# MOUNTAIN-PLAINS CONSORTIUM

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## Pavement Management System for City of Madison

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# Pavement Management System for City of Madison

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## Disclaimer

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# EXECUTIVE SUMMARY

This project aims to implement a pavement management system (PMS) for the City of Madison using four specific objectives: 1) build a city-wide GIS database for PMS compatible and incorporable with the city's GIS system; 2) identify feasible pavement rehabilitation and maintenance (M&R) strategies for city roads; 3) recommend multi-year M&R plans for different budget scenarios; and 4) provide training for the city to continue using PMS with the updated pavement condition data.

An accurate GIS database is the corner stone of this project, since data quality directly affects future pavement condition prediction and M&R budgeting. Based on Pubworks' GIS maps, the updated and expanded GIS database for PMS application was produced and verified under a collaboration between the project team and the city. GIS database modifications include new attributes based on information retrieved from other sources, such as city CAD maps, new and modified roadway links with improved presentation, and PMS data dictionary. Pubworks GIS maps were manually edited by following the reliable road information. On-street parking, pavement thickness, and historical roadway improvements and maintenance activities were added to the database. The GIS database was then imported to the chosen PMS software MicroPAVER [1]for further analysis.

The city-wide pavement condition survey was conducted as part of the project. The survey found that nearly 60 percent of the current pavement in Madison can be considered as good (Pavement Condition Index (PCI) >70) according to the MicroPAVER PCI rating scale. The survey also found that the most common pavement distress types for asphalt pavement are longitudinal cracking, rutting, block cracking, and alligator cracking; and linear cracking, large patch/utility cut for concrete pavement.

To forecast future pavement conditions, pavement performance models were developed for each of the five pavement categories: 1) full-depth pavement (asphalt concrete pavement without granular base); 2) thick pavement (5- to 10-inch asphalt concrete pavement with granular base); 3) thin pavement (2- to 5-inch asphalt concrete pavement with granular base); 4) composite pavement (asphalt overlay on top of Portland Cement Concrete Pavement (PCCP)); and 5) PCCP. Performance regression functions were created based on pavement age and pavement conditions for every category. It is recommended that performance functions be calibrated after each pavement condition survey. The survey can be conducted every two to four years, depending on the situation of pavement deterioration.

M&R plans were analyzed using MicroPAVER based on various budget scenarios, including:
1) the required budget to eliminate all major M&R backlog[2]; 2) the required budget to maintain current pavement conditions; 3) no funding; and 4) the city's current budget level. For this study, four types of M&R treatment were considered for each segment of roadway, including localized stopgap (safety), localized preventive treatment, global preventive treatment, and major repairs.

For small cities like Madison, street system is often underfunded. The lack of sufficient funding restricts pavement M&R work to maintenance- or preventive-oriented activities, which cannot improve pavement conditions. Furthermore, without appropriate maintenance and rehabilitation strategies, pavement will continue to deteriorate, or deteriorate with an accelerated rate, until damage becomes too severe to repair, requiring expensive reconstruction. Changing the status quo can be costly, as indicated by the scenario of eliminating pavement M&R backlog. Analysis shows that the current city five-year budget plan is only a fraction of the funding required to eliminate all backlogs by 2020. With the current funding level, the city

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[1] MicroPAVER™ is considered one of the best M&R management tools and endorsed by the American Public Works Association (APWA). Madison is the member of APWA.

[2] Backlog refers to the required pavement M&R work that cannot be performed due to the lack of funding.

cannot maintain its current pavement performance by 2020. Additional funding for pavement maintenance and major repairs is desired.

In M&R plans for different budget scenarios, pavement performance can be improved by replacing preventive maintenance work with major reconstruction for certain pavement sections, by optimizing major repair sequence, and by selecting appropriate preventive M&R strategies. In the current city's budget, several M&R five-year plans were developed, analyzed, and compared by maximizing overall pavement conditions and minimizing percentage of poor pavement areas by the end of 2020. The top two plans are recommended:  one has the better pavement performance, but its global M&R schedule may be difficult to implement; in the other plan, global M&R follows the current city's chip seal schedule, but results are less optimal and total budget exceeds city funding by $80,000 during the five-year period.

In conclusion, PMS can be instrumental in preserving pavement assets in the state of good repair. Based on the pavement condition survey and pavement performance prediction models, the multi-year M&R plans can be customized and optimized. Model results and monetary values associated with each plan provide necessary information to support data-driven and performance-based decisions on pavement investment by small communitie

# 1. INTRODUCTION

Pavement is the most expensive item associated with highway construction and rehabilitation. According to the SDDOT Fact Book 2014-2015, costs of road improvements are $1.3 million per mile for two-lane primary highway reconstruction and $222,000 per mile for milling and placing two-inch thick asphalt concrete overlay. For non-interstate state-owned highways, maintenance costs are approximately $5,000 per mile per year (Fact Book 2014-2015, SDDOT). Although the expenditure for sustaining and restoring aging pavement at a serviceable level is inevitable, overall cost can be reduced via timely, appropriate, and effective maintenance and rehabilitation (M&R) strategies. The pavement management system (PMS) is an effective way to address the growing concern of managing high expectation from the traveling public, while managing limited finances. A PMS is a set of tools or methods that assist decision makers in finding optimum strategies for providing and maintaining pavements in a serviceable condition over a given period of time (*1*).

Having recognized the importance of managing pavement in a systematic manner, Congress required states to develop and implement PMS with five management systems: (i.e., Bridge Management System (BMS), Safety Management System (SMS), Congestion Management System (CMS), Public Transportation Management System (PTMS), and Intermodal Management System (IMS)) through Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). An effective pavement management system requires reliable information about the road system, sophisticated measurement techniques for pavement conditions, and synergy between engineers and budget analysts to collaborate to develop pavement management strategies. In the past, these were insurmountable challenges faced by local agencies. Most local agencies can now plan and manage local roads and streets effectively and scientifically using computer databases, affordable paving technologies, skilled staff, and increased awareness of residents. Implementing a PMS is becoming a common and viable solution for locals to maintain a good state of repair and support a livable community with limited resources.

Madison is a typical rural community in South Dakota with a population of 6,747 at the 2010 census. It is home to Dakota State University. The city engineering department and public works department are responsible for managing all streets, sidewalks, and alleys or other pubic ways, including 53 miles of streets. Primary pavement maintenance practices, such as chip seal, have been regularly applied on a cyclic basis to extend pavement life and provide a good driving surface. Such treatments only provide temporary solutions to the surface and do not improve structural deficiencies. Most streets and roads in the city were built more than 30 years ago. Repeated traffic load and adverse weather has gradually deteriorated the pavement service quality and weakened its function. To prevent accelerated pavement deterioration on a large scale, the city is taking proactive approaches, such as the implementation of PMS.

The goal of this project is to provide the City of Madison with a PMS capable of meeting four specific objectives:

1) Build a city-wide GIS database for PMS t compatible and incorporable with the city's GIS system for other GIS related activities.
2) Identify feasible pavement maintenance strategies for city roads.
3) Recommend multi-year rehabilitation plans for different budget scenarios.
4) Provide implementation and training for the city to continue using PMS with updated condition data.

# 2. LITERATURE REVIEW

Literature review was performed mainly in the following areas: PMS overview, data collection, pavement condition assessment, survey equipment and technologies, database development, pavement performance prediction model, and selection of M&R strategies.

## 2.1 PMS Overview

Agencies use PMS as a planning tool to aid in identifying cost-effective strategies for maintaining a pavement network and determining the level of funding required to meet agency goals at the desired level of service. A PMS can be defined as the process that consists of collecting, analyzing, maintaining, and reporting pavement data, and assisting decision makers in finding minimum-cost optimum strategies for maintaining pavements in serviceable condition over a given period of time.

A PMS can provide objective information and useful data for analysis, allowing road managers to make consistent, cost-effective, and defensible decisions related to the preservation of a pavement network. A PMS can provide the basis for an informed understanding of possible consequences of alternative decisions. These decision-making activities can be conducted using pavement inventory and condition information stored in the pavement management database. Pavement analysis models include pavement deterioration models, treatment rules, and cost models. An agency can use its PMS to evaluate various pavement rehabilitation, maintenance, and preservation strategies, and estimate the impact of those strategies on the future condition of the pavement network for various budget levels.

Smaller local agencies have similar operational and organizational needs, and face the same challenges as state highway agencies. Lack of adequate resources to establish an initial database and set up the system, or lack of technical expertise to implement a system can keep local agencies from implementing PMS (*2*). Local agencies need a methodology to effectively manage various components of the pavement network.

For local agencies, it also is important to evaluate the benefit and associated cost for implementing PMS in those limited resources before the process begins. Each agency must conduct its own cost/benefit comparison associated with a PMS implementation (*3*). In previous literature, researchers noted a list of benefits for implementing PMS, which can be realized by local agencies by synthesizing pavement management literature and interviews with local agencies using PMS (*2; 3*). PMS will help local agencies realize these benefits:

- Create a centralized location for roadway inventory data, pavement condition information, pavement construction, maintenance, and rehabilitation records.
- Provide a means to monitor pavement network condition and a quantifiable assessment of network condition.
- Facilitate decision-making and increases the chance of making optimal decisions for rehabilitation, maintenance and trade-off option.
- Provide a method to analyze consequences of various funding levels on pavement conditions.
- Amend prioritization of pavement repair work for proper allocation of resources and reduce excessive rehabilitation costs.
- Grant an agency to answer “what-if” questions regarding pavement repair programs and funding levels.
- Provide information needed to analyze the cost-effectiveness of different treatment repairs.
- Justify budget needs to elected officials and other stakeholders.

The cost of a PMS includes cost for implementation and sustaining the PMS. Factors that can affect the cost of a PMS include:

- data collection and database building
- acquisition and installation of required software
- consultant services and personal training
- actual expenditures on the pavement for maintenance and rehabilitation

An agency can perform a quick analysis to understand cost-effectiveness of implementing a PMS, as it might be difficult to quantify all cost components or all the benefits of a PMS. Cost-effectiveness can help the agency minimize unwanted and excess cost and amend in the choice of equipment to implement a PMS more effectively.

The following sections contain a review of basic background, benefits, and associated costs to implement a PMS for local agencies; details on the PMS components, including data requirement; pavement condition assessment; data collection equipment and technologies; pavement performance models; and selection of M&R plans.

## 2.2 Data Requirement for PMS

Effectiveness of a PMS largely depends on data used (*4*). A properly functioning system relies on different types of data to provide vital input for inventory, pavement condition assessment, performance prediction, and improvement recommendations. In general terms, besides traffic volume, two types of data are collected for a PMS: inventory and condition. Inventory data describe physical elements of the road system that do not change markedly over time. Condition data describes the condition of elements expected to change over time. For useful pavement evaluation, pavement condition data should be collected periodically (*5*). Maintenance history and associated cost information also should be collected. The category for data collection is shown in Table 2.1.

**Table 2.1** Data Category and Content [(3)]

| **Data Category** | **Data Item** |
|---|---|
| Inventory | Pavement Surface Type, Pavement Structure, Pavement Age, Functional Class, Segment Length, Segment Width, Segment Use, Number of Lanes, Lane Width, Shoulder Type, Shoulder Width, Jurisdiction |
| Condition | Pavement Roughness/Ride Quality, Skid Resistance, Structural Load Capacity, Surface Distress |
| Maintenance History and Costs | Initial Construction, Pavement Maintenance, Rehabilitation, Reconstruction |
| Traffic | Traffic Volume, Type of Traffic |

Inventory data includes information such as: pavement surface type, pavement structure, pavement thickness, pavement age, functional class, segment length, segment width, lane use, number of lanes, lane width, shoulder type, shoulder width, jurisdiction and so on. Of the inventory data listed, items regarding segment use, physical dimensions of segment, such as length and width, pavement surface type, and pavement age, are required in a pavement database (*3*). Basic lane use information, including roadway, parking lot and airfield, will determine pavement condition assessment strategies under different pavement distress types. Another data item, pavement age, which is calculated from the date of last major M&R work, is required to develop a performance model and must be estimated if any value is missing. Other inventory data, such as pavement thickness and functional class, are not required for PMS, but it can be vital data used to group pavement sections into homogenous families for the development of pavement performance models. Required inventory items can vary for different PMS software. For example, MicroPAVER also requires rank (functional class). (NOTE: I think this is what they were trying to convey.)

Useful pavement evaluation should include pavement condition data collected periodically to document changes of pavement condition over time (*5*). If the quality of condition data is not reliable, recommendations provided by the system will be unreliable. Collected data items also change with the development of technology, including riding comfort collected at the AASHTO road test to a variety of indicators reflecting pavement roughness, skid resistance, structural load capacity and surface distress (*6*). The amount, quality and type of collected data items should be decided by each local agency considering costs and the level of data analysis required. However, as a minimum, pavement distress data must be collected to continue PMS development.

Traffic information is another PMS data item. Traffic load on a pavement section can directly impact the rate of pavement deterioration (*3*). Therefore, when economically possible, it is important to collect traffic data for use in the pavement management process. Both traffic volume and type of traffic are needed for pavement evaluation. Note that trucks and other heavy-weight vehicles contribute to most street damages, making it more critical to gather data on vehicles types rather than detailed passenger car counts. If traffic data is not available, functional classifications may be used as a surrogate measure.

Collecting all data items can be challenging for small agencies. As an example, the City of Bowling Green, KY, is responsible for maintaining 470 lane-miles of roadway. The city authority conducted a study to implement PMS in 2004 (*7*). The study report illustrates that pavement surface distress and roughness data are collected each year for half of the city's road network. To supplement this data, deflection and structural capacity data are collected on arterials and collectors once every three years using an electro-mechanical device named Dynaflect.

The exact type of data required for PMS is dependent on agency requirements and PMS software requirements. Beyond that, two general guidelines should be used for determining the extent of information to include in the network inventory (*3*). First, the data items should be easy to obtain and time-efficient so large amounts of time are not invested in the search for records. Second, the collected information should serve a purpose. If information will not be useful in decision-making for maintenance or rehabilitation of the network, it will most likely not be worth the effort to collect it. The PMS software still needs some specific data items to run. Based on the choice of PMS software, an agency should collect required data items accordingly.

## 2.3 Pavement Condition Assessment

The functions of a pavement are to support traffic load within its designed life cycle without losing its structural strength and provide road users a safe and comfort ride. Pavement evaluation records pavement characteristics that describe its performance through several indices. Pavement management systems started with the AASHTO Road Test conducted from 1956 to 1960 (*6*). Road test staff evaluated the performance of pavements in a way that would be independent of pavement type and could have universal application for describing a pavement's condition. The method developed and used at the road test was based on the pavement's present serviceability (riding comfort). Subjective estimates were obtained by riding over selected pavements judged to represent a wide range of conditions. Ratings were made on a continuous scale from 1 to 5 and were described as very poor, poor, fair, good, and very good. This subjective rating is called the Present Serviceability Rating (PSR), which reflects the riding quality or roughness of the pavement. Later, usual forms of distress associated with different PSR, such as rutting, faulting, cracking, patching, and raveling, were measured for pavement condition assessment. Currently, Pavement distress type is divided into a much more specific group, with 20 type for asphalt surface and 19 types for concrete surface. Surface friction information and deflection information were assessed as a part of pavement condition. A comprehensive pavement evaluation system was built, which includes functional evaluation and structural evaluation depending on which characteristic is being surveyed.

### 2.3.1 Functional and Structural Evaluation

Functional evaluation provides information about surface characteristics that directly affect users' safety and comfort (serviceability). Safety is evaluated in terms of skid resistance and surface texture, while serviceability is quantified through roughness measures.

Structural evaluation provides information on whether the pavement structure is performing satisfactorily under the traffic loading and environmental conditions. This includes surveys on pavement distresses and mechanical or structural properties of pavements. Surface deflection is measured as a pavement surface's vertical deflected distance as a result of an applied (either static or dynamic) load. Indicators evaluated in a surface distress evaluation are:  cracking, surface defects, transverse and longitudinal profile deformations, and miscellaneous defects of the pavement, such as patching. Cracking and surface defects vary between pavement types and generally are measured as a percentage of total surveyed area, as linear units, or as the number of defects. Among surface deformations, the most commonly observed are rutting in asphalt pavements, and faulting in concrete pavements. Although measured differently, both distresses are measured as the vertical deformation of the pavement with respect to pavement surface level.

In today's system, the key pavement characteristics usually considered in an evaluation by pavement function are:  roughness, skid resistance, mechanical/structural properties and surface distress (*8*).  Table 2.2 shows the available indicators and indexes for different pavement functions.

**Table 2.2** Pavement Functions and Characteristics [(8)]

| Evaluation Type | Pavement Function | Pavement Characteristics | Examples of Indicators and Indexes |
|---|---|---|---|
| **Functional Evaluation** | Serviceability | Roughness | International roughness Index (IRI), Present Serviceability Index (PSI), quarter-car index (QI) |
| | Safety | Skid Resistance | Macro-Texture, Micro-Texture, International Friction Index (IFI) |
| **Structural Evaluation** | Structural Capacity | Mechanical Properties | Surface Deflections |
| | | Pavement Distress | Cracking, Surface Defects, Profile Deformations |

### 2.3.2 Pavement Condition Index (PCI)

Saba et al. noted in his study that, at the project level it may be appropriate to evaluate distresses individually, but at the network level definition, some type of composite measure of performance indicator is necessary (*9*). To evaluate pavement condition in terms of distress, various composite indices, such as Pavement Surface Evaluation and Rating (PASER) and PCI, are proposed by different researchers. PASER and PCI are two types of composite indicators on pavement distress, where PASER is based on the estimated distress and PCI is determined by measured distress. PASER is a system for visually rating the surface condition of a pavement on a scale from 1 to 10, with 1 being a pavement in worst condition and 10 being a pavement in excellent condition (*2*).

PCI is a simple, convenient and inexpensive way to monitor condition of the road surface, identify maintenance and rehabilitation needs, and ensure that road maintenance budgets are spent wisely. PCI was developed by the United States Army Corps of Engineers (USACE) (*10*). The method is a composite index based on a visual survey of the number and types of distresses in a pavement. The analysis result is a numerical value between 0 and 100, with 100 representing the best possible condition and 0 representing the worst possible condition. The deduct value is based on the cracking type, severity, and the extent. DOTs may have a modified condition index similar to PCI.

There are six steps to estimating PCI:

1. Identify branches of the pavement with different uses, such as *roadways* and *parking*, on the network layout plan.
2. Divide each branch into sections based on the *pavements design, construction history, traffic, and condition*
3. Create Table 2.3.
4. Determine the number of sample units for inspection.
5. Compute the spacing interval of the units using systematic random sampling. Samples are spaced equally throughout the section with the first sample selected at random. Space interval $i = N/n$ Where N= total number of sample units in the section, n= number of sample units to be inspected.
6. Quantify distresses and determine the deduction value (DV) based on guidelines provided by American Society for Testing and Materials (ASTM).

**Table 2.3** Sample Unit Area for Each Road Surface Type [10]

| Road Surface Type | | Sample Unit Area |
|---|---|---|
| unsurfaced and asphalt surfaced (including asphalt over concrete) | | 2500±1000 sq ft |
| concrete | slab joint space≤25ft | 20±8 slabs |
| | slab joint space>25ft | subdivide each slab into imaginary slabs |

The PCI of the section ($PCI_s$) is calculated as the area weighted PCI of the randomly surveyed sample units ($\overline{PCI}$):

$$PCI_s = \overline{PCI} = \frac{\sum_{i=1}^{n}(PCI_i * A_i)}{\sum_{i=1}^{n} A_i}$$

Where, $\overline{PCI}$= area weighted PCI of randomly surveyed sample units;
$PCI_i$= PCI of random sample unit I;
$A_i$= area of random sample unit I;
n = number of random sample units surveyed.

For local agencies, the types of pavement condition to be evaluated are determined by anticipated objectives and available funding. As a minimum, pavement distress must be evaluated for PMS. Besides pavement distress (*2*), other information, such as roughness, skid resistance and deflection, should be evaluated with the increasing funding. For example, SDDOT evaluated deflections during data collection.

## 2.4 Survey Equipment and Technologies

Collecting each data item is expensive. It requires time, effort, and money to collect, store, retrieve, and use. Multiple technologies exist for measuring attributes of the road network. The challenge is to select the appropriate equipment, given local conditions and applications. Bennett, et al. (*11*) reviewed various types of data collection technologies available for pavements management and developed a framework by which an agency could identify the most appropriate technologies based on need.

Data collection equipment can be divided into five classes, according to the type of pavement characteristic being evaluated: equipment for measuring location, geometry, serviceability, safety, and structural capacity. Each class is subdivided by equipment type according to type of data collected, data accuracy, and methodology used to determine pavement characteristics. Table 2.4 presents a summary of equipment types by function and class.

