THE CITY OF RALEIGH, NC MULTIMODAL TRANSIT CENTER REPORT ADDENDUM

S. WEST STREET EXTENSION ALTERNATIVES STUDY

SUMMARY

The Raleigh Multimodal Transportation Center(MTC) Study envisions an extension of S. West Street south from the current terminus immediately south of W. Martin Street. A grade separation structure at the Norfolk-Southern (NS) and North Carolina Railroad (NCRR) is proposed due to existing and anticipated rail and vehicular traffic. The study corridor spans the "Raleigh Wye", which strongly influences the need for the project and engineering requirements of the crossing. Multiple options exist to provide this connection, which would complete the downtown grid at a key location. This connection will provide vehicular and pedestrian connectivity which will be needed for access and traffic circulation at the MTC .

The City of Raleigh has prepared alternative horizontal and vertical alignments for this connection and developed the concept to a point where impacts can be identified and cost estimates prepared. Horizontal alignment alternatives are a direct north-south connection between W. Martin Street and W. Cabarrus Street, and a curving alignment that shifts the south connection point to the west with a tie to S. Saunders Street. Vertical alternatives are going over the railroad tracks or under. An optimum combination of horizontal and vertical alignment was selected as the Preferred Alternative.

OBJECTIVE

This alternatives analysis has been prepared to address the construction costs, impacts and feasibility of providing a grade-separated crossing of the NS and NCRR Railroad tracks. The study area is a north-south corridor from a northern terminus at S. West Street in the vicinity of W. Martin Street connecting to a southern terminus near W. Cabarrus Street, such that a useable new north-south travel corridor is formed **(Figure 1).**

The proposed design should provide an effective tie at W. Martin Street such that the intersection remains fully open to traffic; and also maintain two lanes of traffic on W. Cabarrus Street, which is an important east-west connection into downtown. Standard clearances at the overpass structures will be provided.

Design Criteria

Design Criteria is shown in Table 1 and is based on City of Raleigh standards except where superseded by AASHTO or NCDOT. The governing criteria used in the conceptual designs are shown in **Table 1**.

The desired minimum Design Speed is 35 mph based on the classification of S. West Street as a collector road; however due to the tight urban conditions design criteria for 30 mph was also developed and used in the design for comparison purposes. The benefit of the lower Design speed is reduced K values, reduced minimum radii at intersections, reduced minimum centerline radii, and less restrictive superelevation requirements that allow greater flexibility for fitting the alignment to the conditions.

Maximum grades and other grade requirements do not change with the reduced design speed.

An important design consideration is that sag curves can provide acceptable safe operating speed in well-lit locations.

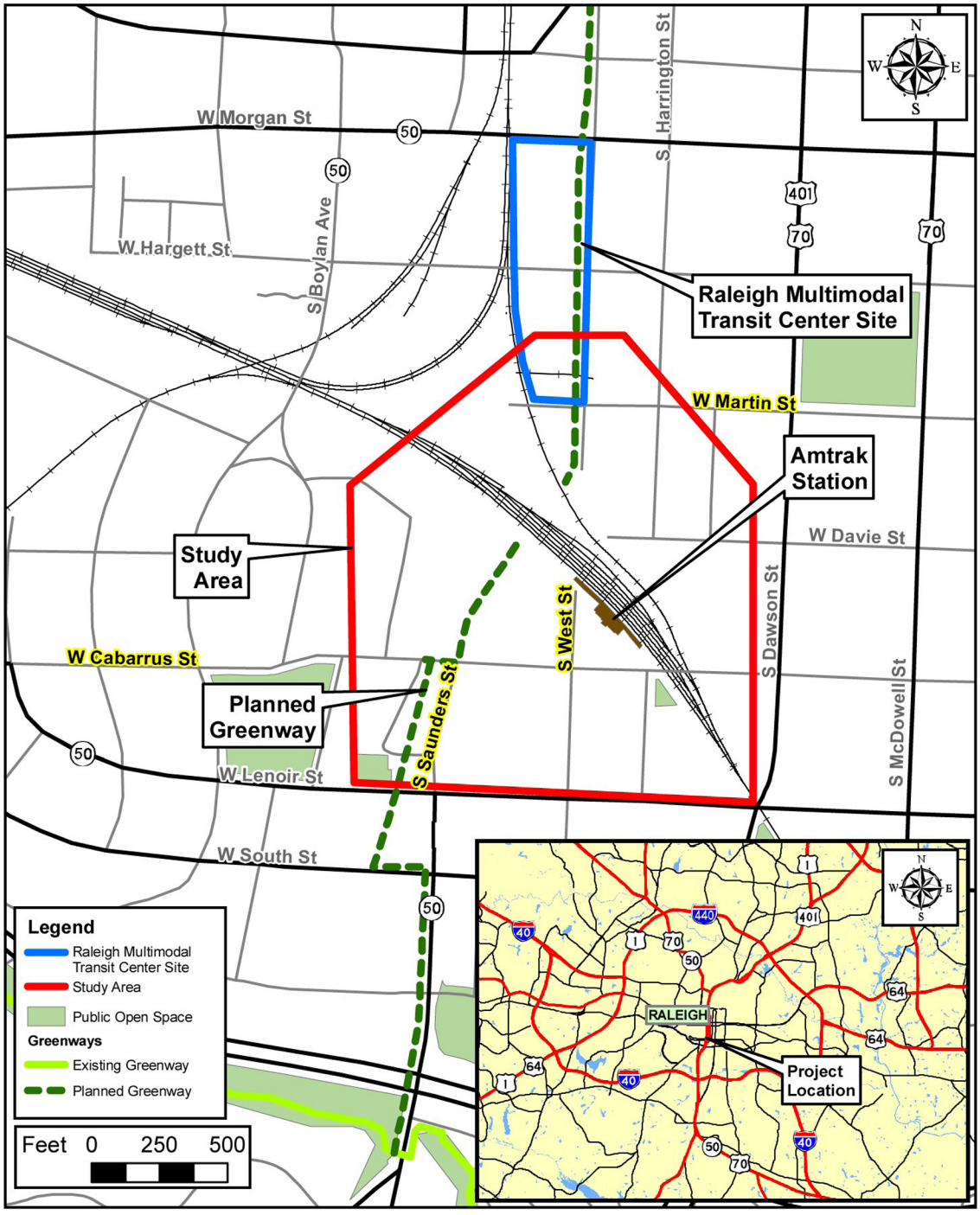


Figure 1 - Location Map

Table 1
Design Criteria

ROUTE	S. West Street	S. West Street	REFERENCE OR REMARKS
LINE	**-L1- or -L2-**	**-L1- or -L2-**	
CLASSIFICATION	Collector Street	Collector Street	COR 2.2
TERRAIN TYPE	Level	Level	RMI 1-1D
DESIGN SPEED mph	35	30	RMI 1-1B
POSTED SPEED mph	unposted	unposted	Statutory 35 mph in City Limits
PROP. R/W WIDTH ft	60	60	COR 3.1, Table 1
CONTROL OF ACCESS	No	No	COR 2.2
CURB AND GUTTER (Y/N)	Yes	Yes	COR 3.3 (2'-6" per NCDOT Std. Dwg. No. 846.01)
TYPICAL SECTION TYPE	2-Lane 2-way	2-Lane 2-way	
LANE WIDTH ft	12	12	AASHTO 04 pg.433
SIDEWALKS (Y/N)	Yes (one side)	Yes (one side)	COR 3.4
BICYCLE LANES (Y/N)	Yes	Yes	Also 10' multi-use path on one side
MEDIAN WIDTH ft	n/a	n/a	
MED. PROTECT. (GR/BARRIER)	n/a	n/a	
GRADE			
MAX.	9%	9%	COR 4.4, Table 5
MIN.	0.75%	0.75%	COR 4.4, Table 5
VERTICAL ALIGNMENT			
MIN. VERTICAL CURVE LENGTH ft	110	110	COR 4.4, Table 5
SAG K VALUE	49 (50)	37 (28)	AASHTO 04 Ex. 3-75 (COR 4.4, Table 5)
CREST K VALUE	29 (50)	19 (28)	AASHTO 04 Ex. 3-72 (COR 4.4, Table 5)
HORIZONTAL ALIGNMENT			
MAX. SUPERELEVATION ft/ft	0.04 **	n/a	COR 4.4, Table 4
MIN. CENTERLINE RADIUS ft	395	300	COR 4.4, Table 4
MIN. TANGENT BETWEEN REVERSE CURVES ft	200	0	COR 4.4, Table 4

ROUTE	S. West Street	S. West Street	REFERENCE OR REMARKS
LINE	-L1- or -L2-	-L1- or -L2-	
SPIRAL (Y/N)	No	No	RMI 1-11
CROSS-STREET INTERSECTION ANGLE ***	75°-90°	75°-90°	COR 4.5
CROSS SLOPES			
PAVEMENT	2.0%	2.0%	RMI 1-3B
PLANTING STRIPS	2.0%	2.0%	RMI 1-7D
SIDEWALKS	2.0%	2.0%	RMI 1-7D
CLEARANCES			
ROADWAY	16’	16’	AASHTO
RAIL	23’	23’	FRA

NOTES:

COR = City of Raleigh Streets, Sidewalks, and Driveway Access Handbook 1995 Edition, Revised January 2009

RMI = NCDOT Roadway Design Manual, Part I

AASHTO 04 = A Policy on Geometric Design of Highways and Streets 2004 Fifth Edition

** Per COR 4.4, at signalized intersections, the maximum grade approaching an intersection should not exceed 2% and extend a minimum distance of 200 feet in each direction measured from the outside edge of travel way of the intersecting street.*

For unsignalized intersections, the maximum grade approaching the intersection should not exceed 5 percent and extend a minimum distance of 100 feet in each direction.

