Design Criteria Report/ Engineer's Report

Hacienda Boulevard (fka Benfield Road)

Collier County, FL
7/15/2015

Prepared for:

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Statement of Certification

I certify that this Design Criteria Report has been prepared by me or under my immediate supervision and that I have experience and training in the field of Traffic and Transportation Engineering.

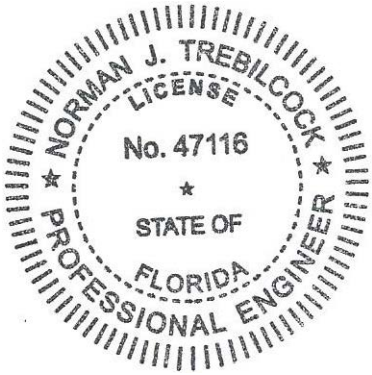

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Table of Contents

A. Planning / Land Development

Hacienda Boulevard (fka Benfield Road) is being proposed as an initial two lane roadway that will ultimately be a four lane facility. The subject section begins at Rattlesnake Hammock Road and runs north approximately 0.6 miles. The purpose of this report it to address the design criteria for the subject section of roadway and other sections of this roadway that maybe constructed within the Hacienda Lakes Development of Regional Impact (DRI). This roadway is being constructed by the Hacienda Lakes DRI developer as part of a development commitment (CC Ordinance 2011-41). Hacienda Boulevard is proposed as a north-south roadway approximately 1 mile east of Collier Boulevard. This roadway will tie into and be part of the Wilson Boulevard Extension/Benfield Road Corridor, which Collier County completed a study report for in December 2009. Within the Hacienda Lakes DRI, there is 1.5 miles of the 20 mile long study area. The land uses along this corridor within the Hacienda Lakes DRI include preserve, existing swamp buggy grounds (not part of Hacienda Lakes DRI), a future public elementary school site, future stormwater management facilities and future residential development.

Based on the adjacent land uses and purpose of this roadway, the recommended access spacing within the Hacienda Lakes DRI is access class 3 (See **Table A-1**) based on the planned connection points within the community.

Table A-1
Proposed Access Management Classification Standards for Roadway

Proposed Access Classification	3
Minimum Connection Spacing (ft)	660 ≥45 mph; 330 < 45 mph
Directional Median Opening Spacing (ft)	660
Full Median Opening Spacing (ft)	1,320
Minimum Signal Spacing (mile)	0.5
Table Reference: CC Resolution 01-247, as amended by Resolution 2013-257	

B. Geometric Design

1. References: The following references will be used in the development of design criteria for Hacienda Lakes Boulevard (fka Benfield Road):

a. Roadway Plans Preparation Manual, January 1, 2013, Florida Department of Transportation (FDOT PPM). The FDOT PPM is commonly used as a design and construction reference, although adherence to the standards contained within the FDOT PPM is not necessarily required.

b. Roadway and Traffic Design Standards, 2014, Florida Department of Transportation (FDOT Standard Index). The FDOT Standard Index is commonly used as a design and construction reference.

c. Construction Standards Handbook for Work within the Public Right-of-Way, Collier County, FL (CC ROW Handbook). This regulates the location, manner, installation, and adjustment of all work performed within the right-of-way of the Collier County roadway network.

d. Collier County Land Development Code (LDC). The LDC generally applies to land development and not County Transportation road projects. There are typical sections in the LDC that are applicable.

e. Collier County Access Management Resolution 01-247, as amended by Resolution 2013-257. This resolution of the Board of County Commissioners of Collier County, FL amends the policy for access management for arterial and collector roadways in Collier County.

f. Florida Department of Transportation Manual of Uniform Minimum Standards for Design, Construction and Maintenance for Streets and Highways (Florida Greenbook, aka FDOT MUMS). The FDOT MUMS publication sets standards intended to provide the basic guidelines for developing and maintaining a highway system with reasonable operating characteristics and a minimum number of hazards. Adherence to the FDOT MUMS requirements is applicable to this facility as directed by Sections 334.044(10) and 336.045 Florida Statutes. The 2011 edition of the FDOT MUMS is the current standard. The 2013 edition of the FDOT MUMS is in draft stage and being reviewed.

g. Wilson Boulevard Extension/Benfield Road Corridor Study, Final December 2009. This planning study was initiated by the Collier County Transportation Department in 2007 and includes the subject roadway segment as part of the corridor study.