**Table 2.4** Equipment Type by Function and Class [(11)]

| Function | Equipment Class | Types of In-situ Measuring Equipment[(8; 11)] | Initial Cost [(11)] |
|---|---|---|---|
| Location or Geometry | Location Referencing, Geometry | Digital Distance Measuring Instruments (DMI) | $400-$2,000 |
| | | GPS | $150-$5,000 |
| | | Video Logging | $1,000-$8,000 |
| | | Inertial Navigation Units | $3,000-$5,000 |
| Serviceability | Roughness | Laser Profilometer | $25,000-$50,000 |
| | | Manual (Rod and Level) | |
| | | Response-type Roughness measuring system | |
| Safety | Skid Resistance / Surface Texture | Static Laser Scanning | |
| | | Locked Wheel Tester | >$50,000 |
| Structural Capability | Mechanical Properties | Falling Weight Deflectometer | >$50,000 |
| | | Deflection Beams | |
| | | Dynamic Cone Penetrometer | |
| | | Clegg Hammer | |
| | Surface Distress | Video Distress Analysis | >$50,000 |
| | | Visual Surveys | |
| | | Ultrasonic, Point and Scanning Lasers | |

### 2.4.1 Location and Geometry Measuring Equipment

Proper location referencing is essential for all surveys. Both structural and functional evaluations can be successful only when using an efficient and accurate referencing methodology (*11*). Typical referencing technologies include: distance-measuring instruments (DMI), Global Positioning Systems (GPS) and video logging. DMIs are precision odometers that measure linear-traveled distance. The pulse generator of DMI is attached to the vehicle's transmission, speedometer sensor, or to a wheel. It also must be calibrated against a known distance. Accuracy of the measurements is proportional to the number of pulses per revolution of the pulse generator. As a result, instruments must be recalibrated periodically, as the number of pulses/km changes as the tires wear. Portable Global Positioning System (GPS) equipment typically outputs latitude, longitude, and elevation in WGS84 datum. The data can be manually recorded or logged automatically with other data using linear referencing. GPS signals can be blocked by nature obstructions (trees, hills, etc.) or urban buildings. The signal reflection with urban buildings can also give inaccurate readings. Therefore, inertial navigation systems are used to estimate trajectory data when GPS signal is lost. Additional filtering systems also are used with GPS to improve the accuracy of the estimates.

### 2.4.2 Roughness Measuring Equipment

Many types of equipment are available for measuring pavement roughness (*12*). Typically, profilers are used equipment that measures surface roughness. A profilometer is a measuring device that measures relative surface roughness, peak to valley, to quantify its roughness. It may operate in either contact or non-contact modes and may use optical or stylus techniques to obtain the actual measurements. A laser profilometer is the most accurate device used to measure pavement roughness. It measures the roadway profile as a series of closely spaced, accurate elevation points in the wheel-path. The distance between points must be short to achieve a high accuracy for describing the road profile. The laser profilometer can be mounted on a survey vehicle to collect pavement roughness (profile) data. Manual roadway profilers, such as rod and level, are conventional surveying equipment, which consists of a precision rod, a level for establishing the horizontal datum, and a tape to mark the longitudinal distance for elevation measurement (*8*). Response-type road roughness measuring systems (RTRRMS) measure the dynamic response of the vehicle to the road, either mechanically or by using accelerometers. Since the vehicle's response changes over time, the systems usually require recalibration. Different types of profilographs[3] such as rolling-straight edges, are considered RTRRMS devices that sense displacements relative to a moving datum.

### 2.4.3 Skid Resistance Measuring Equipment

Skid resistance measuring equipment can be either dynamic or static devices. All types of available devices can measure both transverse and longitudinal skid resistance. Dynamic skid resistance measurements are made either by a locked- or partially-locked-wheel procedure. Equipment can be subdivided into two groups: vehicle-mounted devices and portable devices. Cost and operational characteristics are substantially different for both groups. The trailer is towed at a standard speed and water is applied in front. After the test wheel has been sliding on the pavement for a certain distance to stabilize temperature, friction force in the tire contact patch is recorded for a specified period of time. The initial cost of trailer systems commonly is more than $50,000. The vehicle-mounted systems have significantly higher initial (>$250,000) and operating costs than trailer systems. A laser scanner is a recently-proposed surface texture measuring device with higher accuracy (*13*). Laser scanners can be used to obtain information on areal surface layer through a single measurement, with data homogeneity and representativeness.

### 2.4.4 Mechanical Properties Measuring Equipment

Many different devices are commercially available for measuring deflection or mechanical properties of a roadway pavement. Researchers grouped the deflection measuring devices based on loading mode as: impulse, steady-state dynamic and static (*8*). The Falling Weight Deflectometer (FWD) is the most commonly used impulse deflection device. It applies loadings with a frequency and magnitude similar to that applied by heavy traffic. Sensors, or geophones, are used to measure deflections at several points of the deflection basin. Steady-state dynamic deflection devices also use a similar mode of operation. A relatively large static preload is applied to the pavement and a sinusoidal vibration is created by the dynamic force generator. In general, pavements do not exhibit a linear load vs. deflection relationship. By varying the load, a better characterization of a pavement's response to load can be obtained. Many agencies have replaced steady-state deflection equipment with FWD type devices. One steady-state deflection device still used by some agencies is the Dynaflect. Deflection beams are static devices that consider all moving-wheel approaches that measure pavement deflections. These usually are referred to as

[3] The profilograph is a device used to measure pavement surface roughness. In the early 20th century, profilographs were low speed rolling devices. Today many profilographs are advanced high speed systems with a laser-based height sensor in combination with an inertial system that creates a large scale reference plane.

Benkelman Beams and deflectographs. A Benkelman Beam is a manually-operated device placed on the road surface. Maximum rebound deflection is recorded as the test vehicle moves away. The device is easy to use and has low initial and operating costs; however, it also is slow and not as accurate as FWDs. Additional in-situ equipment is available to measure the mechanical property of pavement, such as the Dynamic Cone Penetrometer (DCP) and Clegg Impact Soil Tester etc. These devices include standard test methods for determining the impact value of a soil (*11*).

### 2.4.5 Surface Distress Measurement Equipment

Pavement surface distress measurements cover a range of distresses, from potholing and cracking to surface deformations, such as rutting. Surface distresses can be captured by several methods. McGhee (*14*) noted that approximately one-half of the reported agencies use the manual data collection method, and automated approaches will soon be more commonly used. Visual distress recording is based on visual observations of distress and recording the extent, severity, and location of the distress on either paper forms or some type of data logging system. With the advent of low cost PDAs, many organizations have transferred paper-based methods to electronic methods (*11*). Digital imaging or video distress surveys are used to record and quantify cracking and surface distresses. The system consists of an imaging unit, which records either still or continuous images of the pavement, and a means for analyzing images manually or automatically. The two types of digital cameras used for distress recording are area scanning and line scanning. Lasers also are used to obtain specific distress type, such as rut depth, ultrasonic, point, and scanning (*11*).

It is helpful to compare relative merits of different equipment against one another and to have different types of equipment available for collecting pavement data. Bennett et al. (*11*) researched what types of equipment are preferable under certain circumstances. They calculated the suitability index by a linear equation, which includes cost and operational characteristics. Each component of the equation was assigned a weight, related to its importance on cost and operation of equipment. The difference in weight between pavement classes was attributed to operational characteristics of equipment, which may be more significant in the roads having a higher standard than the costs of acquiring and operating the equipment. On the other hand, roads of lower standards should focus on lower cost technologies. The authors ranked suitability indexes for different equipment and prepared a cost/performance trade-off matrix based on that ranking. The cost/performance trade-off matrices are provided in Appendix C. The authors concluded that, as a general rule, if an agency has budgetary restrictions, equipment selected for pavement data collection should be located in the right bottom boxes shaded in the matrix. Specialized needs that require specialized equipment may necessitate going beyond that area. Agencies with limited budgets or technical skills should focus on the 4–5 areas of the matrix.

Choice of equipment and techniques during data collection depends on the condition of the items evaluated. For most local agencies, distress data collected using manual methods was chosen because of its low cost. When a high accuracy of the distress information is required, automated methods are preferred. Equipment and technologies associated with other condition items can be chosen using Bennett's study as reference (*11*). For example, in Washington State, three types of condition assessment were performed by local agencies:  visual rating, nondestructive testing (NDT), and destructive testing (*3*).

## 2.5 Development of PMS Database

After data are collected, they are stored and organized to index and query information for decision-making. While computer technologies transform paperwork-based data storage to a digital database, a geographic information system (GIS) can further capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data. In a GIS system, linear referencing is the most commonly used method for road data and spatial location. Most data collection technologies use linear referencing. Data are recorded between a start and an end point. Addresses usually are expressed relative to the start point and ideally, intermediate points. The use of intermediate reference points improves the overall accuracy by limiting any accumulative error in the distance measurements. According to *Pavement Performance Database User Reference Guide (15)*, four basic linear referencing methods (shown in Table 2.5) are used with highway data.

**Table 2.5** Linear Referencing Methods (*15*)

| Linear Referencing Methods | Description |
|---|---|
| Mile Point Method | Use the measured distance from a given or known point to the referenced location |
| Mile Post Method | Use of physical posts-signs are placed at regular intervals along the road, usually one per mile |
| Reference Post Method | Similar to the Mile Post method, except the signs are not at regular intervals |
| Reference Point Method | Use regular identifier features, such as bridges, culverts, light posts, or intersections as referenced locations |

Road surface condition data are collected for the purpose of building effective asset management systems to support the analysis of maintenance and rehabilitation (M&R) strategies. With more data, the need increases to identify homogeneous road segments and use data effectively for planning M&R strategies. In the database, pavement segments must be grouped into homogeneous sections to continue analysis for performance model development and selection of M&R plans. Gendy, et al (*16*) discussed current strategies, i.e. cumulative difference approach (CDA) and absolute difference approach (ADA), for segmenting linearly-referenced pavement condition data and the limitations of these segmentation methods. CDA is a simple and powerful analytical method for segmenting linearly-referenced road condition information. The CDA creates segment borders at maxima and minima locations of the cumulative difference between a response indicator and the average response over an entire section. This approach can be applied to a variety of measured pavement response variables such as International Roughness Index (IRI). ADA depends on limiting the absolute difference between response values within each segment by defining a sliding window that controls the maximum difference between individual responses in each segment.

Once the database is built, updates should be made on inventory, pavement condition, and work history data, and so on. Inventory information does not need to be updated unless a new road is constructed or an existing pavement is rehabilitated. To gather condition data, local agencies must decide how often to conduct the pavement survey, which depends on factors such as funding, staff levels and deterioration rate of the pavement. Based on interviews with counties throughout Washington, it is common for these agencies to inspect arterials every other year and other roads (such as local access and residential) every three years (*3*). State DOTs have complete data items for the development of a PMS database. Compared with state DOTs, local agencies either lack in adequate data items, or different data items are stored in different data sources making it difficult to link all data items.

## 2.6 Pavement Performance Model

A pavement performance prediction model is an integral part in the PMS process. The model is used to objectively identify and prioritize pavement maintenance and rehabilitation work within a best combination of projects over a multi-year program. Pavement performance models predict future condition and suggest timing of needed rehabilitation, and then identifies projects that need minor rehabilitation, major rehabilitation or reconstruction (*17*).

Before reviewing different types of pavement performance models, it must be noted that in spite of an enormous effort made in the pavement engineering field, it is still not possible to make accurate, precise predictions of pavement life (*18*). Saba et al. noted that the available performance prediction models have several limitations. Most of the prediction models involve large simplifications (e.g. in material behavior), some models contain input factors that are difficult to quantify, and most are not comprehensive (do not consider all influencing factors) (*9*). This can be due to factors that can affect pavement performance. Pavement performance can be affected by traffic, structural composition, and environmental factors (*19*). Traffic loading associated factors that can affect pavement performance include traffic volumes, axle loads, number of Equivalent Single Axle Loads (ESALs), tire pressure, type of axles and configuration, load application time, speed etc. Structural composition factors that affect pavement performance most are layer thickness and the main engineering properties of materials used in pavement construction. Environmental associated factors include soil moisture, temperature, freeze and thaw cycles, humidity and precipitation, movement of ground water, capillary water or surface water (*9*).

A pavement performance model can be considered an empirical relation of extrinsic time factors, such as age or number of load applications, to a combination of intrinsic factors, such as structural responses, material properties, drainage, etc., which indicates future performance of pavement. Several performance prediction models have been proposed over the years, some are simple and others are more complex. Haas grouped performance prediction models into three classes: Empirical, Mechanistic-Empirical and Subjective (*20*). Empirical models are based on developing empirical equations with one or more independent variable. A performance model can be a Mechanistic-empirical class model if the stress-strain curve is calculated using principles of mechanics and an empirical transfer function exists to convert response into damage or performance. Subjective models are experience-based models where serviceability loss or other measures of deterioration vs. age are estimated for different combinations of variables.

Gupta et al. also categorized flexible pavement performance models into three categories based on the inclusion of attributes in a model (*19*): surface characteristics-based models, environmental factors-based models, and pavement performance rating models. Surface characteristics-based models mainly include roughness, rut depth, raveling, and potholes etc., generated as a result of traffic factors. The pavement age also is considered in development of such models. Models based on environmental factors include the effect of various environmental factors that can affect pavement performance. Pavement performance rating models allow defining the performance of the pavement using certain arbitrary or weighted values, which varies within a certain range.

An agency can develop its own pavement performance model in several ways. Before developing a performance model, an agency should understand the type of performance model to be used in its pavement management software, both in terms of limitations and appropriate uses. The agency also should understand data needed to support the model. Two broad categories of developing pavement performance models exist: deterministic and probabilistic (*3; 21*). The main difference between the models are model development concept, modeling process and formulation, and model output (*22*). Deterministic models draw relationships between dependent variables with other explanatory variables and predict average value of a dependent variable, such as the remaining life of a pavement or its level of distress. Deterministic models used in pavement management primarily are based on regression analysis. Probabilistic models predict a range (or distribution) of values for a dependent variable. Most probabilistic models used in pavement management are based on Markovian theory (*3*). Broten noted in his study that deterministic performance models are used widely by Washington State local agencies (*3*). It also is relatively easy to apply regression analysis to build deterministic pavement performance models.

Different types of deterministic models can be developed, based on the model forms. The most common model forms for deterministic pavement performance models are linear, polynomial and hyperbolic. The model form also should be selected after reviewing each form, therefore choosing the form that will best represent agency data. Model complexity and model interpretation also should be carefully considered. Using family models can help in addressing this issue, as they can reduce the number of variables needed to develop performance prediction models. Family models group pavement sections by similar characteristics and assume similar deterioration trends for each family. This model also allows a range of values of explanatory variables to be used for developing pavement families.

Various indices are proposed by different researchers to express pavement performance. Saba et al. noted that, at the project level, it may be appropriate to evaluate distresses individually, but at the network level definition, some type of composite measure of performance indicator is necessary (*9*). Several examples of available condition rating indices are: PSI (Present Serviceability Index), PCI (Pavement Condition Index), and PCR (Pavement Condition Rating).

Different indicators, such as individual distress index and composite distress index (PCI and PSR), are used for the development of performance models. SDDOT conducted a study to develop pavement performance models to enhance the PMS used in South Dakota (*23*). The research team designed a questionnaire to extract expert opinion from experienced SDDOT engineers, as there was insufficient historical data to develop necessary models using statistical procedures. Using the answers provided from those questionnaires, the research team developed a set of deduct values necessary to convert raw condition data to a set of condition indexes and a family of performance curves for each condition index with one family member for each different pavement type. SDDOT conducted another study in 1997, which aimed to develop pavement performance curves with two years of historical data, and divided pavement families using thickness type and surface overlay type (*17*). The research team used a least square curve fitting approach to produce performance curves for individual pavement distress from historical data. For asphalt concrete overlay, distress types include: block cracking, fatigue cracking, patch deterioration, roughness, rut depth, and transverse cracking. Four types of functional form, including linear, cubic, quadratic, and Washington State model forms, were initially adopted as model functional form. Therefore, the final model equation used in this study is as follows:

$$PCR = C - M * Age^{B}$$

Where,

C = the maximum value of the PCR (pavement condition rating for individual distress);
M = the slope coefficient of each curve;
Age = pavement age;
B = the exponential coefficient for each curve.

Though the SDDOT models were available for this study, the team did not want to apply the models without accessing the applicability of these models. After reviewing pavement performance curves developed with historical data for the use of PMS in SDDOT, the research team decided to abandon the SDDOT pavement performance models for this study for reasons listed below:

- SDDOT pavement performance models were developed for state highways, which may not be applicable for city roads.
- SDDOT used pavement distress models rather than PCI models. It could be difficult to convert pavement distress models to PCI models.
- The SDDOT models had to be shifted for use on Madison city roads. A curve shift cannot guarantee the accuracy.

Composite indicators, such as PCI and PSR, have recently become more adapted for the development of performance model. PCI primarily is used to develop performance prediction models for the following reasons (*3*):

1. PCI are used for determining when to take action on or apply a treatment to any specific section of pavement.
2. Individual PCI also may be used to help select more specific pavement rehabilitation treatments, thus providing more detailed and usually more accurate cost estimates in the PMS analysis programs.
3. PCI are used to monitor the overall condition of the network.

Instead of PCI, Present Serviceability Rating (PSR), another composite index, can be used to evaluate pavement performance. Lee et al. developed a pavement performance model considering PSR as a dependent variable to estimate performance of the overlaid pavement when existing data were not sufficient to construct both initial and overlaid pavement performance function (*24*). The predictive model is shown as follows:

$$PSR = PSR_i - a * STR^b * AGE^c * CESAL^d$$

Where,
$PSR_i$ = initial value of PSR at construction (4.5 used in analysis);
STR = existing pavement structure;
AGE = age of pavement since construction or major rehabilitation;
CESAL = cumulative 18-kip equivalent single-axle loads (ESALs) applied to pavement in the heaviest traffic lane.

Illustration of a performance model using PCI is shown in Figure 2.1. PCI decreases as pavement age increases, which indicates that pavement condition deteriorates by time. The performance model can be linear or nonlinear. The nonlinear form includes cubic, quadratic, polynomial (used in MicroPAVER software) and Washington State model forms, etc.


**Figure 2.1** Illustration of Non-linear form of Pavement Performance

## 2.7 Pavement Maintenance & Rehabilitation

One of the major expenses in a state or city budget is maintaining and rehabilitating roadway network systems within the city/ state jurisdiction. Thus, the planning of pavement maintenance and rehabilitation (M&R) projects plays an important role in pavement management activities. It involves structural or functional enhancement by adding existing layers in the pavement structure to enhance pavement performance, increase ride quality, and extend service life.

M&R treatments are divided into four parts, also adopted by MicroPAVER: localized stopgap (safety) M& R, localized preventive M& R, global preventive M& R, and major M&R (*8*). Localized stopgap M&R, such as crack sealing and patching, is applied to pavements below the critical PCI to maintain pavement at a safe condition until extensive M& R treatment is performed. Localized preventive M& R and global preventive M& R are applied to pavements above the critical PCI to slow the rate of deterioration. Unlike localized preventive M& R, which is performed only on the distress spots, global preventive M& R, such as chip sealing and slurry sealing, is applied to the entire pavement section. Major M& R, such as mill and overlay, and reconstruction, applies the whole pavement section either above or below the critical PCI, to correct or improve the current pavement condition.

M&R treatment could affect both the short-term jump and long-term performance curves. Table 2.6 shows the M&R treatment adopted by SDDOT and the associated condition change for the six distress index (rating scale is 0-5, with 5 is good) in South Dakota (*23*). In this table, “A” refers to “Absolute reset means when the treatment is applied, the index gets reset to the value supplied”; “R” refers to “Relative reset means when the treatment is applied, the index gets reset by adding the amount of improvement to the current value of the index;” and “N” refers to “No reset means that the treatment has no effect on the index.” Reconstruction, AC overlay, Mill and AC overlay, mill and replace, cold in-place recycle, rout and seal, and chip seal are the main M&R treatments adopted by SDDOT. Observed from the table, Mill 1-inch w/ 3.5-inch AC Overlay, 2-inch Mill and Replace, and Cold In-place Rec w/ 3-inch Overlay can reset all the six distress index to 5, while Route and Seal has no effect on pavement condition. Chip seal can add distress index including transverse cracking, fatigue cracking, patch deterioration and block cracking by 1.

**Table 2.6** Effect of M&R Treatment on Pavement Condition [(23)]

| Treatment Description | Transverse Cracking | Fatigue Cracking | Patch Deterioration | Block Cracking | Roughness | Rut Depth |
|---|---|---|---|---|---|---|
| Reconstruction | A-5 | A-5 | A-5 | A-5 | A-5 | A-5 |
| 2" AC Overlay | A-5 | A-5 | A-5 | A-5 | A-5 | A-4.8 |
| Mill 1" w/ 2" AC Overlay | A-5 | A-5 | A-5 | A-5 | A-5 | A-4.8 |
| Mill 1" w/ 3.5" AC Overlay | A-5 | A-5 | A-5 | A-5 | A-5 | A-5 |
| 2" Mill and Replace | A-5 | A-5 | A-5 | A-5 | A-5 | A-5 |
| Cold In-place Rec w/ 3" Overlay | A-5 | A-5 | A-5 | A-5 | A-5 | A-5 |
| Rout and Seal | N-0 | N-0 | N-0 | N-0 | N-0 | N-0 |
| Chip Seal | R-1 | R-1 | R-1 | R-1 | N-0 | N-0 |

The slope of the resulting pavement performance curve also can impact the type of treatment. To understand the use of slope information, the pavement performance models developed by South Dakota Department of Transport (SDDOT) was reviewed (*23*). In pavement performance models developed by SDDOT, they followed the slope of the performance curve at the current age of the pavement to predict the future condition index value. By following this assumption, the software used for PMS implementation in SDDOT shifted the performance curve horizontally if the current age point for the condition index did not fall on the performance curve. This "shifting" can happen in two different situations (a) at the beginning of the analysis for a particular pavement section, and (b) after a treatment has been applied and the condition indexes have been reset. By recalling the assumption that the slope of the performance curve increases with the increase in pavement age, this can reinforce a second mechanism—that resetting the pavement age can help to show the impact of a treatment implemented on a pavement section. As an example, if the implementation of a treatment resets the pavement age back to zero, the resulting curve will have a smaller slope compared to the slope it would have if the age was not set back to zero.

