THE ASSET MANAGEMENT PLAN FOR THE TOWNSHIP OF ARMSTRONG

2013

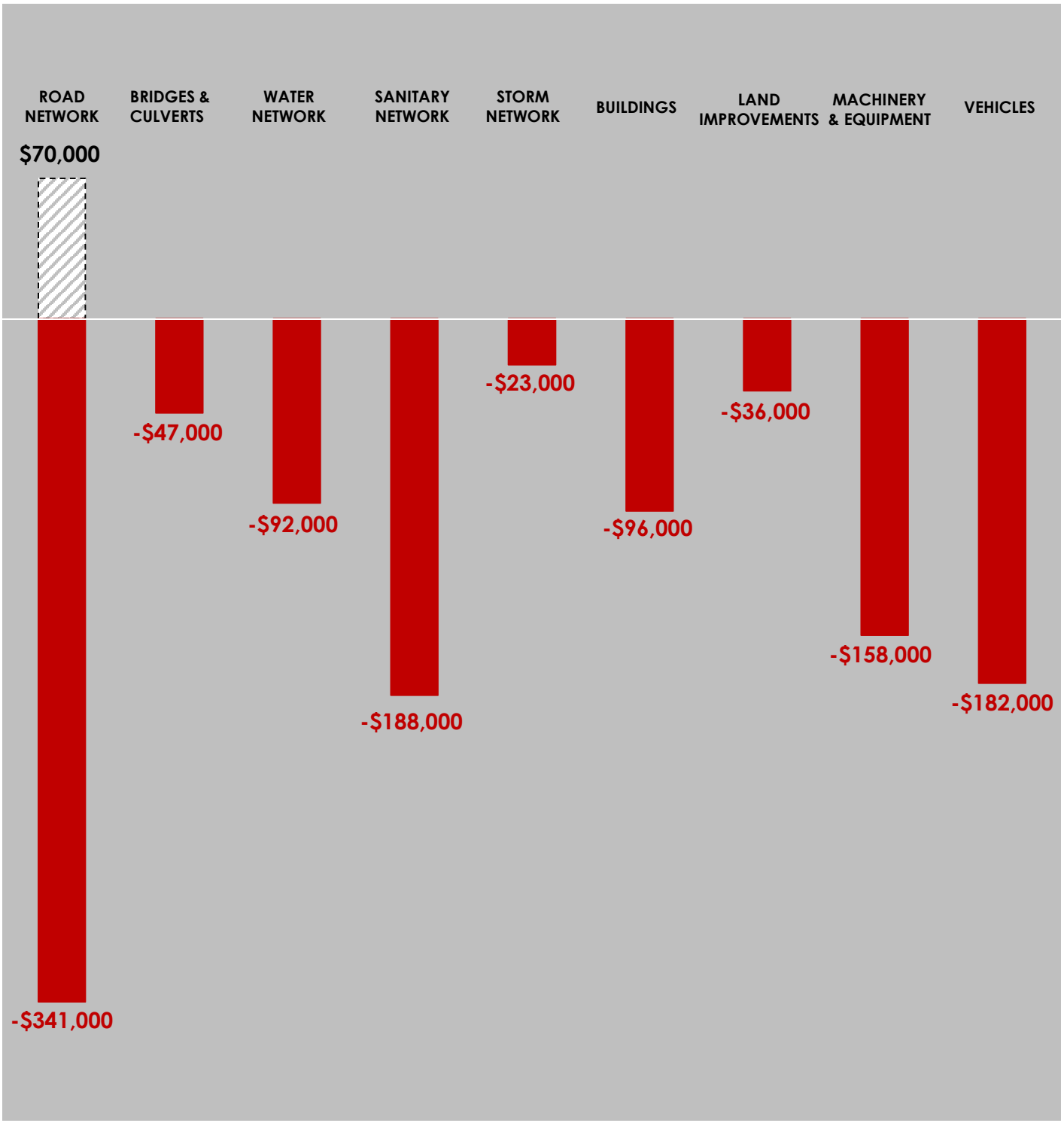
THE TOWNSHIP OF ARMSTRONG
35 10TH STREET
EARLTON, ONTARIO, P0J 1E0

SUBMITTED DECEMBER 2014
BY PUBLIC SECTOR DIGEST
148 FULLARTON STREET, SUITE 1410
LONDON, ONTARIO, N6A 5P3

State of the Infrastructure

The Township of Armstrong

AVERAGE ANNUAL FUNDING REQUIRED **vs.** AVERAGE ANNUAL FUNDING AVAILABLE



Total Annual Deficit: $1,163,000

Annual Funding Available

Annual Funding Deficit

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December 2014

The Township of Armstrong
35 10th Street
Earlton, Ontario, P0J 1E0

We are pleased to submit the 2013 Asset Management Plan (AMP) for The Township of Armstrong. This AMP complies with the requirements as outlined within the provincial *Building Together Guide for Municipal Asset Management Plans.* It will serve as a strategic, tactical, and financial document, ensuring the management of the municipal infrastructure follows sound asset management practices and principles, while optimizing available resources and establishing desired levels of service. Given the broad and profound impact of asset management on the community, and the financial & administrative complexity involved in this ongoing process, we recommend that senior decision-makers from across the organization are actively involved in its implementation.

The performance of a community's infrastructure provides the foundation for its economic development, competitiveness, prosperity, reputation, and the overall quality of life for its residents. As such, we are appreciative of your decision to entrust us with the strategic direction of its infrastructure and asset management planning, and are confident that this AMP will serve as a valuable tool.

Sincerely,
The Public Sector Digest Inc.

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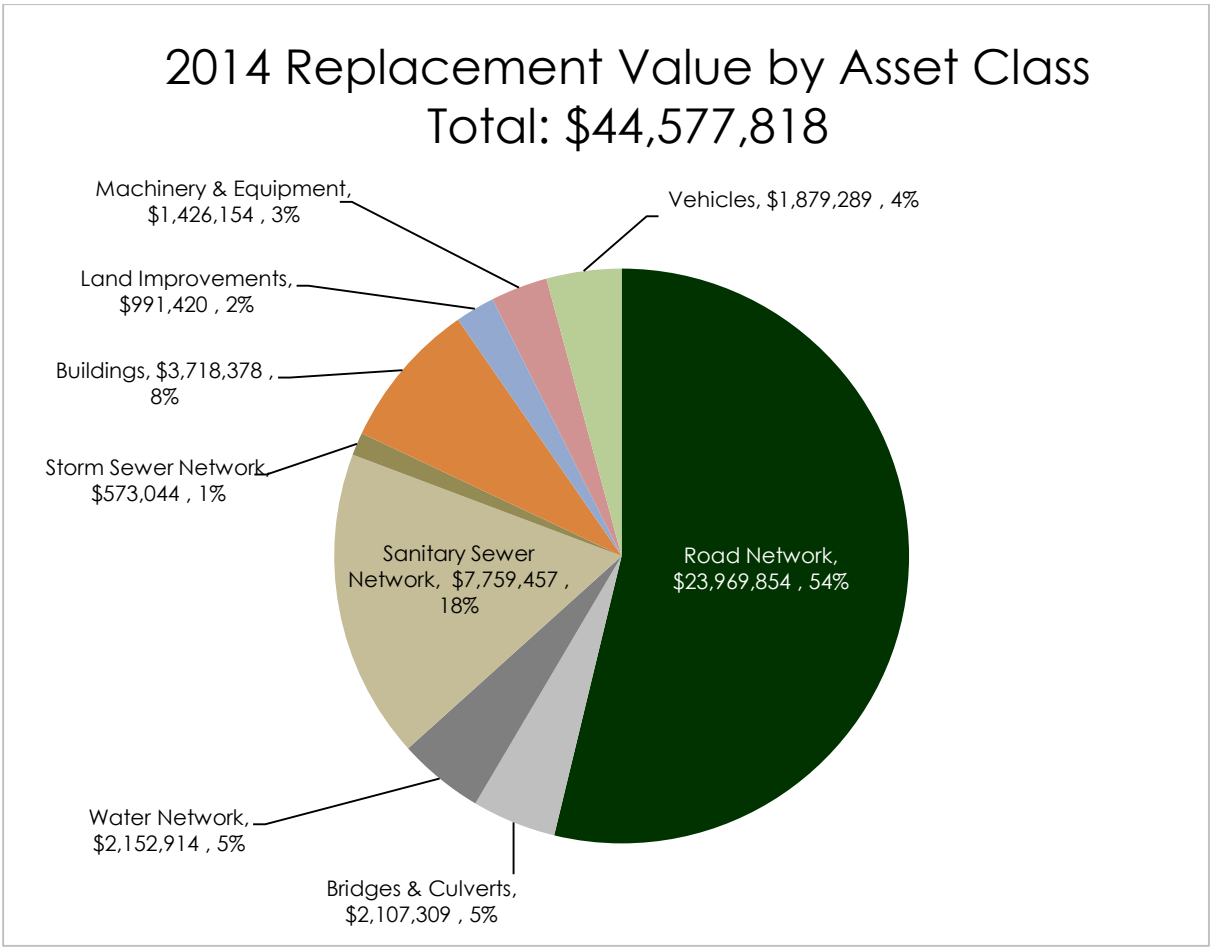
1.0 Executive Summary

The performance of a community's infrastructure provides the foundation for its economic development, competitiveness, prosperity, reputation, and the overall quality of life for its residents. Reliable and well-maintained infrastructure assets are essential for the delivery of critical core services for the citizens of a township.

A technically precise and financially rigorous asset management plan, diligently implemented, will mean that sufficient investments are made to ensure delivery of sustainable infrastructure services to current and future residents. The plan will also indicate the respective financial obligations required to maintain this delivery at established levels of service.

