Roadway Assessment - Otter Creek Road, from Franklin Pike to Radnor Lake State Natural Area

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

BACKGROUND

Otter Creek Road is classified as a local road according to the City of Oak Hill Street Classification Map. The road serves as access to approximately 30 privately owned parcels and visitors to Radnor Lake State Natural Area. The roadway has rural type features. The road has no curbs and curves back and forth through a residential and wooded area. Otter Creek Road is an access to a desirable residential area and to the State Natural Area which is a significant asset to the Oak Hill community. The roadway should be safe and functional while understanding the context and maintaining its assets.

In 2012, Kimley-Horn and Associates, Inc. completed a Condition Assessment and Pavement Management System for the City of Oak Hill, Tennessee. Condition assessment data was collected for all 49 miles of public right of way throughout the City of Oak Hill. The rating system used calculates the Condition Index (CI) of the pavement (from 0–severe distress to 100–perfect condition) by itemizing individual distresses found in the pavement surface. The distresses are measured and given an extent (percentage of pavement affected) and severity value. A distress rating (0-100) is then assigned using a standardized point deduction system. Therefore, the CI of a given road section is 100 reduced by the total distress rating. This method generally follows the American Society for Testing and Materials (ASTM) D6433-11 "Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys" method.

At the time of the survey, Otter Creek Road was the second worst rated road within the City. The worst graded road was Cadillac Drive but that road has since been repaved. As of March 1, 2014, the Condition Index rating of Otter Creek Road is a 39. The following pictures in **Figure 1** show typical pavement distresses that caused the Condition Index of a 39.

Figure 1: Existing Pavement Distresses

The following table, **Table 1**, shows typical distresses for a road within this range and the next range if there is further deterioration.

Table 1: Typical Pavement Distresses for Condition Index 20-40

CI Rating		Typical Distresses – Asphalt Pavement
40 – 31	Fair	Severe surface raveling. Multiple longitudinal and transverse cracking with slight raveling. Longitudinal cracking in wheel path. Block cracking (over 50% of surface). Patching in fair condition. Slight rutting or distortions (1/2" deep or less).
30 – 21	Poor	Closely spaced longitudinal and transverse cracks often showing raveling and crack erosion. Severe block cracking. Some alligator cracking (less than 25% of surface). Patches in fair to poor condition. Moderate rutting or distortion (1" or 2" deep). Occasional potholes.

The following table, **Table 2**, shows typical repair strategies that would be required for a road in the ranges similar to Otter Creek Road.

Table 2: Typical Pavement Repair Activities for Condition Index 20-40

Repair Activity	Budget Type	Typical Repairs	Avg. Cost per S.F.
AC-30	Rehabilitation	Partial-depth mill and replace entire area Provide additional asphalt thickness in replacement section Proof-roll and perform incremental milling and replacement or full depth repairs where required Repair isolated distress areas and overlay entire segment depending on existing site conditions Re-stripe	$2.60
AC-20	Reconstruction	Remove existing asphalt with full-depth milling or pulverization 20% base repair with undercutting to strengthen sub-grade Addition of sub-base as needed Install replacement asphalt section Curb and gutter replacement as needed Re-stripe	$3.50

Since Otter Creek Road has known drainage problems, narrow lane widths, narrow right of way widths and steep slopes on both sides, this road was not a simple candidate for milling and overlaying or simply overlaying similar to what has been done in other areas of the City in recent years. Based on these factors, increased traffic and residential development, the roadway is in need of improvements. The following report is intended to provide the City of Oak Hill with different options to improve Otter Creek Road, from Franklin Pike to Radnor Lake State Natural Area.

DATA COLLECTION

A complete walk through of the project was conducted by Kimley-Horn staff. Necessary measurements were taken and features were field assessed. Traffic counts were taken during the State Natural Area peak season to determine daily volumes for both residential and State Natural Area traffic. A geotechnical investigation was conducted on the existing pavements at various points along the city owned portion of Otter Creek Road. The Metropolitan Government of Nashville and Davidson County (Metro) GIS maps were also used to determine existing right-of-way (ROW) widths and property owners along Otter Creek Road. Metro GIS property and aerial maps can be found in **Appendix A**.

Site Visit

Kimley-Horn conducted a site visit on September 24, 2013. Measurements of pavement widths, side slopes, and drainage structures were taken. Drainage ditches were also field assessed.

Roadway

The pavement widths varied from 18 feet to 20 feet. The side slopes of the roadway varied throughout but were measured to be 3:1 at a maximum. The cross slopes of the roadway pavement were measured periodically throughout the project and were found to be a maximum of 10% superelevated in curves. **Figure 2** below shows the existing typical section for Otter Creek Road.

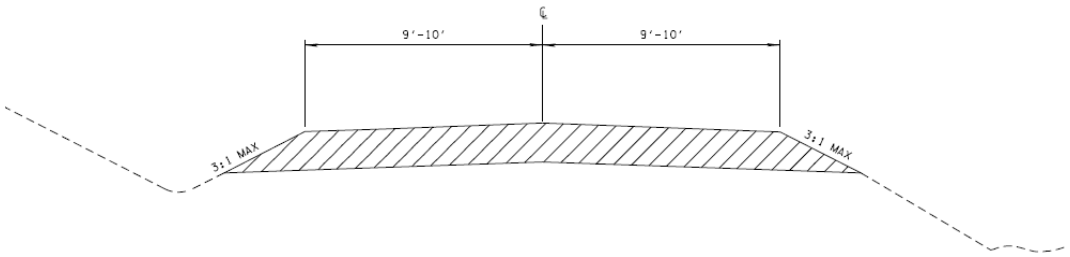


Figure 2: Existing Typical Section of Roadway

The roadway side slopes also show signs of erosion. This erosion is minor in most places. Properly developed, stabilized, and rounded roadside slopes will have less erosion. As erosion along the sides of the road occur, the edges of the pavement become weaker and cracks develop and

eventually failures occur within the pavement. This is discussed further in the Pavement Surface section below.

Existing Drainage

Storm water drainage pipes were found throughout the project. There were five pipes found crossing the roadway. Most driveways have pipes under them to allow for storm water to continue along the ditch line adjacent to the road. Over time many of these pipes have been silted in and do not function properly. **Figure 3** shows a sampling of existing drainage infrastructure. Several properties have private drainage structures as well. There is a detention basin on the eastern edge of the Estates at Radnor Lake residential development that does not appear to capture any stormwater from the existing roadside ditches.

Figure 3: Existing Storm Drainage Pipes

Existing Utilities

Existing overhead utility lines follow alongside one side of Otter Creek Road along the entire project. It crosses from the north to the south side of the roadway at various points. **Figure 4** shows the existing overhead utility lines on both sides of the street. A sanitary sewer line runs down the eastern portion of the road and ends near the eastern most lot of the Estates at Radnor Lake residential development. Water service connects from Kingsview Court through Lot 7 of the Estates at Radnor Lake. An 8" water line then runs on the north side of Otter Creek Road, east to Lot 9 of the Estates at Radnor Lake and west to Lot 4 of the Estates at Radnor Lake. At Lot 4, the line reduces to a 2" and continues to the lot line between Lot 1 and 2 of the Estates at Radnor Lake, where it crosses the road, runs along the south side of the road, to the east until it reaches 837 Otter Creek Road and to the west until it reaches the lot line between Lot 1 and Lot 2 of 929 Otter Creek Road. At this lot line, a 6" water line runs along the lot line between Lot 1 and Lot 2 of 929 Otter Creek Road and also along the lot line between 941 and 945 Forest Acres Court, where it connects to the water line within the Forest Acres Court right of way. Water and sewer mapping has been provided by Metro Water Services and can be found in **Appendix B**.

Figure 4: Existing Overhead Utility Lines

Pavement Surface

Visual inspection of the pavement during the site visit showed a couple different types of needed repair. Some areas along the edge of the pavement are starting to break off. This is a result of the erosion along the edge of the road pulling away the subgrade of the pavement and causing the pavement to crack and fail. Other areas are experiencing general settlement in the middle of the roadway that has caused cracking. The asphalt on the surface has been worn off and aggregate is exposed. The pavement is in need of resurfacing. **Figure 5** shows some existing pavement surface cracking.

Figure 5: Existing Pavement Surface with Cracking

Traffic Counts

Bi-directional vehicle counts were obtained using pneumatic road tube counters; the data collection was performed by the Tennessee Transportation Assistance Program (TTAP). Traffic data was collected along Otter Creek Road at two (2) locations: (1) just west of Franklin Pike, and (2) near the metal gate at the Radnor Lake State Natural Area entrance. The tubes remained at both of these locations for fourteen (14) consecutive days; however, location 1 was damaged on October 16 or October 17. Thus, the 2nd week of data at location 1 is deemed unreliable. The daily counts are summarized in the below **Table 3** below.

Table 3: Traffic Count Data

Date	Day of Week	Otter Creek Road – Vehicles per Day (VPD)					
		Location 1 – Near Franklin Pike			Location 2 – Near Radnor Lake Gate		
		Westbound	Eastbound	Total	Westbound	Eastbound	Total
10/09/13	Wednesday	317	352	669	246	282	528
10/10/13	Thursday	386	388	774	295	301	596
10/11/13	Friday	428	426	854	330	327	657
10/12/13	Saturday	440	443	883	379	386	765
10/13/13	Sunday	447	452	899	392	401	793
10/14/13	Monday	442	454	896	376	373	749
10/15/13	Tuesday	328	336	664	269	270	539
10/16/13	Wednesday	Tube was Damaged (unreliable data)			125	122	247
10/17/13	Thursday				170	171	341
10/18/13	Friday				294	295	589
10/19/13	Saturday				280	277	557
10/20/13	Sunday				422	426	848
10/21/13	Monday				309	318	627
10/22/13	Tuesday				180	185	365

During the first seven (7) days, the Average Daily Traffic (ADT) was 806 vehicles per day (vpd) at location 1, and the ADT was 661 vpd at location 2. Using subtraction, the ADT associated with the single-family residences along Otter Creek Road is 145 vpd.

Therefore, approximately 82 percent of the vehicular traffic along Otter Creek Road is associated with the Radnor Lake State Natural Area and only 18 percent is associated with the single-family residences. **Figure 6** below graphically summarizes the split of traffic along Otter Creek Road that is traveling to Radnor Lake State Natural Area and those traveling to residences within Oak Hill.

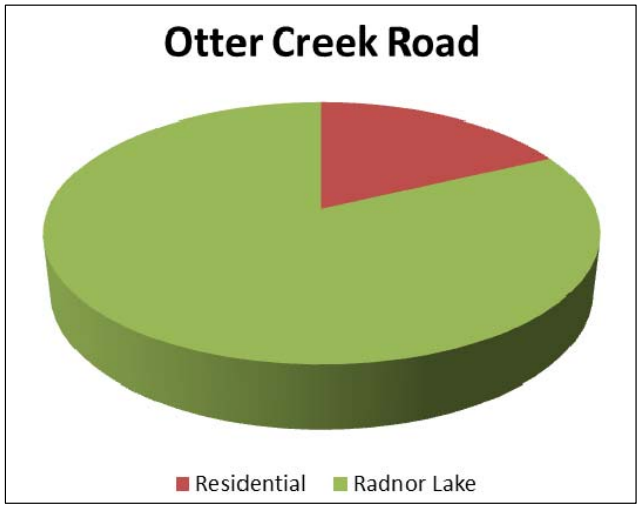


Figure 6: Traffic Count Breakdown

During the second seven (7) days, the ADT at location 2 was 511 vpd – an approximate 22 percent decrease at the Radnor Lake gate from the previous week. To determine if the lower traffic volumes at the Radnor Lake gate during the second week could be due to weather conditions, research from www.wunderground.com was performed and summarized in **Table 4** below.

The vast variation in traffic volumes near the Radnor Lake gate on Wednesdays and Thursdays could be a result of the precipitation that occurred on October 16 and October 17.

The traffic data is provided in **Appendix C**.

Table 4: Weather Data During Traffic Counts

Date	Day of Week	Weather Conditions			
		MEAN Temperature	MAX Temperature	MIN Temperature	Precipitation
10/09/13	Wednesday	66° F	79° F	52° F	0.00 in
10/10/13	Thursday	70° F	82° F	58° F	0.00 in
10/11/13	Friday	68° F	82° F	54° F	0.00 in
10/12/13	Saturday	67° F	81° F	52° F	0.00 in
10/13/13	Sunday	71° F	82° F	60° F	0.00 in
10/14/13	Monday	69° F	80° F	58° F	0.00 in
10/15/13	Tuesday	68° F	75° F	61° F	0.01 in
10/16/13	Wednesday	66° F	70° F	61° F	0.25 in
10/17/13	Thursday	57° F	65° F	49° F	0.06 in
10/18/13	Friday	56° F	66° F	45° F	0.00 in
10/19/13	Saturday	49° F	58° F	40° F	0.01 in
10/20/13	Sunday	50° F	64° F	35° F	0.00 in
10/21/13	Monday	55° F	72° F	38° F	0.00 in
10/22/13	Tuesday	55° F	62° F	48° F	0.00 in

Pavement and Geotechnical Data

Pavement cores were obtained at 4 locations along Otter Creek Road at approximately 1,000 foot spacing. The report provided by S&ME, Inc., see **Appendix D**, recommends a structural number based on the current traffic volumes using the road. The existing pavement section thicknesses meet the required structural number and therefore it is suggested to re-use the existing pavement section rather than completely re-building the road. Re-using the existing pavement section may still consist of widening, and milling and overlaying the surface but this will avoid having to completely remove the existing road surface and re-build it from sub-grade.

