7.0 GRAVEL ROAD MAINTENANCE INVESTIGATION

7.1 Introduction

An important piece of Milton's roadway network includes the unbound or gravel roads located within the City limits and maintained by the City of Milton. These thirteen miles of gravel roads distributed throughout the City are well-liked by the majority of Milton citizens and an important piece of Milton's character. The Atlanta Journal-Constitution reported an article about Milton's gravel roads and citizens used the following words to describe the gravel roads: "scenic, pastoral, peaceful, country, and complexion of the community".[1] It is clear that gravel roads are an important characteristic of Milton, but it is the second point that the article makes - the maintenance costs of gravel roads – which is the focus of this report.

KHA was asked by the City of Milton to provide general input and perspective on gravel road maintenance and costs in order to help the City better plan and accommodate the needed attention of the gravel roads. The main factors which were explored were a basic literature review to gain an understanding of the experience of other jurisdictions and place in perspective the Milton condition, an investigation into the expected schedule and costs of gravel road maintenance, an exploration of the City of Milton's current strategy and user expectation, and determining future strategy in light of economic reasonableness as well as the gathered data.

7.2 Literature Review

On investigating available literature, two main bodies of research in gravel road maintenance cost, strategy, and upgrade comparison (i.e. cost-benefit analysis of upgrading an unbound road to a paved road) were considered. These research teams were trying to answer the questions: how much does it cost to maintain a gravel road? How does that compare to an asphalt (bound) road? What about user costs? When is it cost effective to invest in paving a gravel road? What affect does traffic have on that decision and the cost of maintenance? How does one weigh non-economic factors? These questions are not unique to these research teams and jurisdictions and are similar to those that Milton is asking. Although the research presented may be from different parts of the country with different situations, one can learn from their findings and apply them with care to the situation at hand.

The first comes from the Minnesota Department of Transportation (MnDOT) Local Road Research Board (LRRB)[2], where the researchers looked at historical and estimated construction cost data from multiple counties in Minnesota to determine life cycle costs alternatives between gravel and asphalt roads at varying traffic levels. The researchers also attempted to include non-monetary factors in the decision process of whether to pave a gravel road.

The LRRB acknowledged what KHA found to be true, that there is little useful data on maintenance costs of gravel roads either at the county level or in the literature. In fact, they found the data in the Minnesota counties to be so widely variable and inconsistent, that they decided to use a cost estimating procedure in their study for gravel road maintenance in order to create a baseline of comparison. Most research and published experience on roadway maintenance focuses on paved roadways and often higher

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[1] "Gravel Roads a Drag on City Budget," Atlanta Journal-Constitution, January 24, 2009.

[2] Jahren, Charles T. et. al. "Economics of Upgrading an Aggregate Road," Minnesota Department of Transportation, St. Paul, Mn, January 2005.

traffic volume roads like arterials and interstates. Although these roads represent a higher infrastructure value per area, the network of local or low volume roads, as a whole, represents a significant value that should be considered in a pavement management analysis. A low volume road is typically defined as a roadway with average daily traffic (ADT) volumes of 400 vehicles or less and a design speed of 50 mph or less.[3]

Cash flow diagrams and present worth calculations were used to compare what they found to be typical gravel and asphalt maintenance schedules. Over a 30 year life cycle at an interest rate of 4%, they estimated that the gravel road net present worth was $68,000 while the asphalt was $92,000. In other words, they found considering the maintenance schedule and historic and estimated cost data, that gravel road maintenance for low volume roads would require $24,000 less dollars over a 30 year cycle.

To determine the cash flow comparisons, interviews were conducted with county staff and investigation of historical records. From this, the LRRB team defined the state of practice for maintenance of gravel roads in Minnesota. Although it is expected that technique and frequency of maintenance will be different in Minnesota than Georgia, it is still useful to report their maintenance strategy as a way of comparison or check of reasonableness. Because there is rather limited published information on gravel road maintenance, information from other states and areas of the country is even more valuable.

The team considered a 24' wide roadway with 2' shoulders as their general cross-section to develop their costs on a per mile basis. They found that the typical maintenance schedule consisted of routine grading and re-graveling with two inches of new gravel every five years. They found that a typical road needed to be graded 21 times a year or three times a month from April – October, and the upper bound for re-graveling was five years for any road over 100 ADT; lower volume roads could possibly go longer. The calculated construction costs including materials, labor, and hauling totaled $1,400 per year or $67 per visit for the grading or blading activity and $13,800 for the re-gravel activity every five years. The re-gravel included an estimate gravel cost of $7.00 per cubic yard and a 2.5" thick lift of gravel (to be compacted down to 2"). Therefore, they developed an average estimated an annual maintenance cost for gravel roads at $4,160 per mile.