This Asset Management Plan (AMP) for the Township of Armstrong meets all requirements as outlined within the provincial *Building Together Guide for Municipal Asset Management Plans.* It will serve as a strategic, tactical, and financial document, ensuring the management of the municipal infrastructure follows sound asset management practices and principles, while optimizing available resources and establishing desired levels of service. Given the expansive financial and social impact of asset management on both a township, and its citizens, it is critical that senior decision-makers, including department heads as well as the chief executives, are strategically involved.

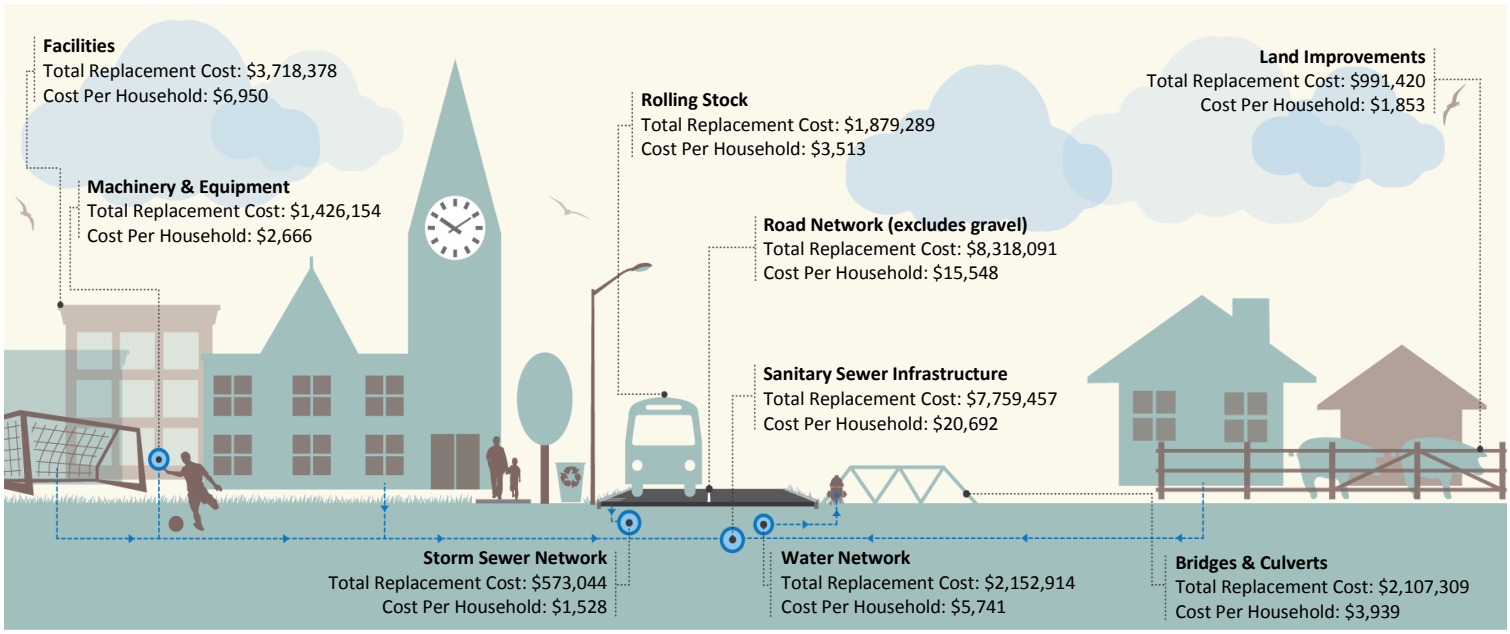
Measured in 2014 dollars, the replacement value of the asset classes analyzed totaled **$44.6 million** for Armstrong.



While the township is responsible for the strategic direction, it is the taxpayer in Armstrong who ultimately bears the financial burden. As such, a 'cost per household' (CPH) analysis was conducted for each of the asset classes to determine the financial obligation of each household in sharing the replacement cost of the township's assets. Such a measurement can serve as an excellent communication tool for both the administration and the council in communicating the importance of asset management to the citizen. The diagram below illustrates the total CPH, as well as the CPH for individual asset classes.

Infrastructure Replacement Cost Per Household

Total: $62,430 per household



In assessing the township's state of the infrastructure, we examined, and graded, both the current condition (Condition vs. Performance) of the asset classes as well as the township's financial capacity to fund the asset's average annual requirement for sustainability (Funding vs. Need). We then generated the township's infrastructure report card. The township received a **cumulative GPA of** '**F**', with an **annual, cumulative infrastructure deficit of $1.2 million**. Armstrong's grades on the Funding vs. Need dimension were consistent, receiving an 'F' across all asset classes.

Based only on age data, the township's grades on the Condition vs. Performance dimension were inconsistent and comparable. Armstrong received its highest grades of 'A' in the bridges & culverts and 'B' in its sanitary sewer network. For the remaining asset classes, its grades varied from a high of 'C+' to a low of 'F'. These grades are indicative of increasing and significant disrepair in the assets. They also signal a potential and substantial financial demand on the township in the near future. For example, based on age data, there is a significant portion of the road network in poor and critical condition, generating a backlog of needs totaling approximately $5.6 million in the next 5 years.

In order for an AMP to be effectively put into action, it must be integrated with financial planning and long-term budgeting. We have developed scenarios that would enable Armstrong to achieve full funding within 5 years or 15 years for the following: tax funded assets, including road network (paved roads), bridges & culverts, storm sewer network, buildings, land improvements, equipment, vehicles and; rate funded assets, including water network, and sanitary sewer network.

The average annual investment requirement for paved roads, bridges & culverts, storm sewers, and its additional general capital categories; buildings, land improvements, equipment, and vehicles is $953,000. Annual revenue currently allocated to these assets for capital purposes is $70,000 leaving an annual deficit of $883,000. To put it another way, these infrastructure categories are currently funded at 7% of their long-term requirements. In 2014, Armstrong Township has annual tax revenues of $1,063,000. Without consideration of any other sources of revenue, full funding would require an annual tax increase of 5.2%. We recommend implementing the increase over 15 years, which involves full funding being achieved by:

a) when realized, reallocating the debt cost reductions of $46,000 to the infrastructure deficit as outlined above.
b) increasing tax revenues by 5.2% each year for the next 15 years solely for the purpose of phasing in full funding to the asset categories covered in this section of the AMP.
c) allocating the $70,000 of gas tax revenue to the paved roads category.
d) increasing existing and future infrastructure budgets by the applicable inflation index on an annual basis in addition to the deficit phase-in.

The average annual investment requirement for sanitary services and water services is $280,000. There are not any annual revenues currently allocated to these assets for capital purposes, leaving an annual deficit of $280,000. To put it another way, these infrastructure categories are currently funded at 0% of their long-term requirements. In 2014, Armstrong Township has annual sanitary revenues of $140,000 and annual water revenues of $272,000. Without consideration of any other sources of revenue, full funding would require a rate increase of 3.7% in sanitary services, and 3.4% increase in water services. We recommend a 10 year option which involves full funding being achieved over 10 years by:

a) when realized, reallocating the debt cost reductions of $136,000 for sanitary services to the applicable infrastructure deficit.
b) increasing rate revenues by 3.7% for sanitary services and 3.4% for water services each year for the next 10 years solely for the purpose of phasing in full funding to the asset categories covered in this section of the AMP.
c) increasing existing and future infrastructure budgets by the applicable inflation index on an annual basis in addition to the deficit phase-in.

The revenue options outlined in this plan allow Armstrong Township to fully fund its long-term infrastructure requirements without further use of debt. However, as explained in sections 7.3.2 and 7.4.2, the recommended condition rating analysis may require otherwise. Although there are no reserves available for use by applicable asset categories during the phase-in period to full funding, the Township of Armstrong's judicious use of debt in the past allows the scenarios to assume that, if required, available debt capacity can be used for high priority and emergency infrastructure investments in the short to medium-term.

2.0 Introduction

This Asset Management Plan meets all provincial requirements as outlined within the Ontario Building Together Guide for Municipal Asset Management Plans. As such, the following key sections and content are included:

1. Executive Summary and Introduction
2. State of the Current Infrastructure
3. Desired Levels of Service
4. Asset Management Strategy
5. Financial Strategy

The following asset classes are addressed:

1. **Road Network:** Urban and rural, paved and gravel
2. **Bridges & Culverts**: Bridges and large culverts with a span greater than 3m
3. **Water Network:** Water mains, valves, hydrants and treatment plant
4. **Sanitary Sewer Network:** Sanitary sewer mains, structures, man holes and pump station
5. **Storm Sewer Network:** Storm sewer mains, catch basins and structures
6. **Buildings:** Administration, airport, cemetery, fire, recreation and storage
7. **Land Improvements:** Fencing and lighting
8. **Vehicles:** Heavy, medium and light duty & rescue vehicles
9. **Equipment:** Miscellaneous capital equipment

Municipalities are encouraged to cover all asset classes in future iterations of the AMP.

This asset management plan will serve as a strategic, tactical, and financial document ensuring the management of the municipal infrastructure follows sound asset management practices and principles, while optimizing available resources and establishing desired levels of service.

At a strategic level, within the State of the Current Infrastructure section, it will identify current and future challenges that should be addressed in order to maintain sustainable infrastructure services on a long-term, life cycle basis.

It will outline a Desired Level of Service (LOS) Framework for each asset category to assist the development and tracking of LOS through performance measures across strategic, financial, tactical, operational, and maintenance activities within the organization.

At a tactical level, within the Asset Management Strategy section, it will develop an implementation process to be applied to the needs-identification and prioritization of renewal, rehabilitation, and maintenance activities, resulting in a 10 year plan that will include growth projections.

At a financial level, within the Financial Strategy section, a strategy will be developed that fully integrates with other sections of this asset management plan, to ensure delivery and optimization of the 10 year infrastructure budget.