Other Office Research

According to the Nashville Metro GIS, there are 30 privately owned parcels along the City of Oak Hill portion on Otter Creek Road. Metro Mapping shows the existing right-of-way width as 50 feet. Several surveys in the area have shown the existing right-of-way as little 45 feet and variable widths.

According to the USGS (U.S. Geological Survey) maps, see **Figure 7**, there does not appear to be any blue-line streams that would require special construction methods and permitting to alter size, shape, or location of ditches.

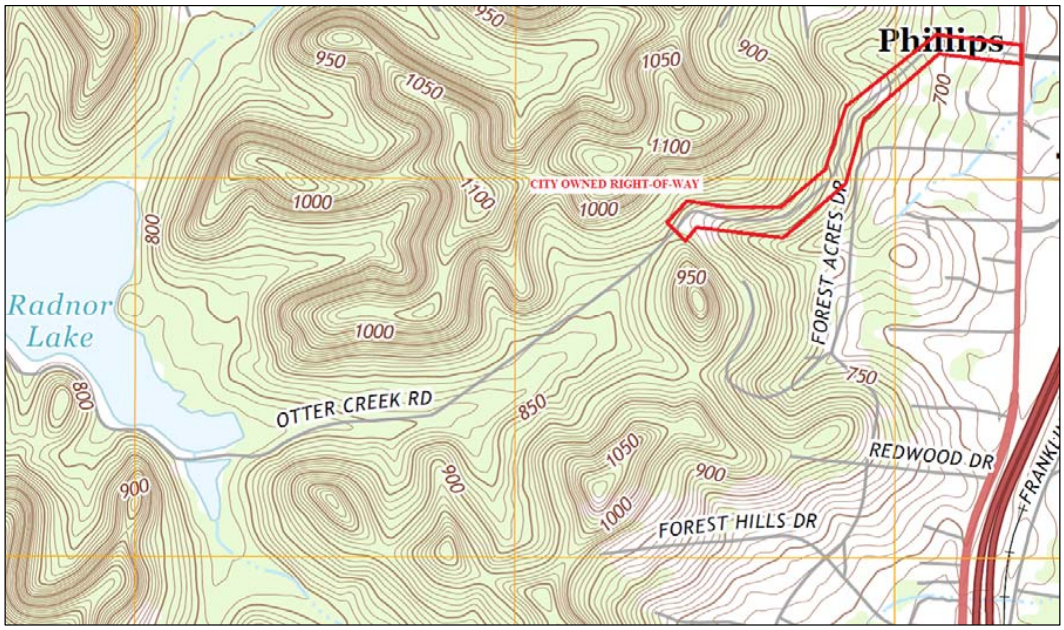


Figure 7: USGS Quadrangle Map

Drainage Research

On the north side of Otter Creek, there has been some recent development of residential properties. Large forested areas have been cleared and replaced with lawns and impervious areas like driveways and structures. **Figure 8** below shows an undeveloped lot and a developed lot on the north side of Otter Creek Road.

Figure 8: Existing Areas Showing Before/After Development

In doing this, the rate at which water runs off the property increases. There are several reasons for this increase. The areas where water can infiltrate back into the soils are decreased because of increased impervious areas. Also, the entire area is more smoothly graded leaving fewer areas for water to pond and seep back into the soils or slowly evaporate.

A common method to determine flow rates of storm water in drainage basins less than 100 acres is called the Rational Method. This method uses a runoff coefficient (C factor) associated with the surface type and condition. Using this method, we find that the C factor changes from about 0.2 to 0.4. This factor affects the flow rate proportionally. Figure 9 shows an excerpt from the TDOT drainage manual that sets the C factors for various land uses.

Surface Type and Condition[1,2]	Runoff Coefficient (C)
Rural Areas	
Concrete or sheet asphalt pavement	0.8 - 0.9
Asphalt macadam pavement	0.6 - 0.8
Gravel roadways or shoulders	0.4 - 0.6
Bare earth	0.2 - 0.9
Steep grassed areas (2H:1V)	0.5 - 0.7
Turf meadows	0.1 - 0.4
Forested areas	0.1 - 0.3
Cultivated fields	0.2 - 0.4
Urban Areas	
Flat residential, with about 30 percent of area impervious	0.40
Flat residential, with about 60 percent of area impervious	0.55
Moderately steep residential, with about 50 percent of area impervious	0.65
Moderately steep developed area, with about 70 percent of area impervious	0.80
Flat commercial/industrial, with about 90 percent of area impervious	0.80

[1]For flat slopes and/or permeable soil, use the lower values. For steep slopes and/or impermeable soil, use the higher values.
[2]For areas where there is a shallow bedrock surface, use the higher values.

Figure 9: Runoff Coefficients (c) for use with the Rational Method
Reference: TDOT Drainage Manual, USDOT, FHWA, HDS-4 (2001)

This means that the newly developed properties have increased the storm water flow rate by a factor of two (2). The velocity of the flow is then also increased by a factor of two (2). This increase in storm water runoff velocity can have serious impacts on the required ditch armor. According to the TDOT drainage manual, Class A-1 riprap is used for velocities up to 5 feet per second, Class B riprap for velocities up to 10 feet per second, and Class C riprap for velocities between 10 and 12 feet per second. Therefore if the developments had preconstruction runoff velocities into the roadside ditch of 5 feet per second and post-construction velocities of 10 feet per second, the armor in the ditch would need to be increased from Class A-1 riprap to Class C riprap.

The detention basin at the east end of the Estates at Radnor Lake development should serve the purpose of holding the water and lowering the peak discharge of the development as a whole before it is released to the east towards Franklin Pike. This detention basin was built with the nine lot development on Otter Creek Road. The current grading of the development does not allow for storm water from these nine lots to enter into the basin. Most of the storm water from the development flows into the roadside ditch along the north side of Otter Creek Road. This ditch empties at several points through pipes flowing south under Otter Creek Road. The eastern end of the ditch bypasses the detention basin entirely. The detention basin does not alleviate any of the drainage problems along Otter Creek Road at the frontage of the newly development residential properties. It does not appear to lower the peak storm water discharge onto Otter Creek Road that has been increased by the new development.

RESULTS AND RECOMMENDATIONS

The Tennessee Department of Transportation (TDOT) has recommended standards based on roadway classification and Average Daily Traffic (ADT). These standards set the roadway pavement, shoulder, and right-of-way (ROW) widths and side slope and roadway grades. There are two separate standards for local roads. One standard is called "Design Standards for Low-Volume Local Roads (ADT<=400)" (RD01-TS-1A). The other is called "Design Standards for Local Roads and Streets" (RD01-TS-1). Each of these standards is described below. The full design standard drawings can be found in **Appendix E**. TDOT does not have a standard for adding curb and gutter to a local road without shoulder. Both standards can include rural type side slopes with open ditch storm drainage. The standard for non-low-volume local roads can use curb and gutter and a closed storm drainage system.

Design Standards for Low-Volume Local Roads (ADT<=400) - (RD01-TS-1A)

This standard can be used on local roads that have an ADT less than or equal to 400 vpd. The standard is typically used for recreational/scenic roads, industrial/commercial access, or access to low to medium density residential development. Otter Creek Road has a couple of these designations. It serves as a recreational road with entrance to the State Natural Area and as a local access road to low density residential development. The traffic counts conducted on Otter Creek Road during peak season (as recommended in the standard) are greater than 400 vpd. The traffic counts for vehicles entering the State Natural Area are greater than 400 vpd. The traffic counts for residential traffic alone are less than 400 vpd. If this were strictly a road serving the City of Oak Hill residents, then the low-volume designation would apply. **Figure 10** shows the typical section requirements for a local volume local road. The existing roadway widths meet the requirements set forth by this standard. If this design standard is chosen, improvements may consist of drainage, resurfacing, curb and gutter in some sections, safety, pavement markings, etc.

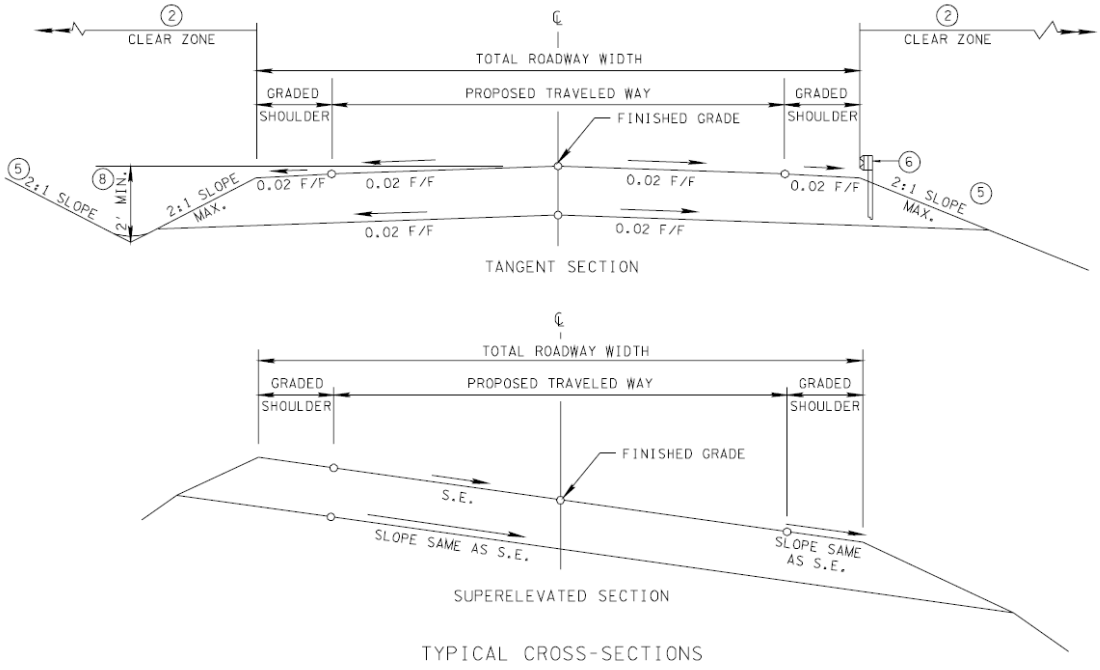


Figure 10: TDOT Typical Sections (Total Roadway Width – 18-20')

Drainage Improvements

There are several ways to improve the open storm water drainage system. The drainage ditch will need to be properly sized and armored based on anticipated future developed conditions. The bottom width of the ditch should be widened. The armor of the ditch can either be higher class rip rap or possibly paved. According to the TDOT Drainage Manual, the flowline of the ditch should be 2-3 feet below the edge of the pavement. Also, the high water elevation of the ditch should be below the bottom of the subgrade.

The existing drainage ditch has not been classified as a blue line stream by USGS. Therefore, velocity reduction structures can be permanently placed along the ditch at increments to reduce the flow and erosion that compromise the ditch. Care should be taken during design of these structures and the ditch size to not inhibit flow and cause flooding into the roadway.

Pipes under driveways need to be cleared of silt deposits and graded near inlets and outlets to allow for positive drainage in the roadside ditches. The roadside ditch should also be directed into the stormwater detention pond that was constructed as part of the Estates at Radnor Lake.

Pavement Improvements

The roadway side slopes also need to be redeveloped. As erosion along the side of the road occur, the edges of the pavement become weaker and cracks develop and eventually failures occur within the pavements. Suitable soil material will need to be brought in to reinforce the edges of the roadway.

The pavement surface should be milled and overlaid. During this process, areas will be found within the pavement that need to be removed to full depth and replaced to strengthen the base. This will improve some areas within the roadway that have cracked or settled.

Summary

This design option can be considered a face-lift and will address overdue maintenance issues. It will have the least temporary and permanent impact to the roadway and adjacent private properties. No right-of-way will be required and minimal temporary construction easements would be needed. The end result will be a new pavement surface, free of cracks and potholes. The ditches will be cleared, adequately sized, and stabilized. The side slopes of the roadway will be re-graded and properly support the roadway sub-base. The drainage pipes under driveways will be cleared of silt and free to flow. Any trees within the clear zone or within 10 feet of the edge of pavement will be removed. This alternative will give the roadway a new clean appearance and function while maintaining the overall aesthetic and rural feel.

Design Standards for Local Roads and Streets - (RD01-TS-1)

This design standard is used for local roads with an ADT greater than 400. There are specifications for roadway width and grades based on the ADT and design speed. Based on this standard, Otter Creek Road would need to be widened to a total width of 30 feet. This would be an increase of 10-12 feet of pavement. The new roadway section would be two 10 foot lanes with 5 foot shoulders. If the road is widened, extra right-of-way may be required as well as temporary easements for construction. Many trees will be cut down in order to build to this standard. There can be an

argument made for a design exemption to decrease the width of the shoulders. A 4 foot shoulder or a 2-3' shoulder if curb and gutter is used may be sufficient. **Figure 11** shows the typical section requirements for a local road (ADT greater than 400).