A research team with the South Dakota Department of Transportation (SDDOT) also worked on defining their typical maintenance strategy for gravel roads as well as created a tool to compare alternative solutions with a life-cycle cost approach.[4] From this research, they developed an interactive macro in Microsoft Excel that allows users to input data on the particular roadway in question including dimensions and traffic, agency unit costs, maintenance frequencies, and user costs to evaluate competing pavement surface types. This program was used for evaluation of Milton's maintenance options and will be discussed in detail later.

The default maintenance program for gravel roads from SDDOT's report includes blading 50 times per year, re-graveling once every six years, and spot graveling once per year. The unit cost for blading was very similar to MnDOT at $65 per mile, re-gravel at $7,036 per mile and spot graveling or pothole repair at $2,420 per mile, totaling to an average annual maintenance cost of $6,843 per mile. Due to the frequency of the blading activity and the addition of the spot gravel maintenance, the SDDOT number is higher than MnDOT reported even though the re-gravel activity is reported at about half of the price in Minnesota.

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[3] Keller, Gordon and James Sherar. "Low-Volume Roads Engineering," US Agency for International Development, July 2003.

[4] Zimmerman, K.A. and A.S. Wolters. "Local Road Surfacing Criteria," South Dakota Department of Transportation, Pierre, SD, June 2004.

It is important to note that both SDDOT and MnDOT did not include maintenance activities like dust abatement, reshaping the crown and cross section, or ditch cleaning and regrading, which are necessary costs for maintaining gravel roads in Milton. These discrepancies and unique features of each agency and each gravel road illustrate the difficulty of comparing agency costs and techniques. The variability in cross section, traffic, use, user expectation, maintenance staff, and quality of the roadway are much higher for a gravel road than for a standard low-volume asphalt roadway. Therefore, agencies should consider their maintenance needs and historical unit bids to determine their budget and cost comparisons.

According to a North Fulton Online article, Fulton County, the prior responsible party for gravel road maintenance in the Milton community, spent $73,442 a year on gravel road maintenance including three scrapings a year and a little gravel and dust abatement when required.[5] This budget over thirteen miles of public gravel roadways is approximately $5,650 per mile, which is similar to what SDDOT and MnDOT reported.

However, the City of Milton situation is even further unique from these counties and other municipalities in that the City does not have a maintenance staff and equipment available and dedicated to the maintenance of their gravel road system. Unlike the counties in South Dakota and even Fulton County, the City must scope and bid projects in the competitive market incurring overhead, profit, and mobilization costs of the construction firms as well as indirect costs or setbacks in managing these contracts, scoping the work, and a learning curve that must be established with each newly selected firm. For example, in discussions with SDDOT, they described a crew that essentially continually maintains their gravel roads within a district by scraping and performing pothole repairs on one roadway, then the next, then continues the cycle; thus, it is not uncommon to have 50 bladings a year per roadway at a significantly low price of $65 per mile. Further, this reported price assumedly includes only the labor time and equipment maintenance, not the capital budget necessary to have a maintenance staff; overhead to manage that staff; equipment costs including capital, storage, and maintenance; etc. The City of Milton does not have those overhead costs, but does see them in the unit costs of construction activities. For example, according to available resources, a finish grading activity or blading would cost the City of Milton closer to $1,500 a mile for the same activity South Dakota reported at $65. Subsequently, Milton must consider their unique circumstances, evaluate historical bids, and clearly understand, plan and communicate the anticipated budget and performance of their gravel roads.

7.3 Milton Maintenance Strategy

To determine a maintenance schedule appropriate for Milton, KHA staff conducted multiple meetings with the Department of Public Works, attended a public meeting regarding gravel roads, conducted site investigations of the roadways, and gathered information on the previous maintenance schedule of Fulton County. From these various sources, KHA gained an understanding that Milton residents enjoy the gravel roads, and the residents that live on these roadways want the roads to remain gravel as a way to maintain their rural character, promote local traffic only, and slow speeds on residential roadways.

Recently, the City of Milton cement stabilized 2.6 miles of unbound roads. Cement stabilization is a new maintenance and rehab technique for this area, but is not uncommon in other areas of the country. Some of the expected benefits of a stabilized roadway could be safety with better stopping ability as well as improved durability. The more durable surface may allow for longer durations between maintenance

[5] Wright, Jason. "Milton wants input on dirt roads," NorthFulton.com, www.northfulton.com, accessed April 30, 2009.

activities, possibly saving money in the long run and minimizing disruptions to residents. On the other hand, possible rebuttals may include that the stabilized roads present a dust abatement issue due to the finer aggregate size and dense composition or promote more traffic volumes and higher speeds due to the relatively smoother surface. KHA recommends that the City closely monitor the performance of the stabilized roadways as well as solicit feedback from a sample of residents to weigh the pros and cons to evaluate this technique as an option in the future.

