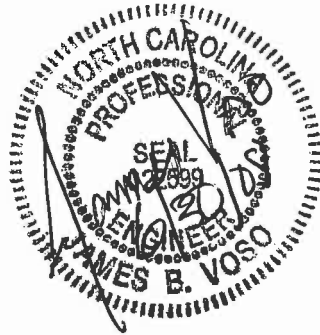


ROADWAY EVALUATION
FOR
WOLF LAUREL
MARS HILL, NORTH CAROLINA

Prepared For

Wolf Laurel Roads and Securities Board
63 Village Lane
Mars Hill, North Carolina 28754

June 30, 2008
Commission No: 2886



MATTERN & CRAIG, INC.
CONSULTING ENGINEERS – SURVEYORS
12 BROAD STREET
ASHEVILLE, NORTH CAROLINA 28801

(828) 254-2201
FAX: (828) 254-4562

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Background and Purpose

The purpose of this Engineering Study is to evaluate the condition of the private road system in the Wolf Laurel subdivision located in Mars Hill, North Carolina. Upon evaluation of the road system, an overall assessment of the condition of the roadway infrastructure is to be determined and needs identified in order to maintain a safe and acceptable roadway system for the residents and guests of the Wolf Laurel proper. Costs associated with the identified maintenance needs will be evaluated so the Wolf Laurel Roads and Securities Board can ascertain what amount of annual expenditures can be expected for the perpetual upkeep of the private road system.

The Wolf Laurel subdivision is a private gated community in the Mars Hill area of North Carolina. Wolf Laurel proper is located in Madison and Yancey Counties and is comprised of almost 50 miles of mostly unpaved single lane roads (see Appendix E prepared by Hampton, Hintz & Associates for an overview of study area). Wolf Laurel Road, a paved two-lane roadway, serves as a collector road providing direct and/or indirect access to most of the other roads within the subdivision. A couple of other roads within the neighborhood are currently paved (Ridgeway Road, a portion of El Miner Drive, a portion of Big Bald Road, Hampton Gap Drive, Village Lane, and a portion of Pisgah Pass) while the remaining roads and the majority of the road mileage are comprised of gravel or dirt roads with an average 14-foot width.

Personnel from Mattern & Craig met with personnel from the Wolf Laurel Roads & Securities Department on Tuesday, June 17, 2008 to tour the road system and to gain an insight into the concerns, problem areas, and areas of significant importance. Based on the concerns expressed and areas identified, Mattern & Craig personnel spent the day evaluating and documenting the condition of a large portion of the roadway system in order to gain an overall assessment of the neighborhood. The findings from this site visit can be found in Appendix A of this report.

Roadway System Evaluation

Mattern & Craig personnel conducted an evaluation of the roadway system on Tuesday, June 17, 2008. While conducting the field investigation, the following goals/objectives served as the impetus of the evaluation:

- Evaluate road system and compile an overall assessment of the condition of the subdivision as a whole
- Identify specific areas of concern
- Identify specific needs
- Identify problem areas that need immediate attention
- Prioritize improvements/recommendations
- Develop a maintenance program/schedule for upkeep
- Identify anticipated costs associated with needed repairs and annual maintenance

The following roads were evaluated by Mattern & Craig personnel during the 6/17/08 field investigation:

1. Wolf Laurel Road
2. Hanging Rock Road
3. Big Bald Road
4. Trillium Lane
5. Buckeye Road
6. May Apple Lane
7. Zebulon Lane
8. Bee Tree Lane
9. Birch Springs Lane
10. Grouse Thicket Lane
11. Flame Azalea Lane
12. Phacelia Lane
13. Granny Lewis Lane
14. Ridgeway Road
15. Chestnut Lane
16. Town Mountain Road
17. Puncheon Lane
18. Oakridge Lane
19. El Miner Drive
20. El Miner Court
21. Glenaire
22. Valley View Circle

While not all inclusive, the roadways evaluated were identified by Roads & Securities personnel as either roads needing immediate attention and/or roads that represent the overall condition of the subdivision. The sample of roads identified above was used to obtain an overall assessment of the condition of the roadway system within Wolf Laurel.

