Town of Leland

Growing our future. Nourishing our roots.

Street Design Manual

Public Services Department

November 2021

Table of Contents

1 Section 1 - General

1.1 Introduction

The street design requirements are provided to engineers and developers who must submit plans and specifications to the Town of Leland for review and approval. The plans and specifications that are submitted must at a minimum comply with these requirements and with the latest revisions of the Town's ordinances, specifically the Streets, Sidewalks, and Other Public Places Ordinance, Subdivision Ordinance, Zoning Ordinance, and Stormwater Ordinance.

1.2 NCDOT Standard Specifications for Roadways and Structures, Latest Edition

The latest revision of the NCDOT "Standard Specifications for Roads and Structures" shall apply unless otherwise specified herein.

All streets within the Town of Leland's corporate limits shall be designed and constructed in accordance with the accepted policies of the most current versions of the N.C. Department of Transportation (NCDOT), Division of Highways; American Association of State Highway and Transportation Officials (AASHTO) Manuals; the Federal Highway Administration's Manual on Uniform Traffic Control Devices (MUTCD); and Town design standards, including the Town Street Design Manual, Standard Specifications, and Standard Details, whichever is stricter in regard to each particular item. NCDOT Standards shall be applicable on all existing state roads, extensions of state roads, or roads expected to be maintained by the state.

1.3 Construction and Inspection

1.3.1 Preconstruction

Prior to the design of any street or sidewalk project, a predesign meeting with Town staff is strongly recommended, including the Planning Department, Public Services Department, and Fire Department. The purpose of the meeting is to review the Town's requirements for streets and sidewalks and allow the designer to discuss the project.

1.3.2 Construction

Streets or sidewalks may not be constructed without the following approvals or permits:

1. Approval of the Project plans and specifications by Town staff
2. Town of Leland Stormwater Permit (if applicable)
3. Town of Leland Encroachment Permit (if applicable)
4. Town of Leland Driveway Permit (if applicable)
5. Town of Leland Floodplain Permit (if applicable)
6. NCDEQ Sedimentation and Erosion Control Permit (if applicable)
7. NCDOT Driveway Permit (if applicable)
8. NCDOT Encroachment Permit (if applicable)
9. Any additional applicable permit required for the proposed project

1.3.3 Streets

No base material shall be placed on a roadway until the storm sewer, subgrade, utilities, and all appurtenances have been inspected and meet Town of Leland Standards as well as the standards and requirements of any utility owner (i.e., Brunswick Reginal Water and Sewer, H2GO) as required.

Field density testing shall be completed in accordance with the Town's Specification. The Town's Construction Inspector may require additional field density testing of subgrade soils during construction. The testing shall be completed by a certified laboratory with sufficient Proctors to evaluate the compaction characteristics of various soils used in the roadbed. The Town's Construction Inspector may also require field density testing of the ABC used and an asphalt mix formula before either is inspected or approved.

When a collector street or thoroughfare widening takes place, the existing edge line of the travel lane shall be sawcut. Achieve an overlap of the final lift of new asphalt by at least 6" onto the existing roadway cross-section. The objective to have the joint between new and old asphalt to be offset from the joint between subgrades (this overlap shall exclude the overlay). In addition, whenever an overlay is required, milling of 1 ½ inch shall occur at both tie-in stations to insure a smooth connection.

1.3.4 Curb and Gutter, Driveways, and Sidewalks

No concrete shall be placed until all forms and subgrades have been approved by the Town's Construction Inspector.

Subgrade shall be excavated to the required depth and shaped to the proper cross section. Where tree roots are encountered, they shall be removed to a depth of 1 foot for the full width of the excavation. The subgrade shall be stable and thoroughly compacted.

Forms shall be set and maintained true to the required lines, grades, and dimensions. Forms shall be constructed with material of such strength and rigidity to prevent any appreciable deflection between supports. Straight forms shall be within a tolerance of ½ inch in 10 feet from a true line horizontally or vertically. Forms shall be thoroughly cleaned of all dirt, mortar and foreign material before being used. All inside form surfaces shall be thoroughly coated with commercial quality form oil.

1.3.5 Multi-Use Pathways (MUP)

Multi-use pathways are designed for both transportation and recreation purposes. Multi-use pathways shall be constructed with asphalt per the Town of Leland Standard Details.

No ABC stone base shall be placed until the subgrade have been approved by the Town's Construction Inspector.

The subgrade shall be excavated to the required depth and shaped to the proper cross section. Where tree roots are encountered, they shall be removed to a depth of 1 foot for the full width of the excavation. The subgrade shall be stable and thoroughly compacted.

No asphalt may be placed until the stone base has been approved by the Town's Construction Inspector.

1.3.6 Traffic Control and Street Signs

Traffic control and street signs within subdivisions which will be maintained by the Town of Leland shall be installed and constructed in accordance with the Town's Standard Specifications, Town's Standard Details and the MUTCD. All specialty traffic control devices including sign posts and street name signs will be owned and maintained by the subdivisions homeowner's association.

All temporary stub outs for future interconnectivity shall have proper MUTCD barricade and signage. Any right of way and construction easements that are necessary for future connection shall be dedicated at the time of the construction of the stub out.

2 Section 2 – Design Standard for Streets

2.1 Design Speed for Residential, Commercial, Collector and Throughfare Streets

The design speed for residential, commercial, collector, and thoroughfare streets shall be at a minimum the projected speed limit for the street. The projected speed limit for the various street types will be as follows unless otherwise directed by the Town Engineer.

