

November 4, 2021

Memorandum to: Mr. Bryan Sowell, PE
Division 12 Project Engineer
NCDOT – Highway Division 12
1710 E. Marion St.
Shelby, NC 28152

From: Gregory K Goins, PE
Manager, Geotechnical

WBS Number: 35993.1.1
TIP Number: U-4700A
F.A. Number: NHF-321(18)
County: Burke, Caldwell, and Catawba Counties
Description: US 321 Widening Improvements from US 70 in Hickory to just north of US 321A/ New Farm Road

Subject: **Geotechnical Report – Pavement Design – Temporary – Revision-2**

RK&K has completed the revised temporary pavement design for the above referenced project. Final Pavement Designs were submitted in a separate report dated August 21, 2020.

Traffic volumes are based on information provided in the Proposed Design Criteria dated 3-8-18. The pavement thickness design is based on the provided traffic volumes, provided traffic duration for temporary pavement, the NCDOT Pavement Design Procedures dated January 4, 2019, and using the CBR value of 5. Pavement thicknesses are provided for Aggregate Base Course and Full Depth Asphalt pavement and are summarized in Table 1 and Table 2, respectively.

Table 1: Pavement Design (Aggregate Base Course)

Line	ADT ⁽¹⁾	Design Life (Years)	Super Pave Mix Thickness					Notes
			S9.5C	S9.5B	I19.0C	B25.0C	ABC ⁽²⁾	
-L- (Start to STA 68+00)	45,394	3	3.0		2.5		10.0	
-L- (STA 68+00 to End)	51,523	3	3.0		2.5		10.0	
-Y4-	7,034	1		2.5			8.0	
-Y4LPD-/ 13 th Street	4,594 ⁽³⁾	1		2.5			9.0	3
-Y4D- and -Y17C-	Varies, See attached Design Criteria	1		2.5 ⁽⁴⁾			6.0 ⁽⁴⁾	4



Table 1: Pavement Design (Aggregate Base Course) – Continued

Line	ADT ⁽¹⁾	Design Life (Years)	Super Pave Mix Thickness					Notes
			S9.5C	S9.5B	I19.0C	B25.0C	ABC ⁽²⁾	
-Y19-	6,734	1		2.5			8.0	
1. ADT are based on project let year: 2025 2. Prime coat is required to be used where surface mix is placed directly on top of ABC. 3. Y4LPD will be carrying the 13 th ST SW traffic and has been designed based on 13 th ST SW 2016 No Build Volume. 4. Temporary Alignment Pavement Thicknesses are per the Recommended Low Volume Pavement Designs, Page 12 of NCDOT Pavement Design Manual.								

Table 2: Pavement Design (Full Depth Asphalt)

Line	ADT ⁽¹⁾	Design Life (Years)	Super Pave Mix Thickness				Notes
			S9.5C	S9.5B	I19.0C	B25.0C	
-L- (Start to STA 68+00)	45,394	3	3.0		2.5	4.5	
-L- (STA 68+00 to End)	51,523	3	3.0		2.5	4.5	
-Y4-, -Y4D-, -Y17C-, and -Y19-	Varies (but is less than 7,034), See attached Design Criteria	1		2.5		4.0	
-Y4LPD-/ 13 th Street	4,594 ⁽²⁾	1		2.5		4.5	2
1. ADT are based on project let year: 2025 2. Y4LPD will be carrying the 13 th ST SW traffic and has been designed based on 13 th ST SW 2016 No Build Volume.							

It is our understanding that temporary pavement along Midway Sands Road will use the -Y21- permanent pavement structure design and will be paved at the same time as the -Y21- alignment.



The subgrade should be prepared in accordance with NCDOT Specifications Section 500. Prevention of infiltration of water into the subgrade is essential for successful performance of the pavements.

Prepared by,



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Attachments:

- Provided Information: Design Criteria and Durations
- 2019 NCDOT Pavement Design Manual (Select Pages)
- Growth Percentage Calculations
- Pavement Design -L- & -Y- Line
- Calculation Summary

PROVIDED INFORMATION
DESIGN CRITERIA
DURATION OF TEMPORARY PAVEMENTS

- PROPOSED DESIGN CRITERIA -

STATE PROJECT: 35993.1.1
F. A. PROJECT: NHF-321(18)
COUNTY: Burke, Caldwell, & Catawba **DIVISION:** 11, 12, & 13
PROJECT DESCRIPTION: US 321 Widening Improvements
 from US 70 in Hickory to just south of US 321A / New Farm Road

TIP: U-4700A
PAGE: 1 of 10
DATE: 03 / 08 / 2018

PREPARED BY: RK&K Engineers

ROUTE	US 321		REFERENCE OR REMARKS
NAME	US 321 from US 70 to Main Ave. Dr. NW (-L- Sta. 68+00)	From Main Ave. Dr. NW (-L- Sta. 68+00) to End of Project	
LINE	-L-		
TRAFFIC DATA			Capacity Analysis Report For Purpose and Need Volume IV (11/16/2011)
ADT CURRENT YR: 2021 =	44,360	50,135	
ADT DESIGN YR: 2041 =	49,775	57,470	
TTST %	6%	4%	
DUALS %	3%	4%	
DHV %	8%	9%	
DIR %	55%	60%	
CLASSIFICATION	Urban Principal Arterial	Principal Arterial	FCM
TERRAIN TYPE	Rolling		DM 1-1D
DESIGN SPEED	60 mph		DM 1-1B
POSTED SPEED	55 mph		DM 1-1B
PROP. R/W WIDTH	Varies	Varies	
CONTROL OF ACCESS	* Full / Limited	* Full / Limited / Partial	
RUMBLE STRIPS (Y/N)	No		DM 1-4P
TYPICAL SECTION TYPE	Divided w/ Shoulder		
LANE WIDTH	12 ft		GB pg 7-5
SIDEWALKS (Y/N)	No		DM 1-7
BICYCLE LANES (Y/N)	No		
MEDIAN WIDTH	22 ft	30 ft	DM 1-2B
MED. PROTECT.	Concrete Barrier	** Raised Median	DM 3-6
SHOULDER WIDTH (total)			
MEDIAN / INSIDE	10 ft	1'-6" C&G	DM 1-2B
OUTSIDE w/o GR	12 ft		DM 1-4B
OUTSIDE w/ GR	15 ft		DM 1-4B
PAVED SHOULDER			
OUTSIDE TOTAL/FDPS	10 ft w/ 4 ft FDPS	10 ft w/ 4 ft FDPS	DM 1-4O
MEDIAN / INSIDE TOTAL/FDPS	10 ft FDPS	---	DM 1-4O
GRADE			
MAX.	6%	4%	GB pg 7-29, 7-4
MIN.	0.3%	0.3%	GB pg 3-119
K VALUE			
SAG	136		GB pg 3-161
CREST	151		GB pg 3-155
HORIZ. ALIGN.			
MAX. SUPER.	0.06		DM 1-15
MIN. RADIUS	1,330 ft		GB pg 3-45
SPIRAL (Y/N)	Yes		DM 1-11
CROSS SLOPES			
PAVEMENT	0.02		DM 1-3B
PAVED SHOULDER	0.04		NCDOT STD. 560.02
TURF SHOULDER	0.04		NCDOT STD 560.02
MEDIAN DITCH	---		
DITCH TYPICAL (A,B)	A		DM 1-2A
CLEAR ZONE	30 ft		DM 1-4N
TYPICAL SECTION NO.	1	2	

NOTES:

- * Full C/A at Interchanges: Limited and/or Partial C/A at other locations.
- ** Median Protection only used in Full C/A locations (Interchange locations).