Through the development of this plan, all data, analysis, life cycle projections, and budget models will be provided through the Public Sector Digest's CityWide suite of software products. The software and plan will be synchronized, will evolve together, and therefore, will allow for ease of updates, and annual reporting of performance measures and overall results.

This will allow for continuous improvement of the plan and its projections. It is therefore recommended that the plan be revisited and updated on an annual basis, particularly as more detailed information becomes available.

2.1 Importance of Infrastructure

Municipalities throughout Ontario, large and small, own a diverse portfolio of infrastructure assets that in turn provide a varied number of services to their citizens. The infrastructure, in essence, is a conduit for the various public services the township provides, e.g., the roads supply a transportation network service; the water infrastructure supplies a clean drinking water service. A community's prosperity, economic development, competitiveness, image, and overall quality of life are inherently and explicitly tied to the performance of its infrastructure.

2.2 Asset Management Plan (AMP) - Relationship to Strategic Plan

The major benefit of strategic planning is the promotion of strategic thought and action. A strategic plan spells out where an organization wants to go, how it's going to get there, and helps decide how and where to allocate resources, ensuring alignment to the strategic priorities and objectives. It will help identify priorities and guide how municipal tax dollars and revenues are spent into the future.

The strategic plan usually includes a vision and mission statement, and key organizational priorities with alignment to objectives and action plans. Given the growing economic and political significance of infrastructure, the asset management plan will become a central component of most municipal strategic plans, influencing corporate priorities, objectives, and actions.

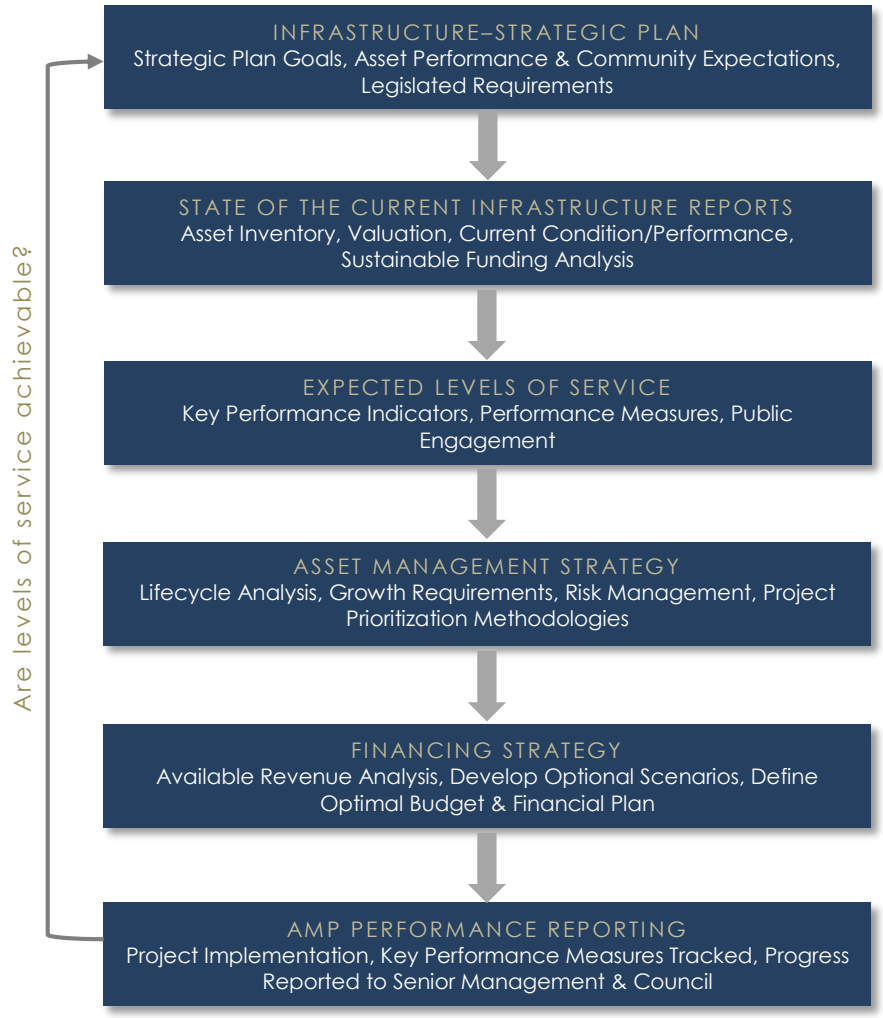
2.3 AMP - Relationship to other Plans

An asset management plan is a key component of the township's planning process linking with multiple other corporate plans and documents. For example:

- **The Official Plan** – The AMP should utilize and influence the land use policy directions for long-term growth and development as provided through the Official Plan.
- **Long Term Financial Plan** – The AMP should both utilize and conversely influence the financial forecasts within the long-term financial plan.
- **Capital Budget** – The decision framework and infrastructure needs identified in the AMP form the basis on which future capital budgets are prepared.
- **Infrastructure Master Plans** – The AMP will utilize goals and projections from infrastructure master plans and in turn will influence future master plan recommendations.
- **By-Laws, standards, and policies** – The AMP will influence and utilize policies and by-laws related to infrastructure management practices and standards.
- **Regulations** – The AMP must recognize and abide by industry and senior government regulations.
- **Business Plans** – The service levels, policies, processes, and budgets defined in the AMP are incorporated into business plans as activity budgets, management strategies, and performance measures.

2.4 Purpose and Methodology

The following diagram depicts the approach and methodology, including the key components and links between those components that embody this asset management plan:



It can be seen from the above that a township's infrastructure planning starts at the corporate level with ties to the strategic plan, alignment to the community's expectations, and compliance with industry and government regulations.

Then, through the State of the Infrastructure analysis, overall asset inventory, valuation, condition and performance are reported. Also, a life cycle analysis of needs for each infrastructure class is conducted. This analysis yields the sustainable funding level, compared against actual current funding levels, and determines whether there is a funding surplus or deficit for each infrastructure program. The overall measure of condition and available funding is finally scored for each asset class and presented as a star rating (similar to the hotel star rating) and a letter grade (A-F) within the Infrastructure Report card.

From the lifecycle analysis above, the township gains an understanding of the level of service provided today for each infrastructure class and the projected level of service for the future. The next section of the AMP provides a framework for a township to develop a Desired Level of Service (or target service level) and develop performance measures to track the year-to-year progress towards this established target level of service.

The Asset Management Strategy then provides a detailed analysis for each infrastructure class. Included in this analysis are best practices and methodologies from within the industry which can guide the overall management of the infrastructure in order to achieve the desired level of service. This section also provides an overview of condition assessment techniques for each asset class; life cycle interventions required, including those interventions that yield the best return on investment; and prioritization techniques, including risk quantification, to determine which priority projects should move forward into the budget first.

The Financing Strategy then fully integrates with the asset management strategy and asset management plan, and provides a financial analysis that optimizes the 10 year infrastructure budget. All revenue sources available are reviewed, such as the tax levy, debt allocations, rates, reserves, grants, gas tax, development charges, etc., and necessary budget allocations are analysed to inform and deliver the infrastructure programs.

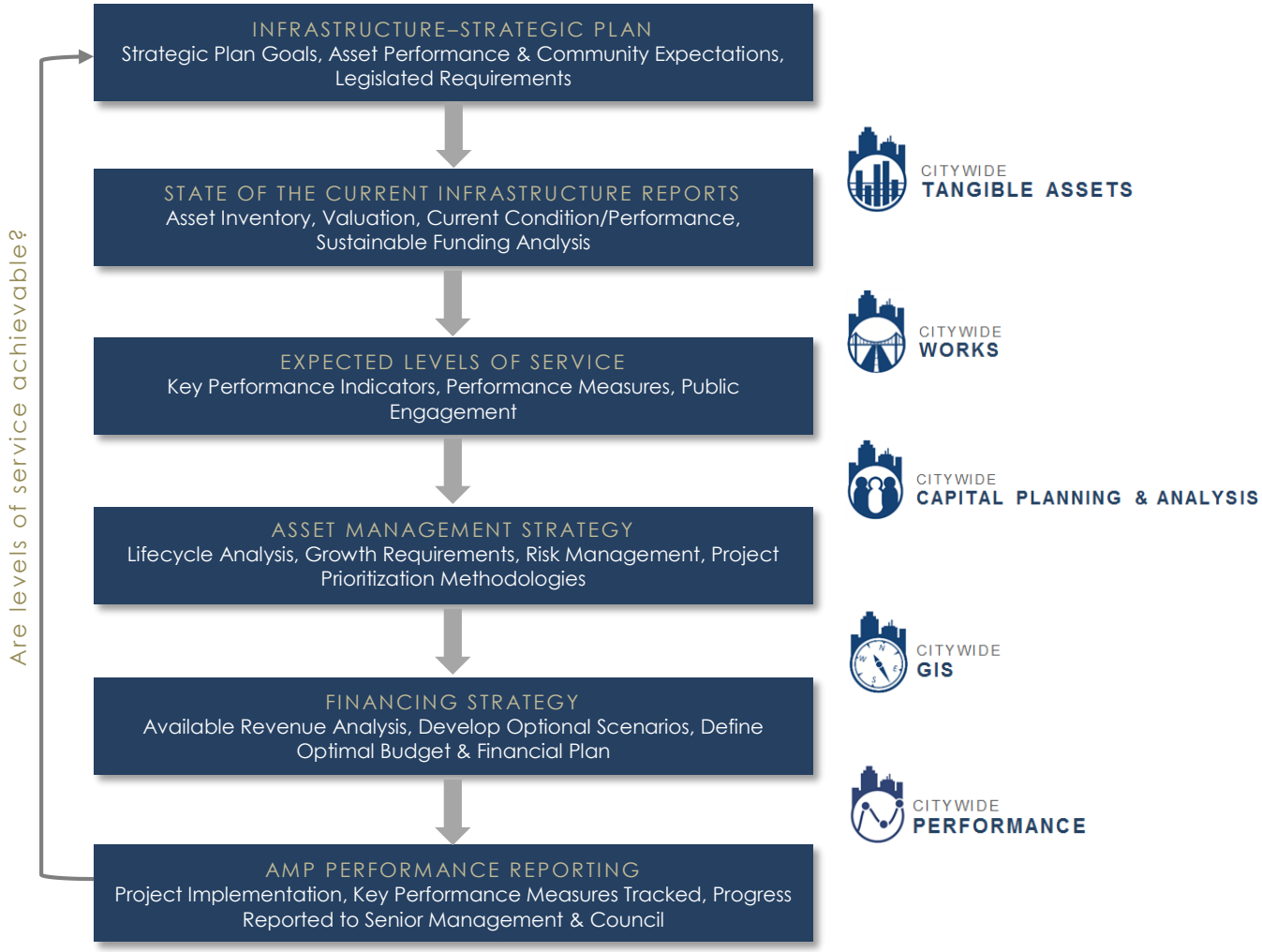
Finally, in subsequent updates to this AMP, actual project implementation will be reviewed and measured through the established performance metrics to quantify whether the desired level of service is achieved or achievable for each infrastructure class. If shortfalls in performance are observed, these will be discussed and alternate financial models or service level target adjustments will be presented.