Street Type	Projected Speed Limit
Residential	25 MPH
Commercial	25 MPH
Collector	35 MPH
Thoroughfare	45 MPH

2.2 Horizontal Street Alignment

All streets shall be constructed with the center of the paved section of the street located on the center of the right of way unless otherwise approved by the Town Engineer or as may be required by the future widening of the street or sidewalk construction.

When a continuous street centerline deflects at any point, a circular curve shall be introduced having a radius on said centerline of not less than the following:

Street Type	Minimum Curve Radius (in feet)
Cul-de-Sac	180 (Based on 25 mph design speed)
Residential Street	180 (Based on 25 mph design speed)
Commercial	180 (Based upon 25 mph design speed)
Collector	470 (Based upon 35 mph design speed)
Thoroughfare	as recommended by the Design Engineer and approved by the Town Engineer

A minimum tangent of 150 feet is required between reverse curves for major streets, highways, boulevards, and collector and other non-residential streets. The tangent shall be extended as necessary to provide the minimum runoff lengths for the superelevated curves per AASHTO guidelines. The minimum tangent length approaching an intersection is 30 feet for residential streets. All intersections of streets classified as collector or greater shall have a tangent section not less than 100 feet approaching the intersection.

Compound horizontal curves with the same direction of curvature shall have the radius of the flatter circular arc no more than 1½ times the radius of the sharper circular arc.

Intersections with thoroughfares, boulevards, or highways shall be at least 800 feet apart. Note that median spacing will require NCDOT or Town approval and shall require greater spacing. There shall be a minimum of 200 feet between centerlines of street jogs on collectors, boulevards, and major streets. Residential and marginal access streets shall not be offset less than 125 from their centerlines.

Thoroughfares, boulevards, and collectors shall be superelevated. Superelevation shall conform to NCDOT and AASHTO standards. Tapers shall be used as necessary in street design. Approach tapers shall be used to shift lanes laterally. The following equations shall be used for tapers as applicable:

L = WS for posted speeds of 45 mph and greater
L = $WS^2/60$ for posted speeds of 40 mph or less
L = Length of taper in feet
S = Posted speed in miles per hour
W = Lateral offsets in feet

Turn bay tapers shall be at least 15:1 for posted speeds of 45 miles per hour and more. The minimum turn bay taper allowed is 8:1. Symmetrical reverse curve tapers are recommended for streets classified as collector or less. Storage lengths for the turn bays shall be calculated using an acceptable method.

Streets with medians shall be designated to allow for proper turning movements for a SU (single unit truck) design vehicle. AASHTO guidelines shall be utilized for the actual median design and median opening dimension.

2.3 Vertical Curves

All changes in street grades shall be connected with vertical curves and the length (L) of both sag and crest vertical curves in feet shall be related to the algebraic difference in grade (A) and a constant K. The K values shall be based upon the design speed of the road using the following AASHTO standard.

Design Speed (MPH)	K value
25	26
30	35
35	50
40	70
45	100

Vertical Curve Length L=KA

Example Local Road with Design Speed of 30 MPH

Slope 1 4%
Slope 2 -2%

Algebraic Difference slope1 – slope 2 4-(-2) = 6%

Vertical Curve Length for Local Street Length = 6 x 35 =210 ft.

2.4 Maximum and Minimum Grades

The maximum grades permitted on any street within one hundred feet of any intersection shall not exceed five (5) percent, unless otherwise approved by the Town Engineer. The minimum grade on any street shall not be less than five-tenths (0.5) percent.

2.5 Street Intersection Radius (Effective Turning Radius)

Street intersections shall be at right angles whenever possible. The minimum desirable intersection angle is 80 degrees. At no time shall a street intersect any other street at less than 75 degrees.

The street intersection radii shall be installed as follows unless otherwise directed in the Town's Ordinances, by Planning Staff, or the Town Engineer. Where two different types of streets intersect, the type of street requiring the larger radius shall govern.

Street Type	Minimum Intersection Radius (in Feet)
Cul-de-Sac	15
Residential	25
Collector and Commercial	30
Thoroughfare	as recommended by the Design Engineer and approved by the Town Engineer

2.6 Sight Triangles

Each intersection must be evaluated to ensure that drivers have the ability to see oncoming traffic on the intersecting street. The distances required shall be based upon the posted speed limit for the street. The sight triangle requirements must also be in conformance with the AASHTO Green Book, latest edition, NCDOT Subdivision Road Standards latest edition, the Town's Standard Details, and the Town's Standard Specifications. Measurements for sight distances at street intersections, including sight triangles, must begin within the roadway or edge of pavement of a proposed or existing street in conformance with the NC General Statutes 160A-306(b)(3).

2.7 Minimum Stopping Sight Distance

The minimum stopping sight distance is the distance required by the driver of a vehicle, traveling at a given speed, to bring the vehicle to a stop after an object on the road becomes visible. Stopping sight distance is measured from the driver's eyes, which is 3.5 feet above the pavement surface, to an object 2 feet high on the road. Stopping sight distance requirement applies to horizontal curves as well as vertical curves. The stopping sight distances are as shown in the Table below. A more detailed explanation of the measurement of stopping sight distance is included in *A Policy on Geometric Design of Highways and Streets (latest edition)* by AASHTO (AASHTO Green Book). For conditions other than level and wet conditions, the stopping sight distances should be calculated based upon the most recent version of the AASHTO, "A Policy on Geometric Design of Highways and Streets" manual (i.e. AASHTO Green Book).