LEGEND:

- DM - NCDOT Roadway Design Manual
- GB - AASHTO - A Policy on Geometric Design of Highways and Streets 2011
- FCM - NCDOT Functional Classification Maps

- PROPOSED DESIGN CRITERIA -

TIP: U-4700A

PREPARED BY: RK&K Engineers

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ROUTE	SR 2231	Loops	Ramps	REFERENCE OR REMARKS
NAME	2nd Ave. SW	2nd Ave. SW Loops	2nd Ave. SW Ramps	
LINE	-Y4-	-Y4LPB- & -Y4LPC-	-Y4RPB- & -Y4RPC-	
TRAFFIC DATA				
ADT CURRENT YR: 2021 =	6,890			Capacity Analysis Report For Purpose and Need Volume IV (11/16/2011)
ADT DESIGN YR: 2041 =	7,640			
TTST %	1%			
DUALS %	5%			
DHV %	9%			
DIR %	60%			
CLASSIFICATION	Principal Arterial	Urban Loop	Urban Ramp	FCM
TERRAIN TYPE	Rolling	Rolling	Rolling	DM 1-1D
DESIGN SPEED	40 mph	25 mph	30 mph	DM 1-1B
POSTED SPEED	35 mph	---	---	DM 1-1B
PROP. R/W WIDTH	Varies	Varies	Varies	
CONTROL OF ACCESS	None	Full	Full	
RUMBLE STRIPS (Y/N)	No	No	No	DM 1-4P
TYPICAL SECTION TYPE	Curb & Gutter	Shoulder (Outside) / C&G (Inside)	** Shoulder	
LANE WIDTH	16 ft Two-Lane / 12 ft Multi-Lane	* 21 ft	*** 18 ft	GB pg 3-103
SIDEWALKS (Y/N)	Yes	No	** No	DM 1-7
BICYCLE LANES (Y/N)	No	No	No	
MEDIAN WIDTH	---	---	---	
MED. PROTECT.	---	---	---	
SHOULDER WIDTH (total)				
MEDIAN / INSIDE	---	14 ft Berm	12 ft	DM 1-7D, 1-4B
OUTSIDE w/o GR	10 ft Berm	12 ft	14 ft	DM 1-7D, 1-4B
OUTSIDE w/ GR	14 ft Berm	15 ft	17 ft	DM 3-5, 1-4B
PAVED SHOULDER				
OUTSIDE TOTAL/FDPS	---	4 ft	4 ft	DM 1-4O
MEDIAN / INSIDE TOTAL/FDPS	---	2'-6" C&G	4 ft	DM 1-4O
GRADE				
MAX.	6%	10%	5%	GB pg 7-4, 8-4
MIN.	0.3 %	0.3 %	0.3 %	GB pg 3-119
K VALUE				
SAG	64	26	37	GB pg 3-161
CREST	44	12	19	GB pg 3-155
HORIZ. ALIGN.				
MAX. SUPER.	0.04	0.08	0.08	DM 1-15
MIN. RADIUS	533 ft	134 ft	214 ft	GB pg 3-44, 3-47
SPIRAL (Y/N)	No	Yes	Yes	DM 1-11
CROSS SLOPES				
PAVEMENT	0.02	0.02	0.02	DM 1-3B
PAVED SHOULDER	---	0.02	0.02	NCDOT STD 560.02
TURF SHOULDER	0.02 Berm	0.08 / 0.02 Berm	0.08	DM 1-7D; NCDOT STD 560.02
MEDIAN DITCH	---	---	---	
DITCH TYPICAL (A,B)	---	A	A	DM 1-2A
CLEAR ZONE	18 ft	18 ft	18 ft	DM 1-4N
TYPICAL SECTION NO.	5	3	4	

NOTES:

- * 18 ft lanes can be used with min. radius of 230 ft.
- ** Use curb & gutter on outside on -Y4RPB- Sta. 13+00 to end with sidewalk and 16.5 ft berm.
- *** Use 14 ft lanes can be used with min. radius of 300 ft.

LEGEND:

- DM - NCDOT Roadway Design Manual
- GB - AASHTO - A Policy on Geometric Design of Highways and Streets 2011
- FCM - NCDOT Functional Classification Maps

- PROPOSED DESIGN CRITERIA -

TIP: U-4700A

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ROUTE	SR 1692	---	SR 1306	REFERENCE OR REMARKS
NAME	1st Ave. SW	Main Ave. Dr. NW	2nd Ave. NW	
LINE	-Y4A- & -Y5-	-Y8-	-Y9-	
TRAFFIC DATA				
ADT CURRENT YR: 2021 =	2,085	2,285	9,650	Capacity Analysis Report For Purpose and Need Volume IV (11/16/2011)
ADT DESIGN YR: 2041 =	2,420	2,620	10,650	
TTST %	1%	2%	3%	
DUALS %	3%	3%	3%	
DHV %	10%	10%	7%	
DIR %	60%	65%	55%	
CLASSIFICATION	Principal Arterial	Urban Local	Minor Arterial	FCM
TERRAIN TYPE	Rolling	Rolling	Rolling	DM 1-1D
DESIGN SPEED	40 mph	40 mph	40 mph	DM 1-1B
POSTED SPEED	35 mph	35 mph	35 mph	DM 1-1B
PROP. R/W WIDTH	Varies	Varies	Varies	
CONTROL OF ACCESS	None	None	None	
RUMBLE STRIPS (Y/N)	No	No	No	DM 1-4P
TYPICAL SECTION TYPE	Curb & Gutter	Curb & Gutter	Curb & Gutter	
LANE WIDTH	16 ft	16 ft	12 ft	
SIDEWALKS (Y/N)	Yes (-Y4A- only)	No	No	DM 1-7
BICYCLE LANES (Y/N)	No	No	No	
MEDIAN WIDTH	---	---	---	
MED. PROTECT.	---	---	---	
SHOULDER WIDTH (total)				
MEDIAN / INSIDE	---	---	---	
OUTSIDE w/o GR	10 ft Berm	10 ft Berm	10 ft Berm	DM 1-7D
OUTSIDE w/ GR	14 ft Berm	14 ft Berm	14 ft Berm	DM 3-5
PAVED SHOULDER				
OUTSIDE TOTAL/FDPS	---	---	---	DM 1-4O
MEDIAN / INSIDE TOTAL/FDPS	---	---	---	DM 1-4O
GRADE				
MAX.	6%	10%	6%	GB pg 7-4, 5-3
MIN.	0.3 %	0.3 %	0.3 %	GB pg 3-119
K VALUE				
SAG	64	64	64	GB pg 3-161
CREST	44	44	44	GB pg 3-155
HORIZ. ALIGN.				
MAX. SUPER.	0.04	0.04	0.04	DM 1-15
MIN. RADIUS	533 ft	533 ft	533 ft	GB pg 3-44
SPIRAL (Y/N)	No	No	No	DM 1-11
CROSS SLOPES				
PAVEMENT	0.02	0.02	0.02	DM 1-3B
PAVED SHOULDER	---	---	---	
TURF SHOULDER	0.02 Berm	0.02 Berm	0.02 Berm	DM 1-7D
MEDIAN DITCH	---	---	---	
DITCH TYPICAL (A,B)	---	---	---	DM 1-2A
CLEAR ZONE	16 ft	16 ft	18 ft	DM 1-4N
TYPICAL SECTION NO.	5 & 6	6	7	

NOTES:

LEGEND:

DM - NCDOT Roadway Design Manual
GB - AASHTO - A Policy on Geometric Design of
Highways and Streets 2011
FCM - NCDOT Functional Classification Maps

- PROPOSED DESIGN CRITERIA -

TIP: U-4700A

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ROUTE	---	---	SR 1312	REFERENCE OR REMARKS
NAME	15th St. NW	7th Ave. NW	9th Ave. NW	
LINE	-Y9A- & -Y9B-	-Y10-	-Y10A-	
TRAFFIC DATA				Capacity Analysis Report For Purpose and Need Volume IV (11/16/2011)
ADT CURRENT YR: 2021 =	< 800	4,150	1,625	
ADT DESIGN YR: 2041 =	< 800	4,730	2,125	
TTST %		1	4	
DUALS %		4	4	
DHV %		10	12	
DIR %		70	55	
CLASSIFICATION	Urban Local	Urban Local	Urban Local	FCM
TERRAIN TYPE	Rolling	Rolling	Rolling	DM 1-1D
DESIGN SPEED	30 mph	40 mph	40 mph	DM 1-1B
POSTED SPEED	25 mph	35 mph	35 mph	DM 1-1B
PROP. R/W WIDTH	Varies	Varies	Varies	
CONTROL OF ACCESS	None	None	None	
RUMBLE STRIPS (Y/N)	No	No	No	DM 1-4P
TYPICAL SECTION TYPE	Curb & Gutter	Curb & Gutter	Curb & Gutter	
LANE WIDTH	* 14 ft	12 ft	12 ft	
SIDEWALKS (Y/N)	No	No	No	DM 1-7
BICYCLE LANES (Y/N)	No	No	No	
MEDIAN WIDTH	---	---	---	
MED. PROTECT.	---	---	---	
SHOULDER WIDTH (total)				
MEDIAN / INSIDE	---	---	---	
OUTSIDE w/o GR	10 ft Berm	10 ft Berm	10 ft Berm	DM 1-4B. DM 1-7D
OUTSIDE w/ GR	14 ft Berm	14 ft Berm	14 ft Berm	DM 1-4B, DM 3-5
PAVED SHOULDER				
OUTSIDE TOTAL/FDPS	---	---	---	DM 1-4O
MEDIAN / INSIDE TOTAL/FDPS	---	---	---	DM 1-4O
GRADE				
MAX.	10%	10%	10%	GB pg 5-3
MIN.	0.3 %	0.3 %	0.3 %	GB pg 3-119
K VALUE				
SAG	37	64	64	GB pg 3-161
CREST	19	44	44	GB pg 3-155
HORIZ. ALIGN.				
MAX. SUPER.	0.04	0.04	0.04	DM 1-15
MIN. RADIUS	250 ft	533 ft	533 ft	GB pg 3-44
SPIRAL (Y/N)	No	No	No	DM 1-11
CROSS SLOPES				
PAVEMENT	0.02	0.02	0.02	DM 1-3B
PAVED SHOULDER	---	---	---	
TURF SHOULDER	0.02 Berm	0.02 Berm	0.02 Berm	DM 1-7D
MEDIAN DITCH	---	---	---	
DITCH TYPICAL (A,B)	---	---	---	DM 1-2A
CLEAR ZONE	14 ft	16 ft	16 ft	DM 1-4N
TYPICAL SECTION NO.	8	9	9	

