

Issaquah, WA

Pavement Management Analysis Report

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APPENDED REPORTS

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Appendix A	Street Inventory and Condition Summary
Appendix B	\$810K Street Rehabilitation Program by Segment
Appendix C	\$810K Street Rehabilitation Program by Year

APPENDED MAPS

Located on Thumb Drive

Functional Classification by Segment
Pavement Condition Index by Segment
Pavement Condition Rating by Segment Using Descriptive Terms
Assembled Projects
Pavement Condition Rating by Project Using Descriptive Terms
\$810K/year Rehab Plan Budget
\$810K/year Post Rehab PCI Map

Abbreviation or Acronym	Definition
\$k	Dollars in thousands (\$,000)
\$M	Dollars in millions
%SP	Percent Spreadability - component of deflection analysis
AC	Asphalt Concrete - asphalt streets, flexible pavements, also known as ACP
ACP	Asphalt Concrete Pavement - asphalt streets, flexible pavements, also known as AC
ART	Arterial roadway functional classification
ASTM	American Society of Testing Methods
Avg	Average
BCI	Base Curvature Index - component of deflection analysis
Brk	Break
CAL	Coarse Aggregate Loss
CDV	Corrected Deduct Value - part of the ASTM D6433 PCI calculation
COL	Collector roadway functional classification
Crk	Crack
DeflCON	Deflection Condition - structural load analysis based on traffic loading and deflection
DMD	Dynamic Maximum Deflection - temperature corrected deflection
Dvdd Slab	Divided Slab
DynaCON	Dynamic Condition - structural layer analysis
ft or FT	Foot
ft2 or FT2	Square foot
FunCL	Functional Classification
FWD	Falling weight deflectometer
GCI	Gravel Condition Index
GFP	Good - Fair - Poor
GIS	Geographic Information System
GISID	GIS segment identification number
H&V	Horizontal and Vertical
IRI	International Roughness Index
Jt	Joint
L&T	Longitudinal and Transverse
LAD	Load associated distress
LOC	Local roadway functional classification - same as RES
LOG	Lip of Gutter
m	Metre or meter
M	Moderate
m2	square metre or square meter
MART	Major arterial roadway functional classification
Max	Maximum
MaxDV	Maximum Deduct Value
MCOL	Major collector roadway functional classification
mi or Mi	Mile
Mn	Minimum
MnART	Minor arterial roadway functional classification
MnCOL	Minor collector roadway functional classification
MOD	Moderate
NLAD	Non-load associated distress
OCI	Overall condition index, also known as PCI
Olay	Overlay
PART	Primary arterial roadway functional classification
Pavetype	Pavement Type
PCC	Portland Cement Concrete - concrete streets
PCI	Pavement Condition Index - generic term for OCI
R&R	Remove and replace
RART	Rural arterial roadway functional classification
PWF	Priority Weighting Factor
Recon	Reconstruction
Rehab	Rehabilitation
RES	Local roadway functional classification - same as LOC
RI or RCI	Roughness Index
S	Strong
SART	Secondary arterial roadway functional classification
SCI	Surface Curvature Index - component of deflection analysis
SDI	Surface Distress Index
SI	Structural Index
STA	Station or chainage
Surf Trtmt	Surface Treatment
TDV	Total Deduct Value
W	Weak

1.0 EXECUTIVE SUMMARY & RECOMMENDATIONS

PROJECT SUMMARY

In 2019 IMS Infrastructure Management Services, LLC (IMS) was contracted by the City of Issaquah to conduct a pavement condition assessment and analysis update on approximately 113 centerline miles of City maintained asphalt and concrete roadways alike.

IMS mobilized their Laser Road Surface Tester (RST) to conduct an objective assessment using industry standard pavement distress protocols such as those found in ASTM D6433-11. The City's network average Pavement Condition Index was found to be a 70 and the City's backlog (roads below a PCI of 40) was at nearly 0%. See section 4 for more information