Minimum Stopping Sight Distance for Level and Wet Conditions

Design Speed (mph)	Stopping Sight Distance (ft)
25	155
30	200
35	250
40	305
45	360

Source: AASHTO Green Book 2018 Edition

2.8 Drainage

Catch basin design and spacing shall be in accordance with the NCDOT Roadway Design Manual, NCDOT Guidelines for Drainage Studies and Hydraulic Design, and the Town of Leland Stormwater Design Manual. Streets shall be designed such that water does not pond on the roadway in the design storm and such that storm runoff does not cross the approach of intersections. Valley gutters should not be constructed to convey stormwater across intersections without written approval from the Town.

No stormwater structures are allowed within road travel lanes.

On paved streets without curb and gutter, ditches or swales must be constructed to convey storm runoff such that water does not pond on the roadway and that standing water does not impact the roadway base.

Low impact development (LID) is encouraged and recommended by the Town. Any LID drainage features located within in the street right-of-way shall be approved in advance by the Town Engineer and shall be designed in a manner not to impact the traveling public using the street or features in the right of way, such as a sidewalk or multi-use pathway. All drainage features must be designed in accordance with the Town of Leland Stormwater Design Manual.

2.9 Concrete Curb and Gutter

All curb and gutter shall be constructed in accordance with the Town of Leland Standard Details and Standard Specifications for Vertical Curb and Gutter or Roll Over Curb and Gutter. The type of curb and gutter to be used will be determined by the street cross section approved by the Planning Department and Public Services Department staff. All curb and gutter shall be constructed with concrete having a compressive strength of at least 3,000 psi after 28 days.

A minimum 5-foot section of curb and gutter shall remain when removing any section of curb for the installation of a driveway, street turnout or repair of curb and gutter. When less than 5 feet of the curb remains, the full section of curb shall be removed to the next joint. Full removal of both the curb and gutter is required when installing a driveway.

For roadways, cut and fill slopes shall begin a minimum of 10’ or 12’ outside the shoulder as shown on the details.

2.10 Concrete Sidewalks

All concrete sidewalks shall be constructed in accordance with the Town of Leland Standard Details and Standard Specifications and at locations and widths as specified in the Town ordinances. Required sidewalks shall be installed at the time of roadway construction or widening unless otherwise bonded through a Town approved performance guarantee. The minimum thickness of a sidewalk shall be 4 inches. At locations where a driveway crosses a sidewalk, a 6-inch depth is required. Sidewalks shall have a uniform slope toward the roadway of ¼ inch per foot. The utility strip between the sidewalk and the back of curb shall not be less than 1/4 inch per foot nor greater than 3/4 inch per foot toward the roadway. No structure such as a sewer manhole, water valve box, sewer cleanout, or water meter box

shall be placed within the sidewalk without the prior approval of the Town Engineer. All obstructions must be at least eighteen (18) inches from the edge of the sidewalk.

Sidewalks shall be located at the distance from the back of the curb as prescribed by the Leland Code of Ordinances. This requirement may not be varied without the approval of the Town Engineer. All concrete sidewalks shall be constructed with concrete having a compressive strength of at least 3,000 psi after 28 days.

2.11 Concrete Curb Ramps

On all streets where sidewalks or multi-use paths are required to be installed, ADA compliant curb ramps shall be constructed in accordance with the Town of Leland Standard Details and Standard Specifications for type and location. The concrete portions of the curb ramps shall be constructed with concrete having a compressive strength of at least 3,000 psi after 28 days. Detectable warning mats shall be red in color.

2.12 Driveways

All vehicular entrance or exit from a property shall be classified as a driveway. In the interest of public safety and convenience, the Town of Leland may restrict the placement of a driveway to a particular location along the property owner's frontage. Driveways will not be allowed along acceleration or deceleration lanes and associated tapers unless approved by the Town Engineer. No driveway will be allowed within the intersection of radii of intersecting roadways.

Standard driveway aprons that conform to the Town of Leland Standard Details and Standard Specifications for driveways shall be used when the Average Daily Traffic (ADT) volume for the driveway is less than 500 vehicles. Street type driveway aprons that conform to the Town of Leland Standard Details and Standard Specifications for driveways shall be used when the ADT volume for the driveway is greater than or equal to 500 vehicles or when access by a WB-40 design vehicle is required. The radius on a street type driveway shall be designed to accommodate a WB-40 design vehicle. The driveway designer shall also ensure that adequate sight distance is maintained in conformance with AASHTO standards.

All driveways shall be constructed in accordance with the appropriate Town of Leland Standard Detail and Standard Specifications. Driveways that connect to an NCDOT maintained street shall be subject to the requirements of the NCDOT for design and permitting.

3 Section 3 – Permanent Pavement Markings and Signage

3.1 Pavement Marking Requirements

Permanent pavement markings shall be installed on newly constructed streets and streets to be resurfaced. Temporary pavement markings may be painted; however, all permanent pavement marking shall be thermoplastic. All street markings shall be installed in accordance with the MUTCD, NCDOT Requirements, and Town of Leland specifications and standard details.

Pavement Marking Requirements

Street Type	Stop Bar	Crosswalk	Centerline	Movement Arrows
Residential	Yes	Yes	No	No
Collector	Yes	Yes	Yes	No
Commercial	Yes	Yes	Yes	Yes
Thoroughfare	Yes	Yes	Yes	Yes

3.2 Stop Bars

Stop bars shall be installed at all streets where a stop condition has been established by a stop sign or a traffic signal. Stop bars will not be installed on any street where traffic is allowed to move without restriction. All stop bars shall be installed in accordance with the Town of Leland Standard Details, the Town of Leland Standard Specifications, and the MUTCD.

