: 39.0197441° Longitude: -94.8663965°
Northing: 265408.2107 Easting: 2202635.917
Station: 27+50

Surface Elev.: 881.507 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
0.2 **2" TOPSOIL**	881.5									
FAT CLAY (CH), reddish brown, brown, stiff										
					13	2-4-6 N=10	1	28		
4.5	877				11	3-4-18 N=22	2	26		
LIMESTONE, brown, highly weathered		5								
5.5	876									
6.0 **SHALE**, brown, highly weathered	875.5									
LIMESTONE, brown										
8.5	873									
Sampler Refusal at 8.5 Feet					0	50/0"	3			

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic SPT Hammer

Advancement Method:
Continuous flight solid stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-1 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 West 96th Terrace
Lenexa, Kansas

Boring Started: 2/22/2016	Boring Completed: 2/22/2016
Drill Rig: 988	Driller: KP
Project No.: 02165011	Exhibit: A-8

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 02165011.GPJ TERRACON2015.GDT 3/17/16

BORING LOG NO. B-6

PROJECT: Clear Creek Parkway Expansion

CLIENT: Shafer Kline & Warren, Inc.
Lenexa, Kansas

SITE: Clear Creek Parkway and Hedge Lane
Shawnee, Kansas

LOCATION See Exhibit A-3

Latitude: 39.0190045° Longitude: -94.8647524°
Northing: 265281.1563 Easting: 2202964.895
Station: 33+00

Surface Elev.: 873.6 (Ft.)

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
	0.3 **4" TOPSOIL**	873.5									
	SANDSTONE, brown, moderately weathered, very weak										
						4	50/4"	1	11		
									18		
	3.5	870									
	Sampler Refusal at 3.5 Feet					0	50/0"	2			

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic SPT Hammer

Advancement Method:
Continuous flight solid stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-1 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 West 96th Terrace
Lenexa, Kansas

Boring Started: 2/22/2016	Boring Completed: 2/22/2016
Drill Rig: 988	Driller: KP
Project No.: 02165011	Exhibit: A-9

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 02165011.GPJ TERRACON2015.GDT 3/17/16

BORING LOG NO. B-7

PROJECT: Clear Creek Parkway Expansion

CLIENT: Shafer Kline & Warren, Inc.
Lenexa, Kansas

SITE: Clear Creek Parkway and Hedge Lane
Shawnee, Kansas

LOCATION See Exhibit A-3

Latitude: 39.0181526° Longitude: -94.8638501°
Northing: 264852.1125 Easting: 2203374.99
Station: 37+00

Surface Elev.: 865.933 (Ft.)

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
	0.2 **2" TOPSOIL**	865.5									
	FAT CLAY (CH), dark gray										
	2.0	864			X	6	15-50/2"	1	17		
	LIMESTONE, gray										
	3.0	863									
	Auger Refusal at 3 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic SPT Hammer

Advancement Method:
Continuous flight solid stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-1 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 West 96th Terrace
Lenexa, Kansas

Boring Started: 2/22/2016	Boring Completed: 2/22/2016
Drill Rig: 988	Driller: KP
Project No.: 02165011	Exhibit: A-10

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 02165011.GPJ TERRACON2015.GDT 3/17/16

BORING LOG NO. B-8

PROJECT: Clear Creek Parkway Expansion

CLIENT: Shafer Kline & Warren, Inc.
Lenexa, Kansas

SITE: Clear Creek Parkway and Hedge Lane
Shawnee, Kansas

LOCATION See Exhibit A-3

Latitude: 39.0174696° Longitude: -94.8620503°
Northing: 264624.1017 Easting: 2203924.108
Station: 43+00

Surface Elev.: 845.995 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
0.2	846									
2" TOPSOIL										
FAT CLAY (CH), dark brown, stiff										
					17	3-5-6 N=11	1	25		
					16		2	24	103	54-20-34
		5								
-brown					18	2-4-6 N=10	3	23		
		10								
-reddish brown, gray, brown					22		4	25	101	
		15								
18.5	827.5									
LEAN CLAY (CL), light brown, light gray, medium stiff					18	3-3-4 N=7	5	24		
		20								
23.5	822.5									
SHALE, olive brown, highly weathered, very weak			▽		18	8-26-50/5"	6	18		
25.0	821	25								
Boring Terminated at 25 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic SPT Hammer

Advancement Method:
Continuous flight solid stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-1 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

▽ *24 feet while sampling*
▽ *24 feet after boring*

Terracon
13910 West 96th Terrace
Lenexa, Kansas

Boring Started: 2/22/2016	Boring Completed: 2/22/2016
Drill Rig: 988	Driller: KP
Project No.: 02165011	Exhibit: A-11

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 02165011.GPJ TERRACON2015.GDT 3/17/16

BORING LOG NO. B-9

PROJECT: Clear Creek Parkway Expansion

CLIENT: Shafer Kline & Warren, Inc.
Lenexa, Kansas

SITE: Clear Creek Parkway and Hedge Lane
Shawnee, Kansas

LOCATION See Exhibit A-3

Latitude: 39.0178696° Longitude: -94.8605526°
Northing: 264779.0841 Easting: 2204321.294
Station: 47+50

Surface Elev.: 848.608 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
0.3 **4" TOPSOIL**	848.5								
FAT CLAY (CH), light gray, brown, stiff									
				18	3-5-8 N=13	1	25		
				18	3-4-5 N=9	2	28		
		5							
-reddish brown, medium stiff				18	3-3-4 N=7	3	27		
		10							
-brown, reddish brown				18	2-2-3 N=5	4	29		
15.0	833.5	15							
Boring Terminated at 15 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
Continuous flight solid stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-1 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 West 96th Terrace
Lenexa, Kansas

Boring Started: 2/22/2016	Boring Completed: 2/22/2016
Drill Rig: 988	Driller: KP
Project No.: 02165011	Exhibit: A-12

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 02165011.GPJ TERRACON2015.GDT 3/17/16

BORING LOG NO. B-10

PROJECT: Clear Creek Parkway Expansion

CLIENT: Shafer Kline & Warren, Inc.
Lenexa, Kansas

SITE: Clear Creek Parkway and Hedge Lane
Shawnee, Kansas

LOCATION See Exhibit A-3

Latitude: 39.0180268° Longitude: -94.8593458°
Northing: 264849.2763 Easting: 2204695.966
Station: 51+00

Surface Elev.: 842.386 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
0.1	842.5								
1" TOPSOIL									
FAT CLAY (CH), gray brown, medium stiff									
				18	2-2-4 N=6	1	28		
-stiff				18	3-4-7 N=11	2	27		
		5							
8.5	834								
LEAN CLAY (CL), brown, gray, medium stiff				18	2-2-3 N=5	3	28		
10.0	832.5	10							
Boring Terminated at 10 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
Continuous flight solid stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-1 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 West 96th Terrace
Lenexa, Kansas

Boring Started: 2/22/2016	Boring Completed: 2/22/2016
Drill Rig: 988	Driller: KP
Project No.: 02165011	Exhibit: A-13

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 02165011.GPJ TERRACON2015.GDT 3/17/16

BORING LOG NO. B-11

PROJECT: Clear Creek Parkway Expansion

CLIENT: Shafer Kline & Warren, Inc.
Lenexa, Kansas

SITE: Clear Creek Parkway and Hedge Lane
Shawnee, Kansas

LOCATION See Exhibit A-3

Latitude: 39.0179465° Longitude: -94.8577623°
Northing: 264844.765 Easting: 2205110.449
Station: 55+50

Surface Elev.: 833.526 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
0.2	833.5	**2" TOPSOIL**									
		FILL - LEAN CLAY, dark brown									
2.0	831.5	**FAT CLAY (CH)**, gray, stiff				18	2-3-6 N=9	1	27		
3.5	830	**LEAN CLAY (CL)**, light gray, medium stiff				18	2-2-3 N=5	2	27		
			5	▽							
		-light brown, soft		▽		18	WOH-2-1 N=3	3	26		
			10								
14.5	819					18	4-9-20 N=29	4	19		
15.0	818.5	**SHALE**, brown, yellow brown, highly weathered, extremely weak	15								
		Boring Terminated at 15 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

Hammer Type: Automatic SPT Hammer

Advancement Method:
Continuous flight solid stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-1 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were provided by others.

Notes:
WOH=Weight Of Hammer

WATER LEVEL OBSERVATIONS

▽ *8 feet while sampling*
▽ *5 feet after boring*

Terracon
13910 West 96th Terrace
Lenexa, Kansas

Boring Started: 2/22/2016	Boring Completed: 2/22/2016
Drill Rig: 988	Driller: KP
Project No.: 02165011	Exhibit: A-14

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 02165011.GPJ TERRACON2015.GDT 3/17/16

BORING LOG NO. B-12

PROJECT: Clear Creek Parkway Expansion

CLIENT: Shafer Kline & Warren, Inc.
Lenexa, Kansas

SITE: Clear Creek Parkway and Hedge Lane
Shawnee, Kansas

LOCATION See Exhibit A-3

Latitude: 39.0180068° Longitude: -94.8561831°
Northing: 264863.2393 Easting: 2205533.014
Station: 60+00

Surface Elev.: 830.856 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
0.3	830.5								
3" TOPSOIL									
FAT CLAY (CH), dark gray, medium stiff (possible fill)				8	2-2-5 N=7	1	26		66-20-46
3.5	827.5								
FAT CLAY (CH), gray, brown, very stiff, desiccated		5		15	5-8-13 N=21	2	8		
8.5	822.5								
FAT CLAY (CH), gray, medium stiff				18	2-2-2 N=4	3	24		
10.0	821	10							
Boring Terminated at 10 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
Continuous flight solid stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-1 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 West 96th Terrace
Lenexa, Kansas

Boring Started: 2/22/2016	Boring Completed: 2/22/2016
Drill Rig: 988	Driller: KP
Project No.: 02165011	Exhibit: A-15

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 02165011.GPJ TERRACON2015.GDT 3/17/16

APPENDIX B
LABORATORY TESTS

Laboratory Test Summary

Representative soil samples were tested in the laboratory to measure their natural water content, dry unit weight, unconfined compressive strength, and Atterberg limits. A pocket penetrometer was used to estimate the approximate unconfined compressive strength of selected samples. The test results are provided on the boring logs included in Appendix A.

The results of a standard Proctor test, CBR test, and Atterberg limits tests performed on a bulk sample will be issued under a separate cover.

The soil samples were classified in the laboratory based on visual observation, texture, plasticity, and the limited laboratory testing described above. The soil descriptions presented on the boring logs are in accordance with the enclosed General Notes and Unified Soil Classification System (USCS). The estimated USCS group symbols for native soils are shown on the boring logs, and a brief description of the USCS is included in this report.

The bedrock units encountered in the borings were described in accordance with the appended Description of Rock Properties on the basis of visual classification of disturbed auger cuttings and drilling characteristics. Core samples and petrographic analysis may indicate other rock types.

APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING

Auger	Split Spoon
Shelby Tube	Macro Core
Ring Sampler	Rock Core
Grab Sample	No Recovery

WATER LEVEL

- Water Initially Encountered
- Water Level After a Specified Period of Time
- Water Level After a Specified Period of Time

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

(HP)	Hand Penetrometer
(T)	Torvane
(b/f)	Standard Penetration Test (blows per foot)
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance Includes gravels, sands and silts.			CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			
Descriptive Term (Density)	Standard Penetration or N-Value Blows/Ft.	Ring Sampler Blows/Ft.	Descriptive Term (Consistency)	Unconfined Compressive Strength, Qu, psf	Standard Penetration or N-Value Blows/Ft.	Ring Sampler Blows/Ft.
Very Loose	0 - 3	0 - 6	Very Soft	less than 500	0 - 1	< 3
Loose	4 - 9	7 - 18	Soft	500 to 1,000	2 - 4	3 - 4
Medium Dense	10 - 29	19 - 58	Medium-Stiff	1,000 to 2,000	4 - 8	5 - 9
Dense	30 - 50	59 - 98	Stiff	2,000 to 4,000	8 - 15	10 - 18
Very Dense	> 50	≥ 99	Very Stiff	4,000 to 8,000	15 - 30	19 - 42
			Hard	> 8,000	> 30	> 42

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

Terracon

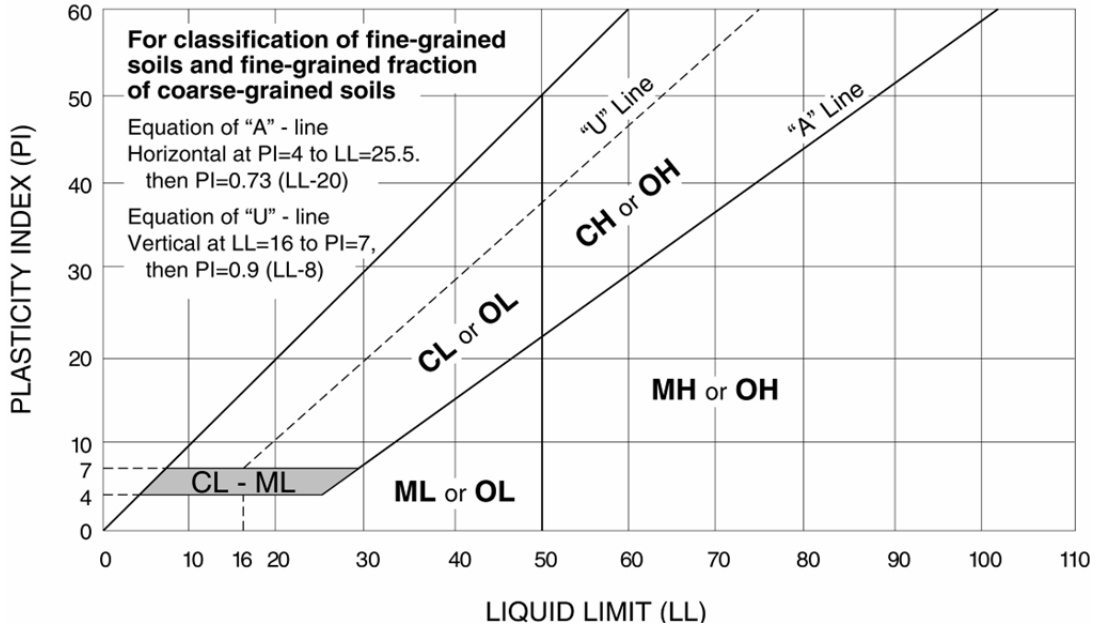
UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line [J]		CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K,L,M,N]
			Liquid limit - not dried			Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K,L,M]
			PI plots below "A" line		MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K,L,M,P]
			Liquid limit - not dried			Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H] If fines are organic, add "with organic fines" to group name.
[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 4 and plots on or above "A" line.
[O] PI < 4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.



Terracon

Exhibit C-2

DESCRIPTION OF ROCK PROPERTIES

WEATHERING	
Term	**Description**
Unweathered	No visible sign of rock material weathering, perhaps slight discoloration on major discontinuity surfaces.
Slightly weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than in its fresh condition.
Moderately weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a continuous framework or as corestones.
Highly weathered	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.
Residual soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.

STRENGTH OR HARDNESS		
Description	**Field Identification**	**Uniaxial Compressive Strength, PSI (MPa)**
Extremely weak	Indented by thumbnail	40-150 (0.3-1)
Very weak	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife	150-700 (1-5)
Weak rock	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer	700-4,000 (5-30)
Medium strong	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer	4,000-7,000 (30-50)
Strong rock	Specimen requires more than one blow of geological hammer to fracture it	7,000-15,000 (50-100)
Very strong	Specimen requires many blows of geological hammer to fracture it	15,000-36,000 (100-250)
Extremely strong	Specimen can only be chipped with geological hammer	>36,000 (>250)

DISCONTINUITY DESCRIPTION			
Fracture Spacing (Joints, Faults, Other Fractures)		**Bedding Spacing (May Include Foliation or Banding)**	
Description	**Spacing**	**Description**	**Spacing**
Extremely close	< ¾ in (<19 mm)	**Laminated**	< ½ in (<12 mm)
Very close	¾ in – 2-1/2 in (19 - 60 mm)	**Very thin**	½ in – 2 in (12 – 50 mm)
Close	2-1/2 in – 8 in (60 – 200 mm)	**Thin**	2 in – 1 ft (50 – 300 mm)
Moderate	8 in – 2 ft (200 – 600 mm)	**Medium**	1 ft – 3 ft (300 – 900 mm)
Wide	2 ft – 6 ft (600 mm – 2.0 m)	**Thick**	3 ft – 10 ft (900 mm – 3 m)
Very Wide	6 ft – 20 ft (2.0 – 6 m)	**Massive**	> 10 ft (3 m)

Discontinuity Orientation (Angle): Measure the angle of discontinuity relative to a plane perpendicular to the longitudinal axis of the core. (For most cases, the core axis is vertical; therefore, the plane perpendicular to the core axis is horizontal.) For example, a horizontal bedding plane would have a 0 degree angle.

ROCK QUALITY DESIGNATION (RQD*)	
Description	**RQD Value (%)**
Very Poor	0 - 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 - 100

*The combined length of all sound and intact core segments equal to or greater than 4 inches in length, expressed as a percentage of the total core run length.

Reference: U.S. Department of Transportation, Federal Highway Administration, Publication No FHWA-NHI-10-034, December 2009 Technical Manual for Design and Construction of Road Tunnels – Civil Elements

Appendix B

Overhead Power Line Mitigation

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Appendix B.1

Westar Coordination Letter

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Westar Energy
Taking energy to heart.

4/5/2016

Dear Mr. Lubliner,

We have reviewed your plans Clear Creek Parkway Cross Section at Power Line Crossing, Clear Creek Improvement District Map, and the Clear Creek PKWY-ConceptStripmap-Roundabout we received on 3-10-16 for the proposed Clear Creek Parkway which will cross under our 115kV overhead electric power line. We refer to our line as 115.08 – Jaggard Substation to Pentagon Substation. The proposed Clear Creek Parkway will cross between our structures 123 and 124 with the center of the road located approximately 47' North West of structure 124.

Based upon our analysis of the drawings provided by your firm, the proposed fill at station -35+00, will not create a ground to phase clearance issue.
However, fill in the amount of one foot (1') piled up and around structure 124 exceeds amounts allowed by Westar. We propose the following to mitigate the fill around structure 124. Options include but are not limited to:

1) Redesign – This would include redesigning the road in order to move the needed fill to the northwest in order to create a ten foot (10') radius around the structure with no fill.
2) Retaining Wall – A retaining wall could be built with the face of the wall at least ten feet (10') from structure 124.
3) Relocation of Structure 124 – In order to minimize changes to your design, we propose that structure 124 could be moved south in order to avoid any fill surrounding the structure. This option could result in the relocation of adjacent structures as well.

Please feel free to contact me with any questions.

Thank You,

Jacob Sowers

Jacob.Sowers@WestarEnergy.com
(785)-575-1850

818 S Kansas Ave / PO Box 889 / Topeka, KS 66601-0889 / WestarEnergy.com

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Appendix B.2

Original Alignment

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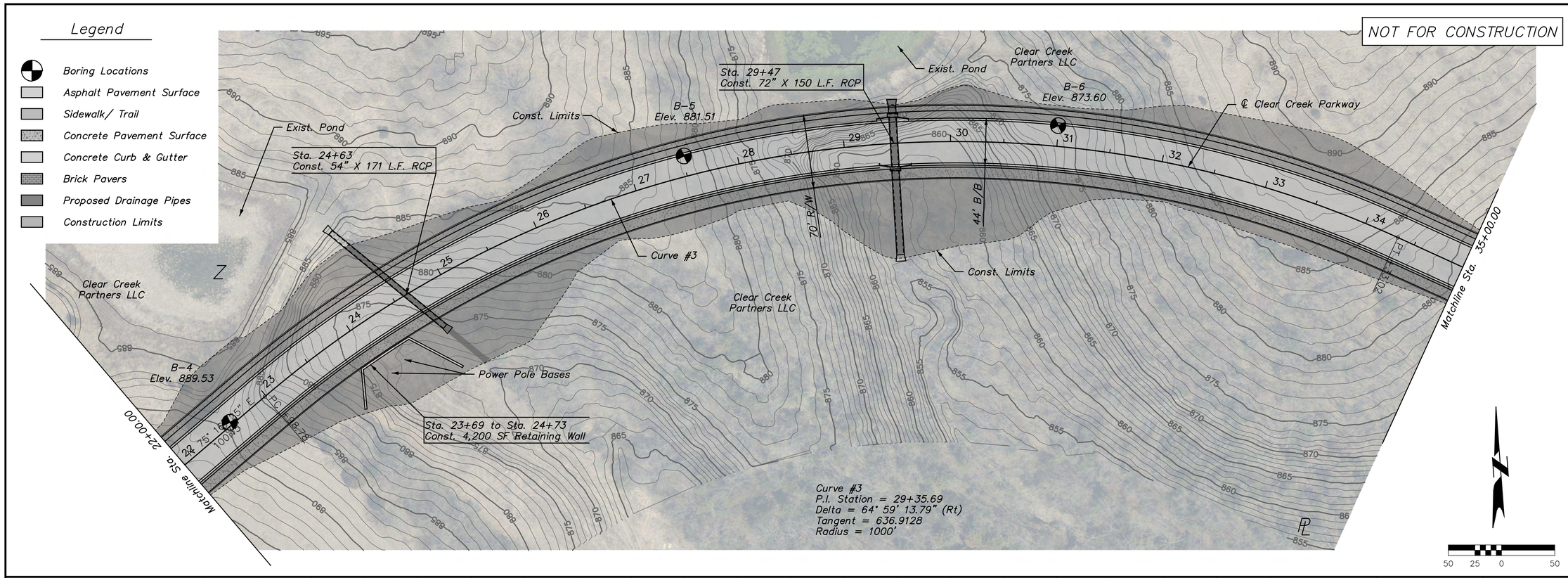

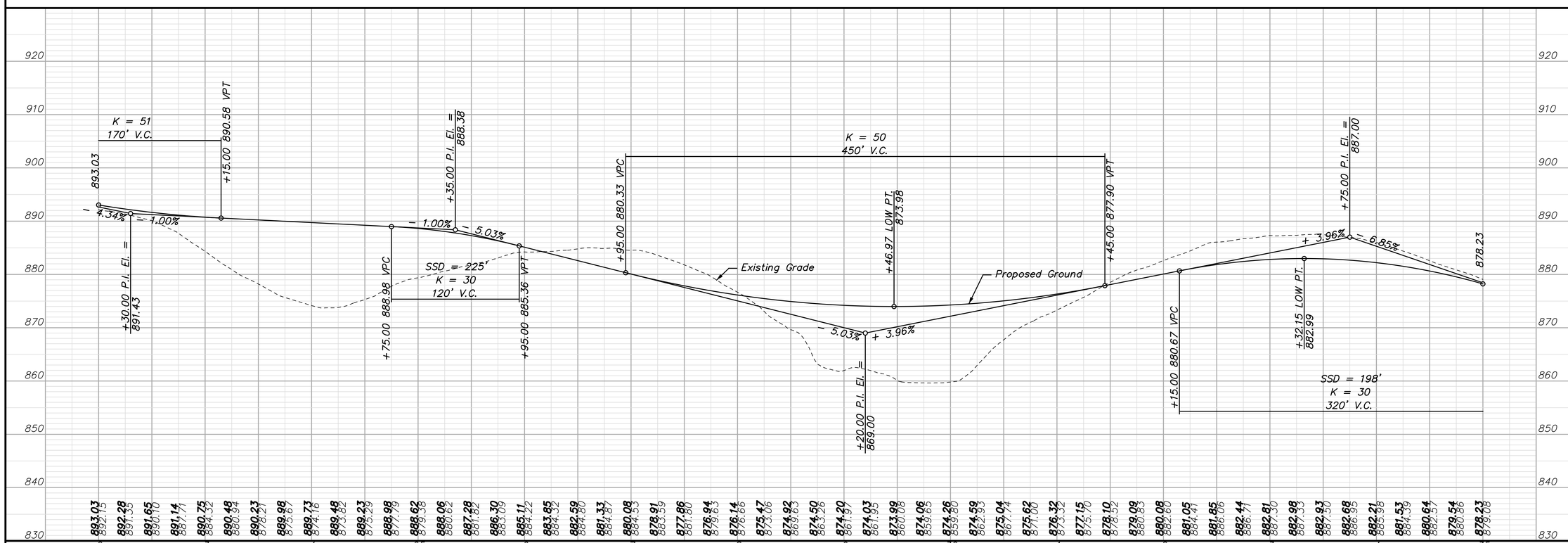

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CLEAR CREEK PARKWAY
CITY OF SHAWNEE, KANSAS

OVERHEAD POWER LINES
ORIGINAL ALIGNMENT
STA. 22+00.00 TO STA. 35+00.00

150561-010

B-9

LAYOUT: MODEL | BY: jkoehler | DATE: 11-APR-2016 1:13:13 PM
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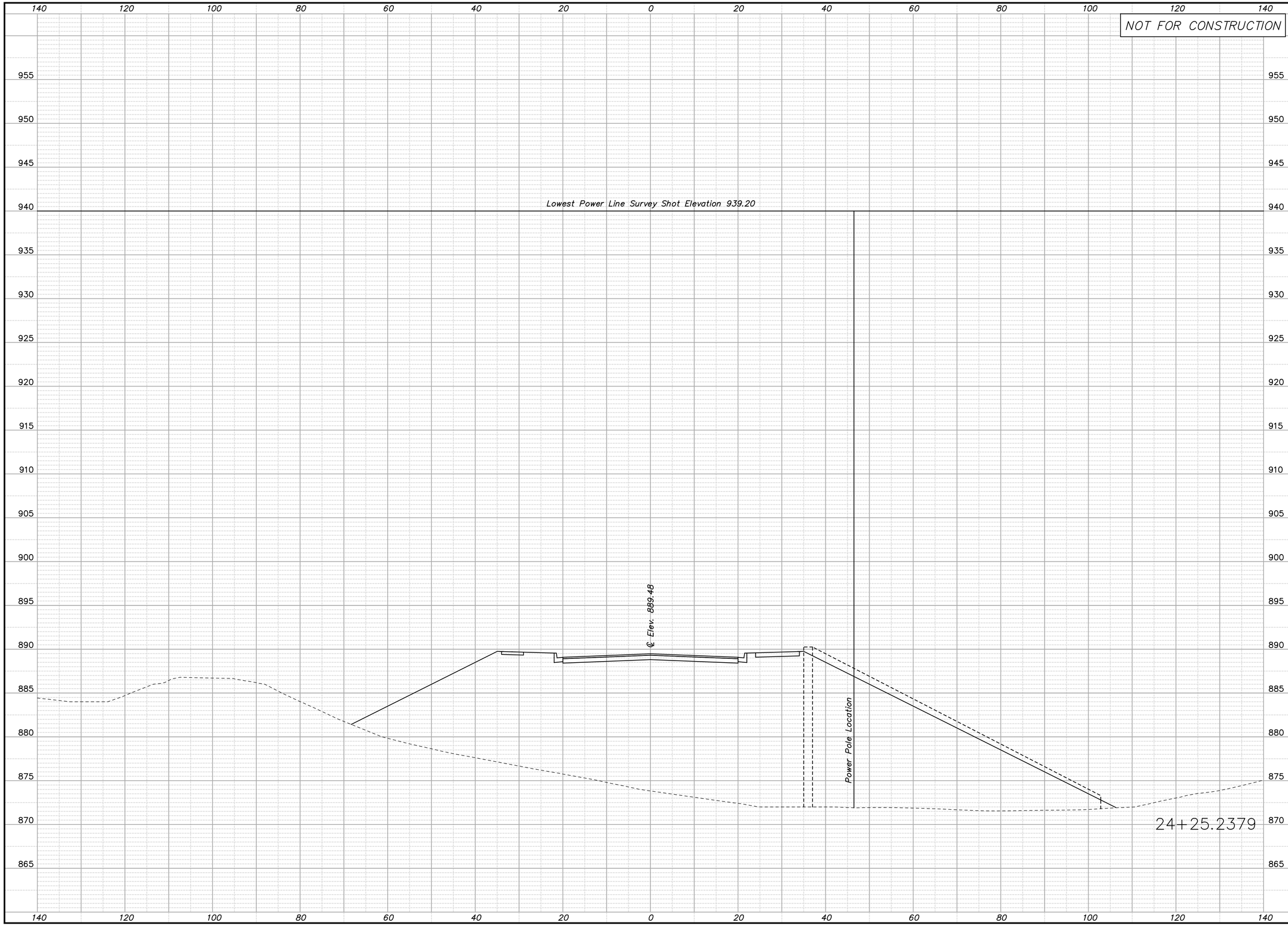

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ORIGINAL ALIGNMENT
CROS SECTION AT POWER LINE CROSSING

150561-010

B-10

LAYOUT: MODEL | BY: jkoehler | DATE: 11-APR-2016 1:13:35 PM
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Appendix B.3

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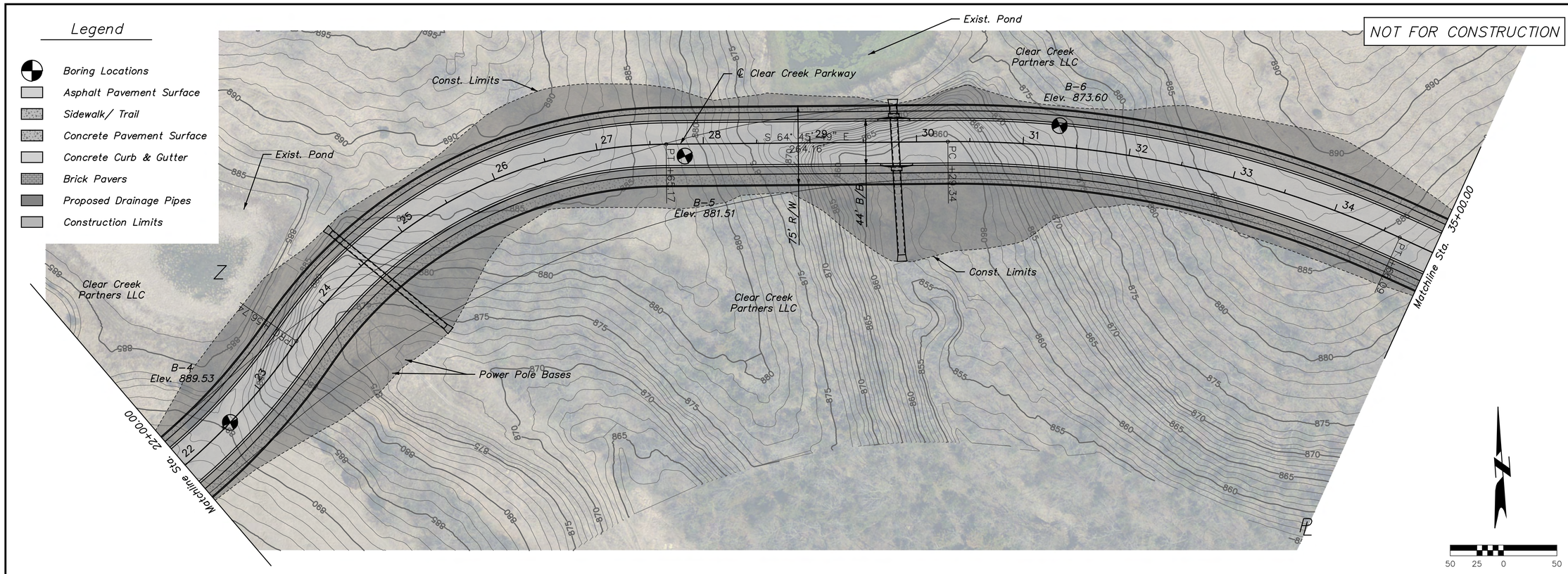

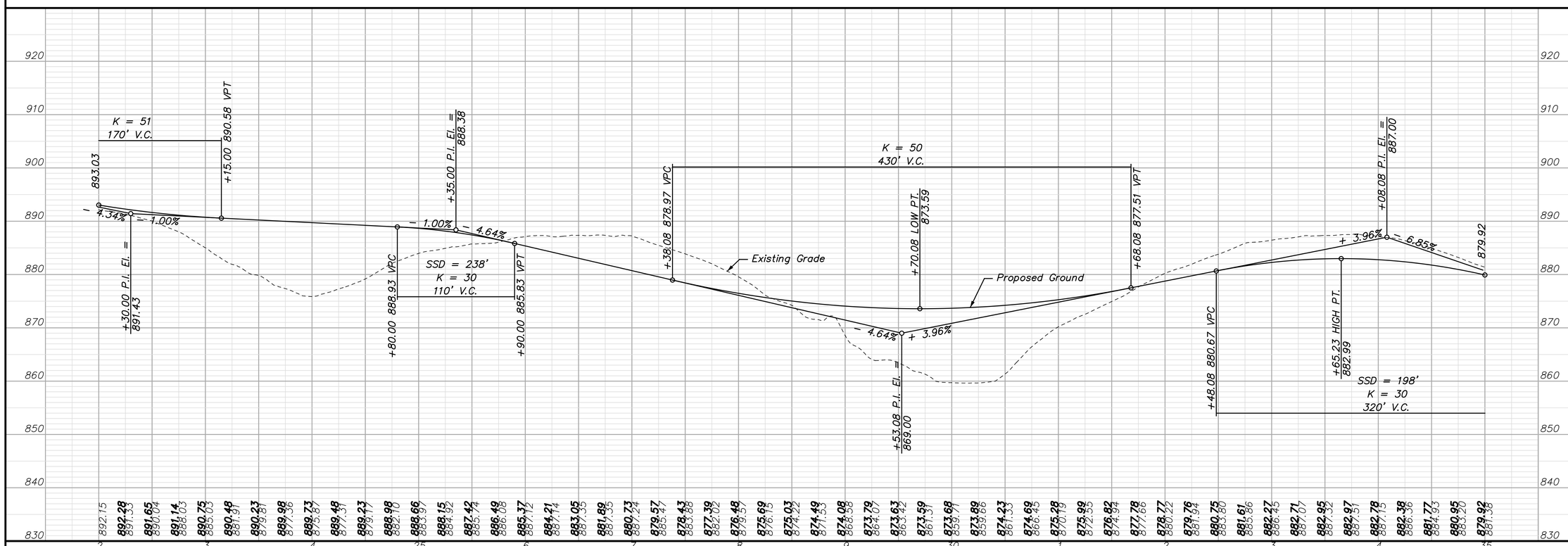

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CITY OF SHAWNEE, KANSAS

OVERHEAD POWER LINES
SHIFTED ALIGNMENT

STA. 22+00.00 TO STA. 35+00.00

150561-010

B-13

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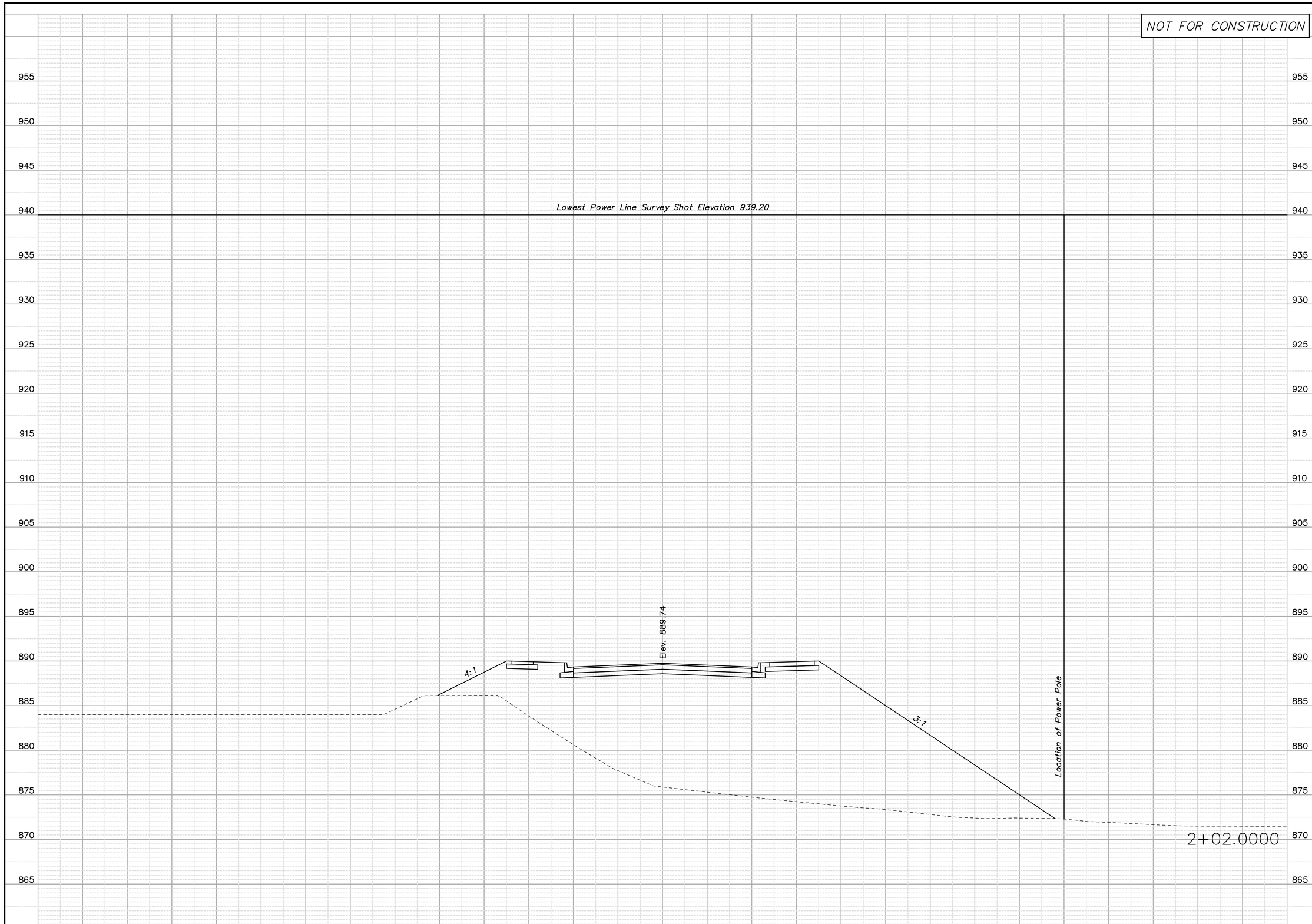

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CLEAR CREEK PARKWAY
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SHIFTED ALIGNMENT
CROSS SECTION AT POWER LINE CROSSING

150561-010

B-14

LAYOUT: MODEL | BY: jkoehler | DATE: 11-APR-2016 1:14:06 PM
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Appendix C

Retaining Wall Options

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Appendix C.1

Large Block Retaining Wall

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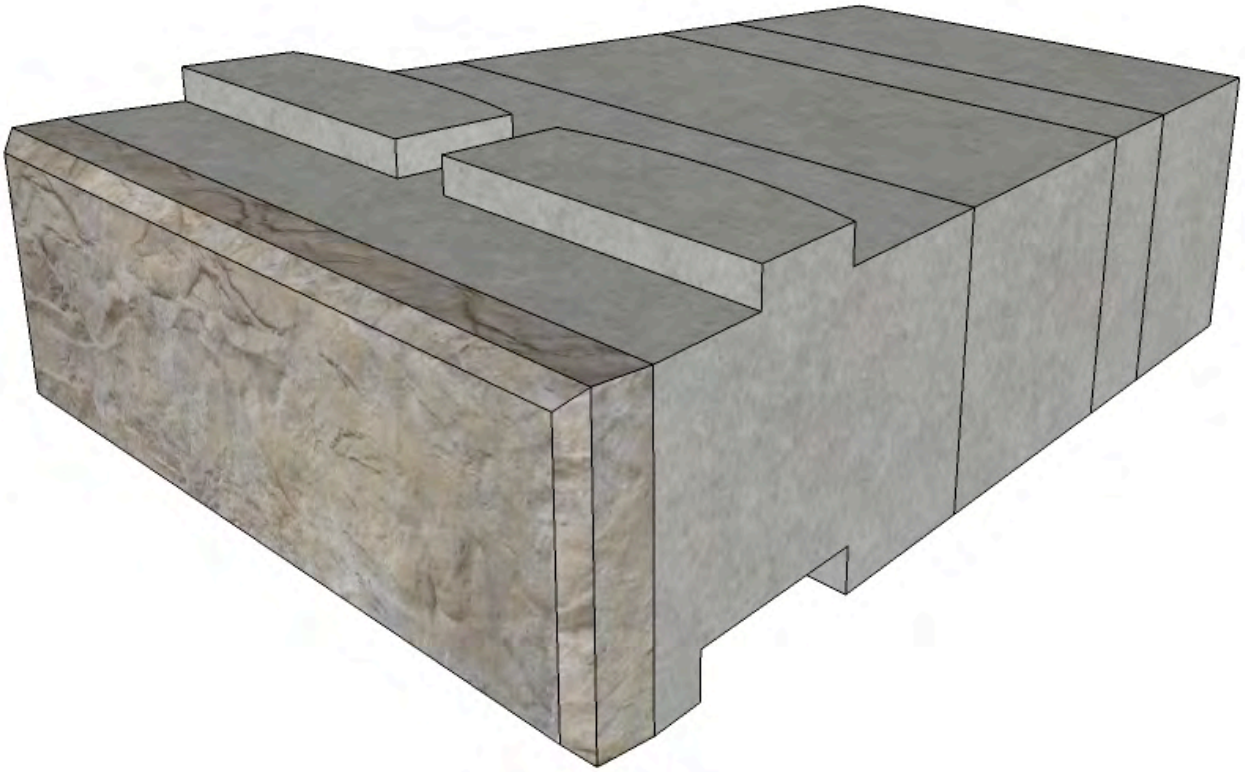
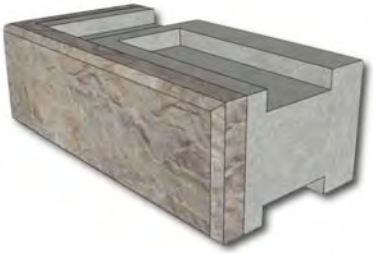


RECON “SERIES 50” RETAINING WALL BLOCK CATALOG

March 2014



ReCon Retaining Walls

MARCH 2014

RECON SERIES 50 RETAINING WALL BLOCK CATALOG

Name Full Base Block - 24”

Unit ID	Weight	Dimensions
FB24	1457	16 in. x 48 in. x 24 in.