At a certain point in the lifespan of a flexible pavement, some rehabilitation activity is required, not only to improve pavement condition and enhance its structural integrity, but also to defer the need for reconstruction. A critical issue facing pavement managers and engineers is the assessment of cost-effectiveness of various flexible pavement rehabilitation treatments to identify the best rehabilitation alternative. Irfan et al. (*25*) analyzed cost-effectiveness of the following flexible pavement rehabilitation treatments:  Functional HMA Overlay, Structural HMA Overlay, Resurfacing (partial 3R standards), and Mill Full-depth and Asphaltic Concrete Overlay. Effectiveness was measured in terms of the immediate jump in pavement performance (short term), treatment service life, and increase in pavement performance (long term). Results suggested that on the basis of treatment service life, HMA functional overlay appeared to be the most cost-effective treatment, followed by resurfacing; and on the basis of immediate performance jump and increase in pavement performance, HMA structural overlay was found to be the most cost-effective, followed by HMA functional overlay. Candidate M&R treatments for local agencies should be decided regarding the cost, resources and common practice is this area.

# 3. PROJECT WORK FLOW

Eight steps should be processed to implement PMS for local agencies, as shown in Figure 3.1 (*8*). For local agencies such as the City of Madison, PCI was chosen as the performance indicator.

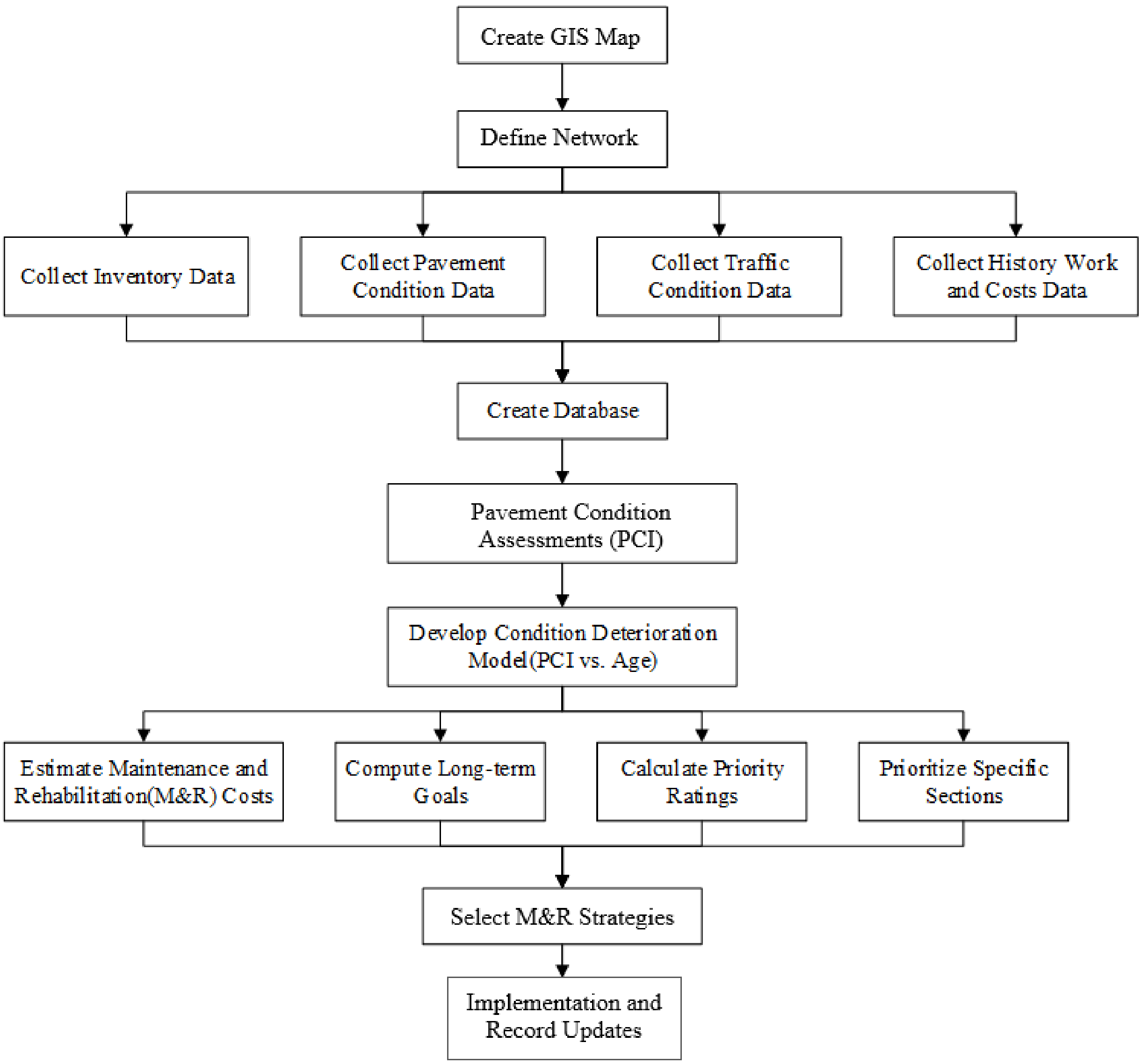



**Figure 3.1** PMS Process Flow Chart

**Step 1 GIS Map Creation**

Obtain local agency data to create GIS map, which will allow all infrastructure facilities to be in correct spatial reference to each other.

**Step 2 Network Definition**

Divide network into branches and sections.

**Step 3 Data Collection**

Collect inventory data, pavement condition data, traffic condition data, history work and costs data.

**Step 4 Development of GIS Database**

Create the system's database and convert into a GIS shape file, using defined networks, collected inventory data, pavement condition data, traffic condition data and history work and costs data.

**Step 5 Pavement Condition Assessments**

Calculate PCI from gathered distress data.

**Step 6 Development of Pavement Performance Model**

Develop pavement performance curve both for individual sections and pavement families.

**Step 7 Selection of M&R Strategies**

Select M&R strategies for each section based on M&R costs, long-term goals, priority ratings, prioritized specific sections, and budget requirements. First, estimate standard unit costs (dollars per square yard) based on different pavement types and M&R strategies. Second, select a planning horizon to meet the management objectives. Third, develop priority index for each section based on PCI, deterioration, traffic volume and history work. Finally, prioritize specific sections and put the sections of political or other importance in higher priority.

**Step 8 Implementation and Record Updates**

Conduct M&R activities and update the history work data into the database.

# 4. COMPARISON OF AVAILABLE PMS TOOLS

Recent Pavement management software can combine the database, analysis scheme and decision criteria in one package. Wolters et al. (2) introduced and evaluated eight PMS software packages based on their analysis methods, report output, and costs, etc. The packages were divided into public domain software and private domain software. Public software is suitable for agencies that need a standard rating system, while the rating system for private software is more customized. Public software provides simplest analysis functions and reporting approaches, while private software analysis and reporting functions are more robust and customizable. Meanwhile, public software costs less than private domain software. In terms of local agencies, such as a small city like Madison, public domain software such as MicroPAVER and StreetSaver are preferred.

Three public PMS software packages also were compared: MicroPAVER, StreetSaver and Cartegraph. The comparison was performed by exploring MicroPAVER and interviewing the sales managers for StreetSaver and CarteGraph. The comparison among these software packages is shown in Table 4.1.

MicroPAVER was originally developed in the mid-1980s by the U.S. Army Corps of Engineers (USACE) to help the Department of Defense manage maintenance and repair for its vast inventory of pavements (*26*). MicroPAVER is a decision-making tool for the development of cost-effective maintenance and repair alternatives for roads and streets, parking lots, and airfields. The software allows for the creation and storage of: pavement network inventory, pavement condition rating, pavement condition performance prediction development, present and future pavement condition prediction through condition analysis, and maintenance and repair needs determination through the analysis of different budget scenarios.

StreetSaver was developed by the Metropolitan Transportation Commission (MTC), which is responsible for transportation planning, financing, and coordinating nine counties in the San Francisco Bay Area, CA (MTC 2009). StreetSaver is an online-based PMS program that helps users to inventory roadway section, minute field inspection data, evaluate pavement performance, and create M&R plans.

Cartegraph is an asset management system that can help agencies track resources, maintain assets, intake requests, and manage workflow. Cartegraph can deal with PMS and other asset managements, such as water and estate management. Since Madison already has an asset management system, this program was not further explored.

**Table 4.1** Comparison among MicroPAVER, StreetSaver and Cartegraph

| | **MicroPAVER** | **StreetSaver** | **Cartegraph** |
|---|---|---|---|
| Vendor | U.S. Army Corps of Engineers | Metropolitan Transportation Commission | Cartegraph |
| Ability to Analyze Another Assets | No | Yes, sidewalks, lights, sign, curb and gutter, etc. | Yes |
| Default Pavement Condition Rating Measure | PCI | PCI | PCI |
| Field Inspection Reference | ASTM D-6433* | ASTM D-6433 | ASTM D-6433 |
| Analyzes Different Maintenance Strategies | Yes | Yes | N/A |
| Analyzes Different Budget Scenarios | Yes | Yes | N/A |
| GIS Integration | Yes | Additional software needed | Yes |
| Customization Capabilities | Yes | Yes | N/A |
| Cost (2011) | APWA members $995; non-members $1095 | $750/year; initial development/consultant license charge is $1500 | $5000+ |
| User's Manual | Yes | Yes | Yes |
| Technical Assistance | Training courses or four-part web-based training | 4-day training class twice per year and customized on-site training | N/A |

*Standard Practice for Roads and Parking Lots PCI Survey by American Society for Testing and Materials (ASTM)

The comparison between MicroPAVER and StreetSaver shows three major differences:

1. Information Access: MicroPAVER is a desktop application, while StreetSaver is an on-line application. As an on-line application, StreetSaver can be accessed from any place and at any time with multiple users' access and an Internet connection. Services provided by the StreetSaver vendor also include database storage, recovery, and backup. However, with a city the size of Madison, even with all benefits offered through such an online application, costs make it difficult to justify use.
2. Price: MicroPAVER charges one-time license fee for $995 for APWA members (note City of Madison is an APWA member) and also offers a company data collection tool, RoadInspector, for free. StreetSaver charges $750 annual service fee in addition to a $1,500 initial development/consultant license fee.
3. Pavement Distress Types: Although both MicroPAVER and StreetSaver comply with the ASTM D-6433 standards, MicroPAVER has more complete distress types (20 for asphalt pavement and 19 for concrete pavement) than StreetSaver (seven for both asphalt and concrete pavement types). MicroPAVER also has distress types for gravel roads, which are unavailable in StreetSaver. The distress types for MicroPAVER, StreetSaver and SD Distress Manual are shown in Table 4.2.

**Table 4.2** Distress Types in MicroPAVER, StreetSaver and SD Distress Manual

| | MicroPAVER | StreetSaver | SD Distress Manual |
|---|---|---|---|
| Flexible Pavement | Alligator CR[1]; Block CR; Bleeding; Corrugation; Depression; Edge CR; Bumps/Sags; Joint-Reflection CR; L&T[2] CR; Lane Shoulder Drop; Patching; Polished Aggregate; Pothole; Reveling; Rutting; Shoving; Slippage CR; Swelling; Weathering; Railroad Crossing | Alligator CR; Block CR; Distortions; L&T CR; Patching&Patch Deterioration; Rutting/Depression; Weathering&Reveling | L&T CR; Fatigue CR; Block CR; Patching&Patch Deterioration |
| Rigid Pavement | Blow-Up; Corner CR; Linear CR; Durability CR; JT Seal Damage; Small Patch; Large Patch; Popouts; Pumping; Scalling; Shrinkage CR; Joint Spall; Corner Spall; Divided Slab; Lane SH Drop; Polished Aggregate; Punchout; Railroad Crossing; Faulting | Corner CR; Divided Slab; Faulting; Linear CR; Patching&Utility Cuts; Scaling/Map CR/Crazing; Spalling | Durability CR; Alkali-Silica Reactivity; Joint Spalling; Corner CR; Punchouts; Joint Seal Damage |
| Gravel Pavement | Corrugation; Dust; Improper Cross Section; Dust; Pothole; Rutting; Loose Aggregate; Inadequate Roadside Drainage | N/A | Corrugation; Dust; Improper Cross Section; Inadequate Roadside Drainage; Loose Aggregate; Potholes; Ruts |

CR is in short for Cracking
L&T is in short for Linear & Transverse

MicroPAVER was recommended based on the following features:

1. complete distress types and high degree of consistency with SD distress manual
2. integration with existing GIS map
3. affordable price for small agencies with APWA membership discount, no annual fee
4. data stored locally

The application of various modules in MicroPAVER for this project was blended in sessions, described below, and supported by screenshots from MicroPAVER.

# 5. DATA COLLECTION AND PROCESSING

## 5.1 Data Collection Plan

A detailed data collection plan for pavement distress and attribute information was developed. There are 633 city-maintained road segments in Madison, constituting 53 miles. Data collection started in early June 2014 and lasted one week (five working days). Specific route information for daily survey is presented in Figure 5.1.

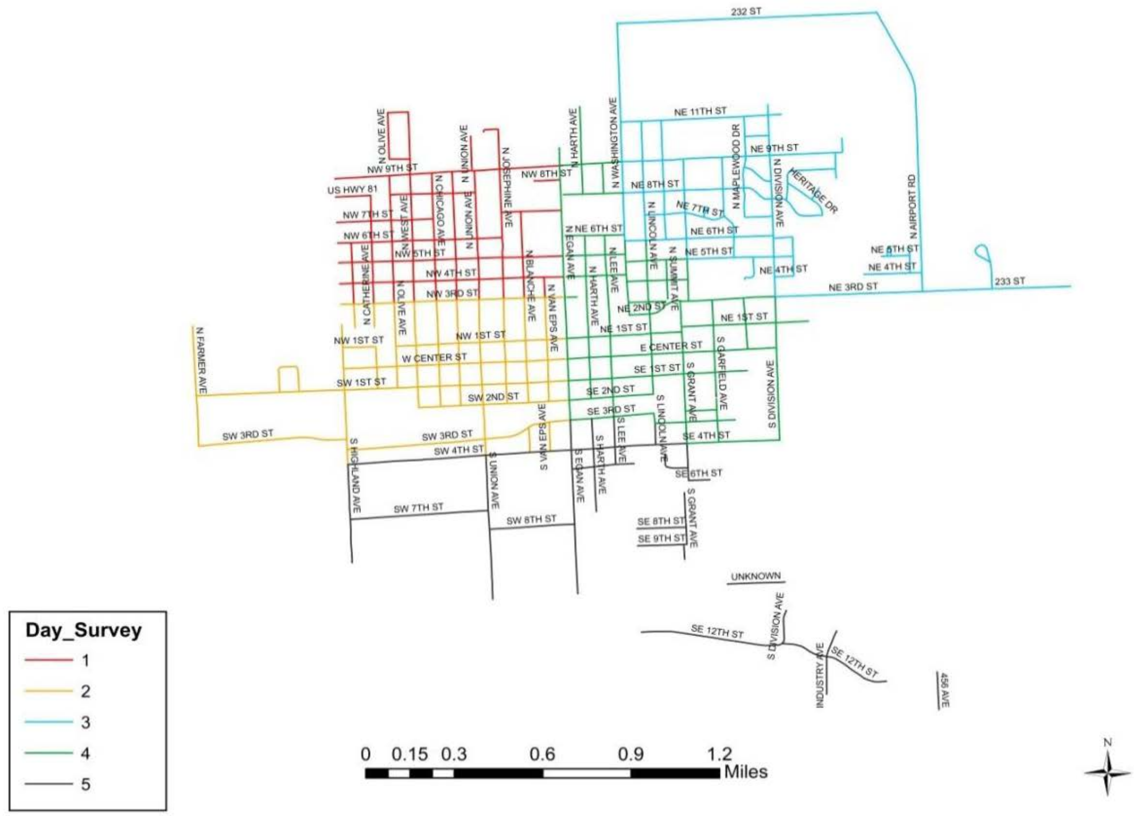



**Figure 5.1** Work Plan Map

The data collection strategy was visual assessment through walking or a windshield survey. Paver Field Inspector or a recording sheet was used as an input tool for storing survey data. Two groups with two people each participated in data collection. Each group surveyed different segments. The distress type and severity were based on average judgment of the two people in one group. Distress Criteria for the survey originated from ASTM D6433-09.

For the pavement survey, each segment was divided into units. The number of sample units to be inspected was determined as follows: for AC, 2,500 sq was chosen as 2500 sq. feet and 3541 units in total. The minimum number of sampling units was determined by statistical formula or defined category. Due to the labor and time limit, the latter one was chosen, as shown in Table 5.1.

**Table 5.1** Table for Selecting the Number of Sample Units to be Inspected

| Given | Survey |
|---|---|
| 1 to 5 sample units | 1 sample unit |
| 6 to 10 sample units | 2 sample unit |
| 11 to 15 sample units | 3 sample unit |
| 16 to 40 sample units | 4 sample unit |
| over 40 sample units | 10% |

The following apparatus were used in the survey:

1) Data Recording Sheets (Tablet): record data.
2) Tape (10feet/3m): measure the distress area for AC and measure the road width
3) Scale (12 inch/300 mm, reads to 1/8 inch/3 mm): measure the distress severity for PCC.
4) Trimble Juno 3B: store photos of some unusual type of distress for the segments.
5) Safety Vest
6) Work Plan

The pavement attributes (pavement type, width, etc.) validation was processed simultaneously with the pavement distress survey, An AutoCAD file provided by the city served as one source of width information, which accelerated the width survey process.

## 5.2 Cost Data Collection

Non-pavement condition data are mainly M&R costs and pavement history (e.g., pavement thickness, pavement age and historical M&R activities). The city provided the following information: unit price for 4-inch surface ($90 per ton), unit price for 8-inch base ($14 per ton), unit chip seal price ($1.05 per square yard), and other relevant costs. Other relevant costs, including costs for crack sealing and pothole repairs, are shown in Table 5.2. Costs for different M&R treatments, such as hot mix and cold mix, were provided for different areas. The cost information was used to estimate costs for each M&R treatment when selecting M& R plans. Additional cost information on M&R activities may be required when implementing the activity selection process in MicroPAVER.

**Table 5.2** Costs for Crack Sealing and Pothole Repairs in 2013

| Treatment for Asphalt Pavement in 2013 | | | Total |
|---|---|---|---|
| Strategy | on chip seal areas | other 6/7ths of town | |
| CRAFTCO | $5,225.22 | $0 | $5,225.22 |
| CRAFTCO-Mastic | $4,454.80 | $4,454.80 | $8,909.60 |
| HOT MIX | $6,613.66 | $6,613.66 | $13,227.32 |
| COLD MIX | $0 | $520 | $520.00 |
| Totals | $16,293.68 | $11,588.46 | $27,882.14 |
| Square Yards | 111,207 | 664,224 | 775,431 |
| $ / SqYd | $0.1465 | $0.0174 | |

The city collected pavement layer thickness information and M&R activities from the available design plan, improvement records, and other documents. A map for completed/scheduled/ planned chip seal activities was provided by the city and is shown in Figure 5.2.


**Figure 5.2** Annual Chip Seal Plan for Madison

To validate pavement thickness, the city conducted coring based on the coring map/plan provided by the research team. Reasonable estimates must be made for the missing information. Initial analysis using sample coring results from the city indicated a significant relationship between PCI and asphalt thickness and gravel thickness (lower p value), so PCI can reflect information on the pavement thickness (asphalt layer thickness and gravel layer thickness). More coring samples should be collected to validate the relationship.

To prepare pavement thickness for performance modeling, a coring plan was developed and delivered to the city. Thirty-nine boring sites randomly selected from each of the three highway classes, i.e., minor arterials, collectors, and local streets, were recommended based on pavement conditions, street name, and location. Among the 39 sites, many of the street sections have exhibited structural distresses such as alligator cracking or rutting, or both. To get a more accurate assessment of pavement thickness in the city, the city engineer accomplished 24 additional cores. The coring plan map is illustrated in Figure 5.3.

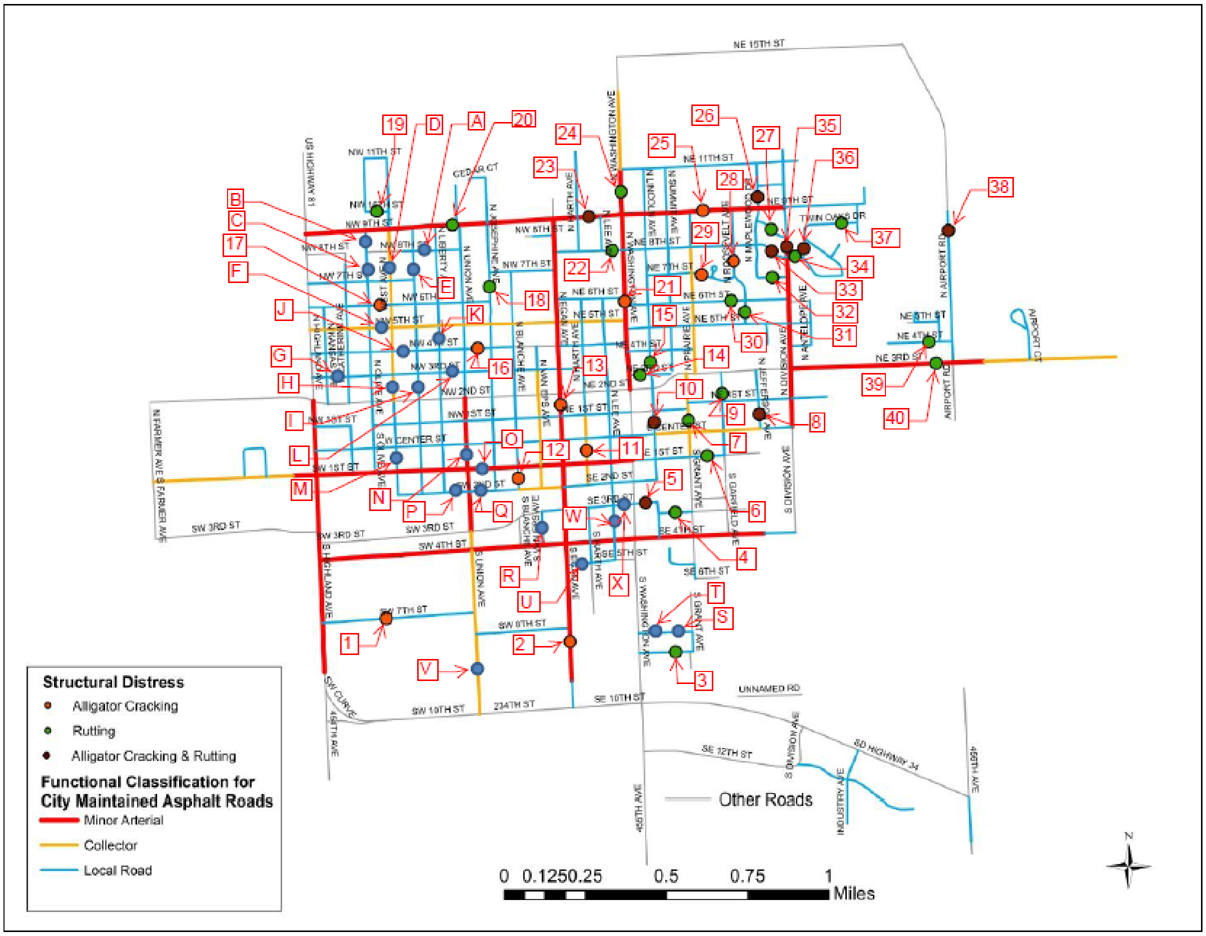



**Figure 5.3** Coring Plan Map with 39 Recommended and 24 Additional Boring Locations

Coring results are summarized shown in Appendix D. Results include the non-deteriorated asphalt thickness, deteriorated asphalt thickness, total asphalt thickness, gravel thickness and soil type. Statistical regression analysis was conducted on PCI in regard to the pavement thickness and functional class, but an insignificant relationship was found. In addition, no correlation was found between pavement thickness and highway functional class. As a result, pavement thickness cannot be estimated using the known attributes, such as PCI and functional class.