2.5 CityWide Software alignment with AMP

The plan will be built and developed hand in hand with a database of municipal infrastructure information in the CityWide software suite of products. The software will ultimately contain the township's asset base, valuation information, life cycle activity predictions, costs for activities, sustainability analysis, project prioritization parameters, key performance indicators and targets, 10 year asset management strategy, and the financial plan to deliver the required infrastructure budget.

The software and plan will be synchronized, and will evolve together year-to-year as more detailed information becomes available. This synchronization will allow for ease of updates, modeling and scenario building, and annual reporting of performance measures and results. This will allow for continuous improvement of the plan and its projections. It is therefore recommended that it is revisited and updated on an annual basis.

The following diagram outlines the various CityWide software products and how they align to the various components of the AMP.



3.0 State of the Infrastructure (SOTI)

3.1 Objective and Scope

Objective: To identify the state of the township's infrastructure today and the projected state in the future if current funding levels and management practices remain status quo.

The analysis and subsequent communication tools will outline future asset requirements, will start the development of tactical implementation plans, and ultimately assist the organization to provide cost effective sustainable services to the current and future community.

The approach was based on the following key industry state of the infrastructure documents:

- Canadian Infrastructure Report Card
- City of Hamilton's State of the Infrastructure reports
- Other Ontario Municipal State of the Infrastructure reports

The above reports are themselves based on established principles found within key, industry best practices documents such as:

- The National Guide for Sustainable Municipal Infrastructure (Canada)
- The International Infrastructure Management Manual (Australia / New Zealand)
- American Society of Civil Engineering Manuals (U.S.A.)

Scope: Within this State of the Infrastructure report, a high level review will be undertaken for the following asset classes:

1. **Road Network:** Urban and rural, paved and gravel
2. **Bridges & Culverts**: Bridges and large culverts with a span greater than 3m
3. **Water Network:** Water mains, valves, hydrants and treatment plant
4. **Sanitary Sewer Network:** Sanitary sewer mains, structures, man holes and pump station
5. **Storm Sewer Network:** Storm sewer mains, catch basins and structures
6. **Buildings:** Administration, airport, cemetery, fire, recreation and storage
7. **Land Improvements:** Fencing and lighting
8. **Vehicles:** Heavy, medium and light duty & rescue vehicles
9. **Equipment:** Miscellaneous capital equipment

3.2 Approach

The asset classes above were reviewed at a very high level due to the nature of data and information available. Subsequent detailed reviews of this analysis are recommended on an annual basis, as more detailed conditions assessment information becomes available for each infrastructure program.

3.2.1 Base Data

In order to understand the full inventory of infrastructure assets within Armstrong, all tangible capital asset data, as collected to meet the PSAB 3150 accounting standard, was loaded into the CityWide Tangible Asset™ software module. This data base now provides a detailed and summarized inventory of assets as used throughout the analysis within this report and the entire Asset Management Plan.

3.2.2 Asset Deterioration Review

Without detailed condition assessment information captured holistically across entire asset networks (e.g. the entire road network), the deterioration review will rely on the "straight line" amortization schedule approach provided from the accounting data. Although this approach is not as accurate for full life cycle

analysis as the use of detailed condition data, it does provide a very good benchmark of future requirements. Essentially, as each asset is analyzed individually uncertainty-based inaccuracies tend to balance one another out across the entire asset category. It provides a very good approach for a high level review.

3.2.3 Identify Sustainable Investment Requirements

A gap analysis was performed to identify sustainable investment requirements for each asset category. Information on current spending levels and budgets was acquired from the organization, future investment requirements were calculated, and the gap between the two was identified.

The above analysis is performed by using investment and financial planning models, and life cycle costing analysis, embedded within the CityWide software suite of applications.

3.2.4 Asset Rating Criteria

Each asset category will be rated on two key dimensions:

- **Condition vs. Performance**: Based on the condition of the asset today and how well performs its function.
- **Funding vs. Need**: Based on the actual investment requirements to ensure replacement of the asset at the right time, versus current spending levels for each asset group.

3.2.5 Infrastructure Report Card

The dimensions above will be based on a simple 1–5 star rating system, which will be converted into a letter grading system ranging from A-F. An average of the two ratings will be used to calculate the combined rating for each asset class. The outputs for all municipal assets will be consolidated within the CityWide software to produce one overall Infrastructure Report Card showing the current state of the assets.

Grading Scale: Condition vs. Performance

What is the condition of the asset today and how well does it perform its function?

Star Rating	Letter Grade	Color Indicator	Description
★★★★★	A		**Excellent**: No noticeable defects
★★★★	B		**Good**: Minor deterioration
★★★	C		**Fair**: Deterioration evident, function is affected
★★	D		**Poor**: Serious deterioration. Function is inadequate
★	F		**Critical**: No longer functional. General or complete failure

Grading Scale: Funding vs. Need

Based on the actual investment requirements to ensure replacement of the asset at the right time, versus current spending levels for each asset group.

Star Rating	Letter Grade	Description
★★★★★	A	**Excellent**: 91 to 100% of need
★★★★	B	**Good**: 76 to 90% of need
★★★	C	**Fair**: 61 to 75% of need
★★	D	**Poor**: 46 – 60% of need
★	F	**Critical**: under 45% of need

3.2.6 General Methodology and Reporting Approach

The report will be based on the seven key questions of asset management as outlined within the National Guide for Sustainable Municipal Infrastructure:

- What do you own and where is it? (inventory)
- What is it worth? (valuation / replacement cost)
- What is its condition / remaining service life? (function & performance)
- What needs to be done? (maintain, rehabilitate, replace)
- When do you need to do it? (useful life analysis)
- How much will it cost? (investment requirements)
- How do you ensure sustainability? (long-term financial plan)

The above questions will be answered for each individual asset category in the following report sections.

3.3 Road Network

F	F	F
CONDITION vs. PERFORMANCE GRADE	FUNDING vs. NEED GRADE	INFRASTRUCTURE REPORT CARD GRADE

3.3 Road Network

Note: The financial analysis in this section includes paved roads. Gravel roads are excluded from the capital replacement analysis, as by nature, they require perpetual maintenance activities and funding. However, the gravel roads have been included in the Road Network inventory and replacement value tables. There is also further information regarding gravel roads in section 3.4 "Gravel Roads – Maintenance Requirements" of this AMP.

3.3.1 What do we own?

The following table shows the nature of the road network inventory.

Road Network Inventory

Asset Type	Asset Component	Quantity/Units
Road Network	Road Section - G/S	578,328 m^2
	Road Section - HCB	20,720 m^2
	Road Section - LCB	91,042$m^{2,}$
	Sidewalk	4,200m^2
	Street Light	80.00

The road network data was extracted from the Tangible Capital Asset module of the CityWide software suite.