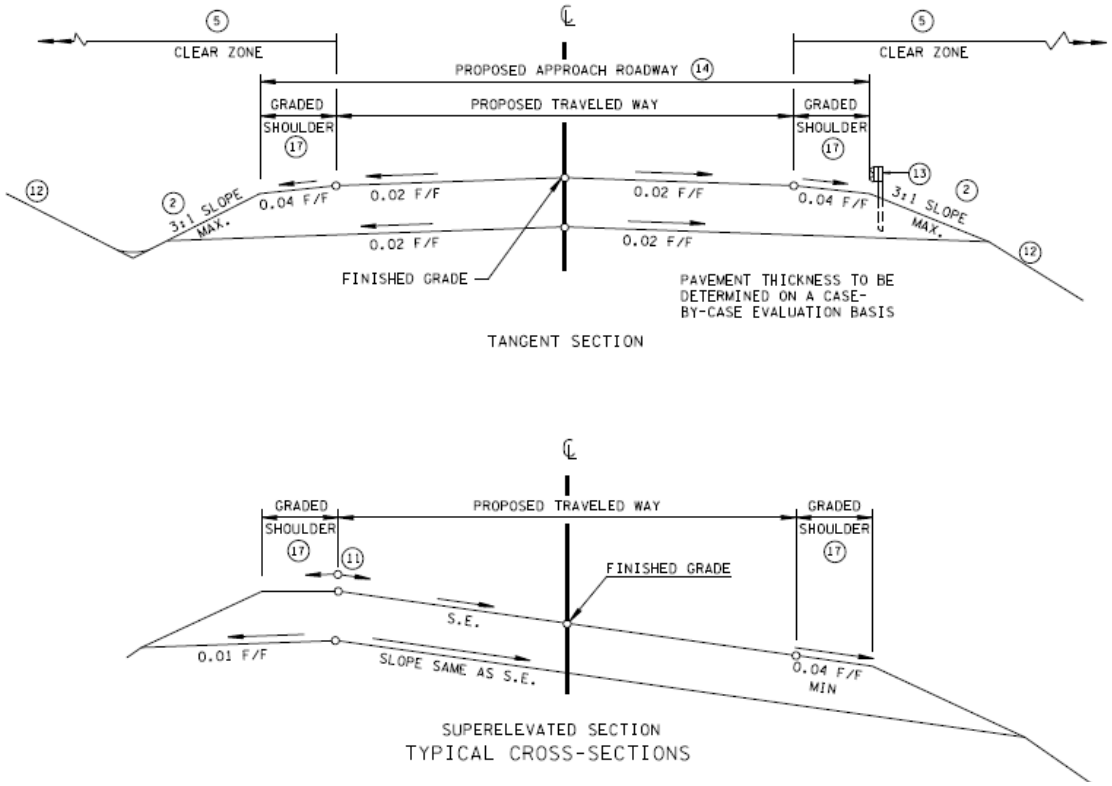


Figure 11: TDOT Typical Sections (20' Proposed Traveled Way and 5' Shoulders)

There will be areas requiring significant fill slopes along the south side of Otter Creek Road and cut slopes along the north. The steepest slopes for each side of the road on the project occur at the same place, with steep slopes upward to the north and steep slopes downward to the south. **Figure 12** shows the some typical areas where steep slopes on each side of the road would require extensive earthwork to widen the road.

Figure 12: Existing Areas which will Require Significant Grading to Widen the Road

Another area that will need special consideration if the roadway is widened is the impact on steep driveways. There are several driveways that are very steep and short. One alternative may be to widen the roadway more on one side than the other to lessen the impacts to properties. Some of these steep driveways are across the street from each other. Different options can be considered during engineering design. **Figure 13** shows some driveways that are steep and may be impacted by widening.

Figure 13: Existing Driveways that will Require Special Consideration if Widened

Summary

This design option will have a bigger impact to the road and adjacent private properties. Additional right-of-way may be required, and there will be more temporary slope and construction easements required. The roadway pavement will be widened to total 30 feet between edges of shoulder or faces of curb. If no curb and gutter is added, the ditches will be moved out past the new roadway shoulders. If curb and gutter is added, most of the ditches will be removed, and underground storm drainage will be installed. All of the driveways along the project will be reconstructed to a point where they properly tie back into existing ground as a result of widening. If curb and gutter is added, the driveways will require the installation of concrete driveway aprons. The look of the road will change as a result of this option. Wider roads can sometimes be safer, but they also can lead to more speeding. If curb and gutter is added to the roadway, the road will lose some of the rural feel and be more of a neighborhood/suburban aesthetic.

Opinion of Probable Construction Costs

Rough order of magnitude opinion of probable construction costs have been developed for three different improvement scenarios on Otter Creek Road. The first option would be to leave the existing roadway widths and only improve the drainage and surface of the pavement with some minor full depth pavement replacement in poor areas that have sub-grade failures. The second option would be to widen the road to the larger design standard and add roadside ditches to carry stormwater. The third option would also widen to the larger design standard but would include curb and gutter and a closed drainage system to carry the stormwater. **Table 5** shows the cost breakdown for each improvement option. These costs do not include survey, engineering, right of way or easement purchase or construction engineering inspection.

Table 5: Rough Order of Magnitude Opinion of Probable Construction Cost

Design Option	Base Estimated Cost	30% Contingency	Total Estimated Cost
No Widening Improve Existing (Design Standard < 400 ADT)	$330,000	$99,000	$429,000
Widen to 5' Shoulders and No Curb and Gutter (Design Standard > 400 ADT)	$560,000	$168,000	$728,000
Widen to 3' Shoulders and Curb and Gutter (Design Standard > 400 ADT)	$740,000	$222,000	$962,000

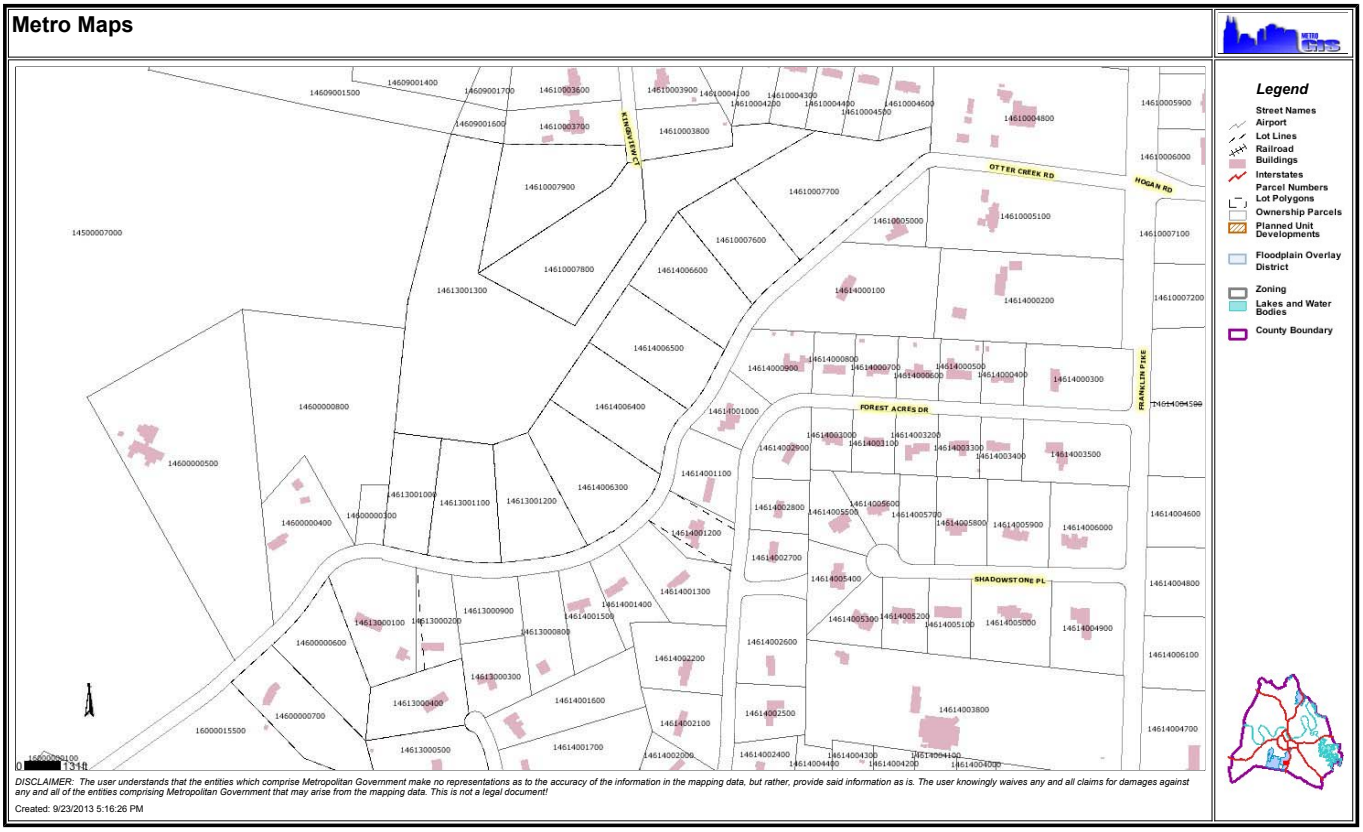
A more detailed spreadsheet for the cost estimates is included in **Appendix F**.

Other Recommendations

It is also recommended that the City of Oak Hill present this report and meet with representatives from the State of Tennessee and Radnor Lake Natural Area. Based on the high percentage of traffic that is utilizing Otter Creek Road to get to the parking area for Radnor Lake State Natural Area, the requirements for the road grow substantially compared to the requirements for just the residents that live on this road. The City of Oak Hill and the State of Tennessee should begin conversations about potential cost sharing for the needed improvements to Otter Creek Road.

APPENDIX A

Metropolitan Government of Nashville and Davidson County
Property Mapping and Aerial Mapping


Metro Maps
OTTER CREEK RD
HOGAN RD
FRANKLIN PIKE
FOREST ACRES DR
SHADOWSTONE PL
KINGSTREET
Legend
Street Names
Airport
Lot Lines
Railroad
Buildings
Interstates
Parcel Numbers
Lot Polygons
Ownership Parcels
Planned Unit Developments
Floodplain Overlay District
Zoning
Lakes and Water Bodies
County Boundary
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Metro Maps

Legend

- Street Names
- Airport
- Lot Lines
- Railroad
- Buildings
- Interstates
- Parcel Numbers
- Lot Polygons
- Ownership Parcels
- Planned Unit Developments
- Floodplain Overlay District
- Zoning
- Lakes and Water Bodies
- County Boundary
- 2010 Orthophoto

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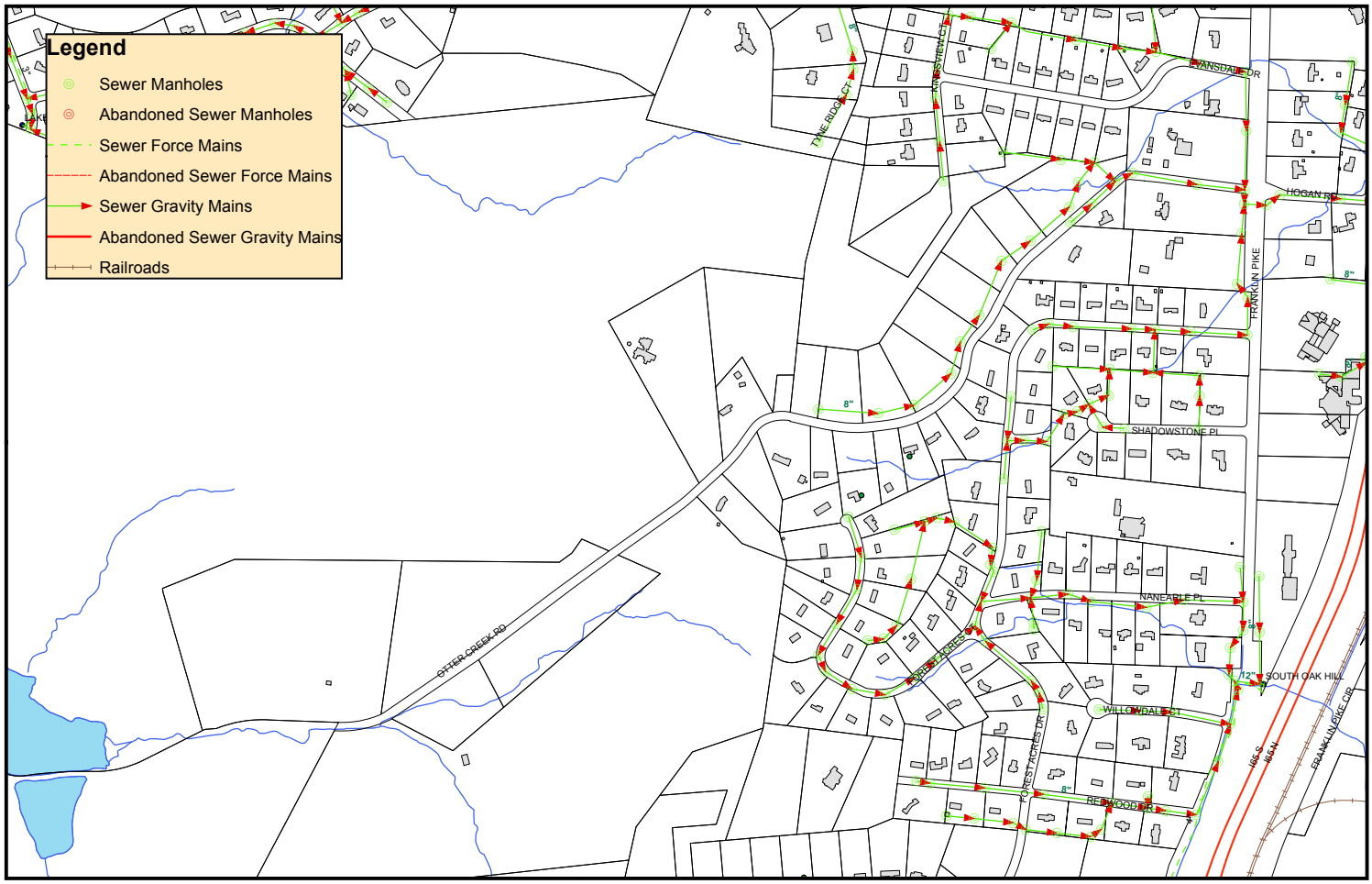
APPENDIX B

