Appendix D

LAS Roads Assessment Service

Roads Asset Management Plan

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Contents

1. Copyright Statement

The preparation of this project was carried out with assistance from the Government of Canada and the Federation of Canadian Municipalities. Notwithstanding this support, the views expressed are the personal views of the authors, and the Federation of Canadian Municipalities and the Government of Canada accept no responsibility for them.

2. Executive Summary

StreetScan was contracted by the Town of Kingsville to assess the conditions of 230.0 centerline kilometers of Town-maintained roads. This final report is a comprehensive account of the project scope and schedule, StreetScan's methodology, and StreetScan's findings in the Town.

StreetScan utilized specialized ScanVan vehicles to assess the condition of roadways in Kingsville. Each ScanVan is outfitted with an array of sensors that includes 2D and 3D cameras. Data collected from the sensors is processed to identify specific road distresses and an overall condition rating for each road segment known as the Pavement Condition Index (PCI). PCI is an ASTM (American Society for Testing and Materials) standard that ranges from 0 to 100, where 0 is the worst possible road condition and 100 is the best. StreetScan developed a Town-wide inventory of road condition and provided the location of potholes and metal features detected in the roadway from the distress data collected.

Maintenance and Repair Suggestions and estimated costs for repair were provided to the Town. These items were based on custom input of road repair preferences and estimated costs unique to the Town. The road condition report and these custom inputs are used to generate Pavement Management plans that the Town can use to make data-driven road repair decisions.

StreetScan delivered the road condition and maintenance and repair suggestion information to the Town via a secure GIS web portal, PaveMON. Kingsville can use PaveMON to visualize and export the information, as well as to adjust parameters and modify or generate new repair work plans. PaveMON also allows visualization of PCI values, imagery for each road and detected features (e.g. potholes, metal), statistics, and more. Staff can access PaveMON quickly from anywhere with any computer, provided there is an internet connection. No downloads or installation needed.

Additionally, the rear images were also made available in PaveMON. Portal training was conducted, and continued training and support is available to the Town.

The following report will review the condition rating system, field assessment, and processing methodology utilized in the Town's Pavement Condition Assessment survey. Kingsville's roads were rated in 'fair' condition at an average PCI of 68.8, with 86.6% of roads above a critical PCI of 55. Only 4.7% of roads were rated as 'very poor' or 'failed'. The estimated cost to repair the entire road network at once to an average PCI of 85 or greater is **$25,349,144.** An overview of current conditions, maintenance and repair suggestions, and projections is provided.

The StreetScan solution emphasizes the ability of the end-user to perform in-depth analysis with multiple filters and adjustable variables. A Town can pursue an analysis at any time on multiple devices with multiple users utilizing the StreetScan web-based software. Some examples and a discussion of this are provided at the end of the report.

3. Condition Rating

StreetScan collected road distress data that was used to calculate a Pavement Condition Index (PCI) for each road segment in the Town. PCI, a road condition standard set by ASTM (American Society of Testing and Materials), is a value that ranges from 0 to 100, where 0 is the worst possible condition and 100 is the best. Towns use PCI to aid in determining the repairs needed for their roads. Typically, a decision tree is established that uses PCI and possibly additional factors. For a given road, the PCI and other factors are plugged into the decision tree and the output is a suggested repair action. Table 1 gives a summary of the Pavement Condition Rating with types of distresses, approximate percentage of segment covered by distresses, and suggested repair/maintenance method that correlates with the PCI range.

Table 1. Pavement Condition Index Summary

PCI Label	PCI range	Description of distresses	Approx. % of segment covered by distresses	Suggested maintenance
Excellent	85-100	No major distresses. Possibly some crack seal in place.	0-5%	No maintenance required.
Good	70-85	Recent crack seal starting to fail, longitudinal + transverse cracks, some recent and clean patches.	5-10%	Preventive maintenance, including patches, crack seal, chip seal, slurry seal, or micro surface.
Fair	55-70	Moderate to severe block cracking, alligator cracking, potholes, and aging patches.	10-25%	Mill and overlay at depths ranging 1-2”.
Poor	40-55	Increased quantity of alligator cracking, block cracking, potholes, and patches.	25-50%	Mill and overlay at depths ranging 2-4”.
Very Poor	20-40	Severe alligator cracking. Failed patches, large quantity of deep and/or wide potholes.	50-75%	Reconstruction of street is required.
Failed	0-20	Ride quality is severely affected by deep and dense potholes, failed patches, and alligator cracking.	75-100%	Reconstruction of street required, replacement of base.

4. Field Assessment Methodology

StreetScan utilized our custom ScanVan system, which allows for rapid data collection without the need to close roads, so data collection can proceed at the given speed limit. The ScanVan utilizes 3D imaging sensors combined with optical cameras. Surface distresses are identified using data from the 3D imaging sensors. A combination of features extracted from the 3D imaging sensors are used to identify distresses in the roadway which impact the PCI rating, generating a data-driven PCI conditions inventory for assessed road segments.