3.3.2 What is it worth?

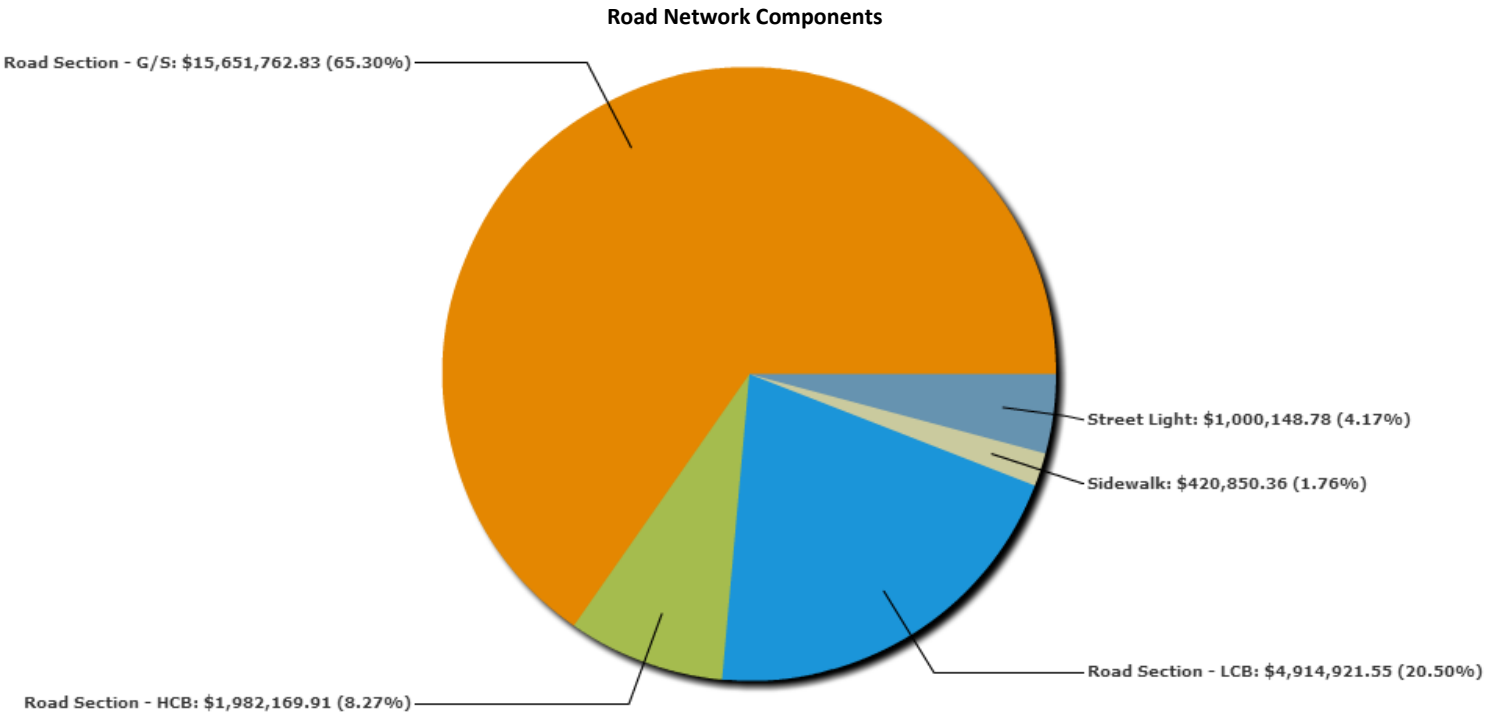
The estimated replacement value of the road network, in 2014 dollars, is approximately $24 million. The cost per household for the road network is $15,548 (excludes gravel) based on 535 households.

Road Network Replacement Value

Asset Type	Asset Component	Quantity/Units	2014 Unit Replacement Cost	2014 Overall Replacement Cost*
Road Network	Road Section - G/S	578,328 m^2	NRBCPI	$15,651,763
	Road Section - HCB	20,720 m^2	NRBCPI	$1,982,170
	Road Section - LCB	91,042$m^{2,}$	NRBCPI	$4,914,922
	Sidewalk	4,200m^2	NRBCPI	$420,850
	Street Light	80.00	NRBCPI	$1,000,149
				$23,969,854

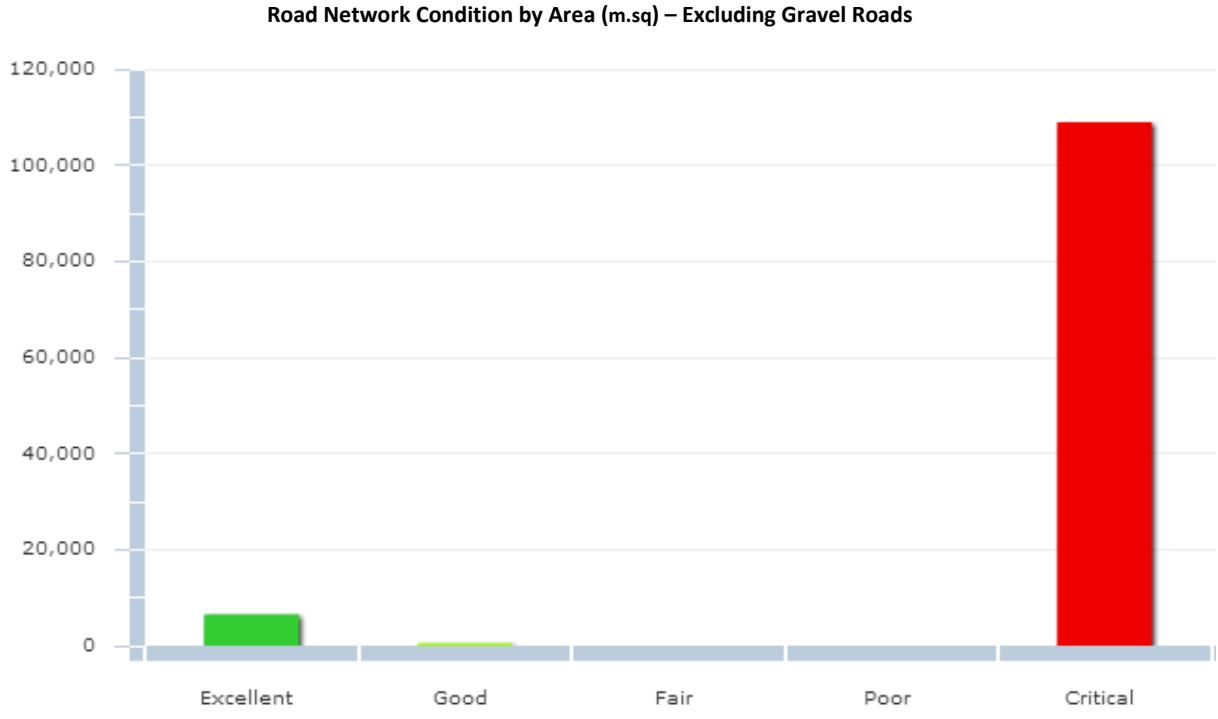
***Note**: Replacement Cost as of 2014-02-28 using NRBCPI inflation measure

The pie chart below provides a breakdown of each of the network components to the overall system value.



3.3.3 What condition is it in?

Based on age analysis only, the majority, 94%, of the township's road network is in critical condition, with the remaining 6% in fair to excellent condition. As such, the township received a Condition vs. Performance rating of 'F'.



3.3.4 What do we need to do to it?

There are generally four distinct phases in an asset's life cycle that require specific types of attention and lifecycle activity. These are presented at a high level for the road network below. Further detail is provided in the "Asset Management Strategy" section of this AMP.

Addressing Asset Needs

Phase	Lifecycle Activity	Asset Life Stage
Minor maintenance	Activities such as inspections, monitoring, sweeping, winter control, etc.	1st Qtr
Major maintenance	Activities such as repairing pot holes, grinding out roadway rutting, and patching sections of road.	2nd Qtr
Rehabilitation	Rehabilitation activities such as asphalt overlays, mill and paves, etc.	3rd Qtr
Replacement	Full road reconstruction	4th Qtr

3.3.5 When do we need to do it?

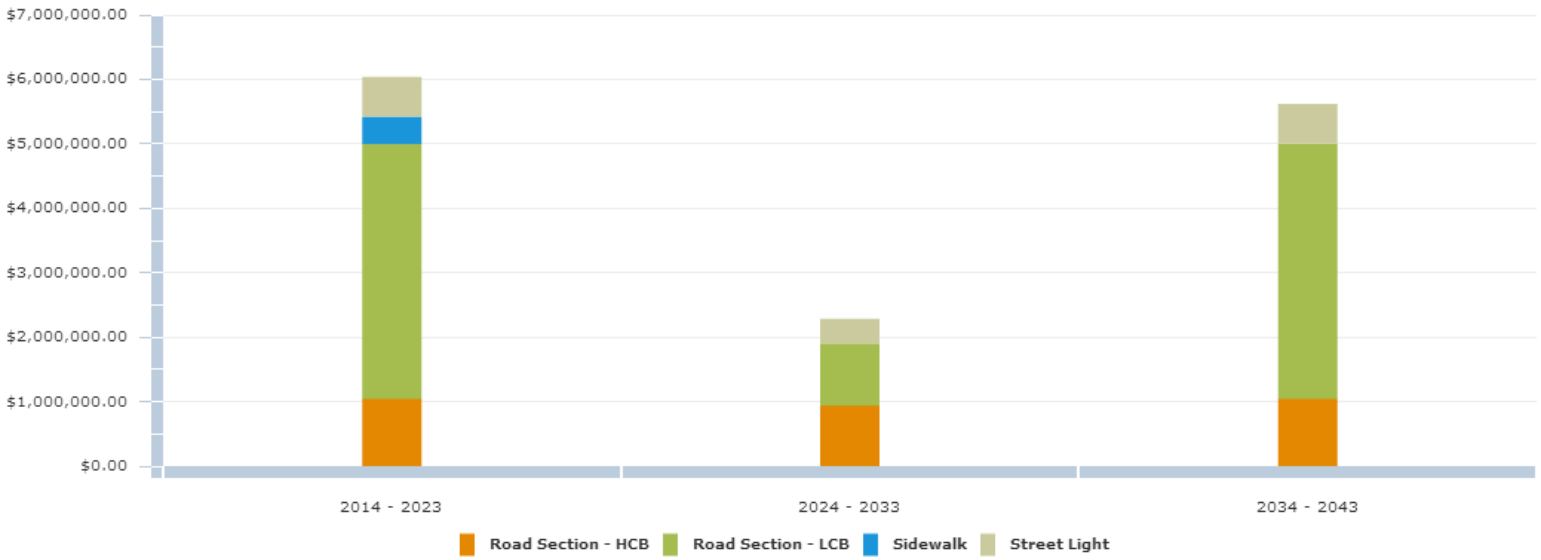
For the purpose of this report, 'useful life' data for each asset class was obtained from the accounting data within the CityWide software database. This proposed useful life is used to determine replacement needs of individual assets. These needs are calculated and quantified in the system as part of the overall financial requirements.