Water and Sewer Mapping – Metro Water Services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Sewer Manholes
Abandoned Sewer Manholes
Sewer Force Mains
Abandoned Sewer Force Mains
Sewer Gravity Mains
Abandoned Sewer Gravity Mains
Railroads
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HOGAN RD
FRANKLIN PIKE
SHADOWSTONE PL
NANEARLE PL
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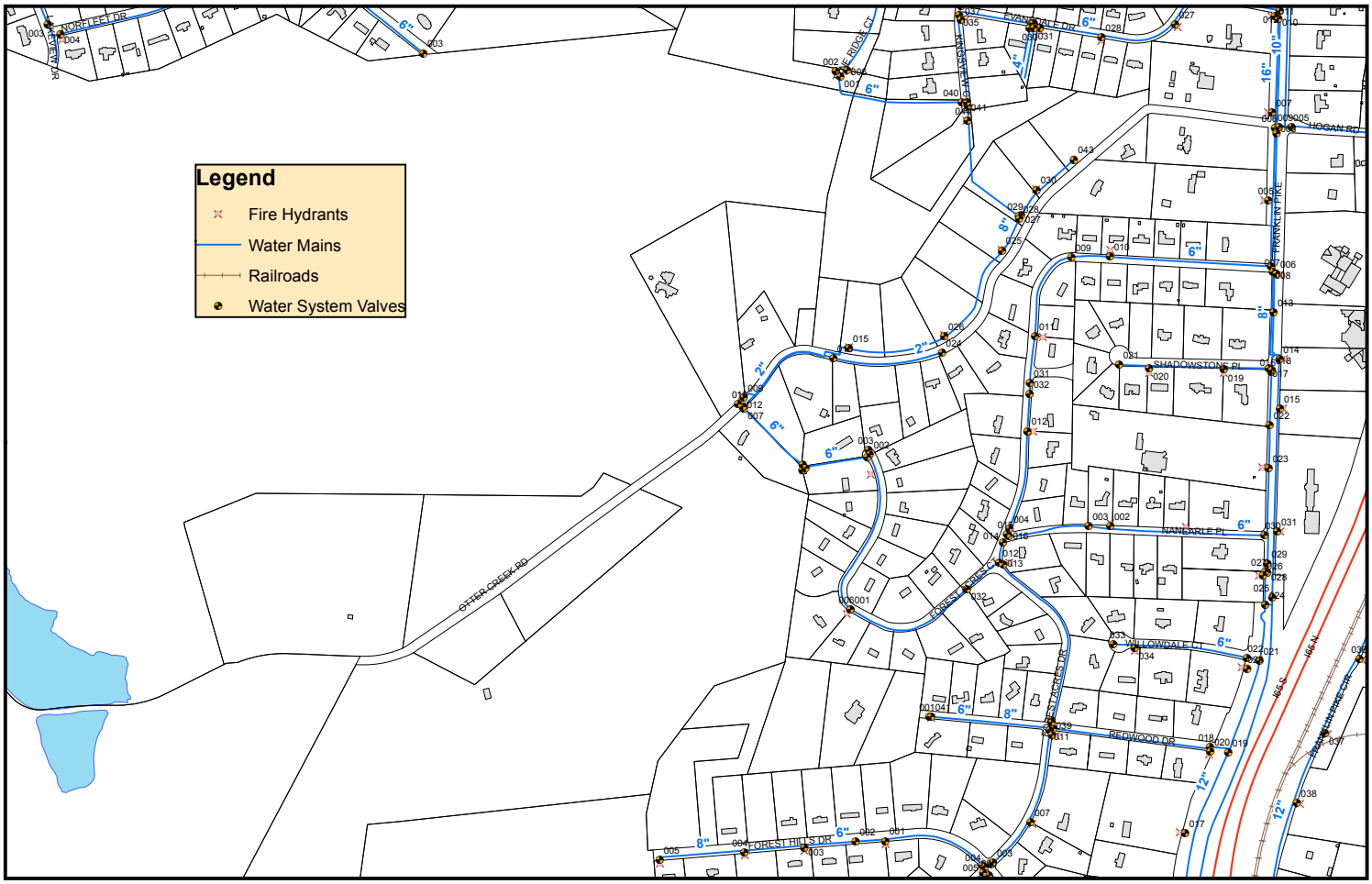

Legend
Fire Hydrants
Water Mains
Railroads
Water System Valves
NORFLEET DR
EVANSDALE DR
HOGAN RD
FRANKLIN PIKE
SHADOWSTONE PL
NANEARLE PL
WILLOWDALE CT
REDWOOD DR
FOREST HILLS DR
FOREST RIDGE CT
EATHER CREEK RD
6"
8"
10"
16"
2"
4"
12"

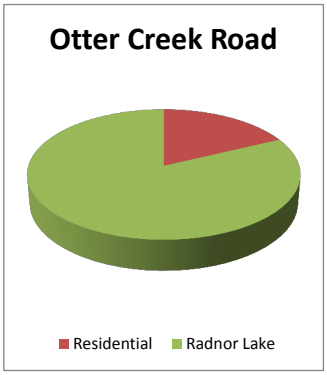
APPENDIX C

Traffic Data

Date	Day of Week	Otter Creek Road					
		#1 - Near Franklin Pike			#2 - Near Radnor Lake		
		Westbound	Eastbound	TOTAL	Westbound	Eastbound	TOTAL
10/09/13	Wednesday	317	352	669	246	282	528
10/10/13	Thursday	386	388	774	295	301	596
10/11/13	Friday	428	426	854	330	327	657
10/12/13	Saturday	440	443	883	379	386	765
10/13/13	Sunday	447	452	899	392	401	793
10/14/13	Monday	442	454	896	376	373	749
10/15/13	Tuesday	328	336	664	269	270	539
TOTAL -->		2788	2851	5639	2287	2340	4627
CHECK -->		2788	2851	5639	2287	2340	4627
AADT -->		398	407	806	327	334	661

Residential Traffic	Radnor Lake Traffic
21.1%	78.9%
23.0%	77.0%
23.1%	76.9%
13.4%	86.6%
11.8%	88.2%
16.4%	83.6%
18.8%	81.2%
17.9%	82.1%
17.9%	82.1%

Date	Day of Week	Otter Creek Road					
		#1 - Near Franklin Pike			#2 - Near Radnor Lake		
		Westbound	Eastbound	TOTAL	Westbound	Eastbound	TOTAL
10/16/13	Wednesday				125	122	247
10/17/13	Thursday				170	171	341
10/18/13	Friday				294	295	589
10/19/13	Saturday				280	277	557
10/20/13	Sunday				422	426	848
10/21/13	Monday				309	318	627
10/22/13	Tuesday				180	185	365
TOTAL -->					1780	1794	3574
CHECK -->					1780	1794	3574
AADT -->					254	256	511



APPENDIX D

Report of Roadway Pavement Depths – S&ME, Inc.

Prepared For:
Kimley-Horn and Associates, Inc.
209 10th Avenue South, Suite 501
Nashville, Tennessee 37203

THE S&ME PROMISE
With S&ME, clients will discover a commitment to safety and quality, a wealth of skills and talent, but above all a fierce dedication to honesty and integrity on every level and every encounter.

Report of Roadway Pavement Depths

Otter Creek Road
Franklin Road to State Park Entrance
Oak Hill, Tennessee
S&ME Project No. 1471-13-207
December 3, 2013

S&ME

820 Fesslers Parkway, Suite 240
Nashville, Tennessee 37210
Office: 615-244-6020
Fax: 615-244-6023
www.smeinc.com

December 3, 2013

Kimley-Horn and Associates, Inc.
209 10th Avenue South, Suite 501
Nashville, Tennessee 37203

ATTENTION: Mr. Zac Dufour

SUBJECT: **Report of Roadway Pavement Depths**
The City of Oak Hill
Nashville, Tennessee
S&ME Project No. 1473-13-207

Dear Mr. Dufour:

S&ME, Inc. (S&ME) is pleased to submit the following *Report of Roadway Pavement Depths* conducted at the multiple sites in the community of Oak Hill, Tennessee. Our services were performed in general accordance with our Proposal No. 7113147, R2, dated July 16, 2013 as authorized by Mr. Kevin Helms, City Manager of Oak Hill on August 15, 2013.

The following report presents our findings for the corings and recommended asphalt section thicknesses. Should you have any questions regarding this report or if we may be of further assistance, feel free to contact us.

Sincerely,
S&ME, Inc.

JEFFREY A. DOUBRAVA REGISTERED ENGINEER AGRICULTURE COMMERCE No. 114351 STATE OF TENNESSEE

12/3/13

David J. Perry, E.I.T.
Staff Professional II

Jeffrey A. Doubrava, P.E.
Engineering Services Manager/
Senior Engineer

FORTY YEARS OF ENGINEERING INTEGRITY

TABLE OF CONTENTS

1. INTRODUCTION

1.1 PURPOSE

The purpose of this exploration was to determine the thickness of the existing roadway pavement, aggregate base and composition of the pavement subgrade soils along Otter Creek Road from Franklin Road to the Radnor Lake State Park entrance for use by Kimley-Horn and Associates in their evaluation of the existing pavement.

1.2 PROJECT DESCRIPTION

Project information has been obtained through a March 5, 2013 email between Mr. Zac Dufour, P.E. of Kimley-Horn and Associates, Inc. (Kimley-Horn) and Mr. Jeff Doubrava, P.E. of S&ME. Traffic counts along Otter Creek Road were provided through a November 13, 2013 email between Mr. Dufour and Mr. David Perry, E.I., of S&ME.

We understand Kimley-Horn is working for the City of Oak Hill to develop a pavement management system. We understand Otter Creek Road from Franklin Road to the Radnor Lake State Park entrance in is being included in the system. The project encompasses about 4,000 linear feet of roadway.

1.3 SCOPE OF STUDY AND REPORT FORMAT

We have been requested to provide the following services:

- Cut cores every 1,000 linear feet to obtain information regarding the pavement section thickness and assess subgrade conditions at each location to assist with Kimley-Horn's evaluation.
- Cut additional cores if authorized by Kimley-Horn during initial field services.
- Provide pavement section thickness recommendations based on provided traffic counts.

The following sections of this report presents discussions of the field exploration, results of measurements, subgrade soil observations, and recommended pavement section thicknesses based on provided traffic counts. Following the text of this report, a photograph log is provided in the appendix.

The scope of services did not include an environmental assessment for determining the presence or absence of wetlands, or hazardous or toxic materials in the soil, bedrock, surface water, or subsurface water.

2. EXPLORATION AND TESTING PROGRAMS

2.1 FIELD EXPLORATION

The roadway thicknesses and subgrade conditions were explored at four locations. The approximate test locations were selected by Kimley-Horn and Associates and were located in the field by Mr. David Perry, E.I.T. of S&ME by estimating right angles and measuring distances from existing site features and street addresses. The appended Core Location plan shows the approximate test locations.

Field sampling and testing were performed on August 22nd, 2013 by S&ME personnel. The locations were cored with a 6-inch diameter drill bit to record asphalt and base stone thicknesses, and obtain the soil sample. The thickness of the aggregate base was determined by using a steel tape measure to locate the bottom of the stone layer in the cored hole. The thickness of the asphalt was determined by measuring the asphalt core once removed from the hole. After measuring and recording the thicknesses of asphaltic concrete and base stone at each core location, a Kessler dual-mass dynamic cone penetrometer (DCP) was inserted in the locations and tests were performed at select intervals in general accordance with ASTM D6951- *Standard Test Method for Use of the Dynamic Cone Penetrometer in Shallow Pavement Applications*. The DCP test data for each core location is included in the Appendix. A manual soil auger bucket was used to collect a sample of the subgrade soils for visual classification.

The test holes were backfilled to the top of the asphaltic pavement with the asphalt core and cold mix asphalt patch.