On the day the roadway evaluation took place, several maintenance operations were observed including bank clearing along Hanging Rock Road; grading/scraping along Trillium Lane, Phacelia Lane, Granny Lewis Lane, and Oakridge Lane; and ditch clean-out along El Miner Drive. Generally, it appears that the Roads & Securities staff does a very good job addressing the maintenance needs of the roadway network. Based on discussions with Roads & Securities staff, the apparent needs/demands currently outpace the abilities of the personnel. With a staff of four employees and one supervisor, the demands of responding to emergency situations and the constant maintenance needs on the over 50 miles of roads means that the Roads & Securities staff is constantly “playing catch-up”. Field observations on June 17th validated this assumption. While the ongoing maintenance operations listed above were observed and locations where previous wash-outs were corrected were observed, many issues and needs were still present and documented.

General and specific observations during the field investigation were photographed and documented by Mattern & Craig personnel. Appendix A of this report contains a summary of the observations made and photographs taken. Appendix B contains an inventory of the existing roadways within the Wolf Laurel proper, the existing cross culverts and their respective conditions, and the tonnage of stone placed on various roads during the 2007 year. This information was prepared by Wolf Laurel Roads & Securities personnel and providedA to Mattern & Craig for use in this report.

Overall Assessment/Specific Concerns

Based on the field investigation conducted on Tuesday, June 17, 2008, several observations were realized regarding the overall condition of the subdivision. First and foremost, the age of the original road and storm drainage work is about 30 years. As such, many of the original culverts that were placed under the roadways are old and rusting. According to Wolf Laurel Roads & Securities staff, several of the original cross culverts in the subdivision have collapsed and have subsequently been replaced and/or repaired. With the age of the remaining existing culverts, similar failures can be expected at locations utilizing these 30 year old culverts. Visual inspection of several culverts indicated significant rust and deterioration of the culvert bottoms.

In addition to the age of existing culverts, a significant deficiency is the apparent lack of adequate cross culverts throughout the subdivision. It was explained to Mattern & Craig staff that cross culverts must be placed on property boundary lines where a storm drainage easement can be maintained. This limits the ability to place culverts where they may be needed. Also, the amount/number of existing cross culverts appears to be insufficient especially in the higher elevation areas of the subdivision. Based on information provided by the Roads & Securities staff, there are 332 existing cross culverts on approximately 46 miles of roadway. This equates to a cross culvert every 730 feet. While there are several methods of determining storm-water runoff amounts and culvert spacing and sizing (*Manning Formula, The Rational Method, The Talbot Formula, etc.*), these methods involve engineering consultation and calculation. Agencies such as State Forest Services often space culverts based on road grade. Spacing recommendations for culverts in the eastern United States are usually based on the Kochenderfer formula which is $400/\text{slope percent} + 100$ (see Appendix C). Based on this information and assuming an average slope of the roadway mileage within Wolf Laurel is 8 percent, cross culverts should be spaced every 150 feet in order to adequately handle the amount of water being shed and the subsequent velocity of this water. Considering this, Wolf Laurel could potentially have over 1,600 culverts throughout its mileage. While this number of culverts may not be practical, it reiterates the fact that the 332 culverts currently in place are not enough to handle the existing demands of the storm water runoff. Currently, the storm-water is channeled in roadside ditches and concentrated to cross culverts. This storm-water is then discharged at the pipe outlets typically with no energy dissipation. This concentration of storm-water overwhelms the existing cross culverts which may be undersized to handle the drainage area they are serving. Furthermore, this concentrated water is discharged through the pipe outlets and is channelized downstream instead of dispersing the water flow and slowing it down. The end result tends to be the creation of gullies and significant erosion at the outlet of these pipes, overtopping of the inlet of culverts, and wash-outs around existing culvert locations. It is highly recommended that additional cross culverts be placed where practical in order to reduce the amount of concentrated storm water at each culvert location. Additional cross culverts would also reduce the velocity of the water and the detrimental effects it has on downstream locations. With additional culverts in place, the need for velocity checks (*rip-rap lined ditches, check dams, etc.*) significantly decreases.

Another general observation of the subdivision was the apparent need for additional gravel on many of the roadways. Several roads evaluated had exposed bedrock showing. Other roads were mostly compacted dirt and lacked any significant gravel or rock. According to information provided by the Roads & Securities staff, to gravel all the unpaved roads within the subdivision with about 4 inches of ABC stone would require over 50,000 tons of gravel at a cost of \$938,000 (*year 2007 costs assumed*). During the 2007 year, 3,749 tons of gravel was placed on various roads at a cost of about \$85,000. This represents less than 10 percent (7.5%) of the 50,000 tons needed to gravel the entire subdivision on an annual basis. In addition to this, several locations were observed where “wedging” was needed in order to grade the roadway away from the fill slope and towards the ditch line. With the low point of the road on the fill slope side, water can and does run down the road and “breaks” over the fill slope bank causing erosion and can lead to complete wash-outs of the fill slope side of the road.

