Date: Wednesday, October 23, 2024

From: Niall Lobley, CAO

Subject: Gravel Roads vs Surface Treated Roads

Report CAO2024-034

This document and its attachments are public and available in an accessible format upon request.

Recommendation

The Council receive the report CAO2024-034 for information

Background

In May 2024, Council directed staff to bring back a report that explored when it is appropriate for an alternative form of road surface to be applied to enhance a gravel road and a cost comparison of the lifetime costs of various road treatments.

There is a significant body of research material from across North America and Canada on this subject and staff have attempted to review some of these many materials and summarize the findings in this report.

Analysis

The Township of Georgian Bluffs has three dominant types of road surface.

Gravel Roads make up approximately 1/3 of the network. A gravel road is a constructed road, with a constructed base of gravel which provides the ability for the road to take loads, and a gravel surface which provides a driving surface for vehicles. The road consists of a travelled portion, shoulders of the road which are part of the road but not maintained as a travelled portion of the roadway, and drainage infrastructure, commonly ditches or swales. The road is shaped during construction and maintenance activities to promote active drainage of material form the roadway to the edges and into the drainage features.

Gravel roads are maintained through three primary practices. The first is routine grading. Over time, gravel roads become compacted differentially, gravel migrates from the surface and the wear surface can become damaged, leading to water puddling and

pothole development. The gravel surface of the road is prone to the affects of traffic and weather and as such, the surface degrades more rapidly than with other surfaces, demanding more frequent maintenance. Grading undertaken on a routine basis addresses these pressures, bringing gravel back in from road edges, reshaping and profiling the road to promote positive drainage and addressing surface discontinuities. Routine grading is undertaken multiple times a year.

The second maintenance practice is undertaken on an annual basis and is the application of calcium chloride or other substances. This serves two purposes; first, it helps suppress and control dust and secondly the treatment helps to bind and harden the surface of the road. Together, these help to retain material on the roadway and lessen the migration of gravel to the sides and loss of fine material.

The third maintenance operation is to add more gravel. Gravel is added ideally every 1 – 3 years but can be extended to every 5. As vehicles travel the road, gravel is lost. While some can be retrieved during routine maintenance, some is not able to be recovered and over time, this results in degradation of the road. Gravel is eroded into finer material and washed away over time, again leading to the surface being compromised and, if left unchecked, the structural integrity of the road being compromised. In order to address this, gravel roads must periodically have new gravel added to them.

With routine maintenance, a gravel road is recognised as one of the most effective and efficient lower volume road types in North America and can accommodate traffic of varying types comfortably and efficiently. Typical maintenance practices would see several grading passes annually, and the application of gravel on an as needed basis, usually every 1 – 3 years. A gravel road, if maintained well, should last with maintenance operations for 100+ years.

Well maintained gravel roads provide an effective surface that is of value in a wide number of areas. Driving on gravel roads can cause dust (for which suppressants can be applied to reduce the effects of), there is more road noise associated with gravel roads and, without routine maintenance or in periods of changeable to significant weather, such as spring, the surface conditions can be changeable.

Surface Treated Roads make up the next most common form of Township roads. A surface treated road is, in essence, largely identical to a gravel road in respect of its load bearing qualities and construction. The difference is that the gravel surface is topped with a bituminous surface with granular materials mixed in. The bituminous surface binds the road together and seals the surface gravel; the granular material mixed in helps to provide traction on the vehicle surface.

While the surface treatment does not change the load capacity of the road, it does seal the surface gravel. This means that washout of material is largely avoided and the movement of gravel to roadsides is mitigated as the surface is bound. This improves the

ability of the road to resist potholes and surface impacts and therefore provides a more reliable road surface.

The typical maintenance practice on a surface treated road would ideally see around 6-7 years after surfacing a second single surface treatment being applied with this being repeated at year 14. Around year 20-25, the road surface would be pulverized, reshaped and re-surface treated. If roads receive a double surface treatment, the lifespan can be extended through to 10 years. Slurry coats may extend each maintenance period by 3 – 5 years as they help re-seal the road from the effects of weather. In essence, the maintenance practise seeks to protect the underlying gravel from exposure; once exposed, the road will deteriorate rapidly.