5. Summary of Field Assessment

StreetScan performed field assessments for the Town of Kingsville between September 16 – September 18. Three total field days culminating in 24 total driving hours were needed to assess the 230.0 centerline kilometers maintained by the Town.

6. StreetScan ScanVan Solution

StreetScan's ScanVan system was used to identify distresses in the roadway which impact the PCI rating. Distresses are extracted from the 3D imaging sensors. These distresses include cracking features, surface texture features, pothole features and bump and depression features.

Figure 1. ScanVan

6.1. 3D Imaging Sensors

StreetScan uses 3D imaging sensors to create a 3D measurement of the road surface. The sensors cover an area of 3m wide x 1m in length with each measurement, with data collection triggered at 1m intervals. The 3D surface data created by the sensors includes various extracted distress types:

- Cracking Features
- Bumps & Depressions Features
- Potholes Feature
- Surface Texture Features

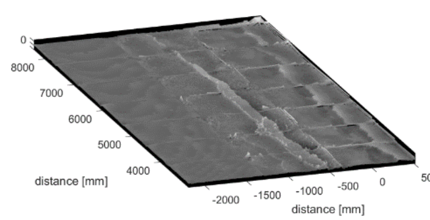

Figure 2. Sample 3D road surface measurement

6.2. Camera (Optical)

Two high-resolution camera systems are installed on the StreetScan ScanVan: a surface (pavement) facing camera and front facing camera. The imagery from these cameras are used in the QC (Quality Control) process to verify the predicted PCI values. In addition, other asset information can be extracted from the images from these camera systems and provided to the customer; such as pavement markings, manhole locations and road sign inventory.

Front Camera View

Surface Camera View

Figure 3. Sample front and rear camera images

7. Data Processing Methodology

The collected data is uploaded to the StreetScan server at the conclusion of data collection. Using advanced processing algorithms, measurements for the following features are extracted:

- Cracking Features
- Bumps & Depressions Features
- Potholes Feature
- Surface Texture Features

For each feature a severity and density are calculated. The features are then combined into the StreetScan PCI algorithm and a pavement condition estimate measurement is calculated for each road segment in the network. After a PCI estimate is calculated, each estimate is verified using video which is created from the optical camera systems. A QC technician can then adjust the PCI estimate if there is an apparent discrepancy between the estimated PCI and what the imagery shows. Typical reasons that the PCI estimate is adjusted is due to insufficient data (road segment too small, usually less than 10m) or if there is excessive foreign debris on the road surface, such as leaves.

8. StreetScan Pavement Management Technology

After collecting condition data and applying algorithms to compute the PCI, StreetScan inputs this information into a unique combination of decision trees and mathematical models to develop a Pavement Management Technology (PMT) system for the Town. The output from these models informs users what repairs are optimal and how to prioritize them in the most cost-effective manner. Kingsville provided preferred repair methods and unique costs. Details of the StreetScan Pavement Management methodology are provided over two subsections. Repairs focus on the StreetScan methodology for determining the optimal repair. Prioritization discusses how StreetScan prioritize repairs within budgetary constraints to optimize repair suggestions.

8.1. Repairs

StreetScan assigns each street segment into one of four categories based on PCI value. These include reconstruction, rehabilitation, preventive, and defer maintenance. These categories, including a description of distresses present along with example repair methods are summarized below in Table 2.

Table 2. Repair Categories

PCI Range	Category	Description	Examples
< 40	Reconstruction	Pavement has endured significant structural damage and a full reconstruction is required to restore the condition.	Reclamation, full depth reconstruction, major mill and overlay
40-70	Rehabilitation	Pavement needs some form of resurfacing to mitigate the effects of rutting, cracking, and other distresses.	Hot-mix overlay, mill and overlay, hot-in-place recycling, hi-float chip seal
70-85	Preventive	Pavement is in the early stages of its life-cycle. This is when repairs are cheapest, fastest, and have the greatest long-term benefit.	crack seal, joint seal, microsurfacing, slurry sealing, chip seal
> 85	Defer Repair	Pavement is in good condition and does not require maintenance.	NA

8.2. Prioritization

StreetScan Pavement Management system was designed to be highly customizable to the user preference, which is reflected in road repair priority. For Kingsville, repair suggestions were based on a priority matrix which included StreetScan's Pavement Management data and Town data such as functional road classification. The overall condition of each road segment is used to develop a benefit (condition change and life extension) to cost ratio for a suggested repair. Combined with expected available budget a priority ranking is developed. This is provided to the Town in the web portal and is used to develop Pavement Management scenarios in the Budget Projection module.

9. Condition Findings and Report Summary

StreetScan finalized and delivered the results of the pavement condition survey in the Town of Kingsville via the custom web portal provided to the Town. A brief summary of findings can be seen below. This includes a Summary of Conditions, and an overview of the Pavement Management plan. Additionally, a set of projections based on suggested repairs, expected budgets, and projected deterioration, is provided. A full set of road segment conditions and maintenance/repair suggestions (including costs) is provided in the Road Conditions Assessment report.