Volume
10.04

Coverage
5.33

Batter
3.6°

Name Full Middle Block - 24”

Unit ID	Weight	Dimensions
FM24	1411	16 in. x 48 in. x 24 in.

Volume
9.73

Coverage
5.33

Batter
3.6°

Name Full Base Block - 39”

Unit ID	Weight	Dimensions
FB39	2276	16 in. x 48 in. x 39 in.

Volume
15.7

Coverage
5.33

Batter
3.6°

Name Full Middle Block - 39”

Unit ID	Weight	Dimensions
FM39	2201	16 in. x 48 in. x 39 in.

Volume
15.18

Coverage
5.33

Batter
3.6°

Name Full Base Block - 45”

Unit ID	Weight	Dimensions
FB45	2550	16 in. x 48 in. x 45 in.

Volume
17.58

Coverage
5.33

Batter
3.6°

Name Full Middle Block - 45”

Unit ID	Weight	Dimensions
FM45	2491	16 in. x 48 in. x 45 in.

Volume
17.18

Coverage
5.33

Batter
3.6°

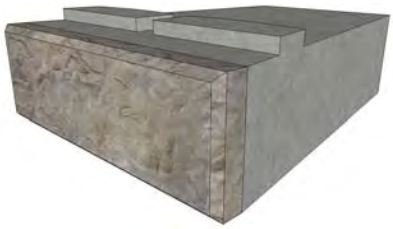
Name Full Base Block - 60”, 66”, 72”, 78”, 84”

Unit ID	Weight	Dimensions
FB60-84	3173-4146	16 in. x 48 in. x varies

Volume
21.88-28.59

Coverage
5.33

Batter
3.6°



Name Full Middle Block - 60”, 66”, 72”, 78”, 84”

Unit ID	Weight	Dimensions
FM60-84	3115-4088	16 in. x 48 in. x varies

Volume
21.48-28.19

Coverage
5.33

Batter
3.6°

Name Full Channel Block

Unit ID	Weight	Dimensions
CHAN	2201	16 in. x 48 in. x 39 in.

Volume
15.18

Coverage
5.33

Batter
26.5

Name Full Top Block - 24”

Unit ID	Weight	Dimensions
T24	971	16 in. x 48 in. x 24 in.

Volume
6.7

Coverage
5.33

Batter
3.6°

Name Half Middle Block - 24”

Unit ID	Weight	Dimensions
HM24	662	16 in. x 24 in. x 24 in.

Volume
4.57

Coverage
2.67

Batter
3.6°

Name Half Middle Block - 39”

Unit ID	Weight	Dimensions
HM39	967	16 in. x 24 in. x 39 in.

Volume
6.67

Coverage
2.67

Batter
3.6°

Name Half Top Block - 24”

Unit ID	Weight	Dimensions
HT24	458	16 in. x 24 in. x 24 in.

Volume
3.16

Coverage
2.67

Batter
3.6°

Name Left Corner Top Block

Unit ID	Weight	Dimensions
LCT	1103	16 in. x 48 in. x 24 in.

Volume
7.61

Coverage
8

Batter
3.6°

Name Right Corner Top Block

Unit ID	Weight	Dimensions
RCT	1103	16 in. x 48 in. x 24 in.

Volume
7.61

Coverage
8

Batter
3.6°

Name Reversible Corner Block

Unit ID	Weight	Dimensions
C	1401	16 in. x 48 in. x 24 in.

Volume
9.66

Coverage
8

Batter
3.6°

Name Fitting Block - 24”

Unit ID	Weight	Dimensions
FF24	1215	16 in. x 48 in. x 24 in.

Volume
8.38

Coverage
5.33

Batter
3.6°

Name Three Quarter Block - 24”

Unit ID	Weight	Dimensions
TQM24	1037	16 in. x 36 in. x 24 in.

Volume
7.15

Coverage
4

Batter
3.6°

Name Three Quarter Block - 39”

Unit ID	Weight	Dimensions
TQM39	1586	16 in. x 36 in. x 39 in.

Volume
10.94

Coverage
4

Batter
3.6°

Name Capstone

Unit ID	Weight	Dimensions
CAP	551	6.5 in. x 48 in. x 26 in.

Volume
3.80

Coverage
2.17

Batter
N/A

Name End Capstone

Unit ID	Weight	Dimensions
ECAP	551	6.5 in. x 48 in. x 26 in.

Volume
3.80

Coverage
2.17

Batter
N/A

Name Full-High Cap Middle Block

Unit ID	Weight	Dimensions
FHCAPM	1450	16 in. x 48 in. x 24 in.

Volume
10.

Coverage
10.66

Batter
0°

Name Full-High Cap End Block

Unit ID	Weight	Dimensions
FHCAPE	1459	16 in. x 48 in. x 24 in.

Volume
10.06

Coverage
13.33

Batter
0°

Name Step Unit

Unit ID	Weight	Dimensions
STEP	680	6.5 in. x 48 in. x 26 in.

Volume
4.69

Coverage
2.17

Batter
N/A

Name Plinth Block

Unit ID	Weight	Dimensions
PLB	1486	16 in. x 24 in. x 47 in.

Volume
10.25

Coverage
2.67

Batter
3.6°

Non-stock item. Check with local producer for availability

Name 8” Capstone

Unit ID	Weight	Dimensions
8CAP	855	8 in. x 48 in. x 26 in.

Volume
5.78

Coverage
2.67

Batter
N/A

Non-stock item. Check with local producer for availability

Note: Please check with local Licensed Producer for availability of specific block types. Not all shapes and sizes are offered by each Licensed Producer.

ReCon Texture Choices…Rustic

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Retaining Wall Systems

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www.reconwalls.com
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Appendix C.2

Rosetta Stone Retaining Wall

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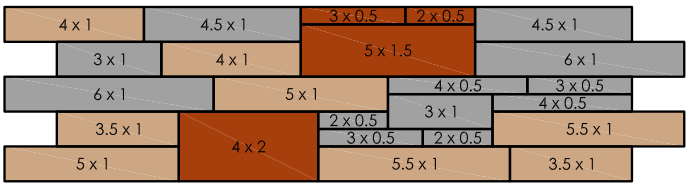
ROSETTA®

OUTCROPPING COLLECTION

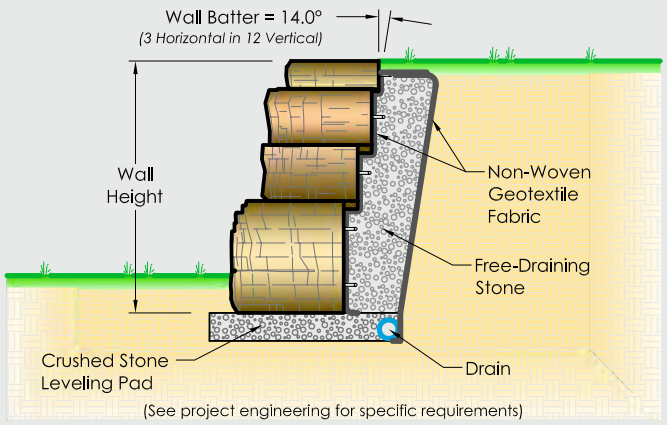
FEATURES

- Beautiful weathered stone textures.
- Consistent dimensions = fast installation.
- Quality materials = long term durability.
- Engineered, interlocking units suitable for any application.
- Multiple natural color blends.

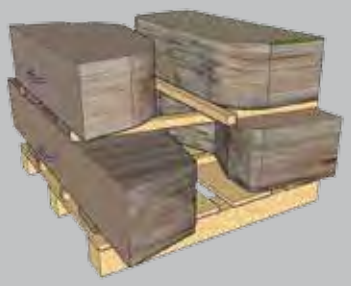
Pre-drawn patterns and custom layout software save time in estimating and installation.



Download at www.discoverrosetta.com



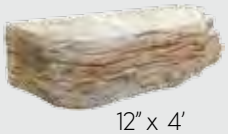
Rosetta is a fully engineered system, capable of performing in any structural application. For details, specifications, and over 200 pre-drawn cross-sections please visit www.discoverrosetta.com/engineering



Sample Pallet

Pallet A: 18s.f. , 4,000 lbs

12" x 3' 6"



12" x 4'

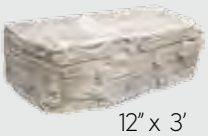
12" x 5'

12" x 5' 6"

Pallet B: 18s.f. , 4,000 lbs

6" x 2'

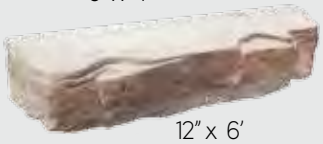
6" x 3'



12" x 3'

6" x 4'

12" x 4' 6"



12" x 6'

Pallet C: 18s.f. , 4,000 lbs

6" x 2'

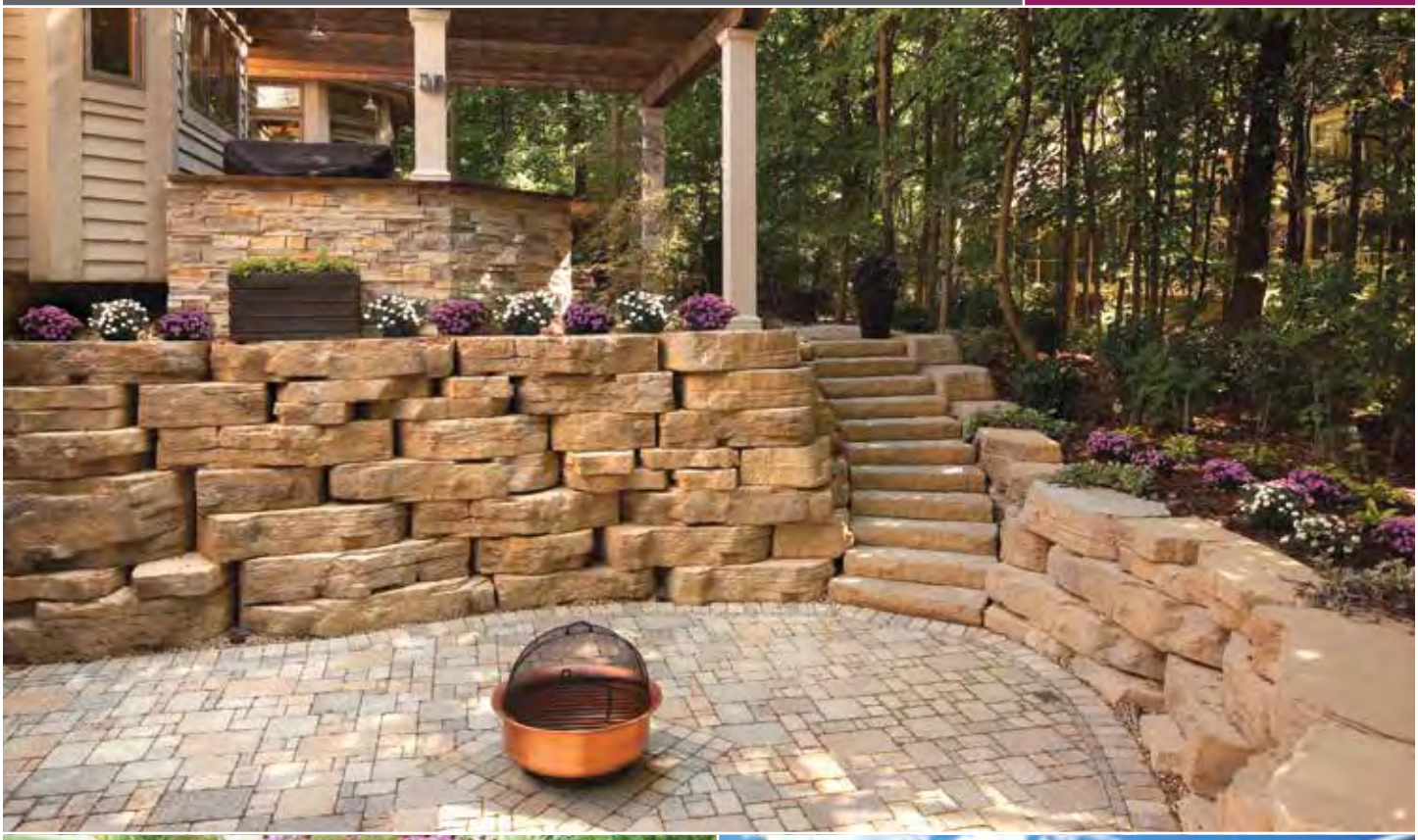
6" x 3'

18" x 5'

24" x 4'

ROSETTA®

OUTCROPPING COLLECTION



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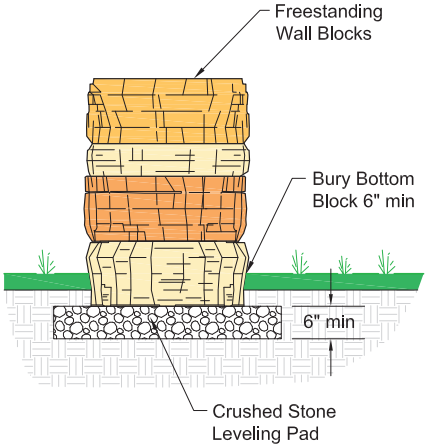
The OUTCROPPING *Freestanding System*

FEATURES

- Same **beautiful** weathered stone textures found on our outcropping units.
- A five sided surface texture allows for free standing (2-sided) installations.
- Optional cored units allow for grouting and re-bar installation for **high heights**.
- Consistent dimensions = **fast installation**.

TYPICAL FREESTANDING WALL



PALLET "D" FREESTANDING BLOCKS

11 sqft wall per pallet | pallet weight = 3130 lbs

12" x 5' Block
Length: 5'
Width: Approx 30"
Height: 12"
Weight: 1,540 lbs

12" x 4' Block
Length: 4'
Width: Approx 30"
Height: 12"
Weight: 1,080 lbs

6" x 4' Block
Length: 4'
Width: Approx 30"
Height: 6"
Weight: 460 lbs

PALLET "E" FREESTANDING BLOCKS

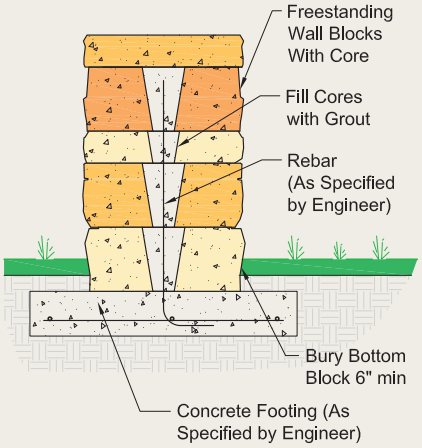
10.5 sqft wall per pallet | pallet weight = 3450 lbs

12" x 6' Block
Length: 6'
Width: Approx 30"
Height: 12"
Weight: 2,080 lbs

12" x 3' Block
Length: 3'
Width: Approx 30"
Height: 12"
Weight: 880 lbs

6" x 3' Block
Length: 3'
Width: Approx 30"
Height: 6"
Weight: 440 lbs

TYPICAL GROUTED WALL SECTION



PALLET "D" BLOCKS (WITH CORE)

11 sqft wall per pallet | pallet weight = 2700 lbs

12" x 5' Block
Length: 5'
Width: Approx 30"
Height: 12"
Weight: 1,360 lbs

12" x 4' Block
Length: 4'
Width: Approx 30"
Height: 12"
Weight: 840 lbs

6" x 4' Block
Length: 4'
Width: Approx 30"
Height: 6"
Weight: 460 lbs

PALLET "E" BLOCKS (WITH CORE)

10.5 sqft wall per pallet | pallet weight = 2950 lbs

12" x 6' Block
Length: 6'
Width: Approx 30"
Height: 12"
Weight: 1,720 lbs

12" x 3' Block
Length: 3'
Width: Approx 30"
Height: 12"
Weight: 760 lbs

6" x 3' Block
Length: 3'
Width: Approx 30"
Height: 6"
Weight: 420 lbs

Appendix C.3

Cast-In-Place Retaining Wall

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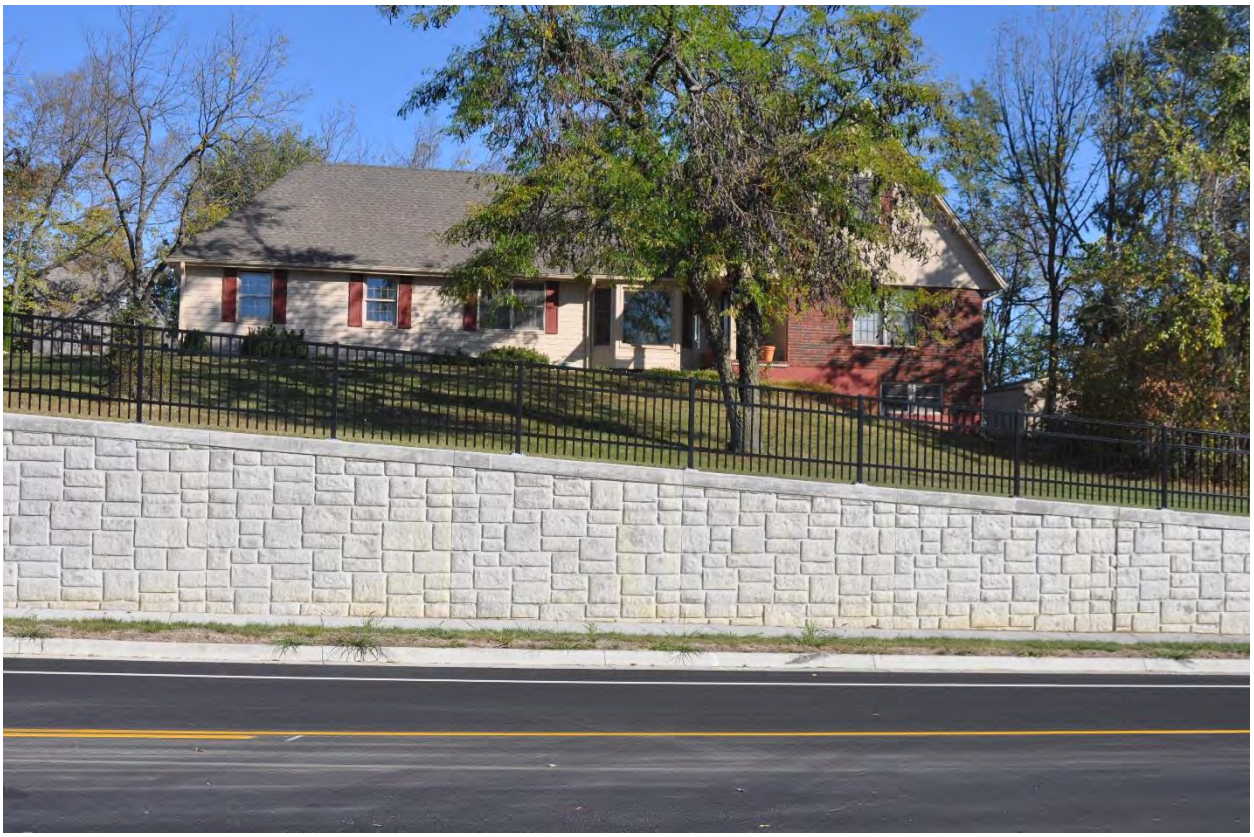

Appendix D

Concept Plans

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Appendix D.1

Alternative 1

Gleason Road T Intersection with Stop Control on Gleason

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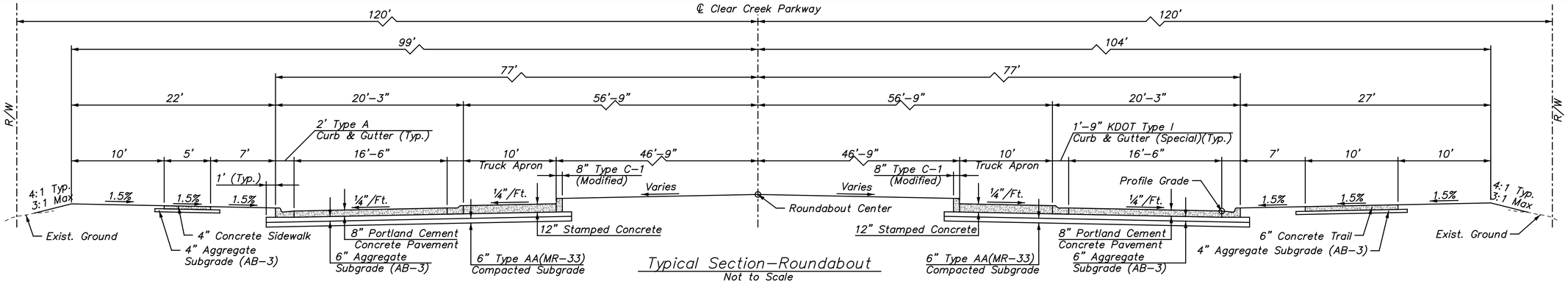
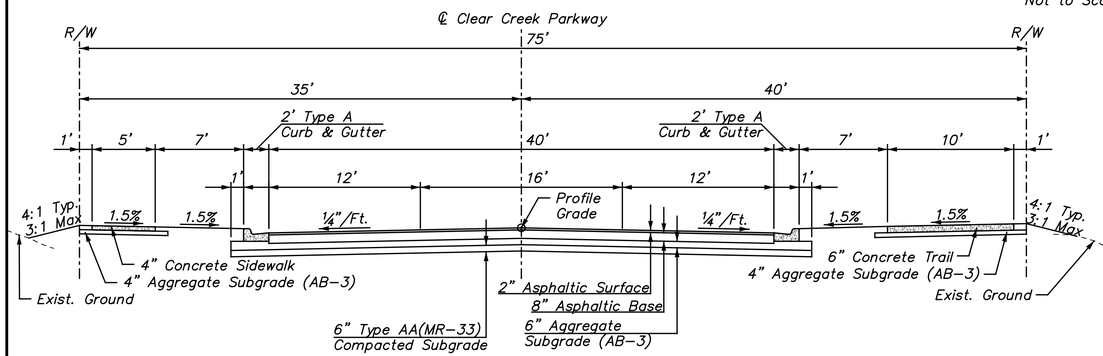
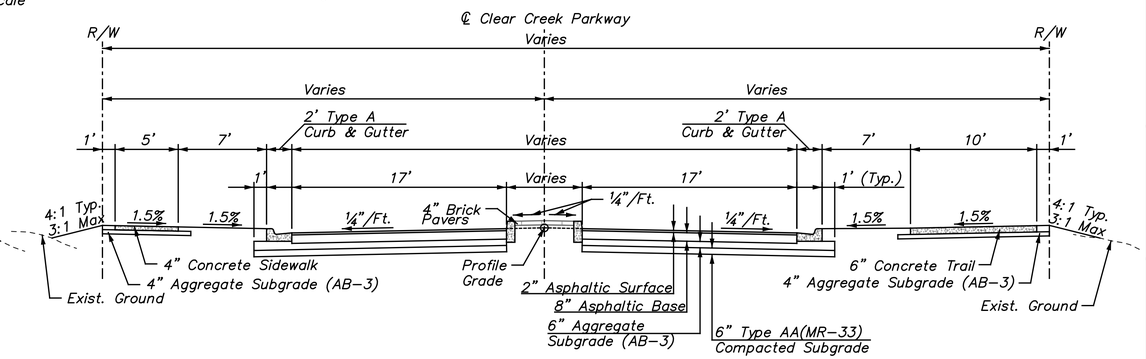


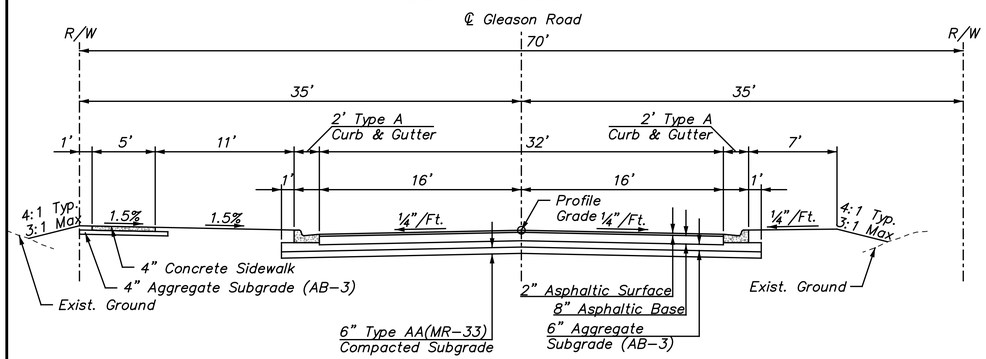
Typical Section–Roundabout
Not to Scale



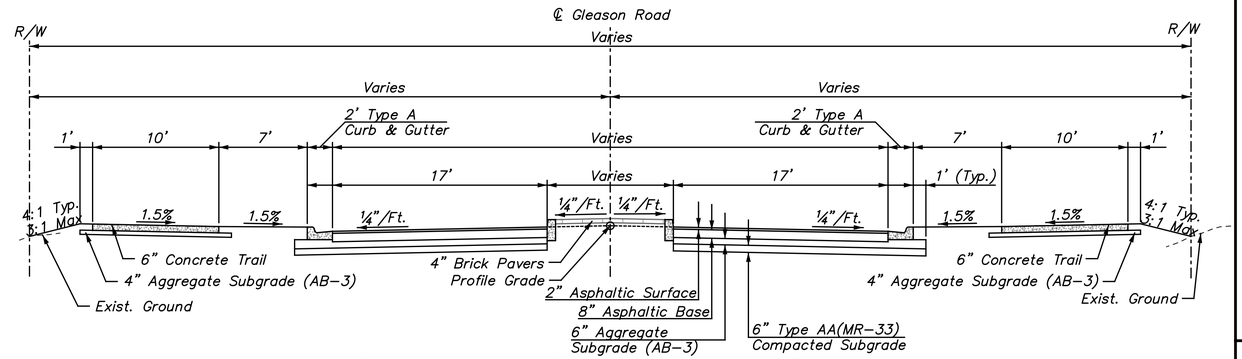
Typical Section–Clear Creek Parkway
Not to Scale
Sta. xx+xx.xx to Sta. xx+xx.xx



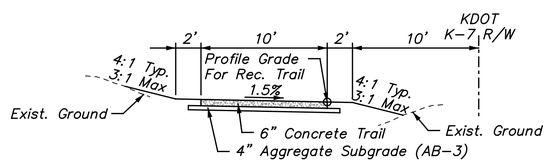
Typical Section–Clear Creek Parkway At Roundabout Splitter Islands
Not to Scale
Sta. xx+xx.xx to Sta. xx+xx.xx



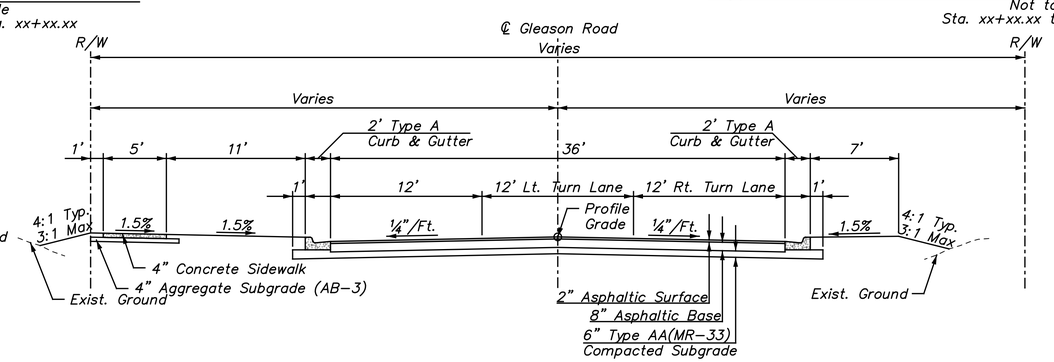
Typical Section–Gleason Road
Not to Scale
Sta. xx+xx.xx to Sta. xx+xx.xx



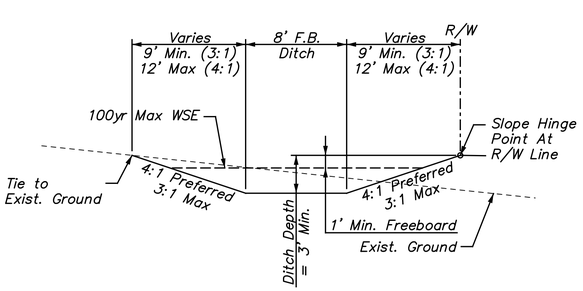
Typical Section–Gleason Road At Roundabout Splitter Islands
Not to Scale
Sta. xx+xx.xx to Sta. xx+xx.xx



Typical Section–Concrete Trail/Golf Cart Path
Not to Scale
Sta. xx+xx.xx to Sta. xx+xx.xx



Typical Section–Gleason Road (T Intersection)
Not to Scale
Sta. xx+xx.xx to Sta. xx+xx.xx



Typical Section–Fill Slope Ditch
Not to Scale
(Only Used Where Needed For Drainage
And/Or to Protect the Roadway Fill Slope)
Sta. xx+xx.xx to Sta. xx+xx.xx

NO.	DATE	REVISIONS	BY	APP'D
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CLEAR CREEK PARKWAY
CITY OF SHAWNEE, KANSAS

TYPICAL SECTIONS
ASPHALT OPTION

150561-010

D-5

LAYOUT: MODEL | BY: jkoehler | DATE: 11-APR-2016 1:10:20 PM
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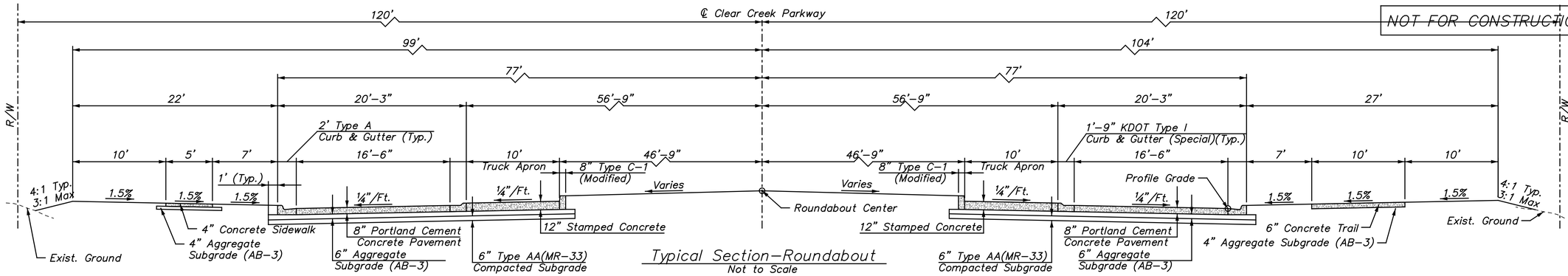
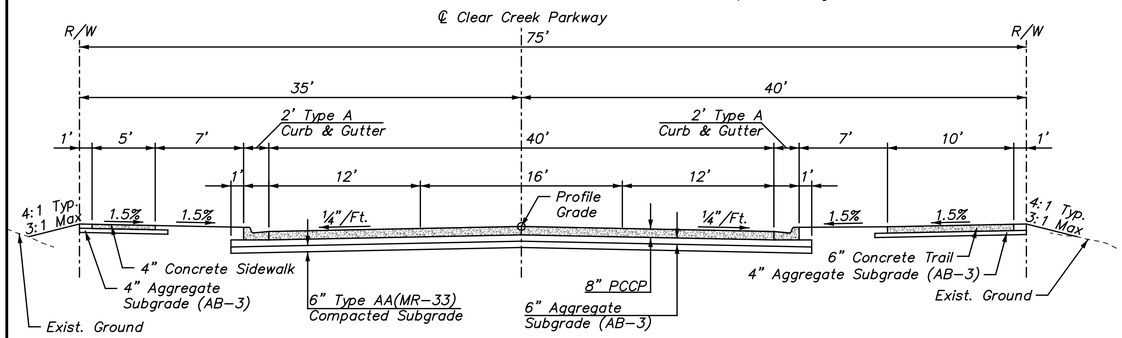
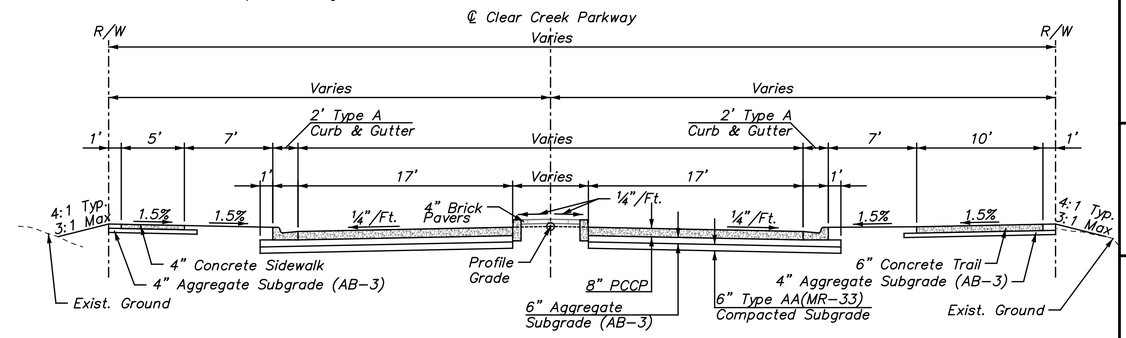


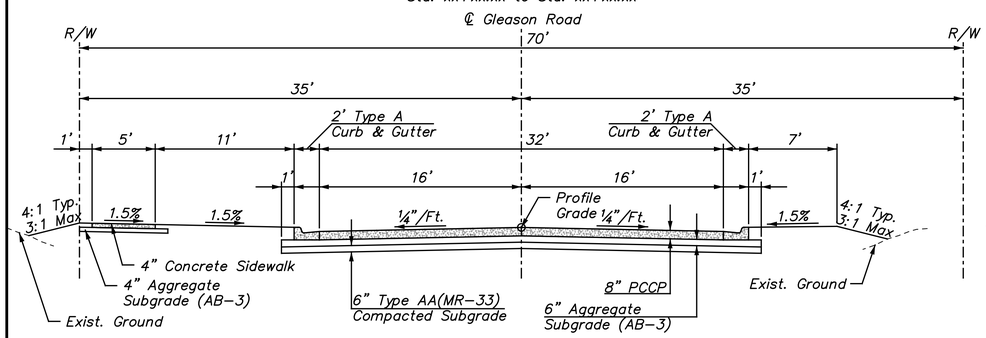
Typical Section–Roundabout
Not to Scale



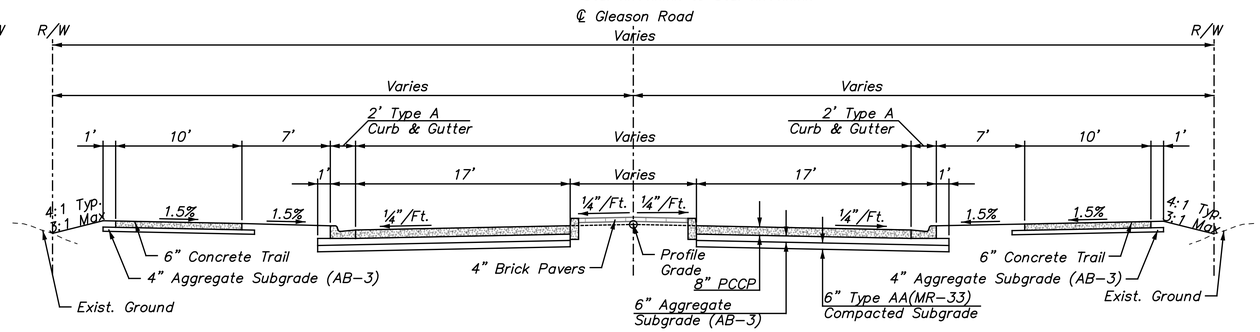
Typical Section–Clear Creek Parkway
Not to Scale
Sta. xx+xx.xx to Sta. xx+xx.xx



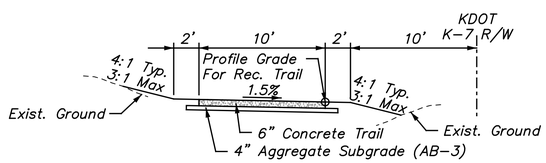
Typical Section–Clear Creek Parkway At Roundabout Splitter Islands
Not to Scale
Sta. xx+xx.xx to Sta. xx+xx.xx



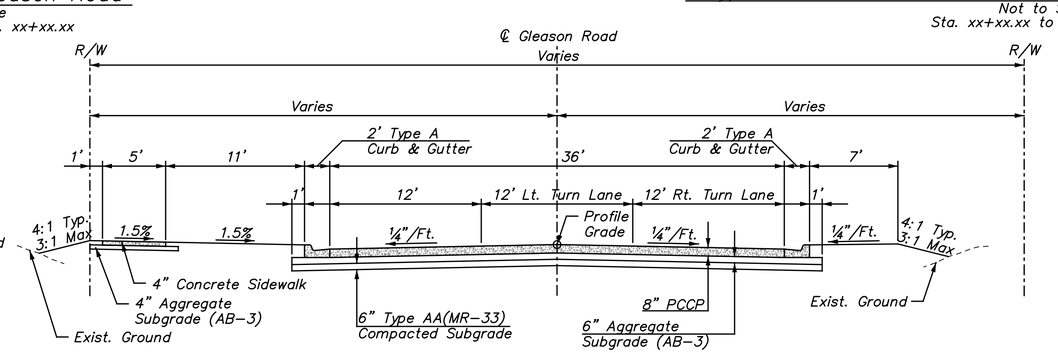
Typical Section–Gleason Road
Not to Scale
Sta. xx+xx.xx to Sta. xx+xx.xx