A well-maintained surface treated road provides a reliable driving surface that is less impacted by the weather conditions. Road noise is less than on gravel, but more than on an asphalt road. There is less dust associated with surface treated roads.

Fundamentally, while gravel and surface treated roads have different maintenance practices associated with them, they provide functionally the same nature of road quality. Both, being well maintained, will provide a high level of service and are effective treatments for roads.

The Township has a number of **asphalt roads**. Asphalt roads differ in their construction to both surface treat and gravel roads. While they rely on a gravel based, the asphalt surface applied adds structural integrity. Asphalt is a flexible product and so is particularly valuable on roads that see heavier traffic such as transport trucks, or high volumes of traffic. Asphalt roads are the most durable surface type and provide the best driving experience.

Asphalt roads last for an extended lifespan with relatively little maintenance. However, once the asphalt begins to fail, road failure can be quick. Over time, the asphalt becomes more brittle leading to cracking. Left unaddressed, water getting into the surface will rapidly deteriorate the road surface leading to cracks and then potholes. Left unchecked the road surface can fail rapidly.

Asphalt roads should be routinely checked for cracks and crack sealing should be a routine activity in all years of the road's lifespan. A micro surface treatment, or slurry coat will help address natural cracking and smaller surface issues and should be applied 5 – 8 years into the roads life span. By year 15, an 'overlay' should be applied that in effect re-seals the surface of the road and for asphalt roads and reconstruction or pulverize and pave should be considered by year 30.

Best Management Practices for Road Surface Types

With all roads, drainage is key. The design, construction and management of roadways, regardless of surface type, must focus on maintaining positive drainage to ensure that

water is able to rapidly drain from the road surface and is not held, trapped or allowed to sit on roads surfacing for long. When water is able to sit on a roadway, whether in depressions, ruts, cracks or potholes, damage to the surface will follow. When water is able to permeate into the subbase of the road and start to erode this, degradation of the roadway will advance rapidly.

Recent winters have had a noticeable impact on gravel roads in the Township; gravel roads respond best when there is a rapid drop in temperatures that is sustained, so the road freezes, and stays frozen during winter. In spring, freeze thaw cycles help to break apart the surface, allowing water to enter the road more deeply, only to refreeze, helping to damage the subbase. While spring is always challenging, recent winters have seen spring like conditions happen cyclically throughout the winter months, subjecting gravel roads to repeated freeze thaw cycles. The wet and changeable weather conditions mean that routine spring grading that would normally address the spring warm up, cannot occur throughout winter months with the same efficacy.

Maintenance and management practices lose efficiency where a road has not been well constructed when installed. When a new road is built the right type of material in the appropriate depths are needed on which the road will eventually be built. Drainage under and alongside the road is a key consideration. The subbase needs to be carefully planned and installed to provide a roadway that will last, with maintenance, to its full lifecycle.

Based on past observations, the former Townships adopted differing approaches to road construction and, generally, roads to the south of the Township tend to be well constructed with solid sub bases, while roads to the north of the Township were less robust in their construction with often a very thin subbase overlaying parent bedrock.

Poorly constructed roads will, regardless of maintenance practices, underperform and will need renewal and replacement after shorter lifespans than well constructed roads.

Assuming that a road is well constructed and assuming that best practices in maintenance are performed, the following lifecycles might be expected:

- Gravel roads: 100 years or more
- Surface Treated Roads: 20 – 30 years
- Asphalt Road: 30 – 50 years

These lifecycles are generalizations and averages; some roads will last longer or shorter depending on the nature of use, climate conditions and local topography, but, assuming routine management practices are followed, these lifecycles might be anticipated. At the end of lifecycle, a more significant reconstruction is required to bring a road back to ‘as built’ conditions.

All roads, as they age, will degrade and, toward the end of lifecycle, typical maintenance activities will have a lesser impact of road surface quality improvement and will degrade more rapidly, as the road beneath the surface can no longer sustain use effectively. Maintenance activities should be performed when roads are in a good condition; once roads start to deteriorate, maintenance practices will become increasing less effective and will provide shorter lived solutions to reoccurring problems.