NOTES:

* Match existing.

LEGEND:

DM - NCDOT Roadway Design Manual
GB - AASHTO - A Policy on Geometric Design of
Highways and Streets 2011
FCM - NCDOT Functional Classification Maps

- PROPOSED DESIGN CRITERIA -

TIP: U-4700A

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ROUTE	---	SR 1371	SR 1314	REFERENCE OR REMARKS
NAME	12th St. Dr. NW	Clement Blvd. NW	14th Ave. Cir. NW	
LINE	-Y11A-	-Y13A- & -Y13B-	-Y15-	
TRAFFIC DATA				Capacity Analysis Report For Purpose and Need Volume IV (11/16/2011)
ADT CURRENT YR: 2021 =	1,545	23,605	825	
ADT DESIGN YR: 2041 =	1,710	26,025	905	
TTST %	1%	1%	6%	
DUALS %	3%	2%	3%	
DHV %	12%	9%	9%	
DIR %	80%	55%	65%	
CLASSIFICATION	Urban Local	Urban Local	Urban Local	FCM
TERRAIN TYPE	Rolling	Rolling	Rolling	DM 1-1D
DESIGN SPEED	40 mph	40 mph	40 mph	DM 1-1B
POSTED SPEED	35 mph	35 mph	35 mph	DM 1-1B
PROP. R/W WIDTH	Varies	Varies	Varies	
CONTROL OF ACCESS	None	None	None	
RUMBLE STRIPS (Y/N)	No	No	No	DM 1-4P
TYPICAL SECTION TYPE	Curb & Gutter	Curb & Gutter	Curb & Gutter	
LANE WIDTH	16 ft	12 ft	12 ft	
SIDEWALKS (Y/N)	No	No	No	DM 1-7
BICYCLE LANES (Y/N)	No	No	No	
MEDIAN WIDTH	---	---	---	
MED. PROTECT.	---	---	---	
SHOULDER WIDTH (total)				
MEDIAN / INSIDE	---	---	---	
OUTSIDE w/o GR	10 ft Berm	10 ft Berm	10 ft Berm	DM 1-7D
OUTSIDE w/ GR	14 ft Berm	14 ft Berm	14 ft Berm	DM 3-5
PAVED SHOULDER				
OUTSIDE TOTAL/FDPS	---	---	---	DM 1-4O
MEDIAN / INSIDE TOTAL/FDPS	---	---	---	DM 1-4O
GRADE				
MAX.	10%	10%	10%	GB pg 5-3
MIN.	0.3 %	0.3 %	0.3 %	GB pg 3-119
K VALUE				
SAG	64	64	64	GB pg 3-161
CREST	44	44	44	GB pg 3-155
HORIZ. ALIGN.				
MAX. SUPER.	0.04	0.04	0.04	DM 1-15
MIN. RADIUS	533 ft	533 ft	533 ft	GB TBL 3-8, 3-9
SPIRAL (Y/N)	No	No	No	DM 1-11
CROSS SLOPES				
PAVEMENT	0.02	0.02	2%	DM 1-3B
PAVED SHOULDER	---	---	---	
TURF SHOULDER	0.02 Berm	0.02 Berm	0.02 Berm	DM 1-7D
MEDIAN DITCH	---	---	---	
DITCH TYPICAL (A,B)	---	---	---	DM 1-2A
CLEAR ZONE	16 ft	18 ft	14 ft	DM 1-4N
TYPICAL SECTION NO.	10	11 & 12	9	

NOTES:

LEGEND:

DM - NCDOT Roadway Design Manual
 GB - AASHTO - A Policy on Geometric Design of
 Highways and Streets 2011
 FCM - NCDOT Functional Classification Maps

- PROPOSED DESIGN CRITERIA -

TIP: U-4700A

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ROUTE	---	SR 1760	SR 1935	REFERENCE OR REMARKS
NAME	15th Ave. NW	Corbin Ln. / Marina Access Rd.	Lake Valley Pl.	
LINE	-Y15A-	-Y17A-	-Y17B-	
TRAFFIC DATA				
ADT CURRENT YR: 2021 =	2,065	< 800	< 800	Capacity Analysis Report For Purpose and Need Volume IV (11/16/2011)
ADT DESIGN YR: 2041 =	2,315	< 800	< 800	
TTST %	1%			
DUALS %	2%			
DHV %	9%			
DIR %	70%			
CLASSIFICATION	Minor Arterial	Rural Local	Rural Local	FCM
TERRAIN TYPE	Rolling	Rolling	Rolling	DM 1-1D
DESIGN SPEED	50 mph	30 mph	30 mph	DM 1-1B
POSTED SPEED	45 mph	25 mph	25 mph	DM 1-1B
PROP. R/W WIDTH	Varies	Varies	Varies	
CONTROL OF ACCESS	None	None	None	
RUMBLE STRIPS (Y/N)	No	No	No	DM 1-4P
TYPICAL SECTION TYPE	Shoulder	Shoulder	Shoulder	
LANE WIDTH	12 ft	10 ft	10 ft	GB pg 7-5, 5-6
SIDEWALKS (Y/N)	No	No	No	DM 1-7
BICYCLE LANES (Y/N)	No	No	No	
MEDIAN WIDTH	---	---	---	
MED. PROTECT.	---	---	---	
SHOULDER WIDTH (total)				
MEDIAN / INSIDE	---	---	---	
OUTSIDE w/o GR	8 ft	2 ft	2 ft	DM 1-4B. DM 1-7D
OUTSIDE w/ GR	11 ft	7 ft	7 ft	DM 1-4B, DM 3-5
PAVED SHOULDER				
OUTSIDE TOTAL/FDPS	4 ft	---	---	DM 1-4O
MEDIAN / INSIDE TOTAL/FDPS	---	---	---	DM 1-4O
GRADE				
MAX.	5%	10%	10%	GB pg 7-4, 5-3
MIN.	0.3 %	0.3 %	0.3 %	GB pg 3-119
K VALUE				
SAG	96	37	37	GB pg 3-161
CREST	84	19	19	GB pg 3-155
HORIZ. ALIGN.				
MAX. SUPER.	0.06	0.04	0.04	DM 1-15
MIN. RADIUS	833 ft	250 ft	250 ft	GB pg 3-45, 3-44
SPIRAL (Y/N)	Yes	No	No	DM 1-11
CROSS SLOPES				
PAVEMENT	0.02	0.02	0.02	DM 1-3B
PAVED SHOULDER	0.02	---	---	NCDOT STD 560.01
TURF SHOULDER	0.08	0.08	0.08	NCDOT STD 560.01
MEDIAN DITCH	---	---	---	
DITCH TYPICAL (A,B)	A	B	B	DM 1-2A
CLEAR ZONE	20 ft	14 ft	14 ft	DM 1-4N
TYPICAL SECTION NO.	13	14	14	

NOTES:

LEGEND:

DM - NCDOT Roadway Design Manual
GB - AASHTO - A Policy on Geometric Design of
Highways and Streets 2011
FCM - NCDOT Functional Classification Maps