2. **Roadway Classification:** The initial decision which needs to be made concerns the classification of the roadway as urban or rural. **Table B-2** illustrates the right-of-way (ROW) requirements for each classification.

   The redeemable characteristics of a rural section, in comparison to an urban section, include lower initial construction cost, e.g., less curbing, fewer drainage structures and smaller diameter pipe – no trunk line; higher design speeds; and improved separation between pedestrians and vehicles. The main disadvantages of a rural typical section include more ROW required, increased maintenance cost (more ROW to maintain), and increased lighting costs, both capital and operational. Landscaping needs might be more easily accommodated within the urban section because of lesser clear zone requirements.

   A rural typical section requires between 20% and 50% more ROW than a comparable urban typical section. Where wetland crossings are unavoidable, minimizing ROW and corresponding environmental impacts will be critical.

Table B-2
Typical Section Requirements

URBAN vs. RURAL (45-50 MPH DESIGN SPEED) TYPICAL SECTION REQUIREMENTS			
	URBAN	**RURAL**	**REFERENCE**
Median Width (FT) Minimum, Desirable Minimum	**15.5 – ≤45mph 19.5 – 50mph**	**22 - <55mph 40 - ≥55mph**	**FDOT MUMS Table 3 – 11**
Roadside Minimum Clear Zone (FT)	**4 – ≤45mph 18 – 50mph**	**18 – 45mph 18 – 50mph**	**FDOT MUMS Table 3 – 12**

Note(s): "Clear zone" is measured from face of curb for urban section; and from edge of travel lane for rural section.

Given the significantly increased ROW associated with a rural section, the design criteria and typical sections presented in this report are limited to those of an **urban** classification for the build-out condition.

3. **Design Speed:** FDOT MUMS Table 3 – 1 recommends a minimum design speed for an arterial to be between 40 mph and 55 mph. Furthermore, the FDOT MUMS recommends the design speed be 5 mph to 10 mph greater than the posted speed limit. It is recommended that for a curb and gutter roadway facility the maximum design speed not to exceed 45 mph (FDOT MUMS, Table 3-12, Note**). It is recognized that, until the properties abutting the roadway develop, the topography will encourage higher operating speeds. Therefore, it may be desirable to have component elements of the roadway designed to a higher design speed. Considering FDOT MUMS criteria, the design speed for this roadway project is 45 mph with a posted speed limit of 45 mph. As an interim measure, the initial 2-lane roadway condition will have a posted speed limit of 40mph. However, as coordinated with Collier County Staff, a design speed of 50 mph will be utilized for the horizontal alignment and the calculation of turn lane lengths.

4. **Sight Distance:** Based on a design speed of 50 mph, a minimum stopping sight distance of 425 feet is set forth in FDOT MUMS Table 3 - 6.

5. **Horizontal Alignment:** Horizontal alignment tables are illustrated in **Appendix L3**.

    a. Superelevation and Curvature – The maximum superelevation rate for urban highways and major streets is e_{MAX} = 0.05 ft/ft (FDOT MUMS page 3-11) and the maximum degree of curvature for a design speed of 50 mph is 6°30" (FDOT MUMS Table 3-3; FDOT PPM – Vol. 1 – Table 2.8.3, page 2-47).

    b. Superelevation Transition – The standard superelevation transition places 80% of the transition on the tangent (50% minimum) and 20% on the curve (50% maximum). Superelvation transitions have a minimum longitudinal slope of 0.5%, per FDOT PPM – Vol. 1, Ch. 2.9, page 2-51.

    c. Curb radii for street intersections are as follows: minimum – 35-ft and standard – 50-ft; standard control radii for crossing movements are 75-ft.

6. **Vertical Alignment:** The grades for vertical alignment should be as flat as practical and should not exceed 5% for a 45 mph design speed (FDOT MUMS, Table 3 - 4). Flat grades and long gentle vertical curves, as applicable, should

be used. Vertical curves are required for a 45 mph design speed when the algebraic difference of intersecting grades exceeds 0.70% (FDOT MUMS, Table 3 - 5).