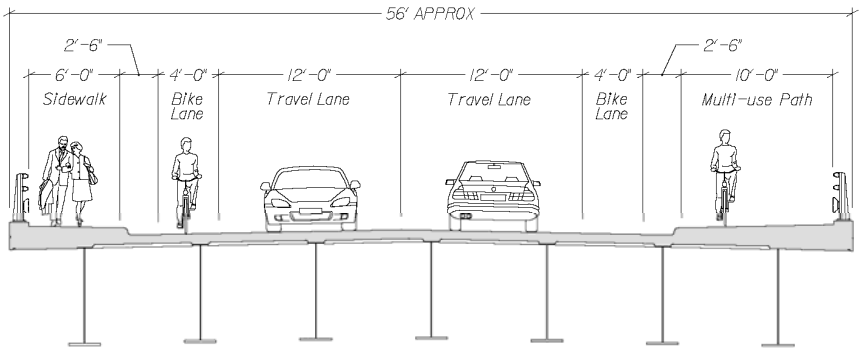
*** AASHTO 04 Ex. 3-16 Minimum Radii and Superelevation for Low-Speed Urban Streets may be applied for this project. For design speed of 35 mph, a horizontal curve radius with radius of 408 ft can be superelevated at 0.02 ft/ft. For design speed of 35 mph, a horizontal curve with radius of 510 ft can be held at normal crown.*

**** Per COR 4.3, a tangent roadway section no less than 100 feet long is required approaching an intersection.*

TYPICAL SECTION

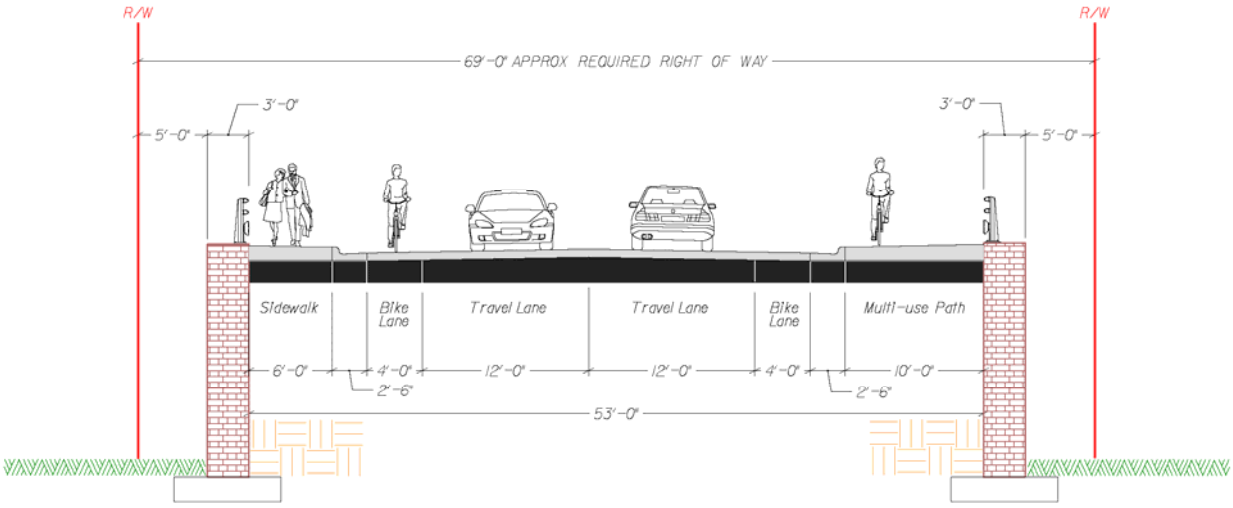
Typical sections have been developed to accommodate vehicular traffic needs while incorporating bicycle and pedestrian features appropriate for the setting **(Figure 2**). The potential northerly extension of a planned greenway along the unnamed tributary to Rocky Branch is reflected in the typical section by incorporating a sidewalk width meeting multi-use path requirements.

Typical sections were prepared for both fill and cut situations. These assumed vertical walls rather than cut or fill slopes in consideration of the highly urbanized conditions. It is possible that during detailed design there may be select locations where cut and fill slopes prove more economical based on R/W appraisals or value engineering, however for purposes of this study the assumed cross section is most representative from a cost standpoint of what may be encountered when actually building the project.



WEST STREET BRIDGE OVER RAILROAD

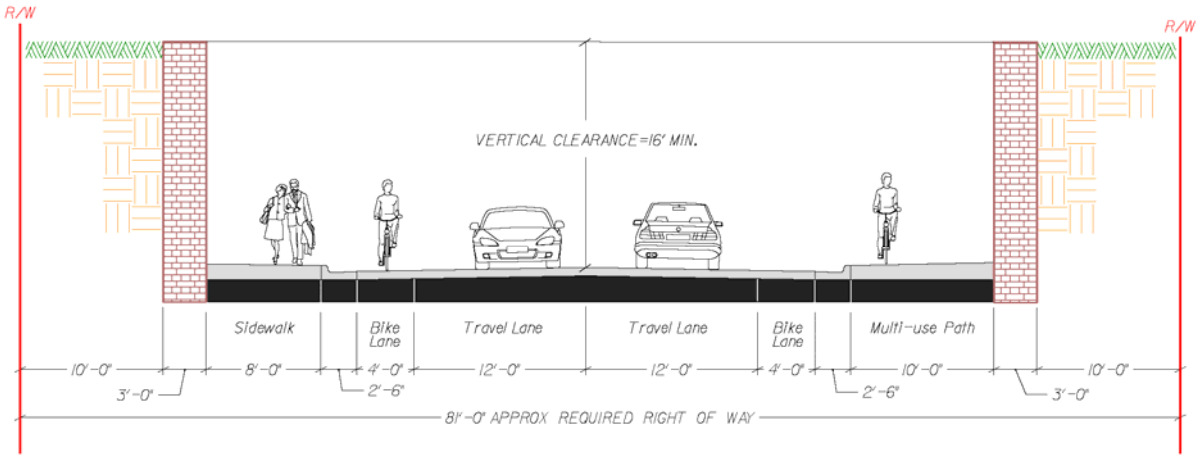
23.0 FEET MINIMUM VERTICAL CLEARANCE



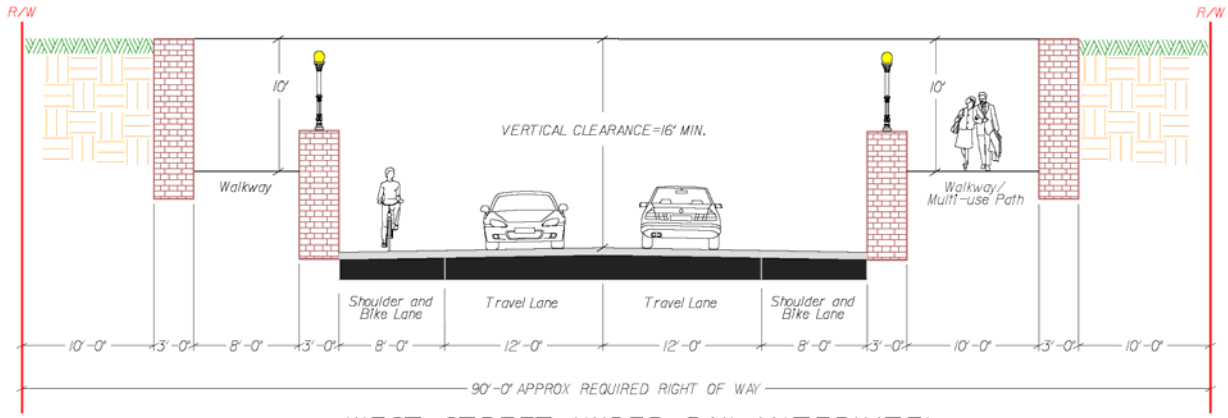
WEST STREET OVER RAIL

FILL SECTION

Figure 2 – Typical Sections



WEST STREET UNDER RAIL



WEST STREET UNDER RAIL (ALTERNATE)

"TERRACED CUT" TYPICAL SECTION

Figure 2 (Continued) – Typical Sections

A roadway bridge overpass typical section was prepared as a basis for cost estimates and to demonstrate the potential structure depth that will be encountered due to the span length. A railroad bridge (roadway underpass) was designed to have a structure depth of 6.3 feet.

ALTERNATIVES

Several key objectives directed the development of alternatives for detailed conceptual design. In general, the alternatives represent the full range of options available within the primary constraint of a tie to the existing intersection at S. West Street and W. Martin Street.

- Match existing grade at W. Martin Street. (Keep W. Martin Street open)
- Match existing grade at W. Cabarrus Street. (Keep W. Cabarrus Street open)
- Consider alignments that connect S. West Street @ W. Martin Street to S. West Street at W. Cabarrus Street.
- Consider alignments that connect S. West Street @ W. Martin Street to S. Saunders Street at W. Cabarrus Street.
- A southern terminus that can be extended and provide traffic service to the south is preferred.
- Consider any other connections that make sense.

Alternative corridors were briefly considered but eliminated due to the railroad yard and "Raleigh Wye" to the west and the presence of an existing, parallel corridor to the east (S. Dawson Street).

Design constraints include:

- The Raleigh Contemporary Arts Museum
- Structures on the southeast corner of W. Martin Street and S. West Street. (Need Cultural Resources Assessment to determine historical significance)
- Privately owned office and industrial buildings with associated parking (north and south approaches).
- Residences on S. Saunders Street (potential historic resource).
- Contamination at former PSNC Gas site.
- Terrain and elevation changes particularly drop in the southeast part of the study area.
- Grade of railroad tracks (cannot be changed)
- Contaminated properties

Note: It is assumed that the AMTRAK station will be relocated prior to commencement of this project.

The conceptual designs (Appendix A) establish a footprint which includes width outside of the sidewalk to account for constructability and consideration of retaining wall tiebacks.

HORIZONTAL ALIGNMENTS

The full range of possible horizontal alignments was considered. Given the need to maintain the intersection of S. West Street at W. Martin Street, the range of connection points at the south termini is limited by allowable curvature and the desirability of connecting at a street which would serve as a continuing route to the south. These objectives reduced the number of possible southern connection points to the existing intersections of S. Saunders Street and S. West Street at W. Cabarrus Street.