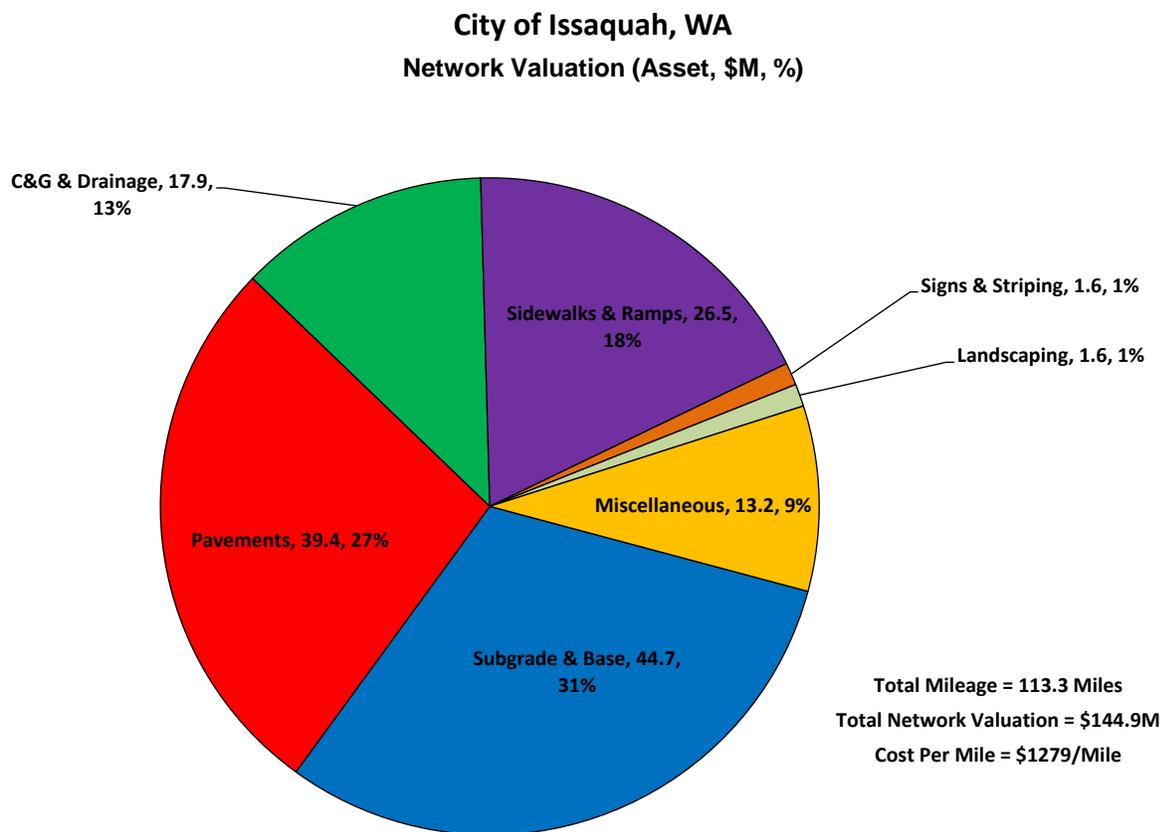


Figure 1- Replacement Value of Roadway Network

As seen in **Figure 1**, Issaquah has just over 113 centerline miles of roadway, encompassing over 2M square yards of pavement surfacing, which is predominantly asphalt. At an average replacement cost for a typical roadway just over \$1M per mile, not including the value of the land, the City has over \$144.9M invested in its paved roadway network.

SUMMARY METRICS OF HEALTH

Pavement Condition Index (PCI) – The PCI score is a ranking assessment on the overall health of a pavement segment on a scale of 0 to 100. The network average PCI is a good global indicator of a network's overall health. *(Explained in section 4)*

Percent of Excellent Roads – Roads with a condition category of Excellent are those that score between a PCI of 85 to 100.

Backlog –Backlog is the Very Poor and Poor roads (between a PCI of 0 and 40) that represent a portion of the network in need of extensive rehabilitation such as full and partial reconstruction. Using sound pavement management and finance principles, a very healthy network will have a backlog of 10% or less.

Issaquah met two out of three of the metrics for evaluating the quality of its roadway network.

- ✓ Issaquah's network average pavement condition score is above the national average currently seen by IMS of 60 to 65, with the City's average scoring a 70.
- The number of streets rated Excellent is below the minimum recommended target of 15% at 10.8%
- ✓ The backlog amount is below the average value of 12% at nearly 0%.

BUDGET SCENARIOS

See section 5 for more information

The current annual budget for Issaquah is \$810K per year dedicated to pavement preservation and rehabilitation. This will grow the backlog to 5% while lowering the average PCI to a 63 over 5 years. Please note this number is an annual budget average across all 5 years of the analysis horizon.

EXECUTIVE SUMMARY CONCLUSION

The Issaquah network has an average PCI of 70 and a backlog of 0.4%, with most of the network landing in the Very Good PCI range. With the City's existing budget, the network conditions will continue to deteriorate into the low 60s PCI range and backlog will grow over time. The city may consider investing closer to the steady state level of \$3.5M annually in order to preserve the current level of service to the community.

2.0 PRINCIPLES OF PAVEMENT MANAGEMENT

2.1 PAVEMENT PRESERVATION

Preservation of existing roads and street systems has become a major activity for all levels of government. Because municipalities must consistently optimize the spending of their budgets, funds that have been designated for pavement must be used as effectively as possible. The best method to obtain the maximum value of available funds is through the use of a pavement management system.

Pavement management is the process of planning, budgeting, designing, evaluating, and rehabilitating a pavement network to provide maximum benefit with available funds.

A pavement management system is a set of tools or methods that assist decision makers in finding optimal strategies for providing and maintaining pavements in a serviceable condition over a given time period. The intent is to identify the optimum level of long-term funding to sustain the network at a predetermined level of service while incorporating local conditions and constraints.

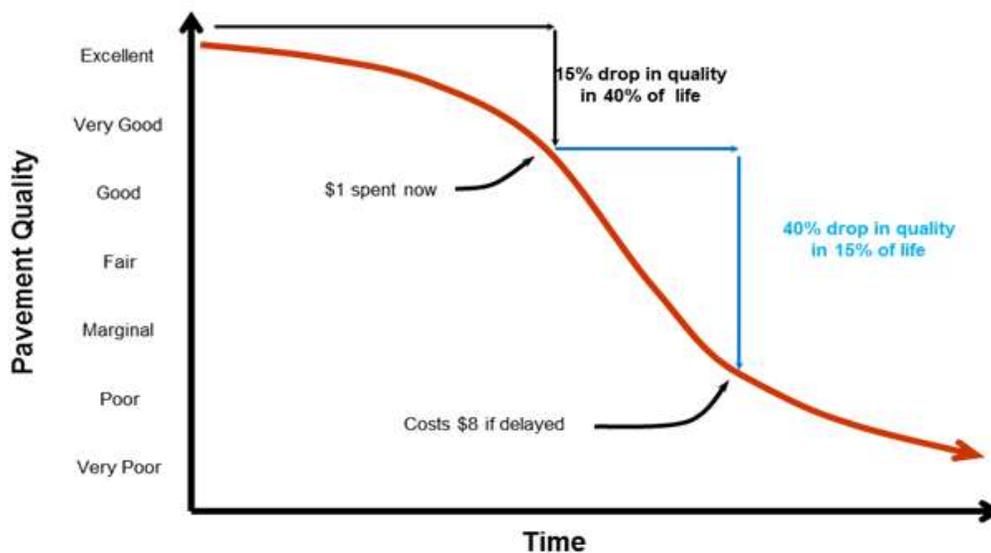


Figure 2 – Pavement Deterioration and Life Cycle Costs

As shown as **Figure 2**, the streets that are repaired while in good condition will cost less over their lifetime than those left to deteriorate to a poor condition. Without an adequate routine pavement maintenance program, streets require more frequent reconstruction, thereby costing millions of extra dollars.