The minimum length of vertical curve must be three times the design speed of the highway (135 feet). As shown in FDOT MUMS, Table 3 – 6, rounded K values for minimum lengths vertical curves with a 45mph design speed are as follows: K value for crest vertical curves is 98; and K value for sag vertical curves is 79.

7. **Cross Section Elements:** Proposed cross sections are illustrated in **Appendix L1** and **Appendix L2**.

   a. Number of Lanes – We have assumed that the initial improved roadway will be 2-lanes (interim design) and that the ultimate cross section will be 4-lanes.

   b. Lane Width and Cross Slope – The minimum travel lane width is 11-ft, per FDOT MUMS, Table 3 – 7. Per FDOT PPM – Vol.1 – Table 2.1.1, page 2-8, 11-ft width is permitted for truck volumes of 10% or less. The 11-ft pavement width is consistent with the Collier County Land Development Code (CC LDC) – major arterial typical roadway section. The minimum auxiliary lane width is 10-ft (FDOT MUMS, Table 3 – 7), however 11-ft lane width is proposed for this project.

      Based on the assumption that the roadway will ultimately be widened to 4-lanes, a standard cross slope of 2% is recommended per FDOT PPM, Vol. 1, Figure 2.1.1, page 2-14. CC LDC typical street section – local street recommends a 3% cross slope. However, consistent with the CC Staff request – arterial typical roadway section, a minimum of 2.0% cross slope is proposed for project.

   c. Shoulder Width – The interim project typical cross section is depicted as a mixed shoulder/curb and gutter facility, as shown in **Appendix L1**. The minimum shoulder width is 10-ft, per FDOT MUMS, Table 3 – 9. The initial-interim section proposes a 10-foot shoulder to include a 5 foot paved bike lane. Per FDOT MUMS – C.7.c.2, the cross slope should be greater than the adjacent travel lane, and it shall not be less than 3% ft/ft

or greater than 8% ft/ft. The initial roadway section proposes a 3 % cross slope for the shoulder.

The project build out typical cross section does not provide shoulders as the roadway is shown in **Appendix L2** as a curb and gutter facility.

d. Type and Width of Median – Assuming the ultimate 4-lane roadway will be urban (curb and gutter), the minimum median width is 15.5-ft for a design speed of 45 mph (FDOT MUMS Table 3-11). Consistent with the CC LDC – arterial typical roadway section, a minimum of 30-ft median width is provided.

e. Roadside Clear Zone and Border Width – The minimum clear zone for an urban facility with 45 mph design speed is presented as follows:

   (1) Initial roadway section: 4-ft – measured from the face of curb - where curb is present and 18-ft measured from the edge of through travel lane where no curb and gutter is present (FDOT MUMS, Table 3-12).

   (2) Build out roadway section: 4-ft – measured from the face of curb (FDOT MUMS, Table 3-12).

   (3) Border Width: The minimum border width for the roadway is 12-ft as measured at the curb lip of any auxiliary lane; and 14-ft for travel lanes (FDOT PPM Vol. 1, Table 2.5.2).

C. Roadside Design

The slopes of all roadsides should be as flat as possible to allow for safe traversal by errant vehicles. A slope of 1:4 or flatter is desired (FDOT MUMS, page 3-25). The roadside slopes should not exceed 1:3 in steepness within the clear zone.

The interim 2-lane as well as the build-out 4-lane roadway design typical section provides for natural drainage flow using a 1:4 slope or flatter, within the clear zone.

D. Pavement Design and Construction

The proposed roadway section is being designed as an ultimate four-lane roadway with 11-ft wide travel lanes and 4-ft bike lanes on both sides of the roadway. The study segment was designed as an urban cross-section with divided median and curb and gutter.

The projected traffic volume on this segment of roadway in 2034 is 38,000 AADT (Per Pavement Design Report, by TCS dated 04-22-2014). The estimated truck traffic (T24 – percent of heavy trucks) is 5%. Similarly, the Rattlesnake Hammock Road extension intersecting Hacienda Boulevard has a design year traffic volume of 36,000 AADT and estimated truck traffic of 4.8%. Based on the similar traffic projections, we would recommend the pavement section for this segment of Hacienda Boulevard match the structural number approved for Rattlesnake Hammock Road extension pavement design. The only exception is that instead of a friction course, we would propose structural course SP-9.5 as the riding surface. In the future this surface could be modified to a friction course when traffic volumes warrant as part of a resurfacing operation.