What the public was interested in was a clear plan of maintenance as well as an understanding of the necessary costs. To help answer that question, KHA has utilized the software tool developed by the SDDOT team to consider a variety of maintenance options described in the scenarios below. The main activities included in the maintenance strategy are: blading, re-gravel, reshape cross section, spot gravel, and dust abatement. Multiple maintenance scenarios and cost information were investigated for gravel roads as well as asphalt for comparison. Each scenario is described in detail below, and a summary is reported in Table 7-5 with discussion to follow. The unit cost data, unless otherwise described in the detail scenario descriptions, considered for Milton came from two common sources of cost data: the *RS Means Site and Landscape Cost Data*[6] and the GDOT Item Means Summary which lists actual project unit costs from 2007-2008 as well as engineering judgment and experience. KHA has confidence in these materials as good sources of useful cost information for planning purposes. Of course, construction prices are volatile, especially in recent times, and prices are always subject to change. The user costs presented in the summary were default values provided by SDDOT. Each scenario and cost information is given for a 20-year design life or life cycle with an interest rate of 5%.

Asphalt maintenance

Asphalt paving or hot mix asphalt (HMA) was investigated as a comparison tool to determine the relative cost for gravel road maintenance versus asphalt. The SDDOT program is set up to be a comparative tool between pavement options, so each following scenario will be compared to the asphalt paving option. Two scenarios for asphalt paving were considered with two different initial costs shown as Ashpalt 1 and 2 in Table 7-5. The first is a conservative approach with an additional $50,000 of initial construction costs due to the costs beyond the asphalt pavement to upgrade the current unbound road to a paved road. Without detailed analysis for each roadway, it is difficult to determine specific costs. From Table 7-1, the typical asphalt maintenance schedule consists of crack sealing every five years, striping and marking every ten years, pothole repairs yearly and an overlay after twenty years. The unit costs for maintenance were developed based on the references noted above and experience.

Table 7-1. Asphalt Maintenance Schedule and Unit Cost

	Times per year	Years between application	Start Year	Unit Cost $/mile
Crack Seal	1	5	5	$3,000
Striping	1	10	10	$1,000
Patching	1	1	1	$1,600
Mill & Overlay (1.5")	1	20	20	$200,000
Average Annual (not adjusted for inflation)				$12,300

6 Spencer, Eugene R., Ed. *RS Means Site Work & Landscape Cost Data*, 27th Edition, Kingston, MA, 2008.

Scenario 1 – Literature maintenance schedule with Georgia unit cost

The first scenario considers a maintenance schedule that one might determine is appropriate based on the literature review, and it is a hybrid of the MnDOT and SDDOT default maintenance schedule with unit costs determined through KHA's investigation of GDOT and other resources as mentioned earlier that are more applicable to the City of Milton. This scenario reports a substantial average annual maintenance cost per mile mostly due to the high frequency of blading suggested by the literature (we used the *lower* of the two values) and the substantially higher unit cost of the same activity. Considering Milton's thirteen miles of gravel roads, this would total to an annual maintenance budget of nearly $500,000, which is not feasible. Further, this cost does not include important maintenance activities for the City like dust abatement and ditch-shaping work. Therefore, more economically suitable options with less frequent maintenance, which is also more comparable to the historical maintenance strategies, are presented in Scenarios 2 and 3, but this provides a good tie back to the literature review.

Table 7-2. Scenario 1 Maintenance Schedule and Unit Cost

	Times per year	Years between application	Start Year	Unit Cost $/mile
Blading	21	1	1	$1,500
Re-gravel (1.0")[1]	1	6	6	$13,000
Spot gravel	1	1	1	$650
Average Annual (not adjusted for inflation)				$34,317

1. Material cost per GDOT Item Means Summary at $20.47/ton and 650 tons/mile

Scenario 2 – General maintenance schedule with Georgia unit costs

The second scenario considers a maintenance schedule and activities more tailored to the Georgia situation again with unit costs developed from available resources. This maintenance schedule considers essentially three maintenance visits with either blading or reshaping as well as dust abatement. The scenario also includes a spot gravel activity for pothole and other repair as well as a re-graveling every six years. From the gathered data, this scenario is probably the best aligned scenario with user expectation of the gravel road condition and activity schedule.