Since pavement thickness cannot be estimated by other variables, additional thickness information was collected by the city from different resources. Updated thickness information for Asphalt Concrete (AC) pavement was checked and there were four types of data source. Table 5.3 shows the available thickness information for AC pavement.

**Table 5.3** Available Thickness Information for AC

| Data Type | # of Segments | Plans | Coring Results | Thickness Source |
|---|---|---|---|---|
| 1 | 54 | √ | √ | Coring Results |
| 2 | 371 | √ | x | Plans |
| 3 | 7 | x | √ | Coring Results |
| 4 | 77 | x | x | Imputed |

Mean substitution, interpolation substitution and regression substitution approaches are the three commonly used conventional non-stochastic data imputation methods. Regression substitution approach is not appropriate for Madison data due to the little relationship between thickness type and other variables (functional class, pavement age). Therefore, mean substitution and modified interpolation substitution approach using geographical location were adopted, and the missing thickness information were imputed either by the mean thickness value of all pavements in the city, or by geographically interpolation using adjacent segments or parallel segments. Figure 5.4 shows the locations of the segments with different thickness data source. For segments with the first data type (both construction plans and coring results have thickness information), thickness information in coring results is used because it's more accurate compared to plans (construction records in plans may be incomplete). For the fourth type without thickness information, imputation methods were applied to estimate the missing information.


**Figure 5.4** Thickness Source Map for AC

## 5.3 Pavement Condition Survey and Evaluation

The research team, assisted by city staff, conducted a pavement condition survey during summer 2014 to record detailed pavement distresses in the city road network. The survey's objective was to obtain the existing condition of pavement maintained by the city. According to MicroPAVER, there are 20 distress types for asphalt pavement and 19 distress types for rigid pavement. Not only the distress type, but also the severity and quantity were surveyed during the process.

Pavement conditions were evaluated by PCI, which provides current pavement condition ratings based on survey results. The result of the evaluation is a numerical value between 0 and 100, with 100 representing the best possible condition and 0 representing the worst possible condition. Distress type, severity and quantity were recorded and input into the PCI calculation algorithm to generate a PCI value. PCI value decreases with the increase of distress. Figure 5.5 shows the standard and custom PCI rating scale.

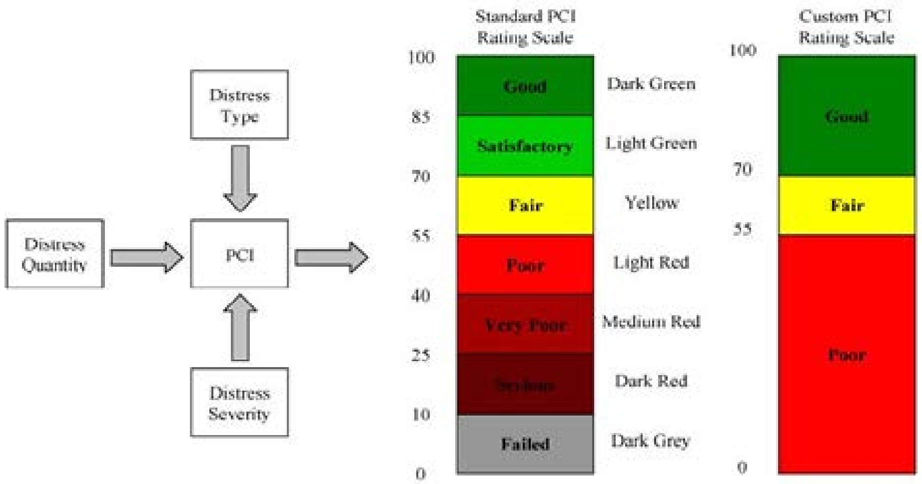



**Figure 5.5** Illustration of Pavement Condition Index [(10)]

According to survey findings, the most common pavement distress types are longitudinal cracking, rutting, block cracking, and alligator cracking for asphalt pavement; and linear cracking, large patch/utility cut for concrete pavement. Figure 5.6 shows photos for all these distress during the survey process.


**Figure 5.6** Illustration of Major Pavement Distress Type in Madison

The pavement PCI, a composite value that reflects the combination of distresses, was calculated using MicroPAVER. The distribution is illustrated in Figure 5.7 and Figure 5.8.

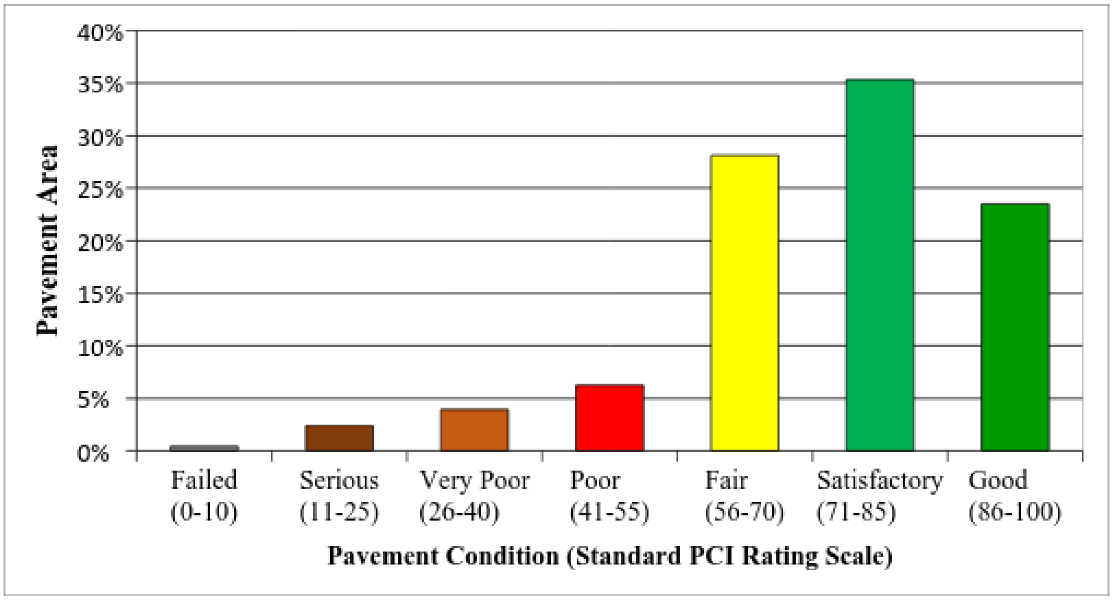



**Figure 5.7** Percentage of Pavement Area for Different Pavement Condition (PCI)

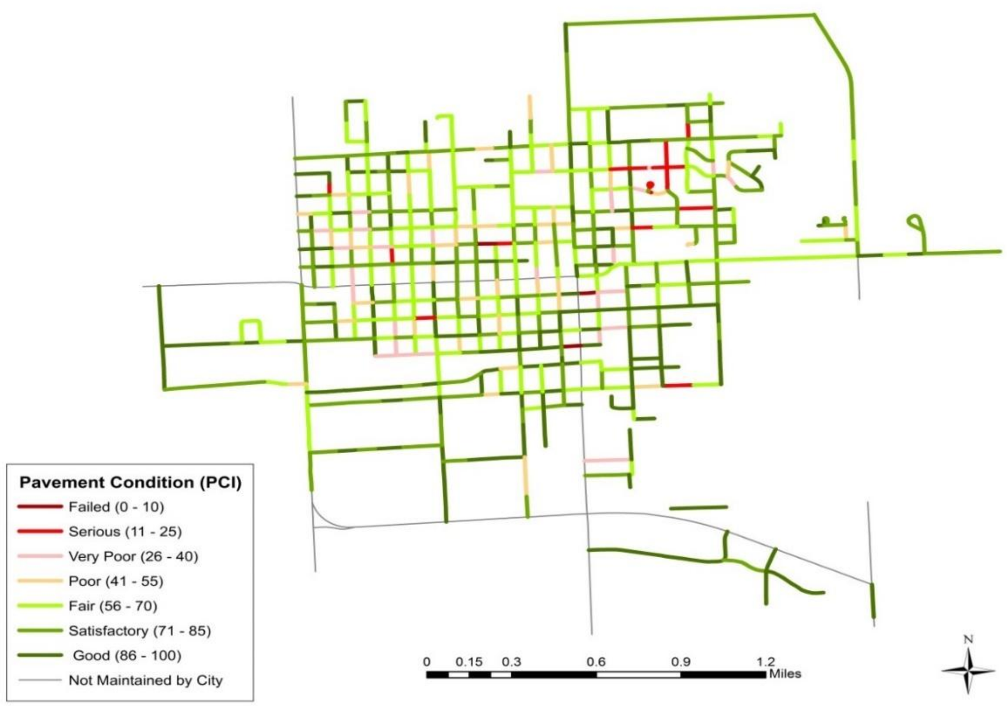



**Figure 5.8** Pavement Condition (PCI) Distribution in Madison City

To gain an impression on the current overall pavement condition, the custom PCI rating scale is shown in Figure 5.9, where nearly 60% of the city's pavement is considered good.

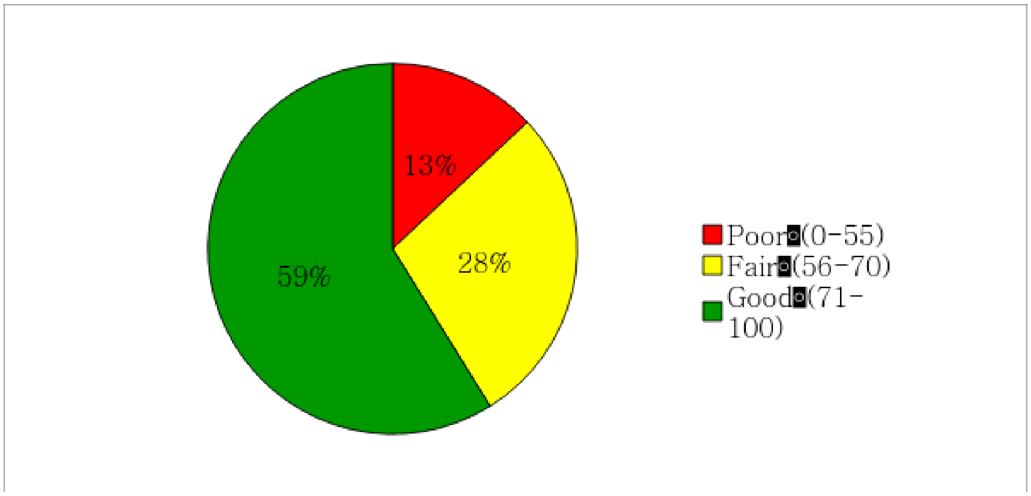



**Figure 5.9** Overall Pavement Condition using Custom PCI Rating Scale

Field observations of typical pavement conditions during the survey are provided in Table 5.4. The first section shown in the table is in perfect condition with a PCI of 100, therefore, no M&R activity is needed. The second section shows good condition with some linear cracking. Preventative activity is an option when funds are available. The third section has some alligator cracking and block cracking, which indicates fair condition (PCI =60). Major M&R treatments, such as localized structural patching and resurfacing, are needed for this section. The last section has a PCI of 43, which requires Major M&R treatments. If funds for M&R treatments are not available, a stopgap M&R is needed.

**Table 5.4** Illustration of Pavement Conditions Observed during the Survey in the City

| On-scene Photo | Location | PCI | Recommended M&R Activity |
|---|---|---|---|
|  | E Center St<br>Section Object ID: 488<br>Between<br>N Grant Ave and<br>N Garfield Ave | 100 | Do Nothing |
|  | N Jefferson Ave<br>Section Object ID: 83<br>Between<br>NE 1st St and<br>NE 3rd St | 87 | Do Nothing or<br>Preventive Maintenance<br>*Crack Sealing* |
|  | SE 4th St<br>Section Object ID: 203<br>Between<br>S Division Ave and<br>S Garfield Ave | 60 | Major M&R<br>*Localized Structural Patching and Resurfacing* |

| | | | |
|---|---|---|---|
|  | N Lee Ave<br>Section Object ID: 340<br>Between<br>NE 1st St and<br>NE 2nd St | 43 | Major M&R<br>*Localized Structural Patching and Resurfacing or Reconstruction* |

## 5.4 Development of the GIS Database

An accurate GIS map is the cornerstone of this project. Its quality directly affects the future pavement condition prediction and M&R budgeting. The GIS map will be imported to MicroPAVER for related analysis. The GIS map of Pubworks was chosen as the base map for Madison PMS. The research team worked closely with city engineers to produce a map for PMS application and documented all the changes in "Madison Map Edition."

**Step 1 Selection of Available GIS Maps**

After comparing cartography and attributes between the city map (Pubworks) and SDDOT non state trunk roadway inventory (NSTRI), the city map was chosen as the base, with additional attributes imported from NSTRI, because the city map has more segments. Relationships between most segments between city map and NSTRI are either one-to-one or many-to-one, which warrants an easy transfer of attribute values from NSTRI to the city map. For relationships that do not completely overlap within one or the other, manual invention is used.

**Step 2 GIS Map Edition Based on True Road Information**

The GIS map was modified based on the city engineer's comments and aerial photograph provided by the city, and then verified using Bing map. The discontinuous segments were connected manually. Then, some surface types were corrected based on the pavement information provided by the city. Next, two fields were added for flagging:  maintenance (city maintenance or by other) and jurisdiction (by the city or Lake county or SDDOT). Last, the GIS database was updated with intersections included in one or two cross streets to avoid double counting the area of intersections.

**Step 3 Creation of Fields Used for MicroPAVER**

To support PMS, new fields were added only for MicroPAVER. The updated GIS map consists of attributes from three sources: 1) original city map, 2) NSTRI, and 3) new.

**Step 4 Creation of Fields for On-street Parking**

On-street parking pavement was not the same as its adjacent roadway. A survey was conducted for the distresses in the on-street parking and new fields were created as shown in Figure 5.10.

| Parking | Separated | Type_park | Park_full | Flag_Park |
|---|---|---|---|---|
| 0 | 0 | | 0 | |
| 0 | 0 | | 0 | |
| 0 | 0 | | 0 | |
| 0 | 0 | | 0 | |
| 0 | 0 | | 0 | |
| 0 | 0 | | 0 | |
| 0 | 0 | | 0 | |
| 0 | 0 | | 0 | |
| 0 | 0 | | 0 | |
| 0 | 0 | | 0 | |
| 2 | 1 | AC | 0 | City Maintenance |
| 1 | 0 | AC | 0 | City Maintenance |
| 0 | 0 | | 0 | |
| 0 | 0 | | 0 | |
| 0 | 0 | | 0 | |
| 0 | 0 | | 0 | |
| 0 | 0 | | 0 | |
| 0 | 0 | | 0 | |
| 1 | 1 | PCC | 0 | By Other |

**Figure 5.10** Screenshot of the Added Fields for On-street Parking Data

**Step 5 Create Fields for Thickness and Improvement& Maintenance Records**

Similar to historical information such as age, rehabilitation history is vital to predict the future pavement performance. Therefore, new fields were created, including last major improvement date and type, last overlay date and type, and last date for preventive maintenance as shown in Figure 5.11.

| Thick_Base | Thick_Pvmt | Construct | Date_Impro | Type_Impro | Date_Olay | Type_Olay | Thick_Olay | Date_Maint |
|---|---|---|---|---|---|---|---|---|
| 8 | 2 | 7/1/1954 | <Null> | Construction | 7/1/1993 | Partial width mill & overlay | 2 | 7/28/2014 |
| 0 | 0 | 7/1/1974 | <Null> | Construction | 7/1/1993 | Partial width mill & overlay | 2 | 7/28/2014 |
| 8 | 2 | 7/1/1966 | <Null> | Construction | 7/1/1993 | Partial width mill & overlay | 2 | 7/28/2014 |
| 8 | 2 | 7/1/1961 | <Null> | Construction | 7/1/2003 | Partial width mill & overlay | 2 | 7/1/2009 |
| 8 | 2 | 7/1/1957 | <Null> | Construction | 7/1/2003 | Partial width mill & overlay | 2 | 7/1/2009 |
| 8 | 2 | 7/1/1957 | <Null> | Construction | 7/1/2003 | Partial width mill & overlay | 2 | 7/1/2009 |
| 8 | 2 | 7/1/1966 | <Null> | Construction | 7/1/1993 | Partial width mill & overlay | 2 | 7/28/2014 |
| 0 | 0 | 1/1/1900 | <Null> | | 7/1/1993 | Partial width mill & overlay | 2 | 7/1/2010 |
| 8 | 2 | 7/1/1956 | <Null> | Construction | 7/1/2003 | Partial width mill & overlay | 2 | 7/1/2009 |
| 8 | 2 | 7/1/1956 | <Null> | Construction | 7/1/2003 | Partial width mill & overlay | 2 | 7/1/2009 |
| 8 | 2 | 7/1/1958 | <Null> | Construction | 7/1/2003 | Partial width mill & overlay | 2 | 7/1/2009 |
| 8 | 2 | 7/1/1954 | <Null> | Construction | 7/1/1993 | Partial width mill & overlay | 2 | 7/28/2014 |
| 8 | 2 | 7/1/1954 | <Null> | Construction | 7/1/1993 | Partial width mill & overlay | 2 | 7/28/2014 |
| 8 | 2 | 7/1/1956 | <Null> | Construction | 7/1/2003 | Partial width mill & overlay | 2 | 7/1/2009 |
| 8 | 2 | 7/1/1960 | <Null> | Construction | 7/1/1993 | Partial width mill & overlay | 2 | 7/28/2014 |
| 8 | 2 | 7/1/1956 | <Null> | Construction | 7/1/1993 | Partial width mill & overlay | 2 | 7/28/2014 |
| 8 | 2 | 7/1/1956 | <Null> | Construction | 7/1/1993 | Partial width mill & overlay | 2 | 7/28/2014 |
| 8 | 2 | 7/1/1956 | <Null> | Construction | 7/1/1993 | Partial width mill & overlay | 2 | 7/28/2014 |
| 8 | 2 | 7/1/1956 | <Null> | Construction | 7/1/1993 | Partial width mill & overlay | 2 | 7/28/2014 |
| 0 | 0 | 1/1/1900 | <Null> | | 7/1/1993 | Partial width mill & overlay | 2 | 7/28/2014 |
| 0 | 0 | 1/1/1900 | <Null> | | 7/1/1993 | Partial width mill & overlay | 2 | 7/28/2014 |
| 8 | 2 | 7/1/1960 | <Null> | Construction | 7/1/1993 | Partial width mill & overlay | 2 | 7/28/2014 |
| 8 | 2 | 7/1/1960 | <Null> | Construction | 7/1/1993 | Partial width mill & overlay | 2 | 7/28/2014 |
| 8 | 2 | 7/1/1960 | <Null> | Construction | 7/1/1993 | Partial width mill & overlay | 2 | 7/28/2014 |
| 0 | 0 | 1/1/1900 | <Null> | | 7/1/1993 | Partial width mill & overlay | 2 | 8/3/2011 |
| 8 | 2 | 7/1/1958 | <Null> | Construction | 7/1/2003 | Partial width mill & overlay | 2 | 7/1/2009 |
| 8 | 2 | 7/1/1965 | <Null> | Construction | 7/1/2003 | Partial width mill & overlay | 2 | 7/1/2009 |
| 8 | 2 | 7/1/1961 | <Null> | Construction | 7/1/2003 | Partial width mill & overlay | 2 | 7/1/2009 |
| 8 | 2 | 7/1/1961 | <Null> | Construction | 7/1/2003 | Partial width mill & overlay | 2 | 7/1/2009 |
| 3 | 2 | 7/1/1975 | <Null> | Construction | 9/12/2007 | Partial width mill & overlay | 2 | 8/3/2011 |
| 0 | 0 | 1/1/1900 | <Null> | | 7/1/1993 | Partial width mill & overlay | 2 | 8/3/2011 |
| 8 | 2 | 7/1/1960 | <Null> | Construction | 7/1/1993 | Partial width mill & overlay | 2 | 8/3/2011 |

**Figure 5.11** Screenshot of the Added Fields for Historical Data

# 6. PAVEMENT PERFORMANCE PREDICTION MODELS

A common practice for predicting pavement conditions is to group pavement sections by attributes (e.g., pavement structure, traffic, weather) and develop statistically valid regression models from historical pavement data within each group. Pavements with similar characteristics are expected to behave and deteriorate in a similar and consistent manner under the same environment, thus the performance functions also are called "family" models.