3.3 Crosswalks

Crosswalks shall be installed where connecting curb ramps have been installed. All locations which are designated for pedestrian traffic crossings shall be designated as a crosswalk with pavement marking and signage (including advanced signage) in accordance with the Town of Leland Standard Details, the Town of Leland Standard Specifications, and the MUTCD.

3.4 Centerlines

White or yellow centerlines, as appropriate, shall be installed on all collector streets and thoroughfares to designate travel lanes. Centerlines shall be installed where right or left turn lanes are constructed. All centerlines shall be installed in accordance with the Town of Leland Standard Details, the Town of Leland Standard Specifications, and the MUTCD.

3.5 Movement Arrows

Movement arrows shall be installed on all collector streets and thoroughfares, and at all street intersections where a Town of Leland maintained street connects with an NCDOT maintained street and turn lanes are constructed. All movement arrows shall be installed in accordance with the Town of Leland Standard Details, the Town of Leland Standard Specifications, NCDOT requirements, and the MUTCD.

3.6 Sign Installation Requirements

At a minimum, stop signs in accordance with the Town of Leland Standard Details, the Town of Leland Standard Specifications, and the MUTCD for type, size and location shall be installed on newly constructed streets prior to the opening of the street for traffic.

For newly constructed streets, street name signs shall be installed on newly constructed streets prior to the opening of the street for traffic. These signs shall be designed in accordance with the Town of Leland Standard Details, the Town of Leland Standard Specifications, and the MUTCD for type, size, and location.

After the final layer of asphalt on a new street or the final layer of asphalt on a street being resurfaced and the crosswalk pavement markings have been installed, crosswalk signs shall be installed if applicable. Crosswalk signs shall be installed at the designated mid-block or non-traffic-controlled locations. These signs shall be designed in accordance with the Town of Leland Standard Details, the Town of Leland Standard Specifications, and the MUTCD for type, size, and location.

4 Section 4 – Pavement Design

4.1 Pavement Design

For any street to be accepted for maintenance by the Town, the pavement and base quantities must be calculated in accordance with this design manual or other approved method and sealed by a NC Professional Engineer. The pavement thickness of any street shall, at a minimum, equal the design shown in the Town of Leland Standard Details.

All streets maintained by the NCDOT must receive approval of the pavement design from NCDOT prior to the beginning of construction. Normal crown for the pavement section shall be ¼"/foot, except as approved for superelevated cross-sections.

4.2 Pavement Design Life

All cul-de-sacs, residential, commercial, collector, and thoroughfare streets shall be designed based on a pavement design life of 20 years or greater.

4.3 Pavement and Base Thickness Design Methodology

The pavement section shall be designed such that the Structural Number for the combination of base, binder and surface courses exceeds the Structural Number calculated using the Soil Support Values (SSV), Average Daily Traffic (ADT), and Number of Trucks (N).

The values for the California Bearing Ratio (CBR), SSV, ADT, and N shall be shown in the following information.

4.4 Calculation of the Soil Support Value (SSV)

The SSV shall be determined based upon the following formula.

SSV = 5.32 * (log CBR) – 1.52

The CBR may be calculated using one of two methods. Use of any other method must be approved by the Town Engineer in advance of the design being submitted to the Town.

The first method for calculating CBR is to determine the actual bearing capacity of the soil. This is done by having a certified soils laboratory take soil samples and perform a CBR Test. The CBR test should be performed in accordance with AASHTO T193 latest edition. A sufficient number of CBR tests shall be made to ensure coverage in the range of soils conditions encountered in the area to be paved. The soil borings shall be taken within 1 foot of the subgrade elevation and shall be spaced at a maximum distance of 500 feet apart. Also, a soil boring should be taken in each soil classification discovered in the area to be paved.

The second method is to use the assigned CBR for the Soil Classification for the area to be paved shown on the County Soil Survey map or other NC licensed geotechnical engineer signed and sealed updated soil survey of the area. The soil types on the street to be paved may be determined by using the Soil Survey of Brunswick County prepared by the U. S. Department of Agriculture. The Unified Soil Classification (USC) soil types within the area to be paved should be identified using the maps in the publication. A copy of the soils map for Brunswick County is available for viewing on the Brunswick

County GIS web page and a shape file for the map is available for downloading from Brunswick County's GIS Web Page. Using the Tables within this document, the Unified Soil Classification (USC) should be converted to the AASHTO soil type using Table 1 - Table 16 from the Brunswick County Soil Survey – "Engineering Index Properties". Using Table 2 or Table 3, determine the lowest CBR for the soil classification. The entire street is to be designed using the lowest CBR value for the AAHSTO soil classifications found in the area to be paved.

When fill is required to bring the existing ground up to the proposed subgrade elevation or the existing soil is not suitable for road construction and the area must be undercut and fill material used, the CBR shall be determined for the fill based upon one of the two methods outlined above. The fill material must be compacted to 100% of its dry density prior to placement of any base material.

Example 1

Lab Test results show the CBR of the Combined Soils is 15.