The key to a successful pavement management program is to develop a reasonably accurate performance model of the roadway, and then identify the optimal timing and rehabilitation strategy. The resultant benefit of this exercise is realized by the long term cost savings and increase in pavement quality over time. As illustrated in **Figure 2**, pavements typically deteriorate rapidly once they hit a specific threshold. A \$1 investment after 40% lifespan is much more effective than deferring maintenance until heavier overlays or possibly reconstruction are required just a few years later.

Once implemented, an effective pavement information management system can assist agencies in developing long-term rehabilitation programs and budgets. The key is to develop policies and practices that delay the inevitable total reconstruction for as long as practical yet still remain within the target zone for cost effective rehabilitation. That is, as each roadway approaches the steepest part of its deterioration curve, apply a remedy that extends the pavement life, at a minimum cost, thereby avoiding costly heavy overlays and reconstruction. **Figure 3** illustrates the concept of extending pavement life through the application of timely rehabilitations.

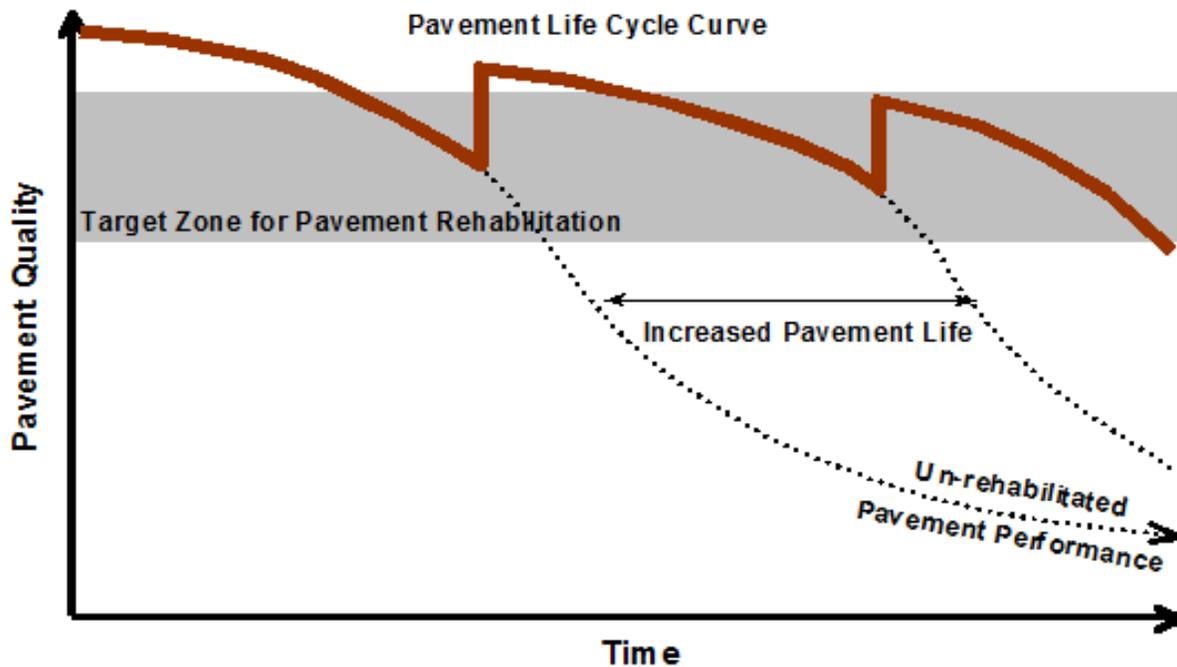


Figure 3 – Pavement Life Cycle Curve

Ideally, the lower limit of the target zone shown in **Figure 3** would have a minimum PCI value in the 60 to 70 range to keep as many streets as possible requiring a thin overlay or less. The upper limit would tend to fall close to the higher end of the Very Good category – that is a pavement condition score approaching 85. Other functions of a pavement management system include assessing the effectiveness of maintenance activities, new technologies, and storing historical data and images.

For Issaquah, a prioritization methodology based on pavement condition, pavement materials, functional class, and strength rating was used to analyze the network condition and develop the proposed 5 year rehabilitation plan.

The analysis methodologies and data collection technologies were based on *ASTM D6433 Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys* (hereinafter ASTM D6433) for assessment of pavement surface condition and the International Roughness Index (IRI) for quantification of pavement roughness on all City streets. These measurements of pavement quality are combined to form an overall 0 to 100 Pavement Condition Index (PCI), with 100 being the best.

2.2 ECONOMIC IMPACTS OF MAINTENANCE & REHABILITATION

The role of the street network as a factor in the City's well-being cannot be overstated. In the simplest of terms, roadways form the economic backbone of a community. They provide the means for goods to be exchanged, commerce to flourish, and commercial enterprises to generate revenue. As such, they are an investment to be maintained.