Specification of pavement family directly affects the sample size, which can influence prediction accuracy due to the data availability. According to the literature review, the most relevant pavement performance families to the City of Madison, SD, are in the SDDOT report entitled "*Statistical Methods for Pavement Performance Curve Building, Historical Analysis, Data Sampling and Storage*" (*17*) in which thickness type (Table 6.1) and surface overlay type (i.e., Original, AC Overlay on Original, Mill and AC Overlay) for asphalt pavements are used to group pavement sections (*23*). Based on available pavement data in Madison, the pavements were categorized into five families:

1. Full Depth: ACP w/no granular base
2. Thick: 5 to 10 in. ACP w/ granular base
3. Thin: 2 to 5 in. ACP w/ granular base
4. ACP on PCCP: Asphalt overlay on top of PCCP
5. PCC: Portland Cement Concrete Pavement

**Table 6.1** Flexible pavement types in South Dakota (SDDOT)

| **Code** | **Type** | **Description** |
|---|---|---|
| **FD** | Full Depth | > 10 in. ACP w/no granular base |
| **THK** | Thick | 5 to 10 in. ACP w/ granular base |
| **TonS** | Thin on Strong | 2 to 5 in. ACP on > 8 in. granular base |
| **TonW** | Thin on Weak | 2 to 5 in. ACP on < 8 in. granular base |
| **AonC** | ACP on PCCP | Asphalt overlay on top of PCCP |

After defining pavement families, the next step is to develop performance function. A performance model developed with MicroPAVER built-in capability is illustrated in Figure 6.1 where "x" denotes the measured locations with PCI and pavement age. The trend line above is the fitted performance curve. The trend line below is the boundary used to remove anomaly points. The pavement condition performance function is configured as a polynomial equation: $PCI=100-1.83684x + 0.01699x^2$ where $x$ is the pavement age (year). Goodness of fit measures, suggesting the degree of the data fitting by the equation, are provided in the lower pane (e.g., coefficient of correlation, $R^2$, standard deviation of error, absolute mean of error and arithmetic mean of error). Large value for coefficient of correlation and $R^2$ means a better fit, while small value for the others indicates the model fits the data better.

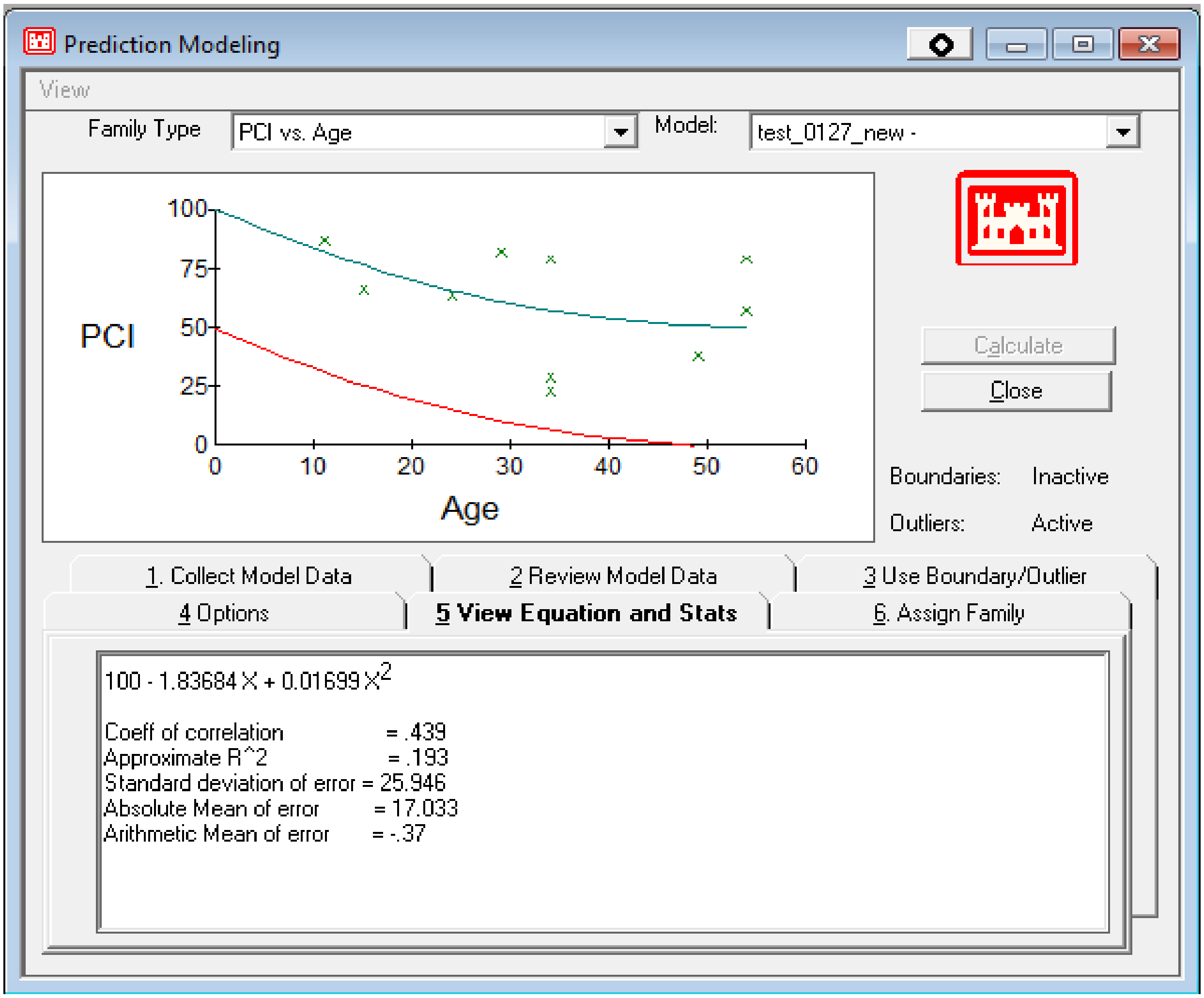



**Figure 6.1** Development of Prediction Model for One Sample Family

Performance functions can be developed by two approaches: the boundary- and average PCI-based approaches. The boundary-based approach sets PCI limits for pavement age to remove anomaly data points, and then builds performance models using data points within boundary. For instance, when a pavement is less than three years old, PCI can be considered to be more than 75; or less than 50 when a pavement approaches terminal age. The other common approach is to average PCI value for segments at the same age. Both boundary-based and average PCI-based models were developed and evaluated (see Appendix E).

Performance models were developed based on the historical pavement and age data collected during each pavement condition survey. Reliable imputation method was applied for missing data. For the PCC family in Madison, only less than one third of the sections (10/32) have the pavement construction date information. Pavement age was imputed for the missing segments. All pavement boundaries were established based on historical data after discussions with the city engineers, except for the PCC family whose boundary was set to be the default MicroPAVER value because of small sample size.

The final models for the city were developed using the boundary-based approach because 1) MicroPAVER cannot automatically generate the average PCI-based model, making it difficult for the city to update; and 2) average PCI-based model curves show flat trend after some years. For several families, PCI value never reduces to 55 or below due to the rehabilitation criterion in the software. The final pavement models for five pavement families are listed in Table 6.2.

**Table 6.2** Pavement Performance Prediction Models for the City

| Name | Description | Equation |
|---|---|---|
| **FD** | ACP w/no granular base | $PCI = 100 - 2.58749Age + 0.01957Age^2$ |
| **THK** | 5 to 10 in. ACP w/ granular base | $PCI = 100 - 1.78149Age$ |
| **THIN** | 2 to 5 in. ACP w/ granular base | $PCI = 100 - 3.70938Age + 0.29928Age^2 - 0.01729Age^3 + 0.00046Age^4 - 0.00001Age^5$ |
| **APC** | Asphalt overlay on top of PCCP | $PCI = 100 - 3.36849Age + 0.05589Age^2 - 0.00031Age^3$ |
| **PCC** | Portland Cement Concrete Pavement | $PCI = 100 - 4.37412Age$ |

# 7. M&R TREATMENTS AND COSTS

Maintenance and rehabilitation (M&R) strategies are composed of a series of cost-effective M&R alternatives and activities. In general, there are four types of treatments categorized by scope and strategy: localized stopgap (safety), localized preventive, global preventive, and major.

- Localized stopgap M&R, such as crack sealing and patching, is applied to pavement below the critical PCI to sustain its safe condition until extensive M&R treatment is needed.
- Localized preventive M&R or global preventive M& R is applied to pavement above the critical PCI to slow down its deterioration.
- Unlike localized preventive M&R, which is only applied on the distressed spot, global preventive M&R, such as chip sealing or slurry sealing, is applied to the entire section.
- Major M&R, such as mill and overlay and reconstruction, is applied to the whole section that is either above or below the critical PCI to correct or improve its current conditions.

For Madison, some M&R treatments such as chip sealing, crack filling, hot mix and cold mix have already been adopted and applied. These customized M&R treatments with the actual costs were identified with the help of the city engineers. Table 7.1 to Table 7.3 show the M&R costs.

**Table 7.1** Localized M&R Treatment

| Name | Amount | Work Unit |
|---|---|---|
| Crack Sealing - AC | $1.00 | ft |
| Crack Sealing - PCC | $1.50 | ft |
| Grinding (Localized) | $4.00 | ft |
| Joint Seal - Silicon | $2.75 | ft |
| Joint Seal (Localized) | $1.50 | ft |
| Patching - AC Deep | $7.00 | sf |
| Patching - AC Leveling | $1.20 | sf |
| Patching - AC Shallow | $4.50 | sf |
| Patching - PCC Full Depth | $25.00 | sf |
| Patching - PCC Partial Depth | $7.00 | sf |
| Shoulder leveling | $1.20 | ft |
| Slab Replacement - PCC | $15.00 | sf |
| Undersealing - PCC | $1.75 | Ft |

**Table 7.2** Global Preventive M&R Treatment

| Name | Amount | Work Unit | Basis |
|---|---|---|---|
| Overlay - AC Thin (Global) | $0.90 | sf | |
| Surface Seal - Fog Seal | $0.02 | sf | $0.18/sqyd |
| Surface Seal - Chip Seal | $0.135 | sf | $1.215/sqyd; including city labor & equip |

**Table 7.3** Major M&R Treatment

| Name | Amount | Work Unit | Basis |
|---|---|---|---|
| 2-inch Cold Mill & Overlay – | $2.35 | sf | IIP formulas excluding mobilization |
| 2-inch overlay | $1.22 | sf | IIP formulas; excluding mob. etc. |
| Complete Reconstruction - AC | $6.50 | sf | |
| Complete Reconstruction - PCC | $10.00 | sf | |
| AC Surface Reconstruction – Geogrid Fabric (Geotek report) | $4.48 | sf | $33.92/sqyd x 5% ('14 $); excluding mob. etc. mobilization |
| AC Surface Reconstruction – Option 3 Traditional (Geotek report) | $4.35 | sf | $35.52/sqyd x 5% ('14 $); excluding mob. etc. |

*"5% ('14 $); excluding mob" indicates the city used our 2014 estimated prices, excluding mobilization, and multiplied it by 105% to account for inflation.

In MicroPAVER, "unit cost by PCI" is used to predict future M&R costs rather than "cost by work type." The cost tables in Appendix F were estimated and compared with the M&R work cost the city provided above. In this project, the MicroPAVER default cost tables were adopted for localized stopgap M&R and localized preventative M&R because of similar costs by work type. Chip seal cost provided by the city was chosen as the global M&R cost based on the current practice of chip seal. For major M&R (AC), calibration was performed using the default cost table. For major M&R (PCC), default cost table were used.

# 8. ANALYSIS OF M&R PLANS WITH DIFFERENT BUDGET SCENARIOS

## 8.1 Objectives

The objectives of a pavement M&R plan are to maintain overall satisfactory pavement conditions and reduce M&R backlog over time. The M&R backlog refers to the required pavement M&R work that cannot be performed due to the lack of funding, which equals total pavement M&R needs (determined by MicroPAVER) less the funded M&R work.

The M&R planning provides recommendations for when and where M&R activities are needed and approximately how much they will cost. M&R plans can be developed either by (1) setting an annual total budget, or (2) specifying a desired pavement condition. Based on the input, an economically viable work plan will be provided. The work plan enables the city to better optimize and prioritize M&R strategy and identify its future pavement M&R funding needs.

In this study, five-year M&R plans were developed under the following four budget scenarios:

1. required annual funding to eliminate major M&R backlog
2. required annual funding to maintain current PCI
3. effect of no funding
4. effect of an estimated current funding

## 8.2 Selection of M&R Category

The critical PCI method was adopted when making M&R plans. This method is to keep all pavements from reaching the critical PCI point after which the deterioration will accelerate. Therefore, it is more economical to maintain the pavements. Figure 8.1 illustrates the assignment and prioritization of M&R in MicroPAVER.

The assignment begins with comparing each section's PCI value with the critical PCI (the default critical value is 55).

- If PCI is below the critical value, cost for major M&R is estimated based on a relationship between PCI and unit cost. Major M&R will be applied when the funds are available and sufficient. Localized stopgap M&R will be applied when there are insufficient funds for major M&R. After major M&R is applied, section's PCI will be reset to 100.
- If PCI is above the critical value, structural distress, such as rutting, will be checked. If structural distresses exist, cost for major M&R will be estimated. Similarly, major M&R will be applied with enough funds. Localized preventive M&R will be applied if funds are not available. If no structural distress exists, global preventive M&R will be chosen when previous global life has been exceeded, otherwise localized preventive M&R will be selected.

After the assignment, priority is given to different M&R categories. Localized stopgap, localized preventive, global preventive, Major (PCI > critical PCI), are Major (PCI < critical PCI) are in a descending priority order. Within each M&R category, priority is assigned based on the combination of pavement use (e.g.: roadway, runway, etc.) and rank (functional class). In Madison dataset, all pavements were treated as roadway, and arterial, collector and local streets were ranked in a descending priority.

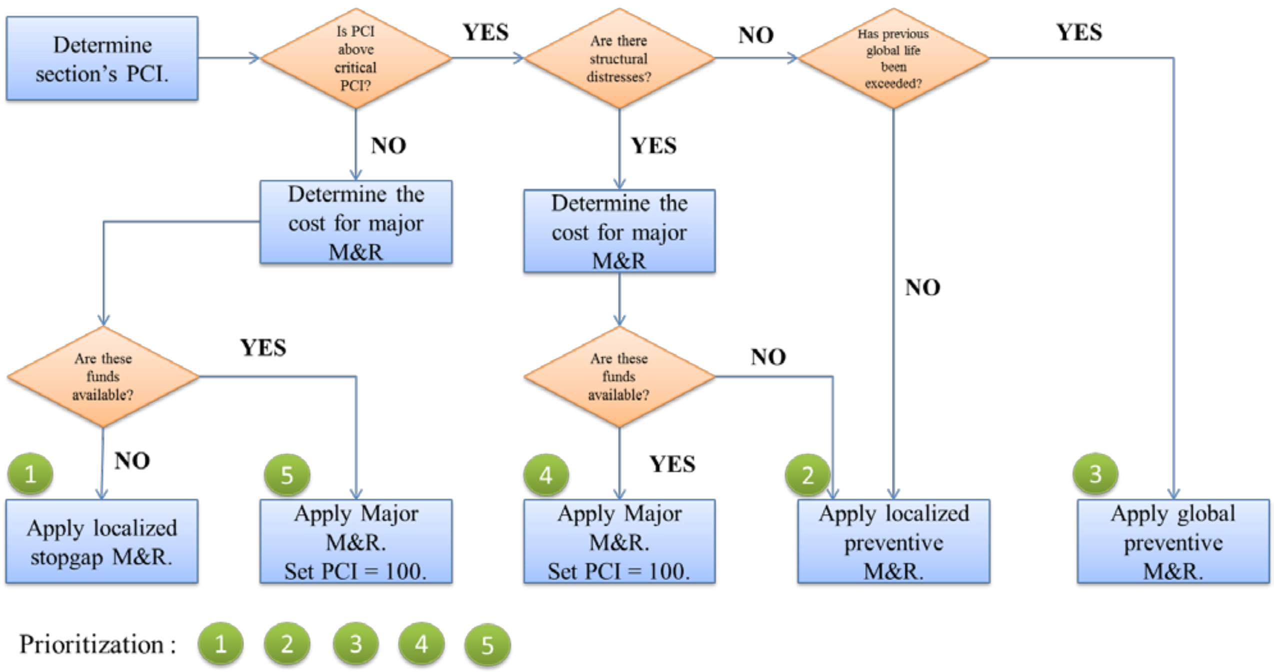



**Figure 8.1** M&R Work Assignment in MicroPAVER

## 8.3 Results & Discussion

The five-year M&R plan beginning in 2016 was created from data stored in the city's MicroPAVER database, the pavement prediction models, and the critical PCI value of 55. The city's current budget over the next five years (2016-2020) was estimated to be \$554K (28K+126K+400K), \$160K (28K+132K), \$767K (28K+139K+600K), \$174K (28K+146K), and \$781K (28K+153K+600K). M&R work was to be finished before the end of each fiscal year, and the initial work date was set as 12/31/2016. Average PCI before the M&R work and before analysis was equal to 66.52, according to the most recent pavement condition survey conducted in the summer of 2014. The M&R unit cost data were provided by the city and the M&R unit cost by PCI was customized based on the default assumptions in MicroPAVER (Appendix F). An inflation rate of 5% was used.

a) *Determine required annual funding to eliminate the city's M&R work backlog.*

This plan identifies which roadway pavements require M&R work during the next five years so that at the end of the fifth year the city's M&R backlog will be eliminated. This means that all city-maintained pavements have either at or above their respective critical PCI values. The annual funding required to eliminate the city's M&R work backlog for pavements is approximately $2.90 M/year for the next five years, as shown in Table 8.1 and Figure 8.2. Backlog will decrease from $8.27 million to $0 million and the average PCI would increase from 66.5 to 81.3. Detailed funding for each M&R type is shown in Appendix G.

**Table 8.1** Costs and Pavement Conditions for Backlog Elimination

| Fiscal Year | Budget | M&R Work Backlog | Average PCI |
|---|---|---|---|
| 2016 | 2,905,213 | 8,274,308 | 72.3 |
| 2017 | 2,898,723 | 6,378,226 | 74.89 |
| 2018 | 2,901,105 | 4,396,558 | 77.09 |
| 2019 | 2,902,104 | 2,266,609 | 79.04 |
| 2020 | 2,835,004 | 0 | 81.26 |

Percentage of pavement with different conditions before and after the implementation of M&R work is shown in Table 8.2. In 2020, 80% of the pavement will be good and 0% will be poor.

**Table 8.2** Percentage of Pavement Area with Different Conditions for Backlog Elimination

| | Poor (0-55) (%) | | Fair (56-70) (%) | | Good (71-100) (%) | |
|---|---|---|---|---|---|---|
| Date | Before | After | Before | After | Before | After |
| 12/31/2016 | 23 | 22 | 30 | 15 | 46 | 62 |
| 12/31/2017 | 22 | 16 | 19 | 18 | 58 | 67 |
| 12/31/2018 | 16 | 9 | 21 | 18 | 62 | 72 |
| 12/31/2019 | 11 | 4 | 21 | 20 | 69 | 75 |
| 12/31/2020 | 5 | 0 | 21 | 20 | 73 | 80 |

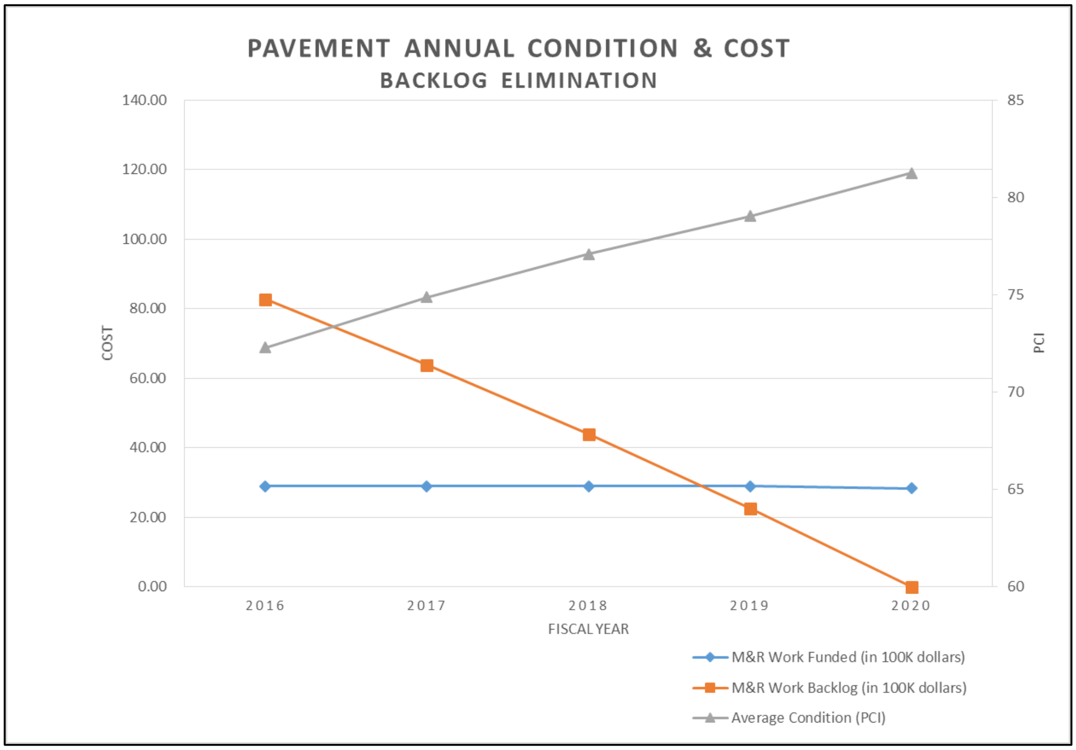



**Figure 8.2** Costs and Pavement Conditions for Backlog Elimination

*b) Determine required annual funding to maintain the City's current PCI.*

Approximately $1.02 M/YR would be needed to maintain the current overall average PCI value of the city's roadway pavements for the next five years, as shown in Table 8.3 and Figure 8.3. The amount of backlog will increase slightly from $10.25 million to $11.49 million. The detailed funding for each M&R type is shown in Appendix G.