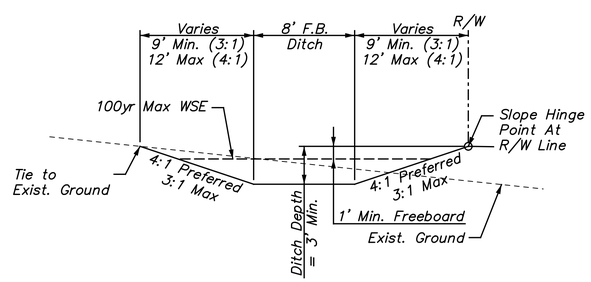
Typical Section–Gleason Road At Roundabout Splitter Islands
Not to Scale
Sta. xx+xx.xx to Sta. xx+xx.xx



Typical Section–Concrete Trail/Golf Cart Path
Not to Scale
Sta. xx+xx.xx to Sta. xx+xx.xx



Typical Section–Gleason Road (T Intersection)
Not to Scale
Sta. xx+xx.xx to Sta. xx+xx.xx



Typical Section–Fill Slope Ditch
Not to Scale
(Only Used Where Needed For Drainage And/Or to Protect the Roadway Fill Slope)
Sta. xx+xx.xx to Sta. xx+xx.xx

NO.	DATE	REVISIONS	BY	APP'D
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1	4–11–16	CONCEPT STUDY & REPORT	JAA	PRP

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Drawn By: JAA
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Issue Date: APR 2016

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CLEAR CREEK PARKWAY
CITY OF SHAWNEE, KANSAS

TYPICAL SECTIONS
CONCRETE OPTION

150561–010

D–6

LAYOUT: MODEL | BY: jkoehler | DATE: 11–APR–2016 1:10:23 PM
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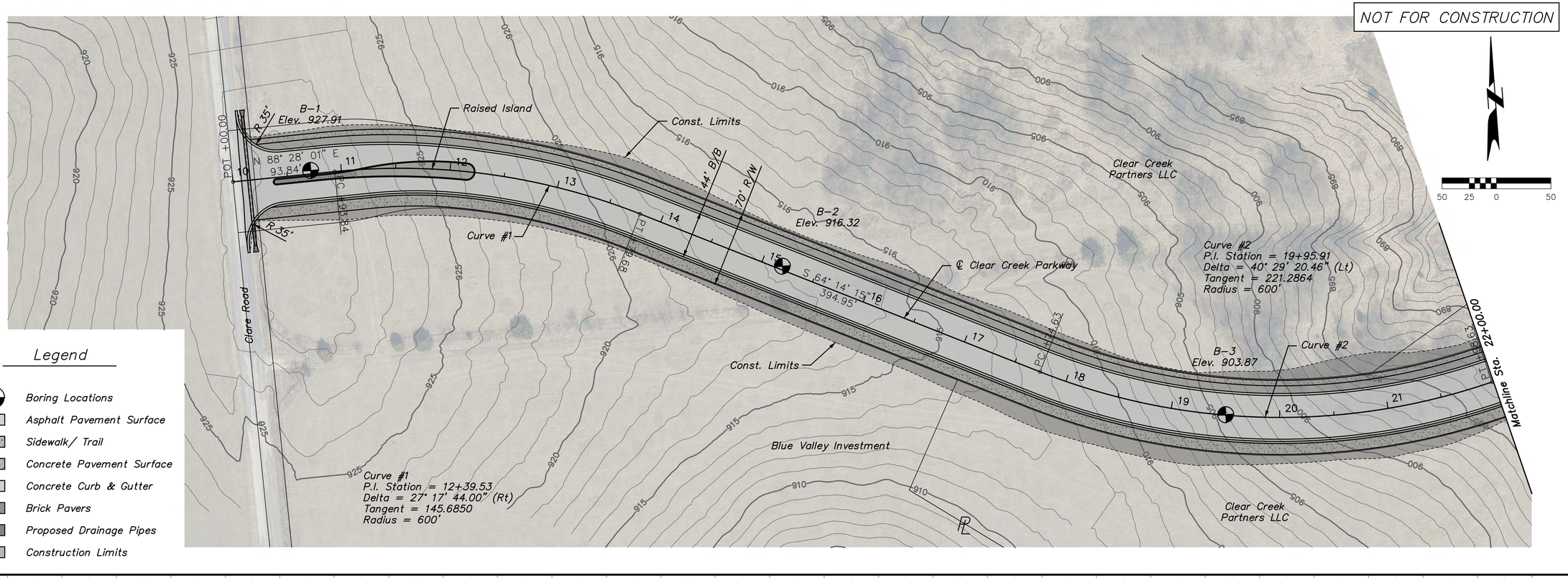
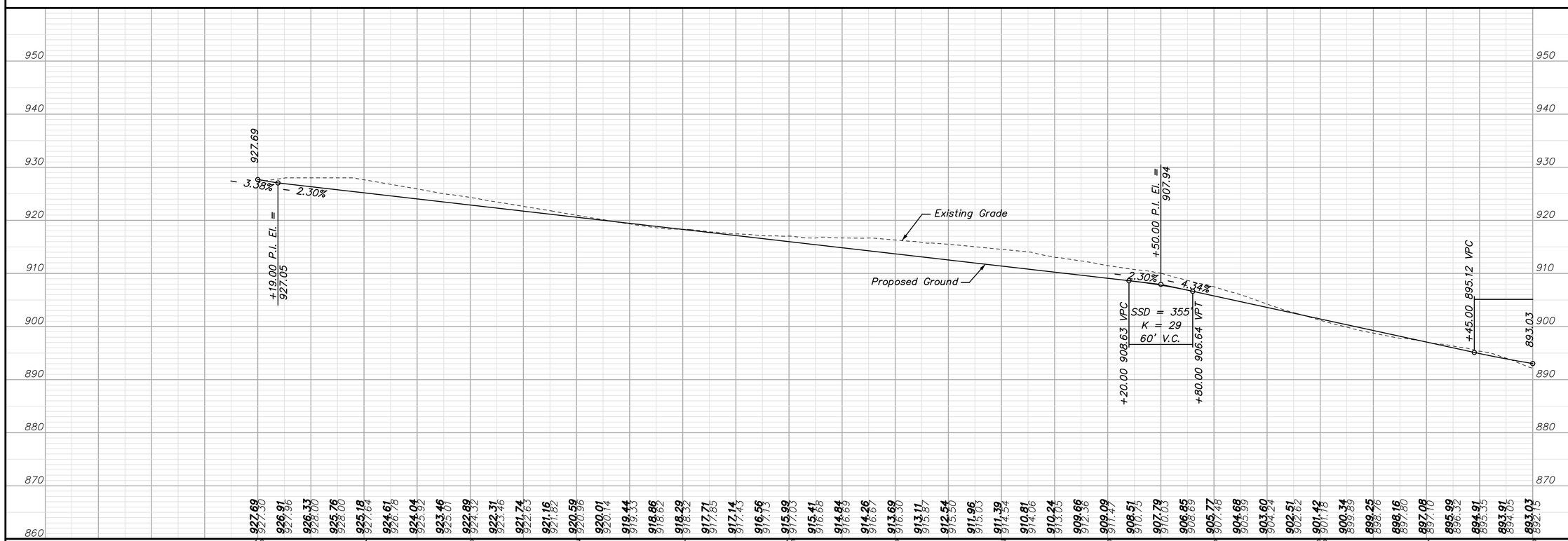


Legend

- Boring Locations
- Asphalt Pavement Surface
- Sidewalk/ Trail
- Concrete Pavement Surface
- Concrete Curb & Gutter
- Brick Pavers
- Proposed Drainage Pipes
- Construction Limits



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CLEAR CREEK PARKWAY
CITY OF SHAWNEE, KANSAS

T INTERSECTION OPTION
PLAN AND PROFILE (1)
STA. 10+00.00 TO STA. 22+00.00

150561-010

D-7

LAYOUT: MODEL | BY: jkoehler | DATE: 11-APR-2016 1:18:21 PM
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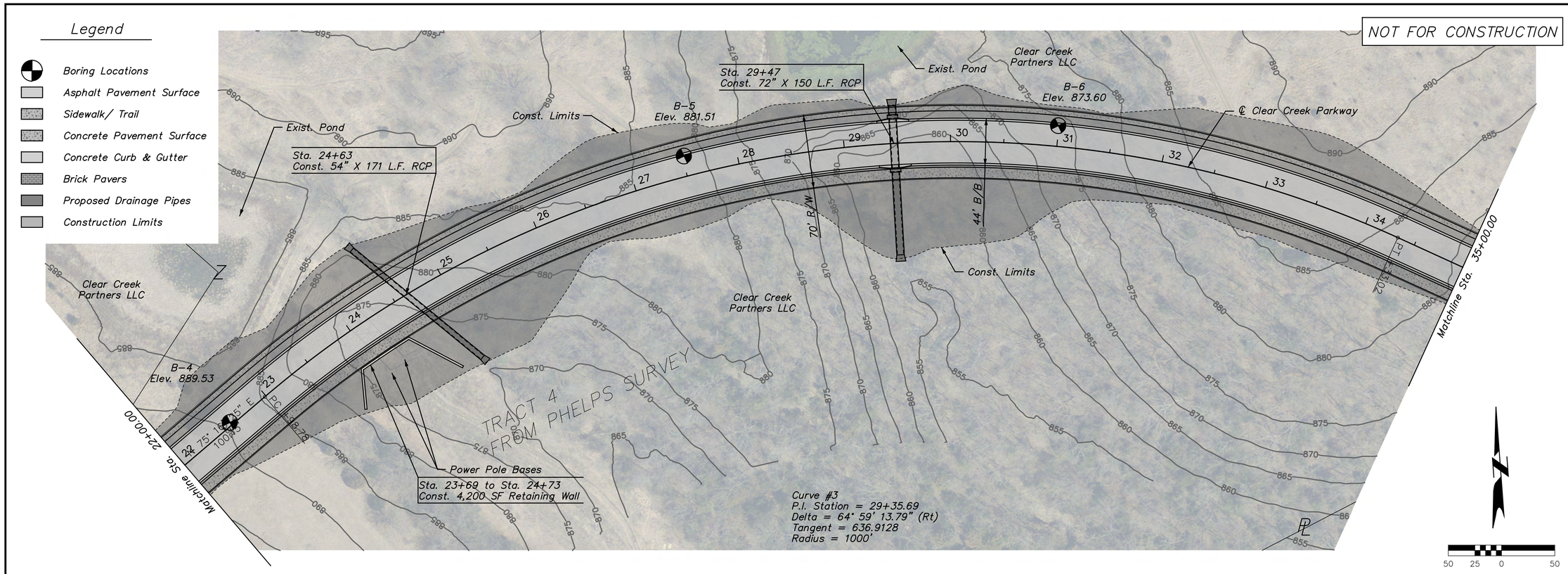

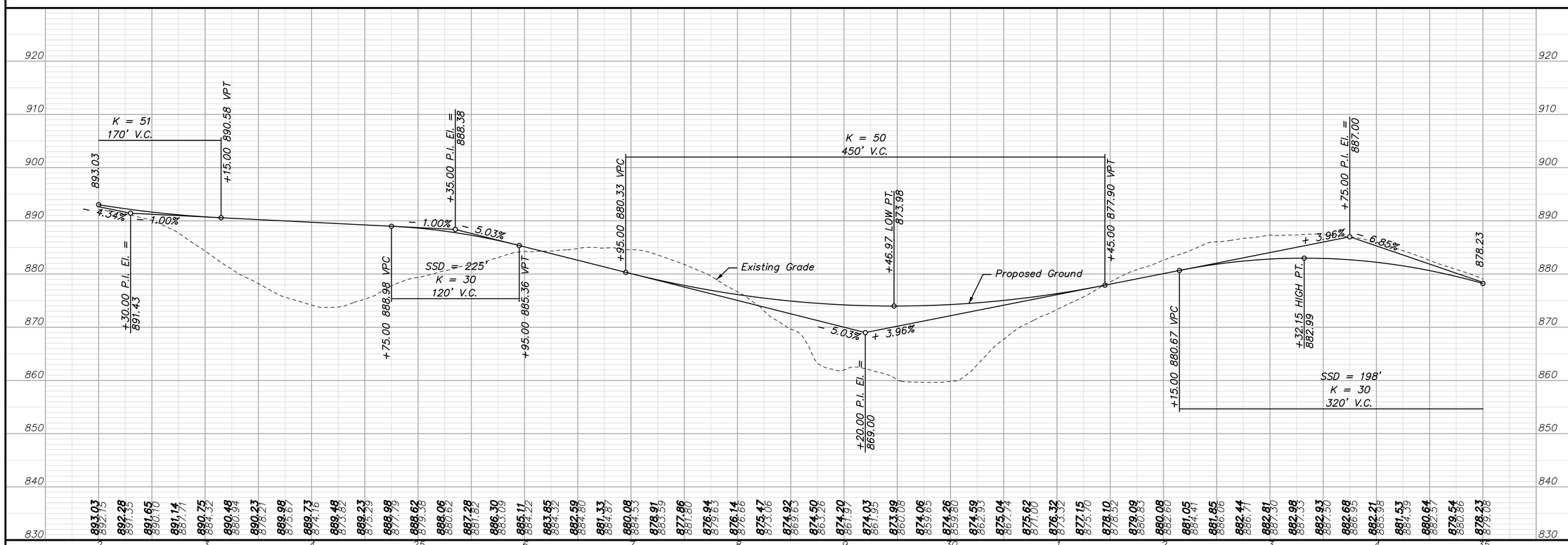

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T INTERSECTION OPTION
PLAN AND PROFILE (2)
STA. 22+00.00 TO STA. 35+00.00

150561-010

D-8

LAYOUT: MODEL | BY: jkoehler | DATE: 11-APR-2016 1:18:53 PM
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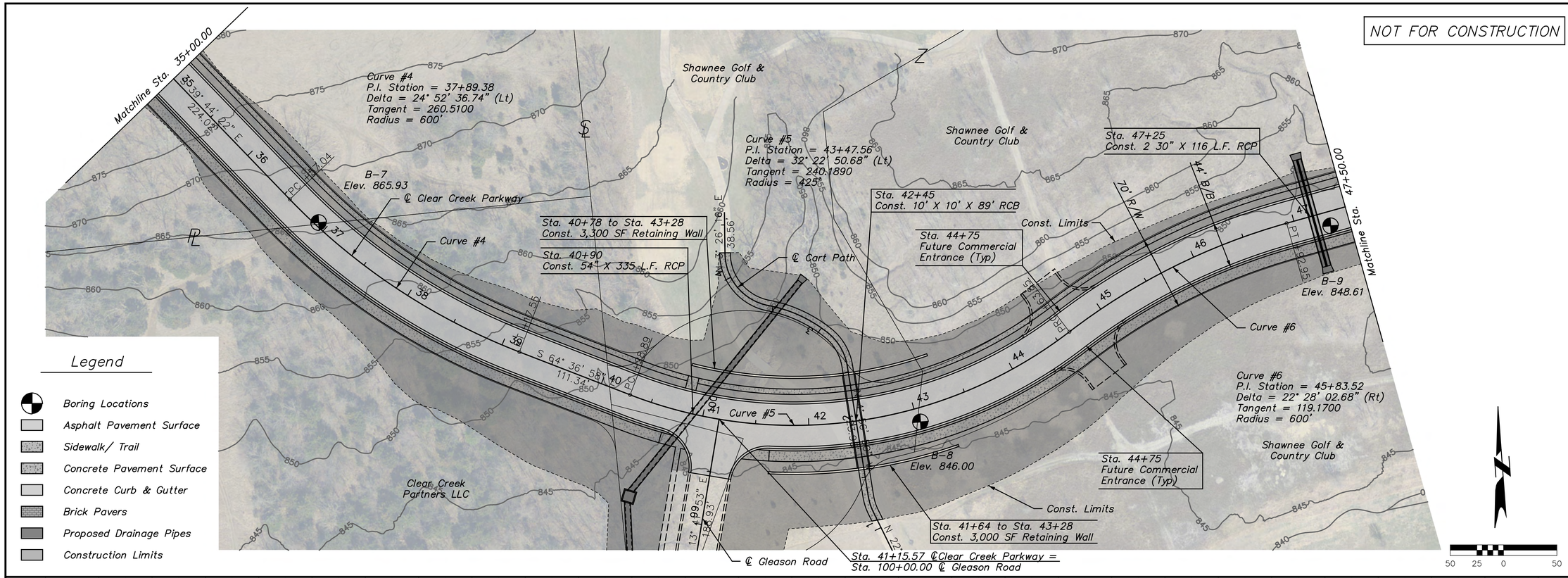

Legend

- Boring Locations
- Asphalt Pavement Surface
- Sidewalk/ Trail
- Concrete Pavement Surface
- Concrete Curb & Gutter
- Brick Pavers
- Proposed Drainage Pipes
- Construction Limits

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1	4-11-16	CONCEPT STUDY & REPORT	JAA	PRP	
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T INTERSECTION OPTION
PLAN AND PROFILE (3)
STA. 35+00.00 TO STA. 47+50.00

150561-010

D-9

LAYOUT: MODEL | BY: jkoehler | DATE: 11-APR-2016 1:19:14 PM
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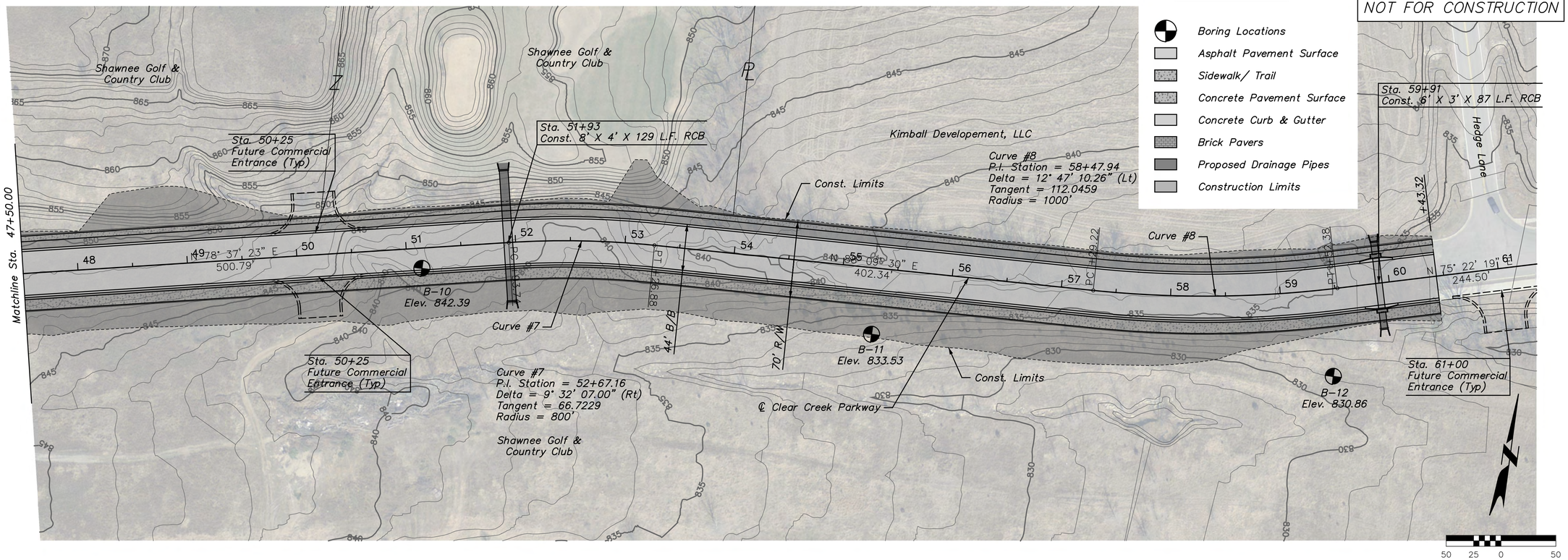

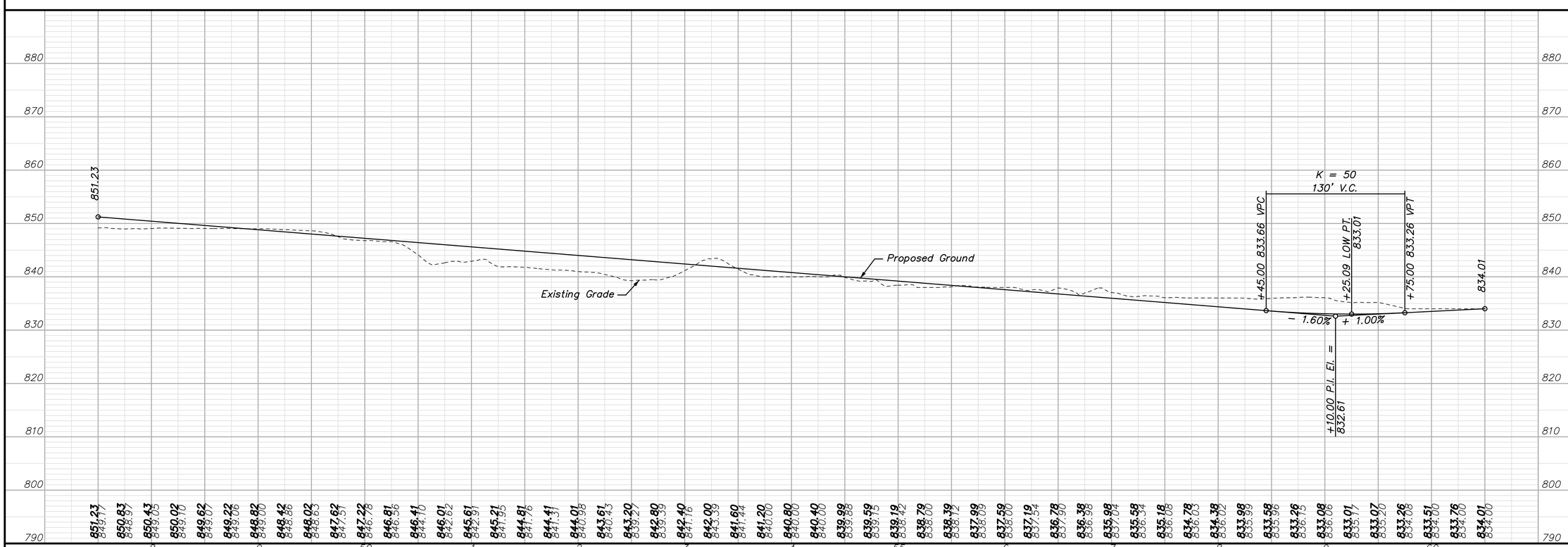

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1	4-11-16	CONCEPT STUDY & REPORT	JAA	PRP

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CITY OF SHAWNEE, KANSAS

T INTERSECTION OPTION
PLAN AND PROFILE (4)
STA. 47+50.00 TO STA. 60+50.00

150561-010

D-10

LAYOUT: MODEL | BY: jkoehler | DATE: 11-APR-2016 1:19:34 PM
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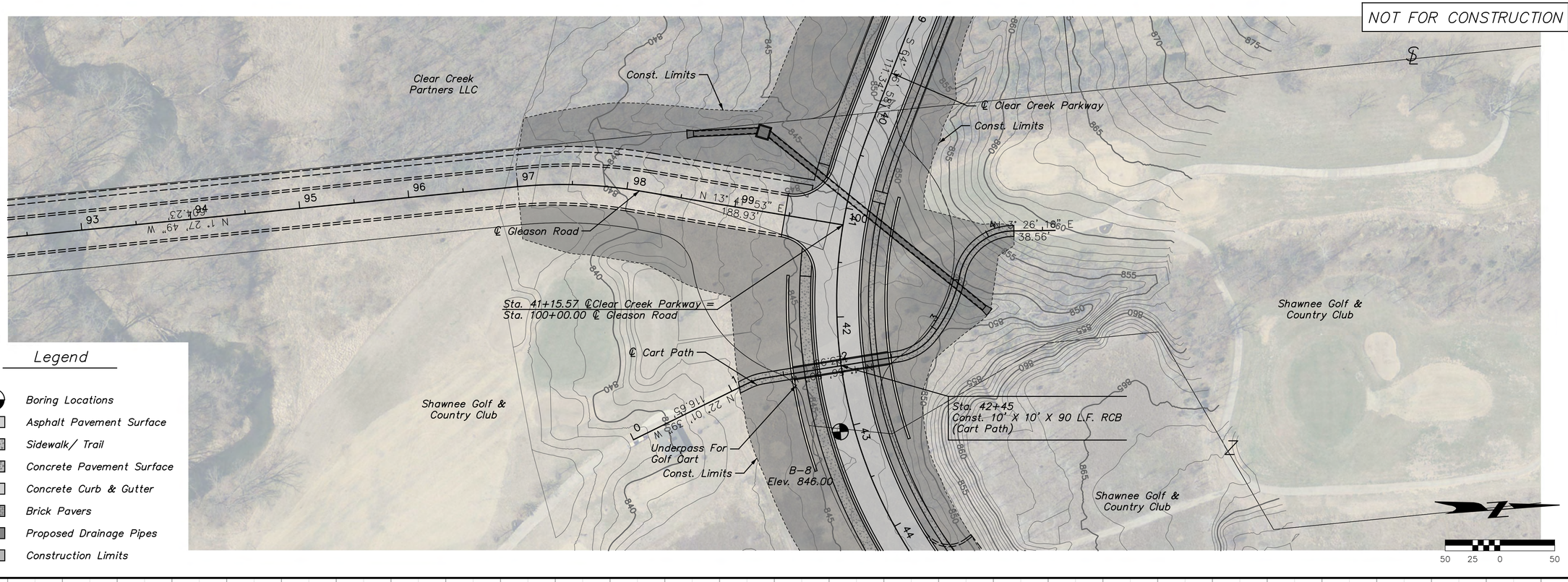
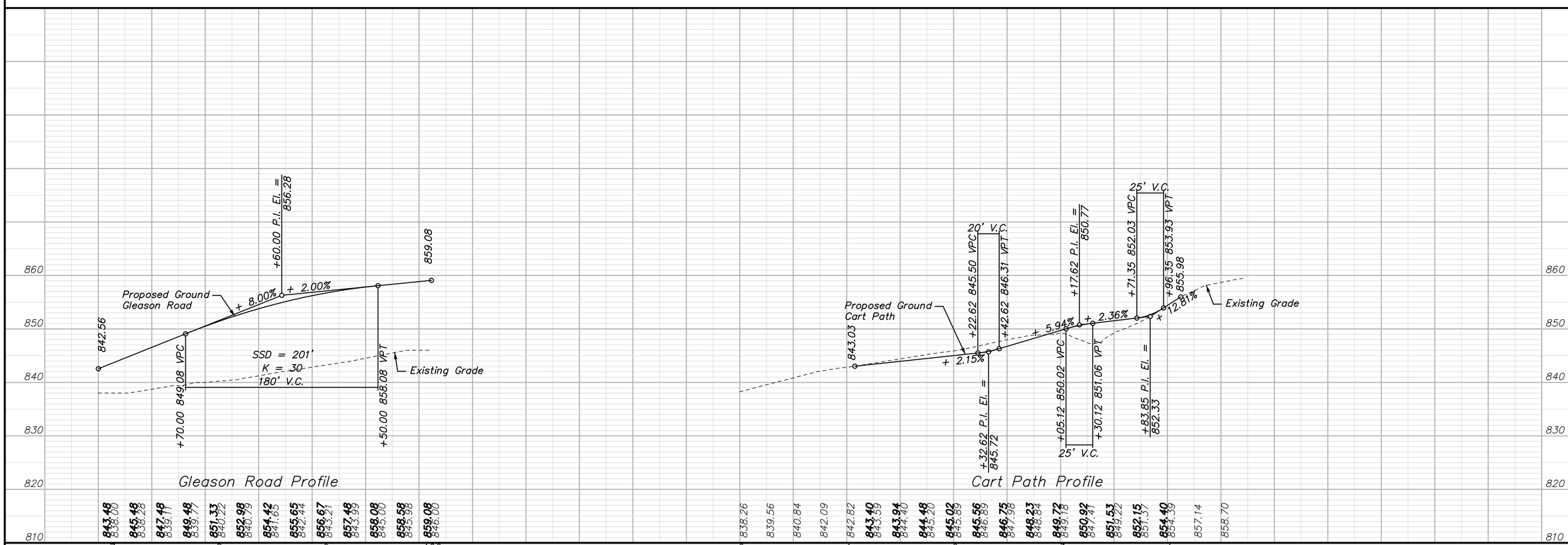


Legend

- Boring Locations
- Asphalt Pavement Surface
- Sidewalk/ Trail
- Concrete Pavement Surface
- Concrete Curb & Gutter
- Brick Pavers
- Proposed Drainage Pipes
- Construction Limits



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CLEAR CREEK PARKWAY
CITY OF SHAWNEE, KANSAS

GLEASON ROAD & CART PATH
PLAN AND PROFILE (5)

150561-010

D-11

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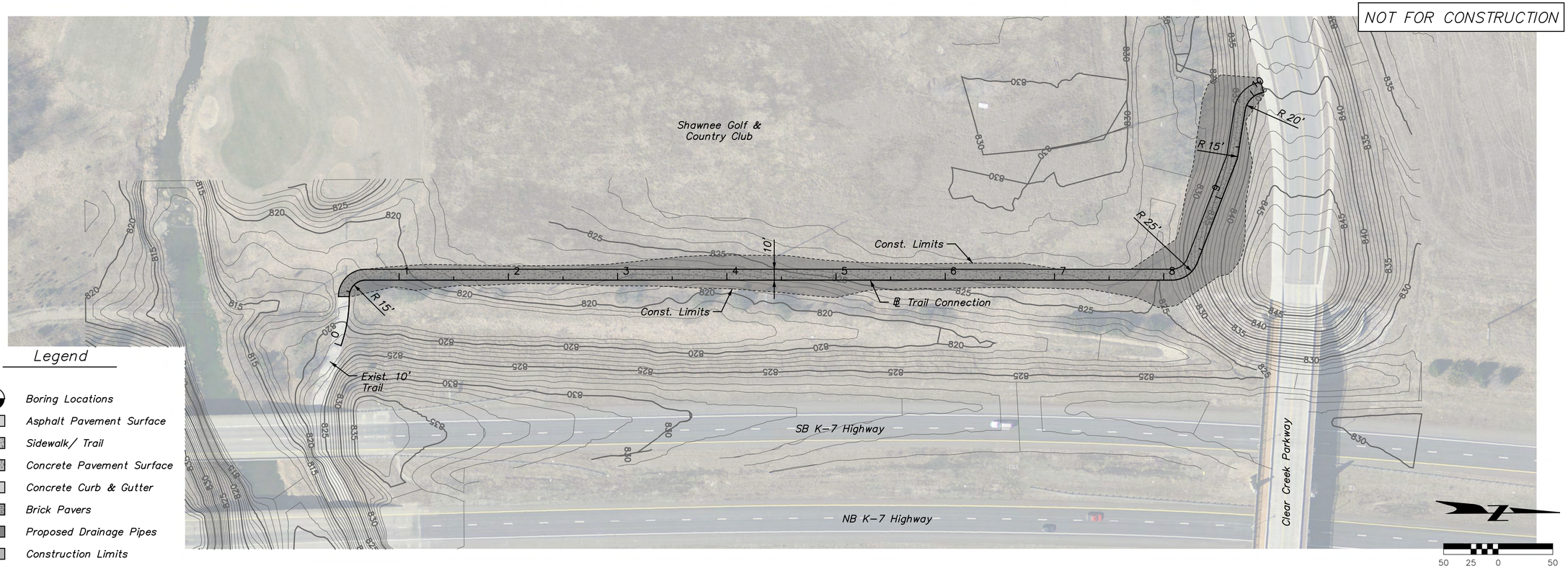

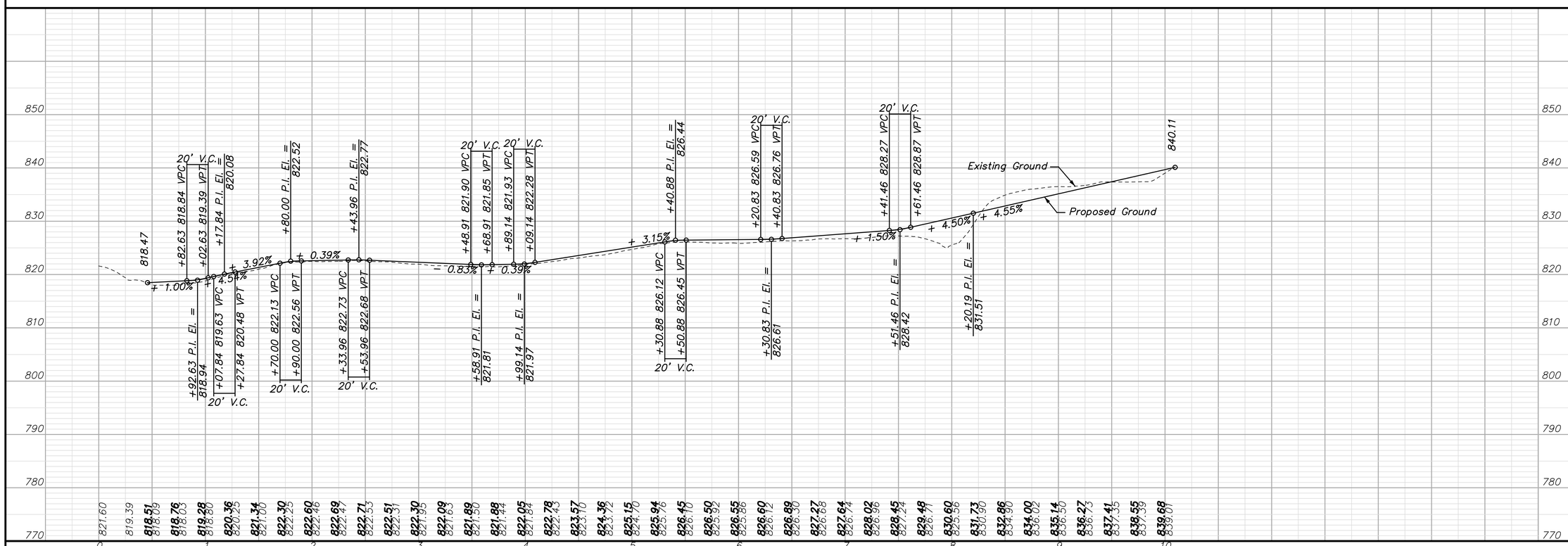

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CLEAR CREEK PARKWAY
CITY OF SHAWNEE, KANSAS

RECREATIONAL TRAIL CONNECTION PLAN AND PROFILE (6)

STA. 0+45.71 TO STA. 10+09.44

150561-010

D-12

LAYOUT: MODEL | BY: jkoehler | DATE: 11-APR-2016 1:12:45 PM
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Appendix D.2

Alternative 2

Gleason Road T Intersection with Traffic Signal

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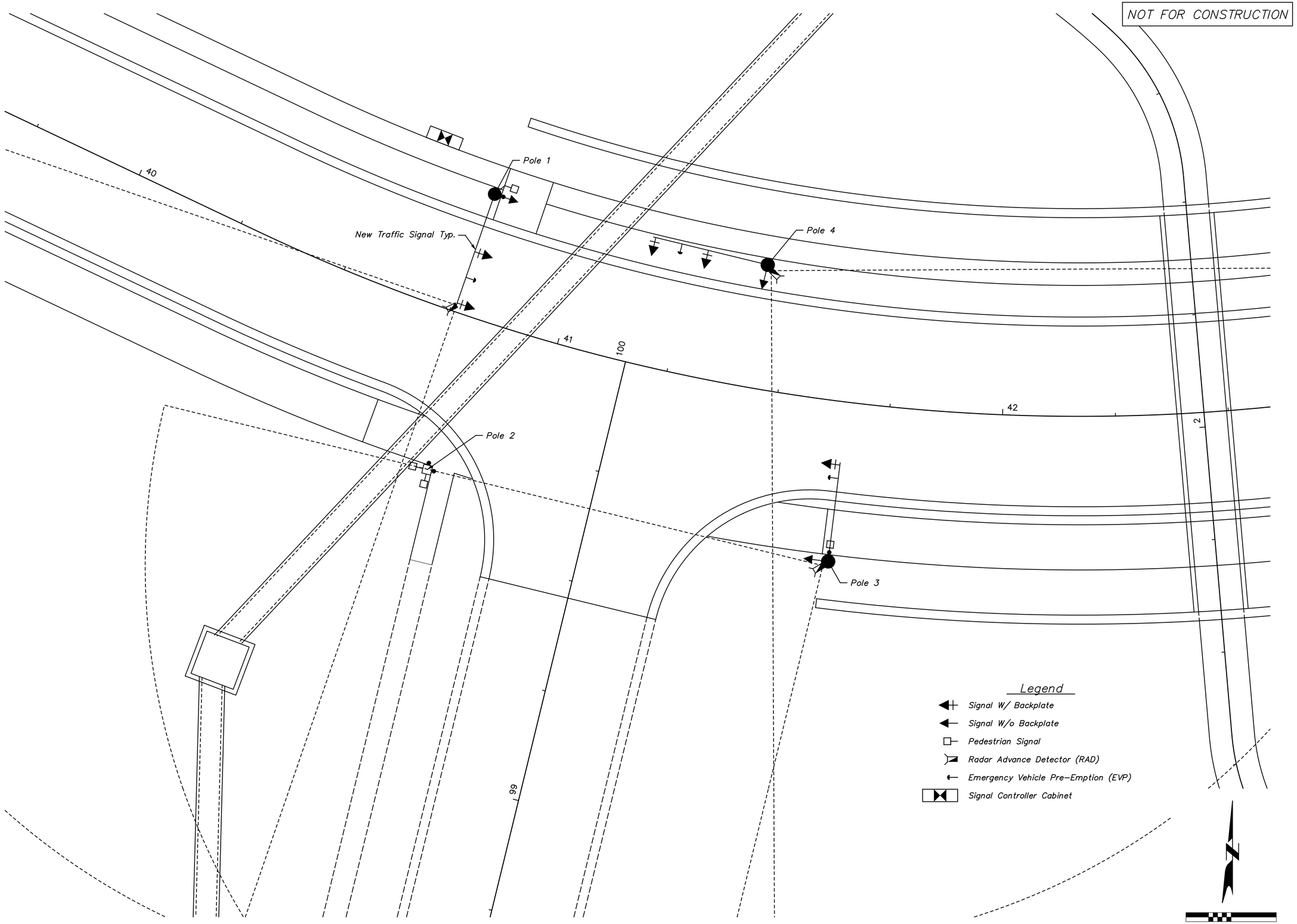
NOT FOR CONSTRUCTION



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1	4-11-16	CONCEPT STUDY & REPORT	JAA	PRP

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CLEAR CREEK PARKWAY
CITY OF SHAWNEE, KANSAS

SIGNAL PLAN
CLEAR CREEK PARKWAY
& GLEASON ROAD

150561-010

D-15

LAYOUT: MODEL | BY: jkoehler | DATE: 11-APR-2016 1:20:09 PM
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Appendix D.3