L1 *is a tangent line connecting the S. West Street centerline at W. Martin Street to the S. West Street centerline at W. Cabarrus Street. This essentially centers the proposed improvements over the existing Right of Way of S. West Street.*

L1 Modified *holds similar Begin and End Points but shifts to the east using deflections and curvature to achieve a roadway alignment shift that allows all Right of Way acquisition to be limited to one side. The east side was chosen because that shift would make maximum use of the Amtrak property and shift away from the potentially historic structures on the west side of S. West Street south of W. Martin Street. A similar "mirror image" alignment could be developed to shift west is detailed Right of Way cost analysis and environmental investigation indicated such a shift would be beneficial.*

L2 *utilizes reverse curves separated by 329 feet of tangent to effect a shift to the west to tie the south end of the corridor to South Sanders street. Curvature was chosen to avoid the need for superelevation.*

VERTICAL ALIGNMENTS

Two options exist for developing the roadway/rail grade separation. The roadway could bridge over the railroad tracks (termed Road Over Rail in the analysis), alternatively the roadway could be lowered sufficiently to allow the railroad tracks to bridge over the roadway (Road Under Rail) while maintaining the existing profile grade of the rail lines.

In either case, profile has the greatest effect on how the project will fit the key constraints, particularly the ability of a particular alignment to match at the endpoints of W. Martin Street and W. Cabarrus Street. Design Speed also has a pronounced effect on profile, limiting grade and vertical curvature in order to provide a safe facility. Crest vertical curves are perhaps the most critical design feature because they limit sight distance for the driver.

Various combinations of grades and vertical curve lengths were developed in order to narrow down a range of possible profiles that represent the most viable or optimum alignments. The profile characteristics are dependant on the length of roadway between touchdown points. Each profile is therefore attached to a horizontal alignment alternative (L1, L1 Mod, or L2) as summarized in **Table 2**.

It was determined that the desirable 35 mph could not be used for all vertical curves while matching grade at the end points of W. Martin Street and W. Cabarrus Street. Alternative profiles were developed, each with distinguishing combinations of vertical curvature and grades.

Maximum allowable grades are important because they will dictate the speed of trucks or other large vehicles. A "level" landing area (2% or less) is also needed on the approach to intersections.

Table 2
Summary of Alternatives

ROAD OVER RAIL OPTIONS			
ALTERNATIVE	**CREST**	**GRADES**	**TOUCHDOWN POINTS**
L1 OVER-1 West-to West	35 MPH (MINIMUM)	9% (MAXIMUM ALLOWABLE)	BLOCKS W. MARTIN STREET BLOCKS W. CABARRUS STREET
L1 OVER-2 West-to-West	30 MPH (less than minimum)	8%	BLOCKS W. MARTIN STREET BLOCKS W. CABARRUS STREET
L1 OVER-3 West-to-West	35 MPH (minimum)	8%	BLOCKS W. MARTIN STREET SPANS W. CABARRUS STREET
L2 OVER-4 West-to-S.Saunders Street	35 MPH	9% (MAXIMUM ALLOWABLE)	BLOCKS W. MARTIN STREET

ROAD UNDER RAIL OPTIONS			
ALTERNATIVE	**SAG**	**GRADES**	**TOUCHDOWN POINTS**
L1 UNDER West-to-West	30 MPH	9% (MAXIMUM)	MATCHES GRADE AT W. MARTIN AND W. CABARRUS STREETS. Approach grades are 4 and 5% respectively
L1 (MOD) UNDER West-to-West	25 MPH	9% (MAXIMUM)	MATCHES GRADE AT W. MARTIN AND W. CABARRUS STREETS. Approach grades are 4 and 5% respectively
L2 UNDER West-to-S. Saunders Street	35 MPH	< 7%	MATCHES GRADE AT W. MARTIN AND W. CABARRUS STREETS. Provides desirable 2% approach grades.

Table 2 and the accompanying conceptual designs demonstrate that a S. West Street overpass cannot be designed to touch down at W. Martin Street and/or W. Cabarrus Street, even using less than minimum design speed criteria. Placing the roadway under the rail lines can be forced to match at the desired cross streets. Only the S. West Street to S. Saunders Street provides the desired design speed **and** approach grades at intersections.

DRAINAGE

A critical design constraint for all alternatives that lower the roadway below existing grade (Road Under Rail) is the ability to provide positive drainage. All of these alternatives assume construction of a pipe southwesterly to the mouth of an existing culvert that extends the unnamed tributary to Rocky Branch north of W. Cabarrus Street. Available contour information places that low point at approximately elevation 284 MSL. The conceptual designs for S. West Street produce a low point above this elevation. Detailed design will have to consider the elevation of the proposed roadway at the low point of the sag vertical curve when setting geometry and clearances to ensure positive drainage.

COST ESTIMATES

Table 3 provides a summary comparison of the alternatives. Detailed Construction Cost Estimates are in Appendix B.

Table 3
Cost Estimates

Road over Rail	
Alternative (Horizontal/Connection/Crest DS)	**Construction Cost** (million)
L1 /West to West/35mph	$9.7
L1 Mod/West to West/30 mph	$9.3
L1/ West over W. Cabarrus/40 mph	$13.2
L2 / West to S. Saunders / 35 mph	$12.6

Road Under Rail	
Alternative (Horizontal/Connection/DS)	**Construction Cost** (million)
L1 / West to West / 30 mph	$20.6
L 2 / West to S. Saunders/35 mph	$18.0

Note: Estimates do not include right-of-way, environmental cleanup, replacement of the existing culvert through the PSNC site, or greater-than-standard railroad horizontal clearance requirements.

ENVIRONMENTAL COMMENTS

The major environmental contamination site for the project is the Raleigh Manufactured Gas Plant (MGP) No. 2 site. MGP No. 2 is under voluntary remedial action by the responsible party (PSNC Energy). According to their "Environmental Remediation Statement" being advertised with their "For Sale" package, site cleanup has been completed for now and long-term groundwater monitoring is ongoing

(likely to continue for 6-8 years, according to PSNC). The contamination was discovered around 1991 and preliminary assessment completed in 1993. The site is listed in CERCLIS and is a state-lead cleanup activity (as opposed to Federal).

The project area is surrounded by several other contaminated/remediated sites, including small-quantity generators of hazardous waste and underground storage tanks (UST) incidents. It is advisable for the City to be fully aware of these constraints, as they could affect the schedule of any proposed construction if not addressed early. Generally, all sites are the responsibility of the original owner and most cleanup activities rely on the original owner for remediation costs.

CONCLUSION

The Preferred Alternative derived in this study is "L2 Under" which extends S. West Street at W. Martin Street southwesterly under the railroad tracks to the S. Saunders Street/W. Cabarrus Street intersection (**Figure 3**). This alternative provides the best result meeting the following project requirements:

- Ability to provide clearance over or under the railroad tracks.
- Maintenance of traffic operations on W. Martin Street and W. Cabarrus Street.
- Minimum (or better) design standards for vertical and horizontal geometry.
- Safest possible intersection approaches.
- Continuation of traffic service south of W. Cabarrus Street, and on to NC 50 which crosses I-40.
- Avoidance of existing building structures.
- An additional benefit of the preferred alternative is aesthetic considerations, specifically reduced visual intrusion provided by lowering the roadway.

Other alternatives fail one or more of the key criteria and in some cases are not viable due to unworkable touch down points.

L2 Under is more costly than alternatives that carry the roadway over the railroad tracks. This is largely due to more expensive deep cuts and retaining walls, railroad overpass structures are more expensive per square foot than roadway bridge structures, and drainage conditions are more challenging. This alternative will also involve a contaminated site and possibly require reconstruction of an existing outfall.