Gravel roads, once constructed, require a high frequency of maintenance, but, with routine maintenance, the road will last for an extended period of time; 100 years or more. The maintenance activities, while frequent, are lower cost both from a materials and labour perspective, and, importantly for municipalities, tend to rely on skills that a typical municipality may expect within its own staff.

Surface Treated roads have a high initial cost associated with the application of the surface treatment. There are costs associated with the material and its application. It is not common for municipalities to have the equipment materials or supplies for this work and so it is frequently outsourced. Maintenance activities, which are also high cost, are required less frequently than on gravel roads, and, when the surface fails, a more significant reconstruction is required. A surface treated road would likely go through 3 or 4 lifecycles and reconstructions in the lifespan of a well-maintained gravel road.

Asphalt roads are significantly higher cost again. The materials and the application of them is expensive and the road needs to be fully constructed prior to the application of the asphalt layers. Regular maintenance is needed, which again, frequently is beyond the capacity of municipal staff and equipment and so needs to be outsourced. Lifecycle maintenance activities are required to preserve the road, which are high cost, and ultimately expensive reconstruction will be required.

The Township is working on an asset management plan and will be sharing this with Council through 2025. It has become clear in working through this that there are challenges in the Township associated with roads maintenance and that the Township has not routinely maintained its roads as per best management practices.

The Township has, over recent years, experienced a lack of consistency in gravel road maintenance practices, which have caused and exacerbated challenges with gravel roads. This lack of consistency is largely the result of a high rate of turnover of management staff and a lack of consistent direction and understanding of the condition of the roads network, alongside a reactive approach to maintenance functions. Caught in a cycle of addressing issues as they occur, a less than ideal focus on systemic challenges associated with asset condition has been adopted.

While the Township has an extensive network of surface treated roads, these do not appear to have had a routine, planned and documented pattern of maintenance, and it is not uncommon to have surface treated roads that have had little to no life cycle

management completed, allowing the road to degrade quicker than lifecycle and require early pulverization and re treatment (Concession 24 as an example).

The Township does not appear to have invested in and performed routine maintenance on many of its asphalt roads, adopting a practice of letting the road age to the point of failure and then replacing.

As such, the Township does not have a reliable record of lifecycle costs associated with routine and regular management and maintenance. Staff have therefore sought to obtain comparable costs of various road surfaces to support the following analysis.

Road Management Costs and Lifecycle Costs.

Work completed by the national engineering group, Stantec[1], shows that, based on maintenance costs alone, the costs of gravel and surface treated roads is comparable. When maintenance gravel is applied more frequently, the costs of gravel road maintenance over time, can in-fact be slightly higher, than surface treatment costs.

However, they note that this assumes that the gravel road being considered for upgrade to a surface treated road is in good condition and is well constructed, which, based on their observations is often not the case for Ontario gravel roads.

If a full lifecycle cost analysis is completed, several examples show that when the construction and reconstruction costs are accounted for, surface treated roads are consistently higher cost than gravel.

The City of Kawartha Lakes [2] had a recommendation that high volume gravel roads (200 ADT (Average Daily Traffic) or more vehicles per day) should be considered for surface treatment. In reviewing whether to increase the threshold for surface treatment to 400 cars per day, staff did a lifecycle cost comparison in 2018.

Based on these numbers, staff estimated lifecycle costs on 40km of gravel road over 15 years to be approximately $7.9M.

If surface treated over 15 years, the lifecycle cost increased to $9.6M.

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[1] https://ctep.ca/wp-content/uploads/2017/05/9-Anderson-Cost-Benefits-Surface-Treating-Gravel-Roads.pdf
[2] https://pub-kawarthalakes.escribemeetings.com/filestream.ashx?DocumentId=68813

Kawartha Lakes reflect similar terrain and topography to the Township and similar climate pressures. Staff anticipate that while these costs will have increased substantially since 2018, the cost differential will have remained. There is a broad consensus of opinion that the lifecycle cost of a surface treated road is higher than a gravel road; the benefits of less frequent maintenance operations, is more than outweighed by the higher capital costs and higher costs, though lower frequency, of maintenance activities.