The overall condition of an agency's infrastructure and transportation network is a key indicator of economic prosperity. Roadway networks, in general, are one of the most important and dynamic sectors in the global economy. They have a strong influence on not only the economic well-being of a community, but a strong impact on quality of life. Well-maintained road networks experience multiple socioeconomic benefits through greater labor market opportunities and decreasing income gap.

As a crucial link between producers and their markets, quality road networks ensure straightforward access to goods and drive global and local economies. Likewise, higher network quality has a strong correlation to improvements in household consumption and income. Roads also act as a key element to social cohesion by acting as a median for integration of bordering regions. This social integration promotes a decreased gap in income along with diversity and a greater sense of community that can play a large role in decreasing rates of poverty.

Conversely, deterioration of roads can have adverse effects on a community and may bring about important and unanticipated welfare effects that the governments should be aware of when cutting transportation budgets. Poor road conditions increase fuel and tire consumption while shortening intervals between vehicle repair and maintenance. In turn, these roads result in delayed or more expensive deliveries for businesses and consumers. Economic effects of poor road networks, such as time consuming and costly rehabilitation, can be reduced if a proactive maintenance approach is successfully implemented. To accomplish this, a pavement assessment and analysis should be completed every few years in an effort update the budget models and rehabilitation plans. As shown below, the IMS Laser Road Surface Tester (featured in **Figure 4**) was mobilized to Issaquah to conduct an objective survey.



Figure 4 – Laser Road Surface Tester (RST)

3.0 THE PAVEMENT MANAGEMENT PROCESS

3.1 FUNCTIONAL CLASS REVIEW

As part of the scope of this assignment, the functional classification designations currently used in the Issaquah pavement management program were adopted for their use in the pavement analysis.

Although there is no uniform standard for classifying pavement into functional classes, The Federal Highway Administration (FHWA), American Public Works Association (APWA) and Institute of Transportation Engineers (ITE) offer some broad guidelines on how to assign classifications that were followed in this study.

The City's functional classification definitions used in the assessment are as follows:

1. **Principal Arterial (PART)** – all cross City corridors consisting of 2 to 4 or more lanes, generally spaced at 1 mile intervals with daily traffic counts generally exceeding 20,000 vehicles per day. Major cross City corridors with a landscaped median were also assigned to Principal Arterials.
2. **Minor Arterial (MnART)** – Continuous and discontinuous cross city and inter-district corridors that are 2 to 4 lanes across and generally have a centerline stripe or a designated bus route. The ADT generally falls in the 10,000 to 20,000 vehicle per day range. They are typically spaced on the ½ or ¼ mile section line and on occasion, may have a short non-landscaped median.
3. **Collector (COL)** – Continuous and discontinuous cross City and inter-district corridors that are 2 to 4 lanes across and generally have a centerline stripe or a designated bus route. The ADT generally falls in the 1,000 to 10,000 vehicle per day range. They are typically spaced on the ½ or ¼ mile section line and on occasion, may have a short non-landscaped median. Major collectors are also assigned to streets segments leading to, or adjacent to, a major traffic generator site such as a regional shopping complex. Collectors form the entrance to communities and may have a decorative landscaped median of short duration.
4. **Local (LOC)** – These are the majority of the street segments consisting of all residential roads not defined above or as industrial/commercial.

The paved roadway network consists of 4 functional classes, covering approximately 113 miles of pavement. The average pavement condition index (PCI) of the roadway network is a 70 and the network's primary pavement type is asphalt. The following table and **Figure 5** summarize the functional classification splits within the system.

City of Issaquah, WA
Network Summary by Functional Class

	Pavetype	Network	Principal Arte	Minor Arterial	Collector	Local
Segment (Block) Count	All Streets	1376	106	68	146	991
	Asphalt	1330	104	67	144	952
	Concrete	46	2	1	2	39
Network Length (ft):	All Streets	598,305	78,208	53,629	73,383	368,357
	Asphalt	584,636	77,688	51,905	71,374	359,245
	Concrete	13,669	520	1,724	2,009	9,112
Network Length (mi):	All Streets	113.3	14.8	10.2	13.9	69.8
	Asphalt	110.7	14.7	9.8	13.5	68.0
	Concrete	2.6	0.1	0.3	0.4	1.7
Average Width (ft):	All Streets	31.8	52.2	39.6	34.8	26.8
	Asphalt	31.8	52.1	39.9	33.9	27.0
	Concrete	31.4	77.7	29.4	65.1	22.1
Network Area (yd2):	All Streets	2,112,795	453,887	235,857	283,614	1,098,415
	Asphalt	2,065,108	449,397	230,225	269,082	1,076,021
	Concrete	47,687	4,490	5,632	14,532	22,394
Current Pavement Condition Index (CPCI) 12/6/19	All Streets	70	63	66	69	75
	Asphalt	70	63	66	69	75
	Concrete	76	90	67	75	75
Pavement Condition Index (Surveyed PCI)	All Streets	71	64	67	70	75
	Asphalt	71	63	67	69	75
	Concrete	76	90	68	76	76
Current Backlog (%)	All Streets	0	Percentage of Network with a PCI < 40			
Current Network Index	All Streets	70	Managable Network Index			
Surface Distress Index (SDI) 12/6/19	All Streets	67	49	58	64	78
	Asphalt	67	48	57	63	78
	Concrete	82	94	77	80	82
Roughness Index (RI) 12/6/19	All Streets	71	78	75	68	68
	Asphalt	71	78	75	68	68
	Concrete	66	82	67	68	62