Therefore, the recommended pavement design section for this roadway is as follows:

- Friction Course = 1" SP-9.5 – structural course
- Structural Course = 2" SP-12.5 – structural course
- Base – Limerock (LBR 100) = 10" (Optional Base Group 9)
- Stabilization (LBR 40) = 12"

High groundwater table exerts detrimental effects on the roadway base and the whole pavement. Based on FDOT base clearance guidelines, a 36-in base clearance is considered adequate for the base protection of most subgrades against high groundwater tables. For this project, a conservative 2-ft base clearance is considered. For more details refer to "Pavement Design Report", by TCS dated 11-24-2014.

In comparing relevant typical sections per **Table D-1**, on the next page, the proposed pavement section is consistent with the existing four-lane section of Rattlesnake Hammock Road between Collier Boulevard and Hacienda Boulevard.

Table D-1
Relevant Pavement Design Comparison

Roadway Link	# Lanes	Thickness (inches)			
		Friction Course	Structural Course	Base Course	Subgrade Course
Hacienda Blvd. (Project)	4	N/A	3"	10"	12"
Collier County Land Development Code	4	N/A	3"	8"	12"
Rattlesnake Hammock Rd. Collier Blvd and Hacienda Blvd	4	1"	2"	10"	12"

E. Roadway Lighting

As an arterial roadway, Collier County, requires roadway lighting designed to the following standards:

1. Proposed street lighting design criteria to be in general conformance with the FDOT 2013 Plans Preparation Manual Conventional Lighting Roadways (Refer to Table 4).

Table 4
Design Comparison

ROADWAY CLASSIFICATION	ILLUMINATION LEVEL AVERAGE INTITIAL HORIZONTAL FOOT CANDLE (H.F.C.)	UNIFORMITY RATIOS		VEILING LUMINANCE RATIO
Hacienda Blvd (Arterial)	1.5	4:1 OR LESS	10:1 OR LESS	0.3:1 OR LESS

2. The design wind speed for the project light poles and foundations is 150 mph.

3. Project to follow Collier County Traffic Operations "Technical Provisions", dated 2012 for applicable lighting specifications.

4. When determining conductor sizes for lighting circuits, the maximum allowable voltage drop from the service point on any one circuit is 7%.

5. The interim phase of the roadway (2 lane condition) will require the lighting on one side of the roadway and at build out (4 lane condition) the lighting will be on both sides.

F. Pedestrian Facilities

The volume of pedestrian traffic is expected to be minimal when the road is initially opened as a two-lane facility. At build-out, pedestrian traffic is anticipated to increase with the surrounding development, especially due to the future school site.

To ensure compliance with the ADA Accessibility Guidelines (as described in the Federal Register), and the Florida Accessibility Code for Building Construction, sidewalk design shall meet the following criteria: minimum clear width – 36-in; maximum cross slope – 2%; maximum longitudinal slope – 1: 20 (FDOT MUMS, page 3-54).

Per FDOT MUMS, the minimum width of a sidewalk should be 5 feet when separated from the back of curb by a buffer strip. The minimum separation from the back of curb is 2-ft. The planting strip – buffer strip should be 6 feet where practical (FDOT MUMS, page 8-4).

Consistent with the CC LDC, arterial typical roadway section, a 6-ft wide sidewalk is provided; the sidewalk shall be a minimum of 6-in thick of concrete and constructed over a compacted subgrade (CC LDC – 6.06.02 – F1).

G. Bicycle Facilities

Per FDOT PPM, page I-8-10, on curb and gutter roadways, a 4-ft minimum bicycle lane width measured from the lip of the gutter is required. Bicycle lanes shall be one-way facilities and carry bicycle traffic in the same direction as adjacent motor vehicle traffic.

All urban arterial sections should be given consideration for either undesignated or designated 4-ft bike lanes (FDOT MUMS, page 3-56).

Per CC LDC – major arterial typical roadway section, a 4-ft bike lane is recommended.