3. EXISTING PAVEMENT

3.1 PAVEMENT SECTION

Measured asphalt pavement section and base stone thicknesses are summarized in the below table:

Core #	Approximate Location	Pavement Section Thickness (inches)		Soil Description
		Asphaltic Concrete	Stone Base	
1	500 feet from Franklin Road	7	5	Lean Clay (CL), Red/Yellow, Moist
2	1500 feet from Franklin Road	5 ½	4	Lean Clay (CL), Red/Yellow, Moist
3	2500 feet from Franklin Road	7	4	Lean Clay (CL), Red/Yellow, Moist
4	3500 feet from Franklin Road	6	5	Lean Clay (CL), Red/Yellow, Moist

3.2 SUBGRADE SECTION

Correlated California Bearing Ratio (CBR) values are summarized in the below table:

Lowest Correlated CBR Value at Each Test Location				
Area	**Otter Creek Road**			
Test Location	C-1	C-2	C-3	C-4
CBR	10	TNP	11	TNP
*TNP=test not performed due to shallow hand auger refusal				

4. PAVEMENT THICKNESS RECOMMENDATIONS

Field CBR test results ranged from 10 to 11 on in-situ materials. The following pavement recommendations have been made based on the provided traffic counts. We have utilized a CBR of 8 in our pavement thickness calculations. We have also assumed the design life for the pavement to be 20 years, and the design terminal serviceability index of 2.0. Based on these assumptions and our experiences with similar projects, we recommend the following flexible (i.e. asphalt) pavement section thicknesses:

Flexible Pavement Sections

Material	Light Duty Section Thickness (inches)	Heavy Duty Section Thickness (inches)	State Highway Reference
Asphalt Surface Course	1 ½	1 ½	TDOT Section 411, Grading D or E
Asphalt Binder Course	2	3	TDOT Section 307, Grading B or BM
Mineral Aggregate Base	4	6	TDOT Section 903, Class A, Grading D

Paving materials and procedures should conform to applicable sections of the Tennessee Department of Transportation (TDOT) *Standard Specifications for Road and Bridge Construction*, latest edition.

We note that the existing pavement section thicknesses meet the minimum structural number required based on the parameters detailed above. As such, we anticipate the road will be widened in lieu of reconstruction or rehabilitation (i.e. remove and replace). We recommend pavement placed during the widening be benched into the existing pavement section layers to help reduce the potential for shear planes within the pavement section. Should reconstruction or rehabilitation be desired, we would anticipate full depth reclamation (FDR) or cement stabilized base with an asphaltic concrete overlay would be a viable option. We are available to perform a FDR mix design and discuss this option should it be pursued.

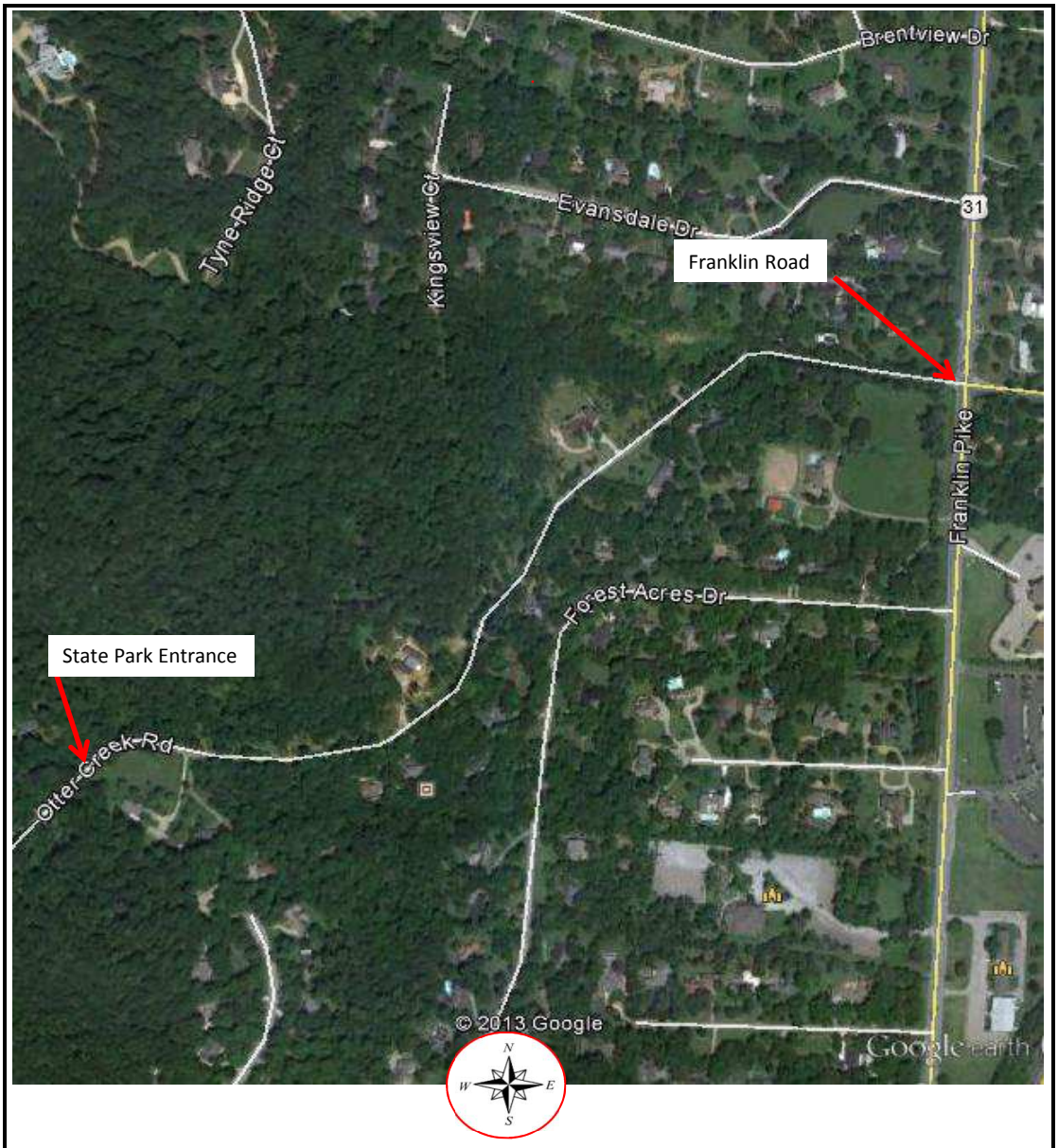
Experience has shown that most pavement failures are caused by localized soft spots in the subgrade or inadequate drainage. Proofrolling observed by our geotechnical engineer can help reduce the incidence of weak spots in the subgrade. However, the civil design must include proper drainage to reduce softening of the subgrade, frost damage, heaving, soil migration, and pumping failures. The pavement surface and subgrade should have a minimum slope of 2 percent. Water infiltrating the mineral aggregate base should be designed to drain into catch basins (through weep holes), out-slope areas, or drainage trenches. It may also be advisable to construct a concrete pad around catch basins to accommodate the problems associated with the frequent saturation of the pavement system in low areas. Maintenance is essential to good long-term pavement performance. Any distressed areas should be promptly repaired to prevent failures from spreading due to loading and water infiltration. Cracks and joints should be sealed annually

Our pavement recommendations are provided based on provided traffic conditions following construction and do not apply to construction equipment and/or other heavy

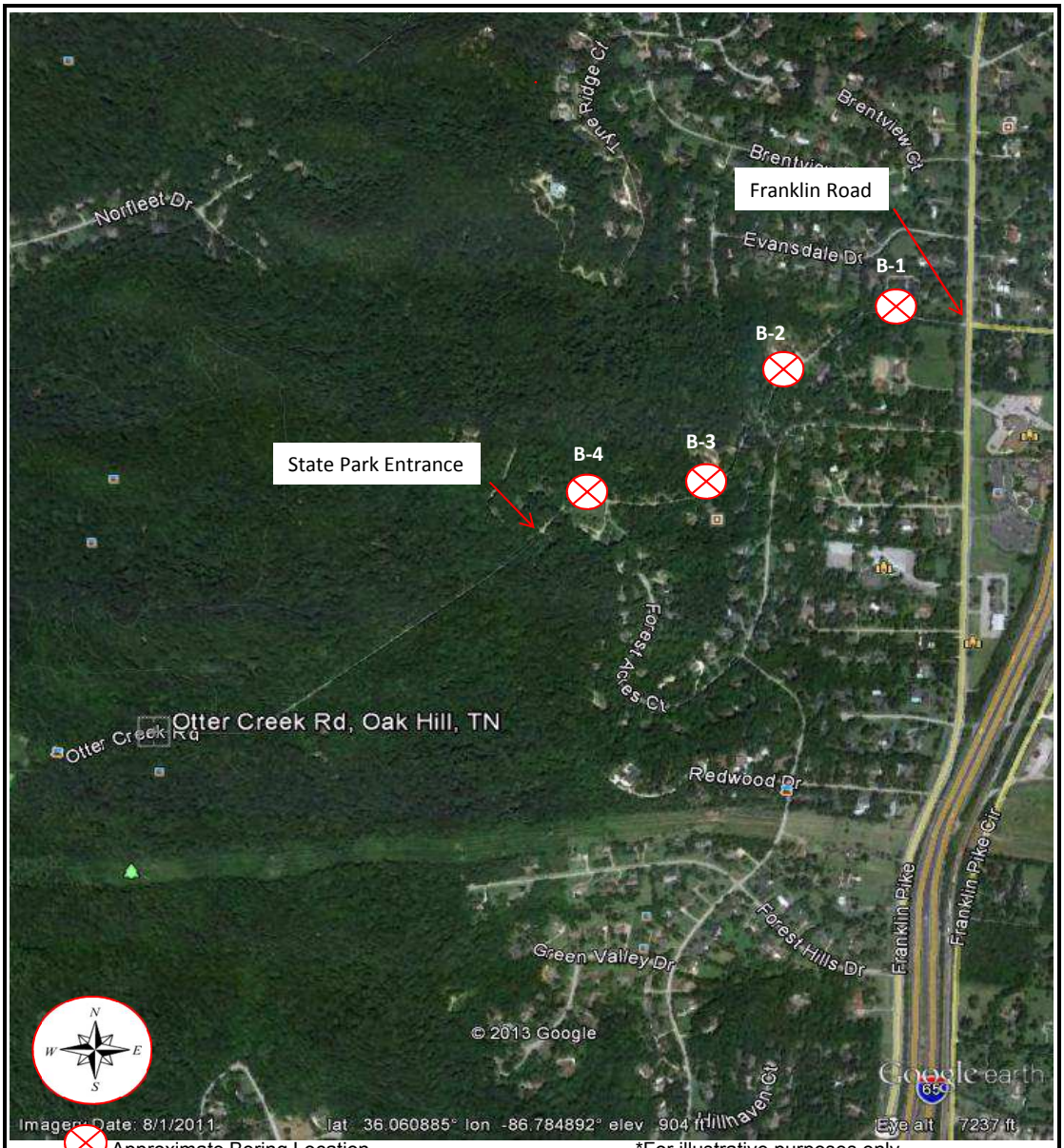
traffic which may distress the pavements during construction. Should they be used during construction, we advise that the owner be aware that extensive damage and/or loss may occur.

APPENDIX

Site Location Map
Boring Location Plan
Coring Logs
Provided traffic counts



Scale: NTS	S&ME	**Site Location Map** **The City of Oak Hill, Otter Creek Road** From Franklin Rd to State Park Entrance Oak Hill, Tennessee	Figure 1
Source: Google Maps			
Checked by: JAD			
Drawn by: DJP			
Date: 11/25/2013		S&ME Project No. 1471-13-207	



Approximate Boring Location

*For illustrative purposes only

Scale: NTS	S&ME	Boring Location Plan	Figure
Source: Google Earth		**The City of Oak Hill, Otter Creek Road**	2
Checked by: JAD		From Franklin Rd to State Park Entrance	
Drawn by: DJP		Oak Hill, Tennessee	
Date:11/25/2013		S&ME Project No. 1471-13-207	

ASPHALT CORE RECORD

Otter Creek Road
Nashville, Tennessee
S&ME Project No. 1473-13-207

Core #1: 500 feet west of Franklin Pike intersection

Date Cored:	August 22, 2013
Operator:	David Perry, Tiffany Anglin
Cores Photographed by:	David Perry
Elevation:	Unknown

Approximate Depth	Description
0 to 7 inches	Asphalt
7 inches to 13 inches	Base Stone
13 inches to 44 inches	Lean Clay (CL), Red/Yellow, Moist
44 inches	Core Hole Terminated

Photograph of Core #1

ASPHALT CORE RECORD

Otter Creek Road
Nashville, Tennessee
S&ME Project No. 1473-13-207

Core #2: 1,500 feet west of Franklin Pike intersection

Date Cored:	August 22, 2013
Operator:	David Perry, Tiffany Anglin
Cores Photographed by:	David Perry
Elevation:	Unknown

Approximate Depth	Description
0 to 5 ½ inches	Asphalt
5 ½ inches to 9 ½ inches	Base Stone
9 ½ inches to 10 inches	Lean Clay (CL), Red/Yellow, Moist
10 inches	Auger and DCP refusal. Possible rock backfill encountered. Hole terminated

Photograph of Core #2

ASPHALT CORE RECORD

Otter Creek Road
Nashville, Tennessee
S&ME Project No. 1473-13-207

Core #3: 2,500 feet west of Franklin Pike intersection

Date Cored:	August 22, 2013
Operator:	David Perry, Tiffany Anglin
Cores Photographed by:	David Perry
Elevation:	Unknown