SSV = 5.32 * (log 15) – 1.52 = 4.73

Example 2

The soil classifications within street right of way are determined to be Leon, Pantego, and Wando. Based upon the Table 1 in the Appendix, the Pantego and Leon soil classifications had an AASHTO soil classification of A-4 while the Wando soil classification had an AASHTO soil classification of A- 3. Based upon the AASHTO Table found in the Appendix, the A-4 soil classification has the lowest CBR range of 10 to 20. Use the lowest of the typical range or 10 for the CBR.

SSV = 5.32 * (log 10) – 1.52 = 3.80

4.5 Calculation of Average Daily Traffic (ADT), Traffic Growth, and Number of Trucks

An estimated average daily traffic (ADT) volume must be determined for the proposed street(s). A design ADT must be calculated using the following formula.

Design ADT = (ADT + ((1 + i) ^n x ADT))/2

For this equation:
ADT is the estimated number trips to be generated by the project.
i is the estimated annual increase in traffic.
n is the design pavement life.

Average Daily Traffic Volume

Type of Use	Trips/Day/Unit
Single Family	9.52
Apartments	6.65
Townhouse/Condominium	5.81

For all other uses, use the latest edition of the Institute of Transportation Engineers (ITE) Trip Generation Manual.

Traffic Growth Estimation (i)

Facility description	Annual growth
Dead end or cul-de-sac street	1%
Collector street	2%
Commercial street	2%
New subdivision street	4%
Existing street (at least 50% developed)	0.5%

For other types of streets, contact Town Engineer for growth rates.

Number of Trucks Estimation (N)

For an estimation of the expected number of trucks use the following chart. Interpolate values where required.

N	Design ADT
200	12,500
100	6,250
80	5,000
40	2,500
30	1,875
20	1,250
10	625
5	312
3	187
1	63

4.6 Calculate the Structural Number (SN)

The structural number for the pavement design shall be calculated using the following formula.

$$SN = \frac{2.41 \times (N^{0.151})}{(1.14^{SSV})}$$ For 20-year pavement design life

To determine the Structural Number for a proposed pavement design section the following coefficient shall be used. Note, no less than 6" and no more than 8" of Base Course shall be used when formulating the pavement design, unless approved by the Town Engineer.

Pavement Layer	Type of Material	Structural Coefficient Per Inch of Thickness
Surface Courses	Sand Asphalt NC DOT Type S9.5b Surface Treatment	0.40 0.44 0.20*
Binder Courses	NC DOT Type I 19.0b	0.44
Base Courses	Coarse Aggregate NC DOT Type B25.0c NC DOT Type 4.75a	0.14 0.30 0.30

* Use as shown. Do not multiply by thickness.

The minimum and maximum lift per type of asphalt mix is as shown in the following table:

Mix Type	Minimum Lift	Maximum Lift
S9.5 b	1.0”	1.5”
S9.5 c, d	1.5”	2.0”
I19.0 b	2.5”	4.0”
B25.0 c	3.0”	5.5”
ABC Stone	3.0”	6.0”

Example 3

Development consisting of 100 single family lots. The CBR value as determined by lab tests performed on the soil within the proposed street right of way was 15 which results in a SSV of 4.73. Normal truck loading and 20-year pavement life is expected. The subdivision will be 100% developed.

ADT 9.52 trip/unit/day x 100 lots = 952 trips/day

Design ADT $\frac{952 + (((1+.04)^{20}) \times 952)}{2}$ = 1519 trips per day

Number of Trucks (N)

N = 1519-1250 = 20 trucks + (269/625)*10 = 20 + 0.43*10 = 24 trucks.

Structural Number

SN= $\frac{2.41 \times N^{.151}}{1.14^{SSV}} = \frac{2.41 \times 24^{.151}}{1.14^{4.73}} = \frac{3.89}{1.86} = 2.09$

Effect of Different Pavement Cross Sections

Try 6” Rock Base, 1.5” Binder, and 1.5” S9.5B Asphalt SN Required 2.09

ABC Stone Base	6” x 0.14 = 0.84
Binder Course	1.5” x 0.44 = 0.66
2” S9.5B Asphalt	1.5” x 0.44 = 0.66
SN	2.16, Design Okay

Example 4:

Development consisting of 500 single family lots. The CBR value as determined by the soil classifications found within the proposed street right of way was 10. This results in a SSV of 3.80. Normal truck loading and 20-year pavement life is expected. The subdivision is 50% developed.

ADT 9.52 trip/unit/day x 500 lots = 4,760 trip/day

Design ADT: $\frac{4760x\ (((1+.005)^{20}) + 4760)}{2}$ = 5010 trips per day

N = 5010-5000 = 10/5000 =.002 .02*10+80=80 trucks

SN= $\frac{2.41 \times N^{.151}}{1.14^{SSV}}$ = $\frac{2.41x\ 80^{.151}}{1.14^{3.8}}$ = $\frac{4.65}{1.645}$ = 2.83

Effect of Different Pavement Cross Sections

Try 8" Rock Base, 3" Asphalt Base and 2" S9.5B Asphalt SN Required 2.83

ABC Stone Base	8" x 0.14 = 1.12
Asphalt Base	3" x 0.3 = 0.9
2" S9.5B Asphalt	2" x 44 = 0.88
SN	2.90, Design Okay

4.7 Applicability

These design requirements shall only apply to new streets and not to streets that have been previously paved. For streets to be resurfaced, the depth and type of asphalt to be used shall be determined by the Town Engineer.

