City of Durham
Unpaved Road Study (revised)
Durham, NC

Prepared for:

The City of Durham

Unpaved Road Study
To
Convert Unpaved Roads to Paved Roads (revised)
Durham, North Carolina

Prepared for:
The City of Durham, North Carolina

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1.0 Executive Summary

The City of Durham maintains over 179 unpaved roads. The 19 miles of unpaved roads are located throughout the city limits and the majority of them are within a 5-mile radius of downtown Durham. The unpaved roads are primarily used for residential access; however, some are used for commercial access or shortcuts to other roads.

Project Description

The purpose of this study has two approaches. The first approach is to address paving the unpaved roads in 2009, should federal stimulus funding become available to the City of Durham. The second approach is to devise five- and ten-year plans to pave all of the unpaved roads if federal stimulus funding does not become available. Our intent is to develop a limited number of typical sections for the roads following City of Durham and NCDOT standards. This approach should limit the overall cost of the paving in 2009 and later years.

Scope of Work

Kimley-Horn and Associates, Summit Consulting, Bree and Associates, and TriMat Materials Testing developed a scope of work to meet the project objectives stated above.

- Kimley-Horn developed a plan to visit each of the known unpaved roads and document the existing conditions. Our intent was to gather enough field information to accurately develop an opinion of probable cost as well as document any design deficiencies or safety concerns.
- Kimley-Horn and Bree visited all of the known unpaved roads to document the existing conditions. Specific items documented in the field included width of road, usable width, shoulder width, ditch depth, primary use, drainage issues, utilities, obstructions, and design deficiencies, as well as photographing the road.
- Separately, Summit Consulting visited each of the known unpaved roads and documented the existing surface and base conditions. Summit Consulting gathered enough information to make a recommendation for typical sections.
- Summit Consulting visited all of the known unpaved roads to document the existing base conditions. Specifically, Summit Consulting determined the base thickness and sub-grade soil types utilizing a truck-mounted CME-55 drill rig equipped with a solid stem auger. A 5-inch hole was advanced in the existing road bed through the stone to expose the sub-grade soils. Additionally, the existing surface conditions along the road were examined.
- TriMat used the information obtained by Summit Consulting to derive several typical section recommendations for the unpaved roads.
- Once all field information was gathered, Kimley-Horn completed an opinion of probable cost for each road based on existing conditions and the recommended typical section, as well as an opinion of probable cost using cement treated base.

- Kimley-Horn then created a database that contains all obtained field information which also includes photographs and an opinion of probable costs.
- Ultimately, Kimley-Horn developed the report in two approaches: 1) assume the roads are paved in 2009 or one paving season, and, 2) assume five- and ten-year plans to pave all of the unpaved roads.

Testing

No testing was conducted with this study. All sub-grade analysis and classification were completed by a trained field engineer. It was also assumed that the traffic volumes were low and testing would not be required. This was approach was used to expedite the study and keep the project cost to a minimum.

Traffic Data

No traffic data was available for the roads at the time of this report. All field personal made visual observations as to the primary use of the road. The categories were residential, commercial, and cut-through.

2.0 Introduction

General

The City of Durham maintains over 179 unpaved roads. The 19 miles of unpaved roads are located throughout the city limits and the majority of them are within a 5-mile radius of downtown Durham. The unpaved roads are primarily used for residential access; however, some are used for commercial access or shortcuts to other roads. When we began this study, we anticipated visiting 197, or 22 miles, of roads; however, we visited 229, or 23 miles, of roads in Durham. After reviewing each street with the City of Durham the number of streets was reduced to 170, or 19 miles of roads maintained by the City.

This report presents the investigation findings, analysis, field information, and recommendations for the unpaved roads within the Durham city limits.

Project Description

The purpose of this study has two approaches. The first approach is to address paving the unpaved roads in 2009, should federal stimulus funding become available to the City of Durham. The second approach is to devise a five- and ten-year plan to pave all of the unpaved roads if federal stimulus funding does not become available. Our intent is to develop a limited number of typical sections for the roads following City of Durham and NCDOT standards. This approach should limit the overall cost of the paving in 2009 and later years.

The report has been developed in accordance with the scope of services dated October 2, 2008. The observations, comments, and recommendations contained in this report have been prepared for the exclusive use of Kimley-Horn and Associates and the City of Durham for this project in accordance with generally accepted engineering practice. No other warranty is expressed or implied. Performance of any engineering investigation is subject to many qualifications inherent to the practice of that profession and to the accuracy of the data obtained. Although a reasonable effort was made to interpret data, correctly depict existing conditions, and identify causes of current problems; variation could exist between tested locations and the historical documents provided by others.