Approximate Depth	Description
0 to 7 inches	Asphalt
7 inches to 11 inches	Base Stone
11 inches to 41 inches	Lean Clay (CL), Red/Yellow, Moist
41 inches	Core Hole Terminated

Photograph of Core #3

ASPHALT CORE RECORD

Otter Creek Road
Nashville, Tennessee
S&ME Project No. 1473-13-207

Core #4: 3,500 feet west of Franklin Pike intersection

Date Cored:	August 22, 2013
Operator:	David Perry, Tiffany Anglin
Cores Photographed by:	David Perry
Elevation:	Unknown

Approximate Depth	Description
0 to 6 inches	Asphalt
6 inches to 11 inches	Base Stone
11 inches to 13 inches	Lean Clay (CL), Red/Yellow, Moist
13 inches	Auger and DCP refusal. Possible rock backfill encountered. Hole terminated

Photograph of Core #4

S&ME

Date	Day of Week	Otter Creek Road					
		#1 - Near Franklin Pike			#2 - Near Radnor Lake		
		Westbound	Eastbound	TOTAL	Westbound	Eastbound	TOTAL
10/09/13	Wednesday	317	352	669	246	282	528
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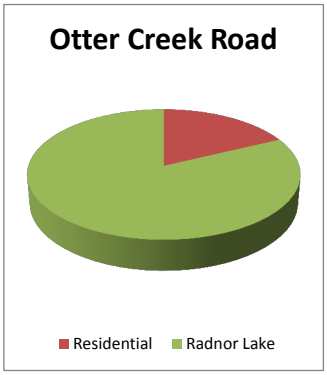
TOTAL -->		2788	2851	5639	2287	2340	4627
CHECK -->		2788	2851	5639	2287	2340	4627
AADT -->		398	407	806	327	334	661

Residential Traffic	Radnor Lake Traffic
21.1%	78.9%
23.0%	77.0%
23.1%	76.9%
13.4%	86.6%
11.8%	88.2%
16.4%	83.6%
18.8%	81.2%
17.9%	82.1%
17.9%	82.1%

Date	Day of Week	Otter Creek Road					
		#1 - Near Franklin Pike			#2 - Near Radnor Lake		
		Westbound	Eastbound	TOTAL	Westbound	Eastbound	TOTAL
10/16/13	Wednesday				125	122	247
10/17/13	Thursday				170	171	341
10/18/13	Friday				294	295	589
10/19/13	Saturday				280	277	557
10/20/13	Sunday				422	426	848
10/21/13	Monday				309	318	627
10/22/13	Tuesday				180	185	365
TOTAL -->					1780	1794	3574
CHECK -->					1780	1794	3574
AADT -->					254	256	511



APPENDIX E

Tennessee Department of Transportation (TDOT) Standard Drawings
RD01-TS-1A and RD01-TS-1

REV. 10-15-02: NEW SHEET. REPLACES RD-TS-1.

DESIGN LOADING: ALL NEW AND REHABILITATED BRIDGES SHALL BE DESIGNED FOR HS-20 LOADING.

FOR NEW ROUTE CONSTRUCTION OR ROUTE RECONSTRUCTION PROJECTS:

THE MINIMUM CLEAR WIDTH FOR NEW BRIDGES SHALL BE EQUAL TO THE FULL WIDTH OF THE APPROACH ROADWAY (CURB-TO-CURB OR FULL SHOULDER WIDTH AS APPLICABLE).

TABLE I.
MINIMUM CLEAR ROADWAY WIDTHS AND DESIGN LOADINGS FOR NEW AND RECONSTRUCTED BRIDGES (SEE PAGE 390)

DESIGN ADT (VEH/DAY)	DESIGN LOADING	MINIMUM CLEAR ROADWAY WIDTH OF BRIDGE (1)
UNDER 400	HS-20	TRAVELED WAY + 4 FT. (2 FT. EACH SIDE)
400 TO 2,000	HS-20	TRAVELED WAY + 6 FT. (3 FT. EACH SIDE)
OVER 2,000	HS-20	APPROACH ROADWAY WIDTH

TABLE II.
MINIMUM STRUCTURAL CAPACITIES AND MINIMUM ROADWAY WIDTHS FOR EXISTING BRIDGES TO REMAIN IN PLACE (SEE PAGE 390) (3)

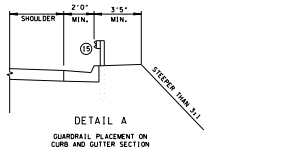
DESIGN ADT (VEH/DAY)	DESIGN LOADING (STRUCTURAL CAPACITY)	MINIMUM CLEAR ROADWAY WIDTH (FT) (4)
0 TO 50	H-15	20
50 TO 250	H-15	20
250 TO 1,500	H-15	22
1,500 TO 2,000	H-15	24
OVER 2,000	H-15	28

TABLE III. MINIMUM DESIGN SPEEDS FOR LOCAL RURAL ROADS

TYPE OF TERRAIN	DESIGN SPEED (MPH) FOR SPECIFIED DESIGN ADT (VEH/DAY)					
	UNDER 50	50-250	250-400	400 TO 1,500	1,500 TO 2,000	2,000 AND OVER
LEVEL	30	30	40	50	50	50
ROLLING	20 (6)	30	30	40	40	40
MOUNTAINOUS	20 (6)	20 (6)	20 (6)	30	30	30

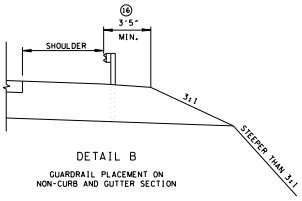
TABLE IV. LOCAL ROADS AND STREETS - DESIGN STANDARDS (8)

DESIGN STANDARDS (FOR GIVEN DESIGN SPEED)		DESIGN SPEEDS (MPH)										MINIMUM WIDTH OF SHOULDERS FOR ALL SPEEDS (FEET) (SEE PAGE 388)
		15	20	25	30	35	40	45	50	55	60	
MINIMUM WIDTH OF TRAVELED WAY IN RURAL AREAS (FEET) (SEE PAGE 388)	DESIGN ADT UNDER 400	18	18	18	18	18	18	20	20	22	22	4 (7)
	DESIGN ADT 400 - 1,500	20 (7)	20 (7)	20 (7)	20 (7)	20 (7)	20 (7)	22	22	22	22	5 (7)(9)
	DESIGN ADT 1,500 - 2,000	20	22	22	22	22	22	22	22	24 (10)	24 (10)	6
	DESIGN ADT OVER 2,000	22	24 (10)	24 (10)	24 (10)	24 (10)	24 (10)	24 (10)	24 (10)	24 (10)	24 (10)	8
MINIMUM RADIUS (FEET) 0.04 MAX. S.E.		70	125	205	300	420	565	730	930	1190	1505	SEE PAGE 145
MINIMUM RADIUS (FEET) 0.06 MAX. S.E.		65	115	185	275	380	510	660	835	1065	1340	
MINIMUM RADIUS (FEET) 0.08 MAX. S.E.		60	105	170	250	350	465	600	760	965	1205	
MAXIMUM RURAL GRADES %	LEVEL TERRAIN	9	8	7	7	7	7	7	6	6	5	SEE PAGE 386
	ROLLING TERRAIN	12	11	11	10	10	10	9	8	7	6	
	MOUNTAINOUS TERRAIN	17	16	15	14	14	13	12	10	10	X	
MINIMUM STOPPING SIGHT DISTANCE (FEET)		80	115	155	200	250	305	360	425	495	570	
MINIMUM "K" VALUE	CREST VERTICAL CURVE	3	7	12	19	29	44	61	84	114	151	SEE PAGE 385
	SAG VERTICAL CURVE	10	17	26	37	49	64	79	96	115	136	
MINIMUM PASSING SIGHT DISTANCE (FEET)		X	710	900	1090	1280	1470	1625	1835	1985	2135	SEE PAGE 386
MINIMUM "K" VALUE FOR CREST VERTICAL CURVE		X	180	289	424	585	772	943	1203	1407	1628	
SUPERELEVATION		SEE STANDARD DRAWINGS RD01-SE-2 AND RD01-SE-3										



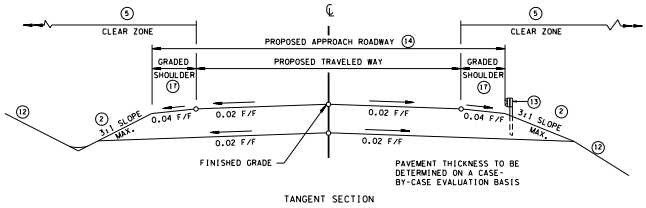
DETAIL A

GUARDRAIL PLACEMENT ON CURB AND GUTTER SECTION

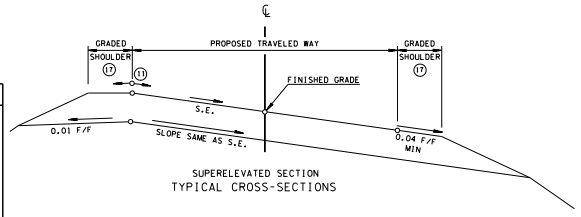


DETAIL B

GUARDRAIL PLACEMENT ON NON-CURB AND GUTTER SECTION



TANGENT SECTION



SUPERELEVATED SECTION
TYPICAL CROSS-SECTIONS

GENERAL NOTES

(A) FOR SPECIFIC CONDITIONS NOT COVERED ON THIS SHEET, REFERENCE SHOULD BE MADE TO "A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS," AASHTO 2001.

(B) FOR URBAN DESIGN GUIDANCE AND CRITERIA, REFERENCE IS MADE TO "A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS," AASHTO, 2001, PAGES 393 TO 408.

(C) PAGE NUMBERS REFERRED TO ON THIS DRAWING ARE FROM "A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS," AASHTO, 2001.

(D) REFERENCE IS ALSO MADE TO THE "ROADSIDE DESIGN GUIDE," AASHTO, 2002.

(E) FOR CORNER SIGHT DISTANCE AT RURAL INTERSECTIONS SEE PAGES 654 THROUGH 681.

(F) IF NO ABOVE GROUND UTILITIES ARE INVOLVED, MINIMUM RIGHT-OF-WAY SHALL BE TRAVELED WAY PLUS CLEAR ZONE (MINIMUM OF 10 FEET EACH SIDE).

(G) IF ABOVE GROUND UTILITIES ARE INVOLVED, MINIMUM RIGHT-OF-WAY SHALL BE SUFFICIENT TO ACCOMODATE THE UTILITIES OUTSIDE THE CLEAR ZONE.

(H) DESIRABLE RIGHT-OF-WAY IS SLOPE LINES PLUS TEN FEET.

FOOTNOTES

(1) WHERE THE APPROACH ROADWAY WIDTH (TRAVELED WAY PLUS SHOULDERS) IS SURFACED, THAT SURFACE WIDTH SHOULD BE CARRIED ACROSS THE STRUCTURE.

(2) 4:1 SLOPE FOR 40 MILES PER HOUR OR GREATER WITH A DESIGN ADT OF 1,000 OR GREATER OR ANY LOCATION GUARDRAIL IS USED.

(3) THESE STRUCTURES SHOULD BE ANALYZED INDIVIDUALLY, TAKING INTO CONSIDERATION THE CLEAR WIDTH PROVIDED, TRAFFIC VOLUMES, REMAINING LIFE OF THE STRUCTURE, PEDESTRIAN VOLUMES, SNOW STORAGE, DESIGN SPEED, ACCIDENT RECORD, AND OTHER PERTINENT FACTORS.

(4) CLEAR WIDTH BETWEEN CURBS OR RAILS, WHICHEVER IS THE LESSER, MINIMUM CLEAR WIDTHS THAT ARE TWO FEET NARROWER MAY BE USED ON ROADS WITH FEW TRUCKS. IN NO CASE SHALL THE MINIMUM CLEAR WIDTH BE LESS THAN THE APPROACH TRAVELED WAY WIDTH.

(5) THE CLEAR ZONE WIDTH SHALL BE DETERMINED FROM STANDARD DRAWING RD01-S-12. SEE THE "ROADSIDE DESIGN GUIDE," AASHTO, 2002, FOR FURTHER INFORMATION ON CLEAR ZONES.

(6) EFFORTS SHOULD BE MADE TO SELECT A DESIGN SPEED GREATER THAN 20 MILES PER HOUR. SEE PAGE 384 FOR FURTHER INFORMATION.

(7) FOR ROADS IN MOUNTAINOUS TERRAIN WITH A DESIGN YEAR ADT OF 0 TO 600 VEHICLES PER DAY AND THE DESIGN SPEED IS GREATER THAN OR EQUAL TO 15 MILES PER HOUR AND LESS THAN OR EQUAL TO 40 MPH, USE 18 FEET TRAVELED WAY WIDTH AND 2 FEET SHOULDER WIDTH.

(8) ALTHOUGH THE SELECTED DESIGN SPEED ESTABLISHES THE LIMITING VALUES OF CURVE RADIUS AND MINIMUM SIGHT DISTANCE THAT SHOULD BE USED IN DESIGN, THERE SHOULD BE NO RESTRICTION ON THE USE OF FLATTER HORIZONTAL CURVES OR GREATER SIGHT DISTANCES WHERE SUCH IMPROVEMENTS CAN BE PROVIDED AS A PART OF AN ECONOMICAL DESIGN (SEE PAGE 69).