- PROPOSED DESIGN CRITERIA -

TIP: U-4700A

PREPARED BY: RK&K Engineers

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ROUTE	SR 1751	---	SR 1759	REFERENCE OR REMARKS
NAME	Grace Chapel Rd.	Grace Chapel Rd. Flyover	Wolfe Rd.	
LINE	-Y19-	-Y19FLY-	-Y19A- & -Y19B-	
TRAFFIC DATA				
ADT CURRENT YR: 2021 =	6,590		< 800	Capacity Analysis Report For Purpose and Need Volume IV (11/16/2011)
ADT DESIGN YR: 2041 =	7,340		< 800	
TTST %	1%			
DUALS %	3%			
DHV %	9%			
DIR %	70%			
CLASSIFICATION	Rural Major Collector	Flyover	Rural Local	FCM
TERRAIN TYPE	Rolling	Rolling	Rolling	DM 1-1D
DESIGN SPEED	50 mph	40 mph	30 mph	DM 1-1B
POSTED SPEED	45 mph	35 mph	25 mph	DM 1-1B
PROP. R/W WIDTH	Varies	Varies	Varies	
CONTROL OF ACCESS	None	Full	None	
RUMBLE STRIPS (Y/N)	No	No	No	DM 1-4P
TYPICAL SECTION TYPE	Shoulder	Shoulder	Shoulder	
LANE WIDTH	12 ft	16 ft	10 ft	GB pg 6-6, 5-6
SIDEWALKS (Y/N)	No	No	No	DM 1-7
BICYCLE LANES (Y/N)	No	No	No	
MEDIAN WIDTH	---	---	---	
MED. PROTECT.	---	---	---	
SHOULDER WIDTH (total)				
MEDIAN / INSIDE	---	12 ft	---	DM 1-4B
OUTSIDE w/o GR	8 ft	14 ft	4 ft	DM 1-4B
OUTSIDE w/ GR	11 ft	17 ft	7 ft	DM 1-4B
PAVED SHOULDER				
OUTSIDE TOTAL/FDPS	4 ft	4 ft	---	DM 1-4O
MEDIAN / INSIDE TOTAL/FDPS	---	4 ft	---	DM 1-4O
GRADE				
MAX.	7%	5%	10%	GB pg 6-3, 5-3
MIN.	0.3 %	0.3 %	0.3 %	GB pg 3-119
K VALUE				
SAG	96	64	37	GB pg 3-161
CREST	84	44	19	GB pg 3-155
HORIZ. ALIGN.				
MAX. SUPER.	0.08	0.06	0.04	DM 1-15
MIN. RADIUS	758 ft	485 ft	250 ft	GB pg 3-47, 3-45, 3-44
SPIRAL (Y/N)	No	Yes	No	DM 1-11
CROSS SLOPES				
PAVEMENT	0.02	0.02	0.02	DM 1-3B
PAVED SHOULDER	0.02	0.02	---	NCDOT STD 560.01, 560.02
TURF SHOULDER	0.08	0.08	0.08	NCDOT STD 560.01, 560.02
MEDIAN DITCH	---	---	---	
DITCH TYPICAL (A,B)	A	A	B	DM 1-2A
CLEAR ZONE	28 ft	18 ft	14 ft	DM 1-4N
TYPICAL SECTION NO.	15	16	17	

NOTES:

LEGEND:

DM - NCDOT Roadway Design Manual
GB - AASHTO - A Policy on Geometric Design of
Highways and Streets 2011
FCM - NCDOT Functional Classification Maps

- PROPOSED DESIGN CRITERIA -

TIP: U-4700A

PREPARED BY: RK&K Engineers

PAGE: 8 of 10

ROUTE	SR 1897		---	REFERENCE OR REMARKS
NAME	Alex Lee Blvd.		Alex. Lee Blvd. Service Roads	
LINE	-Y21-		-Y21A- & -Y21B-	
TRAFFIC DATA				
ADT CURRENT YR: 2021 =	< 800	2,265	< 800	Capacity Analysis Report For Purpose and Need Volume IV (11/16/2011)
ADT DESIGN YR: 2041 =	< 800	2,515	< 800	
TTST %		20%		
DUALS %		4%		
DHV %		5%		
DIR %		75%		
CLASSIFICATION	Urban Local		Urban Local	FCM
TERRAIN TYPE	Rolling		Rolling	DM 1-1D
DESIGN SPEED	40 mph		30 mph	DM 1-1B
POSTED SPEED	35 mph		25 mph	DM 1-1B
PROP. R/W WIDTH	Varies		Varies	
CONTROL OF ACCESS	None		None	
RUMBLE STRIPS (Y/N)	No		No	DM 1-4P
TYPICAL SECTION TYPE	Shoulder	Curb & Gutter	Shoulder	
LANE WIDTH	12 ft	12 ft	15 ft (-Y21A-) / 12 ft (-Y21B-)	GB pg 5-6
SIDEWALKS (Y/N)	No		No	DM 1-7
BICYCLE LANES (Y/N)	No		No	
MEDIAN WIDTH	---	16.75 ft (Raised)	---	
MED. PROTECT.	---	None	---	
SHOULDER WIDTH (total)				
MEDIAN / INSIDE	---	1'-6" C&G	---	
OUTSIDE w/o GR	8 ft	10 ft Berm	6 ft	DM 1-4B, 1-7D
OUTSIDE w/ GR	11 ft	14 ft Berm	9 ft	DM 1-4B, 3-5
PAVED SHOULDER				
OUTSIDE TOTAL/FDPS	---		---	DM 1-40
MEDIAN / INSIDE TOTAL/FDPS	---		---	DM 1-40
GRADE				
MAX.	10%		10%	GB pg 5-3
MIN.	0.3%		0.3 %	GB pg 3-119
K VALUE				
SAG	64		37	GB pg 3-161
CREST	44		19	GB pg 3-155
HORIZ. ALIGN.				
MAX. SUPER.	0.04		0.04	DM 1-15
MIN. RADIUS	533 ft		250 ft	GB pg 3-44
SPIRAL (Y/N)	No		No	DM 1-11
CROSS SLOPES				
PAVEMENT	0.02	0.02	0.02	DM 1-3B
PAVED SHOULDER	---		---	
TURF SHOULDER	0.08	0.02 Berm	0.08	NCDOT STD 560.01; DM 1-7D
MEDIAN DITCH	---		---	
DITCH TYPICAL (A,B)	B	B	B	DM 1-2A
CLEAR ZONE	14 ft	16 ft	14 ft	DM 1-4N
TYPICAL SECTION NO.	18	19	20 & 21	

NOTES:

LEGEND:

DM - NCDOT Roadway Design Manual
GB - AASHTO - A Policy on Geometric Design of
Highways and Streets 2011
FCM - NCDOT Functional Classification Maps

- PROPOSED DESIGN CRITERIA -

TIP: U-4700A

PREPARED BY: RK&K Engineers

PAGE: 9 of 10

ROUTE	---	US321A	SR 1898	REFERENCE OR REMARKS
NAME	Alex Lee Blvd. Ramps	US321A	New Farm Rd.	
LINE	-Y21RPA-, -Y21RPB-, -Y21RPC-, & -Y21RPD-	-Y23-	-Y23-	
TRAFFIC DATA				
ADT CURRENT YR: 2021 =		3,250	12,635	Capacity Analysis Report For Purpose and Need Volume IV (11/16/2011)
ADT DESIGN YR: 2041 =		3,830	19,970	
TTST %		3%	1%	
DUALS %		3%	2%	
DHV %		9%	9%	
DIR %		55%	55%	
CLASSIFICATION	Ramp	Minor Arterial	Rural Local	FCM
TERRAIN TYPE	Rolling	Rolling	Rolling	DM 1-1D
DESIGN SPEED	50 mph	50 mph	30 mph	DM 1-1B
POSTED SPEED	45 mph	45 mph	25 mph	DM 1-1B
PROP. R/W WIDTH	Varies	Varies	Varies	
CONTROL OF ACCESS	Full	None	None	
RUMBLE STRIPS (Y/N)	No	No	No	DM 1-4P
TYPICAL SECTION TYPE	Shoulder	Shoulder	Curb & Gutter	
LANE WIDTH	16 ft	12 ft	12 ft	GB pg 7-5, 5-6
SIDEWALKS (Y/N)	No	No	No	DM 1-7
BICYCLE LANES (Y/N)	No	No	No	
MEDIAN WIDTH	---	---	---	
MED. PROTECT.	---	---	---	
SHOULDER WIDTH (total)				
MEDIAN / INSIDE	12 ft	---	---	
OUTSIDE w/o GR	14 ft	8 ft	10 ft Berm	DM 1-4B, 1-7D
OUTSIDE w/ GR	17 ft	11 ft	14 ft Berm	DM 1-4B, 3-5
PAVED SHOULDER				
OUTSIDE TOTAL/FDPS	4 ft FDPS	2 ft	---	DM 1-4O
MEDIAN / INSIDE TOTAL/FDPS	4 ft FDPS	---	---	DM 1-4O
GRADE				
MAX.	5%	5%	10%	GB pg 7-4, 5-3
MIN.	0.3%	0.3 %	0.3 %	GB pg 3-119
K VALUE				
SAG	96	96	37	GB pg 3-161
CREST	84	84	19	GB pg 3-155
HORIZ. ALIGN.				
MAX. SUPER.	0.08	0.08	0.04	DM 1-15
MIN. RADIUS	758 ft	758 ft	250 ft	GB pg 3-47, 3-44
SPIRAL (Y/N)	Yes	Yes	No	DM 1-11
CROSS SLOPES				
PAVEMENT	0.02	0.02	0.02	DM 1-3B
PAVED SHOULDER	0.02	0.02	---	NCDOT STD. 560.01
TURF SHOULDER	0.08	0.08	0.02 Berm	NCDOT STD. 560.01; DM 1-7D
MEDIAN DITCH	---	---	---	
DITCH TYPICAL (A,B)	A	A	---	DM 1-2A
CLEAR ZONE	28 ft	26 ft	18 ft	DM 1-4N
TYPICAL SECTION NO.	16	22	23	