DM Wills Associated limited have done a number of studies from rural municipalities in Ontario (Township of Cramahe[3], Hamilton[4], North Frontenac[5] etc.). In these studies, on a kilometer by kilometer cost estimate, the lifecycle costs of asphalt are around 450% greater than for surface treated roads. (around $25,000 per kilometer on surface treated per year, to $139,000 - $143,000 per year on asphalt).

DM Willis's work also included work on Gravel roads. The costs provided here assumed external forces supplied and applied gravel. The costs varied between $12,000 and $25,000 a kilometer for lifecycle budgeting purposes and assume gravel was reapplied every five years. Based on the 2024 gravel program, the external costs the Township incurred per kilometer of roadway were approximately $8,000 - $10,000 (gravel and calcium chloride) plus equipment and staff time (internal costs). This is reflective of the value of the staff and equipment that the Township has invested in.

It should be noted that the Kawartha study included all maintenance and management operations, including things such as winter maintenance costs; the DM Willis Associates limited studies reflected external costs associated with maintenance activities.

There is a broad consensus of understanding, that gravel roads are the lowest cost road treatment on a per kilometer basis over their lifecycle than other road types, assuming that best management practices are adopted to maintain a road through its lifecycle.

However, there is a balancing act. Gravel roads, while lower cost on a lifecycle basis than other surface types, become increasingly less satisfactory as volume of use increases. With higher volumes of traffic and larger vehicles, the surface of gravel wears

[3] https://www.cramahe.ca/en/resources/4623---Cramahe-2017-RNS---Final.pdf
[4] https://www.hamiltontownship.ca/en/township-office/resources/2020-Budget-Docs/Hamilton-Road-Needs-Study-Final-Report-2020.pdf
[5] https://pub-kawarthalakes.escribemeetings.com/filestream.ashx?DocumentId=68813

more quickly, to the point that regular maintenance becomes less and less effective at maintaining a reasonable driving surface.

There has been significant work undertaken to determining a threshold of vehicle use, beyond which it is unlikely that a maintenance program can maintain a reasonable surface condition on gravel, and therefore the point at which gravel roads therefore become an untenable option.

The broad consensus appears to be that at a daily traffic count in excess of 500 vehicles, maintaining an acceptable travel surface is no longer feasible. Several studies, based in Ontario and further afield, indicate that a reasonable threshold for considering enhancing a gravel road and re-constructing it as a surface treated road is between 200 and 300 vehicles a day, although, as noted, some municipalities have considered higher numbers, such as 400 ADT based on financial modelling. The Inventory Manual for Municipal Roads and Structures (now absorbed into Provincial Specifications) established a 400 average daily traffic count as the threshold for Ontario, beyond which gravel should no longer be considered a reasonable road surface.

In staffs review of literature on the subject, no sources were encountered that recommended enhancing a gravel road to surface treatment or asphalt based on vehicle counts of less than 200 ADT.

The Township has recently completed an average daily count of vehicles across its road network. No gravel road exceeds 200 ADT. Zion Church Road, between Concession 21 and Concession 24 saw the highest ADT with 158 vehicles on average per day. Of 94 gravel road segments measured, only 4 (around 4.2%) segments saw traffic counts of more than 100 per day.

Based on the above review, there is no support for enhancing existing gravel roads by reconstructing as surface treated roads, based on vehicle loads. Further, it is clearly evident that there is no financial benefit to such upgrades.

There are, however, a range of other factors that might influence surface type and may lead to a desire to enhance the service level offered by roads to residents and users. These include things such as:

- Reduced complaints – surface treated roads, when maintained, will attract fewer complaints

- Reduced dead end maintenance by graders may be a consideration; grading equipment requires a larger turning radius and so eliminating the need for graders to turn has some benefits from an efficiency perspective.

- Winter maintenance can be performed at a (slightly) higher rate of speed on surface treated roads over gravel roads (typically) and so maintenance efficiencies might be found over wider networks

- Climate change is also a consideration particularly in respect to increased ice events and their management during winter.

    - Ice on gravel roads is managed using ice blading by graders. On surfaced roads, traction can be addressed with the application of a salt/sand mix.

    - Ice blading is slow compared to salt/sand application.