Table 7-3. Scenario 2 Maintenance Schedule and Unit Cost

	Times per year	Years between application	Start Year	Unit Cost $/mile
Blading	2	1	1	$1,500
Re-shape Cross section; Ditch	1	1	1	$7,400
Spot gravel	1	1	1	$650
Dust Abatement[1]	3	1	1	$2,050
Re-gravel (1.0")[2]	1	6	6	$13,000
Average Annual (not adjusted for inflation)				$19,367

1. Application rate of 0.2gal/sy at $0.97/gal
2. Material cost per Georgia DOT Item Means Summary at $20.47/ton and 650 tons/mile

Scenario 3 – Modified maintenance schedule with Milton unit costs

The City of Milton Department of Public Works staff provided KHA unit price information for current maintenance activities some of which are higher or lower than what KHA found in the historical GDOT, Milton bid documents and the RS Means resource, and those costs are included in Table 7-4. For example, general maintenance, which we show as 'blading' in the table is higher than reported in Scenario 2, but probably includes more than the blading, such as minor ditch cleaning or other work. On the other hand, it may just be another example in construction pricing variability.

Scenario 3 considers the maintenance schedule that is probably the most economically appropriate for Milton, is adaptable to what is currently planned by the Public Works staff, and is similar to what KHA has surmised that Fulton County performed in the past. This maintenance schedule considers work on three times annually including two bladings with dust abatement, one reshaping activity with dust abatement with an allowance for needed gravel shown as spot maintenance on the table and no re-graveling. According to the staff, the average gravel used in one year is close to 300 tons. The re-graveling activity, at any interval, is a very costly investment for the City due to the material and labor costs and does not seem economically appropriate for the given situation. Further, from what KHA has gathered, a significant re-graveling or capital-type investment has not been performed in the past with acceptable results; that is, in the past prior to the cement stabilization work.

Table 7-4. Scenario 3 Maintenance Schedule and Unit Cost

	Times per year	Years between application	Start Year	Unit Cost $/mile
Blading	2	1	1	$2,800
Re-shape Cross section with Ditch	1	1	1	$5,400
Spot[1]	1	1	1	$350
Dust Abatement[2]	3	1	1	$1,750
Average Annual (not adjusted for inflation)				$16,600

1. Material cost per gravel road bid tab provided by Milton at $15.22/ton
2. Application rate of 0.2gal/sy at $0.83/gal

Summary

A summary of the life cycle costs per scenario in dollars per mile is given below in Table 7-5 to illustrate the different pavement and maintenance options for consideration. As discussed above, the maintenance frequency as suggested by the literature (Scenario 1) is not an economically feasible alternative for the City of Milton given high construction and material costs previously discussed. Given this option, it would be cheaper to pave the roads, even at the higher initial construction cost considered in the Asphalt 1 scenario, due to the frequency of maintenance gravel roads require.

Table 7-5. Summary of Scenario Life Cycle Cost ($/mile)[1]

	Asphalt 1	Asphalt 2	Scenario 1	Scenario 2	Scenario 3
Agency Cost	$330,222	$280,222	$429,052	$242,742	$215,373
User Cost	$16,271	$16,271	$10,994	$10,994	$10,994
Total Cost	$346,492	$296,492	$440,046	$253,736	$226,367

1. Life cycle of 20 years at 5%

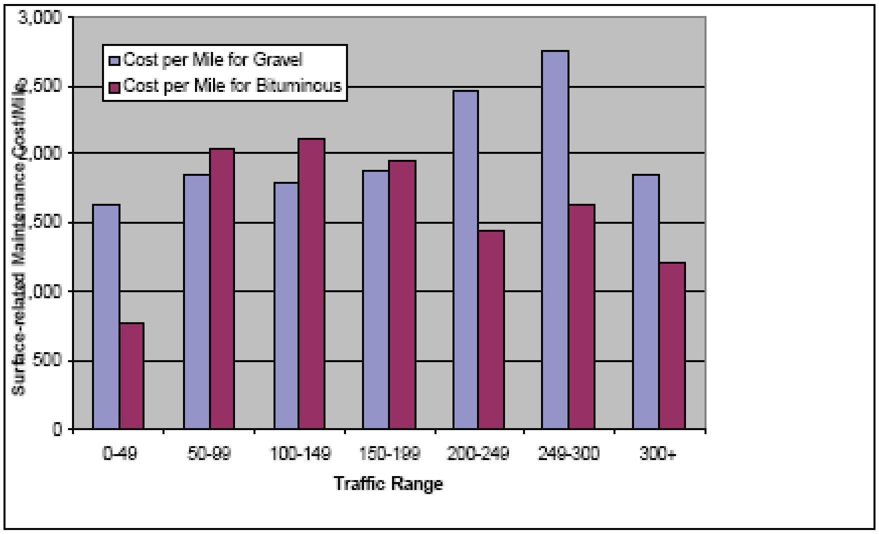
As far as the other two more reasonable scenarios (2 and 3), the life cycle costs are lower than the asphalt options. However, it is important to note that the two scenarios are not too far from the Asphalt 2 scenario, and without the overlay costs at year 20, the Asphalt 2 option would actually be a more cost effective solution. This does not necessarily conclude that asphalt is the best economic option, but it does suggest that the gravel road maintenance budgets need to be watched very closely to be sure that they are still the most economically advantageous solution. If cost or frequency of maintenance increases, whether a result of natural events, increased traffic, or user expectations, then the gravel road option could quickly become the more expensive alternative.