NOTES:

LEGEND:

DM - NCDOT Roadway Design Manual
GB - AASHTO - A Policy on Geometric Design of
Highways and Streets 2011
FCM - NCDOT Functional Classification Maps

U-4700A**Temporary Pavement**

	Estimated	
Roadway	Duration (mo)	Comment
-L-	36	
-Y4-	12	
-Y4D-	12	
-Y4LPD-	12	
-Y17C-	12	
-Y19-	12	

Notes:

1. See Backup tab for estimated durations of individual temporary pavement segments
2. Phase/Step durations are rough estimates and not based on quantities and production rate calculations
3. Temporary pavement required based on 1/17/2020 Revised Transportation Management Plans submittal

2019 NCDOT PAVEMENT DESIGN MANUAL
SELECT PAGES

PAVEMENT LAYER DEPTHS

Max layer depths: Inches

S9.5X = 3.0

I19.0C = 4.0

B25.0C = no restrictions

ABC = normally limited to 12, recommended depths are typically 6*, 8, 10, and 12 inches.

*Typically Secondary Roads.

CTBC = 8 for plant mixed; for road mixed 8 with top 7 mixed.

Single lift depths: Inches

S9.5B = 1.0 to 1.5

S9.5C,D = 1.5* to 2.0

*1.0" may be used in wedging only

I19.0C = 2.5 to 4.0

B25.0C = 3.0* to 5.5

*For B25.0C placed on unstabilized subgrade, the minimum lift thickness is 4.0.

ABC = 6* to 10

*8" Preferred minimum on unstabilized subgrade for primary & greater roadways.

CTBC = 8

FDR = 12

Any deviations from these depths will be noted on the pavement design letter.

To "build" a structural number, as much of the structural number as possible will be put into the surface and intermediate layers. In other words, the depths of these two layers will be maximized.

For normal mixes this total depth is 5-5.5 in, and for heavy duty designs the total depth is 6 in. 7 in. of surface and intermediate depth is typically required on interstate designs.

For curb and gutter and expressway gutter sections, the total surface and intermediate depth will be increased to 7 in. to match curb depth. For shoulder berm gutter sections, the total surface and intermediate depth will be set to match gutter depth.

Two lifts of surface mix is standard for almost all designs. 1.25" or 1.5" of S9.5B and 1.5" of S9.5C/S9.5D are the typical lift depths. An asphalt base, ABC base, or CTBC base is required on all flexible pavement designs. Normally 8 in of ABC is used as the starting depth for aggregate base.

Prime Coat is required to be used where surface mixes is placed directly on top of ABC.

MINIMUM DEPTHS FOR PAVEMENT DESIGNS

Minimum Structure Depths that are Recommended for NCDOT Designs				
	Interstate & Freeways	Primary and Secondary >20,000ADT	Primary <20,000ADT	Secondary <20,000ADT
Full Depth Asphalt	11.0" Asphalt	9.5" Asphalt	7.0" Asphalt	6.5" Asphalt
ABC	7.0" Asphalt and 8" ABC	5.5" Asphalt and 8.0" ABC	3.0" Asphalt and 8.0" ABC	2.5" Asphalt and 6.0" ABC
CTBC	7.0" Asphalt and 8.0" CTBC	5.5" Asphalt and 8.0" CTBC	3.0" Asphalt and 8.0" CTBC	2.5" Asphalt and 8.0" CTBC
Concrete	9.0" Concrete 3.0" of PADC 1.25" of S9.5B**	8.0" Concrete 3.0" of PADC 1.25" of S9.5B**	7.0" Concrete 3.0" of PADC 1.25" of S9.5B**	5.0-6.0" Concrete* and 4.0" ABC

*5.0" is the minimum on residential subdivision streets only.

*5.5" is the minimum on collector roadways.

*6.0" is the minimum on Poor to Fair subgrade type (A-4 to A-7)

** For pavements with <2000 average daily trucks 6" ABC can be used rather than the PADC and S9.5B

PAVEMENT DESIGNS FOR DETOURS

Pavement designs for detours and other temporary pavements will usually be constructed of aggregate base course (ABC) and minimal asphalt depths to reduce construction waste. ABC recovered from detour structures will be re-used in the project or stockpiled to be used by Division Maintenance Forces. Typical design periods are from 6 months to 2 years as provided by Project Design Engineer. Pavement designs prepared for design periods of less than 6 months should be carefully reviewed since required structural numbers may be unreasonably low. For any detour that is expected to carry truck traffic, the minimum asphalt layer shall be 2 inches. Surface mix is required to be the top layer is any flexible design including detours and temporary pavements.

Note: The selection of loading level for SuperPave mixes will be based on the theoretical 20 year accumulation of ESAL's even when the design life used for the pavement structure is for a short duration, with the exception of D mix types, which will be replaced with a C mix.

THIN-DEPTH PAVED SHOULDER DESIGN

For paved shoulders that will not be constructed with full depth of travel lane pavement thickness (see Roadway Design Paved Shoulder Policy), 2 % of the design lane traffic loads will be used for design.

BRIDGE REPLACEMENT PAVEMENT DESIGNS

Due to the small amount of roadway work involved in most of these projects, final pavement designs for bridge replacement projects are typically made without a soils investigation or review committee input. On bridge replacement projects with roadway work less than 1,200 ft in length, a full depth asphalt design is normally recommended. For lengths in excess of 1,200 ft, an aggregate base course (ABC) will be provided if feasible. All of these designs are to be based on a 20 or 30 year design period, based on ADT. If there is an exception, the reason(s) for the exception should be documented on the final pavement design issued to the Roadway Design or Design Services Project Engineer. Overlay designs on existing pavement should consist of one to two lifts of surface and based on the condition of the existing roadway. Recommended bridge replacement pavement designs are listed on next page, as low volume designs.

RECOMMENED LOW VOUME PAVEMENT DESIGNS

This table is an easy method to determine designs typically used for low volume pavements, based on required SN (Page 1). Minimum pavement depths based on road types (page 10) still are required, regardless of this table.