Alternative 3

Gleason Road Roundabout Intersection

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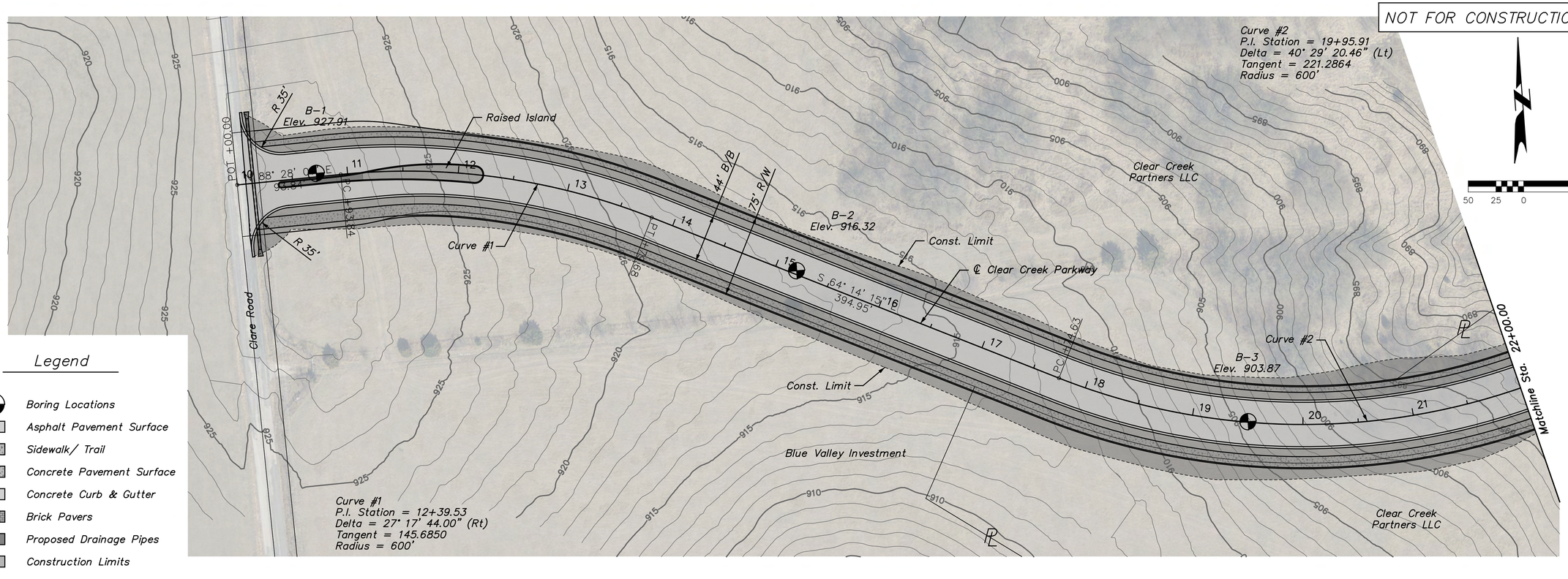
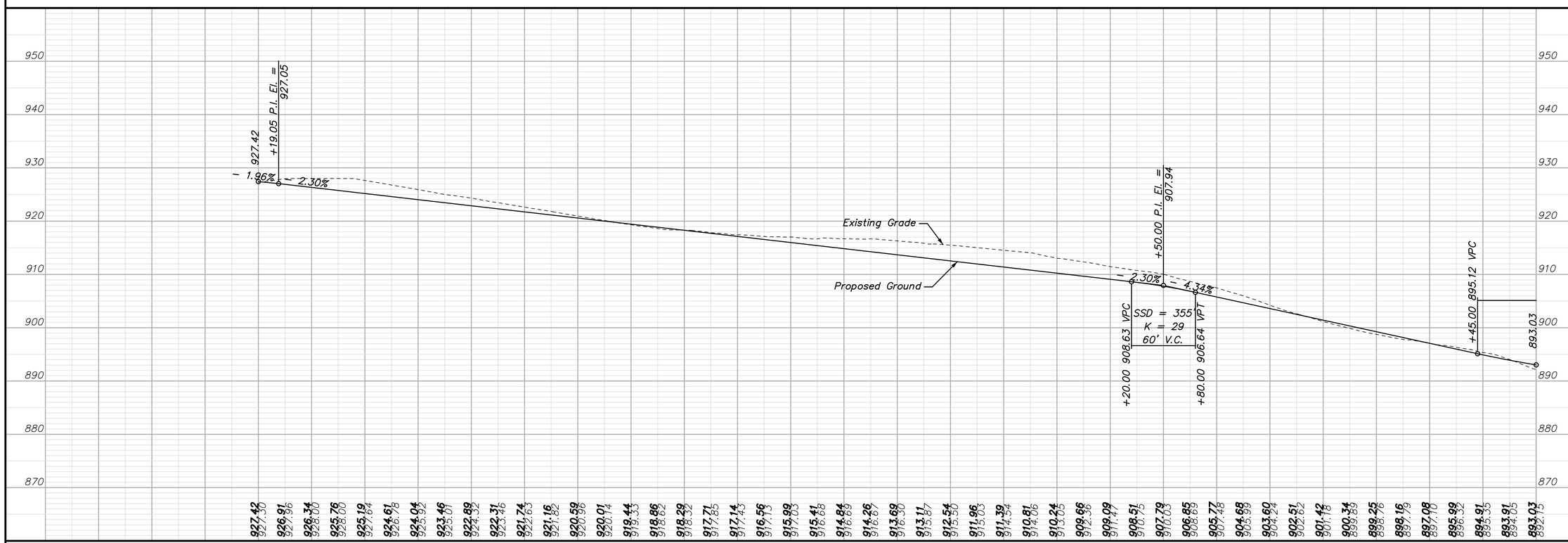


Legend

- Boring Locations
- Asphalt Pavement Surface
- Sidewalk/ Trail
- Concrete Pavement Surface
- Concrete Curb & Gutter
- Brick Pavers
- Proposed Drainage Pipes
- Construction Limits



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1	4-11-16	CONCEPT STUDY & REPORT	JAA	PRP

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CITY OF SHAWNEE, KANSAS

ROUNDABOUT OPTION
PLAN AND PROFILE (1)

STA. 10+00.00 TO STA. 22+00.00

150561-010

D-19

LAYOUT: MODEL | BY: jkoehler | DATE: 11-APR-2016 1:10:30 PM
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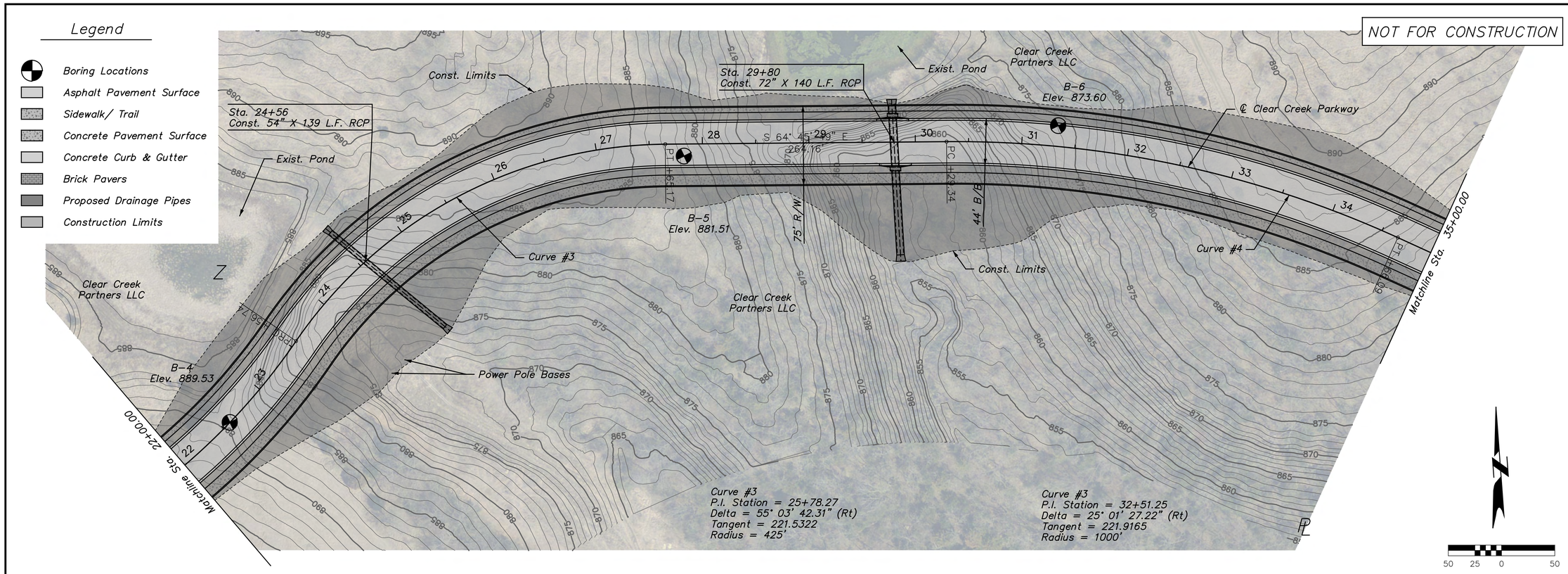

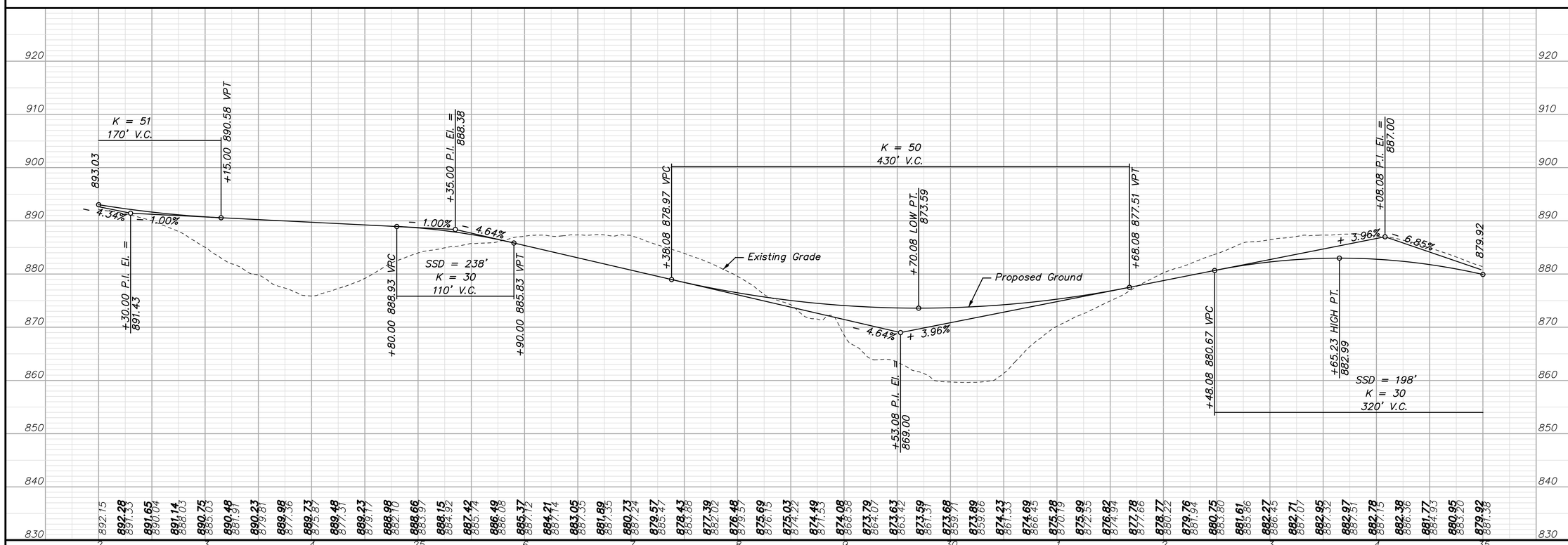

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CITY OF SHAWNEE, KANSAS

ROUNDABOUT OPTION
PLAN AND PROFILE (2)
STA. 22+00.00 TO STA. 35+00.00

150561-010

D-20

LAYOUT: MODEL | BY: jkoehler | DATE: 11-APR-2016 1:11:16 PM
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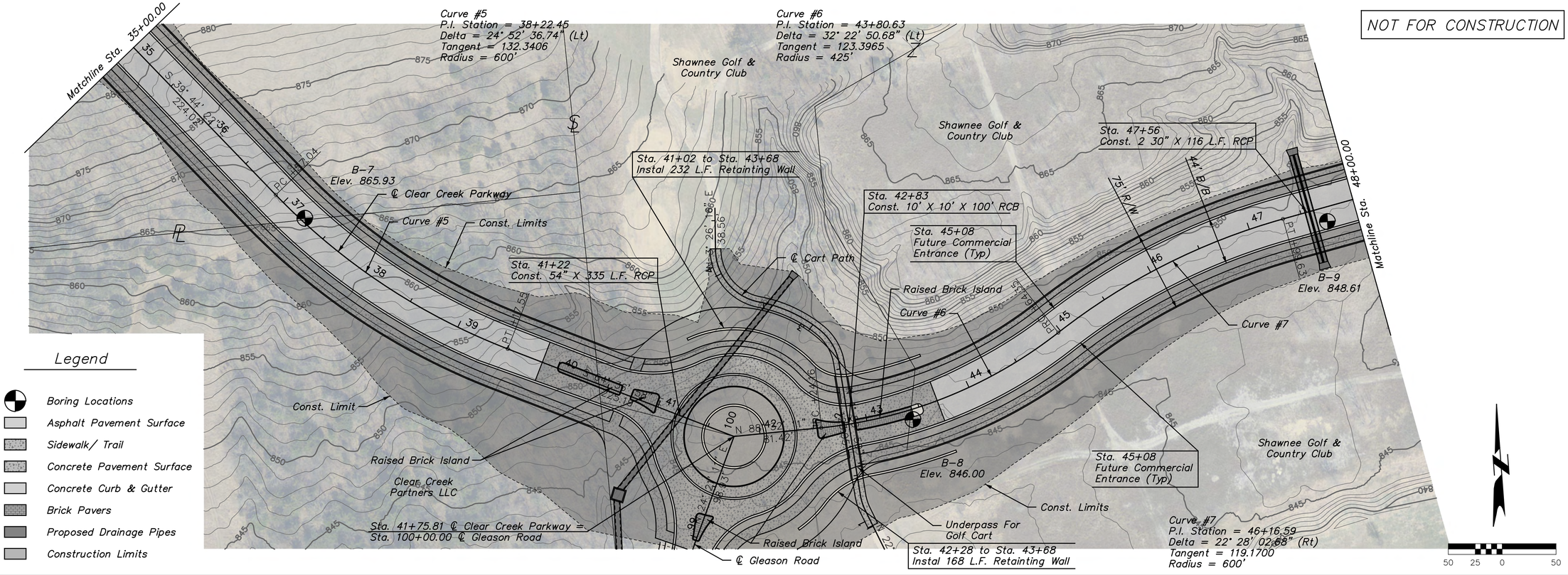
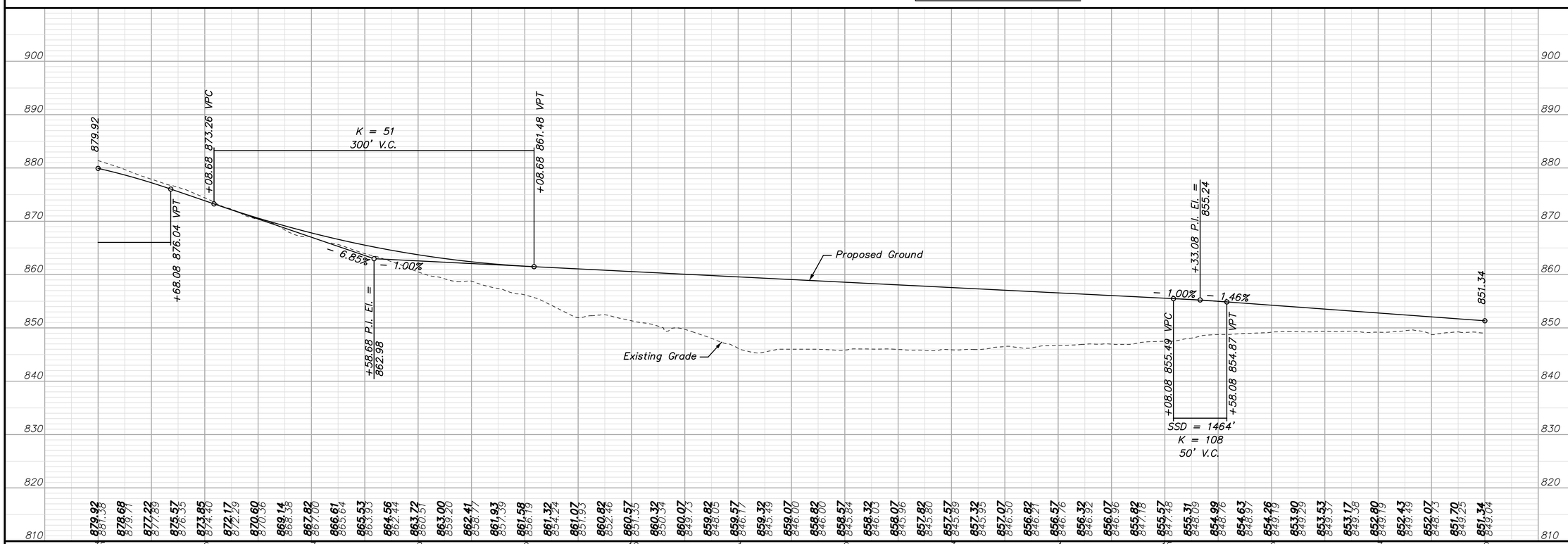


Legend

- Boring Locations
- Asphalt Pavement Surface
- Sidewalk/ Trail
- Concrete Pavement Surface
- Concrete Curb & Gutter
- Brick Pavers
- Proposed Drainage Pipes
- Construction Limits



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1	4-11-16	CONCEPT STUDY & REPORT	JAA	PRP
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CITY OF SHAWNEE, KANSAS

ROUNDABOUT OPTION
PLAN AND PROFILE (3)
STA. 35+00.00 TO STA. 48+00.00

150561-010

D-21

LAYOUT: MODEL | BY: jkoehler | DATE: 11-APR-2016 1:11:40 PM
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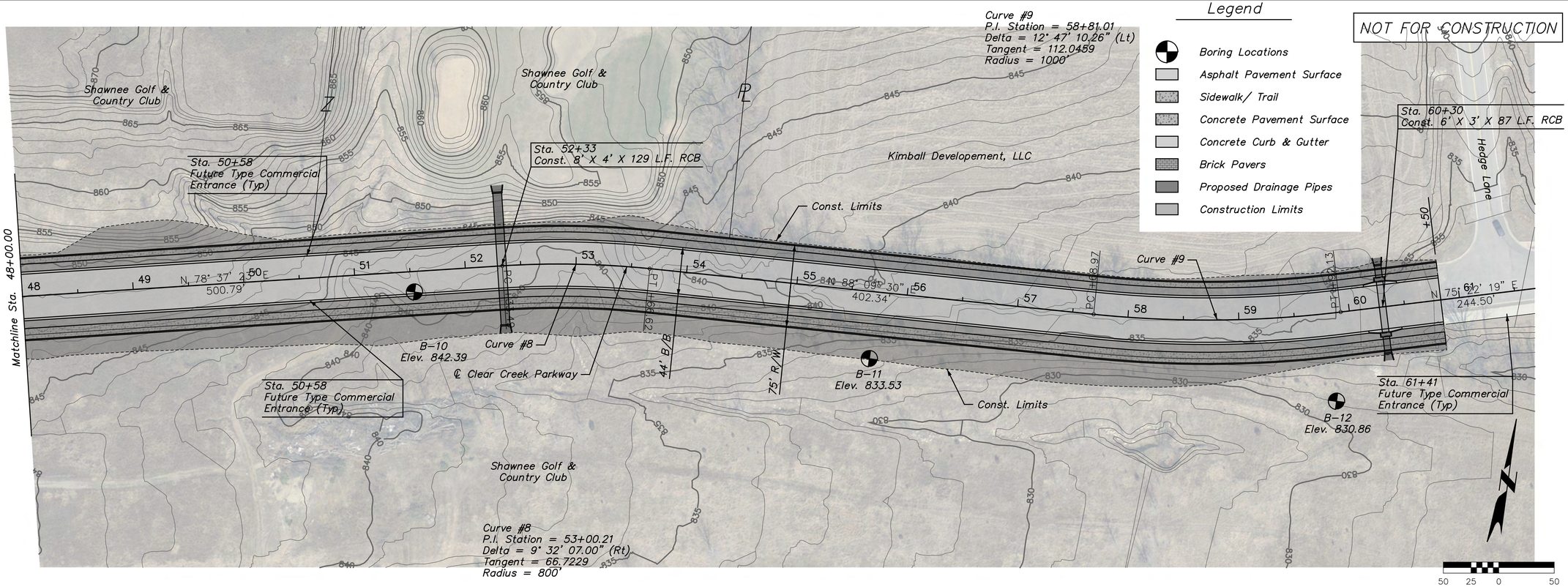

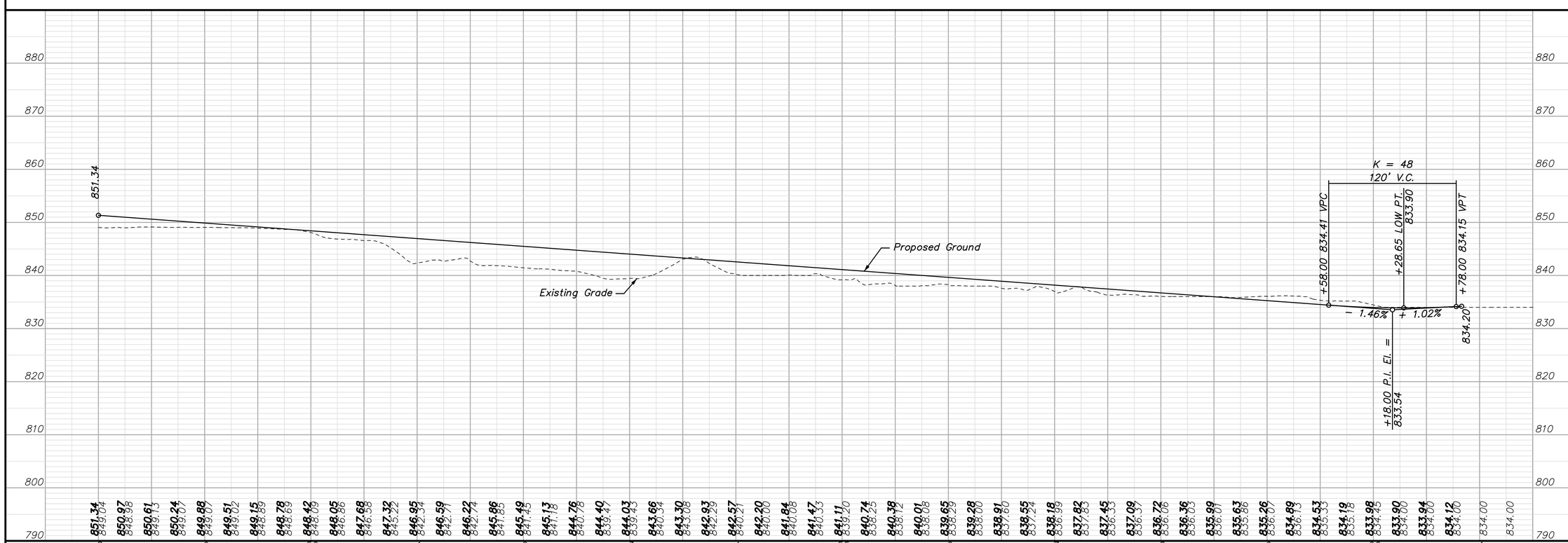

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1	4-11-16	CONCEPT STUDY & REPORT	JAA	PRP

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CITY OF SHAWNEE, KANSAS

ROUNDABOUT OPTION
PLAN AND PROFILE (4)
STA. 48+00.00 TO STA. 60+50.00

150561-010

D-22

LAYOUT: MODEL | BY: jkoehler | DATE: 11-APR-2016 1:12:06 PM
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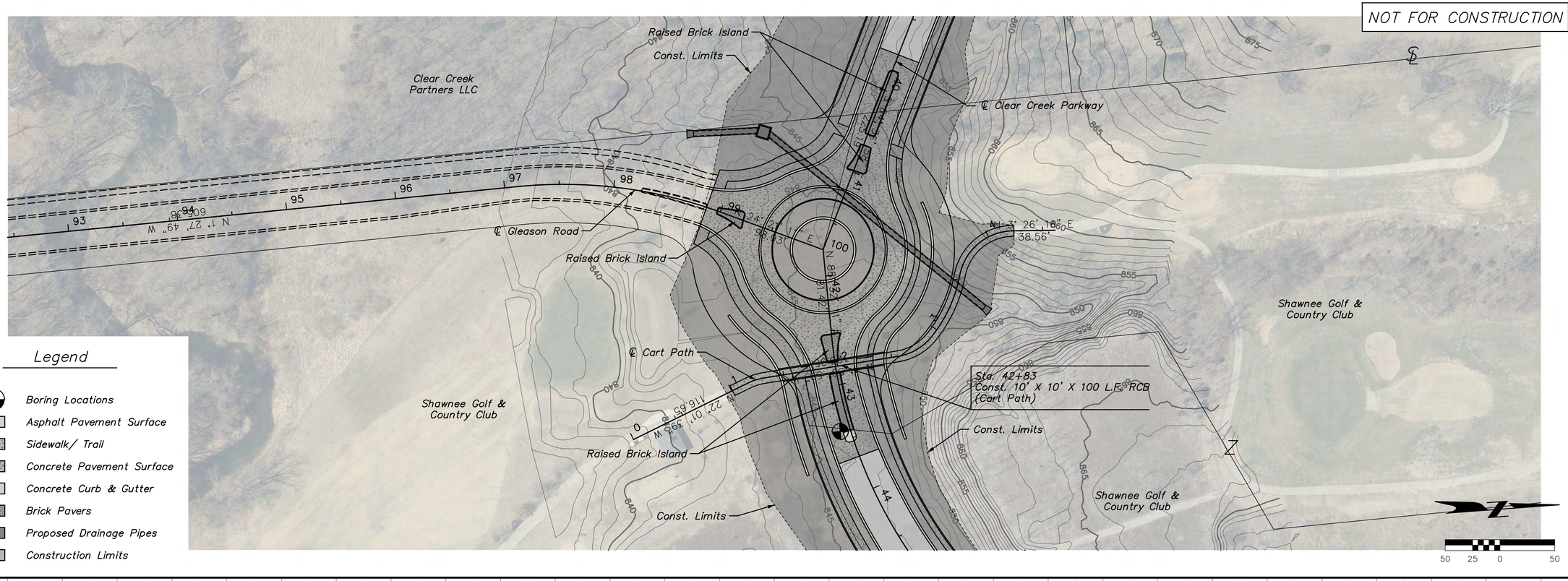
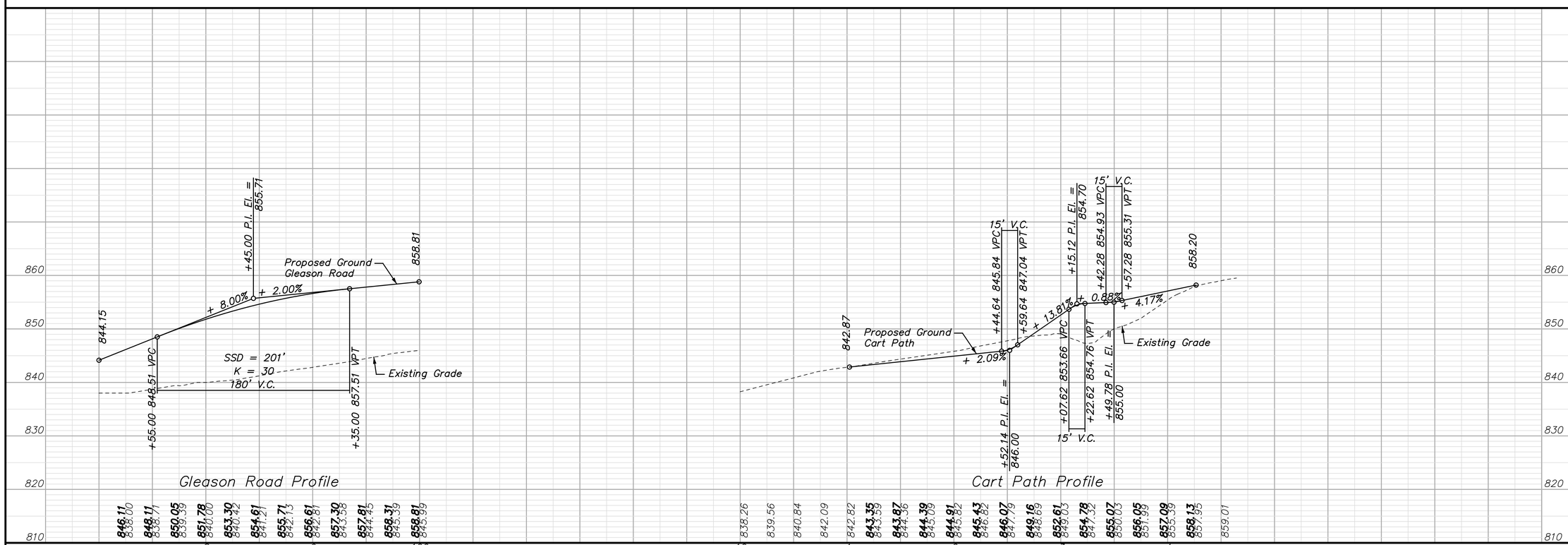


Legend

- Boring Locations
- Asphalt Pavement Surface
- Sidewalk/ Trail
- Concrete Pavement Surface
- Concrete Curb & Gutter
- Brick Pavers
- Proposed Drainage Pipes
- Construction Limits



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NO.	DATE	REVISIONS	BY	APP'D
1	4-11-16	CONCEPT STUDY & REPORT	JAA	PRP
2				
3				
4				
5				

Designed By: PRP
Drawn By: JAA
Checked By: HDL
Issue Date: APR 2016

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CLEAR CREEK PARKWAY
CITY OF SHAWNEE, KANSAS

GLEASON ROAD & CART PATH
PLAN AND PROFILE (5)

150561-010

D-23

Appendix E

Drainage Analysis

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Appendix E.1

Drainage Area Map

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NO.	DATE	REVISIONS	BY	APP'D
1	4-11-16	CONCEPT STUDY & REPORT	JAA	PRP
2				
3				
4				
5				

Designed By: PRP
Drawn By: JAA
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CITY OF SHAWNEE, KANSAS

DRAINAGE AREA MAP

150561-010

E-5

LAYOUT: MODEL | BY: jkoehler | DATE: 11-APR-2016 1:13:02 PM
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Appendix E.2

Cross Road Pipe Calculations

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Culvert Designer/Analyzer Report
Culvert-1-RCP

Analysis Component			
Storm Event	Check	Discharge	215.09 cfs

Peak Discharge Method: User-Specified			
Design Discharge	187.19 cfs	Check Discharge	215.09 cfs

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	1+01	0.080
1+01	1+32	0.040
1+32	2+03	0.080

Natural Channel Points

Station (ft)	Elevation (ft)
0+00	880.58
0+50	877.48
0+61	877.18
0+77	876.43
0+88	875.01
1+01	873.95
1+05	870.29
1+09	870.36
1+17	870.00
1+32	874.00
1+50	875.38
2+00	879.18
2+03	879.58

Tailwater conditions for Check Storm.

Discharge	215.09 cfs	Actual Depth	2.71 ft
Velocity	4.72 ft/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-54 inch Circular	215.10 cfs	882.27 ft	14.08 ft/s
Weir	Roadway (Constant Elevation)	0.00 cfs	882.27 ft	N/A
Total	----------	215.10 cfs	882.27 ft	N/A

Culvert Designer/Analyzer Report
Culvert-1-RCP

Component:Culvert-1

Culvert Summary					
Computed Headwater Eleva	882.27	ft	Discharge	215.10	cfs
Inlet Control HW Elev.	882.27	ft	Tailwater Elevation	872.71	ft
Outlet Control HW Elev.	880.75	ft	Control Type	Inlet Control	
Headwater Depth/Height	2.28				

Grades					
Upstream Invert	872.00	ft	Downstream Invert	870.00	ft
Length	200.00	ft	Constructed Slope	0.010000	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	4.13	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	4.13	ft
Velocity Downstream	14.08	ft/s	Critical Slope	0.010402	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	4.50	ft
Section Size	54 inch		Rise	4.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	880.75	ft	Upstream Velocity Head	2.85	ft
Ke	0.50		Entrance Loss	1.42	ft

Inlet Control Properties					
Inlet Control HW Elev.	882.27	ft	Flow Control	N/A	
Inlet Type	Square edge w/headwall		Area Full	15.9	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Designer/Analyzer Report
Culvert-1-RCP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)					
Discharge	0.00	cfs	Allowable HW Elevation	882.27	ft
Roadway Width	70.00	ft	Overtopping Coefficient	2.90	US
Length	400.00	ft	Crest Elevation	883.85	ft
Headwater Elevation	N/A	ft	Discharge Coefficient (Cr)	2.90	
Submergence Factor (Kt)	1.00				

Sta (ft)	Elev. (ft)
0.00	883.85
400.00	883.85

Culvert Designer/Analyzer Report
Culvert-2-RCP

Analysis Component			
Storm Event	Check	Discharge	471.14 cfs

Peak Discharge Method: User-Specified			
Design Discharge	409.80 cfs	Check Discharge	471.14 cfs

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	1+01	0.080
1+01	1+32	0.040
1+32	2+03	0.080

Natural Channel Points

Station (ft)	Elevation (ft)
0+00	867.58
0+50	864.48
0+61	864.18
0+77	863.43
0+88	862.01
1+01	860.95
1+05	857.29
1+09	857.36
1+17	857.00
1+32	861.00
1+50	862.38
2+00	866.18
2+03	866.58

Tailwater conditions for Check Storm.

Discharge	471.14 cfs	Actual Depth	5.03 ft
Velocity	3.71 ft/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-72 inch Circular	471.15 cfs	873.74 ft	17.16 ft/s
Weir	Roadway	0.00 cfs	873.74 ft	N/A
Total	----------	471.15 cfs	873.74 ft	N/A

Culvert Designer/Analyzer Report
Culvert-2-RCP

Component:Culvert-1

Culvert Summary					
Computed Headwater Eleva	873.74	ft	Discharge	471.15	cfs
Inlet Control HW Elev.	873.74	ft	Tailwater Elevation	862.03	ft
Outlet Control HW Elev.	871.21	ft	Control Type	Inlet Control	
Headwater Depth/Height	2.51				

Grades					
Upstream Invert	858.70	ft	Downstream Invert	857.00	ft
Length	167.00	ft	Constructed Slope	0.010180	ft/ft

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	5.60	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	5.60	ft
Velocity Downstream	17.16	ft/s	Critical Slope	0.010701	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	6.00	ft
Section Size	72 inch		Rise	6.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	871.21	ft	Upstream Velocity Head	4.32	ft
Ke	0.50		Entrance Loss	2.16	ft

Inlet Control Properties					
Inlet Control HW Elev.	873.74	ft	Flow Control	N/A	
Inlet Type	Square edge w/headwall		Area Full	28.3	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Designer/Analyzer Report
Culvert-2-RCP

Component:Weir

Hydraulic Component(s): Roadway					
Discharge	0.00	cfs	Allowable HW Elevation	873.74	ft
Roadway Width	24.00	ft	Overtopping Coefficient	2.90	US
Low Point	873.98	ft	Headwater Elevation	N/A	ft
Discharge Coefficient (Cr)	2.90		Submergence Factor (Kt)	1.00	
Tailwater Elevation	862.03	ft			

Sta (ft)	Elev. (ft)
0.00	887.28
200.00	877.86
300.00	874.92
400.00	873.98
500.00	875.04
600.00	878.10
800.00	882.93

Culvert Designer/Analyzer Report
Culvert-3-RCP

Analysis Component			
Storm Event	Check	Discharge	150.30 cfs

Peak Discharge Method: User-Specified			
Design Discharge	129.76 cfs	Check Discharge	150.30 cfs

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	1+01	0.080
1+01	1+32	0.040
1+32	2+03	0.080

Natural Channel Points

Station (ft)	Elevation (ft)
0+00	851.58
0+50	848.48
0+61	848.18
0+77	847.43
0+88	846.01
1+01	844.95
1+05	841.29
1+09	841.36
1+17	841.00
1+32	845.00
1+50	846.38
2+00	850.18
2+03	850.58

Tailwater conditions for Check Storm.

Discharge	150.30 cfs	Actual Depth	2.27 ft
Velocity	4.25 ft/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-54 inch Circular	150.31 cfs	851.54 ft	15.28 ft/s
Weir	Roadway	0.00 cfs	851.54 ft	N/A
Total	----------	150.31 cfs	851.54 ft	N/A

Culvert Designer/Analyzer Report
Culvert-3-RCP

Component:Culvert-1

Culvert Summary					
Computed Headwater Eleva	851.54	ft	Discharge	150.31	cfs
Inlet Control HW Elev.	851.54	ft	Tailwater Elevation	843.27	ft
Outlet Control HW Elev.	851.43	ft	Control Type	Inlet Control	
Headwater Depth/Height	1.45				

Grades					
Upstream Invert	845.00	ft	Downstream Invert	841.00	ft
Length	284.50	ft	Constructed Slope	0.014060	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	2.67	ft
Slope Type	Steep		Normal Depth	2.63	ft
Flow Regime	Supercritical		Critical Depth	3.60	ft
Velocity Downstream	15.28	ft/s	Critical Slope	0.006126	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	4.50	ft
Section Size	54 inch		Rise	4.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	851.43	ft	Upstream Velocity Head	1.89	ft
Ke	0.50		Entrance Loss	0.95	ft

Inlet Control Properties					
Inlet Control HW Elev.	851.54	ft	Flow Control	N/A	
Inlet Type	Square edge w/headwall		Area Full	15.9	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Designer/Analyzer Report
Culvert-3-RCP

Component:Weir

Hydraulic Component(s): Roadway					
Discharge	0.00	cfs	Allowable HW Elevation	851.54	ft
Roadway Width	24.00	ft	Overtopping Coefficient	2.90	US
Low Point	855.00	ft	Headwater Elevation	N/A	ft
Discharge Coefficient (Cr)	2.90		Submergence Factor (Kt)	1.00	
Tailwater Elevation	843.27	ft			

Sta (ft)	Elev. (ft)
0.00	867.00
200.00	859.00
400.00	855.00
600.00	859.00
800.00	867.00

Culvert Designer/Analyzer Report
Culvert-4-RCP

Analysis Component			
Storm Event	Check	Discharge	42.98 cfs

Peak Discharge Method: User-Specified			
Design Discharge	37.92 cfs	Check Discharge	42.98 cfs

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	1+01	0.080
1+01	1+32	0.040
1+32	2+03	0.080

Natural Channel Points

Station (ft)	Elevation (ft)
0+00	856.58
0+50	853.48
0+61	853.18
0+77	852.43
0+88	851.01
1+01	849.95
1+05	846.29
1+09	846.36
1+17	846.00
1+32	850.00
1+50	851.38
2+00	855.18
2+03	855.58

Tailwater conditions for Check Storm.