**Table 8.3** Costs and Pavement Conditions for Maintaining Current PCI

| Fiscal Year | Budget | M&R Work Backlog | Average PCI |
|---|---|---|---|
| 2016 | 1,020,308 | 10,248,403 | 68.81 |
| 2017 | 1,019,332 | 10,524,231 | 68.74 |
| 2018 | 1,017,668 | 10,857,989 | 68.57 |
| 2019 | 1,018,620 | 11,175,960 | 68.22 |
| 2020 | 1,015,587 | 11,488,207 | 67.84 |

Percentage of pavement area with different conditions before and after the M&R work is shown in Table 8.4, where 54% of the pavements will be good after work in 2020 compared to 46% now.

**Table 8.4** Percentage of Pavement Area by Condition for Maintaining Current PCI

| Date | Poor (0-55) (%) | | Fair (56-70) (%) | | Good (71-100) (%) | |
|---|---|---|---|---|---|---|
| | Before | After | Before | After | Before | After |
| 12/31/2016 | 23 | 22 | 30 | 23 | 46 | 54 |
| 12/31/2017 | 24 | 24 | 26 | 23 | 50 | 53 |
| 12/31/2018 | 25 | 25 | 26 | 21 | 49 | 54 |
| 12/31/2019 | 26 | 26 | 24 | 21 | 51 | 54 |
| 12/31/2020 | 27 | 26 | 22 | 20 | 52 | 54 |

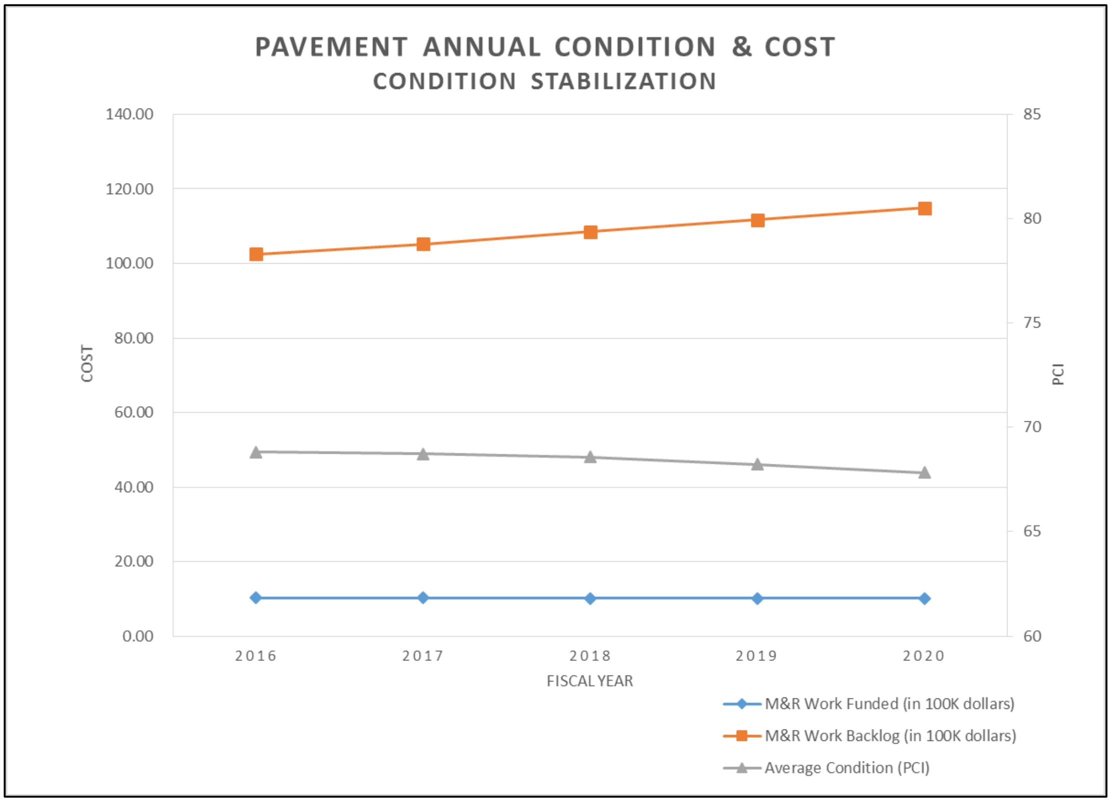



**Figure 8.3** Costs and Pavement Conditions for Maintaining Current PCI

*c) Determine the effect of no funding.*

If Madison spends nothing in the next five years, the amount of backlog will increase from $11.29 million to $17.96 million and the average PCI will decrease from 66.5 to 60.4, as shown in Table 8.5 and Figure 8.4.

**Table 8.5** Costs and Pavement Conditions for No Funding

| Fiscal Year | Budget | M&R Work Backlog | Average PCI |
|---|---|---|---|
| 2016 | 0 | 11,290,570 | 66.52 |
| 2017 | 0 | 12,449,761 | 64.95 |
| 2018 | 0 | 13,874,706 | 63.42 |
| 2019 | 0 | 15,736,544 | 61.91 |
| 2020 | 0 | 17,961,877 | 60.42 |

Percentage of the pavement area with different conditions for this scenario is shown in Table 8.6. Good pavement will decrease from 46% to 32% and poor pavement will increase from 23% to 35%. The poor pavement cannot satisfy functional use and should be repaired immediately.

**Table 8.6** Percentage of Pavement Area with Different Conditions for No Funding

| Date | Poor (0-55) (%) | Fair (56-70) (%) | Good (71-100) (%) |
|---|---|---|---|
| 12/31/2016 | 23 | 30 | 46 |
| 12/31/2017 | 25 | 32 | 43 |
| 12/31/2018 | 28 | 32 | 41 |
| 12/31/2019 | 30 | 34 | 36 |
| 12/31/2020 | 35 | 34 | 32 |

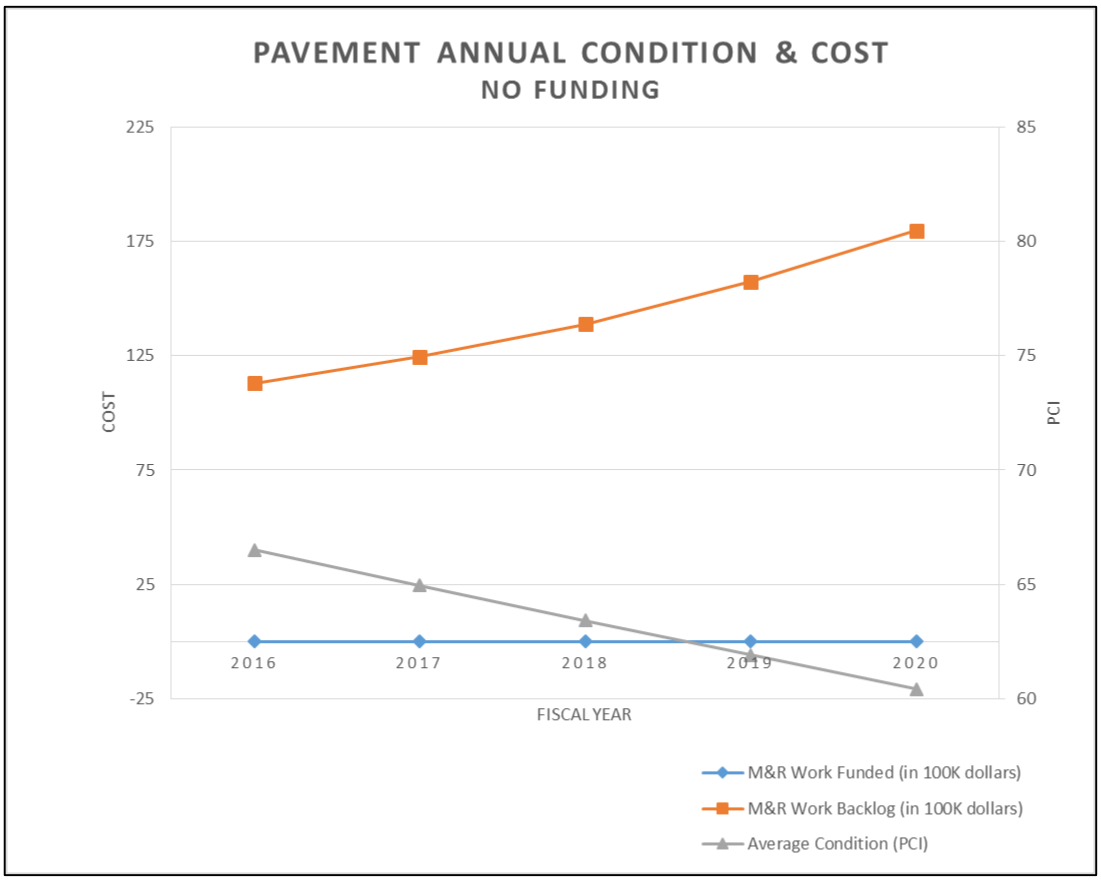



**Figure 8.4** Costs and Pavement Conditions for No Funding

*d) Determine the effect of currently estimated funding.*

Under the city's current pavement maintenance budget for the next five years (i.e., \$554K, \$160K, \$767K, \$174K, \$781K), the amount of backlog will increase from \$10.74 million to \$14.94 million and the average PCI will decrease from 66.52 to 63.85, as shown in Table 8.7 and Figure 8.5. The detailed funding for each M&R type is shown in Appendix G.

**Table 8.7** Costs and Pavement Conditions for Current City Funding

| Fiscal Year | Budget | M&R Work Backlog | Average Condition |
|---|---|---|---|
| 2016 | 553,861.87 | 10,736,708 | 67.55 |
| 2017 | 159,947.26 | 11,980,567 | 65.98 |
| 2018 | 766,639.30 | 12,533,045 | 66 |
| 2019 | 173,963.42 | 13,997,195 | 64.47 |
| 2020 | 779,525.07 | 14,938,303 | 63.85 |

Percentage of the pavement area with different conditions before and after the implementation of M&R work for this scenario is shown in Table 8.8. Good pavements will decrease slightly from 46% to 45%, and poor pavements will be 30%, after work in 2020.

**Table 8.8** Percentage of Pavement Area with Different Conditions for Current City Funding

| Date | Poor (0-55) (%) | | Fair (56-70) (%) | | Good (71-100) (%) | |
|---|---|---|---|---|---|---|
| | Before | After | Before | After | Before | After |
| 12/31/2016 | 23 | 22 | 30 | 27 | 46 | 50 |
| 12/31/2017 | 24 | 24 | 31 | 31 | 44 | 44 |
| 12/31/2018 | 26 | 26 | 32 | 27 | 42 | 47 |
| 12/31/2019 | 28 | 27 | 29 | 29 | 44 | 44 |
| 12/31/2020 | 30 | 30 | 31 | 26 | 39 | 45 |

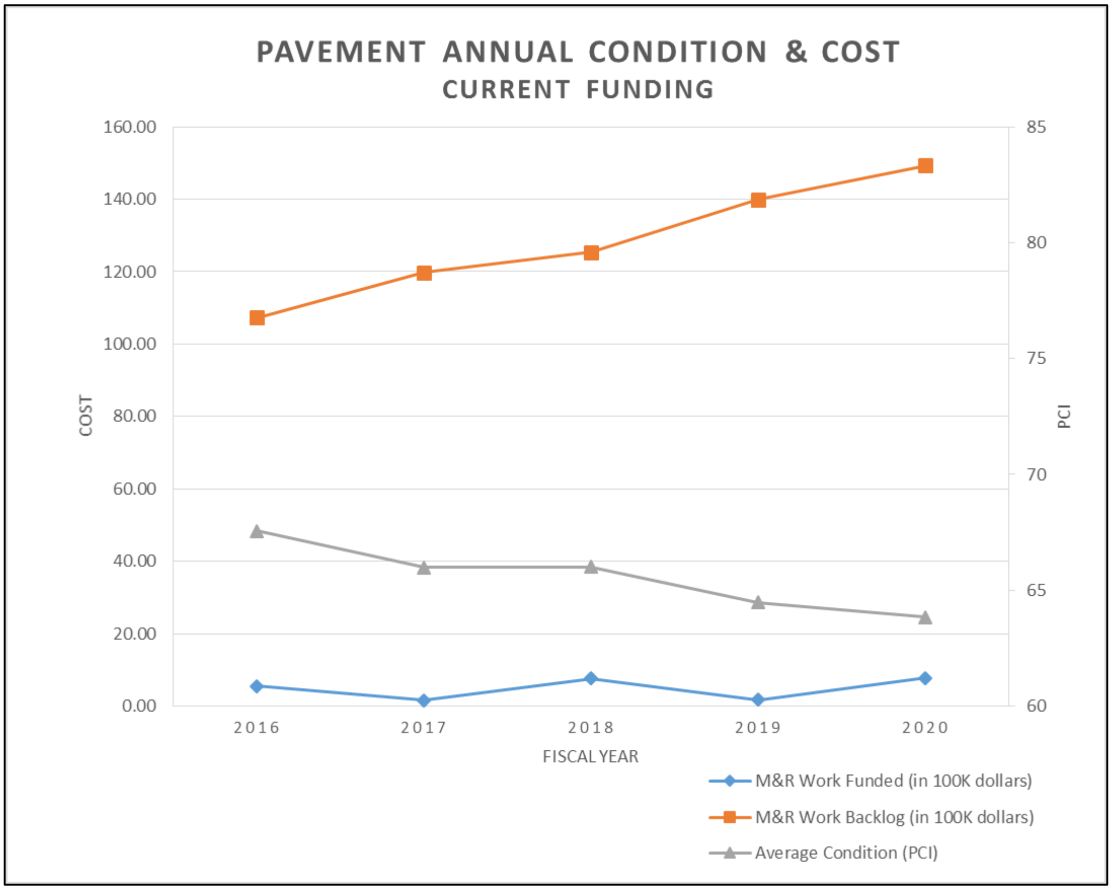



**Figure 8.5** Costs and Pavement Conditions for Current City Funding

*e) Comparison between Different Scenarios*

Pavement conditions and M&R backlog were compared among the four scenarios, as shown in Figure 8.6 and Figure 8.7. According to MicroPAVER, the current city backlog of M&R work is estimated to be $11,290,570. If adequate funding is available to eliminate all backlogs in five years, the PCI value will rise to 80 or above. If no funding is available for the next five years, the amount of backlog will soar to $17,961,877. Under the current budget level, average pavement conditions vary significantly from the no-funding scenario in five years (from 60.42 to 63.85) and there will be fewer pavement segments in poor condition (from 35% to 30%). Estimated to be about $100K annually, the stopgap M&R work will not have any effect on the PCI value, but it will halt pavements from further deterioration. The remaining funds will be used for preventative M&R for pavement with PCI above the critical value, making pavement maintenance more economic over time. As shown, few major M&R work projects will be affordable on a scale that truly can elevate pavement conditions. In summary, the current funding allocated for maintaining the City of Madison's pavement is inadequate, for keeping the existing PCI for the future. Given the extremely tight funding level, the benefit of prioritizing limited options of stopgap and preventive strategies is not apparent.

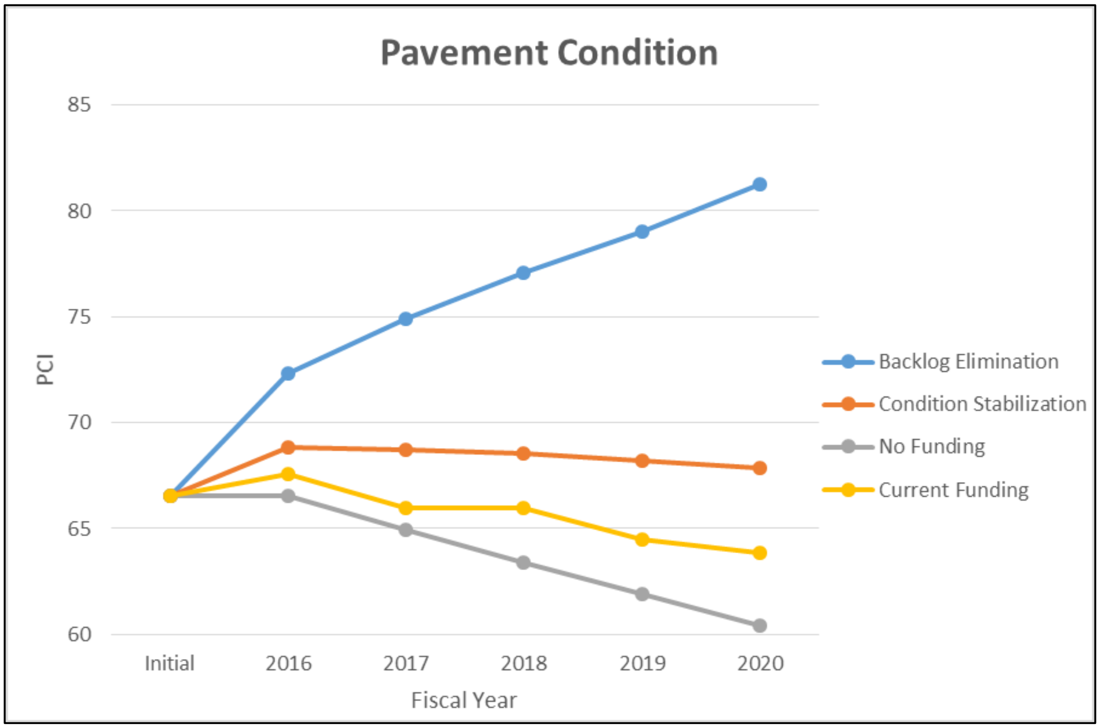



**Figure 8.6** Change of Pavement Condition under Different Budget Scenarios

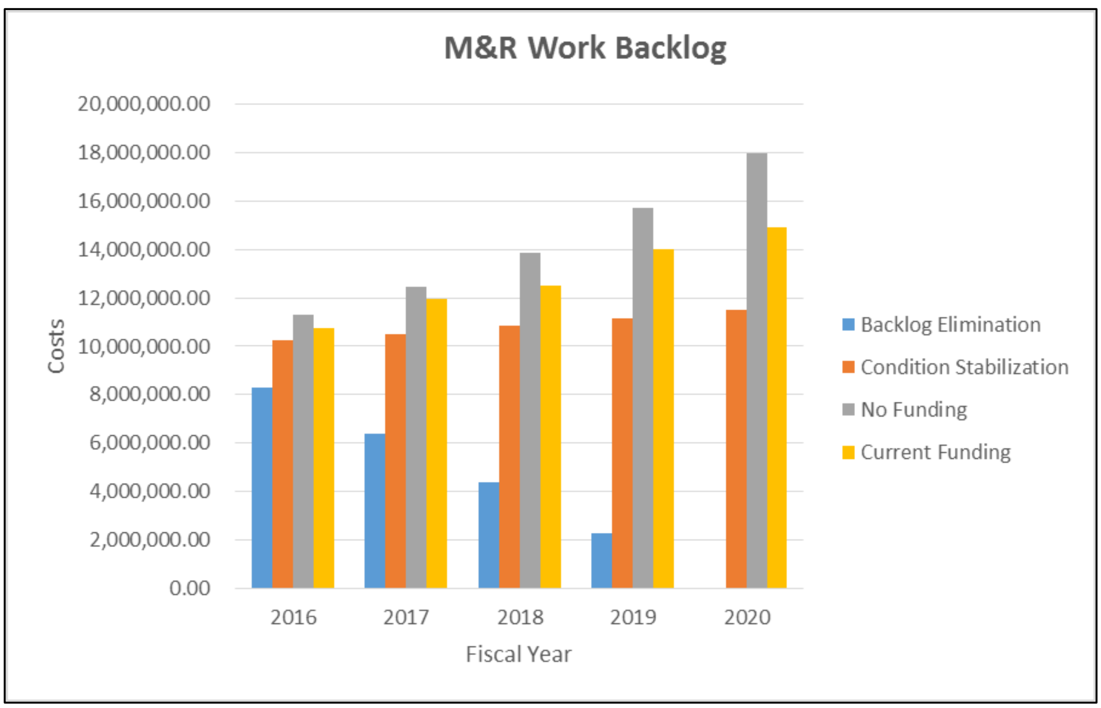
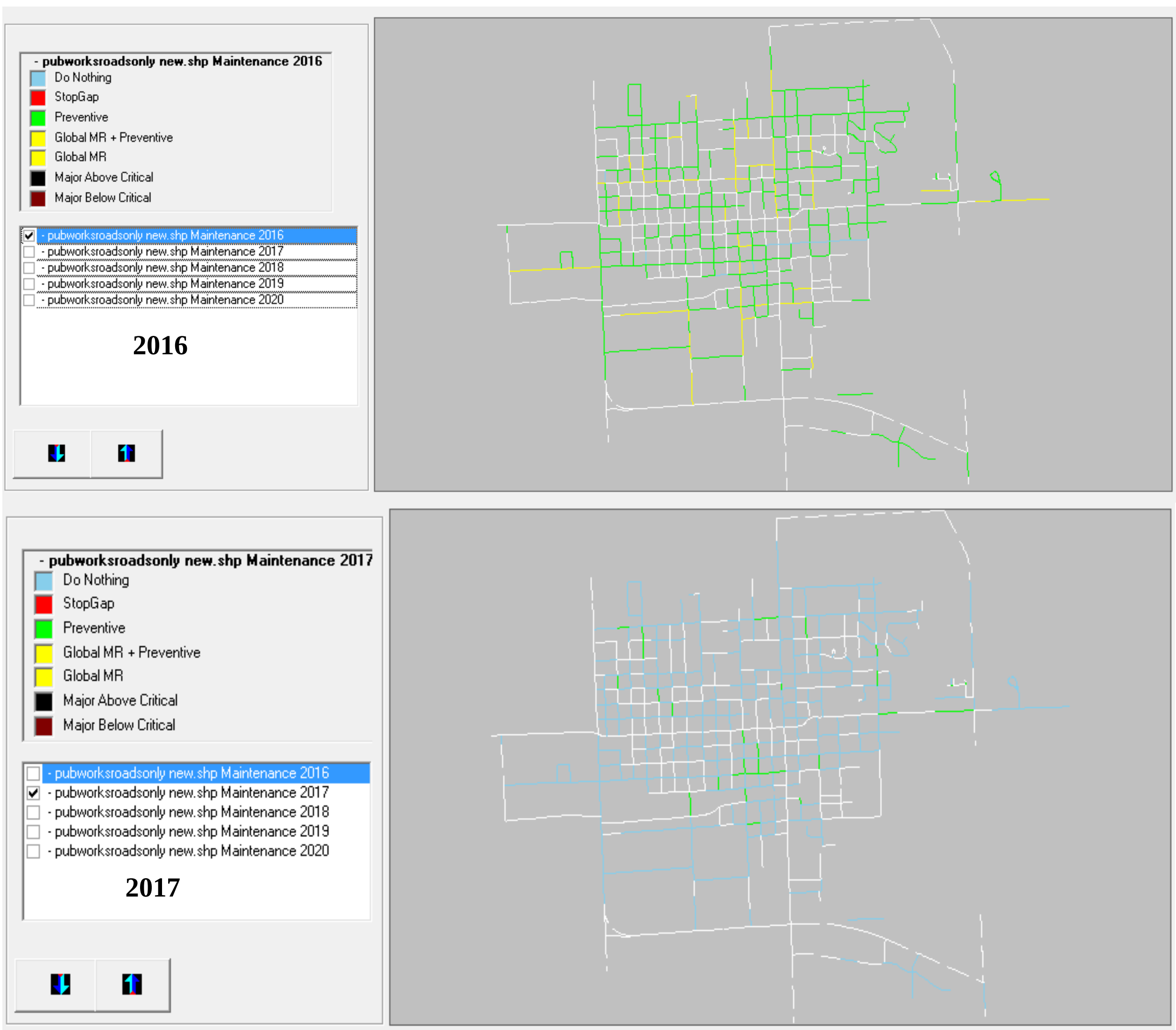