****CHECK DESIGN MEETS MINIMUM DEPTHS FOR PAVEMENT DESIGNS (PAGE 10)****

Without Curb and Gutter Designs:

(Determine if load level is B, C, or D by using the 20 year ESALS - Page 7)

Table A-1 Recommended Pavement Design - (Full Depth)				
Required Structural Number	Surface	Inter.	Base	Structural Number Provided
B LEVEL DESIGNS (Use when 20 year ESALS are <0.3 Million)				
<2.37	2.5" S9.5B		4.0" B25.0C	2.30
2.38 - 2.52	2.5" S9.5B		4.5" B25.0C	2.45
2.53 - 2.67	2.5" S9.5B		5.0" B25.0C	2.60
2.68 - 2.82	2.5" S9.5B		5.5" B25.0C	2.75
2.83 - 3.47	2.5" S9.5B	2.5" I19.0C	4.0" B25.0C	3.40
B, C, & D LEVEL DESIGNS (Use when 20 year ESALS are >0.3 Million)				
<2.59	3.0" S9.5X		4.5" B25.0C	2.52
2.60 - 2.74	3.0" S9.5X		4.5" B25.0C	2.67
2.75 - 2.89	3.0" S9.5X		5.0" B25.0C	2.82
2.90 - 3.04	3.0" S9.5X		5.5" B25.0C	2.97
3.05 - 3.69	3.0" S9.5X	2.5" I19.0C	4.0" B25.0C	3.62
3.70 - 3.84	3.0" S9.5X	2.5" I19.0C	4.5" B25.0C	3.77
3.85 - 3.99	3.0" S9.5X	2.5" I19.0C	5.0" B25.0C	3.92
4.00 - 4.14	3.0" S9.5X	2.5" I19.0C	5.5" B25.0C	4.07

For -Y4D-
& -Y17C-

(Determine if load level is B, C, or D by using the 20 year ESALS - Page 7)

Table A-2 Recommended Pavement Design (ABC)				
Required Structural Number	Surface	Inter.	Base	Structural Number Provided
B LEVEL DESIGNS (Use when 20 year ESALS are <0.3 Million)				
<2.01	2.5" S9.5B *		6" ABC	1.94
2.02 - 2.29	2.5" S9.5B*		8" ABC	2.22
2.30 - 2.57	2.5" S9.5B*		10" ABC	2.50
2.58 - 3.11	2.5" S9.5B	2.5" I19.0C	6" ABC	3.04
3.12 - 3.39	2.5" S9.5B	2.5" I19.0C	8" ABC	3.32
3.40 - 3.67	2.5" S9.5B	2.5" I19.0C	10" ABC	3.60
B, C, & D LEVEL DESIGNS (Use when 20 year ESALS are >0.3 Million)				
<2.23	3.0" S9.5X		6" ABC	2.16
2.24 - 2.51	3.0" S9.5X		8" ABC	2.44
2.52 - 2.79	3.0" S9.5X		10" ABC	2.72
2.80 - 3.33	3.0" S9.5X	2.5" I19.0C	6" ABC	3.26
3.34 - 3.61	3.0" S9.5X	2.5" I19.0C	8" ABC	3.54
3.62 - 3.89	3.0" S9.5X	2.5" I19.0C	10" ABC	3.82

For -Y4D-
& -Y17C-

* Prime coat required

Curb and Gutter Designs:

(Determine if load level is B, C, or D by using the 20 year ESALS - Page 7)

Table B-1 Recommended Pavement Design - (Full Depth)				
Required Structural Number	Surface	Inter.	Base	Structural Number Provided
<4.35	3.0" S9.5X	4.0" I19.0C	4.0" B25.0C	4.28
4.36 - 4.50	3.0" S9.5X	4.0" I19.0C	4.5" B25.0C	4.43

(Determine if load level is B, C, or D by using the 20 year ESALS - Page 7)

Table B-2 Recommended Pavement Design (ABC)				
Required Structural Number	Surface	Inter.	Base	Structural Number Provided
<3.99	3.0" S9.5X	4.0" I19.0C	6" ABC	3.92
4.00 - 4.27	3.0" S9.5X	4.0" I19.0C	8" ABC	4.20
4.28 - 4.55	3.0" S9.5X	4.0" I19.0C	10" ABC	4.48

Growth Percentage Calculation

Project: US 321 Widening

TIP: U-4700A

Traffic Growth Percentages

US321 from US70 to Main Ave. Dr. -L- (Start to 68+00)

%growth		CY(Let Year)	2025
2041 49775		% Duals	3
2021 44360		%TTST	6
0.576 Growth %		Number of Lanes	4
		CY ADT	45394
		55% DIR: Urban Principal Arterial	

US321 from Main Ave Dr. to End -L- (68+00 to End)

%growth		CY(Let Year)	2025
2041 57470		% Duals	4
2021 50135		%TTST	4
0.683 Growth %		Number of Lanes	4
		CY ADT	51523
		60% DIR: Principal Arterial	

-Y4-

%growth		CY(Let Year)	2025
2041 7640		% Duals	5
2021 6890		%TTST	1
0.517 Growth %		Number of Lanes	2
		CY ADT	7034
		60% DIR: Principal Arterial	

-Y4LPD-*

%growth		CY(Let Year)	2025
2041 4990		% Duals	5
2021 4500		%TTST	4
0.517 Growth %		Number of Lanes	2
		CY ADT	4594
		60% DIR	

*: ADT and Traffic Volume are based 13th Street SW Traffic has No Build Traffic of 2016.

-Y19-

%growth		CY(Let Year)	2025
2041 7340		% Duals	3
2021 6590		%TTST	1
0.539 Growth %		Number of Lanes	2
		CY ADT	6734
		70% DIR: Rural Maj. Collector	

PAVEMENT DESIGN CHART

-L- & -Y-Lines

Job Name:US321 Widening Improvements: Parameters used in Design

Parameter	Value
Initial Serviceability	4.20
Terminal Serviceability	2.75 (-L-)
	2.5 (-Y-)
Relaibility Level	90%
Overall Standard Deviation	0.45
Design CBR Value	5

Job Name:US321 Widening Improvements: Temporary Pavement Recommendations (ABC) -L- & -Y- Lines

Route	Name	Line	ADT	Design Life (Years)	Required SN	Pavement Design	Notes
US 321	US 321 from US 70 to Main Ave. Dr. NW (-L- Sta. 68+00)	-L-	45,394	3	3.71	3.0"- S9.5C 2.5" I19.0C 10.0" ABC	
US 321	US 321 from Main Ave. Dr. NW (-L- Sta. 68+00) to End of Project	-L-	51,523	3	3.61	3.0"- S9.5C 2.5" I19.0C 10.0" ABC	
SR2231	Grace Chapel Road	-Y4-	7,034	1	2.23	2.5"- S9.5B 8.0" ABC	
		-Y4D-	Unknown	1	<2.00	2.5"- S9.5B 6.0" ABC	
Loops	13 th Street	-Y4LPD-	4,594	1	2.37	2.5"- S9.5B 9.0" ABC	
	LakeView Terrace	-Y17C-	Unknown	1	<2.00	2.5"- S9.5B 6.0" ABC	
SR1751	Grace Chapel Road	-Y19-	6,734	1	2.33	2.5"- S9.5B 8.0" ABC	

Job Name:US321 Widening Improvements: Temporary Pavement Recommendations (Full Depth) -L- & -Y- Lines

Route	Name	Line	ADT	Design Life (Years)	Required SN	Pavement Design	Notes
US 321	US 321 from US 70 to Main Ave. Dr. NW (-L- Sta. 68+00)	-L-	45,394	3	3.54	3.0"- S9.5C 2.5" I19.0C 4.5" B25.0C	
US 321	US 321 from Main Ave. Dr. NW (-L- Sta. 68+00) to End of Project	-L-	51,523	3	3.61	3.0"- S9.5C 2.5" I19.0C 4.5" B25.0C	
SR2231	Grace Chapel Road	-Y4-	7,034	1	2.23	2.5"- S9.5B 4.0" B25.0C	
		-Y4D-	Unknown	1	<2.00	2.5"- S9.5B 4.0" B25.0C	
Loops	13 th Street	-Y4LPD-	4,594	1	2.37	2.5"- S9.5B 4.5" B25.0C	
	LakeView Terrace	-Y17C-	Unknown	1	<2.00	2.5"- S9.5B 4.0" B25.0C	
SR1751	Grace Chapel Road	-Y19-	6,734	1	2.38	2.5"- S9.5B 4.0" B25.0C	

CALCULATION SUMMARY

-L-

START TO 68+00

Traffic Spreadsheet

Job Name US321 Widening Improvements from US70 in Hickory to just north of US321A/ New Farm Road
Job Number U-4700A
Engineer Saket Kabra

Proposed Road -L-: Sta Start to 68+00

ADT	45394
Duals %	3
TTST %	6
Design Life (Years)	3
Annual Growth Rate %	0.6

Traffic Type	Vehicles Per Day	Vehicles Per Year	Total Growth Factor	Lane Factor	Direction Factor	Truck Factor	ESAL's
Duals	1361.82	497064.3	3.02	0.8	0.5	0.25	149980
TTST	2723.64	994128.6	3.02	0.8	0.5	0.8	959871

Total ESAL's	1,109,851
--------------	-----------

NCDOT FLEXIBLE PAVEMENT DESIGN

Job Name US321 Wideing Improvements from US70 in Hickory to just north of US321A/ New Farm Road
Job Number U-4700A
Engineer Saket Kabra