Discharge	42.98 cfs	Actual Depth	1.23 ft
Velocity	2.87 ft/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	2-30 inch Circular	42.99 cfs	849.07 ft	6.59 ft/s
Weir	Roadway (Constant Elevation)	0.00 cfs	849.07 ft	N/A
Total	----------	42.99 cfs	849.07 ft	N/A

Culvert Designer/Analyzer Report
Culvert-4-RCP

Component:Culvert-1

Culvert Summary					
Computed Headwater Eleva	849.07	ft	Discharge	42.99	cfs
Inlet Control HW Elev.	848.92	ft	Tailwater Elevation	682.23	ft
Outlet Control HW Elev.	849.07	ft	Control Type	Outlet Control	
Headwater Depth/Height	1.03				

Grades					
Upstream Invert	846.49	ft	Downstream Invert	846.00	ft
Length	98.00	ft	Constructed Slope	0.005000	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	1.58	ft
Slope Type	Mild		Normal Depth	1.60	ft
Flow Regime	Subcritical		Critical Depth	1.58	ft
Velocity Downstream	6.59	ft/s	Critical Slope	0.005244	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.50	ft
Section Size	30 inch		Rise	2.50	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	849.07	ft	Upstream Velocity Head	0.65	ft
Ke	0.50		Entrance Loss	0.33	ft

Inlet Control Properties					
Inlet Control HW Elev.	848.92	ft	Flow Control	N/A	
Inlet Type	Square edge w/headwall		Area Full	9.8	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Designer/Analyzer Report
Culvert-4-RCP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)					
Discharge	0.00	cfs	Allowable HW Elevation	849.07	ft
Roadway Width	70.00	ft	Overtopping Coefficient	2.90	US
Length	800.00	ft	Crest Elevation	849.62	ft
Headwater Elevation	N/A	ft	Discharge Coefficient (Cr)	2.90	
Submergence Factor (Kt)	1.00				

Sta (ft)	Elev. (ft)
0.00	849.62
800.00	849.62

Culvert Designer/Analyzer Report
Culvert-5-RCP

Analysis Component			
Storm Event	Check	Discharge	129.72 cfs

Peak Discharge Method: User-Specified			
Design Discharge	112.29 cfs	Check Discharge	129.72 cfs

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	1+01	0.080
1+01	1+32	0.040
1+32	2+03	0.080

Natural Channel Points

Station (ft)	Elevation (ft)
0+00	848.58
0+50	845.48
0+61	845.18
0+77	844.43
0+88	843.01
1+01	841.95
1+05	838.29
1+09	838.36
1+17	838.00
1+32	842.00
1+50	843.38
2+00	847.18
2+03	847.58

Tailwater conditions for Check Storm.			
Discharge	129.72 cfs	Actual Depth	2.11 ft
Velocity	4.06 ft/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-8 x 4 ft Box	129.73 cfs	842.31 ft	9.17 ft/s
Weir	Roadway (Constant Elevation)	0.00 cfs	842.31 ft	N/A
Total	----------	129.73 cfs	842.31 ft	N/A

Culvert Designer/Analyzer Report
Culvert-5-RCP

Component:Culvert-1

Culvert Summary					
Computed Headwater Eleva	842.31	ft	Discharge	129.73	cfs
Inlet Control HW Elev.	842.01	ft	Tailwater Elevation	683.11	ft
Outlet Control HW Elev.	842.31	ft	Control Type	Entrance Control	
Headwater Depth/Height	0.93				

Grades					
Upstream Invert	838.58	ft	Downstream Invert	838.00	ft
Length	116.00	ft	Constructed Slope	0.005000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.77	ft
Slope Type	Steep		Normal Depth	1.76	ft
Flow Regime	Supercritical		Critical Depth	2.01	ft
Velocity Downstream	9.17	ft/s	Critical Slope	0.003359	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	8.00	ft
Section Size	8 x 4 ft		Rise	4.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	842.31	ft	Upstream Velocity Head	1.01	ft
Ke	0.70		Entrance Loss	0.71	ft

Inlet Control Properties					
Inlet Control HW Elev.	842.01	ft	Flow Control	N/A	
Inlet Type	0° wingwall flares		Area Full	32.0	ft²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert-5-RCP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)					
Discharge	0.00	cfs	Allowable HW Elevation	842.31	ft
Roadway Width	70.00	ft	Overtopping Coefficient	2.90	US
Length	800.00	ft	Crest Elevation	842.40	ft
Headwater Elevation	N/A	ft	Discharge Coefficient (Cr)	2.90	
Submergence Factor (Kt)	1.00				

Sta (ft)	Elev. (ft)
0.00	842.40
800.00	842.40

Culvert Designer/Analyzer Report
Culvert-6-RCP

Analysis Component			
Storm Event	Check	Discharge	137.78 cfs

Peak Discharge Method: User-Specified			
Design Discharge	122.66 cfs	Check Discharge	137.78 cfs

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+84	0.080
0+84	1+16	0.040
1+16	2+00	0.080

Natural Channel Points

Station (ft)	Elevation (ft)
0+00	833.06
0+84	831.38
0+96	828.38
1+00	828.38
1+04	828.38
1+16	831.38
2+00	833.06

Tailwater conditions for Check Storm.			
Discharge	137.78 cfs	Actual Depth	2.11 ft
Velocity	3.96 ft/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-6 x 3 ft Box	137.78 cfs	833.37 ft	9.69 ft/s
Weir	Roadway (Constant Elevation)	0.00 cfs	833.37 ft	N/A
Total	----------	137.78 cfs	833.37 ft	N/A

Culvert Designer/Analyzer Report
Culvert-6-RCP

Component:Culvert-1

Culvert Summary					
Computed Headwater Eleva	833.37	ft	Discharge	137.78	cfs
Inlet Control HW Elev.	833.37	ft	Tailwater Elevation	830.49	ft
Outlet Control HW Elev.	833.21	ft	Control Type	Inlet Control	
Headwater Depth/Height	1.54				

Grades					
Upstream Invert	828.76	ft	Downstream Invert	828.38	ft
Length	77.00	ft	Constructed Slope	0.005000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	2.37	ft
Slope Type	Steep		Normal Depth	2.36	ft
Flow Regime	Supercritical		Critical Depth	2.54	ft
Velocity Downstream	9.69	ft/s	Critical Slope	0.004089	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	6.00	ft
Section Size	6 x 3 ft		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	833.21	ft	Upstream Velocity Head	1.27	ft
Ke	0.50		Entrance Loss	0.64	ft

Inlet Control Properties					
Inlet Control HW Elev.	833.37	ft	Flow Control	N/A	
Inlet Type	30 to 75° wingwall flares		Area Full	18.0	ft²
K	0.02600		HDS 5 Chart	8	
M	1.00000		HDS 5 Scale	1	
C	0.03470		Equation Form	1	
Y	0.86000				

Culvert Designer/Analyzer Report
Culvert-6-RCP

Component:Weir

Hydraulic Component(s): Roadway (Constant Elevation)					
Discharge	0.00	cfs	Allowable HW Elevation	833.37	ft
Roadway Width	70.00	ft	Overtopping Coefficient	2.90	US
Length	800.00	ft	Crest Elevation	833.60	ft
Headwater Elevation	N/A	ft	Discharge Coefficient (Cr)	2.90	
Submergence Factor (Kt)	1.00				

Sta (ft)	Elev. (ft)
0.00	833.60
800.00	833.60

Appendix F

Street Lighting Analysis

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Appendix F.1

Street Lighting Fixture Options

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SOLID STATE AREA LIGHTING

RAZAR SERIES-LED

S P E C I F I C A T I O N S

PROJECT NAME:

PROJECT TYPE:

RAZAR

(**MODELS**: RZRM, RZR and RZR-G) PATENT PENDING

OPTICAL HOUSING

Heavy cast low copper aluminum (A356 alloy; <0.2% copper) assembly with integral cooling fins. The Optical Panel mounting surface is milled flat (surface variance <± .002") to facilitate thermal transfer of heat to housing and cooling fins. Solid barrier wall separates optical and electrical compartments. The optical and electrical compartments are integrated to create one assembly. Minimum wall thickness is .188".

ELECTRICAL HOUSING w/ INTEGRATED ARM

Heavy cast low copper aluminum (A356 alloy; <0.2% copper) assembly with integral cooling ribs surrounding the electrical compartment and a flat surface on the top of the arm to accommodate a photocell receptacle. Solid barrier wall separates optical and electrical compartments. The optical compartment and electrical compartment with the integrated support arm combine to create one assembly. Minimum wall thickness is .188". Cast and hinged driver assembly cover is integrated with wiring compartment cover.

PLED™ OPTICS

Emitters (LED's) are arrayed on a metal core PCB panel with each emitter located on a copper thermal transfer pad and enclosed by an LED refractor. In asymmetric distributions, a micro-reflector inside the refractor re-directs the house side emitter output towards the street side and functions as a house side shielding element. Refractors are injection molded H12 acrylic. Each LED refractor is sealed to the PCB over an emitter and all refractors are retained by an aluminum frame. Any one Panel, or group of Panels in a luminaire, have the same optical pattern. LED refractors produce standard site/area distributions. Panels are field replaceable and field rotatable in 90° increments.

LED DRIVER(S)

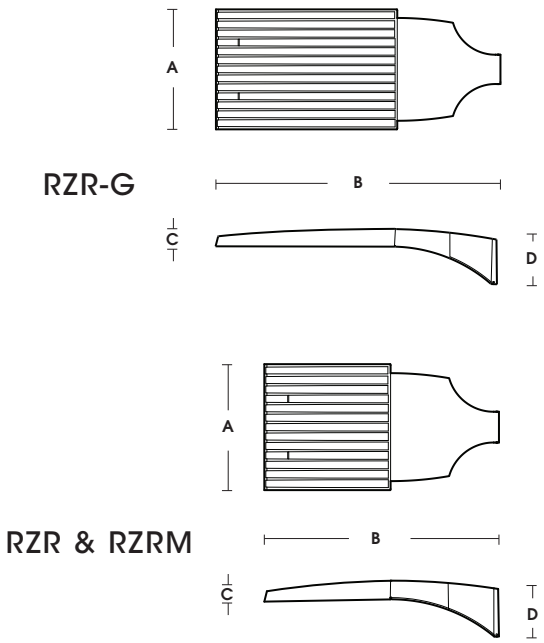
Constant current electronic with a power factor of >.90 and a minimum operating temperature of -40°F. Driver(s) is/are UL and cUL recognized and mounted directly against the Electrical Housing to facilitate thermal transfer, held down by universal clamps to facilitate easy removal. In-line terminal blocks facilitate wiring between the driver and optical arrays. Drivers accept an input of 120-277V, 50/60Hz or 347V-480V, 50,60Hz.

LED EMITTERS

High output LED's are utilized with drive currents ranging from 350mA to 1050mA. 70CRI Minimum. LED's are available in standard Neutral White (4000K), or optional Cool White (5000K) or Warm White (3000K). Consult Factory for other LED options.

FINISH

Electrostatically applied TGIC Polyester Powder Coat on substrate prepared with 20 PSI power wash at 140°F. Four step media blast and iron phosphate pretreatment for protection and paint adhesion. 400°F bake for maximum hardness and durability.



FIXTURE	A	B	C	D
RZR-G	15" 381mm	36.5" 927mm	3" 76mm	7" 187mm
RZR	14.75" 375mm	28.25" 718mm	2.75" 70mm	6.5" 165mm
RZRM	11.5" 292mm	22" 559mm	2.5" 64mm	5.25" 133mm

U.L. Listed for wet location

MADE IN THE USA

2015314

U.S. Architectural Lighting

660 West Avenue O, Palmdale, CA 93551
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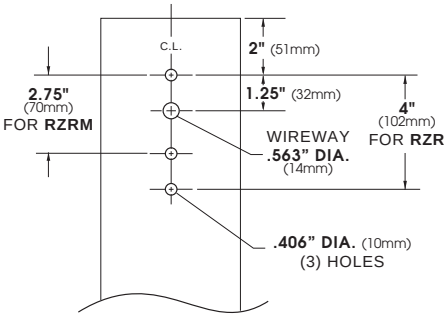
U.S. ARCHITECTURAL LIGHTING

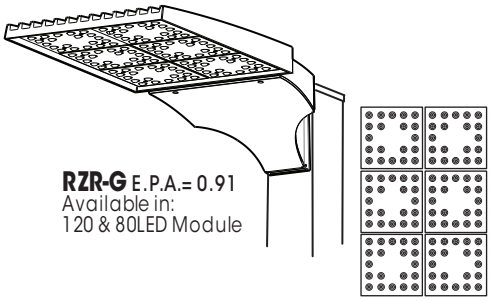
RAZAR SERIES-LED

SPECIFICATIONS

POLE DRILLING TEMPLATE

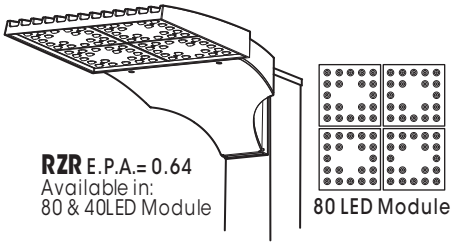


PLED® MODULES



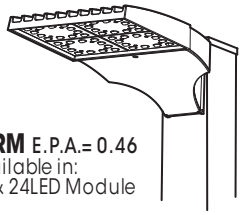
RZR-G E.P.A.= 0.91
Available in:
120 & 80LED Module

120 LED Module



RZR E.P.A.= 0.64
Available in:
80 & 40LED Module

80 LED Module



RZRM E.P.A.= 0.46
Available in:
48 & 24LED Module

48 LED Module

MAX INPUT WATTAGE

# OF LED's	DRIVE CURRENT 350mA	525mA	700mA	1050mA
120	127W	195W	260W	396W
80	87W	131W	174W	266W
48	55W	81W	105W	160W
40	45W	66W	87W	134W
24	28W	41W	53W	81W

Spec/Order Example: RZR/PLED-IV/80LED-700mA/CW/277/RAL-8019-S/10SP

SPEC / ORDERING INFORMATION

MODEL	OPTICS	LED MODE	VOLTAGE	FINISH	OPTIONS

MODEL

- ☐ RZR-G
- ☐ RZR
- ☐ RZRM

OPTICS

- ☐ TYPE II **PLED-II** . . . . . .
- ☐ TYPE II FRONT ROW **PLED-II-FR** . . . . .
- ☐ TYPE II MEDIAN ILLUMINATOR **PLED-II-ML** . . . . .
- ☐ TYPE III **PLED-III** . . . . . .
- ☐ TYPE IV **PLED-IV** . . . . . .
- ☐ TYPE IV **PLED-IV-FT** . . . . .
- ☐ TYPE V NARROW **PLED-VSQ-N** . . . .
- ☐ TYPE V **PLED-V-SQ-M** . .
- ☐ TYPE V **PLED-V-SQ-W** . .

LED MODE

NO. LEDs

RZR-G
- ☐ 120LED
- ☐ 80LED

RZR
- ☐ 80LED
- ☐ 40LED

RZRM
- ☐ 48LED
- ☐ 24LED

DRIVE CURRENT
- ☐ 350mA
- ☐ 525mA
- ☐ 700mA
- ☐ 1050mA

COLOR TEMP - CCT
- ☐ NW (4000K)* *STANDARD
- ☐ CW (5000K)
- ☐ WW (3000K)

CONSULT FACTORY FOR OTHER LED COLORS

VOLTAGE

- ☐ 120
- ☐ 208
- ☐ 240
- ☐ 277
- ☐ 347
- ☐ 480

FINISH

STANDARD TEXTURED FINISH

- ☐ BLACK **RAL-9005-T**
- ☐ WHITE **RAL-9003-T**
- ☐ GREY **RAL-7004-T**
- ☐ DARK BRONZE **RAL-8019-T**
- ☐ GREEN **RAL-6005-T**

FOR SMOOTH FINISH REPLACE SUFFIX "T" WITH SUFFIX "S" (EXAMPLE: RAL-9005-S)

CONSULT FACTORY FOR CUSTOM COLORS

OPTIONS

- ☐ HIGH-LOW DIMMING FOR EXTERNAL CONTROL . . **HLSW**
- ☐ HOUSE SIDE SHIELDING . . . . . .**HS-PLED**
- ☐ PHOTO CELL + VOLTAGE (EXAMPLE: PC120V) **PC+V**
- ☐ TWIST LOCK PHOTO CELL + VOLTAGE (EXAMPLE: PC120V) . . **TPC+V**
- ☐ TWIST LOCK RECEPTACLE ONLY . . . . .**TPR**
- ☐ SINGLE FUSE (120V & 277V) . . . . . **SF**
- ☐ DOUBLE FUSE (208V & 240V) . . . . . **DF**

U.S. Architectural Lighting

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U.S. ARCHITECTURAL LIGHTING

LED COUNT	SOURCE TYPE	SOURCE	INITIAL LUMENS - 4000K	INITIAL LUMENS - 3000K	INITIAL LUMENS - 5000K	L70 GREATER THAN (HR)	STARTING TEMP.	SYSTEM WATTS	VOLTS	MAX INPUT AMPS
24	LED	24 PLED® Optical Module - 350mA	3,073 – 3,340	2,690 – 2,924	3,147 – 3,421	60,000+	-20°F	28	120 277	0.24 0.10
24	LED	24 PLED® Optical Module - 525mA	4,366 – 4,746	3,822 – 4,155	4,471 – 4,860	60,000+	-20°F	41	120 277	0.34 0.15
24	LED	24 PLED® Optical Module - 700mA	5,467 – 5,943	4,786 – 5,203	5,598 – 6,086	60,000+	-20°F	53	120 277	0.45 0.20
24	LED	24 PLED® Optical Module - 1050mA	7,150 – 7,772	6,260 – 6,805	7,322 – 7,960	60,000+	-20°F	81	120 277	0.68 0.30
40	LED	40 PLED Optical Module - 350mA	5,002 – 5,579	4,379 – 4,884	5,122 – 5,713	60,000+	-20°F	45	120 277	0.38 0.17
40	LED	40 PLED® Optical Module - 525mA	7,047 – 7,860	6,170 – 6,881	7,216 – 8,049	60,000+	-20°F	66	120 277	0.55 0.24
40	LED	40 PLED® Optical Module - 700mA	8,822 – 9,840	7,724 – 8,615	9,034 – 10,077	60,000+	-20°F	87	120 277	0.73 0.32
40	LED	40 PLED® Optical Module - 1050mA	11,594 – 12,932	10,150 – 11,322	11,872 – 13,244	60,000+	-20°F	134	120 277	1.12 0.49
48	LED	48 PLED® Optical Module - 350mA	6,145 – 6,680	5,380 – 5,849	6,293 – 6,841	60,000+	-20°F	55	120 277	0.46 0.20
48	LED	48 PLED® Optical Module - 525mA	8,731 – 9,492	7,644 – 8,310	8,941 – 9,720	60,000+	-20°F	81	120 277	0.68 0.29
48	LED	48 PLED® Optical Module - 700mA	10,933 – 11,885	9,572 – 10,406	11,195 – 12,172	60,000+	-20°F	105	120 277	0.88 0.38
48	LED	48 PLED® Optical Module - 1050mA	14,299 – 15,545	12,519 – 13,609	14,642 – 15,919	60,000+	-20°F	160	120 277	1.33 0.58
80	LED	80 PLED® Optical Module - 350mA	10,003 – 11,158	8,758 – 9,769	10,243 – 11,426	60,000+	-20°F	87	120 277	0.75 0.33
80	LED	80 PLED® Optical Module - 525mA	14,093 – 15,720	12,338 – 13,763	14,431 – 16,098	60,000+	-20°F	131	120 277	1.10 0.48
80	LED	80 PLED® Optical Module - 700mA	17,644 – 19,681	15,447 – 17,230	18,067 – 20,155	60,000+	-20°F	174	120 277	1.45 0.63
80	LED	80 PLED® Optical Module - 1050mA	23,188 – 25,864	20,301 – 22,644	23,745 – 26,448	60,000+	-20°F	266	120 277	2.22 0.96
120	LED	120 PLED® Optical Module - 350mA	15,005 – 16,931	13,137 – 14,823	15,365 – 17,339	60,000+	-20°F	127	120 277	1.06 0.46
120	LED	120 PLED® Optical Module - 525mA	21,140 – 23,750	18,508 – 20,793	21,647 – 24,322	60,000+	-20°F	195	120 277	1.63 0.70
120	LED	120 PLED® Optical Module - 700mA	26,466 – 30,399	23,171 – 26,614	27,101 – 31,131	60,000+	-20°F	260	120 277	2.17 0.94
120	LED	120 PLED® Optical Module - 1050mA	34,782 – 38,790	30,452 – 33,961	35,617 – 39,725	60,000+	-20°F	396	120 277	3.33 1.43

NOTES:

1. Max Input Amps is the highest of starting, operating, or open circuit currents
2. Lumen values for LED Modules vary according to the distribution type
3. System Watts includes the source watts and all driver components.
4. Fuse value should be sufficient to protect all wiring components. For electronic driver and LED component protection, use 10KV – 20KV surge suppressors.
5. L70(10K) – TM-21 6x rule applied

WARNING: All fixtures must be installed in accordance with local codes or the National Electrical Code. Failure to do so may result in serious personal injury.

660 West Avenue O, Palmdale, CA 93551
Phone (661) 233-2000 Fax (661) 233-2001
www.usaltg.com

Razar LED Generation

The Ultimate in LED Site Illumination

LED PRODUCT

MADE IN THE USA

Patents Pending

U.S. ARCHITECTURAL LIGHTING

Family of Products

Ultimate Application Flexibility

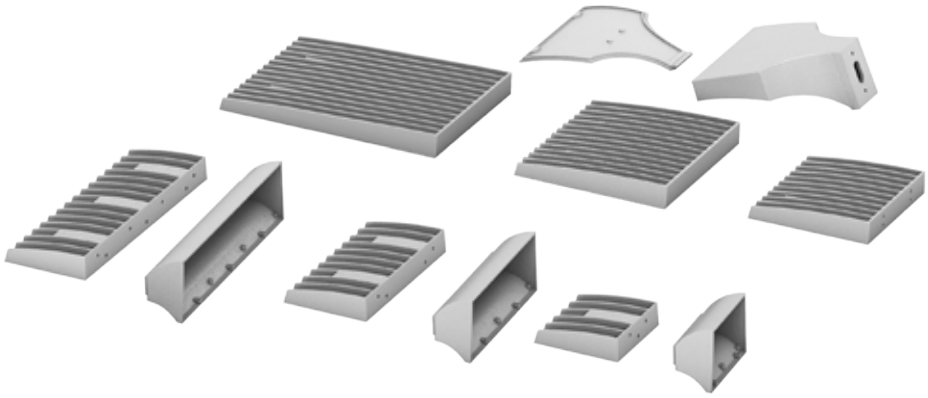
The era of LED's is upon us. This technology has impressed itself on the field of lighting and changed it in ways never before seen. The time is now for a new generation of luminaires that leverage the power and flexibility, the precision and longevity LED's bring to the world of illumination.

The time is now for the Razar LED Generation.

Until now, LED luminaires were created in a vacuum, a roadway fixture here, a wall mount luminaire there. The Razar LED Generation satisfies all these applications with a single, cohesive language of design that unifies the aesthetic of site/area, wall mount, and low level illumination while maintaining architectural harmony.

The optical components are consistent throughout all luminaires that make up the Razar LED Generation as well as their capabilities - field rotatability and replacement, the range of drive currents, dimming, the list goes on.

The Razar LED Generation - Your choice for LED illumination as it should be done.



Heavy Duty Cast Components

The Razar optical housings and arm/electrical compartment components are all constructed of durable corrosion resistant precise low copper aluminum castings with ¼" minimum wall thickness. Prior to finishing, all castings are sand blasted to create a uniform and clean surface for paint adhesion.

Razar LED
Site/Area

Razar LED represents the fullest complement of form and technology in LED illumination. Robust **cast aluminum** housings stand up to all outdoor conditions while creating a form that is both elegant and reflective of its technological core.

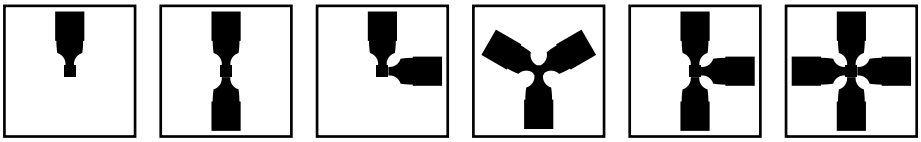
Three housing sizes allow for the selection of the most properly scaled luminaire body so that at the selected mounting height the overall assembly looks balanced and harmonious with the architectural context.

Optically Razar LED allows for the ideal **selection of LED count, color temperature, and drive current** to provide pleasing illumination levels and complementary illumination of the visual terrain. Controlled optics also eliminate uplight (light pollution) and minimize spill light (light trespass) with a **wide variety of distribution patterns that include house side shielding** to suit the requirements of the site.

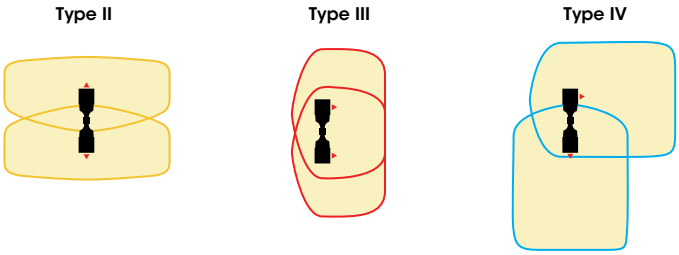
All told it would be difficult to find any luminaire family better suited to fulfill the task of LED illumination other than **Razar LED by U.S. Architectural Lighting**.

Site Adaptive Pole Mounting Configurations and Field Rotatable Optics

The ability to rotate asymmetric optical patterns by 90° increments combines with a wide variety of luminaire mounting configurations to allow complete illumination coverage of any site configuration.



Examples of the flexibility of distribution coverage from twin mount luminaires @ 180°:



Very Low Profile

Complements Today's Architecture
Razar was specifically designed to be an eclectic form, a current trend in contemporary architectural design.

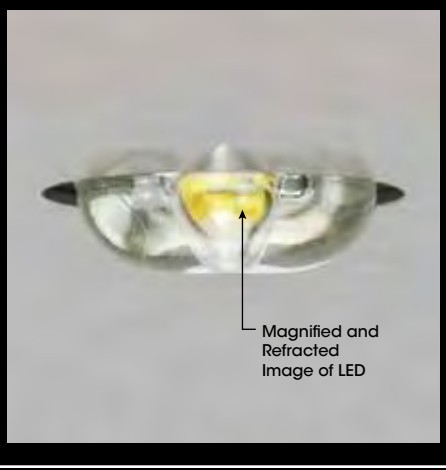
Less Visual Conflict with Background Architecture
With the optical housing only 2.5" deep, Razar disappears into the background.

Low EPA The shallow profile results in an E.P.A. of .64 for the larger luminaire. This allows the use of lighter and less expensive poles.

Ultra High Performance Optics Developed by U.S. Architectural

No Upward Light

All *P*LED™ Modules are rotatable in 90° increments in the field.



Two LED Sizes:

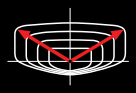
7" Square, 20LED Module The larger Razar LED models (RZR & RZR-G), Wall Mounts and Bollards, utilize the 7" module with 20 LED's.

80LED Module

5" Square, 12LED Module The smaller Razar LED model (RZRM) utilizes a 5" module with 12 LED's.

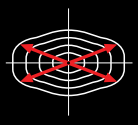
48LED Module

Available Light Distributions

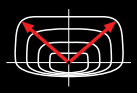


Type II*

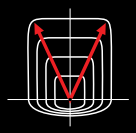
Type II FR*



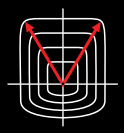
Type II ML



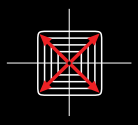
Type III*



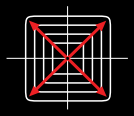
Type IV*



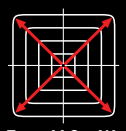
Type IV FT*



Type V Sq. N



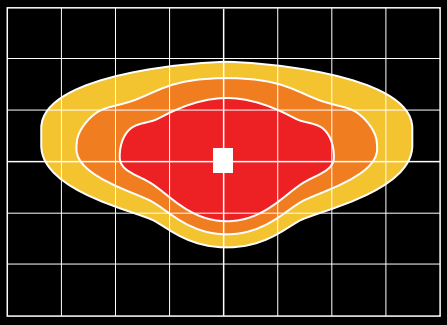
Type V Sq. M



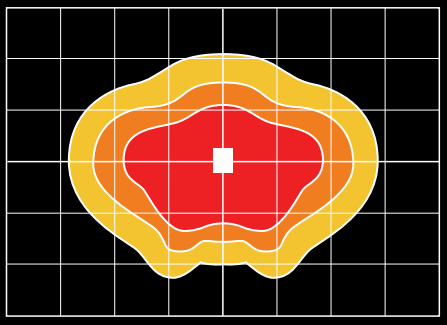
Type V Sq. W

*Asymmetric optics field rotatable in 90° increments.

Razar 175W. LED Package equals 400W Metal Halide with Better Uniformity.



175W. Razar LED



400W Metal Halide

.2 - .5Fc .5 - 1Fc 1Fc and above

9 LED Distributions
Aside from standard IES distribution Types II, III, IV, and VSQ, Razar LED optics include application specific patterns.

For auto dealerships, highlighting the front row of cars in the sales lot is enhanced by the new Type II-FR which concentrates its pattern along a wide band with a narrow forward throw. This makes the front row of cars stand out and draw attention while the color spectrum of LED illumination makes all the nuances in the automotive design shine. Additionally, the new Type VSQ-N heightens the intensity of illumination within the confines of the dealership, not wasting illumination outside the sales area.

Also new is the Razar LED Type II-ML median illuminator which combines the virtues of back-to-back Type II distributions in a single luminaire. Illuminating narrow median strips and roadways has never been made easier.

All modules are field replaceable.

LED Drivers

Drivers are mounted flush against the electrical compartment housing for maximum heat dissipation and held in place by a quick-release slip-bracket for ease of servicing.

Terminal Block

Optional - for use with street lighting projects or as required

Photocell Receptacle

Optional - For individual control of luminaire operation as daylight illumination fades.

Occupancy Sensor

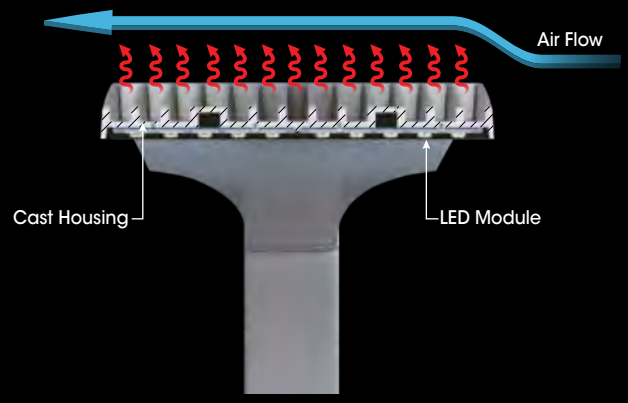
Optional - Location of motion sensor to control the level of the luminaire based on activity within the range the selected sensor.

Surge Protection

Today's energy efficient products rely heavily on electronic circuitry that requires far less power than was used in the past. The sophistication of these components comes with the challenge of being far more sensitive to power fluctuations than legacy products using transformers or core and winding inductors. Fusing offers a measure of protection to wiring, but fuses react too slowly to properly protect electronic HID ballasts and LED drivers.

Surge protectors react quickly to power spikes, absorbing or completely shunting them away from luminaire components. However, unlike fuses, surge protectors are a perishable item. They are rated according to the number and intensity of spike and surges and when that combination of frequency and intensity are reached, they no longer function to protect components down line and must be replaced. Thus, installing surge protectors in easily accessible locations for future maintenance is the prudent course.

U.S. Architectural Lighting supplies a surge protectors with every Razar LED luminaire to insure long term performance.

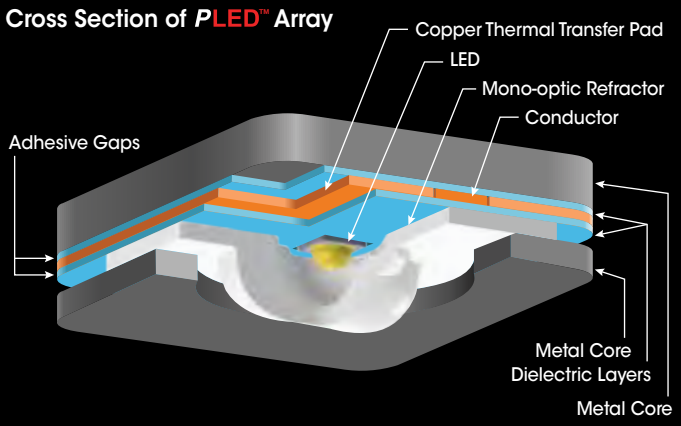


Outstanding Thermal Management

Razar uses U.S. Architectural's new ***P*LED**™ Array which consists of emitters (LED's) distributed across a metal core PCB individually sealed within an injection molded acrylic refractor and sandwiched between a thermally conductive dielectric designed to transfer heat to both the front and back surfaces of the PCB array.

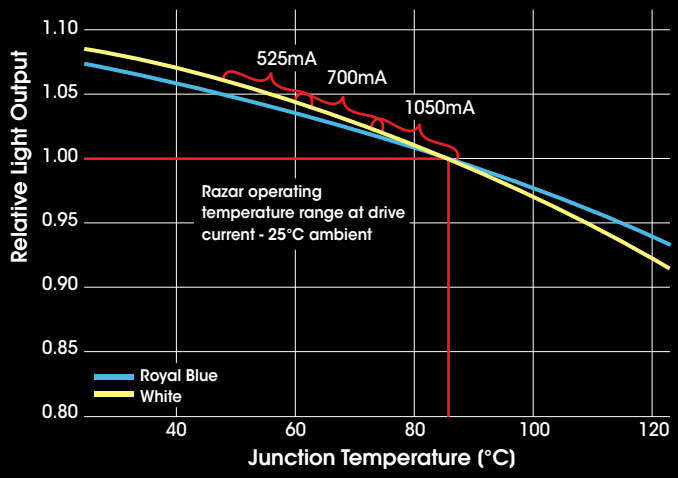
The back of the ***P*LED**™ Array PCB mounts directly to the luminaire housing which has been milled to a flatness of <.003" in 12" for complete surface contact and maximum thermal conductivity. The illuminating side of the ***P*LED**™ Array has a generous surface area that further draws heat from the emitters, convecting that heat to the atmosphere, and lowering the component junction temperatures to maximize lumen output and overall system efficacy.

Cross Section of *P*LED™ Array



Illuminating Surface View

Lumen Output of Lumileds Luxeon "T" - T_j test = 85°C



Drive current and system operating temperatures greatly impact LED life and lumen output. A lower drive current lowers the operating temperature thereby extending the life of the LED, in most cases by tens of thousands of hours. Lower drive currents and lower temperatures also increase the efficacy of the LED improving overall system efficiency.

LED Life Expectancy

Using current industry guidelines (TM21), LED life can only be estimated up to 6x the actual tested time on the component. Most LED's have been tested for @ 10,000 actual hours, thus most manufacturers show a minimum of 60,000hrs of expected life.

All elements in the design and construction of Razar LED are geared to minimize heat and improve luminaire performance. The combination of robust heat-sinking technology and lower drive currents result in L70 LED life expectancies well in excess of 100,000 hours.

No. of LEDs	Drive Current	System Watts	HID Equivalent	Approx. Average Lumens - 4000K
24	525mA	41	70 - 100	4579
	700mA	53	100	5734
	1050mA	80	150 - 175	7499
40	525mA	65	100 - 150	7583
	700mA	86	175	9494
	1050mA	133	200 - 250	12478
48	525mA	81	150 - 175	9158
	700mA	105	200	11457
	1050mA	160	250 - 320	14998
80	525mA	131	200 - 250	15167
	700mA	173	400	18999
	1050mA	266	575	24955
120	525mA	196	450	22750
	700mA	260	575 - 750	28493
	1050mA	399	750 - 1000	37433

Specifications - Razar LED Site/Area

Optical Housing - Heavy cast low copper aluminum (A356 alloy; <0.2% copper, minimum wall thickness .188") assembly with integral cooling fins. The Optical Panel mounting surface is milled flat (surface variance <± .003") to facilitate thermal transfer of heat to housing and cooling fins. Solid barrier wall separates optical and electrical compartments. The optical and electrical compartments are integrated to create one assembly.

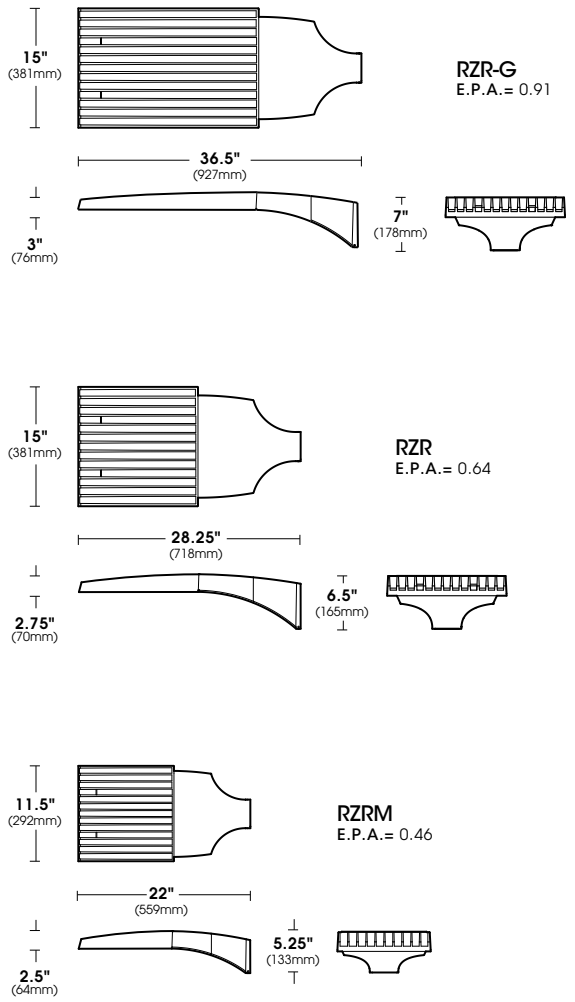
Electrical Housing w/Integrated Arm - Heavy cast low copper aluminum (A356 alloy; <0.2% copper, minimum wall thickness .188") assembly with integral cooling ribs surrounding the electrical compartment and a flat surface on the top of the arm to accommodate a photocell receptacle. Solid barrier wall separates optical and electrical compartments. The optical compartment and electrical compartment with the integrated support arm combine to create one assembly. Cast and hinged driver assembly cover is integrated with wiring compartment cover.

PLED™ Optical Modules – Emitters (LED's) are arrayed on a metal core PCB panel with each emitter located on a copper thermal transfer pad and enclosed by an LED refractor. In asymmetric distributions, a micro-reflector inside the refractor re-directs the house side emitter output towards the street side and functions as a house side shielding element. Refractors are injection molded H12 acrylic. Each LED refractor is sealed to the PCB over an emitter and all refractors are retained by an aluminum frame. Any one Panel, or group of Panels in a luminaire, have the same optical pattern. LED refractors produce a variety of site/area distributions. Panels are field replaceable and field rotatable in 90° increments.

LED Driver(s) – Constant current electronic with a power factor of >.90 and a minimum operating temperature of -22°F. Driver(s) is/are UL and cUL recognized and mounted directly against the Electrical Housing to facilitate thermal transfer, held down by universal clamps to facilitate easy removal. In-line terminal blocks facilitate wiring between the driver and optical arrays. Drivers accept an input of 120-277V, 50/60Hz. (0 - 10V dimmable driver is standard. Driver has a minimum of 3KV internal surge protection.)

Finish - Electrostatically applied TGIC Polyester Powder Coat on substrate prepared with 20 PSI power wash at 140°F. Four step media blast and iron phosphate pretreatment for protection and paint adhesion. 400°F bake for maximum hardness and durability. Texture finish is standard.