3.0 Field Work and Data Collection

Existing Condition Survey

As we developed a plan to efficiently complete field work, it was important to address the map with the road locations. The map provided by the City of was large and cumbersome, making it difficult to use effectively in the field. We divided the map using a grid system, resulting in a 3 x 7 numbered grid. This 21-sheet numbered map allowed us to divide the city and identify the roads to efficiently complete our field observations. The grid system not only facilitated our field effort, it made for easier tracking within the database. In the future, the grid system will allow the City to efficiently group the various unpaved roads into bid sets to help minimize mobilization, thus lowering construction cost.

An important part of this study includes adequate field work and a visual assessment of the current conditions. The visual assessment is the primary way of documenting existing issues including safety issues or maintenance concerns. During our field investigations, we used our professional judgment as to the primary use of the road. Typically during a study of this magnitude, traffic data is incorporated and used in the final recommendations; however, traffic data was unavailable. Our field investigation also included rating these roads on a scale of 1 to 5, five being the best. This information can be somewhat subjective because various individuals performed the assessments. The ratings are included in the database for general information. It is our understanding that this type of study has never been performed on these roads for the City of Durham so there is no previous data to use as a comparison. The rating system could potentially be used by the City should future and/or further evaluation be sought on the lowest rated roads.

Field Observations

Surface Condition
Minor potholes
Major potholes
Loose gravel
Rutting

Design Deficiencies
Sight distance
Alignment
No recovery area
Need guardrail

Drainage Issues
Pipe silted up
Pipe joint separated
Extend pipe
Replace

Miscellaneous Items
Manholes
Water valves
Gas valves

Obstructions
Mail box
Trees
Brush
Signs
Utility poles

Summit Consulting visited each of the roads and inventoried the existing base conditions. To determine the existing base conditions a CME 55 drill rig with a stem auger was used to cut a 5" diameter hole to a sufficient depth to determine soil type in the subgrade. Summit Consulting used the information obtained both from a visual assessment and the information gathered from the auger to provide typical sections, taking into account the primary use of the road. The recommended typical sections were developed to utilize the existing subgrade and stone base. This will help to keep construction cost to a minimum.

4.0 Database

Discussion

After completing the field investigations, a database was developed, meeting the City's criteria to manage the information. The database is user-friendly, contains an accurate portrayal of the current conditions in the field, and allows the City to update the database as needed in the future.

Database

Both Kimley-Horn and Summit Consulting gathered large amounts of data during field visits. Previously completed Kimley-Horn studies were analyzed to determine the best database and what would be included in the generated report. The initial step was to understand information the City wanted gathered and what information the City wanted printed in the final report. After generating a preliminary example of the output, we had a better understanding of our task. We developed a database which would allow the City flexibility for future use as well as serve the purposes of this study.

As stated earlier, the goal was to gather as much information as possible during the site visits to accurately portray the current field conditions as well as document anything that would potentially affect the cost of construction. In order to facilitate this task and keep the information as consistent as possible, a data entry sheet was developed and used to document information for each road. This approach would ensure our field crews gathered the same information at each road and maintain consistency between the crews. The following is a list of the information on the data sheets and description.

Item	Description
Map Location	to be use with the map grid system
Road Name	supplied by the City, but verified in the field
Road Limit	supplied by the City, but verified in the field
Typical Section	supplied by Summit Consulting, proposed typical
Length	supplied by the City, but verified in the field
Width	hand measured in field
Usable Width	hand measured in field
Shoulder Width	hand measured in field
Shoulder to Centerline of Ditch	hand measured in field
Ditch Depth	not physically measured, approximated
Primary Use	visually assessed who was using the road and why
Begin Photo	show the beginning of the road to portray existing condition
End Photo	show the end of road to portray existing condition

Item	Description
Drainage Issue	document standing water, collapsed pipe, etc.
Utilities	utility poles, manholes or valves
Obstructions	utility poles, mailboxes or unsafe conditions
Design Deficiencies	need guardrail, steep grade, sharp curve, etc.
Comment Section	additional observations and photos
Existing Sub-Grade	supplied by Summit Consulting, existing structure
Additional Base needed	supplied by Summit Consulting, in addition to existing structure

With the large amount of data and limited space on a report form, we determined what information would be necessary to document in the report. Information gathered in the field that is not reported on the form is map location, existing sub-grade, additional base needed and usable width. This information can be found in the electronic database for future use.