9.1. Summary of Conditions – Key Findings

StreetScan determined that the road network in Kingsville has an average PCI of 68.6. Of these roads, 86.6% of the roads were above a critical PCI of 55. This means that the majority of Town-owned roads are not in need of total replacement. 51.6% of Town-owned roads (118.7 centerline KM) were found to be a in a "good" or better condition (PCI > 70). StreetScan found that 35.0% of Town owned roads (80.4

centerline KM) were in a “fair” (PCI 70 – 56) condition, 8.7% of roads (20.1 centreline KM) were in “poor” (PCI 55 – 41) condition, with 4.7% of roads (10.8 centerline KM) were found to be in a “very poor” or “failed” condition (PCI < 41).

Table 3. Key findings of StreetScan PMT– PCI distribution

PCI Label	PCI Range	Centerline KM	%
Failed	0-25	0.4	0.2
Very Poor	26-40	10.4	4.5
Poor	41-55	20.1	8.7
Fair	56-70	80.4	35.0
Good	71-85	88.3	38.4
Excellent	86-100	30.4	13.2
	Totals	230.0	100

10. Pavement Management Plan Implementation

For the Town to repair the entire road network to full health in one calendar year up to 85 PCI would require **$25,349,144**. Due to limited resources, towns and cities are unable to repair all roads at once. To prioritize road repair decisions, StreetScan provides a priority ranking for each road assessed. To determine road repair priority, StreetScan relied on custom inputs from Kingsville for repair methods, cost, and functional classification. Preferred road repair type and cost is summarized in Table 4.

Table 4. Preferred Repair Methods + Costs

Repair Method	Description	Life Extension	Unit Cost
Preventive Maintenance	Includes crack seal. Crack seal products are used to fill individual pavement cracks to prevent entry of water or other non-compressible substances such as sand, dirt, rocks or weeds. Crack filler material is typically some form of rubberized asphalt or sand slurry.	5-8 years (Crack Seal) [All Roads]	$5 per sq. m (Crack Seal) [All Roads]
Rehabilitation	Includes mill & overlay and tar & chip projects. Mill and overlay is the removal of a small thickness (~ 2 inches) of existing asphalt concrete prior to placing a surface treatment. Tar and Chip is applied to dirt, or black top surfaces. The method applies a coating of hot liquid asphalt followed	12-15 years (Mill & Overlay) [Asphalt Roads] 5-8 years (Tar & Chip) [Surface Treated Roads]	$45 per sq. m (Mill & Overlay) [Asphalt Roads] $7 per sq. m (Tar & Chip) [Surface Treated Roads]

	by a layer of 3/8" chip rock which is then rolled to compaction.		
Reclamation	Reclamation is an in-place recycling method for reconstruction of existing flexible pavements using the existing pavement section material as the base for the new roadway-wearing surface.	17-20 years (Full-Depth Reconstruction)	\$150 per sq. m (Full-Depth Reconstruction) [Asphalt Roads] \$52 per sq. m (Full-Depth Reconstruction) [Surface Treated Roads]

The first column in Table 4 provides the name of the repair method. The second column provides a description of the repair. The third column provides the number of years that the repair is expected to extend the life of a roadway if it is applied. Lastly, the fourth column gives the unit cost for the repair, which was provided by Kingsville staff based on historic unit costs.

StreetScan utilizes a decision tree to determine which repair from Table 4 to suggest for each road. The decision tree was tailored to the Town's needs based on communications between StreetScan and Town staff. StreetScan provides a cost estimate for each repair suggestion based on unit costs that were provided to StreetScan by the Town. Note that the unit costs used for recommendations are shown in Table 4.

10.1. Repair Prioritization and Work Plans

In addition to repair suggestions and cost estimates, StreetScan's PaveMON software prioritizes road repairs and allows the Town to develop work plans. To accomplish these items, a version of the prioritization equation shown in Eq. 1 is used.

$$PCI(W_{PCI}) + AADT(W_{AADT}) + A(W_A) + J(W_J) + BCR(W_{BCR}) = Priority \quad (1)$$

Where PCI is the PCI of the road. $AADT$ is the average annual daily traffic of the road. Since AADT is not available for Kingsville, traffic volumes are assigned by roadway functional classification, as defined by the Ontario Roads Network. A is the age of the road. J is the jurisdiction of the road (e.g. province, city, private, etc.). BCR is the benefit-to-cost ratio of repairing the road, where benefit is the life extension from Table 4 and costs are calculated using the unit costs also provided in Table 4. All of the W variables are the weights (i.e. W_{PCI}, W_{AADT}, W_A, W_J, W_{BCR}). The weights can be adjusted to give certain factors more of an impact. For example, if a city believes that prioritizations should be based solely on PCI, then W_{PCI} could be set to 1 and all other weights could be set to 0. Note that this is not the recommended strategy. The output from Eq. 1 is a priority value for the road. The value can be compared against priority values for all other roads to determine an optimal repair work plan.

To determine repair work plans that span multiple years, StreetScan must forecast PCIs and develop deterioration curves. An example deterioration curve is shown below.