Most ditches within the Wolf Laurel subdivision were shaped and relatively clean. Some roadways had ditches that were clogged with debris and sediment and needed immediate attention. Some segments of roadways lacked ditch lines on the cut slope side of the road or had inadequate ditch lines. Ditches in the lower lying elevations tended to have vegetation (*grass*) lining the channels. Ditches in the upper elevations of the subdivision tended to be exposed earth material. Ditches should be seeded where vegetation can be established. Where vegetation can not be established, rock silt check dams or rip-rap lined ditches should be utilized to control erosion and velocity of water.

Existing cross culverts tended to lack any inlet protection and most lacked outlet protection. Inlet protection can aid in keeping culverts free of debris and sediment while outlet protection serves as an energy dissipater to channelized water flow and helps to disperse the water over a larger outflow area. Many of the existing cross culverts observed had damaged and/or clogged inlets that greatly reduces the water carrying capacity of the pipe.

Many driveways serving private residences had damaged driveway pipes, clogged driveway pipes or no driveway pipes at all. In addition, most driveways on the cut slope side of the road lacked adequate ditch lines and drainage features and thus shed water onto the road.

As previously stated, motor grader operations (*scraping of roadbeds*) were observed on many roads. While this is a very necessary maintenance procedure to eliminate rutting, wash-boarding and low spots in the roadway, an unintended consequence of this operation was the creation of a “berm” along the fill slope side of the road. This build-up of material along the side of the road prevents water from shedding off the fill slope. Although the road should be graded to shed water towards the ditch, some water will flow along the roadbed particularly after some rutting occurs due to vehicular traffic. This water becomes trapped by the fill slope material and flows along the edge of the road until a break is found on the low side (*fill slope*) of the road.

Several locations within the subdivision could benefit from the placement of guardrail. Currently, it doesn't appear as if any guardrail is being used. Consideration should be given to install guardrail at locations with significant fill slopes (*elevation drops exceeding 10 feet*) coupled with no useable fill slope shoulder width.

As previously indicated, the observations and photographs from the field investigation can be found in Appendix A of this report. During the field investigation, some specific concerns warranting immediate attention were noticed.

Specifically, existing culverts throughout the subdivision that have crushed/damaged inlets should be repaired or replaced. With a crushed or damaged inlet, the water carrying capacity of the pipe is significantly decreased. This coupled with the fact that there are not enough cross culverts currently in place to handle the amount of storm water leads to overtopping of inlets and wash-outs of the road.

Along Hanging Rock Road near lot # 255, an existing cross culvert with significant bank erosion around the outlet of the culvert was observed. It is recommended that the bank be stabilized and outlet protection added immediately. Furthermore, in this same general area of Hanging Rock Road, a road shoulder wash out was observed with water running under the road. No culvert was visible in this location. It is strongly advised that this situation be investigated and if no culvert present, one be installed to prevent additional deterioration.

In several locations (Trillium Lane, May Apple Lane), existing culvert pipes extend too far over the fill slope and should be cut off and outlet protection provided. If the pipe outlet falls on the fill slope, rip-rap outlet protection should be provided along the length of the slope from the outlet to the toe of the fill slope.

On Zebulon Lane near lot # 22, fill slope failure around a cross culvert pipe outlet was observed. It is recommended that this bank be stabilized and outlet protection provided immediately before further slope failure occurs.

Areas where evidence of water rutting the roadway and then breaking off the fill slope is present should be wedged with gravel to slope the roadway towards the cut slope and ditch. Left unattended, these areas will eventually wash out and result in a fill slope failure. Many of these areas have already been addressed in the field.

Existing driveway pipes should be kept clean and clear of debris. Clogged pipes will cause water to exit the ditch and wash over the road. In addition, damaged driveway pipe inlets should be repaired or replaced so their water carrying capacity is not hindered.

The above observations are not an all inclusive list of needed or recommended improvements but rather a compilation of observations made by Mattern & Craig personnel on roads included in the field survey. Other deficiencies more significant than these may exist in the subdivision. These items are only brought to the Wolf Laurel Roads & Securities staff in the event that they were unaware of these specific needs.