5 Section 5 – Dedication of Roads to Town

5.1 Dedication of Roadway to Town Process

For a road to be accepted by the Town for maintenance the following minimums will be required of developers:

1. All construction must be completed and approved by the Town's Construction Inspector.
2. The terms of all applicable permits must be met.
3. A pre-application meeting with Town staff should be held to review the Improvement Dedication Application Form requirements.
4. Submit a completed Improvement Dedication Application form along with all required information as noted in the application.
5. All improvements guaranteed by a Town approved performance guarantee must be completed and approved by the Town.
6. Provide as-built drawings showing all assets to be dedicated.
7. Streets will generally not be considered for dedication until 80% or more of the development or phase is complete and occupied. Any street considered for dedication prior to 80% completion and occupancy will require a street maintenance agreement between the Town and dedicator.

The entity constructing the streets and other improvements is responsible for maintenance of the improvements until such time that the offer of dedication of those improvements is approved by the Town.

6 Section 6 – Appendix

6.1 Table 1 – Engineering Index Properties

[The symbol < means less than. Absence of an entry indicates that data were not estimated. Some soils may have Unified classifications and USDA textures in addition to those shown. In general, the dominant classifications and textures are shown]

Map symbol and soil name	Depth	USDA texture	Classification		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	4	10	40	200		
	In								Pct	
BaB----------	0-23	Fine sand--------	SM, SP-SM	A-2, A-3	100	100	51-100	5-20	---	NP
Baymeade	23-54	Fine sandy loam, sandy clay loam, sandy loam.	SC, SM, SM-SC	A-2, A-4	100	100	60-90	30-49	<25	NP-10
	54-80	Loamy fine sand, sand, loamy sand.	SM, SP-SM	A-2, A-3	100	100	51-75	5-30	---	NP
BDC:										
Baymeade--------	0-23	Fine sand--------	SM, SP-SM	A-2, A-3	100	100	51-100	5-20	---	NP
	23-54	Fine sandy loam, sandy clay loam, sandy loam.	SC, SM, SM-SC	A-2, A-4	100	100	60-90	30-49	<25	NP-10
	54-80	Loamy fine sand, sand, loamy sand.	SM, SP-SM	A-2, A-3	100	100	51-75	5-30	---	NP
Marvyn----------	0-16	Loamy sand-------	SM	A-2	95-100	90-100	50-80	13-30	---	NP
	16-31	Sandy clay loam, sandy loam.	ML, SC, SM-SC, SM	A-4, A-2 A-6, A-7	95-100	90-100	60-80	30-55	24-45	3-15
	31-45	Sandy clay loam, sandy clay.	ML, MH, SM	A-4, A-5, A-7	95-100	90-100	65-80	36-60	38-59	4-19
	45-80	Loamy sand, sandy loam, sandy clay loam.	SM, SC, ML CL	A-1, A-2, A-4	95-100	90-100	45-85	20-55	<40	NP-10
BnB----------	0-48	Fine sand--------	SP-SM	A-3, A-2-4	100	100	65-100	5-12	---	NP
Blanton	48-80	Sandy loam, loamy sand, loamy coarse sand.	SM	A-2-4	100	100	65-96	13-30	<25	NP-3
BO----------	0-15	Silty clay loam	CH, MH	A-7	100	99-100	90-100	80-100	60-100	15-60
Bohicket	15-70	Silty clay, clay, sandy clay.	CH, MH	A-7	100	99-100	80-100	70-95	50-100	16-60
BrB----------	0-10	Fine sandy loam	SM	A-2, A-4	98-100	95-100	50-80	13-40	<20	NP-4
Bragg	10-63	Stratified sandy loam to clay loam.	SM, SM-SC, SC, CL	A-2, A-4, A-6, A-7-6	95-100	90-100	50-95	25-65	11-49	3-25
	63-70	Sandy loam, sandy clay loam, sandy clay.	SM, SC, ML CL	A-4, A-6	95-100	95-100	60-95	39-60	15-40	3-18
	70-75	Variable---------	---	---	---	---	---	---	---	---
CA----------	0-80	Loamy fine sand	SM, SP-SM	A-2, A-3	95-100	90-100	50-75	5-25	---	NP
Carteret										
CH----------	0-4	Silt loam--------	CL-ML, ML, MH	A-7-5, A-4 A-6	100	100	90-100	85-95	22-60	4-24
Chowan	4-34	Loam, silt loam, silty clay loam.	CL, MH, ML	A-7-5, A-4 A-6	100	100	90-100	85-96	22-62	6-30
	34-80	Sapric material	PT	---	---	---	---	---	---	NP
Co----------	0-80	Fine sand--------	SW, SP-SM, SP	A-2, A-3	100	98-100	60-75	3-12	---	NP
Corolla										