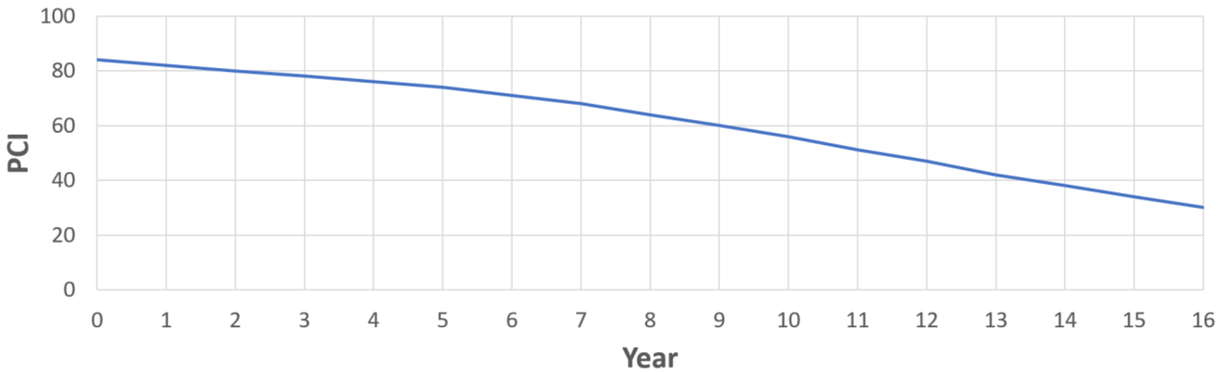

Figure 4. Example deterioration curve

StreetScan utilizes a deterioration model to forecast PCIs and generate deterioration curves. Among the factors considered by the deterioration model are: road age, freezing index (degree-days when air temperatures are below and above zero), cooling index (temperature relation to the relative humidity and discomfort), freeze-thaw cycles, precipitation, equivalent single axle load (conversion of traffic into single axle load), structural number, average annual depth of the floods and snow storms, and average duration of the floods and snow storms.

Note that for all repair suggestions that StreetScan provides, Town staff perform a field review of each recommended street segment, to identify the proper treatment for each specific roadway, based on curb reveal, existing pavement cross section and localized conditions. StreetScan's suggestions are not always suitable for every roadway. In some instances, a roadway may be beyond a maintenance treatment, warranting a mill and overlay or deferred action until a mill and overlay is necessary.

10.2. Suggested Maintenance and Repair – Years 1 to 5

StreetScan utilized the budget planning tool available in Kingsville's PaveMON portal to identify suggested maintenance and repair priorities. Using an annual roads operating budget of $900,000 from the Town, Tables 5 – 9 were generated which indicate the road segments recommended for repair over the next five years.

Table 5. Recommended Repairs - Year 1

StreetName	FromStreetName	ToStreetName	SS_ID	PCI	Maintenance Suggestion	Estimated Cost	Cumulative Cost	Repair Priority	Repair Year
SPRUCE ST S	PEARL ST E	MILL ST E	389	42	Rehabilitation	$28,147	$28,147	24.86	1
MAIN ST W	HERITAGE RD	CEMENTERY RD	614	58	Rehabilitation	$125,785	$153,932	24.00	1
MAIN ST W	CEMETERY RD	PRINCE ALBERT ST S	615	59	Rehabilitation	$46,107	$200,040	23.43	1
NORTH TALBOT RD	BELLE RIVER RD	NEWMAN RD	337	60	Rehabilitation	$9,416	$209,455	22.86	1
MAIN ST W	PRINCE ALBERT ST S	QUEEN ST	645	62	Rehabilitation	$51,985	$261,440	21.71	1
MAIN ST E	JASPERSON LN	CHRYSLER GREENWAY TRAIL	649	72	Preventive Maintenance	$14,508	$275,948	20.00	1
LANSDOWNE AVE	MAPLE ST	MYRTLE ST	82	54	Rehabilitation	$29,342	$305,290	19.71	1
ROAD 2 E	KRATZ RD	GRAHAM SIDE RD	384	66	Rehabilitation	$85,293	$390,583	19.43	1
LAKEVIEW AVE	INDUSTRY RD	13M NORTH OF PARK ST	519	55	Rehabilitation	$55,442	$446,025	19.29	1
MAIN ST E	CHERRY LN N	SANTOS DR	641	74	Preventive Maintenance	$4,719	$450,744	18.57	1
ROAD 3 E	UNION AVE	SPINKS DR	86	57	Rehabilitation	$56,041	$506,784	18.43	1
JASPERSON DR	APPLEWOOD RD	MAIN ST E	475	57	Rehabilitation	$59,254	$566,038	18.43	1
NORTH TALBOT RD	COUNTY 14 RD	BELLE RIVER RD	336	68	Rehabilitation	$10,968	$577,006	18.29	1
SPRUCE ST S	MAIN ST E	PEARL ST E	101	58	Rehabilitation	$28,449	$605,455	18.00	1
ROAD 3 E	SPINKS DR	ALBUNA TOWNLINE	87	58	Rehabilitation	$49,488	$654,943	18.00	1
NORTH TALBOT RD	CONCESSION RD 10	COUNTY 14 RD	317	69	Rehabilitation	$94,201	$749,144	17.71	1
MAIN ST E	REMARK DR	JASPERSON LN	643	76	Preventive Maintenance	$10,592	$759,736	17.14	1
FAIRVIEW AVE	GOSFIELD TOWNLINE	DOWSWELL ST	613	70	Preventive Maintenance	$7,194	$766,930	17.14	1