Cost Opinion

With the information gathered in the field, Kimley-Horn developed two cost opinion's for each road, one using standard asphalt and subgrade and the other using standard asphalt with cement treated base. The major cost item on all roads is paving and sub-grade construction; however, Kimley-Horn did attempt to include all known items on each road. Some additional items factored in to the cost opinion other than asphalt related items are mobilization, testing, any storm drain pipe replacement, pipe removal, pipe cleanout, guardrail, manhole adjustment, valve adjustments, traffic control, minor clearing and relocation of mailboxes. We understand that the City may elect to pave the road and not address other items, but these were included to give an accurate representation of the cost for each road. A cost opinion for each road has been included in the report.

Cost Opinion Assumption

LINE ITEM	ITEM DESCRIPTION	UNIT	UNIT PRICE
1	Mobilization	LS	$5,000
2	Contractor Testing	LS	$1,000
3	Milling	SY	$8
4	Asphalt Concrete Surface Course, Type S9.5B	TON	$70
5	Asphalt Concrete Intermediate Course, Type SF9.5A	TON	$70
6	Asphalt Concrete Base Course, Type B25.0B	TON	Not used
7	Asphalt Binder	TON	$400
8	Aggregate Base Course	TON	$50
9	Incidental Stone Base	TON	$50
10	Removal of Existing Pavement	SY	$4
11	Mixing Existing Base	SY	$6
12	Cement 40#	TON	$135
13	Cement 50#	TON	$135
14	Relocate Excess Material	CY	$7
15	12" R.C. Pipe Culverts, Class III	LF	$25
16	15" R.C. Pipe Culverts, Class III	LF	$30
17	18" R.C. Pipe Culverts, Class III	LF	$35
18	24" R.C. Pipe Culverts, Class III	LF	$40
19	36" R.C. Pipe Culverts, Class III	LF	$55
20	48" R.C. Pipe Culverts, Class III	LF	$70
21	Pipe Removal	LF	$20
22	Pipe Clean Out	EA	$500
23	24" Pipe End Section	EA	$700
24	Fine Grading	LS	$2,000
25	Steel Beam Guardrail	LF	$14
26	Guardrail Anchor Unit, Type 350	EA	$1,500
27	Guardrail Anchor Unit, Type CAT-1	EA	$500
28	Adjust Existing Manhole	EA	$750
29	Adjust Existing Drainage Structure	EA	$750
30	Adjust Existing Water Valve	EA	$200
31	Adjust Existing Gas Valve	EA	$200
32	Pipe Collar	CY	$500
33	Relocate Mailbox	EA	$100
34	Minor Clearing (Brush/Trees)	LS	$2,000
35	Traffic Control	LS	$2,500

5.0 Recommendations

Discussion

Based on the information gathered in the field, Kimley-Horn made recommendations for improvements for design deficiencies and Summit Consulting made recommendations for typical sections.

Typical Sections

Summit Consulting and TriMat together made typical section recommendations for each road based on information collected in the field. The following documents were used as a reference for preparing the recommendations:

- "City of Durham: Pavement Design Requirements"
- "Interim Pavement Design Procedures" from NCDOT Pavement Management Unit, May 6, 1994
- "Asphalt Pavement Design" from Superpave, Section 3, 2006
- "Subdivision Roads: Minimum Construction Standards" by NCDOT Division of Highways Board of Transportation, January 1, 2000

Summary

As shown in the field data and report, Summit Consulting has developed and recommended five typical sections for the unpaved roads within the city limits. All five of the typical sections utilize the existing sub-grade material and are unique to each of the unpaved roads. The following is a summary of the typical sections and what existing condition dictated their use, drawings of each typical section can be found at the end of this report:

<u>Typical Section #1 – Clayey Sub-grades</u>
SF9.5A - 2.5 inches
ABC Stone - 8.0 inches

<u>Typical Section #2 – Clayey Sub-grades (for roads with a lot of existing stone)</u>
SF9.5A - 1.5 inches
ABC Stone - 11.0 inches

<u>Typical Section #3 – Sandy Sub-grades</u>
SF9.5A - 1.5 inches
ABC Stone - 8.0 inches

Typical Section #4 – Heavy Traffic Areas (commercial/industrial)

SF9.5A - 1.0 inches
SF9.5B - 3.0 inches
ABC Stone - 10.0 inches

Typical Section #5 – Light Traffic (good sub-grade/ no outlet)

SF9.5A - 1.5 inches
ABC Stone - 6.0 inches

During the field investigation, we found that the unpaved roads varied greatly in length and width. The unpaved roads varied in length from under one hundred feet to over one quarter-mile. The widths varied from ten feet to over thirty feet. Our observations noted that the primary use for these roads was residential. Existing conditions varied from a dirt/grass path to a true gravel road with rutting or pot holes.