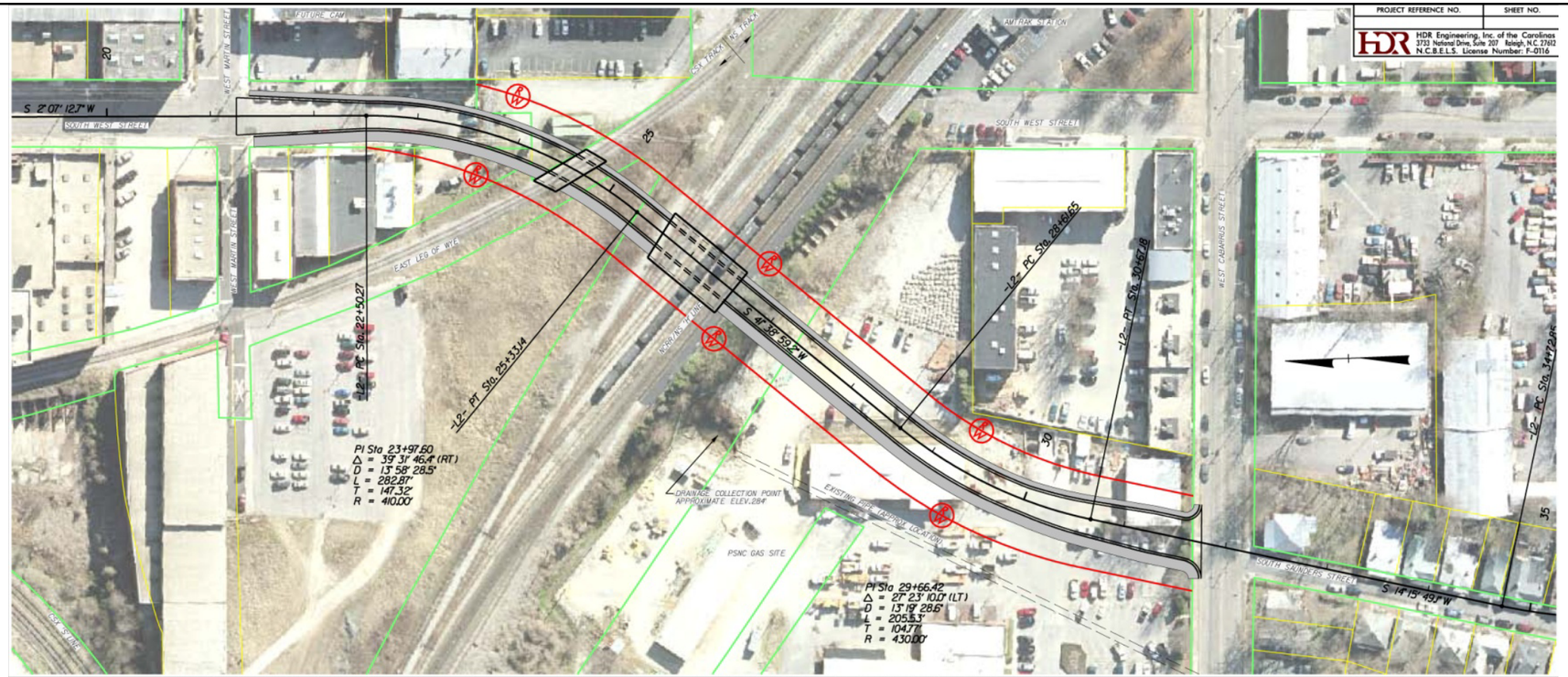


Figure 3 – Preferred Alternative

Appendix A

Conceptual Design Plans

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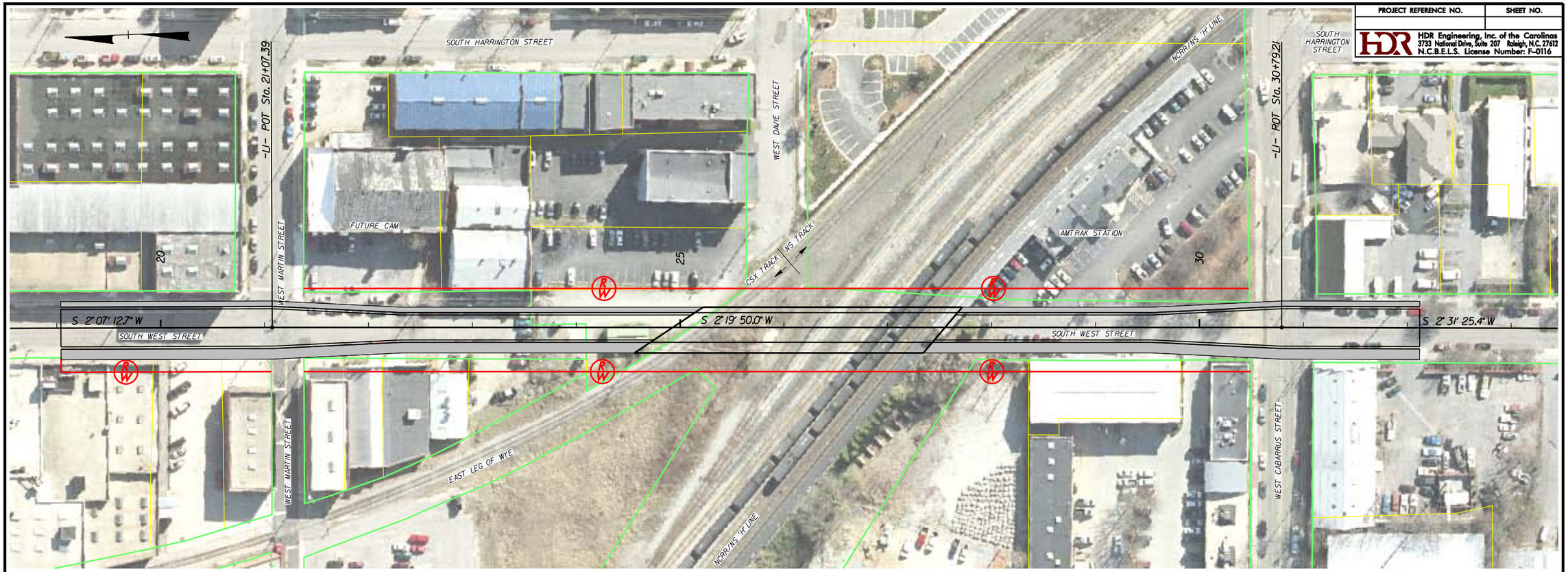

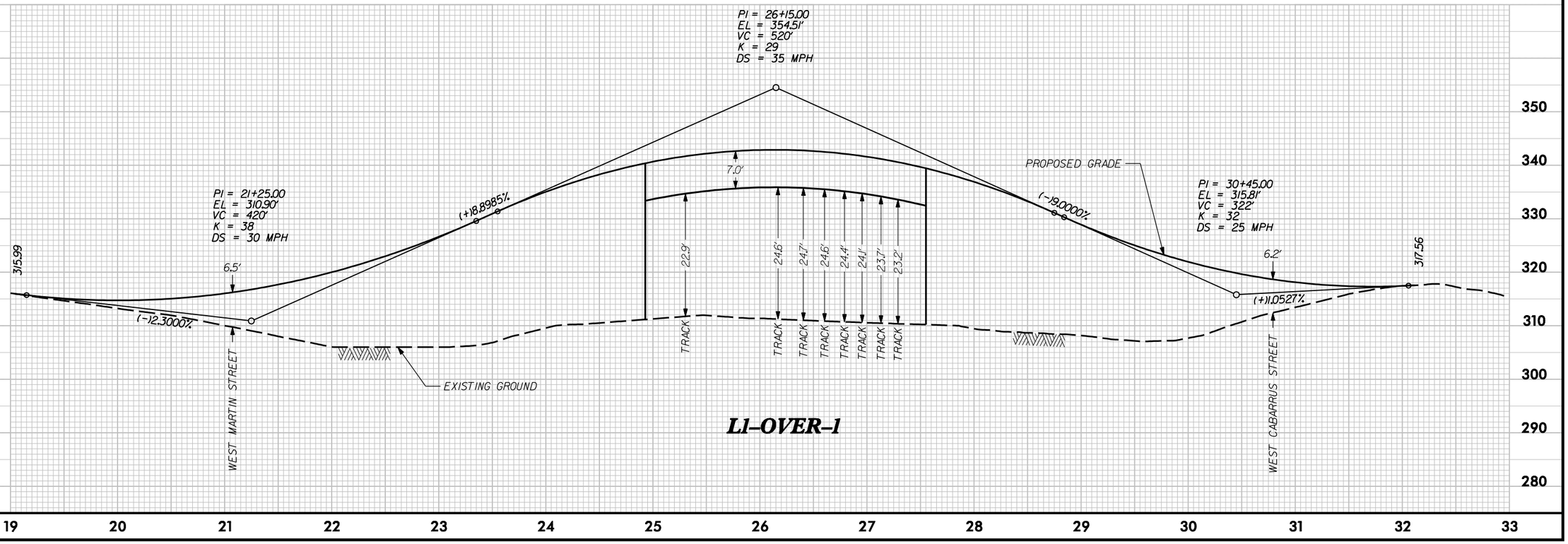

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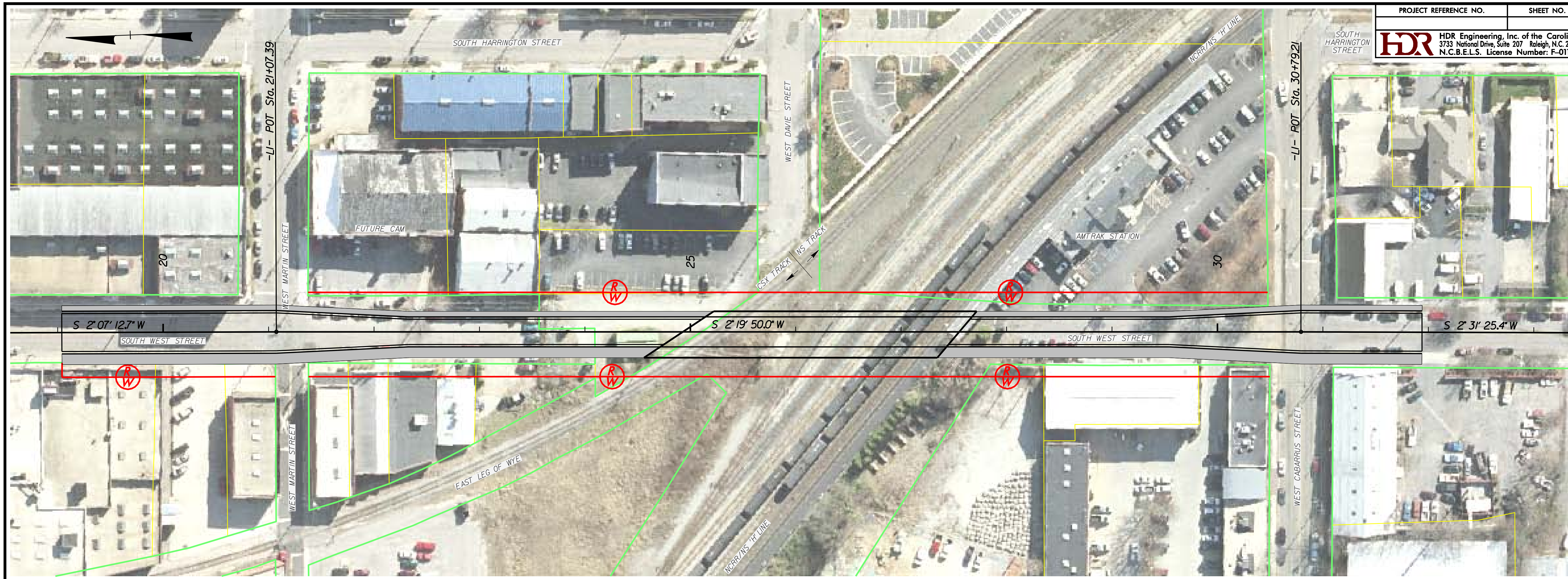