TABLE 16.--ENGINEERING INDEX PROPERTIES--Continued

Map symbol and soil name	Depth	USDA texture	Classification		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	4	10	40	200		
	In								Pct	
CT----------	0-39	Muck----------	PT	---	---	---	---	---	---	---
Croatan	39-63	Sandy loam, fine sandy loam, mucky sandy loam.	SM, SC, SM-SC	A-2, A-4	100	100	60-85	25-49	<30	NP-10
	63-80	Loam, clay loam, sandy clay loam.	CL, CL-ML, SC, SM-SC	A-4, A-6	100	100	75-100	36-95	<36	NP-15
DO----------	0-99	Muck----------	PT	---	---	---	---	---	---	---
Dorovan										
Du----------	0-80	Fine sand--------	SP-SM, SP	A-3	100	95-100	60-75	3-12	---	NP
Duckston										
Fo----------	0-12	Loamy fine sand	SM	A-2	100	100	60-100	15-36	---	NP
Foreston	12-78	Sandy loam, fine sandy loam.	SM, SM-SC	A-2, A-4	100	100	70-100	18-40	<25	NP-5
	78-85	Loamy fine sand, loamy sand, fine sand.	SP-SM, SM	A-2, A-3	100	100	50-98	6-25	---	NP
GoA----------	0-8	Fine sandy loam	SM, SM-SC, SC	A-2, A-4, A-6	95-100	95-100	50-100	15-45	<25	NP-14
Goldsboro	8-70	Sandy clay loam, sandy loam.	SM-SC, SC, CL-ML, CL	A-2, A-4, A-6	98-100	95-100	60-100	25-55	16-37	4-18
	70-80	Variable---------	---	---	---	---	---	---	---	---
Gt----------	0-17	Fine sandy loam	SM, SM-SC	A-2, A-4	100	95-100	60-100	20-45	<30	NP-7
Grifton	17-60	Sandy loam, sandy clay loam, clay loam.	SC, CL	A-4, A-6	98-100	95-100	60-100	31-60	20-35	8-15
	60-80	Variable---------	---	---	---	---	---	---	---	---
Jo----------	0-13	Fine sandy loam	SM, SM-SC, SC	A-2, A-4	100	95-100	70-98	20-49	<30	NP-10
Johns	13-38	Sandy clay loam, sandy loam, clay loam.	SC, SM-SC, CL, CL-ML	A-2, A-4, A-6, A-7	100	95-100	60-98	30-65	20-45	5-25
	38-70	Sand, loamy sand	SM, SP-SM, SP	A-2, A-3	95-100	95-100	51-90	4-25	---	NP
KrB----------	0-80	Fine sand--------	SP, SP-SM	A-3	100	100	60-100	0-7	---	NP
Kureb										
LA----------	0-55	Muck----------	PT	A-8	---	---	---	---	---	---
Lafitte	55-72	Clay, silty clay, silty clay loam.	MH, CH, ML CL	A-7-5, A-7-6	100	100	90-100	80-100	45-100	16-60
Lo----------	0-80	Fine sand--------	SP, SP-SM	A-3, A-2-4	100	100	80-100	2-12	---	NP
Leon										
Lu----------	0-18	Fine sandy loam	SM, SM-SC	A-2, A-4	100	85-100	65-98	15-45	<20	NP-7
Lumbee	18-38	Sandy clay loam, sandy loam, clay loam.	SC, CL	A-4, A-6, A-7	100	90-100	65-98	36-60	19-45	7-25
	38-80	Loamy sand, sand, fine sand.	SP, SM, SP-SM	A-2, A-3	90-100	85-100	50-90	4-25	---	NP

TABLE 16.--ENGINEERING INDEX PROPERTIES--Continued

Map symbol and soil name	Depth	USDA texture	Classification		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	4	10	40	200		
	In								Pct	
Ly Lynchburg	0-16	Fine sandy loam	SM, ML, SM-SC, CL-ML	A-2, A-4	92-100	90-100	75-100	25-55	<30	NP-7
	16-80	Sandy clay loam, sandy loam, clay loam.	SM-SC, SC, CL, CL-ML	A-2, A-4, A-6	92-100	90-100	70-100	25-67	15-40	4-18
Ma Mandarin	0-18	Fine sand	SP, SP-SM, SW-SM	A-3	100	100	90-100	2-10	---	NP
	8-35	Fine sand, sand	SP-SM, SM	A-3, A-2-4	100	100	90-100	5-15	---	NP
	35-62	Fine sand, sand	SP, SP-SM	A-3	100	100	90-100	2-7	---	NP
	62-80	Fine sand, sand	SP, SP-SM	A-3, A-2-4	100	100	90-100	3-12	---	NP
Mk Muckalee	0-6	Loam	ML, SC, SM SM-SC	A-2, A-4	95-100	90-100	50-95	30-60	<30	NP-10
	6-65	Sandy loam, loamy sand.	SM	A-2, A-4	95-100	80-100	60-90	20-40	<20	NP-4
Mu Murville	0-5	Mucky fine sand	SP-SM, SM	A-2, A-3	100	100	85-100	5-30	---	NP
	5-80	Fine sand, sand, loamy fine sand.	SM, SP-SM	A-2	100	100	85-100	5-20	---	NP
NeE, NhE Newhan	0-80	Fine sand	SP, SP-SM	A-3	95-100	95-100	60-75	0-5	---	NP
NoB Norfolk	0-16	Loamy fine sand	SM	A-2	95-100	92-100	50-95	13-30	<20	NP
	16-63	Sandy loam, sandy clay loam, clay loam.	SC, SM-SC, CL, CL-ML	A-2, A-4, A-6	95-100	91-100	70-96	30-63	20-38	4-15
	63-80	Variable	---	---	---	---	---	---	---	---
On Onslow	0-22	Fine sandy loam	SM, ML, SC CL	A-2, A-4	100	95-100	70-99	30-55	<25	NP-10
	22-65	Sandy clay loam, sandy loam, clay loam.	SM, CL, SM-SC, SC	A-2, A-4, A-6	100	95-100	60-98	30-60	<30	NP-14
	65-80	Variable	---	---	---	---	---	---	---	---
PaA Pactolus	0-55	Fine sand	SM, SP-SM	A-2, A-3	100	90-100	51-100	6-30	---	NP
	55-80	Sand, loamy sand, loamy fine sand.	SP-SM, SM	A-2, A-3	100	90-100	51-100	5-30	---	NP
Pn Pantego	0-11	Mucky loam	OL, SM, ML SM-SC	A-2, A-4	100	95-100	60-95	25-75	<35	NP-10
	11-15	Sandy clay loam, sandy loam, clay loam.	SC, CL, SM-SC, CL-ML	A-4, A-6, A-2	100	95-100	80-100	30-80	20-40	4-16
	15-80	Clay loam, sandy clay, sandy clay loam.	CL, SC	A-6, A-7	100	95-100	90-100	36-80	25-49	11-24
Pt. Pits										
Ra Rains	0-15	Fine sandy loam	SM, ML	A-2, A-4	100	95-100	50-85	25-56	<35	NP-10
	15-72	Sandy clay loam, clay loam.	SC, SM-SC, CL, CL-ML	A-2, A-4, A-6	100	95-100	55-98	30-70	18-40	4-20
	72-80	Sandy clay loam, clay loam, sandy clay.	SC, SM-SC, CL, CL-ML	A-4, A-6, A-7	100	98-100	60-98	36-72	18-45	4-28