Due to the low volume of traffic on these roads, we recommend closing the entire road and paving it at one time. This approach should limit the overall impact to citizens and help minimize the cost of construction.

Additional Typical Section Considerations

In addition to the standard paving methods and options, Summit Consulting and TriMat investigated alternate options for paving the unpaved roads. Slurry and matt seals were investigated but these applications are typically more successful on existing asphalt roads. TriMat concluded that this application would not prove feasible for an overwhelming number of the roads studied in this report. If the City decided to repave these roads due to their deteriorated state, it is our opinion that overlay and or milling would be the best alternative.

Another paving alternative considered for this study was Cement Treated Aggregate Base Course (CTABC). TriMat concluded that CTABC should only be considered for longer roads where there is no curb and gutter or the existence of numerous utilities as these conditions will increase the cost. The longest road in the study was found to be a little more than one-half mile in length; seventeen roads were found to be longer than one-quarter mile, with the remaining less than one-quarter mile. Other considerations taken into account with CTABC were the required application equipment and product cure time. All application equipment for CTABC is street legal with the exception of the mixer. The mixer would have to be mobilized for each location. The City would not see any cost benefit for using CTABC due to the large number of short roads contained within the study. Another issue to consider with the CTABC is the cure time, which is approximately 72 hours. During the 72-hour cure time, traffic would not be allowed on the treated road. For this study, CTABC was not uniquely considered due to cost, cure time, potential for multiple mobilizations, more equipment on site, and an inconvenience to the residents or motorists; however cost estimates were developed for the City's consideration.

Priority System

To help the City of Durham efficiently allocate the acquired funds and have the ability to sort through a large amount of data, Kimley-Horn devised a system to prioritize the unpaved roads in this study. The goal was to be able to select the roads that will use the City's funds wisely and omit the roads that are either already paved or unrealistic to pave at the time. The system was designed by assigning points to various characteristics of existing and proposed features. The characteristics considered were proposed typical section, primary use, utilities, design deficiencies, obstructions, and drainage issues. After assigning points for each characteristic, the total value for any given road is compared to the rest of the roads in the study. Roads with a lower number are of highest priority and should be considered in the early projects. Below is how each characteristic was graded.

The proposed typical section was deemed as one of the more important characteristics when evaluating the priority of the individual unpaved roads. Kimley-Horn ranked each proposed typical section based on their constructability and cost. Typical sections with a smaller stone thickness were viewed as easier to construct and less costly. The typical sections were ranked based on these two qualities and then put into three groups and assigned varying points. The table below lists how the typical sections were ranked and the points associated with each group.

Group #	#1	#2		#3	
Assigned Points	1	5		10	
Typical Section #	#5	#3	#1	#2	#4
Constructability	Easy →				Hard
Cost	Lower →				Higher

Paved roads were given a point value of 100 to ensure that the road would be kicked out of the priority sequence. The specific point values were assigned to weight the typical section more than other characteristics, as will be seen in further discussion.

The primary use of the unpaved road was also considered one of the more important characteristics. Based on discussions with the City, roads used for commercial purposes were given higher priority over residential roads because commercial roads tend to see a higher percentage of truck traffic. In addition, the commercial roads are showing increased signs of stress and are in greater need of repair. For prioritization purposes, commercial roads were given 0 points and residential roads were given 5 points.

The final four characteristics fall into the same category. These characteristics are utilities, design deficiencies, obstructions, and drainage issues. The characteristics in this category all carried the same point value. If the unpaved road had any of the above characteristics, it was given 1 point. For example, if a road had a tree just off the road (obstruction), manholes (utility), crushed cross pipe (drainage issue), and a sharp vertical curve (design deficiency), it would receive a total of 4 points for this category. This was done to take into account all of the issues that would make the specific road more complicated or expensive to build.

Finally, all of the points were totaled for each road and compared to the others in the database. Four distinct groups emerged when the data was sorted. Each group was given a rating based on the score. Roads with values between 1-9 received high priority, values of 10-11 received medium priority, values of over 12 received low priority, and existing paved roads received the lowest rating. The priority values (high, medium and low) for each road were included in the final report for each individual road, while the numerical score for each road can be found in the database. This approach will enable the City to easily change the value or sort the database.