Table 6. Recommended Repairs - Year 2

StreetName	FromStreetName	ToStreetName	SS_ID	PCI	Maintenance Suggestion	Estimated Cost	Cumulative Cost	Repair Priority	Repair Year
JASPERSON DR	JASPERSON DR	PEACHWOOD DR	566	60	Rehabilitation	$155,185	$155,185	17.14	2
DIVISION ST N	HORWATH AVE	IVY LN	634	70	Preventive Maintenance	$2,426	$157,611	17.14	2
NORTH TALBOT RD	CAMERON SIDE RD E	CAMERON SIDE RD	84	70	Preventive Maintenance	$996	$158,607	17.14	2
MAIN ST E	WILLIAM AVE	WIGLE AVE	642	76	Preventive Maintenance	$7,521	$166,128	17.14	2
LANSDOWNE AVE	MYRTLE ST	PROSPECT ST	513	61	Rehabilitation	$24,580	$190,708	16.71	2
DIVISION ST N	THORNCREST ST	HILLVIEW CRESCENT	636	71	Preventive Maintenance	$9,870	$200,578	16.57	2
DIVISION ST N	IVY LN	THORNCREST ST	635	71	Preventive Maintenance	$2,745	$203,323	16.57	2
LANSDOWNE AVE	GRACE ST	VIOLA ST	280	62	Rehabilitation	$25,798	$229,121	16.29	2
LANSDOWNE AVE	WELLINGTON ST	GLADSTONE AVE	199	62	Rehabilitation	$28,198	$257,319	16.29	2
ROAD 2 E	GRAHAM SIDE RD	PETERSON LN	379	62	Rehabilitation	$55,612	$312,931	16.29	2
MAIN ST E	SPRUCE ST N	CHERRY LN N	640	78	Preventive Maintenance	$7,912	$320,842	15.71	2
DIVISION ST N	PULFORD ST	WATER ST	616	73	Preventive Maintenance	$1,605	$322,447	15.43	2
DIVISION ST N	PALMER DR	MCCALLUM AVE	633	73	Preventive Maintenance	$3,986	$326,434	15.43	2
DIVISION ST N	KING ST	MAIN ST	637	73	Preventive Maintenance	$3,298	$329,731	15.43	2
LANSDOWNE AVE	GLADSTONE AVE	MAPLE ST	56	65	Rehabilitation	$54,816	$384,548	15.00	2
JASPERSON DR	PEACHWOOD DR	APPLEWOOD RD	304	66	Rehabilitation	$68,161	$452,708	14.57	2
NORTH TALBOT RD	CAMERON SIDE RD	CONCESSION RD 10	315	75	Preventive Maintenance	$37,222	$489,930	14.29	2
DIVISION ST N	MCCALLUM AVE	HORWATH AVE	650	75	Preventive Maintenance	$6,608	$496,539	14.29	2
ROAD 2 E	QUEEN BLVD	UNION AVE	378	67	Rehabilitation	$5,394	$501,933	14.14	2
ROAD 2 E	PETERSON LN	QUEEN BLVD	377	67	Rehabilitation	$22,157	$524,090	14.14	2
LANSDOWNE AVE	ERIE ST	PARK ST	43	67	Rehabilitation	$47,688	$571,778	14.14	2
MAIN ST W	CHESTNUT ST	DIVISION ST N	623	76	Preventive Maintenance	$3,840	$575,619	13.71	2
MAIN ST E	SANTOS DR	WILLIAM AVE	611	82	Preventive Maintenance	$13,726	$589,345	12.86	2
LAKEVIEW AVE	INDUSTRY RD	WIGLE AVE	119	70	Preventive Maintenance	$10,464	$599,809	12.86	2
FAIRVIEW AVE	DOWSWELL ST	PINE ST	624	78	Preventive Maintenance	$14,021	$613,830	12.57	2
ROAD 3 E	DIVISION RD	GRAHAM SIDE RD	364	78	Preventive Maintenance	$118,917	$732,747	12.57	2
DIVISION ST N	WATER ST	BEECH ST	638	78	Preventive Maintenance	$4,420	$737,167	12.57	2
QUEEN ST	QUEEN ST	HAROLD CULL DR	267	72	Preventive Maintenance	$3,585	$740,752	12.00	2
WIGLE AVE	ANGEL CT	KATIE CRESCENT	524	72	Preventive Maintenance	$4,685	$745,437	12.00	2
ROAD 3 W	MCCAIN SIDE RD	DIVISION RD	13	79	Preventive Maintenance	$104,708	$850,144	12.00	2
LANSDOWNE AVE	PROSPECT ST	PROSPECT ST	514	73	Preventive Maintenance	$514	$850,658	11.57	2