(9) MAY BE USED TO ACHIEVE A MINIMUM ROADWAY WIDTH OF 30 FEET FOR DESIGN SPEEDS GREATER THAN 40 MILES PER HOUR.

(10) WHERE THE WIDTH OF THE TRAVELED WAY IS SHOWN AS 24 FEET, THE WIDTH MAY REMAIN AT 22 FEET ON RECONSTRUCTED HIGHWAYS WHERE ALIGNMENT AND SAFETY RECORDS ARE SATISFACTORY.

(11) THE SLOPES OF THE SHOULDER AND ROADWAY PAVEMENT SHALL NOT EXCEED AN ALGEBRAIC DIFFERENCE OF 0.07 FOOT PER FOOT.

(12) SEE STANDARD DRAWINGS RD01-S-11 (CASE 11) AND RD01-S-11B FOR DESIRABLE SLOPES & NOTE REGARDING GEOLOGICAL RECOMMENDATIONS.

(13) SEE DETAILS A AND B FOR GUARDRAIL PLACEMENT AND GUARDRAIL STANDARD DRAWINGS (S-GR-SERIES).

(14) PROPOSED APPROACH ROADWAY WIDTH WILL NOT BE LESS THAN EXISTING WIDTH.

(15) WHEN GUARDRAIL IS PLACED BEHIND CURB AND GUTTER, THE SLOPING CURB HEIGHT MUST BE 4 INCHES OR LESS.

(16) USE 3'5" MINIMUM WHEN SLOPE FROM OUTSIDE EDGE OF SHOULDER TO SUBGRADE IS 3:1. THE 3'5" MINIMUM IS NOT REQUIRED WHEN USING SLOPES OF 4:1 WITH COMBINATION OF PAVEMENT AND BASE THAT IS 12" OR GREATER IN DEPTH.

(17) SHOULDER SURFACE TREATMENT TO BE SPECIFIED BY THE DESIGN DIVISION'S PAVEMENT DESIGN SECTION. DESIGNERS SHOULD REFER TO THE DESIGN GUIDELINES FOR PAVEMENT REQUEST PROCEDURES. WHEN SHOULDERS ARE PAVED AND GRADED SHOULDER WIDTH IS 6 FEET OR GREATER, THE SHOULDER SHOULD BE PAVED THE GRADED SHOULDER WIDTH MINUS TWO FEET. WHEN SHOULDERS ARE PAVED AND THE GRADED SHOULDER WIDTH IS LESS THAN 6 FEET, THE SHOULDER SHOULD BE PAVED THE WIDTH OF THE GRADED SHOULDER.

☐ MINOR REVISION -- FHWA APPROVAL NOT REQUIRED.

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

DESIGN STANDARDS FOR LOCAL ROADS AND STREETS

10-15-02 | RD01-TS-1

GENERAL NOTES

(A) THIS STANDARD DRAWING IS INTENDED TO BE USED FOR THE DESIGN OF LOW-VOLUME (CURRENT ADT <= 400) ROADWAYS CLASSIFIED AS LOCAL ROADS. FOR ADDITIONAL GUIDANCE NOT COVERED ON THIS SHEET, REFERENCE SHOULD BE MADE TO AASHTO "GUIDELINES FOR GEOMETRIC DESIGN OF VERY LOW-VOLUME LOCAL ROADS (ADT <= 400)," 2001.

(B) PROJECT WITH DESIGN SPEEDS GREATER THAN 40 MPH SHALL USE STANDARD DRAWING RD01-TS-1.

(C) FOR INTERSECTION SIGHT DISTANCE, SEE PAGES 40 TO 47 OF THE AASHTO "GUIDELINES FOR GEOMETRIC DESIGN OF VERY LOW-VOLUME LOCAL ROADS (ADT <= 400)," 2001.

(D) IF NO ABOVE GROUND UTILITIES ARE INVOLVED, MINIMUM RIGHT-OF-WAY SHOULD BE TRAVELWAY PLUS CLEAR ZONE.

(E) IF ABOVE GROUND UTILITIES ARE INVOLVED, MINIMUM RIGHT-OF-WAY SHOULD BE SUFFICIENT TO ACCOMMODATE THE UTILITIES OUTSIDE THE CLEAR ZONE.

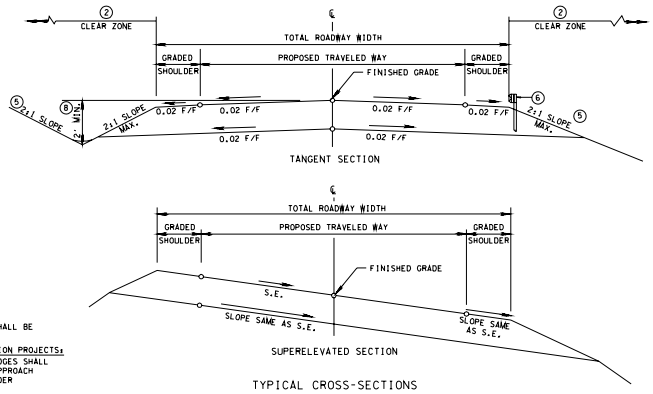
(F) DESIGNER SHOULD CONSIDER ANY KNOWN SITE-SPECIFIC SAFETY PROBLEMS AND TYPICAL DAILY USE OF THE ROADWAY WHEN DETERMINING ROADWAY GEOMETRICS ON A CASE-BY-CASE BASIS. SITE-SPECIFIC SAFETY PROBLEMS MAY BE INDICATED BY CRASH DATA, SKID MARKS, ROADSIDE DAMAGE, SPEED DATA, OR CONCERNS RAISED BY LOCAL OFFICIALS POLICE OR LOCAL RESIDENTS.

(G) FOR EXISTING ROADS, CROSS-SECTION WIDTHS NEED NOT BE MODIFIED, EXCEPT IN THOSE CASES WHERE THERE IS KNOWN EVIDENCE OF A SITE-SPECIFIC SAFETY PROBLEM AS LONG AS THE MINIMUM CRITERIA, AS SHOWN IN THE TABLE BELOW, IS MET.

(H) FOR THIS STANDARD THE FOLLOWING ARE THE POSSIBLE ROADWAY USES:

A. RURAL LOCAL ROADS SERVE A DUAL FUNCTION OF PROVIDING ACCESS TO ABUTTING PROPERTIES AS WELL AS PROVIDING THROUGH OR CONNECTING SERVICE BETWEEN OTHER LOCAL ROADS.
B. RECREATIONAL AND SCENIC ROADS SERVE SPECIALIZED LAND USES, INCLUDING PARKS, TOURIST ATTRACTIONS, AND RECREATION FACILITIES, SUCH AS CAMPSITE OR BOAT-LAUNCH RAMPS. WHEN AVAILABLE, PEAK-SEASON ADT SHOULD BE USED FOR DESIGN.
C. INDUSTRIAL OR COMMERCIAL ACCESS ROADS SERVE DEVELOPMENTS THAT MAY GENERATE A SIGNIFICANT PROPORTION OF TRUCK OR OTHER HEAVY VEHICLE TRAFFIC.
D. URBAN LOCAL ROADWAYS SERVE A DUAL FUNCTION OF PROVIDING ACCESS TO ABUTTING PROPERTIES AS WELL AS PROVIDING THROUGH OR CONNECTING SERVICE BETWEEN OTHER LOCAL ROADS.

(I) ROADWAY SURFACE TYPE SHOULD MATCH EXISTING SURFACE OR SHALL BE DETERMINED BY LOCAL GUIDELINES. WHEN EXISTING SURFACE IS ASPHALT, SEE DESIGN GUIDELINES FOR PAVEMENT DESIGN GUIDANCE.



TYPICAL CROSS-SECTIONS

DESIGN LOADING:
ALL NEW AND REHABILITATED BRIDGES SHALL BE DESIGNED FOR HL-93 LOADING.

FOR NEW CONSTRUCTION OR RECONSTRUCTION PROJECTS:
THE MINIMUM CLEAR WIDTH FOR NEW BRIDGES SHALL BE EQUAL TO THE FULL WIDTH OF THE APPROACH ROADWAY (CURB-TO-CURB OR FULL SHOULDER WIDTH AS APPLICABLE).

TABLE 1

DESIGN STANDARDS FOR LOW-VOLUME LOCAL ROADS AND STREETS (ADT≤400)

DESIGN SPEED (MPH) (3)			15	20	25	30	35	40
MINIMUM TOTAL ROADWAY WIDTH BY USE (FEET)	RURAL LOCAL ROADS		18	18	18	18	18	18
	RECREATIONAL AND SCENIC ROADS		18	18	18	18	18	20
	INDUSTRIAL/COMMERCIAL ACCESS		20	20	21	23	23	23
	URBAN LOCAL ROADS LOW DEVELOPMENT DENSITY (2.0 OR LESS DWELLINGS/ACRE)		20	20	20	20	20	20
	URBAN LOCAL ROADS MEDIUM DEVELOPMENT DENSITY (2.1 TO 6 DWELLINGS/ACRE)		28	28	28	28	28	28
MINIMUM HORIZONTAL CURVE RADIUS (FEET)	RURAL LOCAL, RECREATIONAL AND SCENIC ACCESS ROADWAYS ADT 0 TO 400 (VEH/DAY)	SE DESIGN SPEED (MPH) (3)	15	15	20	20	30	35
		4% MAX. S.E.	70	70	125	125	300	420
		6% MAX. S.E.	65	65	115	115	275	380
		8% MAX. S.E.	60	60	105	105	250	350
	INDUSTRIAL/COMMERCIAL ACCESS ADT 0 TO 400 (VEH/DAY)	SE DESIGN SPEED (MPH) (3)	15	20	25	25	30	35
		4% MAX. S.E.	70	125	205	205	300	420
		6% MAX. S.E.	65	115	185	185	275	380
		8% MAX. S.E.	60	105	170	170	250	350
	URBAN LOCAL ROADWAYS	SE DESIGN SPEED (MPH) (3)	15	20	25	30	35	40
		4% MAX. S.E.	40	80	145	230	345	490
		6% MAX. S.E.	40	75	165	215	320	450
	UNPAVED ROADWAYS	NORMAL CROWN	50	70	105	150	205	270
MINIMUM STOPPING SIGHT DISTANCE (FEET)	ADT 0 TO 100 (VEH/DAY)		65	90	115	135	170	215
	ADT 101 TO 400 (VEH/DAY)		65	95	125	165	205	250
MINIMUM "K" VALUES	CREST VERTICAL CURVE	ADT 0 TO 100 (VEH/DAY)	2	4	7	9	14	22
		ADT 101 TO 400 (VEH/DAY)	2	5	8	13	20	29
	SAG VERTICAL CURVE		10	17	26	37	49	64
MAXIMUM GRADE (%)	TYPE OF TERRAIN	LEVEL	9	8	7	7	7	7
		ROLLING	12	11	11	10	10	9
		MOUNTAINOUS	17	16	15	14	13	12
SUPERELEVATION			SEE STANDARD DRAWING RD01-SE-2 AND RD01-SE-3 (3)					

TABLE 2

MINIMUM CLEAR WIDTHS AND DESIGN LOADINGS FOR NEW AND RECONSTRUCTED BRIDGES

DESIGN ADT (VEH/DAY)	DESIGN LOADING (STRUCTURAL CAPACITY)	MINIMUM CLEAR WIDTH (FEET) (1)
0 TO 100	HL-93	18
101 TO 400	HL-93	20

TABLE 3

MINIMUM CLEAR WIDTHS AND DESIGN LOADINGS (1) FOR EXISTING BRIDGES TO REMAIN IN PLACE (4)

DESIGN ADT (VEH/DAY)	DESIGN LOADING (STRUCTURAL CAPACITY)	MINIMUM CLEAR WIDTH (FEET) (7)
0 TO 100	H-15	18
101 TO 400	H-15	20

FOOTNOTES

(1) FOR BRIDGE PROJECTS WHERE THE TOTAL APPROACH ROADWAY WIDTH (TRAVELED WAY PLUS SHOULDERS) IS SURFACED, THAT SURFACE WIDTH SHOULD BE CARRIED ACROSS THE STRUCTURE. THE WIDTH OF THE BRIDGE CANNOT BE LESS THAN THE PROPOSED ROADWAY WIDTH SELECTED FROM TABLE 1. THE TOTAL APPROACH ROADWAY WIDTH CANNOT BE LESS THAN THE EXISTING ROADWAY WIDTH, AS DETERMINED ABOVE, HOWEVER, ON UN SURFACED RURAL ROADS, WITHOUT DEFINED TRAVELED WAY OR DEFINED SHOULDERS, THE WIDTH DETERMINED FROM TABLE 1 WILL SUFFICE.

(2) SITE-SPECIFIC CONDITIONS AND ENGINEERING JUDGMENT OF THE DESIGNER SHOULD BE THE TWO PRIMARY DETERMINANTS OF THE APPROPRIATE CLEAR ZONE WIDTH FOR LOW-VOLUME LOCAL ROADS. AT LOCATIONS WHERE A CLEAR ZONE OF 6 FEET OR MORE IN WIDTH CAN BE PROVIDED AT LOW COST AND WITH MINIMUM SOCIAL/ENVIRONMENTAL IMPACT, SUCH CLEAR ZONE SHOULD BE CONSIDERED. WHERE PROVISION OF A CLEAR ZONE IS NOT PRACTICAL, NONE IS REQUIRED.