Dimensions

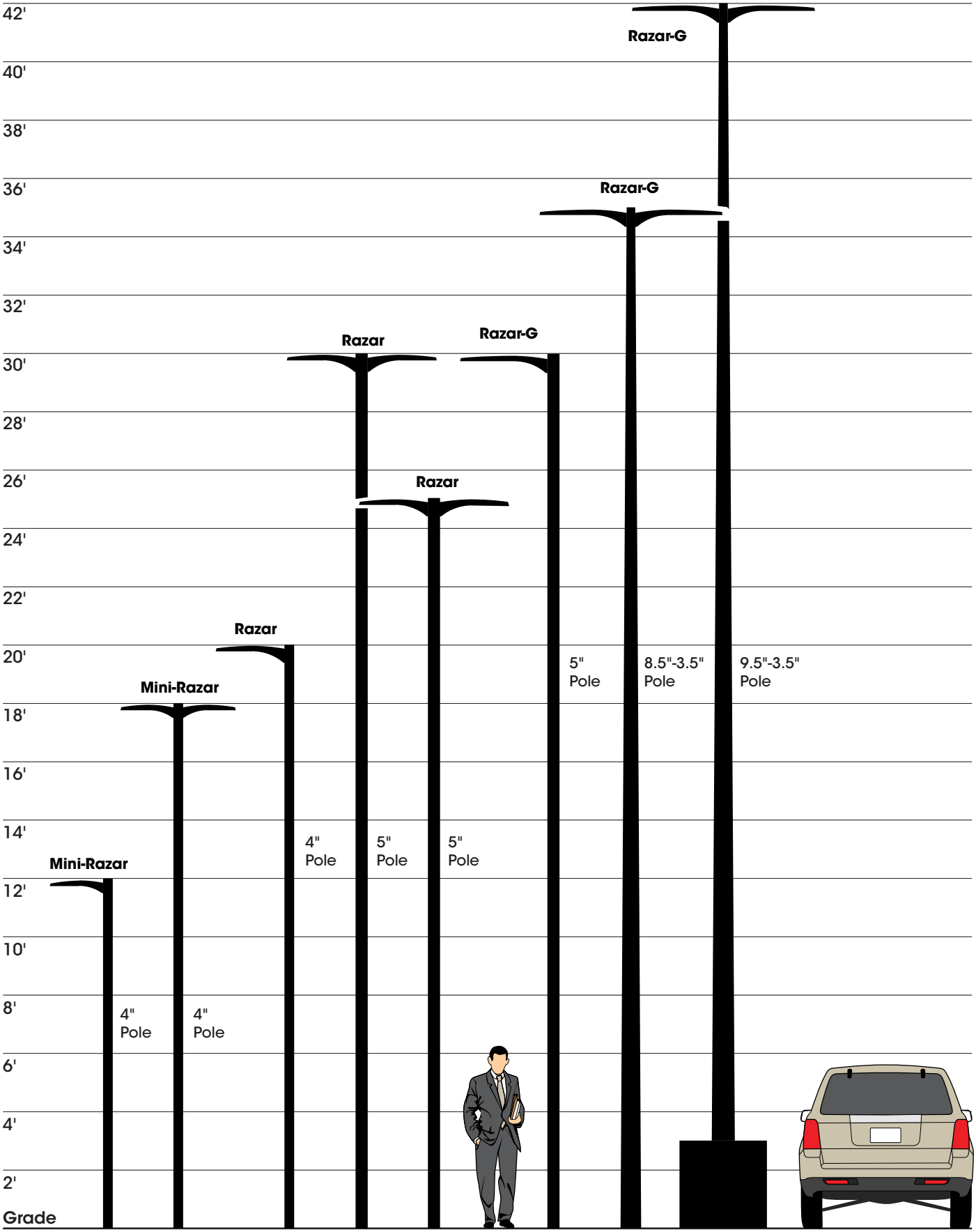


Scale: 1/2" = 1'-0"

Spec/Order Example: RZR/PLED-IV/80LED-700mA/CW/277/RAL-8019-S

MODEL	OPTICS	LED MODE			VOLTAGE	FINISH	OPTIONS
		NO. LEDs	DRIVE CURRENT	COLOR TEMP - CCT			
☐ RZR-G	☐ TYPE II **PLED-II**	**RZR-G** ☐ 120LED ☐ 80LED	☐ 350mA ☐ 525mA ☐ 700mA ☐ 1050mA	☐ NW (4000K)* *STANDARD ☐ CW (5000K) ☐ WW (3000K) CONSULT FACTORY FOR OTHER LED COLORS	☐ 120 ☐ 208 ☐ 240 ☐ 277 ☐ 347 ☐ 480	STANDARD TEXTURED FINISH ☐ BLACK **RAL-9005-T** ☐ WHITE **RAL-9003-T** ☐ GREY **RAL-7004-T** ☐ DARK BRONZE **RAL-8019-T** ☐ GREEN **RAL-6005-T** FOR SMOOTH FINISH REPLACE SUFFIX "T" WITH SUFFIX "S" (EXAMPLE: RAL-9005-S) CONSULT FACTORY FOR CUSTOM COLORS	☐ HIGH-LOW DIMMING FOR EXTERNAL CONTROL . . **HLSW** ☐ HOUSE SIDE SHIELDING . . . . . **HS-PLED** ☐ PHOTO CELL + VOLTAGE (EXAMPLE: PC120V) **PC+V** ☐ TWIST LOCK PHOTO CELL + VOLTAGE (EXAMPLE: PC120V) . . **TPC+V** ☐ TWIST LOCK RECEPTACLE ONLY . . . . . **TPR** ☐ SINGLE FUSE (120V & 277V) . . . . . **SF** ☐ DOUBLE FUSE (208V & 240V) . . . . . **DF**
☐ RZR	☐ TYPE II FRONT ROW **PLED-II-FR** ☐ TYPE II MEDIAN ILLUMINATOR **PLED-II-ML** ☐ TYPE III **PLED-III** ☐ TYPE IV **PLED-IV**	**RZR** ☐ 80LED ☐ 40LED					
☐ RZRM	☐ TYPE IV **PLED-IV-FT** ☐ TYPE V NARROW **PLED-VSQ-N** ☐ TYPE V **PLED-VSQ-M** ☐ TYPE V **PLED-VSQ-W**	**RZRM** ☐ 48LED ☐ 24LED					

Proportion Visualizer



Razar LED Wall Mount
Wall Mounted

The **Razar LED Wall Mount** extends the family of **Razar LED** luminaires to be application specific. U.S. Architectural Lighting designed and engineered the Razar electrical compartment for specific wall mounting adds elegance and architectural relevance to the **Razar LED** luminaire.

The **Razar LED Wall Mount** electrical housing appears to organically reach out from the mounting surface to capture the optical assembly and create the impression of a luminaire that is a natural extension of the building structure.

As light level requirements increase, **Razar LED Wall Mount** extends laterally to include one, two or three optical modules and can be selected with 4 standard drive currents. The result is a luminaire that can equal the task requirements from a 35W PSMH lamp up to a 400W PSMH lamp while extending only 12" from the wall (14" for EM applicaton), retaining the aesthetic focus on the architecture rather than the luminaire. All the while creating a continuity of design in all the elements illuminating the site

Razar LED Wall Mount is ideal whether lighting intimate use locations that have security concerns like an ATM station or providing pathway illumination around campus and retail sites where poles would congest the visual environment. In its largest and highest output form, **Razar LED Wall Mount** with its multiple distributions is more than up to the task of lighting high traffic areas like truck aprons and loading docks that require access by large truck and trailers where poles would interfere and site requirements need maximum optical flexibility.

RZR-WM1

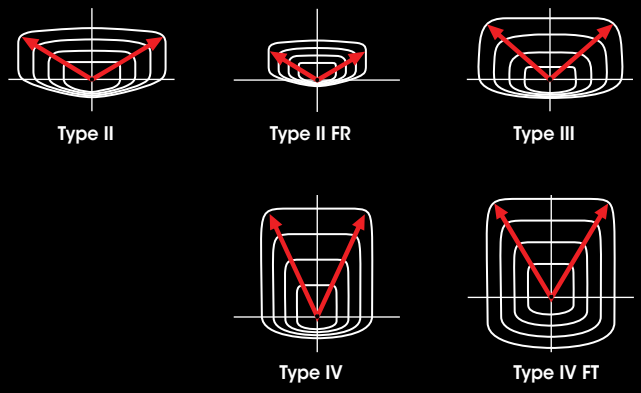
RZR-WM2

RZR-WM3

Available Light Distributions

Five different asymmetric patterns make the Razar LED Wall Mount a powerful tool for lighting acreage around the building structure. Rotatable optics add to that flexibility and allow unique conditions to be lit with ease.

Additionally, optional **house side shielding** reduces the intensity of backlight on the building surface and a 5° front shield reduce high angle brightness visible off site.

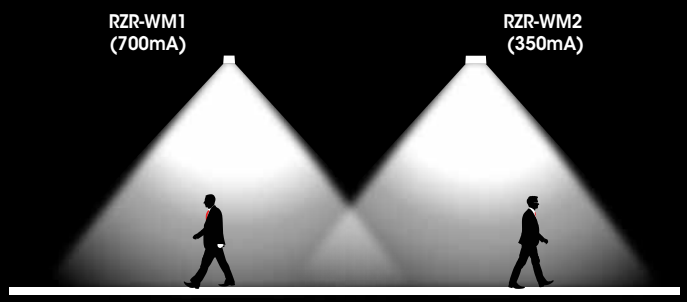


Visual Efficacy

Razar LED Wall Mount also has the same lumen packages available across multiple housing sizes. This feature puts the specifier in control of the visual efficacy (brightness + glare).

Consider: An RZR-WM1 specified with a 700mA drive current will have the same lumen output an RZR-WM2 with a 350mA drive current. Similarly, an RZR-WM1 at 1050mA has the same lumen output as an RZR-WM3 at 350mA.

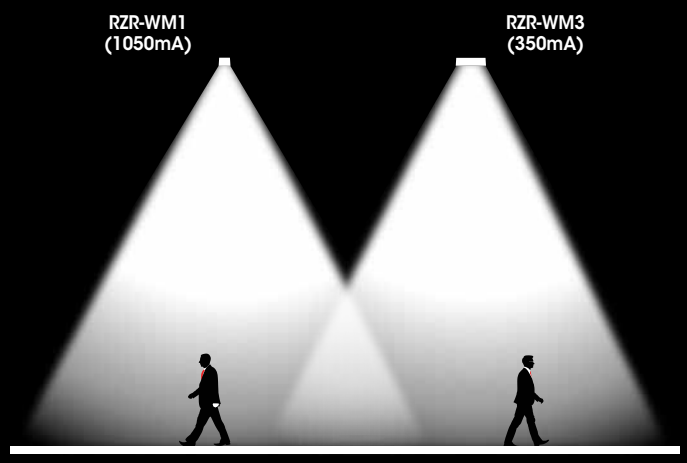
By selecting the smaller luminaire with the lower LED count and higher drive current, costs are kept at a minimum. Selecting the RZR-WM2 or RZR-WM3 in the foregoing example however, will considerably reduces the perceived brightness of the optical system by "spreading" the lumens over a greater number of LED's.



Less Glare. Looking directly at a clear, lit PSMH lamp can be uncomfortable due to its brightness and the resultant glare.

Looking at a coated, lit PSMH lamp, while still bright, is much more comfortable as the lumens are spread over the entire surface of the bulb

In a similar manner, "spreading" the lumen output over a greater number of LED's mitigates fixture brightness .



Additional Options

When using the EM-LED option, the **Razar LED Wall Mount** electrical compartment is extended an additional 2" to allow room for the emergency driver and batteries to be contained within the fixture. The EM-LED system provides power to the LED array to meet the following light levels for a minimum of 90 minutes -

WM1 = 45% @ 350mA
WM2 = 36% @ 350mA
WM3 = 24% @ 350mA

*Multiply the % above by the lumen output @ 350mA

Some building applications require the use of surface conduit. In these applications, the electrical compartment extension is provided with provisions for one ¾" conduit entry on either side of the housing and one entry on the bottom. Specify a SC-RZWM.

Emergency Option

Surface Conduit

Specifications - Razar LED Wall Mounted

Optical Housing - Heavy cast low copper aluminum (A356 alloy; <0.2% copper) assembly with integral cooling fins. The Optical Panel mounting surface is milled flat (surface variance <± .003") to facilitate thermal transfer of heat to housing and cooling fins. The Optical Housing bolts to the Electrical Housing forming a unified assembly. The minimum wall thickness is .188".

Electrical Housing - Heavy cast low copper aluminum (A356 alloy; <0.2% copper) assembly. Minimum wall thickness is .188". Fixture Mounting Plate affixes to mounting surface over a recessed j-box. Electrical Housing anchors on the top edge of the Mounting Plate and stainless steel recessed socket head screws tighten the Electrical Housing to the Mounting Plate from the bottom.

PLED™ Optical Modules - Emitters (LED's) are arrayed on a metal core PCB panel with each emitter located on a copper thermal transfer pad and enclosed by an LED refractor. The asymmetric distributions, have a micro-reflector inside the refractor which re-directs the house side emitter output towards the street side and functions as a house side shielding element. Refractors are injection molded H12 acrylic. Each LED refractor is sealed to the PCB over an emitter and all refractors are retained by an aluminum frame. Any one Panel, or group of Panels in a luminaire, have the same optical pattern. LED refractors produce Type II, III, and Type IV site/area distributions as well as other specialty asymmetric distributions. Panels are field replaceable and field rotatable in 90° increments.

LED Driver(s) - Constant current electronic with a power factor of >.90 and a minimum operating temperature of -22°F. Driver(s) is/are UL and cUL recognized and mounted to a driver assembly plate that has slotted holes to facilitate ease of assembly removal for fixture installation. Quick disconnects for incoming power and optical assembly power are provided. Drivers accept an input of 120-277V, 50/60Hz and utilize 0-10V dimming. 347V-480V, 50,60Hz also available on some models. Surge protector supplied for field installation at the most conveniently serviceable location.

LED Emitters - High output LED's are utilized with drive currents ranging from 350mA to 1050mA. 70CRI Minimum. LED's are available in standard Neutral White (4000K), or optional Cool White (5000K) or Warm White (3000K). Consult Factory for other LED options.

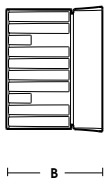
Finish - Electrostatically applied TGIC Polyester Powder Coat on substrate prepared with 20 PSI power wash at 140°F. Four step media blast and iron phosphate pretreatment for protection and paint adhesion. 400°F bake for maximum hardness and durability.

Dimensions

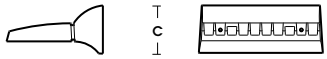
Refer to the Razar LED Wall Mount spec sheet for mounting information.

	A	B	C
RZRW1	8.75" (22mm)	12" (305mm)	6" (152mm)
RZRW1-EM	11" (279mm)	14" (356mm)	6.5" (165mm)

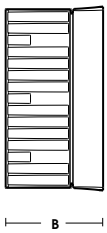
RZR-WM1-LED
E.P.A.= .33



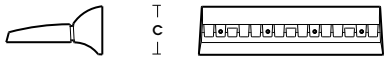
	A	B	C
RZRW2	16" (406mm)	12" (305mm)	6" (152mm)
RZRW2-EM	16" (406mm)	14" (356mm)	6.5" (165mm)



RZR-WM2-LED
E.P.A.= .47



	A	B	C
RZRW3	23" (584mm)	12" (305mm)	6" (152mm)
RZRW3-EM	23" (584mm)	14" (356mm)	6.5" (165mm)



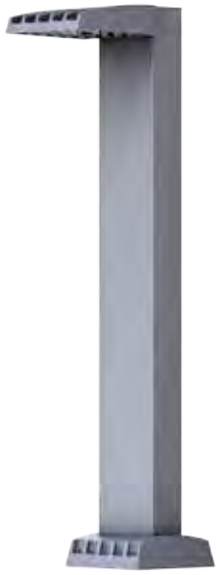
RZR-WM3-LED
E.P.A.= .69

Spec/Order Example: RZR-WM2/PLED-IV/40LED-700mA/CW/277/RAL-8019-S/SF

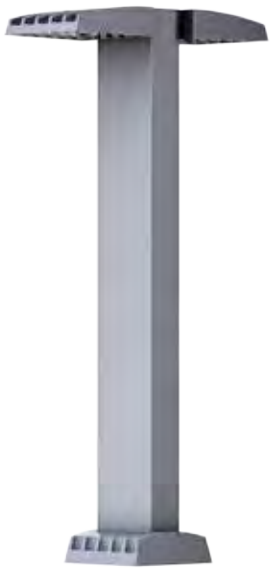
Scale: 1/2" = 1'-0"

MODEL	OPTICS	LED MODE			VOLTAGE	FINISH	OPTIONS
	PLED® DISTRIBUTION TYPE	NO. LEDs	DRIVE CURRENT	COLOR TEMP - CCT	VOLTAGE	STANDARD TEXTURED FINISH	
☐ RZR-WM1	☐ TYPE II **PLED-II**	RZR-WM1 ☐ **20LED**	☐ 350mA ☐ 525mA ☐ 700mA ☐ 1050mA	☐ NW (4000K)* *STANDARD ☐ CW (5000K) ☐ WW (3000K) CONSULT FACTORY FOR OTHER LED COLORS	☐ **120** ☐ **208** ☐ **240** ☐ **277** ☐ **347**[1] ☐ **480**[1] **NOTE:** 1 – NOT AVAILABLE IN RZR-WM1. CONSULT FACTORY	☐ BLACK **RAL-9005-T** ☐ WHITE **RAL-9003-T** ☐ GREY **RAL-7004-T** ☐ DARK BRONZE **RAL-8019-T** ☐ GREEN **RAL-6005-T** FOR SMOOTH FINISH REPLACE SUFFIX "T" WITH SUFFIX "S" (EXAMPLE: RAL-9005-S) CONSULT FACTORY FOR CUSTOM COLORS	☐ HIGH-LOW DIMMING FOR EXTERNAL CONTROL . . **HLSW** ☐ HOUSE SIDE SHIELDING . . . . . **HS-PLED** ☐ PHOTO CELL + VOLTAGE (EXAMPLE: PC120V) . . . **PC+V** ☐ SINGLE FUSE (120V & 277V) . . . . . **SF** ☐ DOUBLE FUSE (208V & 240V) . . . . . **DF** ☐ EMERGENCY BACKUP 1. . **EM1** ☐ EMERGENCY BACKUP 1 (HOUSING ONLY) . . . . . **EMH1** ☐ EMERGENCY BACKUP 2. . **EM2** ☐ EMERGENCY BACKUP 2 (HOUSING ONLY) . . . . . **EMH2** ☐ EMERGENCY BACKUP 3. . **EM3** ☐ EMERGENCY BACKUP 3 (HOUSING ONLY) . . . . . **EMH3** ☐ SURFACE CONDUIT 1. . . **SC1** ☐ SURFACE CONDUIT 2. . . **SC2** ☐ SURFACE CONDUIT 3. . . **SC3**
☐ RZR-WM2	☐ TYPE II FRONT ROW **PLED-II-FR**	RZR-WM2 ☐ **40LED**					
☐ RZRM-WM3	☐ TYPE III **PLED-III**	RZR-WM3 ☐ **60LED**					
	☐ TYPE IV **PLED-IV**						
	☐ TYPE IV-FT **PLED-IV-FT**						

Razar LED Bollard
Bollard



RZRB1



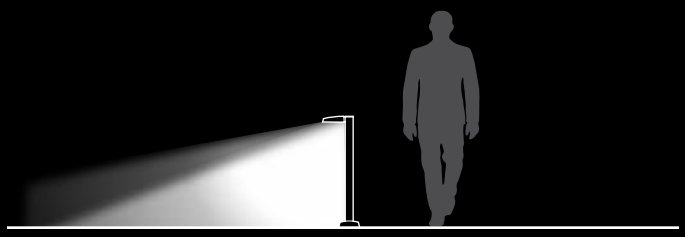
RZRB2

The shape of the Razar LED Bollard immediately identifies the direction of its illumination pattern. A wide variety of asymmetric distributions allows tailoring the lighting distribution for any site requirements and for illuminating narrow walkways or wide, open plaza spaces.

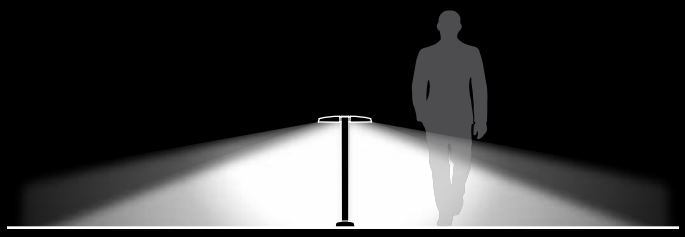
The robust construction of the Razar LED Bollard imparts durability in any application and addresses the heat dissipation needs of its LED source. Thermal efficiency and relatively low drive currents keep the LED module temperatures well below normal LED design parameters. In fact, the Razar LED Bollard housing will heat up more on a summer's day from sunlight radiation than at night from the LED's.

Available in single and twin head configurations, when matched with the various distributions, the solutions presented will satisfy every pathway illumination need. To illustrate the unique capabilities of the Razar LED Bollard, look at the RZRB2. Illumination on one side from a Type II distribution can light a walkway and on the other side, a Type IV distribution can extend the pattern out from the edge of the pathway to illuminate a large landscaped area thereby providing additional nighttime security.

Illumination Characteristics



The RZRB1 model produces an asymmetric light distribution which is clearly expressed by its form. It is ideal for pathways and driveways where illumination is desired from the perimeters. These bollards define visual direction and boundaries for both people and vehicles. The light source, whether LED, HID or compact fluorescent, is concealed from any view above horizontal.



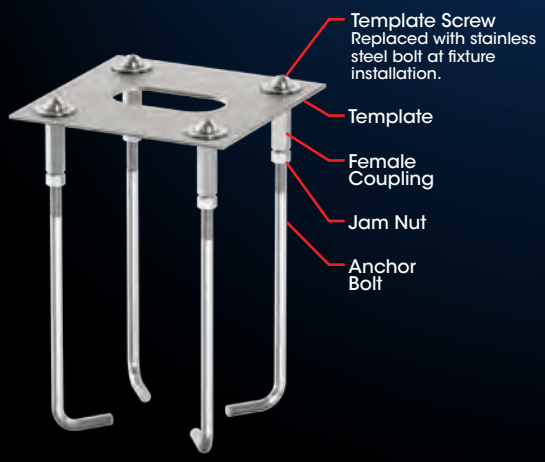
The RZRB2 model is a direct companion to the RZRB1, as both models are typically used on the same project. The RZRB2 produces a symmetric light pattern for open areas where illumination is required on all sides of the bollard. Even when located along pathways, the RZRB2 can illuminate both hardscape on one side, and landscape on the opposite side.

Heat Management

Low drive currents combined with superior heat conduction technology keeps the LED internals at half their rated maximum operating temperature. Generous and robust cooling fins provide a distinctive appearance to the **Razar LED Bollard** and also keep surface temperatures low enough to touch even after hours of operation.

Optical Module

Razar LED Bollard is engineered to use the same PLED optical modules as the Razar LED pole mounted luminaire with all its high performance optics. Five asymmetric distributions provide ultimate flexibility in application to satisfy the needs of any site.



Anchor Bolt Assembly

Anchor bolts, couplers, and template are shipped as an assembly. Place the assembly in concrete and once set, remove the screws holding down the template. The **Razar LED Bollard** base will then bolt down to the couplers.

Riser

The heavy-walled durable extruded aluminum riser is the ideal platform for the optical assemblies. Its robust constructon will reliably withstand the rigors of pathway lighting.

Base and Base Cover

As the foundation for the entire assembly, the base of the **Razar LED Bollard** again shows thoroughness in design and engineering. The cover is cast as a single piece and installed during the assembly of the fixture to insure a clean, seamless appearance and is locked to the base with stainless steel socket headed cap screws. The design-coordinated base cover hides the ingenious anchor assembly that utilizes bolts threaded into female couplers poured into the concrete base. There's no guessing about bolt projections. (See the Anchor Bolt Assembly)

Specifications - Razar LED Bollards

Optical Housing - Heavy cast low copper aluminum (A356 alloy; <0.2% copper) assembly with integral cooling fins. The Optical Panel mounting surface is milled flat (surface variance <± .003") to facilitate thermal transfer of heat to housing and cooling fins. Minimum wall thickness is .188".

Shaft & Base - Extruded aluminum (6061-T6 alloy) riser welded to heavy cast aluminum (A356 alloy; <0.2% copper) base. Riser has minimum wall thickness of .188". Electrical assembly including LED mains driver, LED Emergency driver (optional LED-EM) with batteries, and quick connectors suspended inside riser. Concealed bolts attach the Optical Housing bolts to Riser.

Anchor Bolts - Four 3/8" x 10" x 2" galvanized anchor bolts with couplings, leveling nuts, washers, template, and stainless bolts.

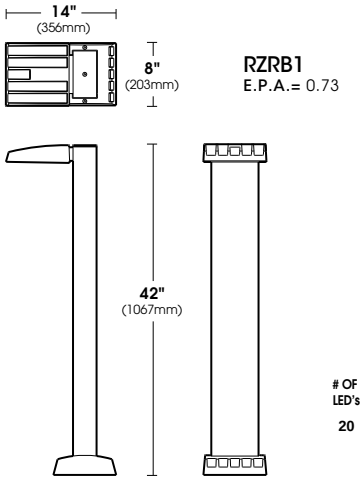
PLED™ Optical Modules - Emitters (LED's) are arrayed on a metal core PCB panel with each emitter located on a copper thermal transfer pad and enclosed by an LED refractor. The asymmetric distributions have a micro-reflector inside the refractor that re-directs the house side emitter output towards the street side and functions as a house side shielding element. Refractors are injection molded H12 acrylic. Each LED refractor is sealed to the PCB over an emitter and all refractors are retained by an aluminum frame. All refractors in a Panel have the same optical pattern. LED refractors produce standard site/area distributions – Type II, and Type IV. Panels are field replaceable and field rotatable in 90° increments.

LED Driver(s) - Constant current electronic with a power factor of >.90 and a minimum operating temperature of -22°F. Driver is UL and cUL recognized and mounted to a retaining bracket suspended inside the Riser. In-line terminal blocks facilitate wiring between the driver and optical arrays. Drivers accept an input of 120-277V, 50/60Hz or 347V-480V, 50,60Hz. Optional Emergency LED driver and batteries provide 16w for 90 minutes through the main LED array. 20KV surge protector suitable for field installation provided. (0 - 10Vdimmable driver is standard except for RZRB1 @ 175mA)

LED Emitters - High output LED's are utilized with drive currents ranging from 175mA to 350mA. 70CRI Minimum. LED's are available in standard Neutral White (4000K), or optional Cool White (5000K) or Warm White (3000K). Consult Factory for other LED options.

Finish - Electrostatically applied TGIC Polyester Powder Coat on substrate prepared with 20 PSI power wash at 140°F. Four step media blast and iron phosphate pretreatment for protection and paint adhesion. 400°F bake for maximum hardness and durability.

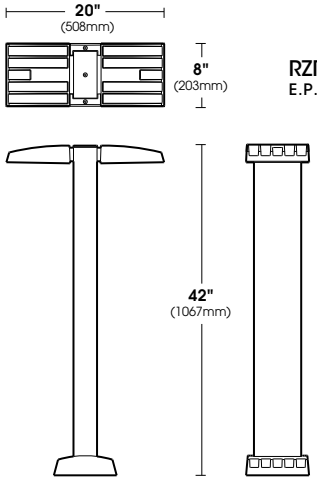
Dimensions



RZRB1
E.P.A.= 0.73

MAX INPUT WATTAGE

# OF LED's	DRIVE CURRENT 175mA	HID EQUIV	350mA	HID EQUIV
20	12W	50W	22W	70W



RZRB2
E.P.A.= 0.81

MAX INPUT WATTAGE

# OF LED's	DRIVE CURRENT 175mA	HID EQUIV	350mA	HID EQUIV
40	22W	50W	44W	70W

Scale: 1/2" = 1'-0"

Spec/Order Example: RZRB2/PLED-II/40PLED-175mA/NW/277/RAL-9005-T

MODEL	OPTICS	LED MODE			VOLTAGE	FINISH	OPTIONS
	PLED® DISTRIBUTION TYPE	NO. LEDs	DRIVE CURRENT	COLOR TEMP - CCT	VOLTAGE	STANDARD TEXTURED FINISH	
☐ RZRB1	☐ TYPE II **PLED-II**	RZRB1[1] ☐ 20LED	☐ 175mA[1]	☐ NW (4000K)* *STANDARD	☐ 120	☐ BLACK **RAL-9005-T**	☐ HOUSE SIDE SHIELDING . . . . . **HS-PLED**
	☐ TYPE II FRONT ROW **PLED-II-FR**		☐ 350mA	☐ CW (5000K)	☐ 208	☐ WHITE **RAL-9003-T**	☐ HIGH-LOW DIMMING FOR HARDWIRED SWITCHING OR NON-INTEGRATED MOTION SENSOR . . . . . **HLSW**
☐ RZRB2	☐ TYPE III **PLED-III**	RZRB2 ☐ 40LED		☐ WW (3000K)	☐ 240	☐ GREY **RAL-7004-T**	☐ SINGLE FUSE (120V & 277V). . . . . **SF**
	☐ TYPE IV **PLED-IV**			OTHER LED COLORS AVAILABLE CONSULT FACTORY	☐ 277	☐ DARK BRONZE **RAL-8019-T**	☐ DOUBLE FUSE (208V & 240V). . . . . **DF**
	☐ TYPE IV **PLED-IV-FT**				☐ 347	☐ GREEN **RAL-6005-T**	☐ EMERGENCY BACKUP1 . . **EM-RZRB1**
					☐ 480		☐ EMERGENCY BACKUP2 . . **EM-RZRB2**

NOTES:
1 – DIMMING NOT AVAILABLE IN RZRB1 AT 175mA DRIVE CURRENT.
2 – CONSULT FACTORY FOR 347V OR 480V OPERATION.

FOR SMOOTH FINISH REPLACE SUFFIX "T" WITH SUFFIX "S" (EXAMPLE: RAL-9005-S)

CONSULT FACTORY FOR CUSTOM COLORS

THE EM-LED SYSTEM PROVIDES POWER TO THE LED ARRAY TO MEET THE FOLLOWING LIGHT LEVELS FOR A MINIMUM OF 90 MINUTES:

RZRB1 = 90% @ 175mA
RZRB1 = 45% @ 350mA
RZRB2 = 50% @ 175mA
RZRB2 = 36% @ 350mA

*MULTIPLY THE % ABOVE BY THE LUMEN OUTPUT @ 350mA

Razar LED Generation

The Ultimate in LED Site Illumination

MADE IN THE USA

U.S. ARCHITECTURAL LIGHTING

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660 West Avenue O
Palmdale, California 93551
Toll Free (800) 877-6537
www.usaltg.com

Patents Pending

McGraw-Edison

DESCRIPTION

The Ventus™ LED area luminaire provides uncompromising optical performance and outstanding versatility for a wide variety of area and roadway applications. Patent pending modular LightBAR™ technology delivers uniform and energy conscious illumination to walkways, parking lots, roadways, building areas and any security lighting application. UL/cUL Listed for wet locations.

		Type
Catalog #		
Project		
Comments		Date
Prepared by		

SPECIFICATION FEATURES

Construction
Die-cast aluminum frame secures thermally conductive, extruded aluminum heat sink to independent electrical chamber. Heavy-wall, die-cast aluminum housing and door isolates driver components for cooler operation. The unique construction allows for passive cooling and natural cleaning of the extruded heat sink ensuring reliable operation at 40°C high ambient conditions. Stainless steel fasteners and hinging allow access to electrical components for installation and maintenance. Optional tool-less hardware available for ease of entry into electrical chamber.

Optics
Choice of twelve patented, high-efficiency AccuLED Optics™ distributions. Optics are precisely designed to shape the light output, maximizing efficiency and application spacing. AccuLED Optics technology creates consistent distributions with the scalability to meet customized application requirements. Offered Standard in 4000K (+/- 275K) CCT and minimum 70 CRI. Optional 3000K CCT, 5000K CCT and 5700K CCT. For the ultimate level of spill light control, an optional house-side shield accessory can be field or factory installed. The house-side shield is designed to seamlessly integrate with the SL2, SL3 or SL4 optics.

Electrical
LED drivers mount to die-cast aluminum back housing for optimal heat sinking, operation efficacy, and prolonged life. Standard drivers feature electronic universal voltage (120-277V 50/60Hz), 347V 60Hz or 480V 60Hz operation. 480V is compatible for use with 480V Wye systems only. Greater than 0.9 power factor, less than 20% harmonic distortion, and is suitable for operation in -40°C to 40°C ambient environments. All fixtures are shipped standard with 10kV/10kA common – and differential – mode surge protection. LightBARs feature an IP66 enclosure rating and maintain greater than 95% lumen maintenance at 60,000 hours per IESNA TM-21. Occupancy sensor and dimming options available.

Mounting
Cast aluminum 6" arm includes bolt guides allowing for easy positioning of fixture during installation to pole or wall surface. Standard single carton packaging of housing, square pole arm and round pole adapter for contractor friendly arrival of product on site. Optional internal mast arm mount accepts a 1-1/4" to 2" O.D. horizontal tenon, while a two-bolt clamping mechanism secures fixture. Cast-in leveling guides provide +/-5° vertical leveling adjustment. Tenon adapters available to slipfit over poles equipped with 2-3/8" or 3-1/2" O.D. tenon. 3G vibration rated.

Finish
Cast components and arm finished in super TGIC polyester powder coat paint, 2.5 mil nominal thickness for superior protection against fade and wear. Standard colors include black, bronze, grey, white, dark platinum and graphite metallic. RAL and custom color matches available. Consult the McGraw-Edison Architectural Colors brochure for the complete selection.

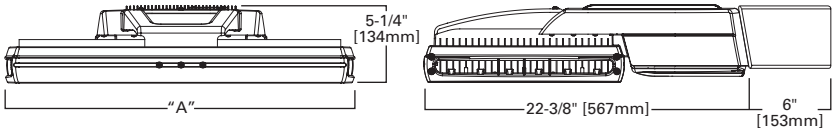
Warranty
Five-year warranty.

VTS
VENTUS LED

2 - 12 LightBARs
Solid State LED

AREA LUMINAIRE

DIMENSIONS



DIMENSIONAL DATA

Number of LightBars	"A" Width	Weight		EPA [Square Feet]	
		Without Arm	With Arm	Without Arm	With Arm
2-4	12-7/8" [328mm]	24 lbs. [10.91 kgs.]	29 lbs. [13.18 kgs.]	0.94	1.00
5-8	18" [458mm]	30 lbs. [13.64 kgs.]	35 lbs. [15.91 kgs.]	1.10	1.20
9-12	25-7/8" [658mm]	39 lbs. [17.73 kgs.]	44 lbs. [20.00 kgs.]	1.31	1.44

CERTIFICATION DATA
UL/cUL Listed
LM79 / LM80 Compliant
IP66 LightBARs
3G Vibration Rated
DesignLights Consortium™ Qualified*
ISO 9001

ENERGY DATA
Electronic LED Driver
>0.9 Power Factor
<20% Total Harmonic Distortion
120-277V/50Hz & 60Hz, 347V/60Hz, 480V/60Hz
-40°C Minimum Temperature
40°C Ambient Temperature Rating
50°C Ambient Temperature Rating (HA option)

SHIPPING DATA
Approximate Net Weight:
(See Tabulated Reference Data)

EATON
Powering Business Worldwide

*www.designlights.org

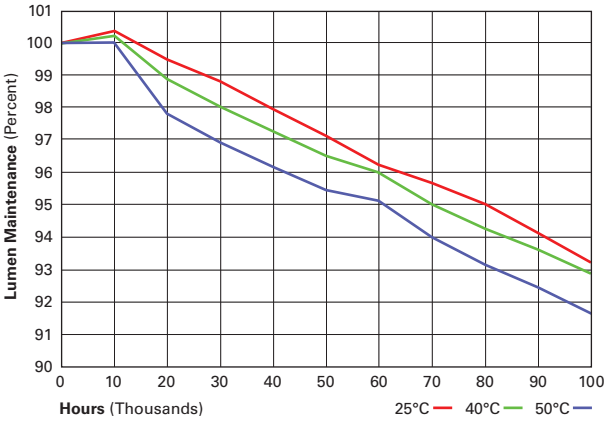
POWER AND LUMENS BY BAR COUNT (21 LED LIGHTBAR)

Number of LightBARs		E02	E03	E04	E05	E06	E07	E08	E09	E10	E11	E12
Drive Current		350mA Drive Current										
Power (Watts)		52W	75W	97W	127W	149W	173W	195W	226W	247W	270W	292W
Current @ 120V (A)		0.44	0.63	0.82	1.07	1.26	1.45	1.63	1.89	2.08	2.26	2.45
Current @ 277V (A)		0.20	0.28	0.36	0.48	0.56	0.64	0.71	0.84	0.92	0.99	1.07
Power (Watts)		58W	82W	99W	132W	159W	174W	196W	227W	247W	271W	293W
Current @ 347V (A)		0.19	0.28	0.29	0.39	0.48	0.56	0.57	0.68	0.76	0.85	0.86
Current @ 480V (A)		0.15	0.20	0.21	0.30	0.36	0.41	0.42	0.51	0.57	0.62	0.63
T2	Lumens	6,173	9,260	12,347	15,434	18,520	21,607	24,694	27,780	30,867	33,954	37,041
	BUG Rating	B2-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B3-U0-G3	B4-U0-G4	B4-U0-G4	B4-U0-G4	B4-U0-G4	B4-U0-G4	B4-U0-G4
T3	Lumens	6,117	9,175	12,233	15,292	18,350	21,409	24,467	27,525	30,584	33,642	36,700
	BUG Rating	B2-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B3-U0-G3	B4-U0-G4	B4-U0-G4	B4-U0-G4	B4-U0-G4	B4-U0-G4	B4-U0-G4
T4	Lumens	5,953	8,929	11,905	14,882	17,858	20,835	23,811	26,787	29,764	32,740	35,716
	BUG Rating	B1-U0-G2	B2-U0-G2	B2-U0-G2	B2-U0-G3	B3-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G4	B3-U0-G4	B3-U0-G5	B3-U0-G5
5MQ	Lumens	6,398	9,597	12,795	15,994	19,193	22,392	25,591	28,790	31,989	35,187	38,386
	BUG Rating	B3-U0-G1	B3-U0-G2	B4-U0-G2	B4-U0-G2	B4-U0-G2	B4-U0-G2	B5-U0-G3	B5-U0-G3	B5-U0-G3	B5-U0-G4	B5-U0-G4
5WQ	Lumens	6,315	9,472	12,630	15,787	18,945	22,102	25,260	28,417	31,575	34,732	37,890
	BUG Rating	B3-U0-G1	B4-U0-G2	B4-U0-G2	B4-U0-G2	B5-U0-G3	B5-U0-G3	B5-U0-G3	B5-U0-G4	B5-U0-G4	B5-U0-G4	B5-U0-G4
5XQ	Lumens	6,325	9,488	12,650	15,813	18,975	22,138	25,301	28,463	31,626	34,788	37,951
	BUG Rating	B3-U1-G2	B3-U1-G3	B4-U1-G3	B4-U1-G3	B4-U1-G4	B5-U1-G4	B5-U2-G5	B5-U2-G5	B5-U2-G5	B5-U2-G5	B5-U2-G5
SL2	Lumens	6,018	9,026	12,035	15,044	18,053	21,061	24,070	27,079	30,088	33,096	36,105
	BUG Rating	B1-U0-G2	B2-U0-G2	B2-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G4	B3-U0-G4	B4-U0-G4
SL3	Lumens	6,034	9,051	12,067	15,084	18,101	21,118	24,135	27,152	30,169	33,186	36,202
	BUG Rating	B1-U0-G2	B2-U0-G2	B2-U0-G2	B2-U0-G3	B3-U0-G3	B3-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G4	B3-U0-G4	B3-U0-G5
SL4	Lumens	5,802	8,703	11,604	14,505	17,406	20,307	23,207	26,108	29,009	31,910	34,811
	BUG Rating	B1-U0-G2	B2-U0-G2	B2-U0-G2	B2-U0-G3	B3-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G4	B3-U0-G4	B3-U0-G5	B3-U0-G5
RW	Lumens	6,231	9,346	12,462	15,577	18,692	21,808	24,923	28,039	31,154	34,270	37,385
	BUG Rating	B3-U0-G3	B3-U0-G3	B4-U0-G4	B4-U0-G4	B4-U0-G4	B4-U0-G4	B5-U0-G5	B5-U0-G5	B5-U0-G5	B5-U0-G5	B5-U0-G5
SLL/SLR	Lumens	5,375	8,062	10,749	13,436	16,124	18,811	21,498	24,186	26,873	29,560	32,247
	BUG Rating	B1-U0-G2	B1-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G4	B3-U0-G4	B3-U0-G5	B3-U0-G5	B3-U0-G5	B3-U0-G5	B3-U0-G5

LUMEN MAINTENANCE

Ambient Temperature	25,000 Hours*	50,000 Hours*	60,000 Hours*	100,000 Hours	Theoretical L70 (Hours)
25ºC	> 99%	> 97%	> 96%	> 93%	> 450,000
40ºC	> 98%	> 97%	> 96%	> 92%	> 425,000
50ºC	> 97%	> 96%	> 95%	> 91%	> 400,000

* Per IESNA TM-21 data.