Table 7. Recommended Repairs - Year 3

StreetName	FromStreetName	ToStreetName	SS_ID	PCI	Maintenance Suggestion	Estimated Cost	Cumulative Cost	Repair Priority	Repair Year
CHERRY AVE	LEWIS AVE	HERITAGE RD	138	20	Reclamation	$214,520	$214,520	11.43	3
OAK AVE	LEWIS AVE	MCCAIN SIDE RD	241	20	Reclamation	$212,812	$427,332	11.43	3
FAIRVIEW AVE	PINE ST	MAIDSTONE AVE	625	80	Preventive Maintenance	$14,162	$441,494	11.43	3
DIVISION ST N	HILLVIEW CRESCENT	PULFORD ST	639	80	Preventive Maintenance	$5,670	$447,163	11.43	3
CULL DR	WOODLAWN CRESCENT	QUEEN ST	495	74	Preventive Maintenance	$1,775	$448,938	11.14	3
LANSDOWNE AVE	MILL ST E	GRACE ST	397	74	Preventive Maintenance	$3,013	$451,951	11.14	3
WIGLE AVE	MAIN ST E	MURRAY ST	269	74	Preventive Maintenance	$6,941	$458,892	11.14	3
DIVISION ST N	DIVISION RD N	PALMER DR	652	81	Preventive Maintenance	$1,424	$460,316	10.86	3
MAIN ST W	QUEEN ST	CHESTNUT ST	644	81	Preventive Maintenance	$3,218	$463,534	10.86	3
LANSDOWNE AVE	PROSPECT ST	ERIE ST	211	75	Preventive Maintenance	$3,250	$466,783	10.71	3
MAIN ST E	DIVISION ST S	SPRUCE ST N	612	85	Defer Maintenance	$0	$466,783	10.71	3
WIGLE AVE	MURRAY ST	ANGEL CT	525	75	Preventive Maintenance	$4,013	$470,796	10.71	3
Road 9 W	ARNER TOWNLINE	HIGHWAY 3	668	25	Reclamation	$728,840	$1,199,636	10.71	3

Table 8. Recommended Repairs - Year 4

StreetName	FromStreetName	ToStreetName	SS_ID	PCI	Maintenance Suggestion	Estimated Cost	Cumulative Cost	Repair Priority	Repair Year
WIGLE AVE	ERIEVIEW DR	LAKEVIEW AVE	193	75	Preventive Maintenance	$3,638	$3,638	10.71	4
Peterson Road	ROAD 3 E	ROAD 2 E	655	27	Reclamation	$476,048	$479,686	10.43	4
ARNER TLINE	ADAMS LN	DEAD END	430	28	Reclamation	$17,268	$496,954	10.29	4
HERRINGTON ST	HARRINGTON ST	DIVISION ST S	500	76	Preventive Maintenance	$6,055	$503,009	10.29	4
NORTH TALBOT RD	COUNTY RD 8	CONCESSION RD 11	214	76	Preventive Maintenance	$77,155	$580,164	10.29	4
NORTH TALBOT RD	CONCESSION RD 1	CAMERSON SIDE RD	151	76	Preventive Maintenance	$42,358	$622,522	10.29	4
MAPLE AVE	LEWIS AVE	MCCAIN SIDE RD	136	29	Reclamation	$212,983	$835,505	10.14	4
ROAD 3 E	GRAHAM SIDE RD	PETERSON LN	85	77	Preventive Maintenance	$40,015	$875,520	9.86	4
HERRINGTON ST	QUEEN ST	HARRINGTON ST	268	77	Preventive Maintenance	$813	$876,333	9.86	4

Table 9. Recommended Repairs - Year 5

StreetName	FromStreetName	ToStreetName	SS_ID	PCI	Maintenance Suggestion	Estimated Cost	Cumulative Cost	Repair Priority	Repair Year
CEDAR ISLAND DR	CEDAR ISLAND RD	2ND BLVD	439	31	Reclamation	$38,107	$38,107	9.86	5
BEECH ST	WATERMILL ST	SPRUCE ST N	254	77	Preventive Maintenance	$5,784	$43,891	9.86	5
DIVISION ST N	CONCESSION RD 2 E	SANDYBROOK WAY	632	83	Preventive Maintenance	$12,585	$56,475	9.71	5
ARNER TLINE	CHELSEA CR	ADAMS LN	431	33	Reclamation	$32,846	$89,321	9.57	5
Cameron Side Road E	COUNTY RD 8	CONCESSION RD 11	667	33	Reclamation	$1,251,948	$1,341,269	9.57	5

10.3. Budget Projection Scenarios

The impact of different yearly budget amounts on network-wide PCI projections can be created within the PaveMON portal utilizing the findings from the StreetScan road condition assessment and repair prioritizations made by incorporating Town-specific repair methods and custom costs. The impact of different budgets on the back-log of work is summarized below. These projections are based on expected deterioration rates, anticipated yearly budgets, and condition change based on repair methods. The four scenarios assessed are as follows:

- Budget Scenario #1: $900K [Red line]
- Budget Scenario #2: $1.5M [Red line]
- Budget Scenario #1: $2.1M [Green line]
- Budget Scenario #1: $2.7M [Black line]