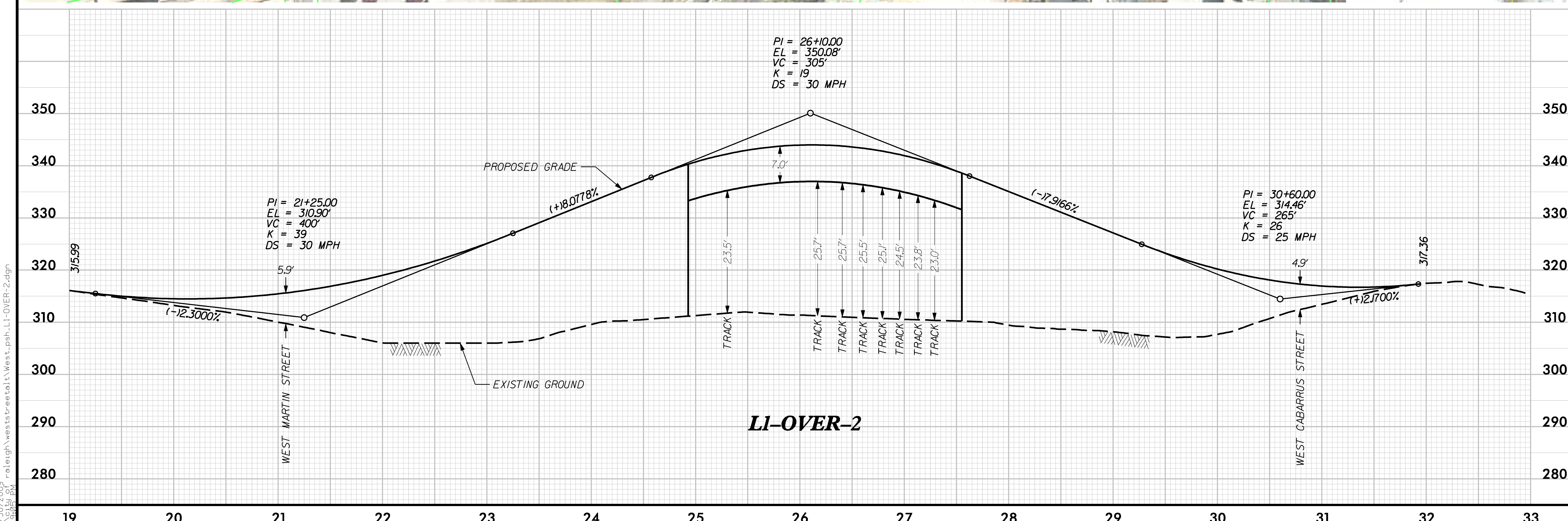

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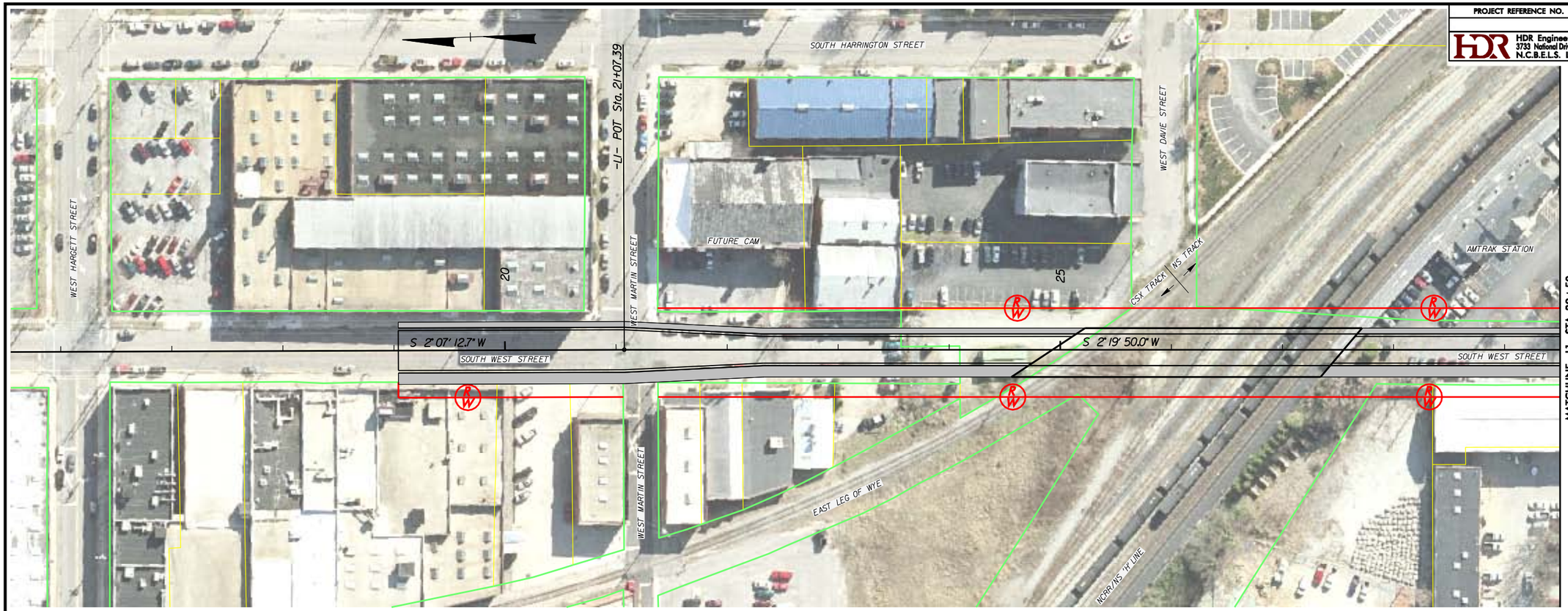

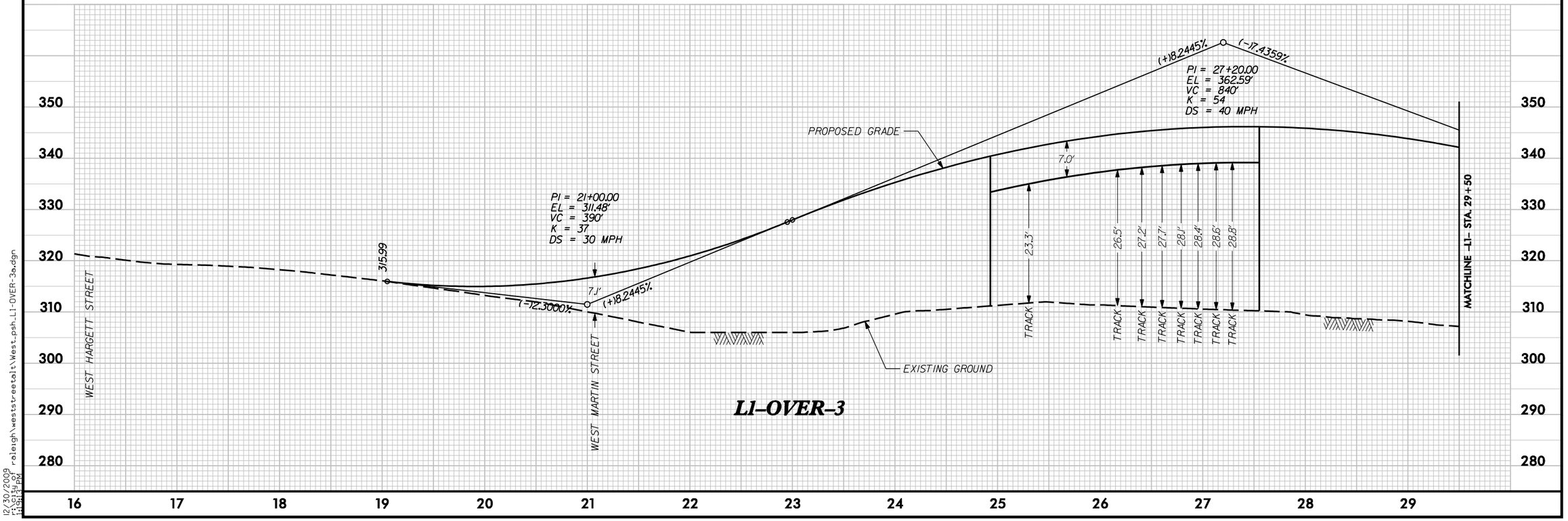

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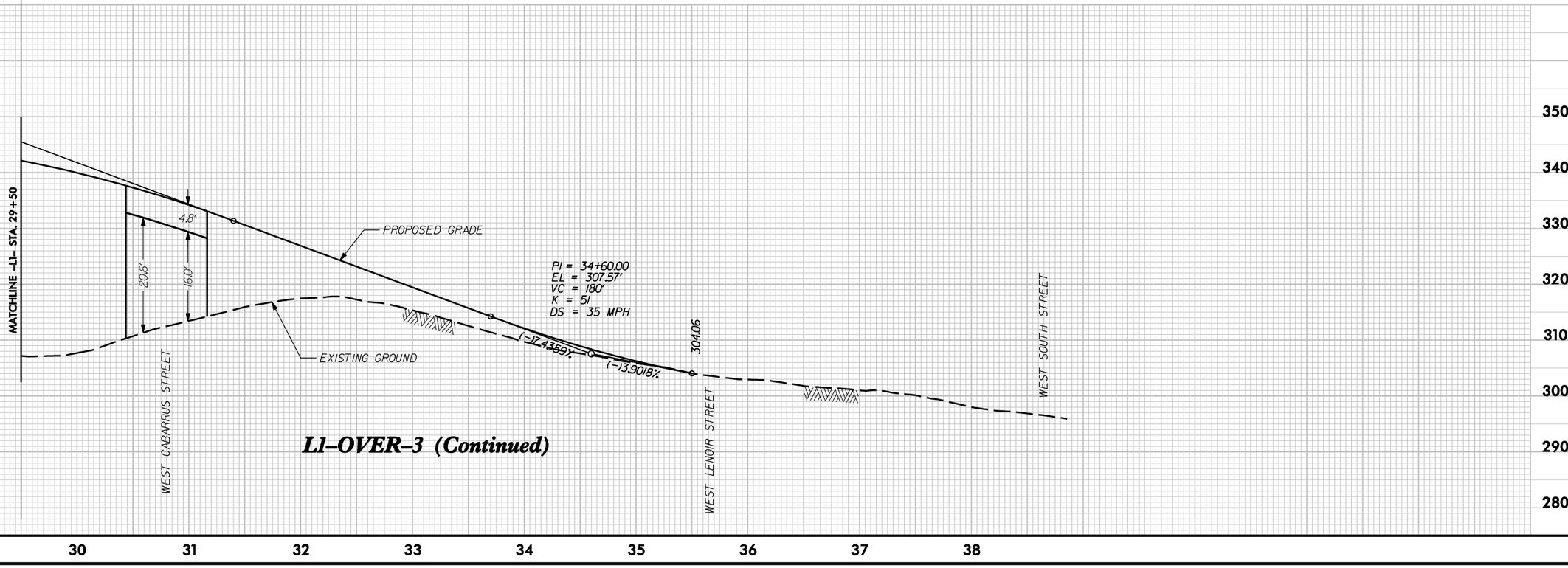