LUMEN MULTIPLIER

Ambient Temperature	Lumen Multiplier
10ºC	1.02
15ºC	1.01
25ºC	1.00
40ºC	0.99
50ºC	0.96

LIGHTBAR OPERATION WITH 2L BI-LEVEL SWITCHING OPTION

Number of LightBars	Circuit 1	Circuit 2
2	1	1
3	2	2
4	2	2
5	3	2
6	3	3
7	4	3
8	4	4
9	5	4
10	6	4
11	7	4
12	8	4

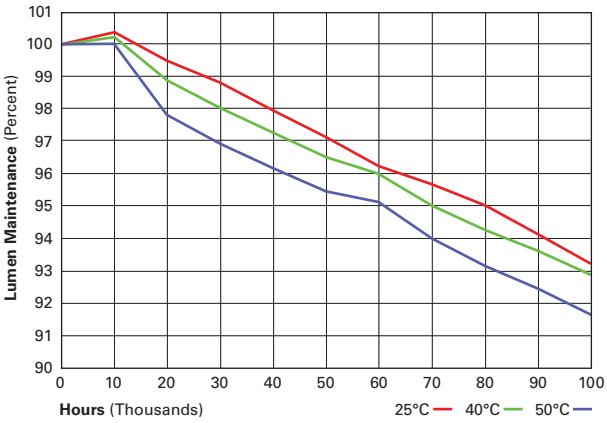
POWER AND LUMENS BY BAR COUNT (7 LED LIGHTBAR)

Number of LightBARs		F02	F03	F04	F05	F06	F07	F08	F09	F10	F11	F12
Drive Current		1A Drive Current										
Power (Watts)		55W	78W	102W	133W	157W	180W	204W	235W	259W	283W	307W
Current @ 120V (A)		0.46	0.66	0.86	1.12	1.31	1.51	1.71	1.97	2.17	2.37	2.57
Current @ 277V (A)		0.21	0.29	0.37	0.50	0.58	0.66	0.74	0.88	0.96	1.04	1.12
Power (Watts)		60W	85W	105W	137W	164W	181W	204W	236W	259W	284W	308W
Current @ 347V (A)		0.19	0.28	0.30	0.41	0.49	0.58	0.60	0.71	0.79	0.88	0.90
Current @ 480V (A)		0.15	0.21	0.22	0.31	0.37	0.43	0.44	0.53	0.59	0.65	0.66
T2	Lumens	5,096	7,644	10,193	12,741	15,289	17,837	20,385	22,933	25,482	28,030	30,578
	BUG Rating	B2-U0-G2	B2-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B3-U0-G3	B3-U0-G3	B4-U0-G4	B4-U0-G4	B4-U0-G4	B4-U0-G4
T3	Lumens	5,050	7,574	10,099	12,624	15,149	17,673	20,198	22,723	25,248	27,772	30,297
	BUG Rating	B2-U0-G2	B2-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B3-U0-G3	B4-U0-G4	B4-U0-G4	B4-U0-G4	B4-U0-G4	B4-U0-G4
T4	Lumens	4,914	7,371	9,828	12,285	14,742	17,199	19,656	22,114	24,571	27,028	29,485
	BUG Rating	B1-U0-G2	B1-U0-G2	B2-U0-G2	B2-U0-G2	B2-U0-G3	B2-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G4	B3-U0-G4	B3-U0-G4
5MQ	Lumens	5,281	7,922	10,563	13,204	15,844	18,485	21,126	23,767	26,407	29,048	31,689
	BUG Rating	B3-U0-G1	B3-U0-G1	B3-U0-G2	B4-U0-G2	B4-U0-G2	B4-U0-G2	B4-U0-G2	B5-U0-G3	B5-U0-G3	B5-U0-G3	B5-U0-G3
5WQ	Lumens	5,213	7,820	10,426	13,033	15,640	18,246	20,853	23,459	26,066	28,672	31,279
	BUG Rating	B3-U0-G1	B3-U0-G2	B4-U0-G2	B4-U0-G2	B4-U0-G2	B4-U0-G3	B5-U0-G3	B5-U0-G3	B5-U0-G3	B5-U0-G4	B5-U0-G4
5XQ	Lumens	5,222	7,832	10,443	13,054	15,665	18,276	20,886	23,497	26,108	28,719	31,330
	BUG Rating	B3-U1-G2	B3-U1-G3	B4-U1-G3	B4-U1-G3	B4-U1-G3	B4-U1-G4	B5-U1-G4	B5-U2-G4	B5-U2-G5	B5-U2-G5	B5-U2-G5
SL2	Lumens	4,968	7,451	9,935	12,419	14,903	17,387	19,870	22,354	24,838	27,322	29,806
	BUG Rating	B1-U0-G1	B2-U0-G2	B2-U0-G2	B2-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B3-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G4
SL3	Lumens	4,981	7,471	9,962	12,452	14,943	17,433	19,924	22,414	24,905	27,395	29,886
	BUG Rating	B1-U0-G1	B1-U0-G2	B2-U0-G2	B2-U0-G2	B2-U0-G3	B3-U0-G3	B3-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G4	B3-U0-G4
SL4	Lumens	4,790	7,184	9,579	11,974	14,369	16,764	19,158	21,553	23,948	26,343	28,738
	BUG Rating	B1-U0-G2	B1-U0-G2	B2-U0-G2	B2-U0-G2	B2-U0-G3	B3-U0-G3	B3-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G4	B3-U0-G4
RW	Lumens	5,144	7,716	10,287	12,859	15,431	18,003	20,575	23,147	25,719	28,290	30,862
	BUG Rating	B3-U0-G3	B3-U0-G3	B3-U0-G3	B4-U0-G4	B4-U0-G4	B4-U0-G4	B4-U0-G4	B4-U0-G4	B5-U0-G5	B5-U0-G5	B5-U0-G5
SLL/SLR	Lumens	4,437	6,655	8,874	11,092	13,311	15,529	17,747	19,966	22,184	24,403	26,621
	BUG Rating	B1-U0-G2	B1-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G4	B2-U0-G4	B3-U0-G4	B3-U0-G5	B3-U0-G5	B3-U0-G5

LUMEN MAINTENANCE

Ambient Temperature	25,000 Hours*	50,000 Hours*	60,000 Hours*	100,000 Hours	Theoretical L70 (Hours)
25°C	> 99%	> 97%	> 96%	> 93%	> 450,000
40°C	> 98%	> 97%	> 96%	> 92%	> 425,000
50°C	> 97%	> 96%	> 95%	> 91%	> 400,000

* Per IESNA TM-21 data.



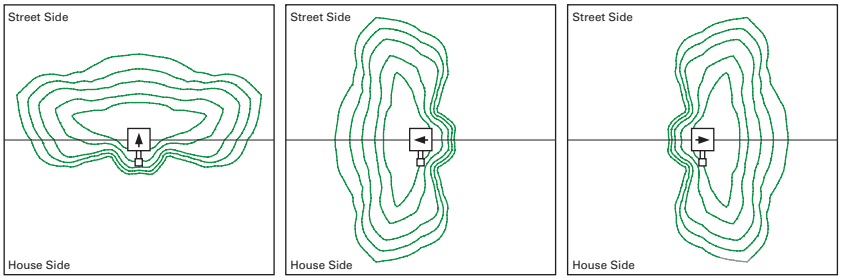
LUMEN MULTIPLIER

Ambient Temperature	Lumen Multiplier
10°C	1.02
15°C	1.01
25°C	1.00
40°C	0.99
50°C	0.96

LIGHTBAR OPERATION WITH 2L BI-LEVEL SWITCHING OPTION

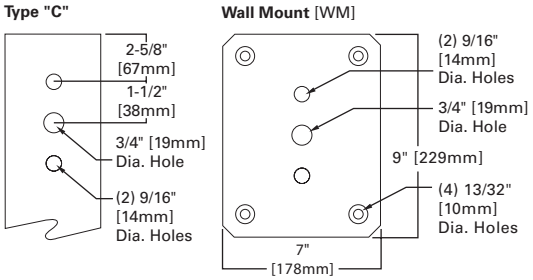
Number of LightBars	Circuit 1	Circuit 2
2	1	1
3	2	2
4	2	2
5	3	2
6	3	3
7	4	3
8	4	4
9	5	4
10	6	4
11	7	4
12	8	4

OPTIC ORIENTATION



Standard | **Optics Rotated Left @ 90°** [L90] | **Optics Rotated Right @ 90°** [R90]

DRILLING PATTERNS



ORDERING INFORMATION

Sample Number: VTS-E12-LED-E1-T3-GM

Product Family [1, 2, 3]	Number of LightBARs [4, 5]		Lamp Type	Voltage	Distribution	Color
VTS=Ventus	**E02**=(2) 21 LED LightBARs **E03**=(3) 21 LED LightBARs **E04**=(4) 21 LED LightBARs **E05**=(5) 21 LED LightBARs **E06**=(6) 21 LED LightBARs **E07**=(7) 21 LED LightBARs **E08**=(8) 21 LED LightBARs **E09**=(9) 21 LED LightBARs **E10**=(10) 21 LED LightBARs **E11**=(11) 21 LED LightBARs **E12**=(12) 21 LED LightBARs	**F02**=(2) 7 LED LightBARs **F03**=(3) 7 LED LightBARs **F04**=(4) 7 LED LightBARs **F05**=(5) 7 LED LightBARs **F06**=(6) 7 LED LightBARs **F07**=(7) 7 LED LightBARs **F08**=(8) 7 LED LightBARs **F09**=(9) 7 LED LightBARs **F10**=(10) 7 LED LightBARs **F11**=(11) 7 LED LightBARs **F12**=(12) 7 LED LightBARs	**LED**=Solid State Light Emitting Diodes	**E1**=Electronic (120-277V) **347**=347V [6, 7] **480**=480V [6, 7, 8]	**T2**=Type II **T3**=Type III **T4**=Type IV **5MQ**=Type V Square Medium **5WQ**=Type V Square Wide **5XQ**=Type V Square Extra Wide **SL2**=Type II with Spill Control **SL3**=Type III with Spill Control **SL4**=Type IV with Spill Control **RW**=Rectangular Wide **SLL**=90° Spill Light Eliminator Left **SLR**=90° Spill Light Eliminator Right	**AP**=Grey **BZ**=Bronze **BK**=Black **DP**=Dark Platinum **GM**=Graphite Metallic **WH**=White

Options (Add as Suffix)	**Accessories** (Order Separately) [23]
P=Button Type Photocontrol (120, 208, 240 or 277V. Must Specify Voltage) [6] **R**=NEMA Twistlock Photocontrol Receptacle **PER7**=NEMA 7-PIN Twistlock Photocontrol Receptacle [9] **HA**=50°C High Ambient Temperature Rating [10, 11] **2L**=Two Circuits [7, 12, 13, 14] **L90**=Optics Rotated 90° Left [15] **R90**=Optics Rotated 90° Right [15] **7030**=70 CRI / 3000K CCT [16] **7050**=70 CRI / 5000K CCT [16] **7060**=70 CRI / 5700K CCT [16] **8030**=80 CRI / 3000K CCT [16] **TH**=Tool-less Door Hardware **LCF**=LightBAR Cover Plate Matches Housing Finish **WG**=Wire Guard **WM**=Wall Mount with Arm **IM**=Integral Mast Arm **MS-LXX**=Motion Sensor for On/Off Operation [17] **MS/X-LXX**=Motion Sensor for Bi-Level Operation [18] **MS/DIM-LXX**=Motion Sensor for Dimming Operation [19, 20] **DIM**=0-10V Dimming Drivers [21] **HSS**=Factory Installed House Side Shield [22]	**VA1033-XX**=Single Tenon Adapter for 2-3/8" O.D. Tenon **VA1034-XX**=2@180° Tenon Adapter for 2-3/8" O.D. Tenon **VA1035-XX**=3@120° Tenon Adapter for 2-3/8" O.D. Tenon **VA1036-XX**=4@90° Tenon Adapter for 2-3/8" O.D. Tenon **VA1037-XX**=2@90° Tenon Adapter for 2-3/8" O.D. Tenon **VA1038-XX**=3@90° Tenon Adapter for 2-3/8" O.D. Tenon **VA1039-XX**=2@120° Tenon Adapter for 2-3/8" O.D. Tenon **VA1040-XX**=Single Tenon Adapter for 3-1/2" O.D. Tenon **VA1041-XX**=2@180° Tenon Adapter for 3-1/2" O.D. Tenon **VA1042-XX**=3@120° Tenon Adapter for 3-1/2" O.D. Tenon **VA1043-XX**=4@90° Tenon Adapter for 3-1/2" O.D. Tenon **VA1044-XX**=2@90° Tenon Adapter for 3-1/2" O.D. Tenon **VA1045-XX**=3@90° Tenon Adapter for 3-1/2" O.D. Tenon **VA1046-XX**=2@120° Tenon Adapter for 3-1/2" O.D. Tenon **FSIR-100**=Wireless Configuration Tool for Occupancy Sensor [24] **OA/RA1016**=NEMA Photocontrol - Multi-Tap **OA/RA1027**=NEMA Photocontrol - 480V **OA/RA1201**=NEMA Photocontrol - 347V **MA1253**=10kV Circuit Module Replacement **LB/HSS**=Field Installed House Side Shield [25]

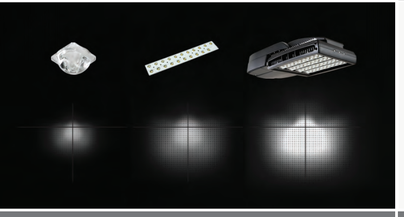
NOTES:
1. Customer is responsible for engineering analysis to confirm pole and fixture compatibility for all applications. Refer to our white paper WP513001EN for additional support information.
2. DesignLights Consortium™ Qualified. Refer to www.designlights.org Qualified Products List under Family Models for details.
3. 6" arm and round pole adapter included with fixture.
4. 21 LED LightBAR powered at 350mA, 7 LED LightBAR powered at 1A.
5. Standard 4000K CCT and nominal 70CRI.
6. Not available with HA option.
7. Must specify voltage.
8. Only for use with 480V Wye systems. Per NEC, not for use with ungrounded systems, impedance grounded systems or corner grounded systems (commonly known as Three Phase Three Wire Delta, Three Phase High Leg Delta and Three Phase Corner Grounded Delta systems).
9. Must specify DIM option to add dimming driver(s). Only available in E02-E06 and F02-F06.
10. Not available with DIM option or MS/DIM-LXX.
11. Not available with button photocontrol or motion sensor.120 - 277V only.
12. Requires two electrical circuits to luminaire. See LightBAR operation table for additional information.
13. Consult factory before ordering in combination with MS-LXX or MS/X-LXX options.
14. Not available in 347V or 480V.
15. Not available with 5MQ, 5WQ or 5XQ distributions. Not available with HSS option.
16. Extended lead times apply.
17. Sensor housed in external box mounted to the luminaire. Available in E02-E12 and F02-F12 configurations. Replace XX with mounting height in feet for proper lens selection, (e.g., MS-L25). Consult factory for additional information.
18. Sensor housed in external box mounted to the luminaire. Available in E02-E12 and F02-F12 configurations. Replace X with number of bars operating in low output mode and replace XX with mounting height for proper lens selection, (e.g., MS/3-L25). Maximum 4 bars in low output mode. Consult factory for additional information.
19. Not available with HA option. Only available in F02-F06 and E02-E06. Includes Dimming Drivers. Not available in 347V or 480V.
20. Replace XX with mounting height in feet for proper lens selection, (e.g., MS/DIM-L25).
21. Available in E02-E06 and F02-F06 only.
22. Only for use with SL2, SL3 and SL4 distributions. Not available with L90 or R90 options.
23. Replace XX with color suffix.
24. Only compatible with MS/DIM-LXX motion sensor.
25. One required for each LightBAR. Not available with L90 or R90 options.

LightBAR™ TECHNOLOGY

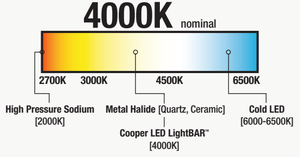
ENERGY SAVINGS + ENVIRONMENTAL STEWARDSHIP
The simplest and most effective way to reduce a lighting fixture's impact on the environment is to minimize its energy consumption. By incorporating Cooper Lighting's patented LED LightBAR™ technology, Ventus provides energy savings between 30-75% over standard HID solutions.

LONG LIFE
With a 50,000+ hour rated life [at 70% lumen maintenance], Ventus operates six [6] times longer than traditional Metal Halide solutions.

SCALABLE ILLUMINATION



WARM WHITE COLOR



Each patented LED LightBAR™ optic renders the entirety of the pattern. As the number of LightBARS™ increases so too the application illuminance, allowing lumen and energy output to be scaled and optimized per application. Obtrusive spill light and over lighting is replaced by uniform, application specific illumination.

Lighting Designers, Architects and Specifying Engineers have long preferred light sources which provide a balanced spectral power distribution and warm white light. Typical LED solutions standardize on a cold blue 6000-6500K correlated color temperature [CCT] to maximize lumen output. The Ventus provides warm white light at a standard 4000K CCT with no sacrifice in lumen output.

AccuLED Optics™

SUPERIOR EFFICIENCY + CONTROL
With efficiencies as high as 95%, patented AccuLED Optics™ are as much as 30% more efficient than traditional HID optical systems. Available in thirteen [13] beam distributions, AccuLED Optics™ provide the flexibility and performance required for any outdoor application.

VENTUS LED

ORDERING INFORMATION

SAMPLE NUMBER: VTS-B12-LED-E1-T3-GM

PRODUCT FAMILY [1]
VTS=Ventus

NUMBER OF LIGHTBARS [2, 3]
B02=[2] 21 LED LightBARs
B03=[3] 21 LED LightBARs
B04=[4] 21 LED LightBARs
B05=[5] 21 LED LightBARs
B06=[6] 21 LED LightBARs
B07=[7] 21 LED LightBARs
B08=[8] 21 LED LightBARs
B09=[9] 21 LED LightBARs
B10=[10] 21 LED LightBARs
B11=[11] 21 LED LightBARs
B12=[12] 21 LED LightBARs
C02=[2] 7 LED LightBARs
C03=[3] 7 LED LightBARs
C04=[4] 7 LED LightBARs
C05=[5] 7 LED LightBARs
C06=[6] 7 LED LightBARs
C07=[7] 7 LED LightBARs
C08=[8] 7 LED LightBARs
C09=[9] 7 LED LightBARs
C10=[10] 7 LED LightBARs
C11=[11] 7 LED LightBARs
C12=[12] 7 LED LightBARs

LAMP TYPE
LED=Solid State Light Emitting Diodes

VOLTAGE
E1=Electronic [120-277V]
347=347V [4]
480=480V [4]

DISTRIBUTION
T2=Type II
T3=Type III
T3S=Type III Short
T4=Type IV
SL2=Type II w/Spill Control
SL3=Type III w/Spill Control
SL4=Type IV w/Spill Control
5MQ=Type V Square Medium
5WQ=Type V Square Wide
5XQ=Type V Square Extra Wide
SLL=90° Spill Light Eliminator Left
SLR=90° Spill Light Eliminator Right
RW=Rectangular Wide

COLOR
AP=Grey
BZ=Bronze
BK=Black
DP=Dark Platinum
GM=Graphite Metallic
WH=White

OPTIONS + ACCESSORIES [see below]

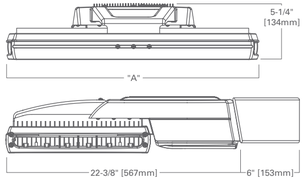
OPTIONS + ACCESSORIES [Must be listed in the order shown and separated by a dash]

OPTIONS [5]
P=Button Type Photocontrol [120, 208, 240 or 277V Only] [4, 6]
R=NEMA Photocontrol Receptacle
2L=Bi-Level Switching Capable [7]
L90=Optics Rotated 90° Left
R90=Optics Rotated 90° Right
HA=50°C High Ambient Temperature Rating [4]
7060=70 CRI / 6000K CCT [8]
8030=80 CRI / 3000K CCT [8]
LCF=LightBAR Cover Plate Matches Housing Finish
TH=Tool-less Door Hardware
WM=Wall Mount with Arm
IM=Internal Mast Arm
MS-LXX=Motion Sensor for On/Off Operation [9]
MS/X-LXX=Motion Sensor for Bi-Level Operation [10]

ACCESSORIES [11]
OA/RA1016=NEMA Twistlock Photocontrol—Multi-Tap
OA/RA1027=NEMA Twistlock Photocontrol—480V
OA/RA1201=NEMA Twistlock Photocontrol—347V
MA1253=10kV Circuit Module Replacement
VA1033-XX=Single Tenon Adapter for 2-3/8" O.D. Tenon
VA1034-XX=2 @ 180° Tenon Adapter for 2-3/8" O.D. Tenon
VA1035-XX=3 @ 120° Tenon Adapter for 2-3/8" O.D. Tenon
VA1036-XX=4 @ 90° Tenon Adapter for 2-3/8" O.D. Tenon
VA1037-XX=2 @ 90° Tenon Adapter for 2-3/8" O.D. Tenon
VA1038-XX=3 @ 90° Tenon Adapter for 2-3/8" O.D. Tenon
VA1039-XX=2 @ 120° Tenon Adapter for 2-3/8" O.D. Tenon
VA1040-XX=Single Tenon Adapter for 3-1/2" O.D. Tenon
VA1041-XX=2 @ 180° Tenon Adapter for 3-1/2" O.D. Tenon
VA1042-XX=3 @ 120° Tenon Adapter for 3-1/2" O.D. Tenon
VA1043-XX=4 @ 90° Tenon Adapter for 2-3/8" O.D. Tenon
VA1044-XX=2 @ 90° Tenon Adapter for 3-1/2" O.D. Tenon
VA1045-XX=3 @ 90° Tenon Adapter for 3-1/2" O.D. Tenon
VA1046-XX=4 @ 90° Tenon Adapter for 3-1/2" O.D. Tenon

NOTES: **1** 6" arm and round pole adapter included with fixture. **2** 21 LED LightBAR powered at 350mA and 7 LED LightBAR powered at 1A. **2** Standard 4000K CCT nominal 70 CRI. **3** Consult factory for availability. **4** 347 and 480V not available with HA option. **5** Add as suffix. **6** Must specify voltage. **7** Low-level output varies by bar count specified. Consult factory. **8** Consult factory for lead times and lumen multiplier. **9** Sensor housed in external box mounted to the luminaire. Available in B02-B12 and C02-C12 configurations. Replace XX with mounting height in feet for proper lens selection (i.e. MS-L25). Consult factory for additional information. **10** Sensor housed in external box mounted to the luminaire. Available in B02-B12 and C02-C12 configurations. Replace X with number of bars operating in low output mode and replace XX with fixture mounting height for proper lens selection (i.e. MS/3-L25). Maximum bars in low output mode. Consult factory for additional information. **11** Order separately, replace XX with color suffix. **12** Specifications and dimensions subject to change without notice.

DIMENSIONS



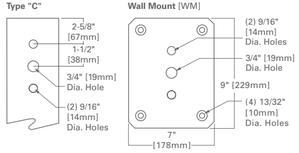
TABULATED DATA

# of Bars	"A" Width [in/mm]
2-4	12-7/8" [328]
5-8	18" [458]
9-12	25-7/8" [658]

AMBIENT DATA

Ambient Temperature	Lumen Multiplier
10°C	1.04
15°C	1.03
25°C	1.00
40°C	0.96
50°C	0.92

DRILLING PATTERNS



CERTIFICATIONS

UL & cUL Listed
3G Vibration Tested
ISO 9001
IP66 LightBARs
ARRA Compliant

ENERGY DATA

Electronic LED Driver
>0.9 Power Factor
<20% Total Harmonic Distortion
120-277V/50 & 60Hz, 347V/60Hz, 480V/60Hz
40°C Ambient Temperature Rating
-30°C Minimum Temperature

EPA

Effective Projected Area [sq. ft]

	w/o Arm	w/Arm
2-4 Bars	0.94	1.00
5-8 Bars	1.10	1.20
9-12 Bars	1.31	1.44

SHIPPING DATA

Approximate Net Weight

	w/o Arm	w/Arm
2-4 Bars	24 [10.91 kgs.]	29 [13.18 kgs.]
5-8 Bars	30 [13.64 kgs.]	35 [15.91 kgs.]
9-12 Bars	39 [17.73 kgs.]	44 [20.00 kgs.]

25% PCRF

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www.cooperlighting.com

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Printed in USA

COOPER Lighting

McGraw-Edison

SustainabLEDesign™

Ventus LED

Architectural Area Luminaire

COOPER Lighting

INNOVATION CENTER

INNOVATION IN ACTION

BEST-IN-CLASS DESIGN + RELIABILITY

The Cooper name has stood for innovation, service and expertise for over 175 years. Today, Cooper Lighting's LED Innovation Center is home to the design, validation and manufacturing of proprietary LED technologies. Through changing times and technologies, Cooper answers the call to provide relevant, industry-leading solutions to challenging market needs.

Precision design practices and rigorous reliability testing result in dependable luminaries that thrive in outdoor environments. The Ventus area/roadway luminaire is rated for operation in -30°C to 40°C ambient environments [for 50°C ambient, specify HA option], comes equipped with 10kV transient surge protection and is backed by a five-year warranty from a world class manufacturer.

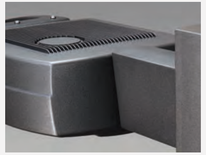
FEATURES + BENEFITS

CONSTRUCTION + FINISH
Die-cast and extruded aluminum construction finished in Super TGIC polyester powder coat paint. Six [6] standard colors. RAL and custom colors available.

ACCULED OPTICS™
AccuLED Optics™ provide shaped distributions and scalability to meet exacting application requirements. Ventus is offered in 2-12 LightBAR™ configurations with a choice of thirteen [13] high efficiency optical systems. Optional factory-set optic rotation [L90 or R90] allows uniform product orientation on the site independent of optical orientation. LightBARs feature an IP66 enclosure rating.

POWER AND LUMENS BY NUMBER OF LIGHTBARS

Number of LightBARs	DISTRIBUTION												
	Power [Watts]	T2	T3	T3S	T4	SL2	SL3	SL4	5MQ	5WQ	5XQ	RW	SLR/ SLL
	7 LED LIGHTBAR												
C02	54	3,668	3,654	3,557	3,503	3,594	3,550	3,610	3,855	3,832	3,738	3,663	3,433
C03	77	5,554	5,533	5,386	5,305	5,442	5,375	5,465	5,837	5,802	5,660	5,546	5,198
C04	101	7,557	7,528	7,327	7,217	7,404	7,313	7,435	7,941	7,894	7,701	7,545	7,072
C05	131	9,228	9,193	8,948	8,813	9,041	8,930	9,080	9,697	9,640	9,404	9,214	8,636
C06	154	11,209	11,167	10,869	10,705	10,982	10,847	11,030	11,779	11,710	11,423	11,192	10,490
C07	178	12,969	12,919	12,575	12,385	12,706	12,550	12,761	13,628	13,548	13,216	12,949	12,137
C08	202	14,481	14,426	14,041	13,830	14,187	14,013	14,249	15,217	15,127	14,757	14,459	13,552
C09	232	16,800	16,737	16,291	16,045	16,460	16,258	16,531	17,654	17,550	17,121	16,775	15,723
C10	255	18,738	18,667	18,169	17,895	18,358	18,133	18,437	19,690	19,574	19,095	18,709	17,536
C11	279	20,506	20,429	19,884	19,584	20,091	19,844	20,178	21,549	21,422	20,898	20,475	19,191
C12	303	22,109	22,025	21,438	21,114	21,661	21,395	21,754	23,232	23,096	22,530	22,075	20,690
	21 LED LIGHTBAR												
B02	51	4,512	4,495	4,375	4,309	4,421	4,366	4,440	4,741	4,714	4,598	4,505	4,223
B03	73	6,832	6,806	6,625	6,525	6,693	6,611	6,722	7,179	7,137	6,962	6,822	6,394
B04	95	9,295	9,259	9,013	8,877	9,106	8,995	9,146	9,767	9,710	9,472	9,281	8,698
B05	124	11,350	11,307	11,006	10,840	11,120	10,984	11,168	11,927	11,857	11,567	11,333	10,622
B06	146	13,787	13,735	13,369	13,167	13,508	13,342	13,566	14,488	14,403	14,050	13,767	12,903
B07	168	15,951	15,891	15,467	15,234	15,628	15,436	15,696	16,762	16,664	16,256	15,927	14,928
B08	190	17,811	17,744	17,271	17,010	17,450	17,236	17,526	18,717	18,607	18,151	17,784	16,669
B09	219	20,664	20,586	20,037	19,735	20,246	19,997	20,333	21,715	21,587	21,059	20,633	19,339
B10	241	23,047	22,960	22,348	22,011	22,580	22,303	22,678	24,219	24,076	23,487	23,012	21,569
B11	263	25,223	25,127	24,458	24,089	24,712	24,408	24,818	26,505	26,349	25,704	25,185	23,605
B12	285	27,194	27,091	26,369	25,971	26,643	26,315	26,758	28,576	28,408	27,712	27,152	25,449



MOUNTING CONFIGURATIONS
Ventus is shipped complete with a 6" arm and round pole adapter for consolidated arrival of product to the site. Optional mounting methods include a wall mount plate [WM] and an internal mast arm mount [IM] that accepts 1-1/4" to 2-3/8" O.D. horizontal tenons with +/- 5° vertical leveling adjustment. Tenon adapters available to slipfit over poles equipped with 2-3/8" or 3-1/2" O.D. tenon. 3G vibration rated.

SURGE SUPPRESSION
Ventus is shipped standard with a replaceable circuit module [MA1253] incorporating internal fusing and MOVs designed to withstand 10kV of transient line surge.

ALUMINUM HEAT SINK
Unique extruded aluminum construction allows for passive cooling and natural cleaning of the heat sinks ensuring reliable operation in -30°C to 40°C ambient environments [For 50°C ambient, specify HA option].

BI-LEVEL SWITCHING
LightBAR™ additive design technology allows for reduction in luminaire power consumption without impacting the overall shape or directionality of the distribution. Optional bi-level switching [2L] configurations allow energy saving power reductions while closely maintaining lighting uniformity levels.

Appendix F.2

Street Lighting Calculations

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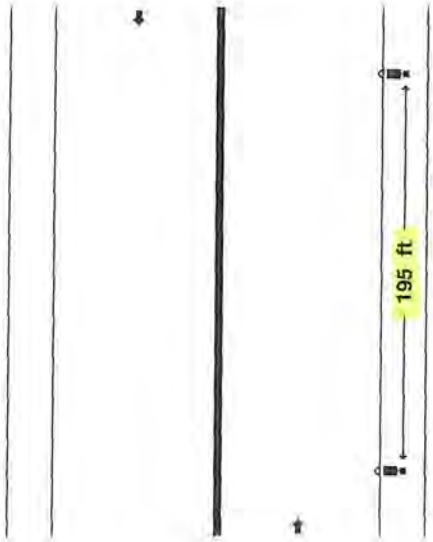
Design Information

Project	CLEAR CREEK PARKWAY
Number	150561-010
Name	RAZOR COMPARISON 173.5 watt
Company	SKW



Roadway Information

Number Left Lanes	1
Left Lane Width	22 ft
Median Width	0 ft
Number Right Lanes	1
Right Lane Width	22 ft
Calculation Method	IES RP8-2000
Pavement Reflectance	Asphalt - R3
Roadway Classification	Collector
Pedestrian Conflict	Medium

Luminaire Information

Right Side

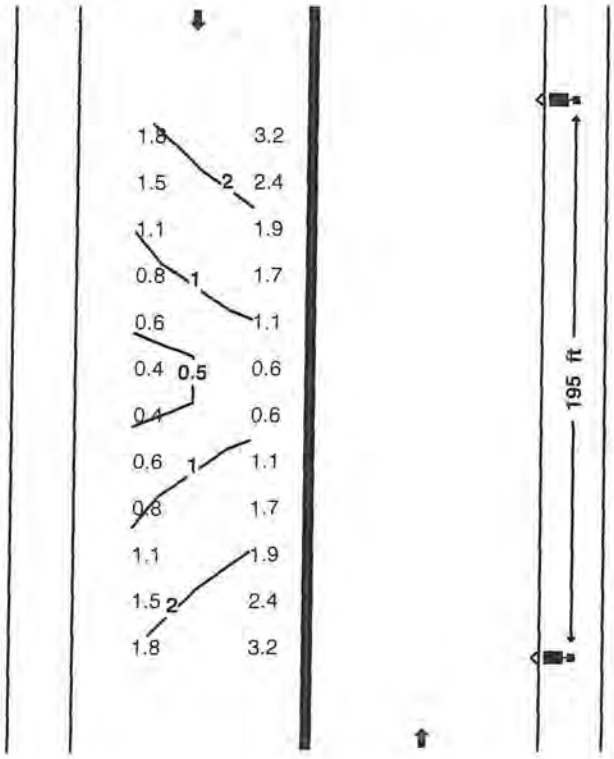
Label	A
Catalog Number	RZR-G-II-80PLED-NW-700
Photometric File	RZRG-2-80PLED-NW--700.IES
Lamp Lumens	Absolute
Light Loss Factor	0.96
Input Power	173.5 W
Tilt	0°
Arm Length	0.75 ft
Mounting Height	30 ft
Setback	3 ft
Quantity	28

Calculation Results - Left Side

Luminance			Illuminance					
Average	0.8	cd/m²	Average	1.4	fc	Lv Ratio	0.4	
Max	1.7	cd/m²	Max	3.2	fc	STV	5.6	
Min	0.3	cd/m²	Min	0.4	fc	Spacing	195	ft
Max/Min	5.7		Max/Min	8.0		Length	5280	ft
Avg/Min	2.7		Avg/Min	3.5		Quantity	28	

Calculations are based on procedures established by the governing standards body or standard industry practice. Visual computes output performance based on input data as provided by, and which is the sole responsibility of, the user. Acuity Brands Lighting, Inc. cannot be held responsible for the variations in actual situations which can effect calculated output.

Illuminance



Grid Statistics

Average	1.4	fc
Max	3.2	fc
Min	0.4	fc
Max/Min	8.0	
Avg/Min	3.5	

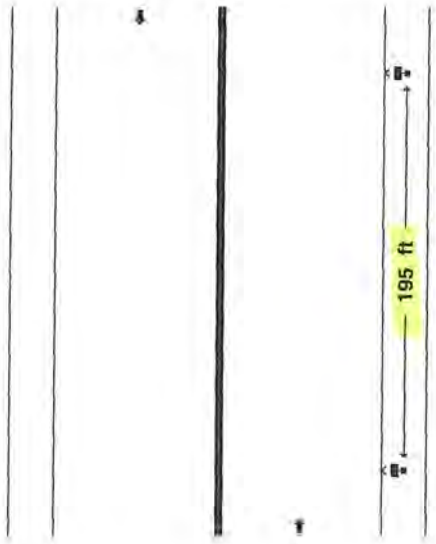
Grid Properties

Number of Rows	12	
Row Spacing	16.25	ft
Number of Columns	2	
Column Spacing	11	ft

Calculations are based on procedures established by the governing standards body or standard industry practice. Visual computes output performance based on input data as provided by, and which is the sole responsibility of, the user. Acuity Brands Lighting, Inc. cannot be held responsible for the variations in actual situations which can effect calculated output.

Design Information

Project	CLEAR CREEK PARKWAY
Number	150561-010
Name	VENTUS COMPARISON
Company	SKW



Roadway Information

Number Left Lanes	1
Left Lane Width	22 ft
Median Width	0 ft
Number Right Lanes	1
Right Lane Width	22 ft
Calculation Method	IES RP8-2000
Pavement Reflectance	Asphalt - R3
Roadway Classification	Collector
Pedestrian Conflict	Medium

Luminaire Information

Right Side

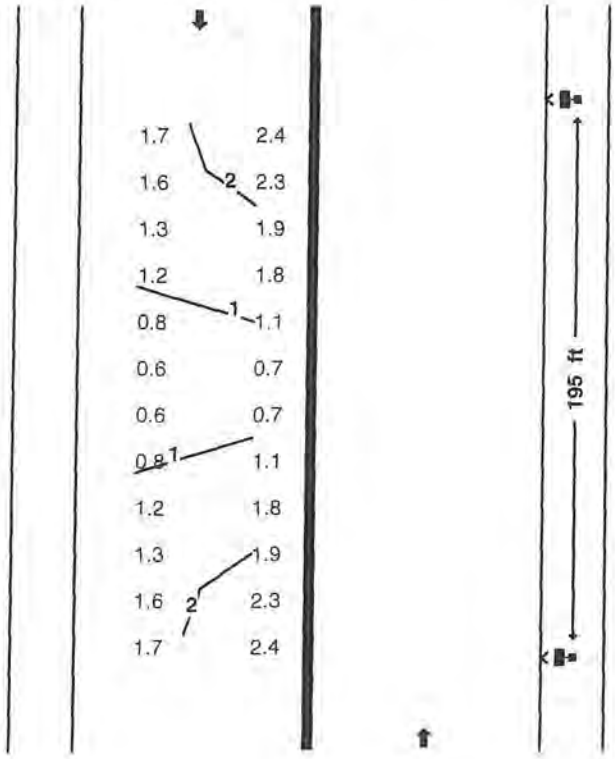
Label	A
Catalog Number	VTS-E10-LED-E1-T3
Photometric File	VTS-E10-LED-E1-T3.ies
Lamp Lumens	Absolute
Light Loss Factor	0.96
Input Power	247.7 W
Tilt	0°
Arm Length	0.75 ft
Mounting Height	30 ft
Setback	3 ft
Quantity	28

Calculation Results - Left Side

Luminance			Illuminance					
Average	0.8	cd/m²	Average	1.4	fc	Lv Ratio	0.4	
Max	1.8	cd/m²	Max	2.4	fc	STV	5.3	
Min	0.5	cd/m²	Min	0.6	fc	Spacing	195	ft
Max/Min	3.6		Max/Min	4.0		Length	5280	ft
Avg/Min	1.6		Avg/Min	2.3		Quantity	28	

Calculations are based on procedures established by the governing standards body or standard industry practice. Visual computes output performance based on input data as provided by, and which is the sole responsibility of, the user. Acuity Brands Lighting, Inc. cannot be held responsible for the variations in actual situations which can effect calculated output.

Illuminance



Grid Statistics

Average	1.4	fc
Max	2.4	fc
Min	0.6	fc
Max/Min	4.0	
Avg/Min	2.3	

Grid Properties

Number of Rows	12	
Row Spacing	16.25	ft
Number of Columns	2	
Column Spacing	11	ft

Calculations are based on procedures established by the governing standards body or standard industry practice. Visual computes output performance based on input data as provided by, and which is the sole responsibility of, the user. Acuity Brands Lighting, Inc. cannot be held responsible for the variations in actual situations which can effect calculated output.