**Figure 8.7** Required Funding for M&R Work Backlog under Different Budget Scenarios

## 8.4 M&R Activities Recommendations under Current Budget

This section presents a variety of M&R strategies and activities to be performed under the current budget level of the city. Without any intervention, MicroPAVER recommends the list of localized maintenance from 2016 to 2020 in Figure 8.8. For each work category, specific work type should be determined after on-site survey.

Most of the M&R work recommended is either localized stopgap or localized preventative M&R. Only a small portion of area is slated for global preventative M&R and major M&R. According to MicroPAVER, localized preventative M&R has a higher priority than global preventive and major repairs (Figure 8.1). This prioritization scheme confines most of the pavement M&R expenditures to preventative M&R and in particular, localized preventive M&R, because it's more economical to maintain than to repair under the current funding constraint. Another reason for fewer global preventive projects is that new global preventive M&R work is not needed if the previous one has not expired.



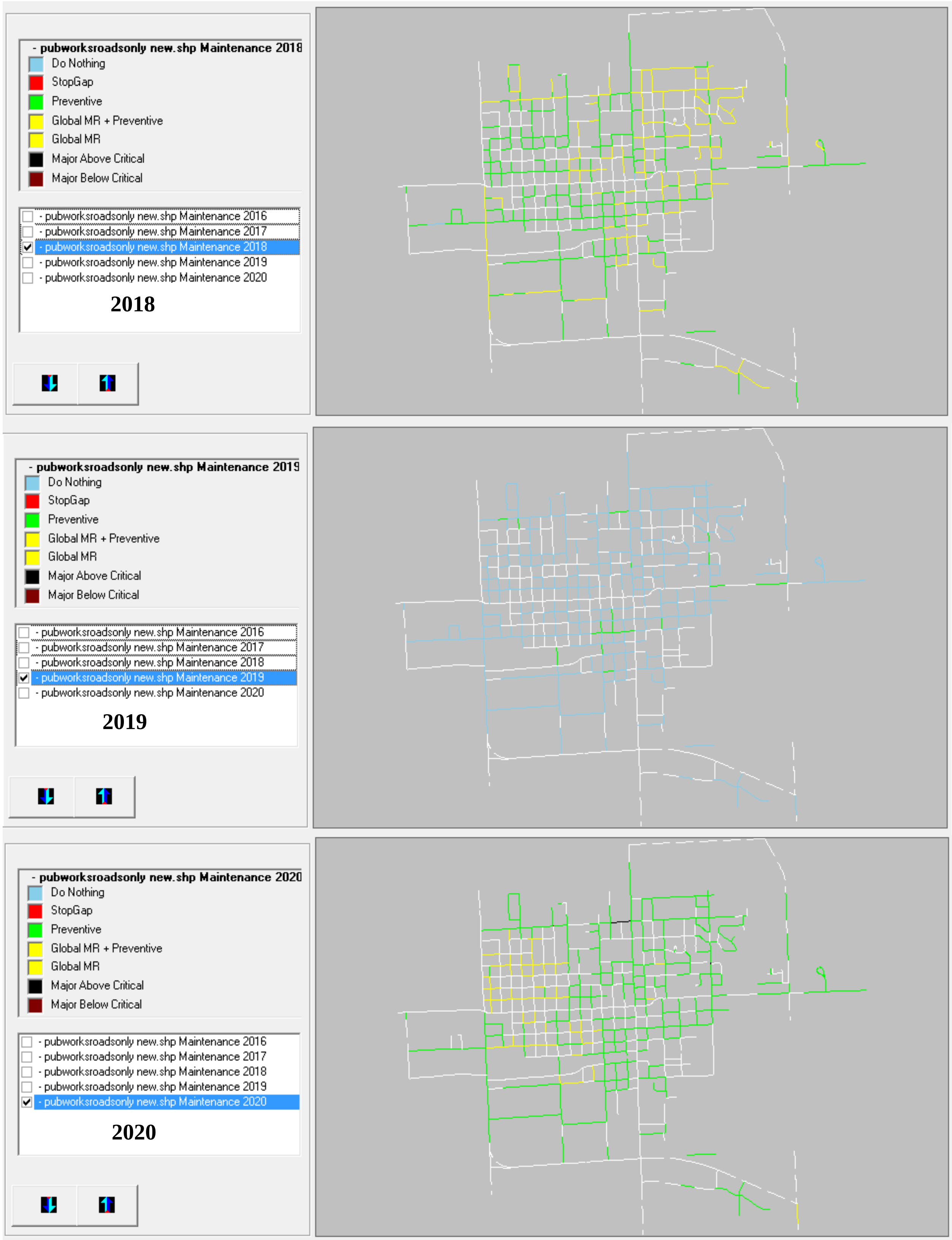



**Figure 8.8** Maps of the Recommended Projects

# 9. CUSTOMIZED M&R PLANS UNDER CITY BUDGET

## 9.1 Comparison of Analysis Alternatives

Currently, the city performs global maintenance (chip seal only) every year for one-seventh of all pavement segments, as shown in Figure 9.1. The sequential maintenance strategy ensures that the same street segment will not be repeatedly treated and all city streets will be maintained after the seven-year cycle. Estimated annual funding for the global M&R are $126K, $132K, $139K, $146K and $153K from 2016 to 2020. Every year $28K is allocated for localized stopgap M&R. For major M&R, $400K will be allocated in 2016, $600K in 2018 and $600K in 2020.


**Figure 9.1** Current Annual Maintenance (Chip Seal) Plan for Madison

In the future, the city plans to repair some pavement segments with poor conditions. If so, the project recommendation will be rather different because major M&R will be performed for a few selected pavement segments at the cost of not implementing preventive M&R for a larger area. Therefore, trade-offs between the original M&R plan recommended by MicroPAVER and the alternative plan, including major M&R work, must be understood. Criteria for performing major M&R in the proposed plan was set for segments with structural distresses (See Appendix H: e.g., alligator cracking and rutting) and PCI <=25 and Section ID 202 of 0.1 miles long was selected for major M&R (reconstruction). Reconstruction cost was estimated at $116,340, nearly one-fifth of the current city budget for 2016 pavement maintenance. On the flip side, 125 sections will receive no preventive M&R due to the shift of funding to major M&R work. In this plan, trading stopgap M&R and localized preventative M&R for a large number of pavement sections (i.e., 125 sections totaling more than nine miles) for one 0.1-mile section with major M&R will not considerably improve the average pavement conditions. Specific analysis is needed to trace the affected pavement segments if any major M&R work may significantly limit funding originally allocated to preventive maintenance effort.

In addition, it was found that preventative M&R strategies recommended in the original plan by MicroPAVER were mainly localized M&R. Alternatively, another plan was proposed to limit M&R activities to localized stopgap, global preventative, and major M&R. In other words, no localized preventative M&R was included in this plan.

The two alternatives for the five-year M&R plan under the current city budget were compared to the annual M&R plan that the city current performs and the original plan recommended by MicroPAVER. Comparisons were based on yearly average PCI and the percentage of pavement areas with different conditions. The results are presented in Table 9.1.

The results in Table 9.1 show that the average PCI for the three M&R plans (i.e., with major M&R in year one, without localized preventive M&R, and with the current city practice) is higher than the original plan recommended by MicroPAVER. The city's current M&R plan scores highest in terms of the average PCI, which is a little higher than the alternative plan without localized preventive M&R.

**Table 9.1** Average PCI with Four Alternative Plans under Current Budget*

| Year | Original Plan[1] | Alternative 1[2] | Alternative 2[3] | Current[4] |
|---|---|---|---|---|
| **2016** | 67.55 | 66.98 | 68.36 | 67.85 |
| **2017** | 65.98 | 65.42 | 67.09 | 66.72 |
| **2018** | 66 | 65.38 | 66.9 | 66.68 |
| **2019** | 64.47 | 63.86 | 65.54 | 65.57 |
| **2020** | 63.85 | 63.5 | 65.14 | 65.34 |

* 1: MicroPaver recommendation; 2: With Major M&R in Year One; 3: Without Localized Preventive;
4: City M&R Plan

The detailed funding schedule and allocation for the alternative plan without localized preventive M&R is shown in Table 9.2. This plan recommends gradually decreasing funding for global M&R, but increasing funding for Major M&R from 2016 to 2020. The mixed funding strategy results in the optimal resource allocation, which is the reason why the average PCI increases as compared to the original M&R plan recommended by MicroPAVER.

**Table 9.2** Funding Allocation for Plan without Localized Preventive under Current Budget

| **Year** | **2016** | **2017** | **2018** | **2019** | **2020** |
|---|---|---|---|---|---|
| **Stopgap** | 84,198 | 93,545 | 104,513 | 116,491 | 130,046 |
| **Localized Preventive** | 0 | 0 | 0 | 0 | 0 |
| **Global Preventive** | 210,179 | 66,159 | 96,325 | 38,843 | 61,097 |
| **Major Under Critical** | 2,120 | 0 | 0 | 0 | 0 |
| **Major Above Critical** | 256,284 | 0 | 564,231 | 9,037 | 589,118 |
| **Total** | 552,782 | 159,704 | 765,070 | 164,372 | 780,262 |

The noticeable improvement in PCI happens because when more pavement segments are in good condition, fewer segments will be in poor condition. Figure 9.2 shows that the alternative plan without localized preventive M&R and the city's current seven-year cycle plan perform better when considering both the average PCI and the percentage of pavement segments with different conditions.

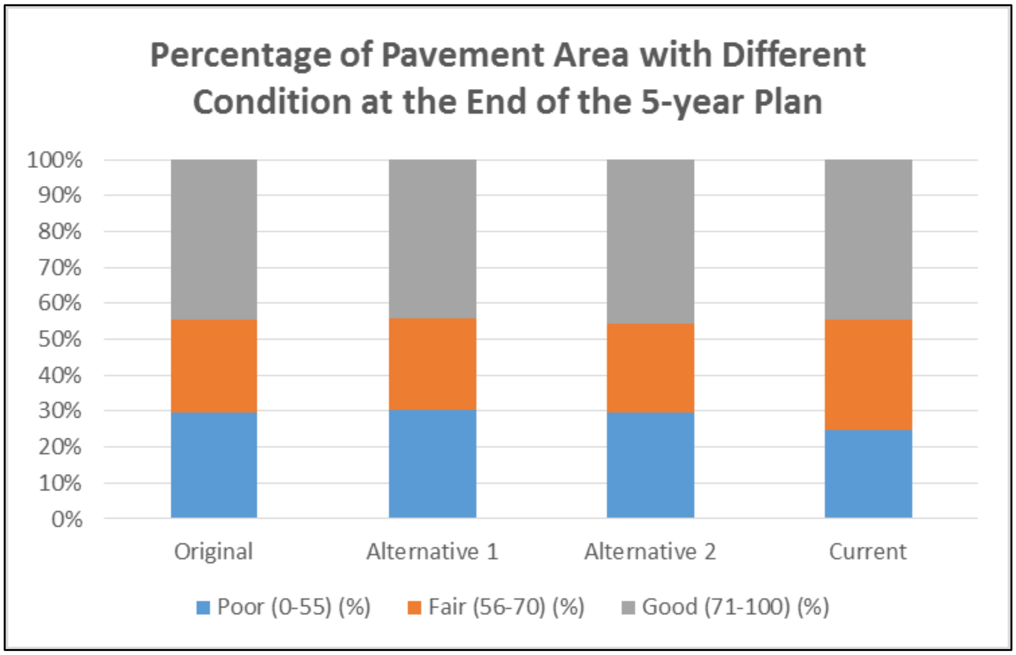



**Figure 9.2** Comparisons of Different Plans under Current Budget

## 9.2 Analysis of M&R Strategies

The analysis objective is to identify optimal funding allocation among different M&R categories to maximize the average pavement condition (PCI), and minimize the percentage of poor pavement areas (PCI<55) by the end of 2020.

First, preventive strategies were planned to determine whether global or localized strategies should be used. A pavement can be either treated locally for its distressed spots or treated globally if the distress type is rather homogenous across the surface. Both localized and global M&R are preventive strategies for pavement with PCI larger than 55, but localized treatments are applied to specific distressed areas and global treatments are applied to the entire pavement section. The uniformity of global preventive strategy suggests that only certain distress types can be treated. For instance, chip sealing only copes with skid-causing distress, such as polished aggregate and bleeding. Localized preventive, on the other hand, can treat all kinds of distress types due to its flexibility. Unit cost also affects the pavement area to be treated. In this study, unit cost for global M&R (chip sealing) is $\$0.135/ft^2$; while for localized preventive M&R the unit cost varies from 0 to $\$0.25/ft^2$, depending on the PCI value.

The comparison in Table 9.1 shows better pavement performance after implementing global preventive only M&R. Table 9.3 shows a comparison between plans with localized preventive M&R only and global preventive M&R. Results indicate that global preventive M&R outperforms localized preventive M&R when treating pavements with PCI larger than 55. A hybrid of localized and global preventive may be a third option. Given the complexity of deciding where to apply what, and practicality of the implementation, the hybrid option is not considered in this study. If a distress type is homogenous across the surface and the unit cost for global M&R is comparable to localized M&R, global preventive M&R is preferred.

**Table 9.3** Comparison between Localized Preventive and Global Preventive

| Date | Localized Preventive M&R | | | | Global Preventive M&R | | | |
|---|---|---|---|---|---|---|---|---|
| | Average PCI | Percentage of Pavement Area (%) | | | Average PCI | Percentage of Pavement Area (%) | | |
| | | Poor | Fair | Poor | | Poor | Fair | Poor |
| 12/31/2016 | 66.73 | 22 | 30 | 47 | 68.29 | 23 | 24 | 53 |
| 12/31/2017 | 64.78 | 25 | 32 | 42 | 67.07 | 24 | 27 | 48 |
| 12/31/2018 | 63.45 | 27 | 31 | 41 | 65.96 | 26 | 28 | 46 |
| 12/31/2019 | 62 | 30 | 33 | 37 | 64.63 | 27 | 28 | 45 |
| 12/31/2020 | 60.69 | 33 | 32 | 35 | 63.12 | 30 | 30 | 41 |

Second, for all the pavement sections with PCI below 55, the option to first treat the pavement section with the worst condition or pavement with the best condition must be evaluated. MicroPAVER adopts "worst - last" in which the lowest priority for major M&R is assigned to the pavement with the lowest PCI. Results in Table 9.1 indicate that this prioritization scheme may not lead to an optimal plan. Research was conducted on the comparison between "best - first" and "worst – first," with no clear winner shown *(27)*. In this study, sensitivity analysis was performed to determine whether pavement with the worst condition should be treated first or last. Seventeen sections were selected, which have very low PCI (<= 25) with structural distresses. The major M&R projects for the 17 segments listed in Table 9.4 were based on the rank of functional classification and pavement PCI. The reconstruction unit cost is $6.5/ft$^2$.

**Table 9.4** List of the Worst Pavement Sections

| **Priority ID** | **Branch ID** | **Section ID** | **Rank*** | **Age** | **PCI** | **True Area(ft$^2$)** | **Unit Cost** | **Total Cost** |
|---|---|---|---|---|---|---|---|---|
| 1 | SE 4TH ST | 202 | B | 39 | 25 | 17898 | $6.50 | $116,337 |
| 2 | SE 2ND ST | 107 | E | 57 | 10 | 10281 | $6.50 | $66,826 |
| 3 | NE 7TH ST | 705 | E | 41 | 11 | 1433 | $6.50 | $9,314 |
| 4 | N ROOSEVE | 387 | E | 45 | 14 | 18798 | $6.50 | $122,187 |
| 5 | N ROOSEVE | 84 | E | 45 | 14 | 16094 | $6.50 | $104,611 |
| 6 | NE 8TH ST | 669 | E | 49 | 14 | 7755 | $6.50 | $50,407 |
| 7 | CIRCLE DR | 707 | E | 41 | 16 | 3498 | $6.50 | $22,737 |
| 8 | CIRCLE DR | 721 | E | 41 | 16 | 3498 | $6.50 | $22,737 |
| 9 | NE 8TH ST | 587 | E | 49 | 16 | 11090 | $6.50 | $72,085 |
| 10 | N CATHERI | 366 | E | 36 | 19 | 9120 | $6.50 | $59,280 |
| 11 | N CHICAGO | 187 | E | 55 | 21 | 11922 | $6.50 | $77,493 |
| 12 | N MAPLEWO | 6 | E | 34 | 23 | 11763 | $6.50 | $76,459 |
| 13 | NE 6TH ST | 128 | E | 45 | 23 | 21518 | $6.50 | $139,867 |
| 14 | NE 8TH ST | 156 | E | 41 | 23 | 10941 | $6.50 | $71,116 |
| 15 | W CENTER | 480 | E | 16 | 24 | 11417 | $6.50 | $74,210 |
| 16 | NE 5TH ST | 585 | E | 53 | 25 | 12549 | $6.50 | $81,568 |
| 17 | NE 8TH ST | 157 | E | 49 | 25 | 10567 | $6.50 | $68,685 |

*B: arterial, E: residential

Third, localized stopgap M&R was applied for sections where major M&R should have been done if there had been sufficient funding. Considering the original MicroPAVER plan, the recommended localized stopgap M&R annual budget was $84K, $94K, $105K, $116K and $130K for 2016-2020. The rest of the budget of $470K, $66K, $662K, $58K and $651K for 2016-2020 can be allocated for major M&R. Seven plans (a-f2) with the increasing number of major M&R projects selected from the 17 candidate pavement sections were compared (Table 9.5). For each plan, localized stopgap M&R was firstly applied to pavements with PCI less than 55, then major M&R was applied to some of or all of the 17 segments. Following this, the M&R strategies were optimized for the pavement sections where PCI values are larger than or equal to 55. In all seven plans, no localized preventive M&R was considered. Funding allocation for each plan is shown in Appendix I. The City of Madison suggested another plan (Plan g) in which the global M&R will be $126K, $132K, $139K, $146K and $153K for 2016-2020, respectively.

**Table 9.5** Plans including the Major M&R for the 17 Worst Pavements

| | **Major M&R for the 17 Worst Pavements** | | | | |
|---|---|---|---|---|---|
| **Plan** | **2016** | **2017** | **2018** | **2019** | **2020** |
| **a** | - | - | - | - | - |
| **b** | 1 | - | 2 | 3 | 4 |
| **c** | 1,2 | 3 | 4,5 | 6 | 7,8 |
| **d** | 1,2,3 | - | 4,5,6 | 7,8 | 9,10,11 |
| **e** | 1,2,3,4 | - | 5,6,7,8 | - | 9,10,11,12 |
| **f** | 1,2,3,4,5 | 6 | 7,8,9,10,11,12,13,14,15 | - | 16,17 |
| **f2** | 1,2,3,7,8,10,11 | - | 4,5,6,9,14,17 | - | 12,13,15,16 |
| **g** | 1,2,3,7,8,10,11 | - | 4,5,6,9,14,17 | - | 12,13,15,16 |
| **g2** | 1,2,3,10,11 | - | 4,5,6,7,8,9,14,17 | - | 12,13,15,16 |

Between Plan f2 and Plan g, the number of major M&R projects and their schedules are the same. The difference lies in the funding for global preventive. Plan g allocates more funding for global preventive than actually needed, according to the default assumptions in MicroPaver. As a result, the total budget in Plan g should be increased (around 200K in total) as shown in Figure 9.3, or the funding for localized stopgap M&R and major M&R will be inadequate.