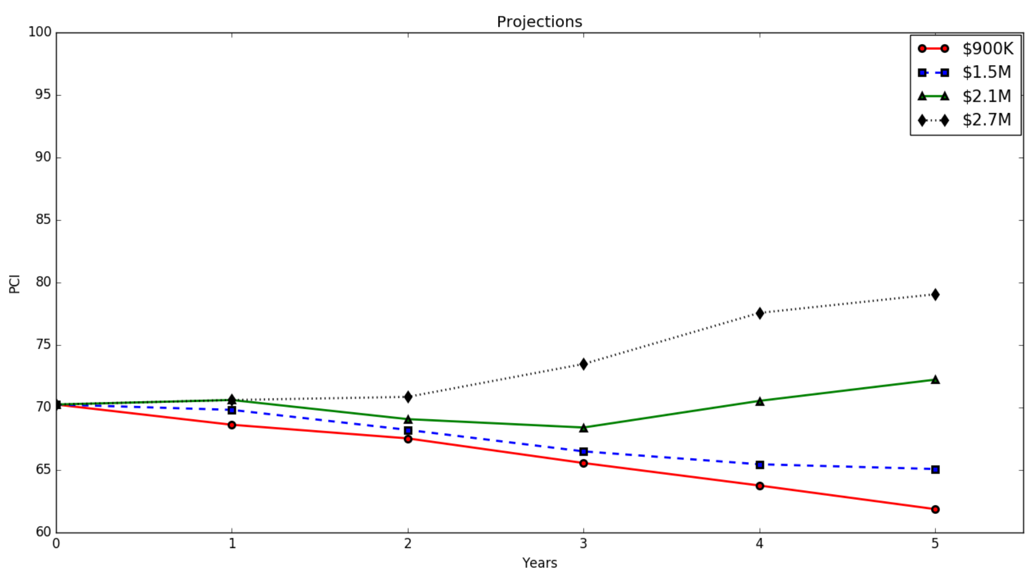

Figure 5. Projected PCI budget scenarios

11. Visualization & Reporting

The StreetScan solution emphasizes the ability of the end-user to perform in-depth analysis with multiple filters and adjustable variables. A Town can pursue an analysis at any time on multiple devices with multiple users utilizing PaveMON, the StreetScan web-based software. PaveMON allows for easy generation of visual reports as well as statistics and graphics for communication of data-driven repair decisions created with the custom-software.

11.1. Visualization - PaveMON summary

For visualizing the results of data collection and data driven repair decisions, StreetScan provides a web-based GIS application, PaveMON. This app requires zero installation and can be accessed from any computer, tablet, or phone connected to the internet. The app is built on the ArcGIS JavaScript platform and is customized to the Town's requirements. Its functions include GIS spatial analysis capabilities such as measuring, charting, and spatial queries. There are database management capabilities as well, such as querying and statistical functions.

All features and indexes collected and created by StreetScan are stored in the PaveMON software. As there is no need to visualize all data at the same time, data is stored in layers. Having a layer-based design gives a significant boost to the speed of this application as users will be querying only a fraction of the terabytes of data being managed.