Using the above priority rating system, the priority rankings are as follows:

Priority Ranking	Total Number of Roads
High	76
Medium	86
Low	43
Already Paved	24

This ranking system was established to separate the roads based on the existing conditions. This ranking system does not take in to account the likely hood of the road being paved based on its use. A road could be ranked "High", but the likely hood of it being paved is low. For example, a road could be in good condition, have plenty of sub-grade stone, no utilities and no design deficiencies and only serve as a short cut, with no businesses or houses. The City would most likely never pave this road due to the road's primary use and lack of traffic. The ranking system will serve as a starting place to group roads and decide on the need for pavement, but ultimately the decision to pave any given road will be made by the City.

6.0 Federal Stimulus Plan

Objective

As part of this study, Kimley-Horn was charged with devising a plan for quick implementation of the paving project should the City of Durham receive federal stimulus funding. Our approach to this aspect of the study was to find a creative solution or implement a new plan that has not been used on other projects.

Discussion

Kimley-Horn has worked on several projects with the City. Most, if not all, have been let for construction. Those projects were analyzed and it was discovered that there is a significant amount of time required for the procurement process or getting the contractor working. One requirement of the first stimulus package was that projects had to be "shovel ready" in order to be considered for funding. It is anticipated that if there is additional stimulus funding, similar requirements will apply. Typically the procurement process, from advertisement to notice-to-proceed, can take anywhere from 95 to 100 days, leaving a very short time to get the project under construction to meet the 120-day parameter. Another important issue to consider is the industry standard for seasonal limitations. The seasonal limitation paving window closes on December 15 and opens on March 15. This is very important to any paving project. If the City were to get funding in August and have to complete the procurement process, it would be approximately two weeks before the paving window closed for the season.

Approach

In order to utilize any federal stimulus funding, the City of Durham should eliminate the current procurement process. If the City anticipates receiving federal funding, the procurement process should already be complete and contractor's selected. It is recommended that the City use an on-call system similar to the City's current on-call contracts with consultants. The City can prequalify contractors based on their unit prices and estimated quantities. The prequalification criteria should include, but not be limited to, the ability to complete the work, DBE participation, similar projects and past projects with the City. These contracts can be setup the same way other projects are setup with similar contract language, including DBE goals and technical specifications. The only difference would be the contractors would not know the specific location. The City should anticipate selecting three contractors and place them in a queue for the work. Once funding is received and in place, contractors would be given a package which contained the road location, typical section, anticipated quantities, guidance for traffic control and other work required from our field observations. The locations given to each contractor would be grouped based on location or proximity to other roads to minimize mobilization cost and help expedite the project. We recommend limiting the authorization to each contractor in the amount of three million dollars, as this would allow the work to be easily managed by the contractor and City of Durham. Once any given contractor completed his authorized work, he could re-enter the queue and receive more work.

Cost to Complete in the Year 2009

The opinion of probable cost to complete the paving of all roads in 2009 is approximately $7,100,000 based on the proposed typical sections and the observations made in the field at each road. Based on the Engineers Opinion of Probable Cost of $7,100,000, these projects could be divided evenly among three contractors.

Schedule

Based on past experience, production rates for aggregate base course are 1,500 tons or approximately 700 feet per day and 600 tons of asphalt or approximately 2,000 feet per day. Based on the quantity assumptions per day, the majority of roads should be completed in four to six days per location, including utility adjustments and pipe work. With these assumptions and the work split between three contractors, it is our opinion that the roads could be paved in 250 days. In order to facilitate this schedule, it was assumed that each road would be closed to traffic during construction. This will expedite construction and help control construction cost by minimizing traffic control and mobilizations.

Conclusion

The City of Durham can pave all of the existing unpaved roads if they receive federal stimulus funding in one paving season if they have contractors ready to go in mid-April of any year. This conclusion is based on of the estimated 250 days necessary to complete the recommended work and the seasonal limitation date of December 15. This would also require that typical procurement process be changed to include the prequalification of contractors. If the federal stimulus funding were to be in place after mid-April, the City could still complete a portion of the paving before the December 15 deadline. The "Cost to Complete in the Year 2009" is based on standard asphalt and subgrade. CTABC was not considered in the cost and schedule, as the cost and schedule would be relatively the same.

7.0 General 5-year Plan

Objective

Another objective of the study is to develop a 5-year plan to be put in place should the City of Durham not receive any federal stimulus funding. This aspect of the study would maintain the City's same procurement process that is currently in place for construction projects. If the City is not under any time constraint, there is no reason to revise the process.