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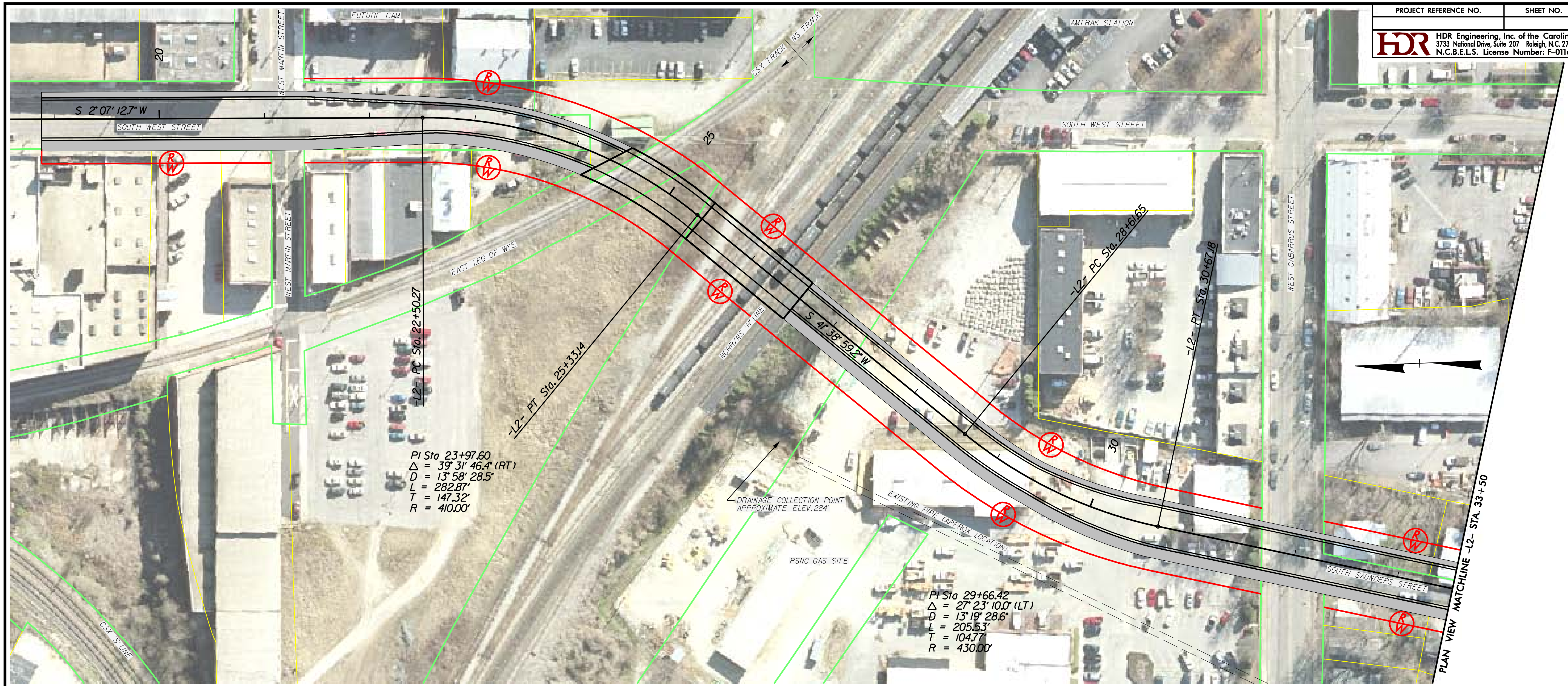

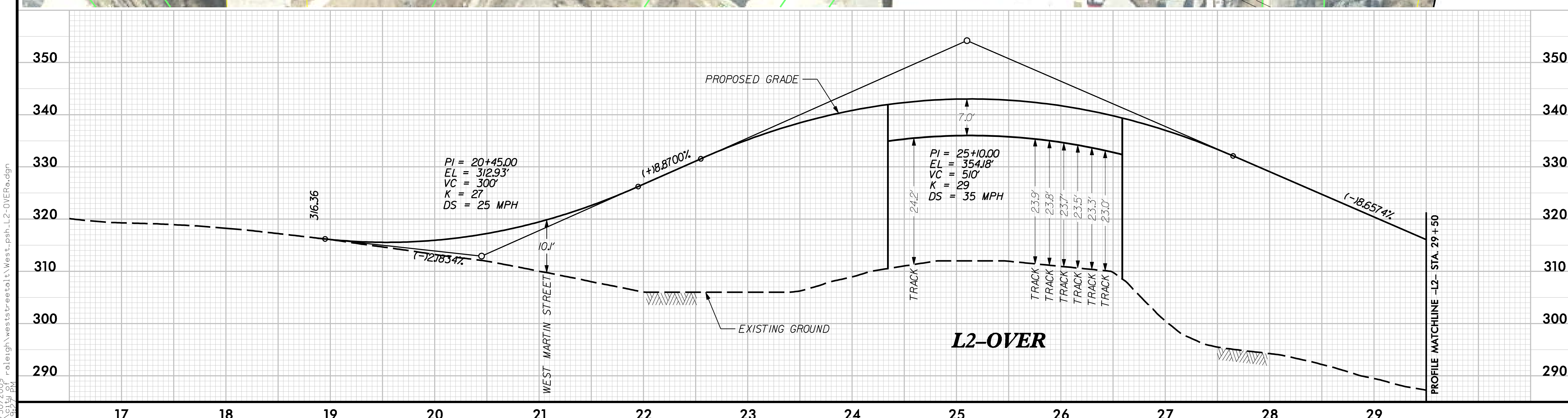

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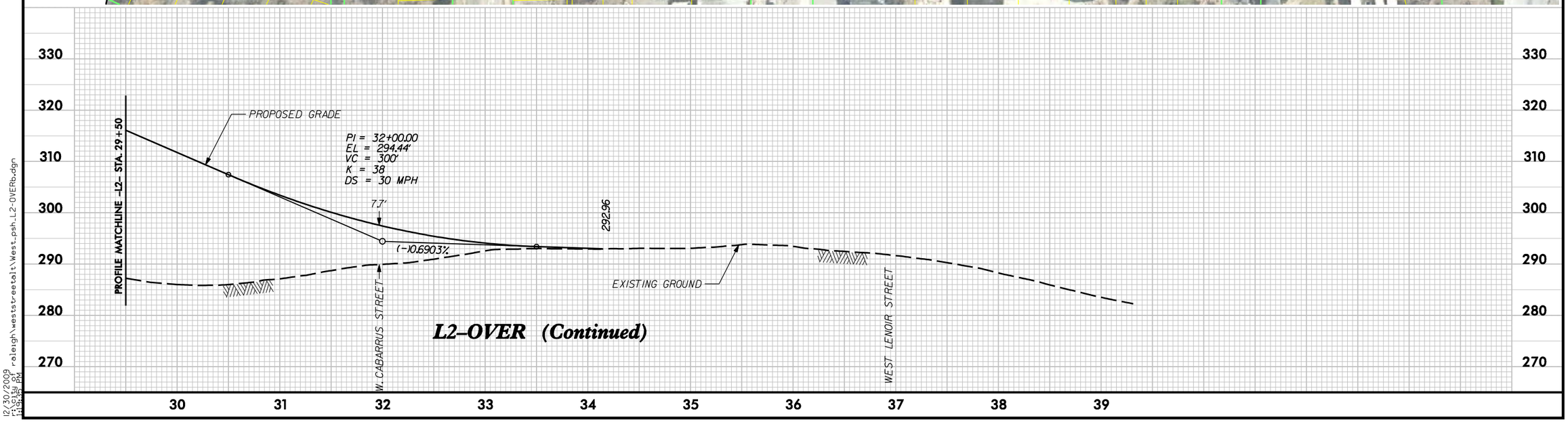