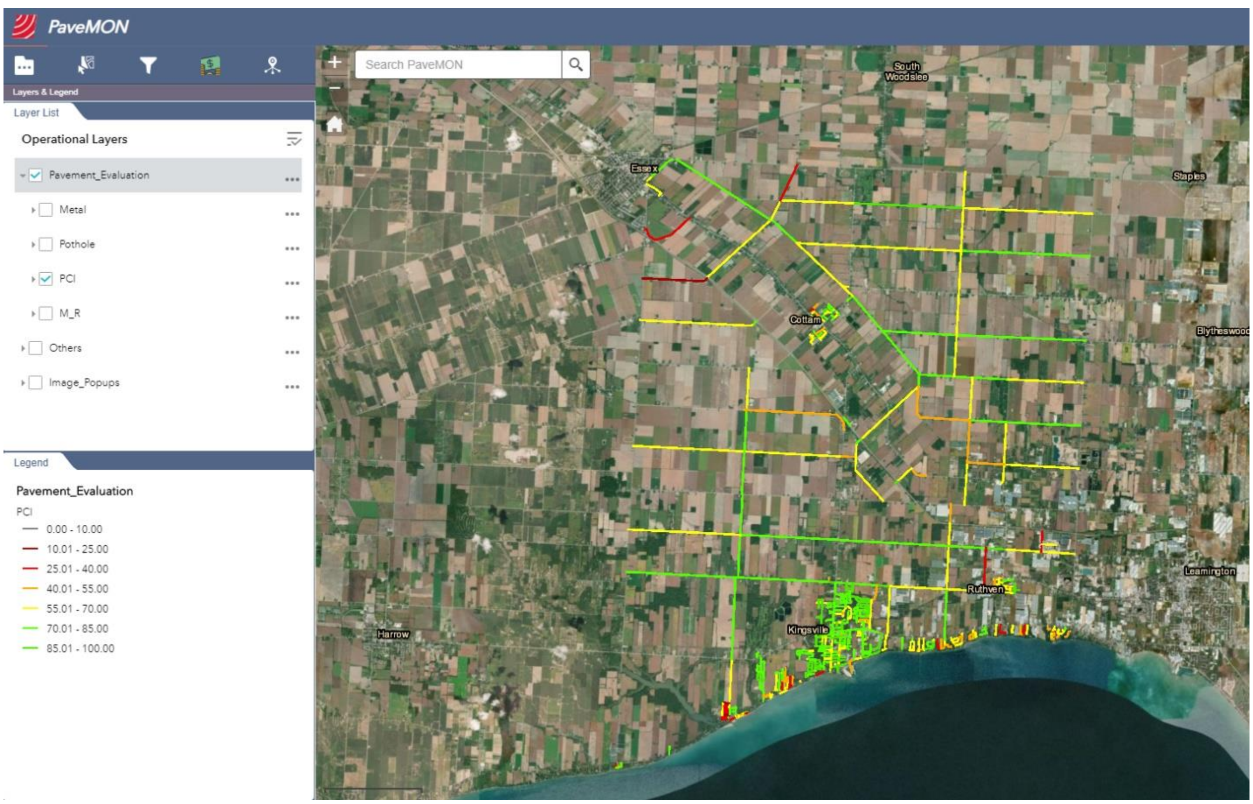

Figure 6. Sample PaveMON screengrab, PCI

12. Reporting

Custom reports are created by the Town of Kingsville to test budget scenarios, develop pavement management plans, and create graphics and statistics. Portal training was provided to the Town and ongoing support is provided. Below is an example of the functionality provided by the software.

The user can create pavement management plans and reports utilizing different budget scenarios. This can be applied to different spatial distances. For example, the Town could decide to run a budget scenario utilizing the Town-wide PCI data or the data for a specific neighborhood only. In addition, segments can be filtered out utilizing specific attributes such as existing road condition, functional class, or surface type (pavement or surface treatment) to yield unique plans that are custom to the Town. These reports can be exported in a tabular format, GIS shapefile, or feature data-layer that can be stored in the web portal. These feature data-layers can then be used to create data-driven statistics, maps, and graphics.

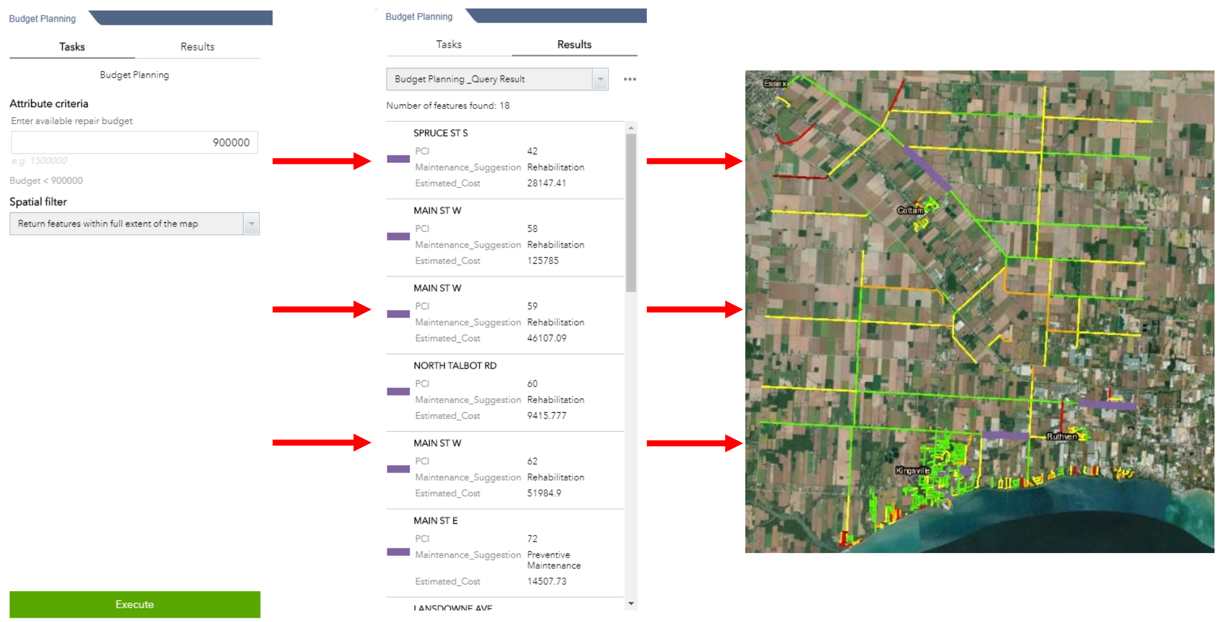

Figure 7. Sample PaveMON screengrab, budget scenario tool

References

[1] *ASTM D6433 – 18: Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys*

[2] *O. Reg. 366/18: MINIMUM MAINTENANCE STANDARDS FOR MUNICIPAL HIGHWAYS*

[3] *http://dpw.lacounty.gov/gmed/lacroads/TreatmentPavement.aspx*