Recommended Approach

Based on the results of the site evaluation, we have prepared the following recommended approach to establish the perpetual upkeep and maintenance of the Wolf Laurel subdivision roadway system. Many of these items are already being performed by Wolf Laurel Roads & Securities staff. Additional staff and/or equipment may be necessary in order to perform the recommended repairs/maintenance on a routine basis. The approach is broken down into four (4) categories for Immediate Needs, Semi-Annual Needs (*twice per year*), Annual Needs (*once per year*) and Long Term Needs.

Immediate Needs

1. Add outlet protection on all existing cross culverts.
2. Address private driveways to ensure adequate storm drainage facilities are provided. Facilities to include driveway pipes and/or driveway cut slope ditches as necessary.
3. Existing cut/fill slopes with bare earth should be stabilized with vegetation to prevent washing of silt/sediment into ditches and to prevent bank erosion.
4. Locations with significant fill slope bank erosion (as identified in this report or at other locations not specifically mentioned in this report) should be stabilized immediately to prevent future slope failure.

Semi-Annual Needs

1. Shape ditches, clean ditches of debris and sediment build-up, and stabilize ditches with vegetation, rock check dams and/or rip-rap lined ditches as necessary.
2. Inspection and clean-out of existing cross culverts and driveway pipes.
3. Grading/scraping of gravel road surfaces. In addition to grading, care should be taken to keep debris from building up on the fill slope shoulder. Bank clearing/mowing.
4. Wedging with gravel in low points of roadways to push water away from fill slope and towards cut slope ditch line.

Annual Needs

1. Establish a schedule for the replacement of existing cross culverts/damaged culverts. Recommend the replacement of a minimum of 36 culverts per year (*3 per month*).
2. Establish a schedule for the annual installation of additional cross culverts starting on roadways with minimal to no culverts present. Recommend a minimum of 36 new culverts per year (*3 per month*).
3. Gravel roads with 6 inches of compacted ABC stone per year (*bi-annual*).
4. Patch/repair potholes and deficiencies on paved roads within the subdivision.

Long Term Needs

1. Consider paving of certain collector roads within the subdivision in order to reduce the annual maintenance needs of the subject facilities. At a minimum, recommend Buckeye Road for consideration of paving.
2. Guardrail on excessive fill slopes and/or in areas with no usable shoulder width.
3. Additional staffing/equipment needs.

Refer to Appendix D of this report for Typical Construction Details.

Opinion of Probable Costs

Based on the maintenance needs identified previously, a cost estimate was prepared in order to predict the annual costs associated with the maintenance and upkeep of the roadway system contained within the Wolf Laurel proper. The unit costs presented here-in represent typical material, delivery, equipment and labor costs associated with the type of work specified. These costs represent year 2008 expenses. Over the last three to five years, the cost of materials related to this type of work has experienced dramatic increases and is expected to continue to increase proportionally in future years. An 8 to 12% annual increase per year can be expected to keep up with inflation and the increasing costs of petroleum and steel products. If steps aren't taken to develop a maintenance program for the Wolf Laurel subdivision now but rather delayed for several years, the ultimate costs at the time of implementation will be exponentially more (*an approximate increase of \$150,000 per year for each year the program is delayed*).

In addition to the annual costs described in the following chart, other costs in the form of additional staff and/or equipment may be necessary to adequately keep up with the demands of the subdivision. Currently, with a staff of four employees and one supervisor, the Roads & Securities Board has a difficult time making headway on improvements to the roadway system that would lead to less maintenance needs.

If the Wolf Laurel Roads & Securities Board adopts this or some similar form of approach for maintenance of the roadway network, it can expect an annual cost in 2008 dollars in the range of \$1.4 million to \$1.5 million per year (*see cost estimate on next page*). As previously indicated, costs associated with the necessary maintenance and repairs are expected to increase annually. However, as the recommended approach is implemented, the annual costs should decrease as less emergency repairs should be needed. For example, the addition of rock silt check dams, rip-rap lined ditches and pipe outlet protection will reduce erosion, potential wash-outs and necessary ditch repair/maintenance. This decreased annual cost of maintenance will most likely be offset by the increasing cost of inflation resulting in an annual budget in the range of \$1.5 million per year for the perpetual upkeep of the subdivision.