Proposed Road -L- Sta 68+00 to End

W_{t18kip}	CBR	p_t	G_t	Mr	SN_{trial}	Req'd $\log(W_{t18kip})$	Calculated $\log(W_{t18kip})$
1,109,851	3	2.75	-0.27	5161.17	4.24	6.05	6.05
1,109,851	4	2.75	-0.27	6204.54	3.94	6.05	6.05
1,109,851	5	2.75	-0.27	7157.01	3.73	6.05	6.05
1,109,851	6	2.75	-0.27	8042.81	3.56	6.05	6.05
1,109,851	7	2.75	-0.27	8876.74	3.42	6.05	6.05

W_{t18kip} Number of 18 kip single axle load applications during design life

CBR design CBR value

G_t $= \log((4.2 - p_t)/2.7)$

p_t terminal serviceability factor

Reliability 90% = $Z_n = -1.282$

Resilient MoD $Mr = 2555 \cdot (CBR)^{0.64}$

SN_{trial} trial structural number

1,109,851

Job Name US321 Wideing Improvements from US70 in Hickory to just north of US321A/ New Farm Road
Job Number U-4700A
Engineer Saket Kabra

Proposed Road -L-: Sta Start to 68+00

Recommended Flexible Pavement Section

		SN / inch	Thickness (inches)	SN
Proposed Pavement	Asphalt Surface Course (9.5C)	0.44	3.00	1.32
	Asphalt Intermediate Course (I19.0C)	0.44	2.50	1.10
	Asphalt Base Course (B25.0C)	0.30	4.50	1.35
	ABC Stone	0.14		
	Cement Treated CABC	0.23		
	Class IV	0.13		
	Cement Stabilized Subgrade	0.14		
	Permeable Asphalt Drainage Course	0.14		
			Total Structural Number	3.77
			Required Structure Number	3.73

0.04 OK

Job Name US321 Wideing Improvements from US70 in Hickory to just north of US321A/ New Farm Road
Job Number U-4700A
Engineer Saket Kabra

Proposed Road -L-: Sta Start to 68+00

Recommended Flexible Pavement Section

		SN / inch	Thickness (inches)	SN
Proposed Pavement	Asphalt Surface Course (9.5C)	0.44	3.00	1.32
	Asphalt Intermediate Course (I19.0C)	0.44	2.50	1.10
	Asphalt Base Course (B25.0C)	0.30		0.00
	ABC Stone	0.14	10.0	1.40
	Cement Treated CABC	0.23		0.00
	Class IV	0.13		
	Cement Stabilized Subgrade	0.14		
	Permeable Asphalt Drainage Course	0.14		
		Total Structural Number		3.82
		Required Structure Number		3.73

0.09 OK

-L-

68+00 TO END

Traffic Spreadsheet

Job Name US321 Widening Improvements from US70 in Hickory to just north of US321A/ New Farm Road
Job Number U-4700A
Engineer Saket Kabra

Proposed Road -L-: 68+00 to End

ADT	51523
Duals %	4
TTST %	4
Design Life (Years)	3
Annual Growth Rate %	0.7

Traffic Type	Vehicles Per Day	Vehicles Per Year	Total Growth Factor	Lane Factor	Direction Factor	Truck Factor	ESAL's
Duals	2060.92	752235.8	3.02	0.8	0.5	0.25	227216
TTST	2060.92	752235.8	3.02	0.8	0.5	0.8	727090

Total ESAL's	954,305
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NCDOT FLEXIBLE PAVEMENT DESIGN

Job Name US321 Wideing Improvements from US70 in Hickory to just north of US321A/ New Farm Road
Job Number U-4700A
Engineer Saket Kabra

Proposed Road -L-: 68+00 to End

W_{t18kip}	CBR	p_t	G_t	Mr	SN_{trial}	Req'd $\log(W_{t18kip})$	Calculated $\log(W_{t18kip})$
954,305	3	2.75	-0.27	5161.17	4.12	5.98	5.98
954,305	4	2.75	-0.27	6204.54	3.84	5.98	5.98
954,305	5	2.75	-0.27	7157.01	3.63	5.98	5.98
954,305	6	2.75	-0.27	8042.81	3.46	5.98	5.98
954,305	7	2.75	-0.27	8876.74	3.32	5.98	5.98

W_{t18kip} Number of 18 kip single axle load applications during design life

CBR design CBR value

G_t $= \log((4.2 - p_t)/2.7)$

p_t terminal serviceability factor

Reliability 90% = $Z_n = -1.282$

Resilient MoD $Mr = 2555 \cdot (CBR)^{0.64}$

SN_{trial} trial structural number

954,305

Job Name US321 Wideing Improvements from US70 in Hickory to just north of US321A/ New Farm Road
Job Number U-4700A
Engineer Saket Kabra

Proposed Road -L-: 68+00 to End

Recommended Flexible Pavement Section

		SN / inch	Thickness (inches)	SN
Proposed Pavement	Asphalt Surface Course (9.5C)	0.44	3.00	1.32
	Asphalt Intermediate Course (I19.0C)	0.44	2.50	1.10
	Asphalt Base Course (B25.0C)	0.30		0.00
	ABC Stone	0.14	10.0	1.40
	Cement Treated CABC	0.23		0.00
	Class IV	0.13		
	Cement Stabilized Subgrade	0.14		
	Permeable Asphalt Drainage Course	0.14		
		Total Structural Number		3.82
		Required Structure Number		3.63

0.19 OK

Job Name US321 Wideing Improvements from US70 in Hickory to just north of US321A/ New Farm Road
Job Number U-4700A
Engineer Saket Kabra

Proposed Road -L-: 68+00 to End

Recommended Flexible Pavement Section

		SN / inch	Thickness (inches)	SN
Proposed Pavement	Asphalt Surface Course (9.5C)	0.44	3.00	1.32
	Asphalt Intermediate Course (I19.0C)	0.44	2.50	1.10
	Asphalt Base Course (B25.0C)	0.30	4.50	1.35
	ABC Stone	0.14		
	Cement Treated CABC	0.23		
	Class IV	0.13		
	Cement Stabilized Subgrade	0.14		
	Permeable Asphalt Drainage Course	0.14		
			Total Structural Number	3.77
			Required Structure Number	3.63

0.14 OK

-Y4-

Traffic Spreadsheet

Job Name US321 Wideing Improvements from US70 in Hickory to just north of US321A/ New Farm Road
Job Number U-4700A
Engineer Saket Kabra

Proposed Road -Y4-

ADT	7034
Cars %	0
Duals %	5
TTST %	1
Design Life (Years)	1
Annual Growth Rate %	0.517

Traffic Type	Vehicles Per Day	Vehicles Per Year	Total Growth Factor	Lane Factor	Direction Factor	Truck Factor	ESAL's
Cars	0	0	1.00	1	1	0.0004	0
Duals	351.7	128370.5	1.00	1	1	0.30	38511.15
TTST	70.34	25674.1	1.00	1	1	0.95	24390.4

Total ESAL's	62,902
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NCDOT FLEXIBLE PAVEMENT DESIGN

Job Name US321 Wideing Improvements from US70 in Hickory to just north of US321A/ New Farm Road
Job Number U-4700A
Engineer Saket Kabra

Proposed Road -Y4-

W_{t18kip}	CBR	p_t	G_t	Mr	SN_{trial}	Req'd $\log(W_{t18kip})$	Calculated $\log(W_{t18kip})$
62,902	3	2.5	-0.20091	5161.17	2.54	4.80	4.80
62,902	4	2.5	-0.20091	6204.54	2.36	4.80	4.80
62,902	5	2.5	-0.20091	7157.01	2.24	4.80	4.80
62,902	6	2.5	-0.20091	8042.81	2.14	4.80	4.80
62,902	7	2.5	-0.20091	8876.74	2.06	4.80	4.81

W_{t18kip} Number of 18 kip single axle load applications during design life
 CBR design CBR value
 $G_t = \log((4.2 - p_t)/2.7)$
 p_t terminal serviceability factor
 Reliability 90% = $Z_n = -1.282$
 Resilient MoD $Mr = 2555 \cdot (CBR)^{0.64}$
 SN_{trial} trial structural number

62,902

Job Name US321 Wideing Improvements from US70 in Hickory to just north of US321A/ New Farm Road
Job Number U-4700A
Engineer Saket Kabra

Proposed Road -Y4-

Recommended Flexible Pavement Section

		SN / inch	Thickness (inches)	SN
Proposed Pavement	Asphalt Surface Course (9.5B)	0.44	2.50	1.10
	Asphalt Intermediate Course (I19.0C)	0.44		0.00
	Asphalt Base Course (B25.0C)	0.30		0.00
	ABC Stone	0.14	8.0	1.12
	Cement Treated CABC	0.23		0.00
	Class IV	0.13		
	Cement Stabilized Subgrade	0.14		
	Permeable Asphalt Drainage Course	0.14		
Total Structural Number				2.22
Required Structure Number				2.24

-0.02 Not OK

Note: This is within the margin of error and deemed acceptable.