7.4 Traffic Considerations

The second focus of the research at MnDOT LRRB considered the effect of traffic volumes on required maintenance and therefore cost for bound and unbound roads. They took historical economic and traffic volume data from four counties to determine not only the comparison between asphalt and gravel costs, but what affect traffic or ADT had on those figures. They hypothesized that at some traffic level, gravel road maintenance frequency would increase to where it would surpass asphalt in maintenance costs. Their objective was to determine such a threshold.

Investigation into the individual county data and the dataset as a whole led LRRB to identify the threshold where gravel road maintenance is more costly than the investment in asphalt or bound options to be between 100-200 ADT. From Figure 7-1, the cost per mile for gravel and bituminous (asphalt) are shown versus traffic or ADT, and it shows the change in relative costs around 150 vehicles per day. The researchers recommend from an economic viewpoint, that a jurisdiction should begin planning the investment to pave or upgrade a road when traffic volumes reach 100 vehicles and conduct the upgrade before the growth reaches 200 at which point the cost of the gravel road maintenance to the agency is higher than that of asphalt.

Figure 7-1. Five Year Average Maintenance Cost/Mile vs. ADT[7]



The City of Milton obtained JAMAR Technologies, Inc. to provide traffic counts and ADT values for City's gravel roads, and these findings are presented on a map included in Appendix B. From the data, many of Milton's gravel roads are above the 100 vehicle per day threshold that LRRB reported, and two count locations are above the 200 threshold. Therefore, it is reasonable to assume from the available research that many of Milton's gravel roads are reaching a traffic level that creates maintenance issues including poor conditions and thus increased maintenance efforts and dollars. This situation is apparent in the traffic data as well as reports from staff and the public, increasing confidence in the numbers reported by LRRB. It should be noted, however, that these counts were conducted after the 2.6 mile stabilization project, and many residents reported higher traffic volumes after the stabilization at the public meeting conducted on April 30, 2009; therefore, the effect areas may have recently inflated numbers.

7.5 Conclusions and Recommendations

From the above discussion, investigation, and available research, KHA recommends that the City of Milton consider following a maintenance strategy as outlined in Scenario 3 and modified as required to fit budget constraints. The recommended strategy would cost approximately $215,800 annually. Depending on annual funding levels, the City will have to determine the realistic amount of maintenance, and KHA recommends that the City communicate to the community the yearly maintenance plan and costs in comparison to this recommendation. This will give the users an idea of the expected level of service. KHA recommends that the City and staff use the presented information to evaluate their maintenance strategy, plan for necessary funding, and communicate with the residents in the future.

In addition, KHA recommends that the City of Milton monitor the maintenance costs and the performance of the gravel roads as they continue to manage these roadways. The City should separately monitor the performance, maintenance cost, and user experience of the cement stabilized sections. From this investigation, it was found that the maintenance costs for the gravel roads are fairly close to those of a paved road, and the traffic volumes support the idea that gravel maintenance is increasingly

[7] Jahren, Charles T. et. al. "Economics of Upgrading an Aggregate Road," Minnesota Department of Transportation, St. Paul, Mn, January 2005.

more costly to the City as discussed in section 7.4. The City should closely monitor the costs of maintenance and consider other options that may be less costly over the long term whether that is an on-call contract with a contractor for maintenance or investing in City equipment or staff. The other evident options are to lower expectations of the quality and service of the roads or continue to allocate more funds for higher frequency maintenance. Other less direct options include deterring traffic or otherwise limiting access to these roadways. In any case, gravel road maintenance will require attention and time of the City as determined by experience and supported by the available research.