(3) FOR THE DESIGN OF SUPER ELEVATION TRANSITIONS, USE THE SUPER ELEVATION DESIGN SPEED LISTED DIRECTLY ABOVE THE SELECTED MINIMUM HORIZONTAL CURVE RADIUS. FOR EXISTING ROADS WHERE SUPER ELEVATION IS NOT PRESENT AND NO SITE-SPECIFIC SAFETY PROBLEM IS KNOWN, SUPER ELEVATION MAY NOT BE NECESSARY. REMOVAL OF NORMAL CROWN BY SUPER ELEVATING THE ENTIRE ROADWAY AT THE NORMAL CROSS SLOPE MAY BE USED UNLESS SUPER ELEVATION IS NEEDED AS DETERMINED BY THE DESIGNER. THE DESIGNER SHOULD ASSESS THE PROJECT SITE AND USE ENGINEERING JUDGEMENT WHEN MAKING THIS DETERMINATION. FOR UNPAVED ROADS, REMOVAL OF NORMAL CROWN BY SUPER ELEVATING THE ENTIRE ROADWAY AT THE NORMAL CROSS SLOPE MAY BE USED OR SUPER ELEVATION MAY BE ELIMINATED.

(4) THESE STRUCTURES SHOULD BE ANALYZED INDIVIDUALLY, TAKING INTO CONSIDERATION THE CLEAR WIDTH PROVIDED, TRAFFIC VOLUMES, REMAINING LIFE OF THE STRUCTURE, PEDESTRIAN VOLUMES, SNOW STORAGE, DESIGN SPEED, ACCIDENT RECORD, AND OTHER PERTINENT FACTORS.

(5) MAXIMUM 2(H):1(V) OR AS RECOMMENDED BY THE GEOTECHNICAL OFFICE. WHEN A 2(H):1(V) SLOPE IS USED, AND THE FILL HEIGHT EXCEEDS SIX FEET, GUARDRAIL SHOULD BE CONSIDERED. WHERE RIGHT-OF-WAY IS NOT AN ISSUE, STANDARD DRAWING RD01-S-11 (CASE II) SLOPES MAY BE USED.

(6) SEE GUARDRAIL STANDARD DRAWINGS (S-GR-SERIES) FOR GUARDRAIL PLACEMENT. FOR LOW-VOLUME LOCAL ROAD BRIDGE REPLACEMENT PROJECTS, USE MINIMUM GUARDRAIL SHOWN ON STANDARD DRAWING S-GR-23A. FOR ALL OTHER PROJECT REFERENCE SHOULD BE MADE TO THE AASHTO "ROADSIDE DESIGN GUIDE", 2002.

(7) CURB-TO-CURB OR BETWEEN RAILS, WHICHEVER IS THE LESSER.

(8) MINIMUM DITCH OR SWALE SHALL BE 2 FOOT DEEP WITH 2(H):1(V) SIDE SLOPES. THIS V-DITCH OR SWALE SHALL BE USED UNLESS CONDITIONS NECESSITATE OTHERWISE (SUCH AS DISCHARGE IN DITCH OR UNDERMINING OF ROADWAY SURFACE).

(9) DESIGN SPEED SHOULD BE SELECTED BASED ON ACTUAL OR ANTICIPATED OPERATING SPEED AND CONDITIONS ON THE ROAD BEING DESIGNED.

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

DESIGN STANDARDS FOR LOW-VOLUME LOCAL ROADS (ADT ≤ 400)

3-15-07 | RD01-TS-1A

APPENDIX F

Rough Order of Magnitude Opinion of Probable Construction Costs

No Widening

ESTIMATED ROADWAY QUANTITIES					
ITEM NO.	**DESCRIPTION**	**UNIT**	**TOTAL**	**UNIT PRICE**	**AMOUNT**
105-01	CONSTRUCTION STAKES, LINES AND GRADES	LS	1	$5,000.00	$5,000.00
201-01	CLEARING AND GRUBBING	LS	1	$20,000.00	$20,000.00
203-01	ROAD & DRAINAGE EXCAVATION (UNCLASSIFIED)	C.Y.	1800	$15.00	$27,000.00
203-03	BORROW EXCAVATION (UNCLASSIFIED)	C.Y.	500	$15.00	$7,500.00
209-08.02	TEMPORARY SILT FENCE (WITH BACKING)	L.F.	6500	$4.00	$26,000.00
303-01	MINERAL AGGREGATE TYPE A BASE, GRADING D	TON	500	$20.00	$10,000.00
303-02	MINERAL AGGREGATE, TYPE "B" BASE, GRADING "D"	C.Y.	75	$25.00	$1,875.00
307-01.01	ASPHALT CONCRETE MIX (PG64-22) (BPMB-HM) GRADING A	TON	205	$90.00	$18,450.00
403-01	BITUMINOUS MATERIAL FOR TACK COAT (TC)	TON	2	$748.00	$1,496.00
411-01.10	ACS MIX (PG64-22) GRADING "D"	TON	710	$100.00	$71,000.00
415-01.01	COLD PLANING BITUMINOUS PAVEMENTS	TON	650	$35.00	$22,750.00
709-05.06	MACHINED RIP-RAP (CLASS A-1)	TON	2500	$40.00	$100,000.00
712-01	TRAFFIC CONTROL	LS	1	$10,000.00	$10,000.00
712-06	SIGNS (CONSTRUCTION)	S.F.	40	$7.50	$300.00
712-04.01	FLEXIBLE DRUMS (CHANNELIZING)	EACH	50	$35.00	$1,750.00
712-05.01	WARNING LIGHTS (TYPE A)	EACH	4	$35.00	$140.00
712-05.03	WARNING LIGHTS (TYPE C)	EACH	26	$35.00	$910.00
713-11.01	"U" SECTION STEEL POSTS	LB.	20	$3.20	$64.00
713-13.02	FLAT SHEET ALUMINUM SIGNS (0.080" THICK)	S.F.	100	$13.50	$1,350.00
716-05.01	PAINTED PAVEMENT MARKING (4" LINE)	L.M.	1.5	$900.00	$1,350.00
717-01	MOBILIZATION	LS	1	$10,000.00	$10,000.00
				ITEMS TOTAL:	**$326,935.00**
				30% CONTINGENCY	**$98,080.50**
				TOTAL	**$425,015.50**

Add Shoulder with No Curb

ESTIMATED ROADWAY QUANTITIES					
ITEM NO.	**DESCRIPTION**	**UNIT**	**TOTAL**	**UNIT PRICE**	**AMOUNT**
105-01	CONSTRUCTION STAKES, LINES AND GRADES	LS	1	$5,000.00	$5,000.00
201-01	CLEARING AND GRUBBING	LS	1	$150,000.00	$150,000.00
203-01	ROAD & DRAINAGE EXCAVATION (UNCLASSIFIED)	C.Y.	2000	$15.00	$30,000.00
203-03	BORROW EXCAVATION (UNCLASSIFIED)	C.Y.	1100	$15.00	$16,500.00
209-08.02	TEMPORARY SILT FENCE (WITH BACKING)	L.F.	6500	$4.00	$26,000.00
303-01	MINERAL AGGREGATE TYPE A BASE, GRADING D	TON	2506	$20.00	$50,120.00
303-02	MINERAL AGGREGATE, TYPE "B" BASE, GRADING "D"	C.Y.	75	$25.00	$1,875.00
307-01.01	ASPHALT CONCRETE MIX (PG64-22) (BPMB-HM) GRADING A	TON	205	$90.00	$18,450.00
403-01	BITUMINOUS MATERIAL FOR TACK COAT (TC)	TON	2	$748.00	$1,496.00
407-20.05	SAW CUTTING ASPHALT PAVEMENT	L.F.	4100	$4.10	$16,810.00
411-01.07	ASPHALT CONCRETE MIX (PG64-22) (ACS) GRADING E (SHOULDER)	TON	343	$90.00	$30,870.00
411-01.10	ACS MIX (PG64-22) GRADING "D"	TON	710	$100.00	$71,000.00
415-01.01	COLD PLANING BITUMINOUS PAVEMENTS	TON	650	$35.00	$22,750.00
709-05.06	MACHINED RIP-RAP (CLASS A-1)	TON	2500	$40.00	$100,000.00
712-01	TRAFFIC CONTROL	LS	1	$10,000.00	$10,000.00
712-06	SIGNS (CONSTRUCTION)	S.F.	40	$7.50	$300.00
712-04.01	FLEXIBLE DRUMS (CHANNELIZING)	EACH	50	$35.00	$1,750.00
712-05.01	WARNING LIGHTS (TYPE A)	EACH	4	$35.00	$140.00
712-05.03	WARNING LIGHTS (TYPE C)	EACH	26	$35.00	$910.00
713-11.01	"U" SECTION STEEL POSTS	LB.	20	$3.20	$64.00
713-13.02	FLAT SHEET ALUMINUM SIGNS (0.080" THICK)	S.F.	100	$13.50	$1,350.00
716-05.01	PAINTED PAVEMENT MARKING (4" LINE)	L.M.	1.5	$900.00	$1,350.00
717-01	MOBILIZATION	LS	1	$10,000.00	$10,000.00
				ITEMS TOTAL:	**$556,735.00**
				30% CONTINGENCY	**$167,020.50**
				TOTAL	**$723,755.50**

Add Shoulder with Curb

ESTIMATED ROADWAY QUANTITIES					
ITEM NO.	**DESCRIPTION**	**UNIT**	**TOTAL**	**UNIT PRICE**	**AMOUNT**
105-01	CONSTRUCTION STAKES, LINES AND GRADES	LS	1	$5,000.00	$5,000.00
201-01	CLEARING AND GRUBBING	LS	1	$150,000.00	$150,000.00
203-01	ROAD & DRAINAGE EXCAVATION (UNCLASSIFIED)	C.Y.	1200	$15.00	$18,000.00
203-03	BORROW EXCAVATION (UNCLASSIFIED)	C.Y.	1100	$15.00	$16,500.00
209-08.02	TEMPORARY SILT FENCE (WITH BACKING)	L.F.	6500	$4.00	$26,000.00
303-01	MINERAL AGGREGATE TYPE A BASE, GRADING D	TON	1510	$20.00	$30,200.00
303-02	MINERAL AGGREGATE, TYPE "B" BASE, GRADING "D"	C.Y.	75	$25.00	$1,875.00
307-01.01	ASPHALT CONCRETE MIX (PG64-22) (BPMB-HM) GRADING A	TON	205	$90.00	$18,450.00
403-01	BITUMINOUS MATERIAL FOR TACK COAT (TC)	TON	2	$748.00	$1,496.00
407-20.05	SAW CUTTING ASPHALT PAVEMENT	L.F.	4100	$4.10	$16,810.00
411-01.07	ASPHALT CONCRETE MIX (PG64-22) (ACS) GRADING E (SHOULDER)	TON	206	$90.00	$18,540.00
411-01.10	ACS MIX (PG64-22) GRADING "D"	TON	710	$100.00	$71,000.00
415-01.01	COLD PLANING BITUMINOUS PAVEMENTS	TON	650	$35.00	$22,750.00
607-03.02	18" CONCRETE PIPE CULVERT (CLASS III)	L.F.	2000	$35.00	$70,000.00
607-05.02	24" CONCRETE PIPE CULVERT (CLASS III)	L.F.	1000	$45.00	$45,000.00
607-06.02	30" CONCRETE PIPE CULVERT (CLASS III)	L.F.	750	$60.00	$45,000.00
607-07.02	36" CONCRETE PIPE CULVERT (CLASS III)	L.F.	250	$75.00	$18,750.00
611-12.01	CATCH BASINS, TYPE 12, 0' - 4' DEPTH	EACH	14	$3,000.00	$42,000.00
611-14.01	CATCH BASINS, TYPE 14, 0' - 4' DEPTH	EACH	2	$5,000.00	$10,000.00
702-03	CONCRETE COMBINED CURB & GUTTER	C.Y.	515	$175.00	$90,125.00
712-01	TRAFFIC CONTROL	LS	1	$10,000.00	$10,000.00
712-06	SIGNS (CONSTRUCTION)	S.F.	40	$7.50	$300.00
712-04.01	FLEXIBLE DRUMS (CHANNELIZING)	EACH	50	$35.00	$1,750.00
712-05.01	WARNING LIGHTS (TYPE A)	EACH	4	$35.00	$140.00
712-05.03	WARNING LIGHTS (TYPE C)	EACH	26	$35.00	$910.00
713-11.01	"U" SECTION STEEL POSTS	LB.	20	$3.20	$64.00
713-13.02	FLAT SHEET ALUMINUM SIGNS (0.080" THICK)	S.F.	100	$13.50	$1,350.00
716-05.01	PAINTED PAVEMENT MARKING (4" LINE)	L.M.	1.5	$900.00	$1,350.00
717-01	MOBILIZATION	LS	1	$10,000.00	$10,000.00
				ITEMS TOTAL:	**$733,360.00**
				30% CONTINGENCY	**$220,008.00**
				TOTAL	**$953,368.00**