Discussion

The main issue of a 5-year plan to pave the roads is not schedule, it is funding. Unlike the federal stimulus funding approach, a 5-year plan will cost the City of Durham more to pave the roads as opposed to completing the work in one year or one paving cycle. It is our opinion that the City would see an increase of approximately 5% - 6% per year in construction cost. For a 5-year plan, the roads to be paved first should be the roads that are in the worst condition or have design deficiencies. These roads can be easily identified and sorted within the database. This portion of the study ignores the seasonal limitation requirement and assumes that paving would occur in manner to allow it to be completed during the normal paving season.

Approach

For a 5-year plan, the City would need to identify which roads to pave first based on need or identified safety issues. The allocation of roads to contractors would need to incorporate proximity to other indentified roads to help limit construction costs. As discussed earlier, a map grid system has been developed that will allow the City to see the proximity of one road to another as well as sort the database based on map location. For this plan it was assumed that the scope of work would include paving approximately 4 miles each year or allocating approximately $1,400,000 worth of work in the first year. One benefit of this plan is that it allows the City to advertise and bid one project per year or hire one contractor for the year. Another benefit to this plan is that the procurement process remains unchanged. The City can use the same DBE requirements, contract language, and technical specifications that are currently in use. One drawback to this plan is that it will cost more. As stated earlier, we assume that construction costs will increase 5% - 6% every calendar year. In the end this plan will potentially cost the City an additional $750,000 to $900,000 over five years.

Schedule

Based on past experience, production rate for aggregate base course is 1,500 tons per day or approximately 700 feet per day and 600 tons of asphalt per day or approximately 2,000 feet per day. Based on the quantity assumptions per day, the majority of roads allocated in any year should be completed in four to six days per location, including utility adjustments and pipe work. With these assumptions and working with one contractor, it is our opinion that the allocated roads could be paved in 50 to 60 days. In order to facilitate this schedule, it was assumed that each road would be

closed to traffic during construction. This will expedite construction and help control construction cost by minimizing traffic control and mobilizations.

Conclusion

The City should consider a 5-year paving plan if time constraints are not an issue and there is flexibility on the construction start date. A 5-year plan is easier for the City to manage, as opposed to the federal stimulus plan. The City can also administer this plan similar to current resurfacing projects. This plan also allows the City more flexibility with the seasonal limitations as the construction duration is much smaller and can be accomplished in a shorter amount of time. It is our opinion that the City could begin the procurement process in mid-June of any year and still be complete by the December 15 deadline. The "5-year plan" is based on standard asphalt and subgrade. CTABC was not considered in the cost and schedule, as the cost and schedule would be relatively the same.

8.0 General 10-year Plan

Objective

Another objective of the study was to develop a 10-year plan that could be implemented should the City of Durham not receive any federal stimulus funding. This aspect of the study would maintain the City's same procurement process that is currently in place for construction projects. If the City is not under any time constraint, there is no reason to revise the process.

Discussion

The main issue with a 10-year plan to pave the roads is not schedule, it is funding. Unlike the federal stimulus funding approach, a 10-year plan will cost the City of Durham more as opposed to completing the work in one year or one paving cycle. The City could expect to see an increase of approximately 5% - 6% per year in construction cost. For a 10-year plan, the roads to be paved first should be the roads that are in the worst condition or have design deficiencies. These roads can be easily identified and sorted within the electronic database. This portion of the study ignores the seasonal limitation requirements and assumes that paving would occur in manner to allow it to be completed during the normal paving season.

Approach

For a 10-year plan, the City would need to identify which roads to pave first based on need or identified safety issues. The allocation of roads to contractors would need to incorporate proximity to other indentified roads to help limit construction costs. As discussed earlier, a map grid system has been developed that will allow the City to see the proximity of one road to another as well as sort the database based on map location. Under this plan we assumed paving approximately 2 miles each year or allocating approximately $710,000 worth of work in the first year. One benefit to this plan is that it allows the City to advertise and bid one project a year or hire one contractor per year. Another benefit to this plan is that the procurement process remains unchanged. The City can use the same DBE requirements, contract language, and technical specifications that are currently being used. One drawback to this plan is it will cost the more. As stated earlier, we assume that construction costs will increase 5% to 6% every calendar year. In the end this plan will potentially cost the City an additional $1,900,000 to $2,300,000 over ten years.