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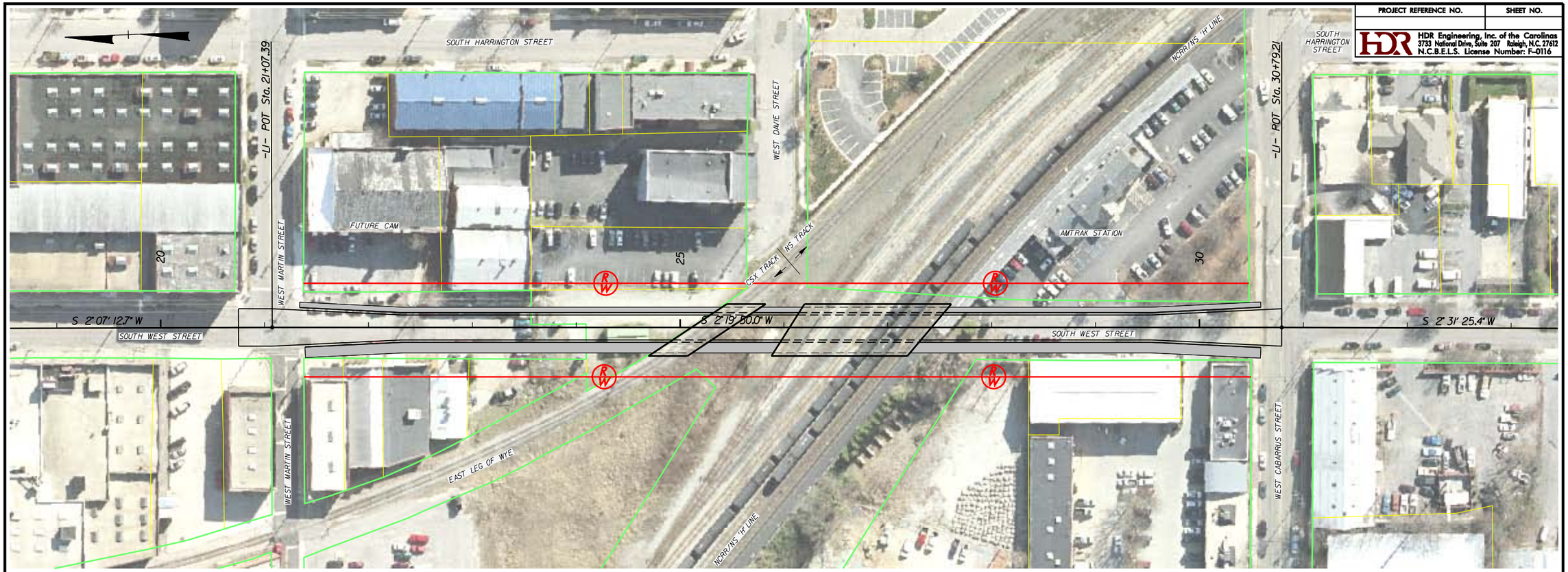

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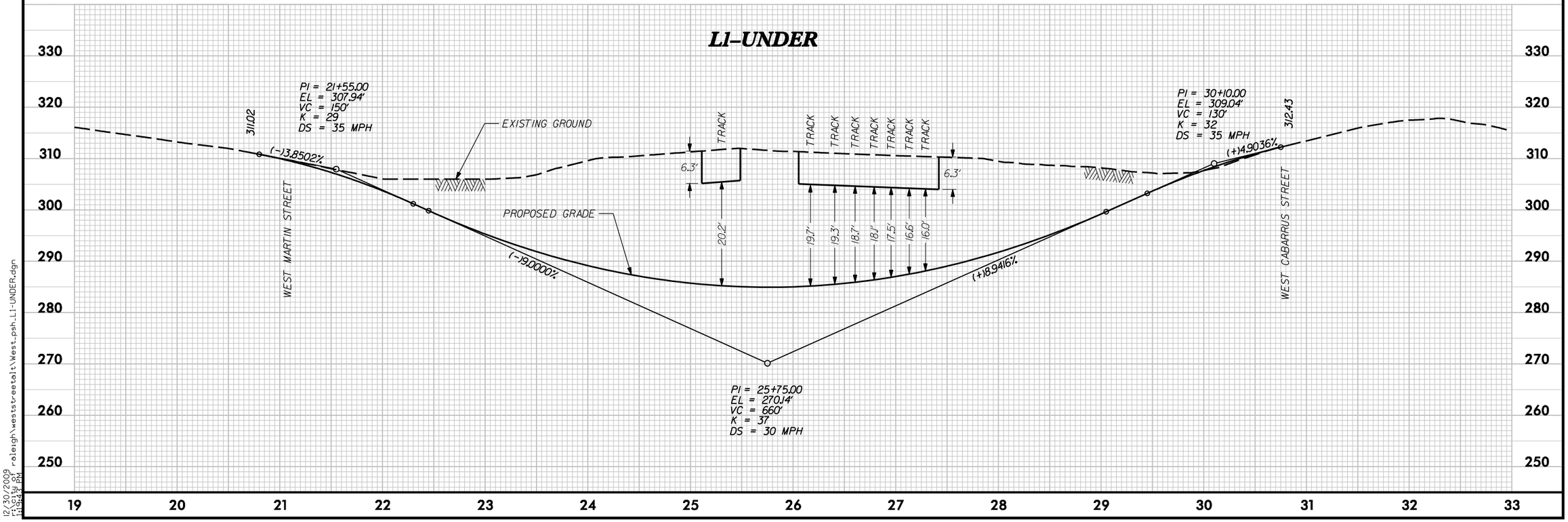

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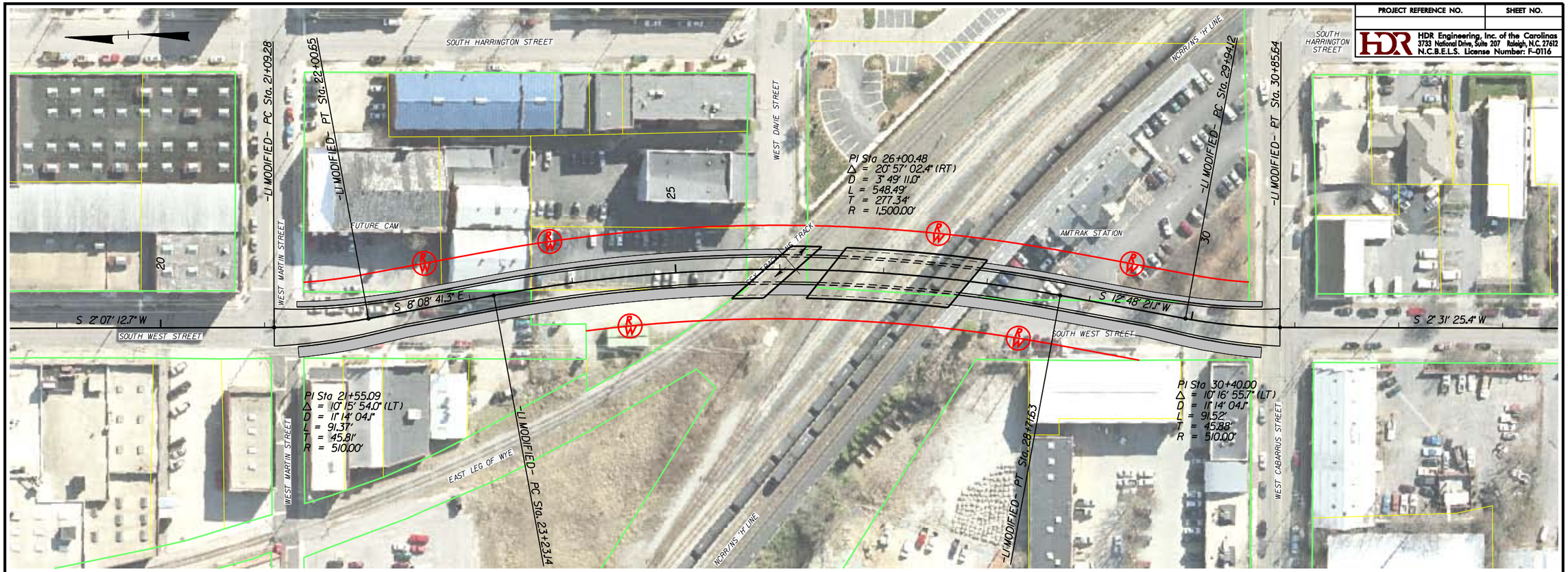

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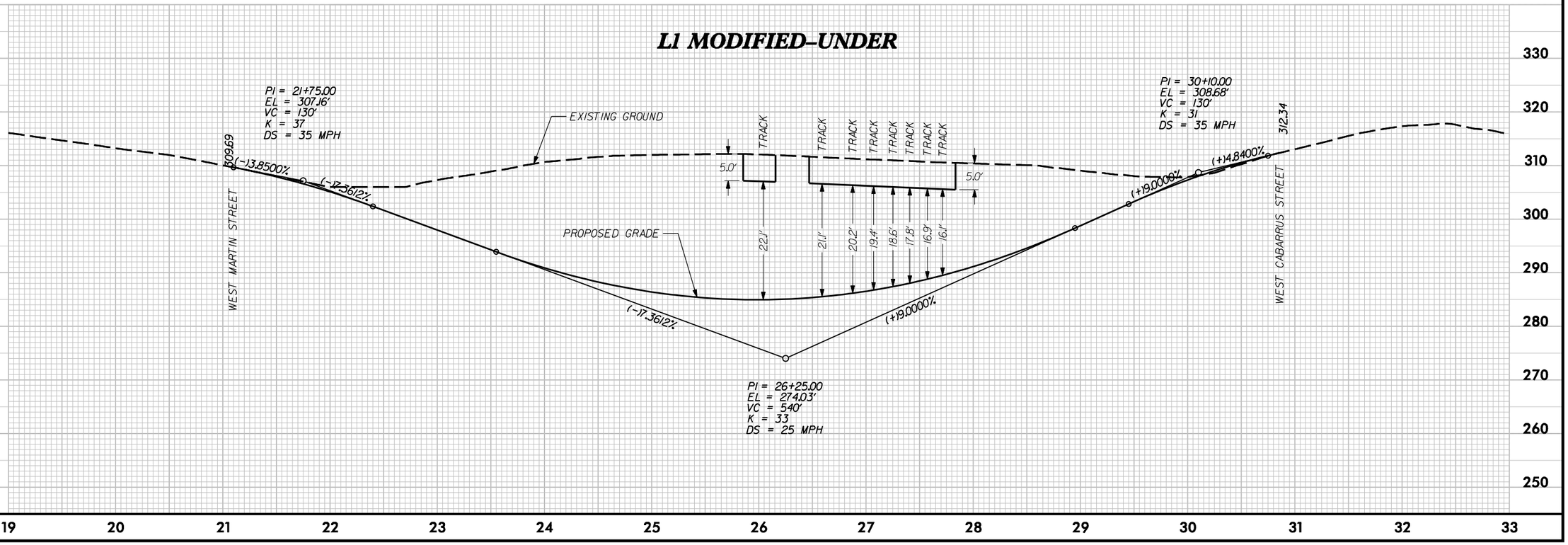