Asset Useful Life in Years

Asset Type	Asset Component	Useful Life
Road Network	Road Section - G/S	10
	Road Section - HCB	20
	Road Section - LCB	20
	Sidewalk	30
	Street Light	20

As additional field condition information becomes available, the data can be loaded into the CityWide system to increase the accuracy of current asset age and, therefore, that of future replacement requirements. The following graph shows the projection of road network replacement costs based on the age of the asset only.

Road Network Replacement Profile (excludes gravel roads)



3.3.6 How much money do we need?

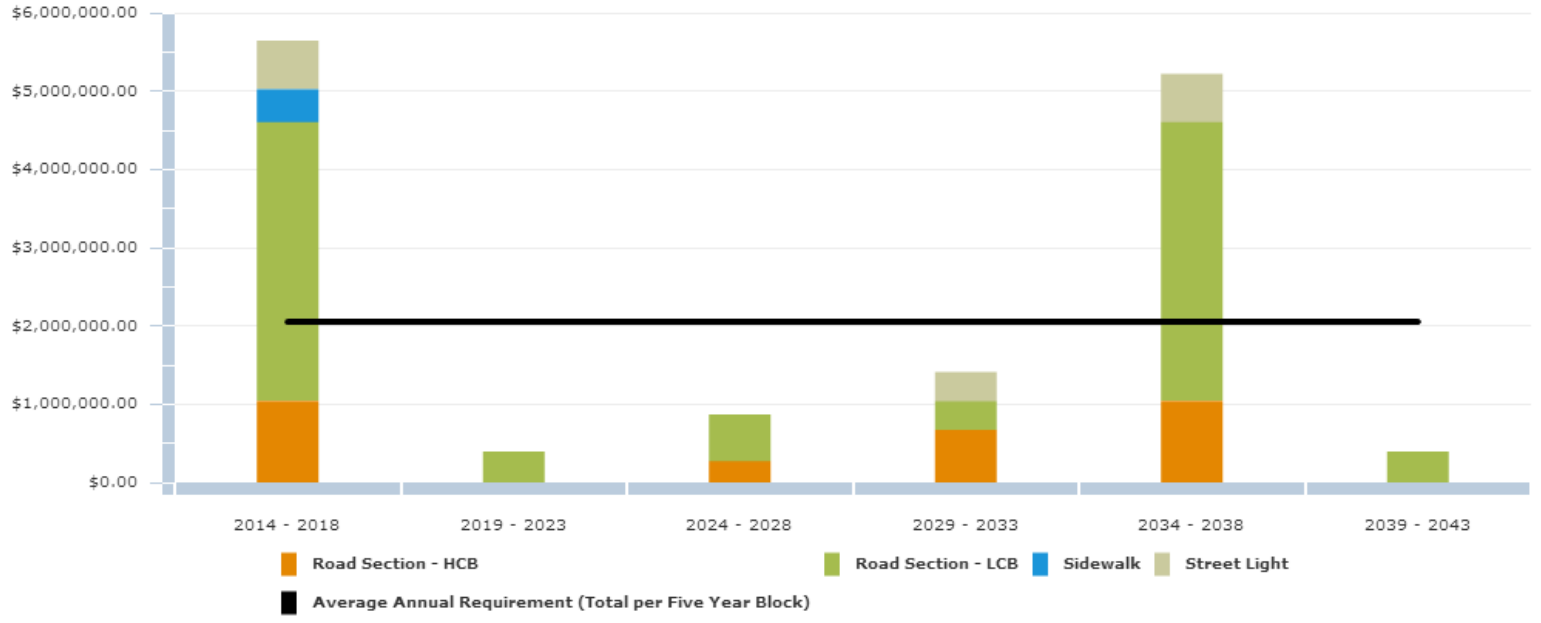
The analysis completed to determine capital revenue requirements was based on the following constraints and assumptions:

1. Replacement costs are based upon the unit costs identified within the "What is it worth" section.
2. The timing for individual road replacement was defined by the replacement year as described in the "When do you need to do it?" section.
3. All values are presented in 2014 dollars.
4. The analysis was run for a 30 year period to ensure all assets went through at least one iteration of replacement, therefore providing a sustainable projection.

3.3.7 How do we reach sustainability?

Based upon the above parameters, the average annual revenue required to sustain Armstrong's paved road network is approximately **$411,000**. Based on Armstrong's current annual funding of **$70,000**, there is an annual **deficit of $341,000**. As such, the township received a Funding vs. Need rating of 'F'. The following graph illustrates the expenditure requirements in five year increments against the sustainable funding threshold line.

Sustainable Funding Requirements per Five Year Block (excludes gravel roads)



In conclusion, based on age analysis only, there is a significant portion of the road network in critical condition, generating a backlog of needs totaling approximately $5.6 million in the next 5 years. It should be noted, however, that the useful life for the roads and sidewalks, as supplied by the Township, appear to be very conservative. Increasing the useful life will reduce the immediate requirements listed above. More importantly, a condition assessment program should be established to aid in prioritizing overall needs for rehabilitation and replacement and to assist with optimizing the long and short term budgets. Further detail is outlined within the "asset management strategy" section of this AMP.

3.3.8 Recommendations

The township received an overall rating of 'F' for its road network, calculated from the Condition vs. Performance and the Funding vs. Need ratings. Accordingly, we recommend the following:

1. A condition assessment program should be established to aid in prioritizing overall needs for rehabilitation and replacement and to assist with optimizing the long and short term budgets.

2. The useful life projections used by the township should be reviewed for consistency with industry standards.

3. As approximately 85% of the township's road network is gravel roads, a detailed study should be undertaken to assess the overall maintenance costs of gravel roads and whether there is benefit to converting some gravel roads to paved , or surface treated roads, thereby reducing future costs. This is further outlined within the "Asset Management Strategy" section of this AMP.

4. Once the above studies are complete or underway, the data should be loaded into the CityWide software and an updated "current state of the infrastructure" analysis should be generated.

5. An appropriate % of asset replacement value should be used for operations and maintenance activities on an annual basis. This should be determined through a detailed analysis of O & M activities and be added to future AMP reporting.

6. The Infrastructure Report Card should be updated on an annual basis.

3.4 Gravel Roads – Maintenance Requirements

3.4.1 Introduction

Paved roads are usually designed and constructed with careful consideration given to the correct shape of the cross section. Once paving is complete the roadway will keep its general shape for the duration of its useful life. Gravel roads are quite different. Many have poor base construction, will be prone to wheel track rutting in wet weather, and traffic will continually displace gravel from the surface to the shoulder area, even the ditch, during wet and dry weather. Maintaining the shape of the road surface and shoulder is essential to ensure proper performance and to provide a sufficient level of service for the public.

Therefore, the management of gravel roads is not through major rehabilitation and replacement, but rather through good perpetual maintenance and some minor rehabilitation which depend on a few basic principles: proper techniques and cycles for grading; the use and upkeep of good surface gravel; and, dust abatement and stabilization.

3.4.2 Maintaining a Good Cross Section

In order to maintain a gravel road properly, a good cross section is required consisting of a crowned driving surface, a shoulder with correct slope, and a ditch. The crown of the road is essential for good drainage. A road with no crown, or insufficient crown, will cause water to collect on the surface during a rainfall, will soften the crust, and ultimately lead to rutting which will become severe if the subgrade also softens. Even if the subgrade remains firm, traffic will cause depressions in the road where water collects and the road will develop potholes. It is a generally accepted industry standard that 1.25cm per 12cm (one foot), approximately 4%, on the cross slope is ideal for road crown.

The road shoulder serves some key functions. It supports the edge of the travelled portion of the roadway, provides a safe area for drivers to regain control of vehicles if they are forced to leave the road, and finally, carries water further away from the road surface. The shoulder should ideally meet the edge of the roadway at the same elevation and then slope away gradually towards the ditch.

The ditch is the most important and common drainage structure for gravel roads. Every effort should be made to maintain a minimal ditch. The ditch should be kept free of obstructions such as eroded soil, vegetation or debris.

3.4.3 Grading Operations

Routine grading is the activity that ensures gravel roadways maintain a good cross section or proper profile. The three key components to good grading are: operating speed, blade angle, and blade pitch.

Excessive operating speed can cause many problems such as inconsistent profile, and blade movement or bouncing that can cut depressions and leave ridges in the road surface. It is generally accepted that grader speed should not exceed 8km per hour. The angle of the blade is also critical for good maintenance and industry standards suggest the optimal angle is between 30 and 45 degrees. Finally, the correct pitch or tilt of the blade is very important. If the blade is pitched back too far, the material will tend to build up in front of the blade and will not fall forward, which mixes the materials, and will move along and discharge at the end of the blade.

3.4.4 Good Surface Gravel

Once the correct shape is established on a roadway and drainage matters are taken care of, attention must be given to the placement of good gravel. Good surface gravel requires a percentage of stone which gives strength to support loads, particularly in wet weather. It also requires a percentage of sand size particles to fill the voids between the stones which provide stability. And finally, a percentage of plastic fines are needed to bind the material together which allows a gravel road to form a crust and shed water. Typical municipal maintenance routines will include activities to ensure a good gravel surface through both spot repairs (often annually) and also re-graveling of roadways (approximately every five years).

3.4.5 Dust Abatement and stabilization

A typical maintenance activity for gravel roads also includes dust abatement and stabilization. All gravel roads will give off dust at some point, although the amount of dust can vary greatly from region to region. The most common treatment to reduce dust is the application of Calcium Chloride, in flake or liquid form, or Magnesium Chloride, generally just in liquid form. Of course, there are other products on the market as well. Calcium and Magnesium Chloride can be very effective if used properly. They are hygroscopic products which draw moisture from the air and keep the road surface constantly damp. In addition to alleviating dust issues, the continual dampness also serves to maintain the loss of fine materials within the gravel surface, which in turn helps maintain road binding and stabilization. A good dust abatement program can actually help waterproof and bind the road, in doing so can reduce gravel loss, and therefore, reduce the frequency of grading.