Job Name US321 Wideing Improvements from US70 in Hickory to just north of US321A/ New Farm Road
Job Number U-4700A
Engineer Saket Kabra

Proposed Road -Y4-

Recommended Flexible Pavement Section

Proposed Pavement		SN / inch	Thickness (inches)	SN
	Asphalt Surface Course (9.5B)	0.44	2.50	1.10
	Asphalt Intermediate Course (I19.0C)	0.44		0.00
	Asphalt Base Course (B25.0C)	0.30	4.00	1.20
	ABC Stone	0.14		0.00
	Cement Treated CABC	0.23		0.00
	Class IV	0.13		
	Cement Stabilized Subgrade	0.14		
	Permeable Asphalt Drainage Course	0.14		
			Total Structural Number	2.30
			Required Structure Number	2.24

0.06 OK

-Y19-

Traffic Spreadsheet

Job Name US321 Wideing Improvements from US70 in Hickory to just north of US321A/ New Farm Road
Job Number U-4700A
Engineer Saket Kabra

Proposed Road -Y19-

ADT	6734
Cars %	0
Duals %	3
TTST %	1
Design Life (Years)	1
Annual Growth Rate %	0.6

Traffic Type	Vehicles Per Day	Vehicles Per Year	Total Growth Factor	Lane Factor	Direction Factor	Truck Factor	ESAL's
Cars	0	0	1.00	1	1	0.0004	0
Duals	202.02	73737.3	1.00	1	1	0.30	22121.19
TTST	67.34	24579.1	1.00	1	1	0.95	23350.1

Total ESAL's	45,471
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NCDOT FLEXIBLE PAVEMENT DESIGN

Job Name US321 Wideing Improvements from US70 in Hickory to just north of US321A/ New Farm Road
Job Number U-4700A
Engineer Saket Kabra

Proposed Road -Y19-

W_{t18kip}	CBR	p_t	G_t	Mr	SN_{trial}	Req'd $\log(W_{t18kip})$	Calculated $\log(W_{t18kip})$
45,471	3	2.5	-0.20091	5161.17	2.41	4.66	4.67
45,471	4	2.5	-0.20091	6204.54	2.24	4.66	4.66
45,471	5	2.5	-0.20091	7157.01	2.12	4.66	4.66
45,471	6	2.5	-0.20091	8042.81	2.02	4.66	4.66
45,471	7	2.5	-0.20091	8876.74	1.95	4.66	4.66

W_{t18kip} Number of 18 kip single axle load applications during design life
 CBR design CBR value
 $G_t = \log((4.2 - p_t)/2.7)$
 p_t terminal serviceability factor
 Reliability 90% = $Z_n = -1.282$
 Resilient MoD $Mr = 2555 \cdot (CBR)^{0.64}$
 SN_{trial} trial structural number

45,471

Job Name US321 Wideing Improvements from US70 in Hickory to just north of US321A/ New Farm Road
Job Number U-4700A
Engineer Saket Kabra

Proposed Road -Y19-

Recommended Flexible Pavement Section

Proposed Pavement		SN / inch	Thickness (inches)	SN
	Asphalt Surface Course (9.5B)	0.44	2.50	1.10
	Asphalt Intermediate Course (I19.0C)	0.44		0.00
	Asphalt Base Course (B25.0C)	0.30		0.00
	ABC Stone	0.14	8.0	1.12
	Cement Treated CABC	0.23		0.00
	Class IV	0.13		
	Cement Stabilized Subgrade	0.14		
	Permeable Asphalt Drainage Course	0.14		
Total Structural Number				2.22
Required Structure Number				2.12

0.10 OK

Job Name US321 Wideing Improvements from US70 in Hickory to just north of US321A/ New Farm Road
Job Number U-4700A
Engineer Saket Kabra

Proposed Road -Y19-

Recommended Flexible Pavement Section

USE Table A-1<0.3

Proposed Pavement		SN / inch	Thickness (inches)	SN
	Asphalt Surface Course (9.5B)	0.44	2.50	1.10
	Asphalt Intermediate Course (I19.0C)	0.44		0.00
	Asphalt Base Course (B25.0C)	0.30	4.00	1.20
	ABC Stone	0.14		0.00
	Cement Treated CABC	0.23		0.00
	Class IV	0.13		
	Cement Stabilized Subgrade	0.14		
	Permeable Asphalt Drainage Course	0.14		
			Total Structural Number	2.30
			Required Structure Number	2.12

0.18 OK

-Y4LPD-

Traffic Spreadsheet

Job Name US321 Wideing Improvements from US70 in Hickory to just north of US321A/ New Farm Road
Job Number U-4700A
Engineer Saket Kabra

Proposed Road -Y4LPD-

ADT	4594
Cars %	0
Duals %	5
TTST %	4
Design Life (Years)	1
Annual Growth Rate %	0.5

Traffic Type	Vehicles Per Day	Vehicles Per Year	Total Growth Factor	Lane Factor	Direction Factor	Truck Factor	ESAL's
Cars	0	0	1.00	1	1	0.0004	0
Duals	229.7	83840.5	1.00	1	1	0.30	25152.15
TTST	183.76	67072.4	1.00	1	1	0.95	63718.8

Total ESAL's	88,871
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NCDOT FLEXIBLE PAVEMENT DESIGN

Job Name US321 Wideing Improvements from US70 in Hickory to just north of US321A/ New Farm Road
Job Number U-4700A
Engineer Saket Kabra

Proposed Road -Y4LPD-

W_{t18kip}	CBR	p_t	G_t	Mr	SN_{trial}	Req'd $\log(W_{t18kip})$	Calculated $\log(W_{t18kip})$
88,871	3	2.5	-0.20091	5161.17	2.69	4.95	4.95
88,871	4	2.5	-0.20091	6204.54	2.50	4.95	4.95
88,871	5	2.5	-0.20091	7157.01	2.37	4.95	4.95
88,871	6	2.5	-0.20091	8042.81	2.27	4.95	4.96
88,871	7	2.5	-0.20091	8876.74	2.18	4.95	4.95

W_{t18kip} Number of 18 kip single axle load applications during design life
 CBR design CBR value
 $G_t = \log((4.2 - p_t)/2.7)$
 p_t terminal serviceability factor
 Reliability 90% = $Z_n = -1.282$
 Resilient MoD $Mr = 2555 \cdot (CBR)^{0.64}$
 SN_{trial} trial structural number

88,871

Job Name US321 Wideing Improvements from US70 in Hickory to just north of US321A/ New Farm Road
Job Number U-4700A
Engineer Saket Kabra

Proposed Road -Y4LPD-

Recommended Flexible Pavement Section

		SN / inch	Thickness (inches)	SN
Proposed Pavement	Asphalt Surface Course (9.5B)	0.44	2.50	1.10
	Asphalt Intermediate Course (I19.0C)	0.44		0.00
	Asphalt Base Course (B25.0C)	0.30		0.00
	ABC Stone	0.14	9.0	1.26
	Cement Treated CABC	0.23		0.00
	Class IV	0.13		
	Cement Stabilized Subgrade	0.14		
	Permeable Asphalt Drainage Course	0.14		
Total Structural Number				2.36
Required Structure Number				2.37

-0.01 OK

Note: This is within the margin of error and deemed acceptable.

Job Name US321 Wideing Improvements from US70 in Hickory to just north of US321A/ New Farm Road
Job Number U-4700A
Engineer Saket Kabra

Proposed Road -Y4LPD-

Recommended Flexible Pavement Section

Proposed Pavement		SN / inch	Thickness (inches)	SN
	Asphalt Surface Course (9.5B)	0.44	2.50	1.10
	Asphalt Intermediate Course (I19.0C)	0.44		0.00
	Asphalt Base Course (B25.0C)	0.30	4.50	1.35
	ABC Stone	0.14		0.00
	Cement Treated CABC	0.23		0.00
	Class IV	0.13		
	Cement Stabilized Subgrade	0.14		
	Permeable Asphalt Drainage Course	0.14		
			Total Structural Number	2.45
			Required Structure Number	2.37

0.08 OK