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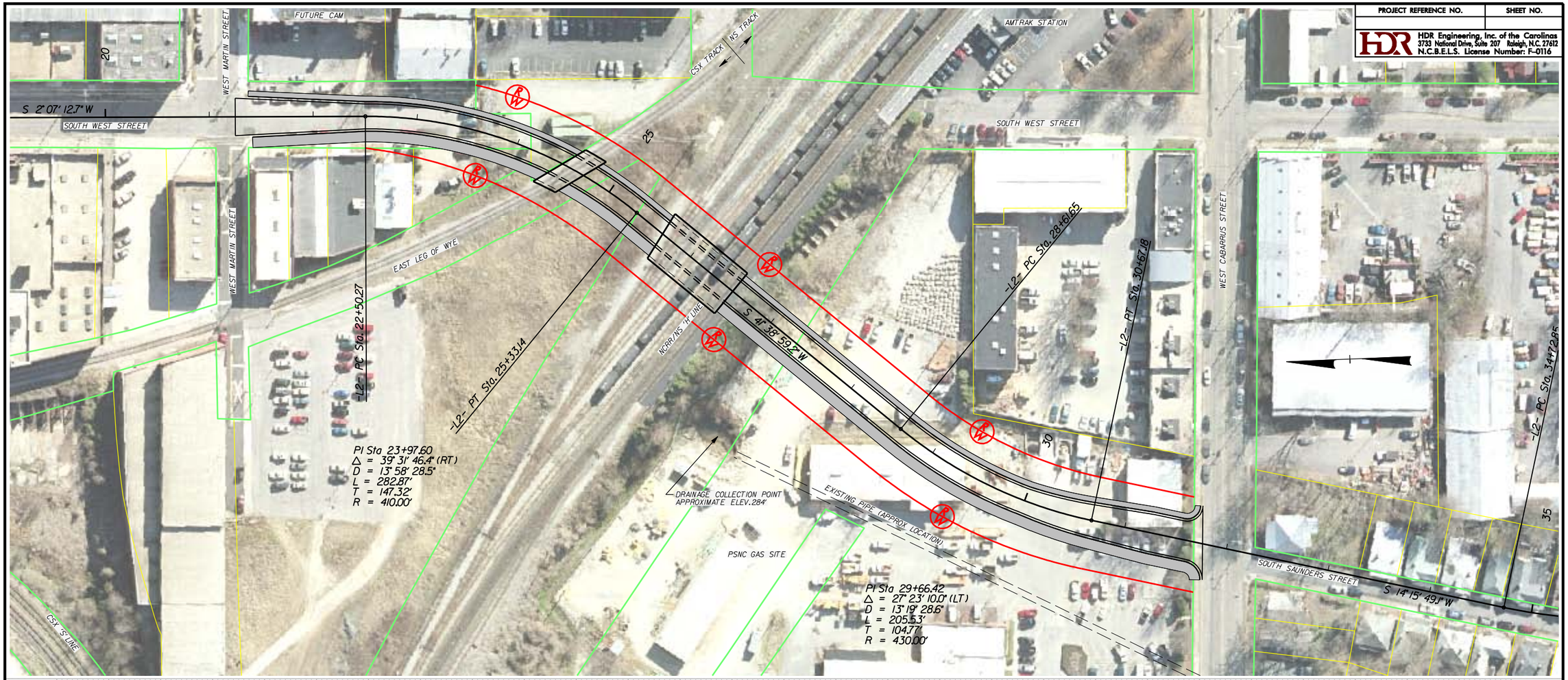

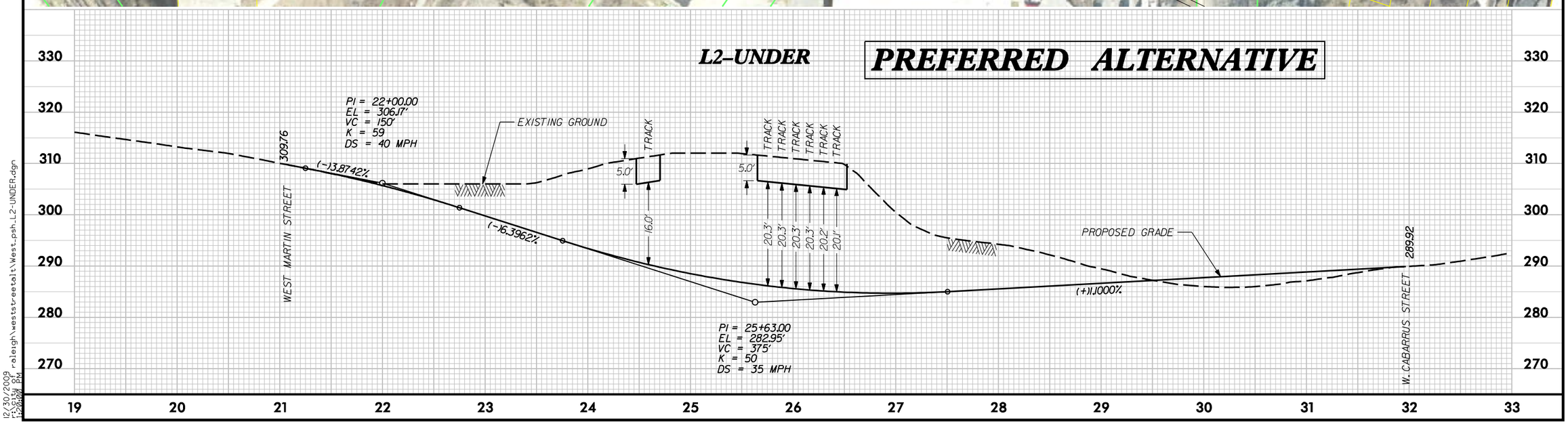

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Appendix B

Detailed Cost Estimates

West Street Extension Alternatives Study
Cost Estimates

Road over Rail

Pay Item	Unit	Unit Cost	Quantity L1-Over-1	Cost L1-Over-1	Quantity L1-Over-2	Cost L1-Over-2	Quantity L1-Over-3	Cost L1-Over-3	Quantity L2-Over	Cost L2-Over
Roadway Bridge	SF	$ 175	11943	$ 2,090,025	11943	$ 2,090,025	15270	$ 2,672,250	10256	$ 1,794,800
MSE Wall	SF	$ 100	31077	$ 3,107,700	28642	$ 2,864,200	45004	$ 4,500,400	49886	$ 4,988,600
Concrete Sidewalk	SY	$ 40	1735	$ 69,400	1705	$ 68,200	2195	$ 87,800	2185	$ 87,400
Asphalt Pavement	SY	$ 40	3374	$ 134,960	3332	$ 133,280	4090	$ 163,600	4442	$ 177,680
Curb and Gutter	LF	$ 25	2092	$ 52,300	2056	$ 51,400	2580	$ 64,500	2604	$ 65,100
Pedestrian Railing	LF	$ 125	2092	$ 261,500	2056	$ 257,000	2580	$ 322,500	2604	$ 325,500
Drainage Structures w/frame and grates	EA	$ 2,000	20	$ 40,000	20	$ 40,000	25	$ 50,000	26	$ 52,000
Storm Drainage Pipe	LF	$ 40	2000	$ 80,000	2000	$ 80,000	2500	$ 100,000	2600	$ 104,000
Pavement Markings	LF	$ 1	2092	$ 2,092	2056	$ 2,056	2580	$ 2,580	2604	$ 2,604
Mobilization and Traffic Control (15% of construction cost)	LS		1	$ 875,697	1	$ 837,924	1	$ 1,194,545	1	$ 1,139,653
TOTAL CONSTRUCTION COST				**$ 6,713,674**		**$ 6,424,085**		**$ 9,158,175**		**$ 8,737,337**
Add 20% Uncertainty factor for inflation and urban conditions				$ 1,342,735		$ 1,284,817		$ 1,831,635		$ 1,747,467
Add 20% Engineering Fee				$ 1,611,282		$ 1,541,780		$ 2,197,962		$ 2,096,961
GRAND TOTAL				**$ 9,667,690**		**$ 9,250,683**		**$ 13,187,771**		**$ 12,581,765**

Road under Rail

Pay Item	Unit	Unit Cost	Quantity L1-Under	Cost L1-Under	Quantity L2-Under	Cost L2-Under
Rail Bridge Superstructure	TF	$ 8,500	545	$ 4,632,500	407	$ 3,459,500
Rail Bridge Abutments and Retaining Walls Per Track	EA	$ 700,000	8	$ 5,600,000	8	$ 5,600,000
Soil Nail Wall with Brick Facing or Pile Panel Retaining Wall	SF	$ 100	18580	$ 1,858,000	14428	$ 1,442,800
Concrete Sidewalk	SY	$ 40	1536	$ 61,440	1728	$ 69,120
Asphalt Pavement	SY	$ 40	2888	$ 115,520	3053	$ 122,120
Curb and Gutter	LF	$ 25	1847	$ 46,175	2088	$ 52,200
Drainage Structures w/frame and grates	EA	$ 2,000	18	$ 36,000	20	$ 40,000
Storm Drainage Pipe	LF	$ 40	1800	$ 72,000	2000	$ 80,000
Pavement Markings	LF	$ 1	1847	$ 1,847	2088	$ 2,088
Mobilization and Traffic Control (15% of construction cost)	LS		1	$ 1,863,522	1	$ 1,630,174
TOTAL CONSTRUCTION COST				**$ 14,287,004**		**$ 12,498,002**
Add 20% Uncertainty factor for inflation and urban conditions				$ 2,857,401		$ 2,499,600
Add 20% Engineering Fee				$ 3,428,881		$ 2,999,521
GRAND TOTAL				**$ 20,573,286**		**$ 17,997,123**

Note: Cost Estimates do not include Right-of-Way Acquisition, environmental cleanup, replacement of existing culvert through the PSNC site or greater-than-standard railroad horizontal clearance requirements.