Schedule

Based on past experience, the production rate for aggregate base course is 1,500 tons per day or approximately 700 feet per day and 600 tons of asphalt per day or approximately 2,000 feet per day. Based on the quantity assumptions per day, the majority of roads allocated in any year should be completed in four to six days per location, including utility adjustments and pipe work. With these assumptions and working with one contractor, it is our opinion that the allocated roads could be paved in 20 to 30 days. In order to facilitate this schedule, it was assumed that each road would be

closed to traffic during construction. This will expedite construction and help control construction cost by minimizing traffic control and mobilizations.

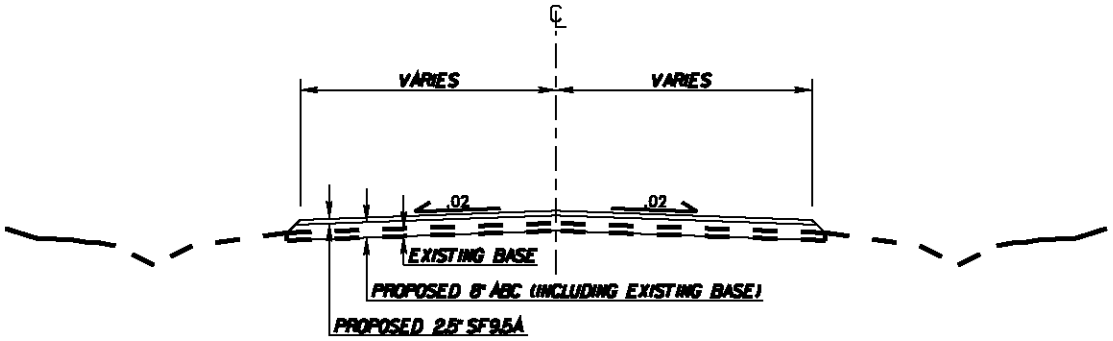
Conclusion

The City should consider a 10-year paving plan if time constraints are not an issue and there is flexibility on the construction start date. A10-year plan is easier for the City to manage, as opposed to the federal stimulus plan and the 5-year paving plan. The City can also administer this plan similar to current resurfacing projects. This plan also allows the City more flexibility with the seasonal Limitations as the construction duration is much smaller and can be accomplished in a shorter amount of time. It is our opinion that the City could begin the procurement process in mid-July of any year and still be complete by the December 15 deadline. The "10-year plan" is based on standard asphalt and subgrade. CTABC was not considered in the cost and schedule, as the cost and schedule would be relatively the same.

9.0 Bid Packages

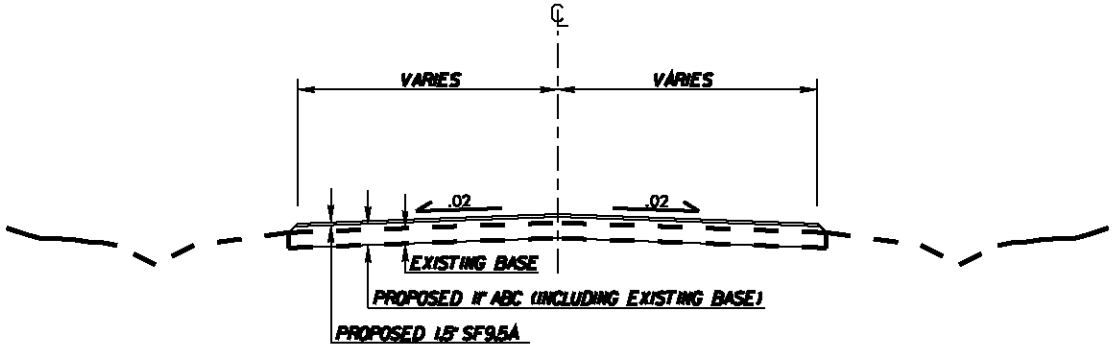
Objective

The final objective of this study is to develop a sample bid package that can be supplied to a contractor to bid and begin work on any road. The purpose of the bid package is to assist the City to streamline the process for starting projects. It will be our intent to use similar projects, such as one of the City's resurfacing contracts, to develop the packages. Kimley-Horn can assist the City of Durham with bid packages upon receiving written notice from the City of Durham.