The most significant cost associated with the maintenance and upkeep of the subdivision is the annual graveling of roadways. The following cost estimate assumes half of the neighborhood would be graveled with 4 to 6 inches of ABC stone per year. If the Roads & Securities Board chooses to gravel less roadway mileage per year (*one-third, one quarter, etc.*) the annual costs can be significantly decreased but other needs/problems may arise on roads not receiving stone on a bi-annual basis. Also, paving roads can significantly reduce the annual maintenance needs/costs of the subject facility but up-front costs for paving is more. A paved road requires no grading, scraping or wedging. The life expectancy of a paved road is typically 25-35 years with proper patching/sealing. For every mile of road paved, the up-front (*capital outlay*) cost is about \$250,000 - \$300,000 (*for a typical 18' two lane, two way road*) but an estimated annual maintenance savings of 33 percent/mile can be expected (*\$1,500/mile maintenance costs for gravel versus \$1,000/mile maintenance costs for paved*).

**Opinion of Probable Cost for the Maintenance
And Upkeep of the Wolf Laurel Subdivision Roadway System
Estimated Annual Costs (in 2008 dollars)**

Description	Quantity	Unit	Unit Price	Extended Total
Rip-Rap at Culvert Outlets	432	TON	\$70.00	\$30,240.00
Rip-Rap at Culvert Inlets	84	TON	\$70.00	\$5,880.00
Hydroseeding	1	ACRE	\$2,500.00	\$2,500.00
Synthetic Ditch Liner/Matting	5,280	LF	\$10.00	\$52,800.00
Rip-Rap Slope Protection/Stabilization	100	TON	\$70.00	\$7,000.00
Ditch Cleaning/Repair/Shaping	200	MAN-DAY	\$1,500.00	\$300,000.00
Rock Silt Check Dams	50	EA	\$700.00	\$35,000.00
Class B Stone Ditch Liner	500	TON	\$70.00	\$35,000.00
Culvert Inspection and Clean Out	1,000	MAN-HOUR	\$35.00	\$35,000.00
Roadway Grading/Scraping and Shoulder Work	300	MAN-HOUR	\$150.00	\$45,000.00
Bank Clearing/Grass Cutting	350	MAN-HOUR	\$50.00	\$17,500.00
Wedging	1,000	TON	\$25.00	\$25,000.00
Road Gravel - ABC Stone	25,000	TON	\$25.00	\$625,000.00
Replace Existing Culvert	36	EA	\$750.00	\$27,000.00
Repair Damaged Culvert	36	EA	\$500.00	\$18,000.00
Install New Culvert	36	EA	\$750.00	\$27,000.00
Asphalt Paving Repair	250	SY	\$50.00	\$12,500.00
Guardrail	500	LF	\$20.00	\$10,000.00
Emergency Response	1	LUMP	\$10,000.00	\$10,000.00

Anticipated Annual Cost: \$1,320,420.00
Construction Contingency (10%): \$132,042.00
Total 2008 Annual Cost: \$1,452,462.00

SAY: \$1.5 MILLION

Notes:

Rip-Rap at Outlets: Assumes an average of 4 tons per location. Assumes outlet protection provided at the 36 new culverts installed per year, the 36 existing culverts replaced per year, and at 36 existing culverts without protection per year.

Rip-rap at Inlets: Assumes an average of 1 ton per location. Assumes inlet protection provided at the 36 new culverts installed per year, the 36 existing culverts replaced per year, and at 12 existing culverts without protection per year.

Rip-rap Slope Protection: Assumes an average of 10 tons per location. Assumes 10 locations per year needing protection/stabilization/repair.

Class B Stone Ditch Liner: Assumes 1 ton per every 10 linear feet of ditch lined. Assumes an average of 5,000 linear feet of ditch lined per year.

Culvert Inspection and Clean-out: Assumes 2 hours per location. Assumes an average of 500 culverts and driveway pipes inspected and cleaned per year.

Wedging: Assumes 100 tons per location. Assumes 10 locations per year to receive wedging treatment/work to push water away from fill slope towards ditch.

Guardrail: Assumes 500 linear feet per year of guardrail to be installed.

Emergency Response: Assumes Wolf Laurel Roads & Securites staff will periodically need to respond to emergency situations (tree removal, road wash-out, bank failure, culvert failure, etc.) not accounted for in the maintenance and upkeep items identified above.