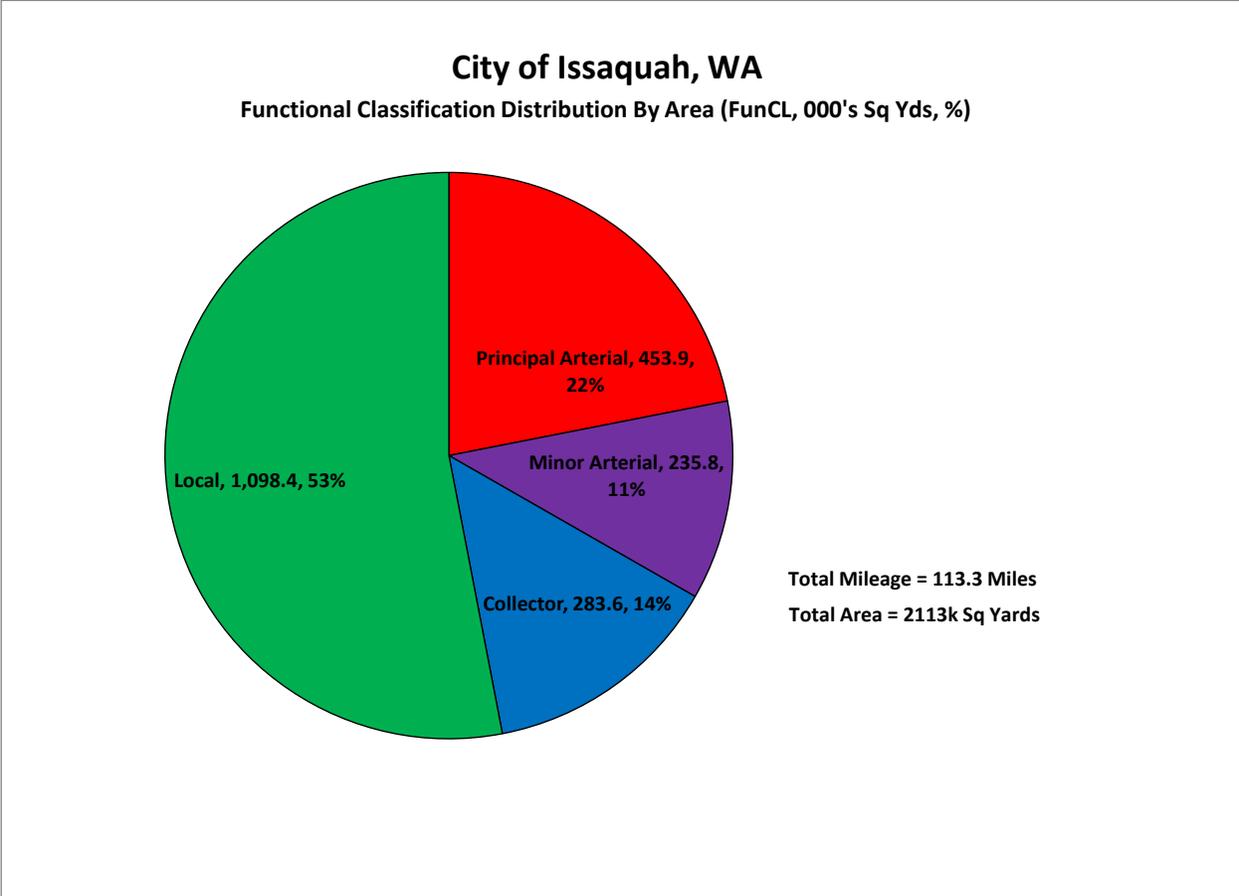


Figure 5 – Functional Class Distribution by Mileage

The amount of streets classified as Local falls slightly below the typical distribution of other networks recently surveyed by IMS. Typically, 12% to 18% of a network falls in the collector category with 62% to 75% of the segments being categorized as locals. In Issaquah, the amount of local roads is slightly lower than the standard averages, while the segments classified as Major and Minor Arterials is slightly higher. This simply indicates that the City of Issaquah may be responsible for maintaining more square yards of pavement than other agencies of similar mileage and/or population.

As discussed later in this report, the functional classifications also play a critical role in the rehabilitation candidate selection process as Arterials are generally given preference over other rehab candidates due to their higher traffic counts and steeper deterioration curves.

The following figure (**Figure 6**) highlights the functional classifications used for the Issaquah roadway network. An electronic version of this map is appended to this report.