Appendix G

Concept Landscape Plans and Rendering

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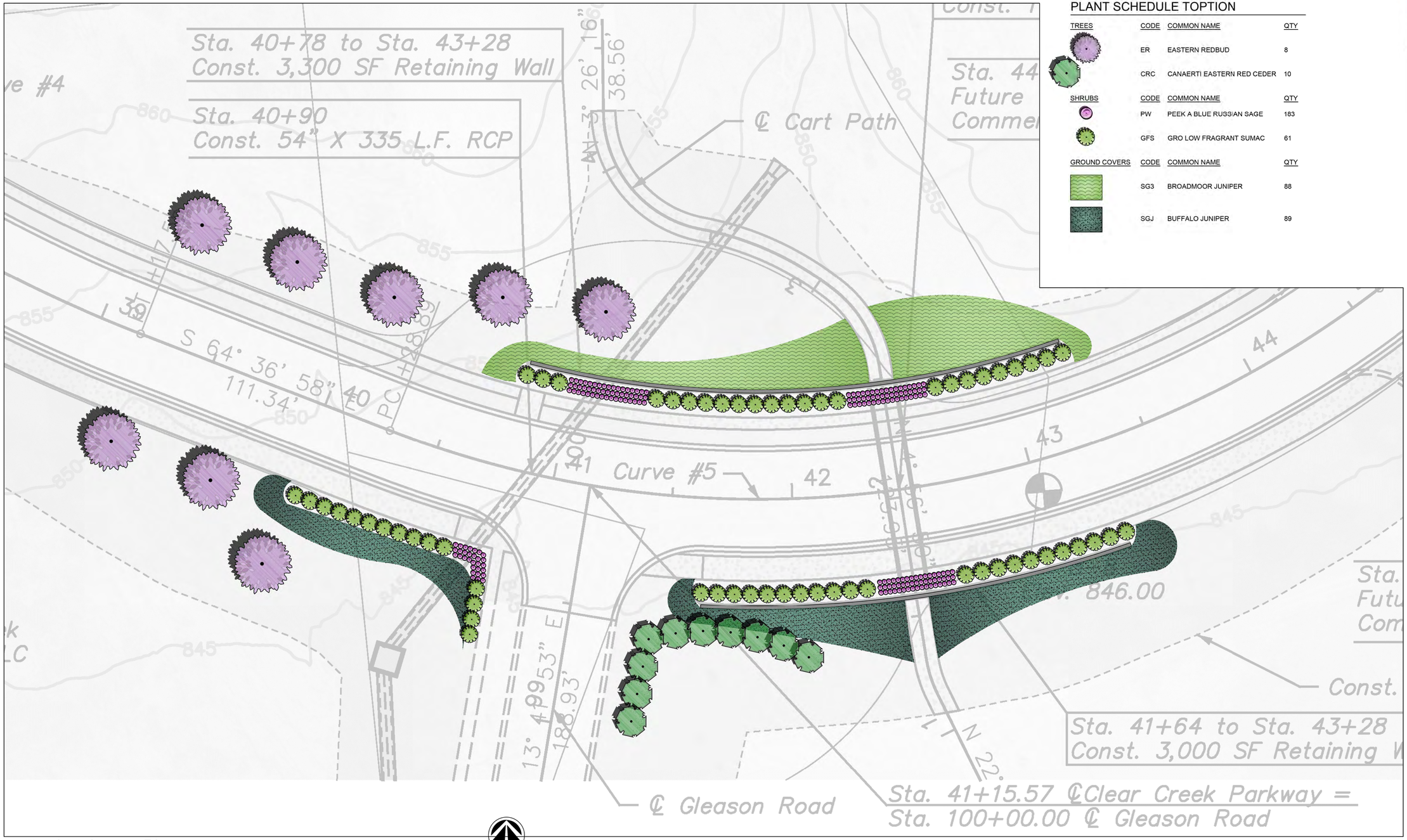


PLANT SCHEDULE TOPTION

TREES	CODE	COMMON NAME	QTY
	ER	EASTERN REDBUD	8
	CRC	CANAERTI EASTERN RED CEDER	10

SHRUBS	CODE	COMMON NAME	QTY
	PW	PEEK A BLUE RUSSIAN SAGE	183
	GFS	GRO LOW FRAGRANT SUMAC	61

GROUND COVERS	CODE	COMMON NAME	QTY
	SG3	BROADMOOR JUNIPER	88
	SGJ	BUFFALO JUNIPER	89

1 Landscape Plan

SCALE: 1" = 20' - 0"

NORTH

0 20 40 60 feet

SCALE: 1" = 20'

landwor STUDIO
103 S. CHESTNUT STREET
OLATHE, KS 66061
TEL 913-764-0787
FAX 913-764-0487
LANDSCAPE ARCHITECTURE

CLEAR CREEK PARKWAY
CITY OF SHAWNEE, KANSAS

T-INTERSECTION OPTION

Professional Seal

NOT FOR CONSTRUCTION

Prints Issued

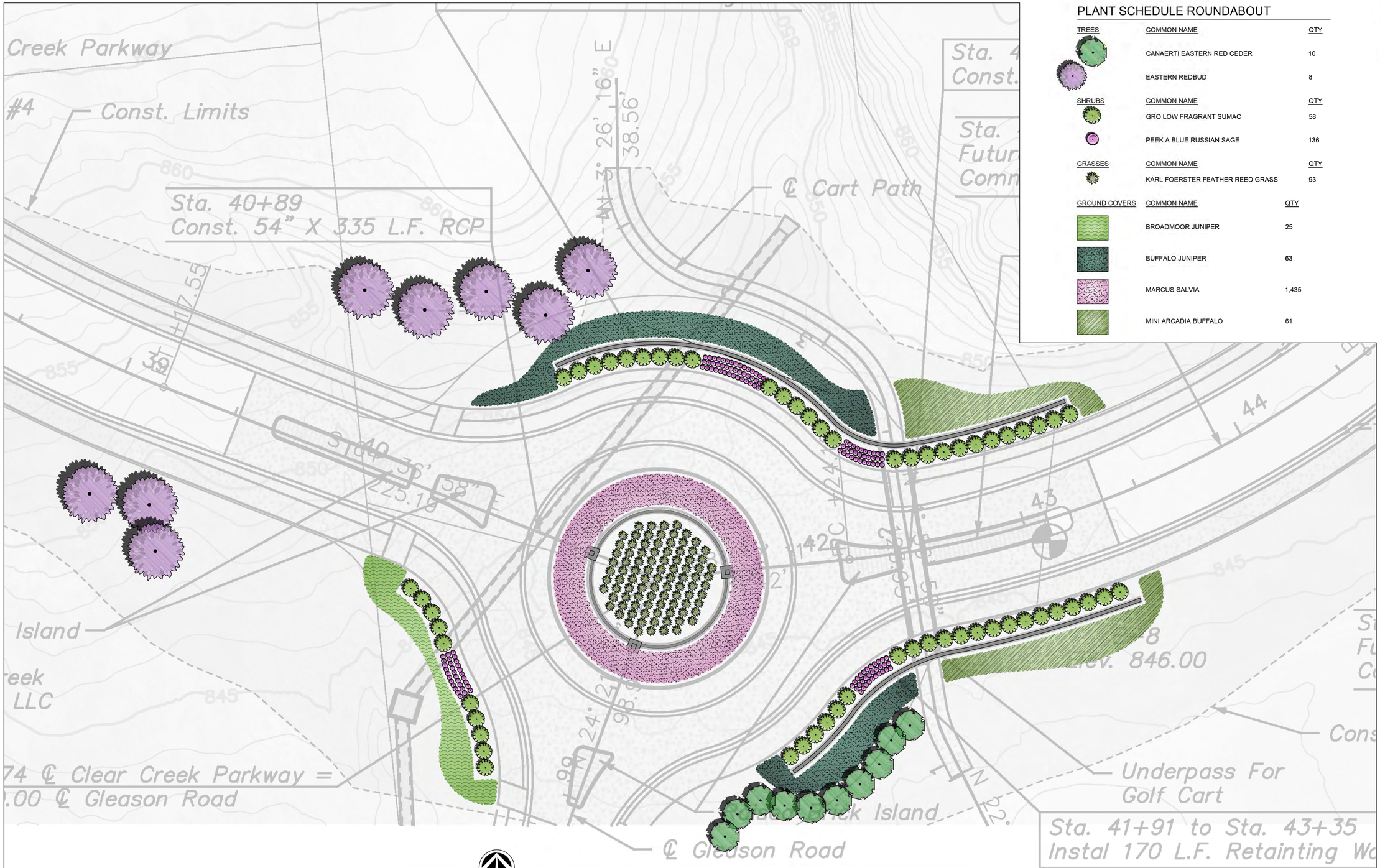
	Description	
1	CONCEPTS	0
2		
3		
4		
5		
6		
7		

Project Number:	15-1
Drawn By:	
Checked By:	KD

Sheet Number

G-3

OF 2 TOTAL SHEETS



1 Landscape Plan

SCALE: 1" = 20' - 0"

PLANT SCHEDULE ROUNDABOUT

TREES	COMMON NAME	QTY
	CANAERTI EASTERN RED CEDER	10
	EASTERN REDBUD	8

SHRUBS	COMMON NAME	QTY
	GRO LOW FRAGRANT SUMAC	58
	PEEK A BLUE RUSSIAN SAGE	136

GRASSES	COMMON NAME	QTY
	KARL FOERSTER FEATHER REED GRASS	93

GROUND COVERS	COMMON NAME	QTY
	BROADMOOR JUNIPER	25
	BUFFALO JUNIPER	63
	MARCUS SALVIA	1,435
	MINI ARCADIA BUFFALO	61

landwor STUDIO
103 S. CHESTNUT STREET
OLATHE, KS 66061
TEL 913-764-0787
FAX 913-764-0487
LANDSCAPE ARCHITECTURE

CLEAR CREEK PARKWAY

CITY OF SHAWNEE, KANSAS

ROUNDABOUT OPTION

Professional Seal

NOT FOR CONSTRUCTION

Prints Issued

	Description	
1	CONCEPTS	0-
2		
3		
4		
5		
6		
7		

Project Number:	15-1
Drawn By:	
Checked By:	KD

Sheet Number

G-4

OF 2 TOTAL SHEETS

Appendix H

Construction Cost Estimates

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Engineer's Opinion of Probable Construction Costs
T Intersection with Stop Control Alternative

Recap of Quantities (Base Bid)				
Bid Item	***Unit***	***Quantity***	***Extension***	***Cost***
Construction Staking	*LS*	*1*	*$ 10,000.00*	*$ 10,000.00*
Removal of Existing Structures	*LS*	*1*	*$ 10,000.00*	*$ 10,000.00*
Clearing & Grubbing	*LS*	*1*	*$ 30,000.00*	*$ 30,000.00*
Unclassified Excavation	*CY*	*20500*	*$ 8.00*	*$ 164,000.00*
Embankment	*CY*	*76200*	*$ 5.00*	*$ 381,000.00*
Contractor Furnished Borrow (1.15%)	*CY*	*55700*	*$ 10.00*	*$ 557,000.00*
6" Compacted Subgrade	*SY*	*25989*	*$ 4.00*	*$ 103,956.00*
4" Sidewalk	*SF*	*25025*	*$ 5.00*	*$ 125,125.00*
6" Trail	*SF*	*49223*	*$ 7.00*	*$ 344,561.00*
6" Sidewalk Ramp	*SF*	*940*	*$ 7.00*	*$ 6,580.00*
4" Sidewalk/ Trail Subgrade	*SY*	*10523*	*$ 2.00*	*$ 21,046.00*
6" Concrete Pavement (Golf Cart Path)	*SF*	*2295*	*$ 7.00*	*$ 16,065.00*
4" Aggregate Subgrade (Golf Cart Path)	*SY*	*306*	*$ 2.00*	*$ 612.00*
10'x10' RCB (Golf Cart Underpass)	*LF*	*97*	*$ 700.00*	*$ 67,900.00*
6" Concrete Trail (Recreational Trail Connection)	*SF*	*9704*	*$ 7.00*	*$ 67,928.00*
4" Aggregate Subgrade (Recreational Trail Connection)	*SY*	*1294*	*$ 2.00*	*$ 2,588.00*
Pedestrian Bridge	*LS*	*1*	*$ 30,000.00*	*$ 30,000.00*
Curb & Gutter Type A	*LF*	*9998*	*$ 17.00*	*$ 169,966.00*
Curb & Gutter Type C-1	*LF*	*380*	*$ 10.00*	*$ 3,800.00*
Median Pavers	*SF*	*321*	*$ 20.00*	*$ 6,420.00*
5'x4' Curb Inlet	*EA*	*15*	*$ 4,000.00*	*$ 60,000.00*
8'x4' Curb Inlet	*EA*	*16*	*$ 5,500.00*	*$ 88,000.00*
11'x4' Curb Inlet	*EA*	*4*	*$ 7,250.00*	*$ 29,000.00*
6'x6' Junction Box	*EA*	*1*	*$ 5,000.00*	*$ 5,000.00*
18" Pipe	*LF*	*1496*	*$ 75.00*	*$ 112,200.00*
24" Pipe	*LF*	*1616*	*$ 90.00*	*$ 145,440.00*
30" Pipe	*LF*	*522*	*$ 120.00*	*$ 62,640.00*
36" Pipe	*LF*	*250*	*$ 160.00*	*$ 40,000.00*
48" Pipe	*LF*	*100*	*$ 200.00*	*$ 20,000.00*
54" Pipe	*LF*	*389*	*$ 220.00*	*$ 85,580.00*
72" Pipe	*LF*	*150*	*$ 250.00*	*$ 37,500.00*
5'x3' RCB	*LF*	*87*	*$ 400.00*	*$ 34,800.00*
8'x4' RCB	*LF*	*129*	*$ 550.00*	*$ 70,950.00*
30" End Section	*EA*	*4*	*$ 1,800.00*	*$ 7,200.00*
54" End Section	*EA*	*4*	*$ 2,000.00*	*$ 8,000.00*
72" End Section	*EA*	*2*	*$ 2,500.00*	*$ 5,000.00*
5'x3' RCB Wingwall	*EA*	*2*	*$ 15,000.00*	*$ 30,000.00*
8'x4' RCB Wingwall	*EA*	*2*	*$ 25,000.00*	*$ 50,000.00*
Retaining Wall (Power Poles)	*SF*	*2100*	*$ 45.00*	*$ 94,500.00*
Retaining Wall (Cart Underpass)	*SF*	*3150*	*$ 55.00*	*$ 173,250.00*
Pavement Marking & Signing	*LS*	*1*	*$ 10,000.00*	*$ 10,000.00*
Traffic Control	*LS*	*1*	*$ 5,000.00*	*$ 5,000.00*
Landscaping	*LS*	*1*	*$ 30,000.00*	*$ 30,000.00*
Asthetics Treatments	*LS*	*1*	*$ 20,000.00*	*$ 20,000.00*
Street Lighting	*LS*	*1*	*$ 100,000.00*	*$ 100,000.00*
Erosion Control	*LS*	*1*	*$ 15,000.00*	*$ 15,000.00*
Seeding & Sodding	*LS*	*1*	*$ 50,000.00*	*$ 50,000.00*
			Subtotal	*$ 3,507,607.00*
		Contingency	*15%*	*$ 526,141.05*
			Total	***$ 4,033,748.05***

Engineer's Opinion of Probable Construction Costs
T Intersection with Stop Control Alternative

Recap of Quantities (Asphalt Option)				
Bid Item	***Unit***	***Quantity***	***Extension***	***Cost***
2" Aphaltic Surface	*SY*	*20649*	*$ 8.00*	*$ 165,192.00*
8" Asphaltic Base	*SY*	*20649*	*$ 30.00*	*$ 619,470.00*
			Subtotal	*$ 784,662.00*
		Contingency	*15%*	*$ 117,699.30*
			Total	***$ 902,361.30***

Recap of Quantities (Concrete Option)				
Bid Item	***Unit***	***Quantity***	***Extension***	***Cost***
8" Portland Cement Concrete Pavement	*SY*	*20649*	*$ 55.00*	*$ 1,135,695.00*
			Subtotal	*$ 1,135,695.00*
		Contingency	*15%*	*$ 170,354.25*
			Total	***$ 1,306,049.25***

Option Total Costs Summary	
Pavement Option	***Cost***
Total Estimated Cost with Aphalt Pavement	*$ 4,936,109.35*
Total Estimated Cost with Concrete Pavement	*$ 5,339,797.30*

Engineer's Opinion of Probable Construction Costs
T Intersection with Traffic Signal Alternative

Recap of Quantities (Base Bid)				
Bid Item	***Unit***	***Quantity***	***Extension***	***Cost***
Construction Staking	*LS*	*1*	*$ 10,000.00*	*$ 10,000.00*
Removal of Existing Structures	*LS*	*1*	*$ 10,000.00*	*$ 10,000.00*
Clearing & Grubbing	*LS*	*1*	*$ 30,000.00*	*$ 30,000.00*
Unclassified Excavation	*CY*	*20500*	*$ 8.00*	*$ 164,000.00*
Embankment	*CY*	*76200*	*$ 5.00*	*$ 381,000.00*
Contractor Furnished Borrow (1.15%)	*CY*	*55700*	*$ 10.00*	*$ 557,000.00*
6" Compacted Subgrade	*SY*	*25989*	*$ 4.00*	*$ 103,956.00*
4" Sidewalk	*SF*	*25025*	*$ 5.00*	*$ 125,125.00*
6" Trail	*SF*	*49223*	*$ 7.00*	*$ 344,561.00*
6" Sidewalk Ramp	*SF*	*940*	*$ 7.00*	*$ 6,580.00*
4" Sidewalk/ Trail Subgrade	*SY*	*10523*	*$ 2.00*	*$ 21,046.00*
6" Concrete Pavement (Golf Cart Path)	*SY*	*255*	*$ 7.00*	*$ 1,785.00*
4" Aggregate Subgrade (Golf Cart Path)	*SY*	*306*	*$ 2.00*	*$ 612.00*
10'x10' RCB (Golf Cart Underpass)	*LF*	*97*	*$ 700.00*	*$ 67,900.00*
6" Concrete Trail (Recreational Trail Connection)	*SF*	*9704*	*$ 7.00*	*$ 67,928.00*
4" Aggregate Subgrade (Recreational Trail Connection)	*SY*	*1294*	*$ 2.00*	*$ 2,588.00*
Pedestrian Bridge	*LS*	*1*	*$ 30,000.00*	*$ 30,000.00*
Curb & Gutter Type A	*LF*	*9998*	*$ 17.00*	*$ 169,966.00*
Curb & Gutter Type C-1	*LF*	*380*	*$ 10.00*	*$ 3,800.00*
Median Pavers	*SF*	*321*	*$ 20.00*	*$ 6,420.00*
5'x4' Curb Inlet	*EA*	*15*	*$ 4,000.00*	*$ 60,000.00*
8'x4' Curb Inlet	*EA*	*16*	*$ 5,500.00*	*$ 88,000.00*
11'x4' Curb Inlet	*EA*	*4*	*$ 7,250.00*	*$ 29,000.00*
6'x6' Junction Box	*EA*	*1*	*$ 5,000.00*	*$ 5,000.00*
18" Pipe	*LF*	*1496*	*$ 75.00*	*$ 112,200.00*
24" Pipe	*LF*	*1616*	*$ 90.00*	*$ 145,440.00*
30" Pipe	*LF*	*522*	*$ 120.00*	*$ 62,640.00*
36" Pipe	*LF*	*250*	*$ 160.00*	*$ 40,000.00*
48" Pipe	*LF*	*100*	*$ 200.00*	*$ 20,000.00*
54" Pipe	*LF*	*389*	*$ 220.00*	*$ 85,580.00*
72" Pipe	*LF*	*150*	*$ 250.00*	*$ 37,500.00*
5'x3' RCB	*LF*	*87*	*$ 400.00*	*$ 34,800.00*
8'x4' RCB	*LF*	*129*	*$ 550.00*	*$ 70,950.00*
30" End Section	*EA*	*4*	*$ 1,800.00*	*$ 7,200.00*
54" End Section	*EA*	*4*	*$ 2,000.00*	*$ 8,000.00*
72" End Section	*EA*	*2*	*$ 2,500.00*	*$ 5,000.00*
5'x3' RCB Wingwall	*EA*	*2*	*$ 15,000.00*	*$ 30,000.00*
8'x4' RCB Wingwall	*EA*	*2*	*$ 25,000.00*	*$ 50,000.00*
Retaining Wall (Power Poles)	*SF*	*2100*	*$ 45.00*	*$ 94,500.00*
Retaining Wall (Cart Underpass)	*SF*	*3150*	*$ 55.00*	*$ 173,250.00*
Pavement Marking & Signing	*LS*	*1*	*$ 10,000.00*	*$ 10,000.00*
Traffic Signal	*LS*	*1*	*$ 250,000.00*	*$ 250,000.00*
Traffic Control	*LS*	*1*	*$ 5,000.00*	*$ 5,000.00*
Landscaping	*LS*	*1*	*$ 30,000.00*	*$ 30,000.00*
Asthetics Treatments	*LS*	*1*	*$ 20,000.00*	*$ 20,000.00*
Street Lighting	*LS*	*1*	*$ 100,000.00*	*$ 100,000.00*
Erosion Control	*LS*	*1*	*$ 15,000.00*	*$ 15,000.00*
Seeding & Sodding	*LS*	*1*	*$ 50,000.00*	*$ 50,000.00*
			Subtotal	*$ 3,743,327.00*
		Contingency	*15%*	*$ 561,499.05*
			Total	***$ 4,304,826.05***

Engineer's Opinion of Probable Construction Costs
T Intersection with Traffic Signal Alternative

Recap of Quantities (Asphalt Option)				
Bid Item	***Unit***	***Quantity***	***Extension***	***Cost***
2" Aphaltic Surface	*SY*	*20649*	*$ 8.00*	*$ 165,192.00*
8" Asphaltic Base	*SY*	*20649*	*$ 30.00*	*$ 619,470.00*
			Subtotal	*$ 784,662.00*
		Contingency	*15%*	*$ 117,699.30*
			Total	***$ 902,361.30***

Recap of Quantities (Concrete Option)				
Bid Item	***Unit***	***Quantity***	***Extension***	***Cost***
8" Portland Cement Concrete Pavement	*SY*	*20649*	*$ 55.00*	*$ 1,135,695.00*
			Subtotal	*$ 1,135,695.00*
		Contingency	*15%*	*$ 170,354.25*
			Total	***$ 1,306,049.25***

Option Total Costs Summary	
Pavement Option	***Cost***
Total Estimated Cost with Aphalt Pavement	*$ 5,207,187.35*
Total Estimated Cost with Concrete Pavement	*$ 5,610,875.30*

Engineer's Opinion of Probable Construction Costs
Roundabout Alternative

Recap of Quantities (Base Bid)				
Bid Item	***Unit***	***Quantity***	***Extension***	***Cost***
Construction Staking	*LS*	*1*	*$ 10,000.00*	*$ 10,000.00*
Removal of Existing Structures	*LS*	*1*	*$ 10,000.00*	*$ 10,000.00*
Clearing & Grubbing	*LS*	*1*	*$ 30,000.00*	*$ 30,000.00*
Unclassified Excavation	*CY*	*20500*	*$ 8.00*	*$ 164,000.00*
Embankment	*CY*	*76200*	*$ 5.00*	*$ 381,000.00*
Contractor Furnished Borrow (1.15%)	*CY*	*55700*	*$ 10.00*	*$ 557,000.00*
8" Concrete Pavement	*SY*	*2180*	*$ 55.00*	*$ 119,900.00*
6" Aggregate Subgrade (AB-3)	*SY*	*27484*	*$ 3.00*	*$ 82,452.00*
6" Compacted Subgrade	*SY*	*27484*	*$ 4.00*	*$ 109,936.00*
4" Sidewalk	*SF*	*25480*	*$ 5.00*	*$ 127,400.00*
6" Trail	*SF*	*51472*	*$ 7.00*	*$ 360,304.00*
6" Sidewalk Ramp	*SF*	*800*	*$ 7.00*	*$ 5,600.00*
4" Sidewalk/ Trail Aggregate Base (AB-3)	*SY*	*10820*	*$ 2.00*	*$ 21,640.00*
6" Concrete Pavement (Golf Cart Path)	*SF*	*2295*	*$ 7.00*	*$ 16,065.00*
4" Aggregate Subgrade (Golf Cart Path)	*SY*	*306*	*$ 2.00*	*$ 612.00*
10'x10' RCB (Golf Cart Underpass)	*LF*	*100*	*$ 700.00*	*$ 70,000.00*
6" Concrete Trail (Recreational Trail Connection)	*SF*	*9704*	*$ 7.00*	*$ 67,928.00*
4" Aggregate Subgrade (Recreational Trail Connection)	*SY*	*1294*	*$ 2.00*	*$ 2,588.00*
Pedestrian Bridge	*LS*	*1*	*$ 30,000.00*	*$ 30,000.00*
Curb & Gutter Type A	*LF*	*10229*	*$ 17.00*	*$ 173,893.00*
Curb & Gutter Type C-1	*LF*	*850*	*$ 10.00*	*$ 8,500.00*
Curb & Gutter Type KDOT Type I (Special)	*LF*	*357*	*$ 16.00*	*$ 5,712.00*
Curb & Gutter Type C-1 (Modified)	*LF*	*290*	*$ 10.00*	*$ 2,900.00*
Median Pavers	*SF*	*2191*	*$ 20.00*	*$ 43,820.00*
5'x4' Curb Inlet	*EA*	*15*	*$ 4,000.00*	*$ 60,000.00*
8'x4' Curb Inlet	*EA*	*16*	*$ 5,500.00*	*$ 88,000.00*
11'x4' Curb Inlet	*EA*	*4*	*$ 7,250.00*	*$ 29,000.00*
6'x6' Junction Box	*EA*	*1*	*$ 5,000.00*	*$ 5,000.00*
18" Pipe	*LF*	*1496*	*$ 75.00*	*$ 112,200.00*
24" Pipe	*LF*	*1616*	*$ 90.00*	*$ 145,440.00*
30" Pipe	*LF*	*522*	*$ 120.00*	*$ 62,640.00*
36" Pipe	*LF*	*250*	*$ 160.00*	*$ 40,000.00*
48" Pipe	*LF*	*100*	*$ 200.00*	*$ 20,000.00*
54" Pipe	*LF*	*486*	*$ 220.00*	*$ 106,920.00*
72" Pipe	*LF*	*150*	*$ 250.00*	*$ 37,500.00*
5'x3' RCB	*LF*	*87*	*$ 400.00*	*$ 34,800.00*
8'x4' RCB	*LF*	*129*	*$ 550.00*	*$ 70,950.00*
30" End Section	*EA*	*4*	*$ 1,800.00*	*$ 7,200.00*
54" End Section	*EA*	*4*	*$ 2,000.00*	*$ 8,000.00*
72" End Section	*EA*	*2*	*$ 2,500.00*	*$ 5,000.00*
5'x3' RCB Wingwall	*EA*	*2*	*$ 15,000.00*	*$ 30,000.00*
8'x4' RCB Wingwall	*EA*	*2*	*$ 25,000.00*	*$ 50,000.00*
Retaining Wall (Cart Underpass)	*SF*	*3150*	*$ 55.00*	*$ 173,250.00*
Pavement Marking & Signing	*LS*	*1*	*$ 10,000.00*	*$ 10,000.00*
Traffic Control	*LS*	*1*	*$ 5,000.00*	*$ 5,000.00*
Landscaping	*LS*	*1*	*$ 30,000.00*	*$ 30,000.00*
Asthetics Treatments	*LS*	*1*	*$ 20,000.00*	*$ 20,000.00*
Street Lighting	*LS*	*1*	*$ 100,000.00*	*$ 100,000.00*
Erosion Control	*LS*	*1*	*$ 15,000.00*	*$ 15,000.00*
Seeding & Sodding	*LS*	*1*	*$ 50,000.00*	*$ 50,000.00*
			Subtotal	*$ 3,717,150.00*
		Contingency	*15%*	*$ 557,572.50*
			Total	***$ 4,274,722.50***

Engineer's Opinion of Probable Construction Costs
Roundabout Alternative

Recap of Quantities (Asphalt Option)				
Bid Item	***Unit***	***Quantity***	***Extension***	***Cost***
2" Aphaltic Surface	*SY*	*27484*	*$ 8.00*	*$ 219,872.00*
8" Asphaltic Base	*SY*	*27484*	*$ 30.00*	*$ 824,520.00*
			Subtotal	*$ 1,044,392.00*
		Contingency	*15%*	*$ 156,658.80*
			Total	***$ 1,201,050.80***

Recap of Quantities (Concrete Option)				
Bid Item	***Unit***	***Quantity***	***Extension***	***Cost***
8" Portland Cement Concrete Pavement	*SY*	*27484*	*$ 55.00*	*$ 1,511,620.00*
			Subtotal	*$ 1,511,620.00*
		Contingency	*15%*	*$ 226,743.00*
			Total	***$ 1,738,363.00***

Option Total Costs Summary	
Pavement Option	***Cost***
Total Estimated Cost with Aphalt Pavement	*$ 5,475,773.30*
Total Estimated Cost with Concrete Pavement	*$ 6,013,085.50*

Appendix I

Future Traffic Volumes and LOS

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst		Intersection	Clear Creek and Gleason
Agency/Co.	Shafer, Kline & Warren Inc.	Jurisdiction	City of Shawnee, KS
Date Performed	2/26/2016	Analysis Year	Future with full development
Analysis Time Period	PM Peak Hr		

Project Description *Clear Creek Parkway Extension*

East/West Street: *Clear Creek* | North/South Street: *Gleason*

Intersection Orientation: *East-West* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		144	116	399	277	
Peak-Hour Factor, PHF	1.00	0.85	0.85	0.85	0.85	1.00
Hourly Flow Rate, HFR (veh/h)	0	169	136	469	325	0
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	1	1	0
Configuration			TR	L	T	
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	222		338			
Peak-Hour Factor, PHF	0.85	1.00	0.85	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	261	0	397	0	0	0
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	1	0	1	0	0	0
Configuration	L		R			

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		L	L		R			
v (veh/h)		469	261		397			
C (m) (veh/h)		1267	86		807			
v/c		0.37	3.03		0.49			
95% queue length		1.73	25.69		2.76			
Control Delay (s/veh)		9.5	1021		13.7			
LOS		A	F		B			
Approach Delay (s/veh)	--	--	413.3					
Approach LOS	--	--	F					

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ROUNDABOUT REPORT

General Information		Site Information	
Analyst		Intersection	*Clear Creek Pkwy and Gleason*
Agency or Co.	*Shafer, Kline & Warren Inc.*	E/W Street Name	*Clear Creek Parkway*
Date Performed	*3/1/2016*	N/S Street Name	*Gleason*
Time Period	*PM Peak Hour*	Analysis Year	*Future with Full Developoment*
		Project ID	*One Circulating Lane*

Project Description:

Volume Adjustment and Site Characteristics

	EB				WB				NB				SB			
	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	U
Number of Lanes(N)	0	1	0		0	1	0		0	1	0		0	0	0	
Volume (V), veh/h	0	144	116	0	399	277	0	0	222	0	338	0	0	0	0	0
Heavy Veh. Adj. (f_{HV}), %	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Peak Hour Factor (PHF)	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
No. of Pedestrians Crossing Entry	0				0				0				0			

Critical and Follow-Up Headway Adjustment

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (sec)	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929
Follow-Up Headway (sec)	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858

Flow Computations

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Circulating Flow (V_c), pc/h	479			266			173			1077		
Exiting Flow (V_{ex}), pc/h	579			598			0			618		
Entry Flow (V_e), pc/h		312			811			672			0	
Entry Volume veh/h		306			795			659				

Capacity and v/c Ratios

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Capacity (c_{PCE}), pc/h		700			866			950			385	
Capacity (c), veh/h		686			849			931			377	
v/c Ratio (X)		0.45			0.94			0.71				

Delay and Level of Service

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		11.6			39.3			16.2				
Lane LOS		B			E			C				
Lane 95% Queue		2.3			14.2			6.2				
Approach Delay, s/veh	11.63			39.26			16.18					
Approach LOS, s/veh	B			E			C					
Intersection Delay, s/veh	23.19											
Intersection LOS	C											

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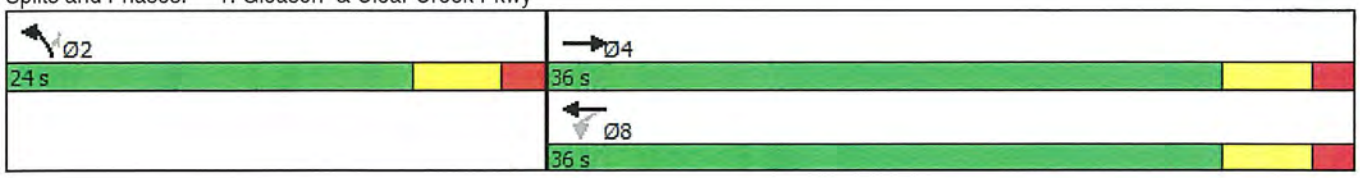
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	144	116	399	277	222	338
Future Volume (vph)	144	116	399	277	222	338
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)		0	200		0	0
Storage Lanes		0	1		1	1
Taper Length (ft)			25		25	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	0.940					0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	1751	0	1770	1863	1770	1583
Flt Permitted			0.574		0.950	
Satd. Flow (perm)	1751	0	1069	1863	1770	1583
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)	97					398
Link Speed (mph)	30			30	30	
Link Distance (ft)	335			328	520	
Travel Time (s)	7.6			7.5	11.8	
Peak Hour Factor	0.85	0.85	0.85	0.85	0.85	0.85
Adj. Flow (vph)	169	136	469	326	261	398
Shared Lane Traffic (%)						
Lane Group Flow (vph)	305	0	469	326	261	398
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(ft)	12			12	12	
Link Offset(ft)	0			0	0	
Crosswalk Width(ft)	16			16	16	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)		9	15		15	9
Number of Detectors	1		1	1	1	1
Detector Template	Thru		Left	Thru	Left	Right
Leading Detector (ft)	20		20	20	20	20
Trailing Detector (ft)	0		0	0	0	0
Detector 1 Position(ft)	0		0	0	0	0
Detector 1 Size(ft)	20		20	20	20	20
Detector 1 Type	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel						
Detector 1 Extend (s)	0.0		0.0	0.0	0.0	0.0
Detector 1 Queue (s)	0.0		0.0	0.0	0.0	0.0
Detector 1 Delay (s)	0.0		0.0	0.0	0.0	0.0
Turn Type	NA		Perm	NA	Prot	Perm
Protected Phases	4			8	2	
Permitted Phases			8			2
Detector Phase	4		8	8	2	2
Switch Phase						
Minimum Initial (s)	5.0		5.0	5.0	5.0	5.0
Minimum Split (s)	24.0		24.0	24.0	24.0	24.0
Total Split (s)	36.0		36.0	36.0	24.0	24.0

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Total Split (%)	60.0%		60.0%	60.0%	40.0%	40.0%
Maximum Green (s)	30.0		30.0	30.0	18.0	18.0
Yellow Time (s)	4.0		4.0	4.0	4.0	4.0
All-Red Time (s)	2.0		2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0		6.0	6.0	6.0	6.0
Lead/Lag						
Lead-Lag Optimize?						
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Recall Mode	None		None	None	None	None
Walk Time (s)	7.0		7.0	7.0	7.0	7.0
Flash Dont Walk (s)	11.0		11.0	11.0	11.0	11.0
Pedestrian Calls (#/hr)	0		0	0	0	0
Act Effct Green (s)	26.2		26.2	26.2	12.9	12.9
Actuated g/C Ratio	0.51		0.51	0.51	0.25	0.25
v/c Ratio	0.33		0.86	0.34	0.59	0.57
Control Delay	6.4		31.6	9.3	23.7	5.9
Queue Delay	0.0		0.0	0.0	0.0	0.0
Total Delay	6.4		31.6	9.3	23.7	5.9
LOS	A		C	A	C	A
Approach Delay	6.4			22.5	13.0	
Approach LOS	A			C	B	

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 51.5
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.86
Intersection Signal Delay: 16.1 — Intersection LOS: B
Intersection Capacity Utilization 64.1% — ICU Level of Service C
Analysis Period (min) 15

Splits and Phases: 1: Gleason & Clear Creek Pkwy



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	144	116	399	277	222	338
Future Volume (vph)	144	116	399	277	222	338
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)		0	200		0	0
Storage Lanes		0	1		1	1
Taper Length (ft)			25		25	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	0.940					0.850
Flt Protected			0.950		0.950	
Satd. Flow (prot)	1751	0	1770	1863	1770	1583
Flt Permitted			0.312		0.950	
Satd. Flow (perm)	1751	0	581	1863	1770	1583
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)	62					398
Link Speed (mph)	30			30	30	
Link Distance (ft)	335			328	520	
Travel Time (s)	7.6			7.5	11.8	
Peak Hour Factor	0.85	0.85	0.85	0.85	0.85	0.85
Adj. Flow (vph)	169	136	469	326	261	398
Shared Lane Traffic (%)						
Lane Group Flow (vph)	305	0	469	326	261	398
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(ft)	12			12	12	
Link Offset(ft)	0			0	0	
Crosswalk Width(ft)	16			16	16	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)		9	15		15	9
Number of Detectors	1		1	1	1	1
Detector Template	Thru		Left	Thru	Left	Right
Leading Detector (ft)	20		20	20	20	20
Trailing Detector (ft)	0		0	0	0	0
Detector 1 Position(ft)	0		0	0	0	0
Detector 1 Size(ft)	20		20	20	20	20
Detector 1 Type	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex
Detector 1 Channel						
Detector 1 Extend (s)	0.0		0.0	0.0	0.0	0.0
Detector 1 Queue (s)	0.0		0.0	0.0	0.0	0.0
Detector 1 Delay (s)	0.0		0.0	0.0	0.0	0.0
Turn Type	NA		pm+pt	NA	Prot	Perm
Protected Phases	4		3	8	2	
Permitted Phases			8			2
Detector Phase	4		3	8	2	2
Switch Phase						
Minimum Initial (s)	5.0		5.0	5.0	5.0	5.0
Minimum Split (s)	24.0		11.0	24.0	24.0	24.0
Total Split (s)	24.0		17.0	41.0	24.0	24.0

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Total Split (%)	36.9%		26.2%	63.1%	36.9%	36.9%
Maximum Green (s)	18.0		11.0	35.0	18.0	18.0
Yellow Time (s)	4.0		4.0	4.0	4.0	4.0
All-Red Time (s)	2.0		2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0		6.0	6.0	6.0	6.0
Lead/Lag	Lag		Lead			
Lead-Lag Optimize?	Yes		Yes			
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Recall Mode	None		None	None	None	None
Walk Time (s)	7.0			7.0	7.0	7.0
Flash Dont Walk (s)	11.0			11.0	11.0	11.0
Pedestrian Calls (#/hr)	0			0	0	0
Act Effct Green (s)	12.7		30.1	30.1	13.2	13.2
Actuated g/C Ratio	0.23		0.54	0.54	0.24	0.24
v/c Ratio	0.68		0.85	0.32	0.62	0.59
Control Delay	24.1		27.6	8.7	26.6	6.4
Queue Delay	0.0		0.0	0.0	0.0	0.0
Total Delay	24.1		27.6	8.7	26.6	6.4
LOS	C		C	A	C	A
Approach Delay	24.1			19.8	14.4	
Approach LOS	C			B	B	

Intersection Summary

Area Type: Other
Cycle Length: 65
Actuated Cycle Length: 55.5
Natural Cycle: 65
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.85
Intersection Signal Delay: 18.5 — Intersection LOS: B
Intersection Capacity Utilization 64.1% — ICU Level of Service C
Analysis Period (min) 15

Splits and Phases: 1: Gleason & Clear Creek Pkwy

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