The interim 2-lane roadway design proposes undesignated bike lanes as follows: 5-ft wide lane on the west side (as part of a 10-ft shoulder) and 4-ft wide lane on the east side (adjacent to the curb and gutter). The proposed ultimate four-lane roadway section is designed with designated 4-ft bike lanes on both sides of the roadway.

Where bicycle lanes are provided between the through lane and right turn lane, bus bay or parking lane they shall be 5-ft wide. Please note that the minimum auxiliary lane width is 10-ft, per FDOT MUMS, Table 3 – 7).

H. Public Transit

Public Transit is anticipated along this roadway at build out as depicted in the adopted Master Mobility Plan for the Hacienda Lakes DRI (See Figure 1, on the next page). During the interim phase, Collier Area Transit (CAT) bus routes are not anticipated.

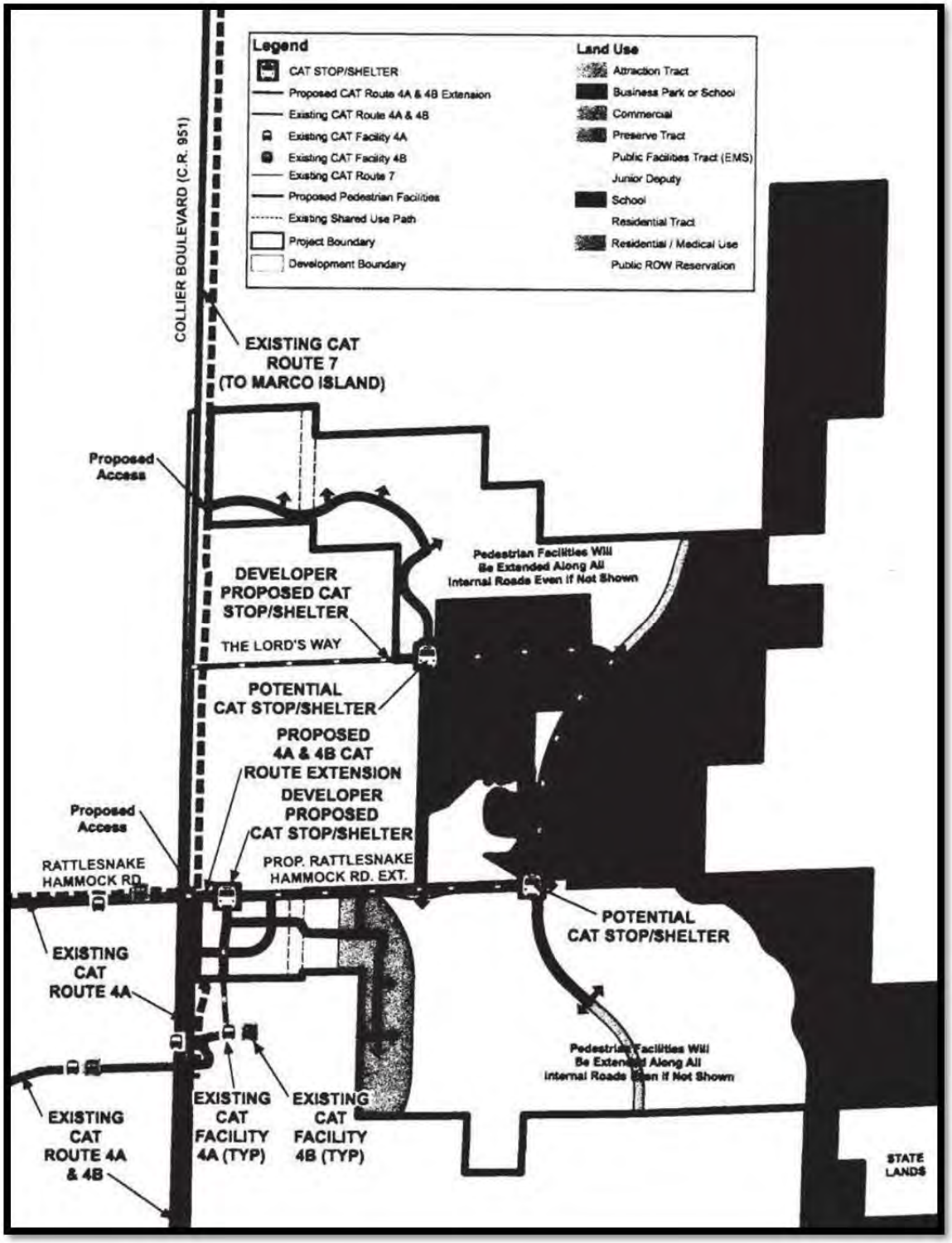


Figure 1: Excerpt from the approved Hacienda Lakes PUD/DRI for the PUD/DRI Master Mobility Plan. A potential CAT bus route may use Hacienda Boulevard, with a bus stop potentially at the intersection of Hacienda Boulevard and Rattlesnake Hammock Road at build out.

I. Bridges and Other Structures – N/A

No bridges are anticipated within the project limits. A standard box culvert to serve as an animal crossing for small mammals is anticipated and this structure would meet applicable FDOT construction specifications. Additionally, storm sewer pipes and drainage structures will meet FDOT construction specifications as well.

J. Signing and Marking

The basic requirements governing signing and marking methods will follow:

- The Manual on Uniform Traffic Control Devices (MUTCD) – latest applicable edition.
- FDOT Road Design Standards – latest applicable edition.
- Current Collier County Traffic Operations Standards
- FDOT Manual of Uniform Minimum Standards for Design, Construction and Maintenance for Streets and Highways – latest applicable edition.

K. Conclusions

1. **Roadway Classification / Design Speed**