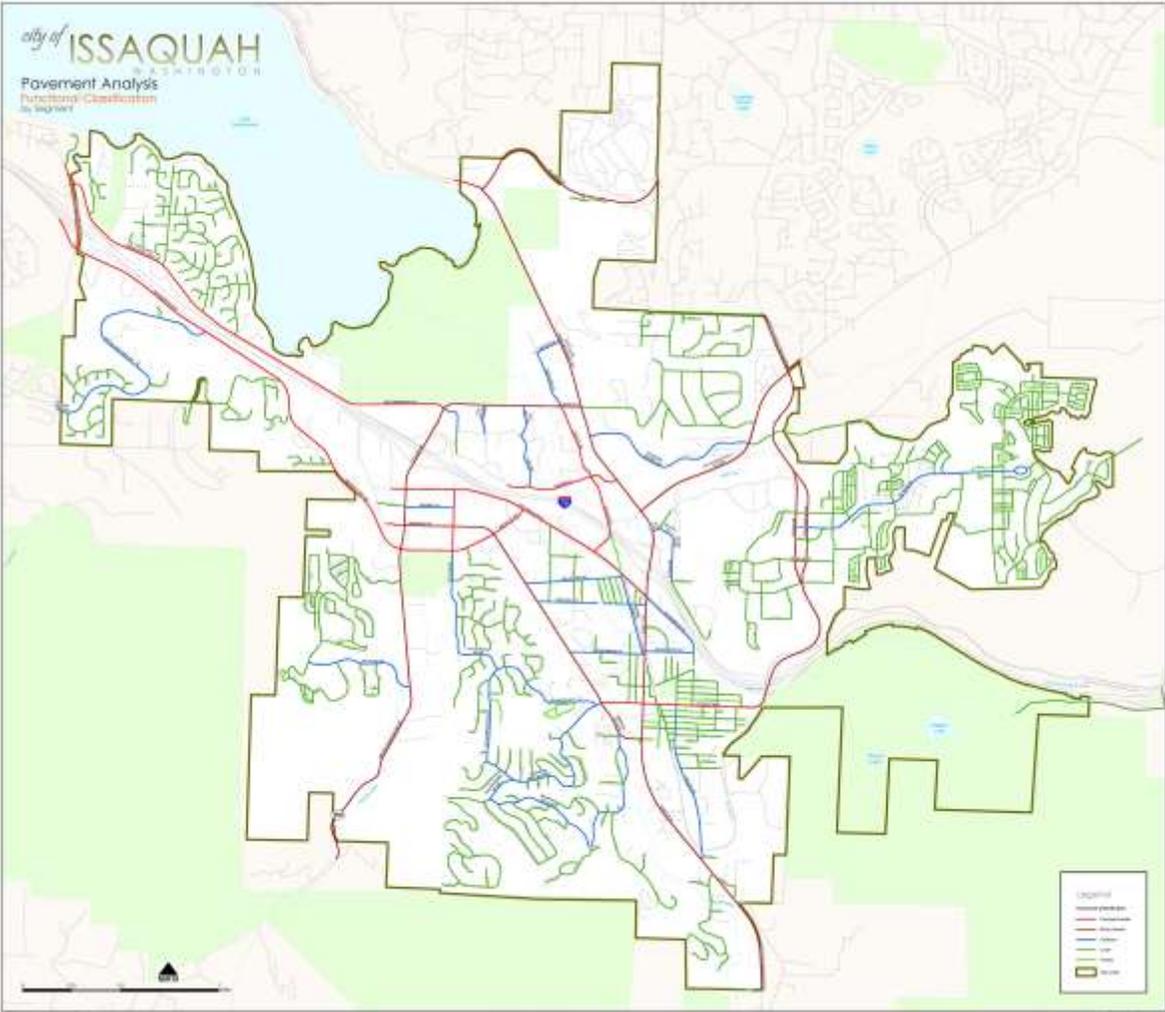


Figure 6 – Issaquah Functional Classification Designation

3.2 ASSEMBLY OF DATA INTO PROJECTS

Issaquah's Geographic Information System (GIS) was used as the basis for segmenting the roadway network on a block-by-block basis. Each segment was assigned a unique identifier referred to as a GISID, establishing a one-to-one relationship between the GIS and the street inventory. The segments form the basic building block of the pavement management system and are where all attribute and condition data are stored.

The centerline segments were aggregated together within the pavement management system to form logical projects that the analysis and rehabilitation program are developed against.

- Arterial projects run from major intersection to major intersection up to 1 mile in length.
- Similar to arterials, collector streets within a neighborhood were aggregated together to form a single project where practical.
- Local streets along a homogenous route were aggregated together along with adjacent side streets to form a small neighborhood based approach.

Segments were joined only when the pavement condition and functional classification were homogeneous in nature such that when joined they have a relatively uniform condition that may be rehabilitated using a single strategy.

The following figure (**Figure 7**) highlights the projects, used for the analysis. An electronic version of this map is appended to this report.