TABLE 16.--ENGINEERING INDEX PROPERTIES--Continued

Map symbol and soil name	Depth	USDA texture	Classification		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	4	10	40	200		
	In								Pct	
Tm---------- Tomahawk	0-12	Loamy fine sand	SM, SP-SM	A-2-4, A-1-B	100	95-100	40-70	10-30	---	NP
	12-23	Sandy loam, fine sandy loam.	SM, SC, SM-SC	A-2-4, A-4	100	95-100	50-80	20-49	<25	NP-10
	23-80	Fine sand, sand, loamy sand.	SM, SP-SM	A-2-4, A-1-B, A-3	100	95-100	35-65	5-20	---	NP
To---------- Torhunta	0-11	Mucky fine sandy loam.	SM	A-2-4, A-4	100	95-100	70-85	20-49	<25	NP-4
	11-50	Sandy loam, fine sandy loam.	SM, SM-SC	A-2, A-4	100	95-100	70-92	20-40	<25	NP-7
	50-80	Loamy sand, sand, sandy loam.	SM, SP-SM, SM-SC	A-2, A-3	100	95-100	65-92	5-35	<25	NP-4
Ur. Urban land										
WaB---------- Wando	0-55	Fine sand--------	SP-SM, SM	A-2, A-3	96-100	95-100	60-98	5-25	---	NP
	55-99	Sand, fine sand	SP, SP-SM, SM	A-2, A-3	98-100	98-100	51-98	2-20	---	NP
WdB: Wando----------	0-55	Fine sand--------	SP-SM, SM	A-2, A-3	96-100	95-100	60-98	5-25	---	NP
	55-99	Sand, fine sand	SP, SP-SM, SM	A-2, A-3	98-100	98-100	51-98	2-20	---	NP
Urban land.										
Wo---------- Woodington	0-14	Fine sandy loam	SM	A-2, A-4	100	95-100	50-100	20-50	<25	NP-3
	14-55	Sandy loam, fine sandy loam.	SM	A-2, A-4	100	95-100	50-100	20-50	<25	NP-3
	55-80	Sandy loam, loamy sand, loamy fine sand.	SM, SP-SM	A-2, A-4	100	95-100	50-100	10-50	<25	NP-3
YaB---------- Yaupon	0-7	Silty clay loam	ML, CL, SC	A-4, A-6	100	90-100	70-100	50-90	<35	NP-15
	7-76	Silty clay, clay, sandy clay.	CL, CH	A-7	100	90-100	85-100	51-90	41-60	15-30

6.2 Table 2 & 3 – Unified Soils Classifications

Table 2. Unified Soil Classification

USCS Symbol	Typical CBR Range	M_R Range (ksi)	M_R Default (ksi)
CH	1 – 5	2.5 – 7	4
MH	2 – 8	4 – 9.5	6
CL	5 – 15	7 – 14	9
ML	8 – 16	9 – 15	11
SW	20 – 40	17 – 28	21
SP	15 – 30	14 – 22	17
SW-SC	10 – 25	12 – 20	15
SW-SM	15 – 30	14 – 22	17
SP-SC	10 – 25	12 – 20	15
SP-SM	15 – 30	14 – 22	17
SC	10 – 20	12 – 17	14
SM	20 – 40	17 – 28	21
GW	60 – 80	35 – 42	38
GP	35 – 60	25 – 35	29
GW-GC	20 – 60	17 – 35	24
GW-GM	35 – 70	25 – 38	30
GP-GC	20 – 50	17 – 32	23
GP-GM	25 – 60	20 – 35	26
GC	15 – 40	14 – 28	20
GM	30 – 80	22 – 42	30

Table 3. AASHTO Soil Classification

AAHSTO Symbol	Typical CBR Range	M_R Range (ksi)	M_R Default (ksi)
A-7-6	1 – 5	2.5 – 7	4
A-7-5	2 – 8	4 – 9.5	6
A-6	5 – 15	7 – 14	9
A-5	8 – 16	9 – 15	11
A-4	10 – 20	12 – 18	14
A-3	15 – 35	14 – 25	18
A-2-7	10 – 20	12 – 17	14
A-2-6	10 – 25	12 – 20	15
A-2-5	15 – 30	14 – 22	17
A-2-4	20 – 40	17 – 28	21
A-1-b	35 – 60	25 – 35	29
A-1-a	60 – 80	30 – 42	38


Town of
Leland
Growing our future. Nourishing our roots.