   a. The ultimate four-lane roadway will be the urban type with a closed (curb and gutter) drainage system.
   b. The design speed for the roadway project is 45 mph and the maximum posted speed limit will be 45 mph (4-lane roadway condition). An interim speed limit of 40mph is proposed for the 2-lane roadway condition.
   c. As coordinated with Collier County Staff, a design speed of 50 mph will be utilized for the horizontal alignment and the calculation of turn lane lengths.
2. **Drainage / Stormwater Management**
   a. The 25-year, 3-day storm event will be used to determine minimum flood protection elevations for the roadway. The edge of pavement of the

outside mainline shall be set at the greater of this grade, or as required for base protection per FDOT standards, or as required by storm sewer calculations per FDOT standards, as applicable.

b. The Hacienda Lakes Development backbone water management system is designed to provide water quality treatment and water quantity attenuation to the roadway in the interim (2-lane) and ultimate (4-lane) configuration.

3. <u>Typical Cross-Section</u>

a. Travel lanes will be 11 feet wide recognizing the smaller size of today's automobiles and the low anticipated truck traffic volume.

b. The proposed ultimate four-lane roadway section is designed with 4 foot bike lanes on both sides of the roadway. Where the bike lane is between a thru lane and a right turn lane, its width shall be 5 feet and the corresponding right turn lane width shall be 10 feet. The interim 2-lane roadway design proposes a paved 5-ft bike lane in one direction (as part of a 10-ft shoulder) and a 4-ft bike lane in the opposing direction (on the curbed side of roadway).

c. Pedestrian traffic is accommodated by installing a 6 foot wide sidewalk on one side of the interim section and both sides of the ultimate section.

d. The ultimate 4-lane roadway section will have a typical 30-ft median width is provided.