    - Recent winters have meant that at times, the only way to address rapid ice accumulation has been to deploy sander to gravel roads. The application of sand/salt to gravel is not desirable, but unavoidable at time to maintain the network.

    - Salt dissolves; sand is swept of treated roads in spring; it is retained on gravel roads and is understood to enhance degradation of a gravel surface.

- During summer, dust can be a challenge on gravel roads and can lead to complaints and resident concerns; in wetter weather, dust can create dirt issues

- Potholes are unavoidable on gravel roads and so constant management to address these is needed

- Wildlife and environmental considerations may also be a factor in deciding on road surface types; gravel roads retain heat to a lesser degree and as such may not be as attractive to some wildlife seeking to bask (such as turtles). Wildlife mortality rates increase as speed and traffic volumes increase, so slower less heavily used roads can provide environmental benefits to wildlife. Gravel roads are not treated using salt, and so impacts of salt alongside of gravel roads is much less than with other surface types.

It might be the decision of a municipality to provide surface treated roads, despite the higher lifecycle costs and lack of defined need based on traffic counts, to address resident concerns and offer a higher level of service.

263 surfaced road segments were analysed for the for average daily vehicles counts. These include asphalt, concrete and surface treated. 163 (62%) of these segments had ADTs less than 200, and 98 (37%) had fewer than 100. This shows that the Township does maintain surfaced roads that convey significant less traffic than perhaps supports surfacing, largely as a result of seeking operational efficiencies (noted above).

Most of these surfaced sections of road seeing light use (less than 200) are in developed suburban areas; Sutacriti, Presqu'ile, Brooke, Balmy Beach and in parts of Oxenden. Smaller residential development such as Neerhoff and Mountain Lake also show surfaced residential streets including asphalt, the high initial costs being borne by the developer. Surfacing has also been applied to areas such as the Springmount industrial area and to roads associated to year-round use by aggregate industry vehicles.

Other roads where surface treatment has been applied are roads that carry high traffic volumes. The highest traffic volumes are seen in areas such as Concession 3 and 5 in Derby, Sideroad 6 and the residential streets of Brooke. These roads are frequently seeing 750 ADT or higher, with the highest used roads in the Township experiencing up to 3000 ADT.

Staff recognise that over recent years, roads maintenance has not been as consistent as is ideal and, that as gravel roads require frequent maintenance, the impacts of this lack of consistency are most acutely felt on these roads. It is noted that this same challenge presents itself on surfaced roads, but as the degradation on this can be slower, the impacts are not as noticeable.

The Asset Management Plan is nearing completion, and based on this, Council will inform desired service levels to inform lifecycle costs and longer-term budget priorities can be established. During this process, Council will be able to make decisions around surface and road type and whether a more aggressive approach to road surfacing is warranted and can be financially supported.

Once a defined service level is adopted, it may be appropriate to complete a full Roads Needs Analysis. The Township last undertook a roads needs assessment in 2014, updating this with revised asset inventory and service levels may be prudent. In the meantime, with planned and implemented improvements already in place to address maintenance consistency, staff are not recommending that any existing gravel roads be considered for upgrading to surface treatment.

Financial Impact

None. Report is for information only and financial impacts will be addressed through service level reviews as part of the Asset Management plan and implementation.

Budget associated with a Roads Needs Study will be considered as part of budget setting.

Strategic Priorities

N/A

Conclusion

In spring, 2024, Council asked staff to bring back information on when it becomes cost effective to upgrade a gravel road to a surface treated road. Based on a review of available sources, lifecycle costs of gravel roads are less than for surface treated and asphalt, despite the higher frequency of maintenance activities required. The ability to maintain an effective gravel road surface becomes less with increased traffic volumes and it is generally considered that road surfaces should be enhanced from gravel when daily vehicle counts surpass 200 – 300 and no later than when average daily traffic (ADT) volumes pass 400.

The Township currently has no gravel roads that experience greater traffic volumes than 200 ADT.

The report notes that other factors should be considered when changing the nature of road surfaces and that surface treated roads provide a range of service level enhancements over gravel roads which may influence a decision as to whether an upgrade should be considered.

Respectfully Submitted: Niall Lobley, CAO