3.4.6 The Cost of Maintaining Gravel Roads

We conducted an industry review to determine the standard cost for maintaining gravel roads. However, it became apparent that no industry standard exists for either the cost of maintenance or for the frequency at which the maintenance activities should be completed. Presented below, as a guideline only, are two studies on the maintenance costs for gravel roads:

3.4.7 Minnesota Study (2005)

The first study is from the Minnesota Department of Transportation (MnDOT) Local Road Research Board (LRRB), where the researchers looked at historical and estimated cost data from multiple counties in Minnesota.

The study team 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 costs including materials, labour, and hauling totaled $1,400 per year or $67 per visit for the grading 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 annual maintenance cost for gravel roads at $4,160 per mile. This converts to $2,600 per km of roadway and if adjusted for inflation into 2012 dollars, using the Non-Residential Building Construction Price Index (NRBCPI), it would be $3,500.

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

3.4.8 South Dakota study (2004)

This second study was conducted by South Dakota's Department of Transportation (SDDOT). The default maintenance program for gravel roads from SDDOT's report includes grading 50 times per year, re-graveling once every six years, and spot graveling once per year. The unit cost for grading was very similar to Minnesota 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 grading activity and the addition of the spot gravel maintenance, the SDDOT number is higher than Minnesota reported even though the re-gravel activity is reported at about half of the price in Minnesota.

This converts to $4,277 per km of roadway and if adjusted for inflation into 2012 dollars, using the NRBCPI, it would be $5,758.

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

3.4.9 Ontario Municipal Benchmarking Initiative (OMBI)

One of the many metrics tracked through the Ontario Municipal Benchmarking Initiative is the "Operating costs for Unpaved (Loose top) Roads per lane Km." As referenced from the OMBI data dictionary, this includes maintenance activities such as dust suppression, loose top grading, loose top gravelling, spot base repair and wash out repair.

Of the six Ontario municipalities that included 2012 costs for this category, there is a wide variation in the reporting. The highest cost per lane km was $14,900 while the lowest cost was $397. The average cost was $6,300 per lane km. Assuming two lanes per gravel road to match the studies above, the Ontario OMBI average becomes $12,600 per km of roadway.

Summary of Costs

Source	2012 Maintenance Cost per km (adjusted for inflation using NRBCPI)
Minnesota Study	$3,500
South Dakota Study	$5,758
OMBI Average (six municipalities)	$12,600

3.4.10 Conclusion

As discussed above, there are currently no industry standards in regards to the cost of gravel road maintenance and the frequency at which the maintenance activities should be completed. Also, there is no established benchmark cost for the maintenance of a km of gravel road and the numbers presented above will vary significantly due to the level of service or maintenance that's provided (i.e., frequency of grading cycles and re-gravel cycles).

Armstrong currently spends $850,827 (based on 2012 numbers) annually on gravel road maintenance. With a gravel road network of approximately 275 km, the maintenance cost per km of roadway is $3,094. This appears to be slightly less than the typical budget limits as shown above. Of course there are many variables in this analysis, therefore it is recommended that a detailed study be undertaken to establish different cost options associated with different levels of service and that this be included with future updates to this AMP.

3.5 Bridges & Culverts

A	F	D+
CONDITION vs. PERFORMANCE GRADE	FUNDING vs. NEED GRADE	INFRASTRUCTURE REPORT CARD GRADE

3.5 Bridges & Culverts

3.5.1 What do we own?

As shown in the summary table below, the township owns 3 bridges and 1 large culverts.

Bridges & Culverts Inventory

Asset Type	Asset Component	Quantity	Units
Bridges & Culverts	Bridge	3	695.72m^2
	Culvert	2	121.92m

The bridges & culverts data was extracted from the Tangible Capital Asset module of the CityWide software suite.

3.5.2 What is it worth?

The estimated replacement value of the township's bridges & culverts, in 2014 dollars, is approximately $51 million. The cost per household for bridges & culverts is $14,732 based on 3,490 households.

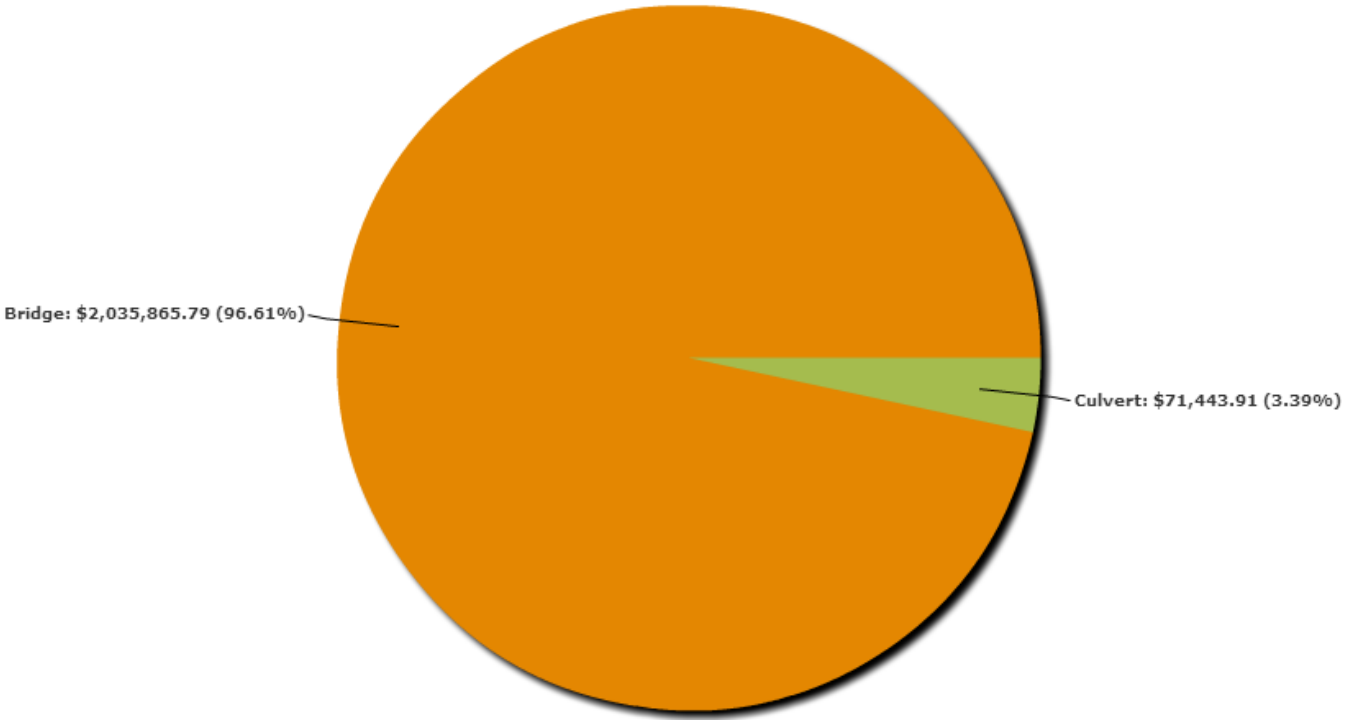
Bridges & Culverts Replacement Value

Asset Type	Asset Component	Quantity	Units	2014 Unit Replacement Cost	2014 Overall Replacement Cost*
Bridges & Culverts	Bridge	3	695.72m^2	NRBCPI	$2,035,866
	Culvert	2	121.92m	NRBCPI	$71,444
					$2,107,309

***Note**: Replacement Cost as of 2014-02-28 using NRBCPI inflation measure

The pie chart below provides a breakdown of each of the bridges & culverts components to the overall structures value.

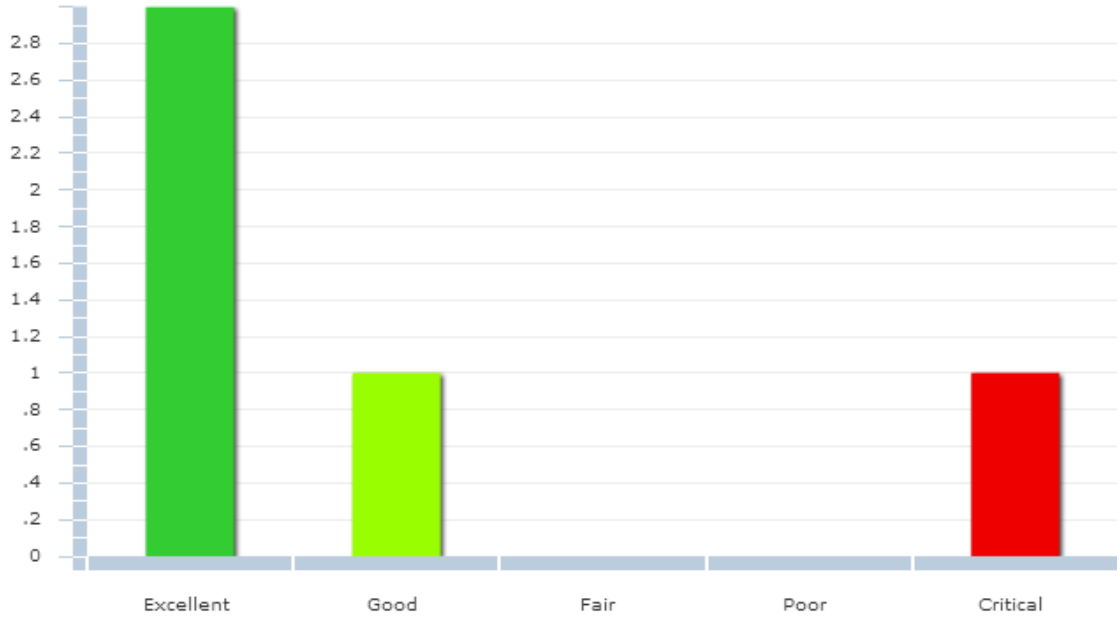
Bridges & Culverts Components – Based on Replacement Cost



3.5.3 What condition is it in?

Based on age analysis only, 80% of the township's bridges & culverts are in good to excellent condition, with the remaining 20% in critical condition. As such, the township received a Condition vs. Performance rating of 'A'.