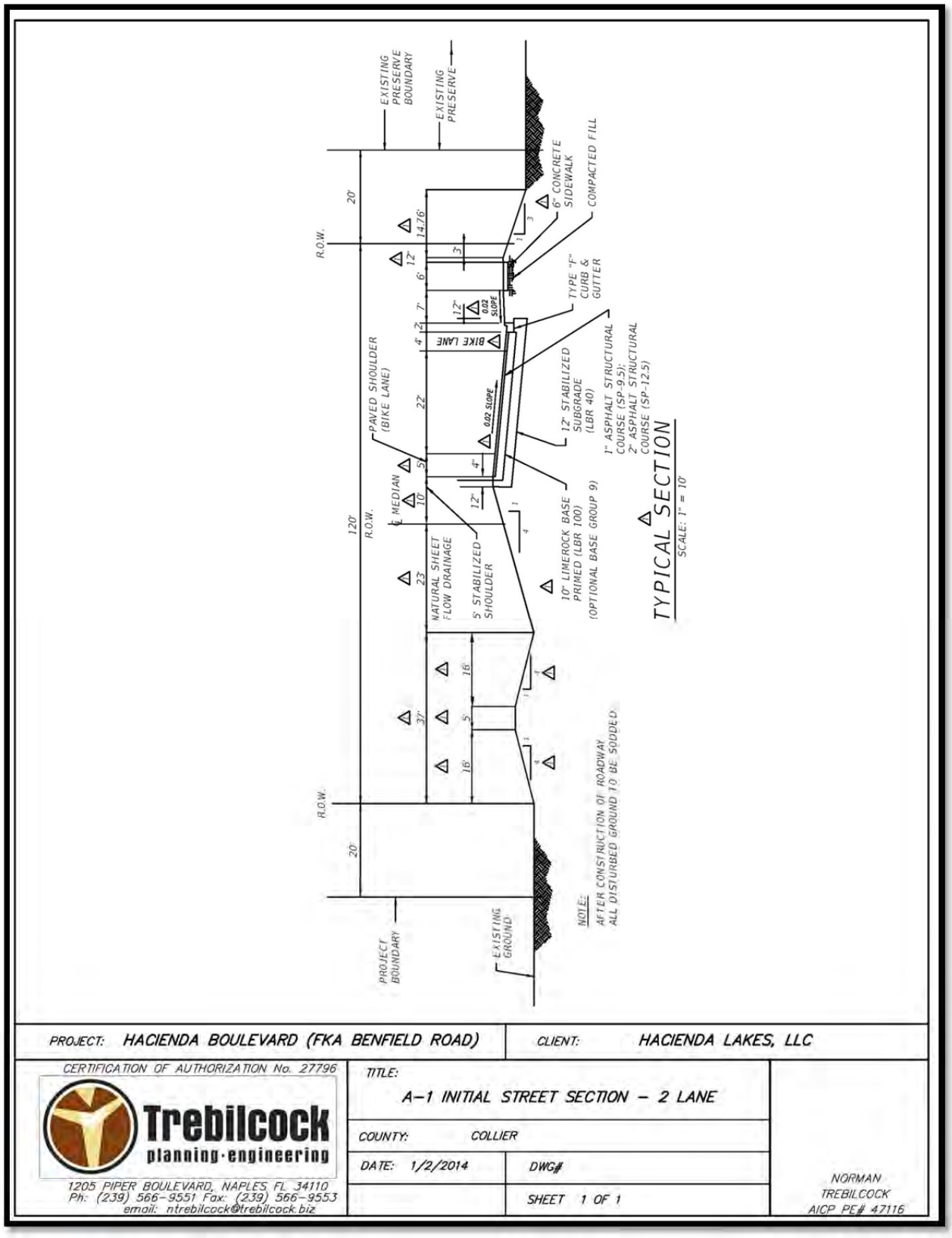
L. Tables / Appendices

L1 – Typical Section – Initial 2-Lane Street Section

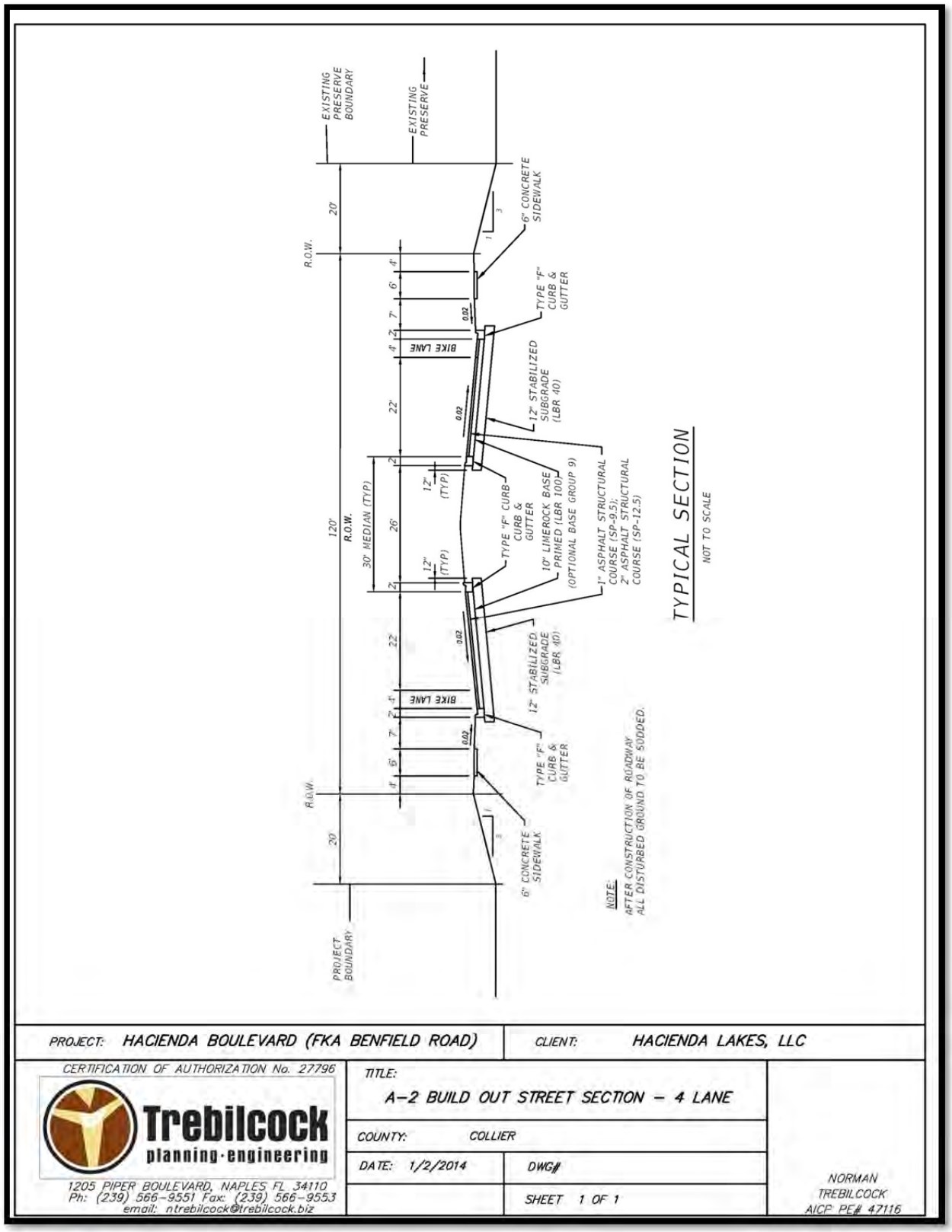
L2 – Typical Sections / Build-out 4-Lane Street Section

L3 – Superelevation Table

L1 – Typical Section – Initial 2-Lane Street Section



L2 – Typical Section – Build-out 4-Lane Street Section



L3 – Superelevation Table

Table L3.1 – Input Parameters

Urban	=	Type of Roadway
50 mph = S	=	Roadway design speed
4 = NL	=	Number of lanes
11 ft = LW	=	Lane width
30 ft= MW	=	Median width
4 ft = BW	=	Bike lane width adjacent to roadway
0.8 = Tf	=	Straight transition factor
82 ft = W	=	Roadway width = NL*LW+MW+2*BW
150 = d:1	=	Ratio of transition to superelevation
400 ft	=	Minimum curve length
750 ft = 15*S	=	Desirable curve length
200 ft	=	Minimum full superelevation length within curve
120 ft	=	ROW Width

Table L3.2

Superelevation Curve Data

D (deg) = Degree of Curve	R (ft) = Interior Radius	Rd (@Centerline) = R +ROW/2	e (ft/ft) = Superelevation Rate	Superelevation Transition (ft) = Lst = e * W*d*Tf	Curve Length (ft), (@ Centerline) = CLd = (Lst/Tf*(1-Tf)*2+Min Full Super Length, or min curve length)*Rd/R
0.25	22,920	22,980	NC		
0.50	11,460	11,520	NC		
0.75	7,640	7,700	NC		
1.00	5,730	5,790	NC		
1.50	3,820	3,880	NC		
2.00	2,865	2,925	NC		
2.50	2,292	2,352	RC		
3.00	1,910	1,970	RC		
3.50	1,637	1,697	RC		
4.00	1,433	1,493	RC		
5.00	1,146	1,206	0.023	226	421
6.00	955	1,015	0.040	394	425