TYPICAL SECTION 1

CLAYEY SUBGRADES

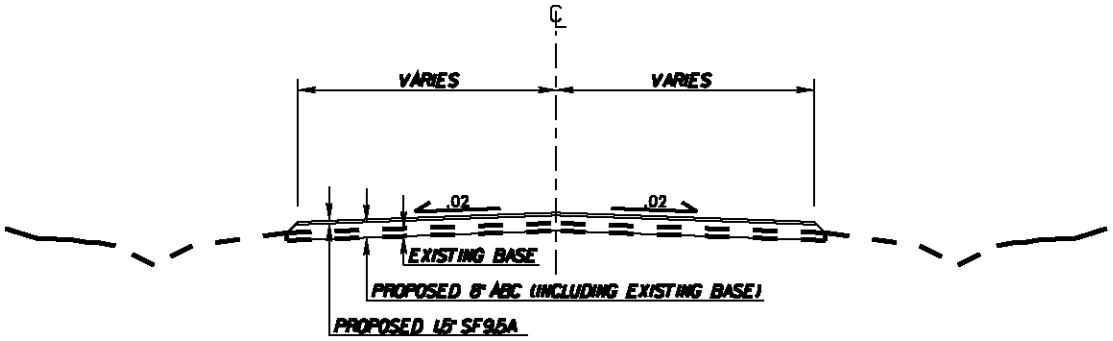


TYPICAL SECTION 2

CLAYEY SUBGRADES (ROADS WITH A LOT OF EXISTING STONE)

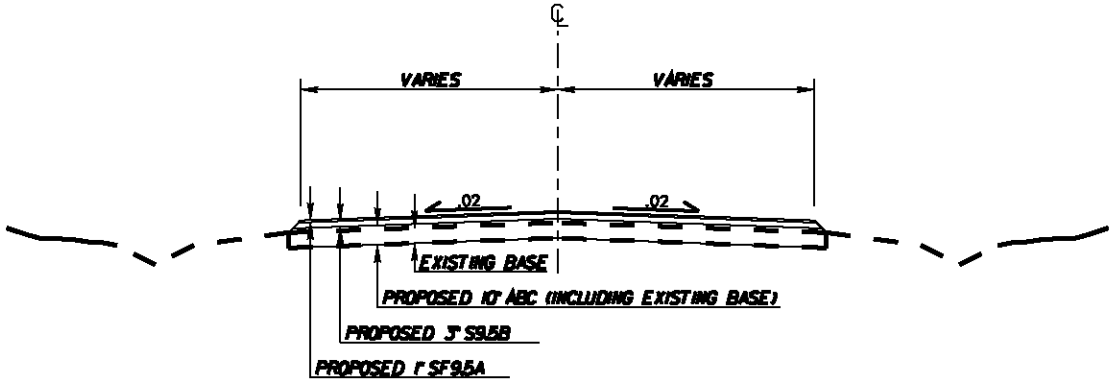
NOT TO SCALE

Kimley-Horn and Associates, Inc.	CITY OF DURHAM UNPAVED ROAD STUDY	TYPICAL SECTIONS	FIGURE 1



TYPICAL SECTION 3

SANDY SUBGRADES

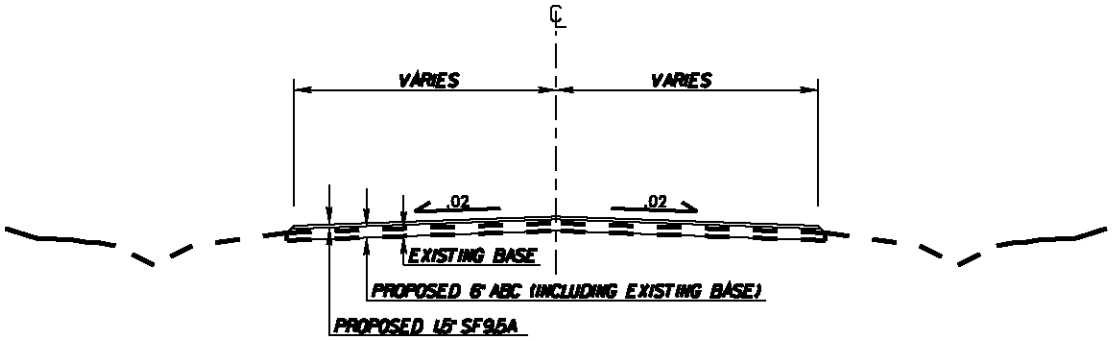


TYPICAL SECTION 4

HEAVY TRAFFIC AREA (COMMERCIAL/INDUSTRIAL)

NOT TO SCALE

Kimley-Horn and Associates, Inc.	CITY OF DURHAM UNPAVED ROAD STUDY	TYPICAL SECTIONS	FIGURE 2



TYPICAL SECTION 5

LIGHT TRAFFIC (GOOD SUBGRADE/NO OUTLET)

NOT TO SCALE

Kimley-Horn and Associates, Inc.	CITY OF DURHAM UNPAVED ROAD STUDY	TYPICAL SECTIONS	FIGURE 3