Bridge & Culvert Condition by Quantity



3.5.4 What do we need to do to it?

There are generally four distinct phases in an asset's life cycle. These are presented at a high level for the bridge and culvert structures below. Further detail is provided in the "Asset Management Strategy" section of this AMP.

Addressing Asset Needs

Phase	Lifecycle Activity	Asset Life Stage
Minor Maintenance	Activities such as inspections, monitoring, sweeping, winter control, etc.	1st Qtr
Major Maintenance	Activities such as repairs to cracked or spalled concrete, damaged expansion joints, bent or damaged railings, etc.	2nd Qtr
Rehabilitation	Rehabilitation events such as structural reinforcement of structural elements, deck replacements, etc.	3rd Qtr
Replacement	Full structure reconstruction	4th Qtr

3.5.5 When do we need to do it?

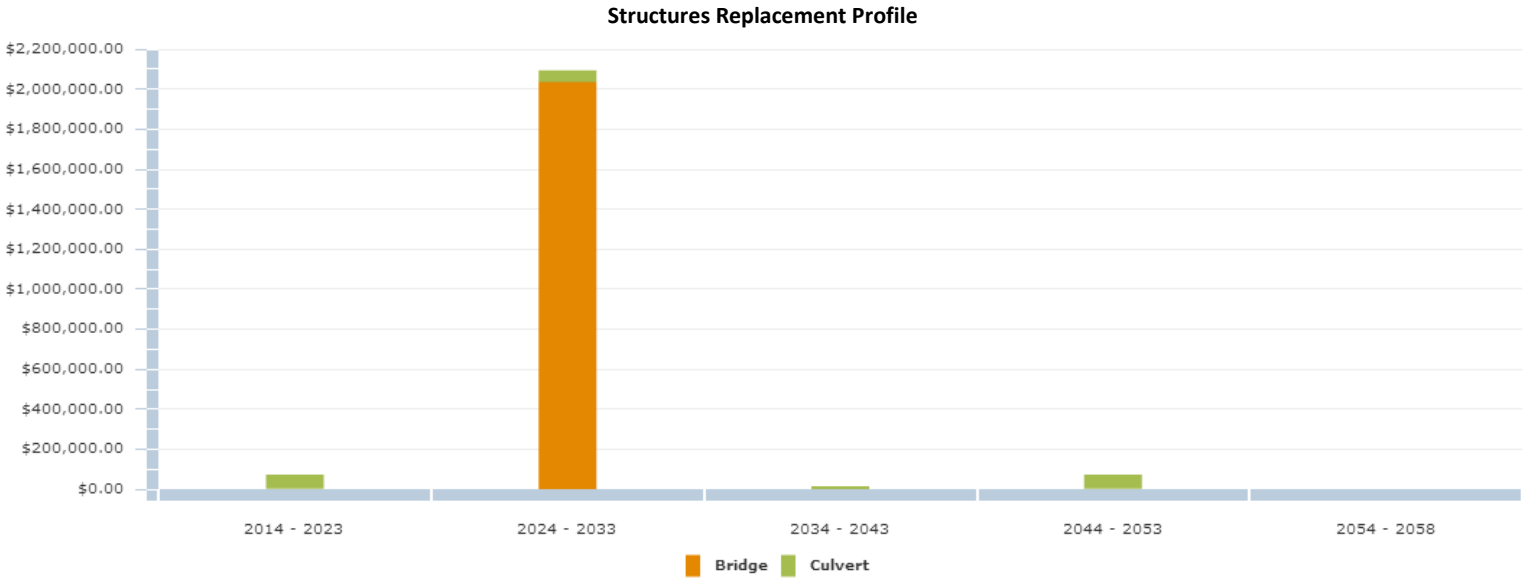
For the purpose of this report, 'useful life' data for each asset class was obtained from the accounting data within the CityWide software database. This proposed useful life is used to determine replacement needs of individual assets, which are calculated in the system as part of the overall financial requirements.

Asset Useful Life in Years

Asset Type	Asset Component	Useful Life in Years
Bridges & Culverts	Bridge	45
	Culvert	12, 15

As additional field condition information becomes available, the data can be loaded into the CityWide system to increase the accuracy of current asset age and, therefore, that of future replacement requirements. The following graph shows the projection of road network replacement costs based on the age of the asset only.

The following graph shows the current projection of structure replacements based on the age of the asset only.



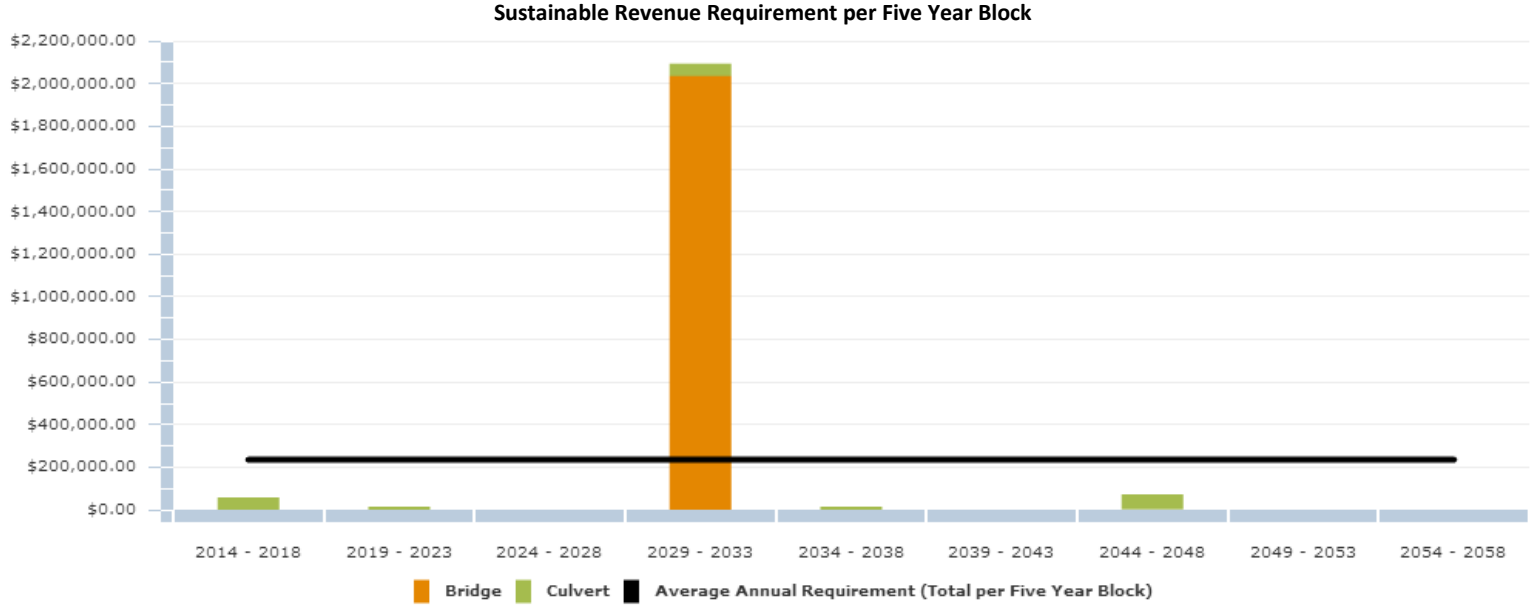
3.5.6 How much money do we need?

The analysis completed to determine capital revenue requirements was based on the following constraints and assumptions:

1. Replacement costs are based upon the "What is it worth" section above.
2. The timing for individual structure replacement was defined by the replacement year as described in the "When do you need to do it?" section above.
3. All values are presented in 2014 dollars.
4. The analysis was run for a 45 year period to ensure all assets cycled through at least one iteration of replacement, therefore providing a sustainable projection.

3.5.7 How do we reach sustainability?

Based upon the above assumptions, the average annual revenue required to sustain Armstrong's bridges & culverts is **$47,000**. Based on Armstrong's current annual funding of **$0**, there is an annual **deficit of $47,000**. As such, the township received a Funding vs. Need rating of 'F'. The following graph presents five year blocks of expenditure requirements against the sustainable funding threshold line.



In conclusion, based on age data only, the majority of bridges and large structures are in good to excellent condition. However, there are needs to be addressed within the next 5 years totaling approximately $58 thousand. A condition assessment program should be established, or current condition data should be loaded into the CityWide system, to aid in prioritizing overall needs for rehabilitation and replacement and to assist with optimizing the long and short term budgets. Further detail is outlined within the "asset management strategy" section of this AMP.

It should also be noted, within the detailed 10 year infrastructure plan, the Township has identified culvert replacements, at a cost of $315,000, as a priority project.

3.5.8 Recommendations

The township received an overall rating of 'D+' for its bridges & culverts, calculated from the Condition vs. Performance and the Funding vs. Need ratings. Accordingly, we recommend the following:

1. A condition assessment program should be established, or current condition data should be loaded into the CityWide system, to aid in prioritizing overall needs for rehabilitation and replacement and to assist with optimizing the long and short term budgets.

2. An appropriate % of asset replacement value should be used for operations and maintenance activities on an annual basis. This should be determined through a detailed analysis of O & M activities and added to future AMP reporting.

3. The Infrastructure Report Card should be updated on an annual basis.