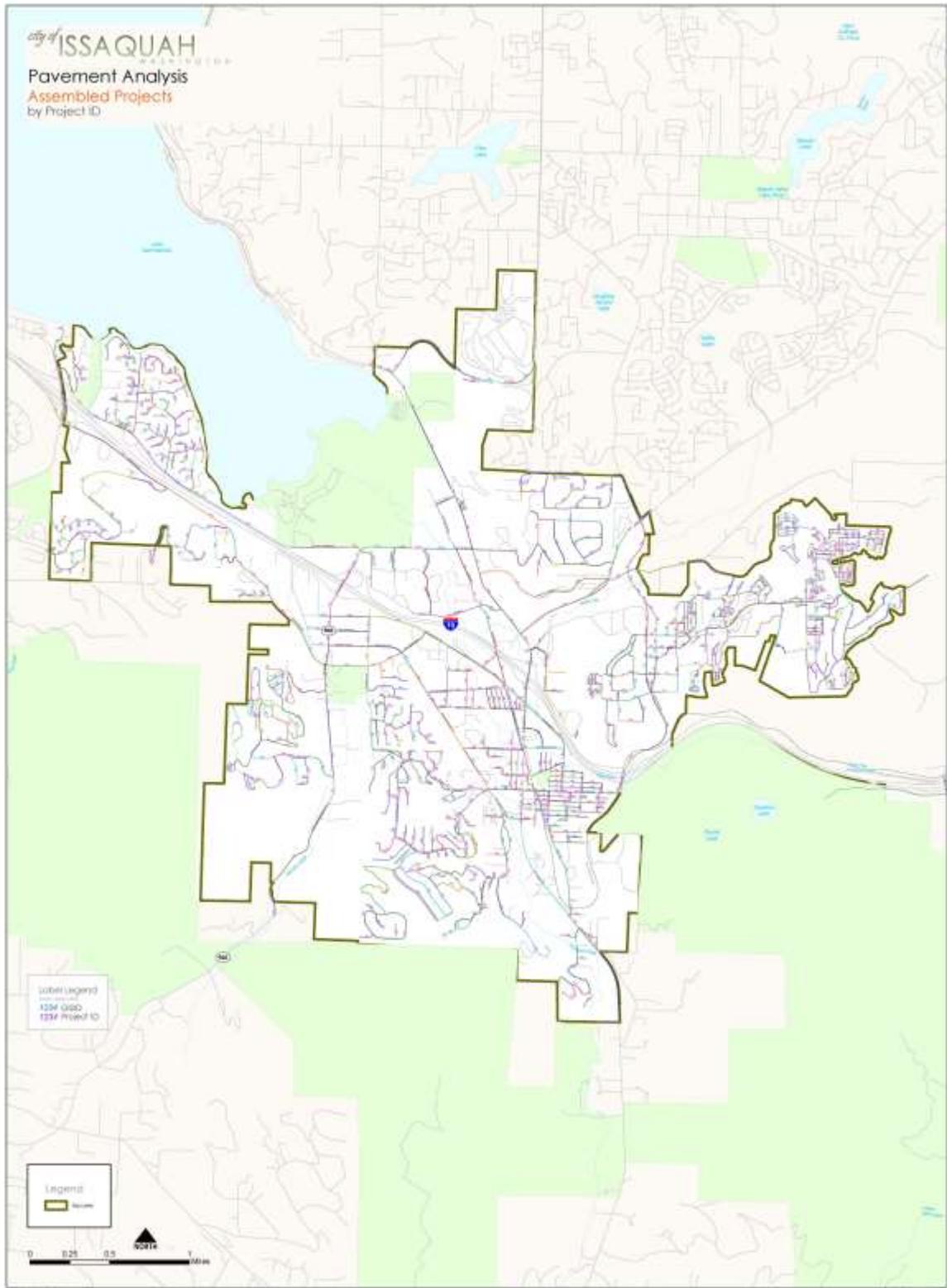


Figure 7 – Issaquah Assembled Projects

3.3 FIELD SURVEY METHODOLOGY

Following a set of predefined assessment protocols matching the pavement management software (ASTM D6433), a specialized piece of survey equipment – referred to as a Laser Road Surface Tester (Laser RST, pictured on page 5) – is used to collect observations on the condition of the pavement surface, as well as collect high definition digital imagery and spatial coordinate information. The Laser RST surveys each local street from end to end in a single pass, while all other roadway classifications are completed in two passes.

Key pavement condition data elements collected by the Laser RST include:

Surface Distress Index – The Laser RST collects surface distress observations based on the extent and severity of distresses encountered along the length of the roadway following ASTM D6433 protocols for asphalt and concrete pavements. The surface distress condition (cracking, potholes, raveling, and the like) is considered by the traveling public to be the most important aspect in assessing the overall pavement condition.

Presented on a 0 to 100 scale, the Surface Distress Index (SDI) is an aggregation of the observed pavement defects. Within the SDI, not all distresses are weighted equally. Certain load associated distresses (caused by traffic loading), such as rutting or alligator cracking on asphalt streets, or divided slab on concrete streets, have a much higher impact on the surface distress index than non-load associated distresses such as raveling or patching. Even at low extents and moderate severity – less than 10% of the total area – load associated distresses can drop the SDI considerably. ASTM D6433 also has algorithms within it to correct for multiple or overlapping distresses within a segment.

For this project, extent and severity observations were collected, processed, and loaded into the pavement management software. Within the software, the following distresses, listed in order from greatest to lowest impact, are presented as a 0 to 10 rating for review and reporting:

- Alligator Cracking – Alligator cracking is quantified by the severity of the failure and number of square feet. Even at low extents, this can have a large impact on the condition score as this distress represents a failure of the underlying base materials.
- Wheel Path Rutting – Starting at a minimum depth of ¼ inch, wheel path ruts are quantified by their depth and the number of square feet encountered. Like alligator cracking, low densities of rutting can have a large impact on the final condition score.
- Longitudinal, Transverse, Block (Map), and Edge Cracks – These are quantified by their length and width. Longitudinal cracks that intertwine are the start of alligator cracking.
- Patching – Patching is quantified by the extent and quality of patches. When the majority of a roadway surface is covered by a patch, such as a large utility replacement, the rating of the patch is minimized. All potholes are rated as patches.
- Distortions – All uneven pavement surfaces, such as depressions, bumps, sags, swells, heaves, and corrugations, are included as distortions and are quantified by the severity and extent of the affected area.
- Raveling – Raveling is the loss of fine aggregate materials on the pavement surface and is measured by the severity and number of square feet affected.

- Bleeding – Bleeding is the presence of free asphalt on the roadway surface caused by too much asphalt in the pavement or insufficient voids in the matrix. The result is a pavement surface with low skid resistance and is measured by the amount and severity of the area.
- Similar distresses were collected for concrete streets including divided slab, corner breaks, joint spalling, faulting, polished aggregate, and scaling.

Roughness Index – Roughness is recorded following the industry standard “International Roughness Index” (IRI), a measure of the change in elevation over a distance expressed as a slope and reported in millimeters/meter. The IRI value is converted to a 0 to 100 score and reported as the Roughness Index (RI) as follows:

$$RI = (11 - 3.5 \times \ln(IRI)) \times 10$$

$\ln(IRI)$ is the natural logarithm of IRI.

In common terms, a newer street would generally have a Roughness Index above 85, while one due for an overlay would be in the range 40 to 70. Failed streets typically have roughness values below 40.

Structural Index – The full street network was tested for structural adequacy using a Dynaflect deflectometer device. (Pictured Below) The field data is then compared to what loads the road is expected to carry as well as used to develop a layer analysis to evaluate if the base materials and pavement structure are working as a single unit. The final result is a single 0 to 100 index value. Scores above a 75 indicate the pavement is structurally adequate, between a 45 and 75 indicate additional structure is required, and those below a 45 generally require replacement.

Pavement Condition Index (PCI) – Following our field surveys, the condition data is assembled to create a single score representing the overall condition of the pavement. The Pavement Condition Index (PCI) is calculated as follows:

(arterials & collectors) **PCI** = 25% Roughness Index +25% Structural Index + 50% Surface Distress Index

(locals) **PCI** = 33% Roughness Index + 66% Surface Distress Index

Development of the pavement management plan and budgets were completed using Issaquah - specific rehabilitation strategies, unit rates, priorities, and pavement performance curves. The process was iterative in its attempt to obtain the greatest efficiency and cost benefit.



4.0 ISSAQUAH SURVEY PAVEMENT CONDITION

4.1 UNDERSTANDING THE PAVEMENT CONDITION INDEX

The following compares the Pavement Condition Index (PCI) to commonly used descriptive terms. Divisions between the terms are not fixed, but are meant to reflect common perceptions of condition.

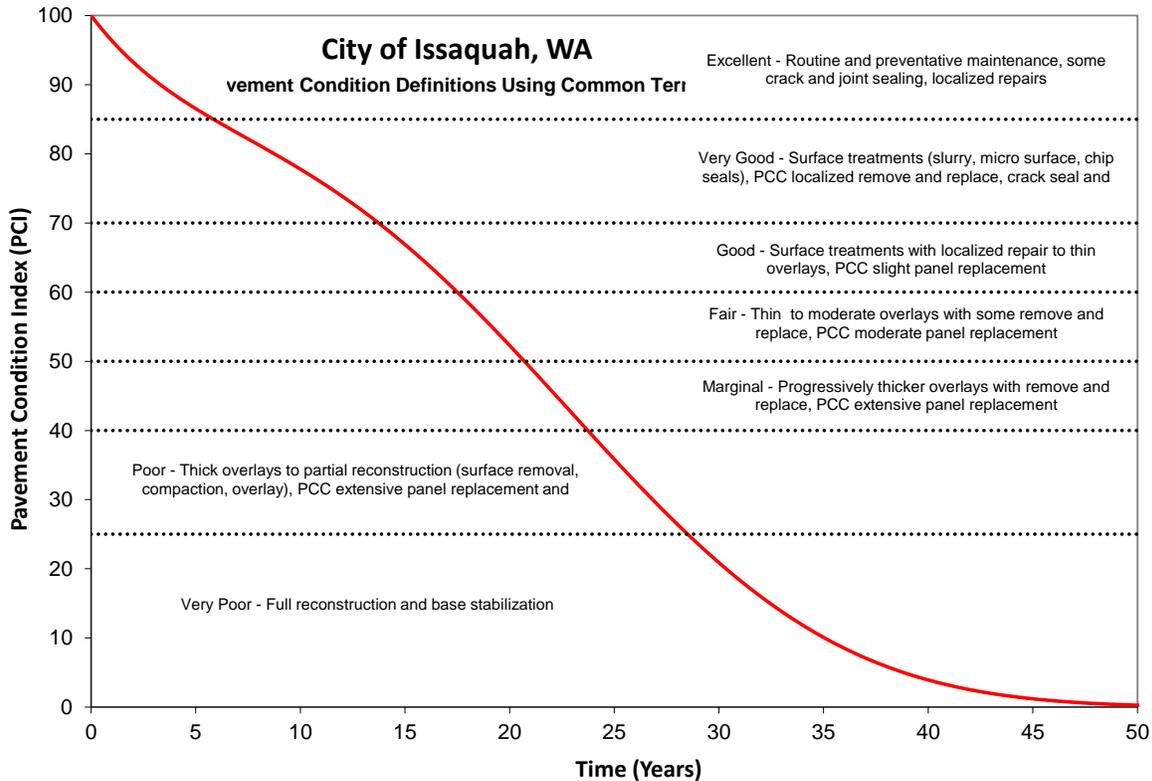


Figure 8 – Understanding the Pavement Condition Index (PCI) Score

The following table details a general description for each of these condition levels with respect to remaining life and typical rehabilitation actions:

PCI Range	Description	Relative Remaining Life	Definition
85 – 100	Excellent	15 to 25 Years	Like new condition – little to no maintenance required when new; routine maintenance such as crack and joint sealing.
70 – 85	Very Good	12 to 20 Years	Routine maintenance such as patching and crack sealing with surface treatments such as seal coats or slurries.
60 – 70	Good	10 to 15 Years	Heavier surface treatments, chip seals and thin overlays. Localized panel replacements for concrete.
40 – 60	Marginal to Fair	7 to 12 Years	Heavy surface-based inlays or overlays with localized repairs. Moderate to extensive panel replacements.
25 – 40	Poor	5 to 10 Years	Sections will require very thick overlays, surface replacement, base reconstruction, and possible subgrade stabilization.
0 – 25	Very Poor	0 to 5 Years	High percentage of full reconstruction.