The question is where to invest extra funding for global preventive and whether additional funding provides extra value in terms of increased average PCI or reduced poor pavement areas. According to Figure 9.3, the extra funding was manually assigned to appropriate sections for global M&R following the procedures below:

1) In the GIS database, pavement candidates are first identified using the following criteria: 1) city maintained AC section; 2) PCI >=55; 3) minimum year from previous or recommended global/major M&R is one.
2) New sections to be treated with additional M&R funding are selected from candidates in the GIS shapefile for each year. The sections adjacent to previously selected M&R in the same year are considered first until total costs equal the budget.
3) The selected sections are imported to MicroPAVER as required projects to obtain the optimized M&R plan.

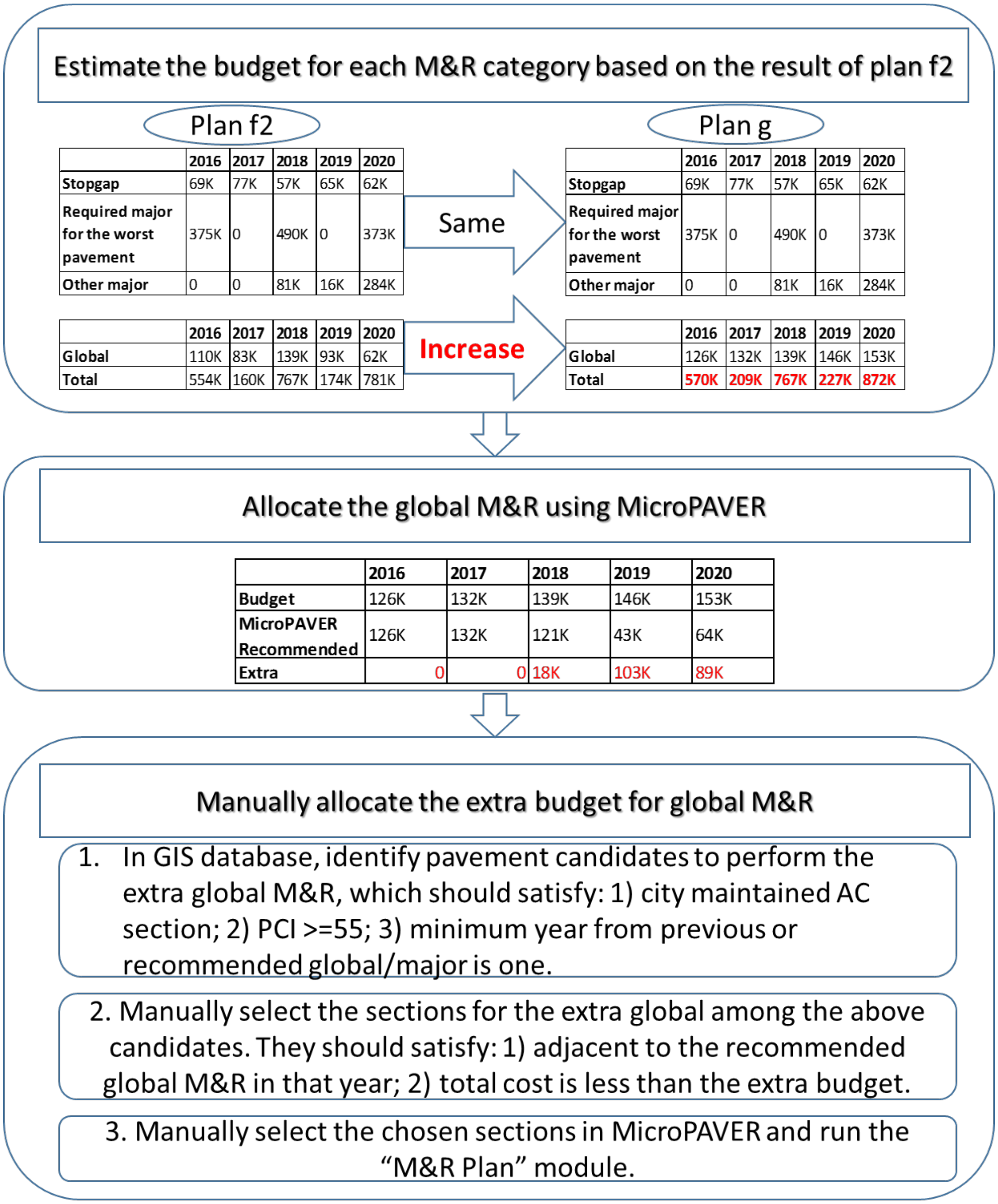



**Figure 9.3** Flow Chart of Plan g

In Plan g, the recommended global M&R work for each year is not located close to each other, so it's difficult to implement. To facilitate the implementation, another plan g2 was proposed, which allocate the global M&R based on the current chip seal schedule. Between Plan f2 and Plan g2, the schedule of required major projects has been changed slightly—major projects with Priority ID 7 and 8 have been shifted from year 2016 to 2018. This is because the total cost in year 2016 would exceed the current city budget if performing the required major projects shown in Plan f2. As a consequence, budget for stopgap and other major projects were changed as shown in Figure 9.4. Stopgap cost in Plan g2 was estimated based on the unfunded stopgap shown in MicroPAVER if performing the required major and global M&R only. Another major cost was the rest budget, which equals total budget less stopgap, required major and global. In 2017 and 2019, current total budget is short for stopgap, required major and global, so the total should be increased to $210K and $206K respectively. Compared to Plan f2, total budget in Plan g2 for the five years is increased by approximately $80K, but is still less than that in Plan g. In Plan g2, although current chip seal cost estimated by MicroPAVER is less than the global budget, it is assumed that the city will spend all global funding on the required chip seal (shown in Table 31).

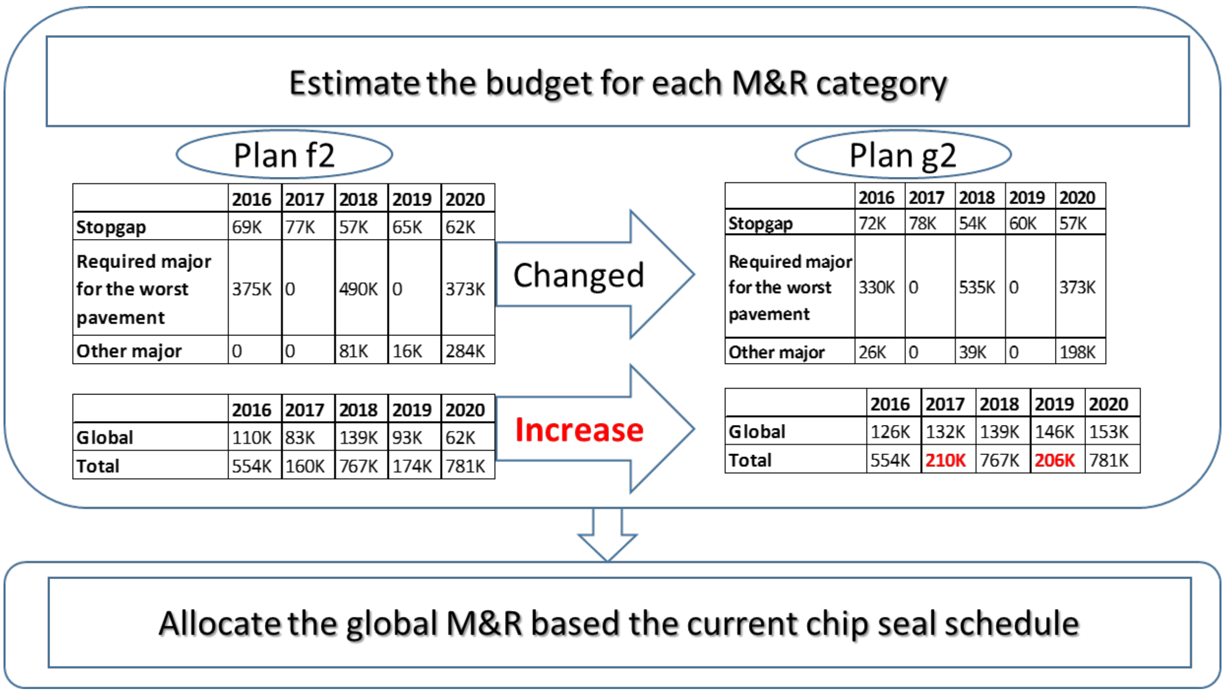


**Figure 9.4** Flow Chart of Plan g2

Pavement performance (average PCI and percentage of poor pavement) at the end of 2020 were used to compare different plans. The results are shown in Figure 9.5. When the number of major M&R projects increases from Plan a to g, the resultant PCI value increases and the percentage of poor pavement decreases. In Plan f2, after applying major M&R to all 17 sections, the second highest PCI and third lowest percentage of pavement in poor condition were obtained. In Plan g2, PCI was the fourth highest, while percentage of pavement in poor condition was second lowest. Although the final PCI is the highest in Plan g, this plan required 210K more funding than the rest of the plans. Further comparison was made for the global M&R among Plan f2, Plan g and Plan g2. In Plan f2, an average increase of 4.91 in PCI (3-year increase in life) was achieved on the 301 sections after implementing global M&R. While in Plan g, the added global M&R expenses increased the average PCI by 5.36 for a total of 357 sections (3-5 year increase in life). In comparison, after global M&R work in Plan g2, PCI was increased by 4.01 (3-year increase in life) for 369 sections. In conclusion, as the number of major projects increases, the average PCI increases. Plan g yields the highest PCI among all plans (PCI=66.53) at the expense of 210K additional funding. Funding was invested in sections with global preventive treatment, resulting in an average of 5.36 points more in PCI (3.5 year increase in life) for 357 sections. Comparing Plan f2 and Plan g2, although a three-year life increase achieved for the treated pavements in both plans, PCI increased much more in Plan f2 than Plan g2 (4.91 vs. 4.01). This indicates that global M&R in Plan f2 is more reasonably scheduled than Plan g2. Figure 9.5 also shows that the M&R plan directly recommended by MicroPAVER is not the optimal (lowest PCI and highest percentage of poor pavement area).

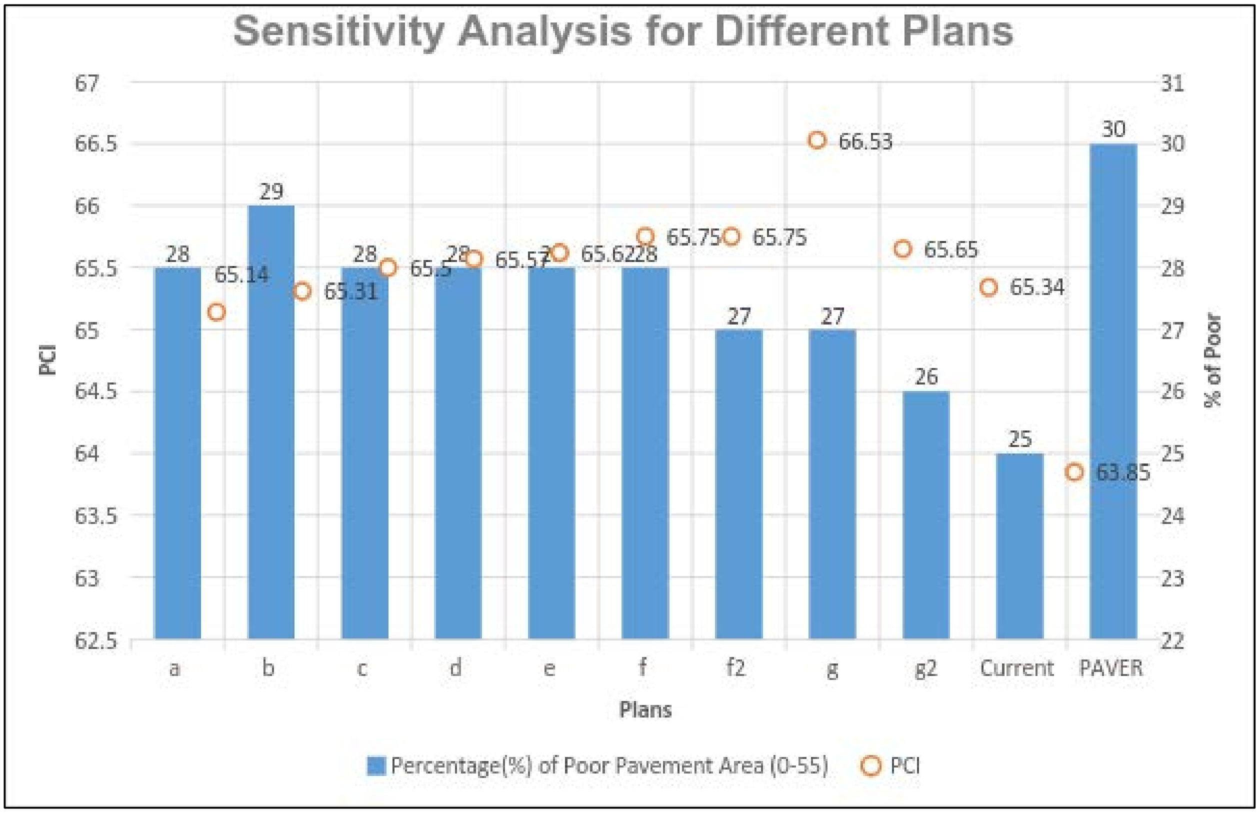


**Figure 9.5** Sensitivity Analysis for Different Plans

It is worth noting that the city currently budgets only $28K for localized stopgap, which is not sufficient to cover all segments with a PCI value less than 55. The pavement functionality and safety may be compromised if neither stopgap nor major repair is applied. Considering the benefit/cost and implementation, Plan f2 and Plan g2 are recommended. For Plan f2, the schedule for global M&R is optimized, but difficult to implement. For Plan g2, global M&R work is the current chip seal and is easy to implement. However, this schedule is not optimal and it increases the budget by approximately $80K. Table 9.6 presents the budget allocation among the current city plan, Plan g and recommended plans (Plan f2 & Plan g2). Detailed recommended M&R projects for plan f2 and plan g2 were presented in Appendix J.

**Table 9.6** Budget Allocation between Current Plan and the Recommendation

| Date | 12/31/2016 | 12/31/2017 | 12/31/2018 | 12/31/2019 | 12/31/2020 |
|---|---|---|---|---|---|
| **Current City Plan** | | | | | |
| **Stop Gap** | 28,000 | 28,000 | 28,000 | 28,000 | 28,000 |
| **Global Preventive Budget (Estimated Chip Seal)** | 126,000 (125,652) | 132,000 (119,397) | 139,000 (116,582) | 146,000 (120,917) | 153,000 (121,953) |
| **Major** | 400,000 | 0 | 600,000 | 0 | 600,000 |
| **Total** | 554,000 | 160,000 | 767,000 | 174,000 | 781,000 |
| **Plan f2** | | | | | |
| **Stop Gap** | 68,577 | 76,767 | 56,126 | 64,410 | 61,066 |
| **Global Preventive** | 109,861 | 82,805 | 138,715 | 92,113 | 61,098 |
| **Major** | 374,719 | 0 | 566,772 | 13,660 | 655,255 |
| **Total** | 553,157 | 159,572 | 761,614 | 170,183 | 777,419 |
| **Plan g** | | | | | |
| **Stop Gap** | 68,577 | 76,767 | 56,126 | 64,410 | 60,740 |
| **Global Preventive** | 125,934 | 130,782 | 137,208 | 140,903 | 151,157 |
| **Major** | 374,719 | 0 | 566,772 | 13,660 | 655,255 |
| **Total** | 569,229 | 207,549 | 760,107 | 218,972 | 867,152 |
| **Plan g2** | | | | | |
| **Stop Gap** | 71,266 | 77,118 | 53,035 | 59,723 | 56,812 |
| **Global Preventive Budget (Estimated Chip Seal Cost)** | 126,000 (125,652) | 132,000 (119,397) | 139,000 (116,582) | 146,000 (120,917) | 153,000 (121,953) |
| **Major** | 355,565 | 0 | 566,083 | 0 | 563,403 |
| **Total** | 552,831 | 209,118 | 758,118 | 205,723 | 773,215 |

# 10. CONCLUSIONS & RECOMMENDATIONS

The goal of this project was to develop a PMS for the City of Madison. The goal was accomplished by achieving four specific objectives: 1) build a city-wide GIS database for PMS, which is compatible and incorporable with the city's GIS system; 2) identify feasible pavement maintenance strategies for city roads; 3) recommend multi-year rehabilitation plans for different budget scenarios; and 4) provide PMS and MicroPAVER training.

Pavement maintenance in Madison is underfunded. Required funding for backlog elimination by the end of 2020 is about $2.90 million/year, which is far more than the city's current budget. The current budget cannot even maintain the same level of pavement performance by 2020. Hence, additional funding is recommended for pavement maintenance and repair.

If the city keeps the budget at the current level, its pavement M&R plan must be optimized to provide additional pavement performance. The overall strategy is called the critical PCI method, which keeps all pavements from reaching the critical PCI point after which the deterioration will accelerate. Under this strategy, different M&R plans were developed, analyzed and compared to the original MicroPAVER plan. It was found that by modifying the original MicroPAVER M&R plan, better pavement performance was obtained. The evaluation criteria are to maximize the final pavement condition (PCI) and minimize the percentage of poor pavement areas (PCI<55) by the end of 2020. Among all the plans, Plan f2 and Plan g2 were recommended because of the overall high PCI and low percentage of poor pavement areas. Plan f2's schedule for global M&R is optimized, but may be difficult to implement. Plan g2's schedule for global M&R follows the same city's chip seal schedule; however, this schedule is less optimal than f2 and the total budget exceeds current funding by $80K during the five-year period. The performance of each plan and their tradeoffs provide necessary information to support the city's decision-making on pavement investment.

The proposed multi-year M&R plan can improve the performance of AC pavement. However, for the PCC pavement in Madison, less than one-third of the sections (10/32) have the pavement construction date information, which contributes to the inaccuracy of the performance model. It is recommended that in the future, the city collect more information about PCC pavement.

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# APPENDIX

## A. PMS Project Kickoff Meeting Minutes - February 14, 2014

**<u>9:00-9:05</u> Introduction**

Attendance: Dr. Xiao Qin (SDSU), Zhao Shen (SDSU), Zhaoxiang He (SDSU); Hao Wang (Rutgers Via Skype); Chad Comes (City of Madison, SD)

**<u>9:05-9:35</u> Overview of project scope and objectives (presenter: Drs. Qin, Xiao and Wang, Hao)**

XQ reviewed the project scope, objectives, tasks, deliverables, and schedule. The presentation is attached in the end of the minutes.

**<u>9:35-9:45</u> Overview Madison GIS coverage: a comparison between City GIS map and SDDOT SD NSTRI (Non-State Trunk Road Inventory) (Presenter: Zhao Shen)**

ZS compared two GIS maps acquired from Madison and SDDOT NSTRI, respectively. The major differences between the two are the link length and available attributes. In general, SDDOT NSTRI map has longer links than Madison map. Moreover, SDDOTT NSTRI has more link attributes (e.g., lane width, surface type, shoulder width, etc.) than city map. According to Chad, both maps are produced and provided by SDDOT District 1 GIS unit who distributes the map to local agencies who pay the membership dues. It is unclear why they are different. It is possible that the city map wad reprocessed by PubWorks. A meeting with the map creator and provider District 1 must be scheduled ASAP to gain more understanding of the map source, attribute, linear referencing system, etc.

**<u>9:45-10:00</u> Introduction of MicroPAVER (Presenter: Zhaoxiang He)**

ZH briefly introduced the data requirements, pavement condition assessment standards (PCI from ASTM) and main functions of MicroPaver. It is worth noting that PAVER Field Inspector™ is the PAVER™ companion software that uses GIS/ GPSand innovative graphics to facilitate pavement inspection with handheld computer tablets. Chad mentioned that city has ArcPad that may be used for facilitating data collection. SDSU has two Trimble Juno units that can also be used for data collection.

**<u>10:00-10:15</u> Overview of City Street and Pavement Needs (Presenter: Chad Comes)**

1) No real pavement improvement funding or systematic process except for chip seals
2) Chip Seals – 7-year cycle
3) Desire to begin systematic program for identifying and prioritizing needed street improvements
4) It is anticipated that street distress run full gamut of those typically encountered in asphalt pavement
5) Not a single pavement distress particularly encountered consistently throughout system. Most commonly; however, simple function of most pavements reaching their lifecycles and despite very consistently applied chip seal process, streets are showing more rapid failures patterns.
6) Improvement anticipated to range from simple overlay to full surfacing removal and replacement.
7) Also, some street reconstruction projects could be incorporated dependent upon coordinated review of underground utility condition
8) As a significant component of this effort, the city would like a complete street GIS system to provide for pavement management functions, condition tracking, and improvement record keeping purposes, etc. The system in no way should be tied to or created from any existing GIS databases currently available/in use.

**<u>10:15-10:45</u> Current Data (e.g., construction records, inspection report, maintenance cost, annual budget, etc.) (Presenter: Chad Comes)**

1) No real pavement improvement funding or systematic process except for chip seals
2) Chip Seals – seven-year cycle
3) Desire to begin systematic program for identifying and prioritizing needed street improvements
4) It is anticipated that street distress run full gamut of those typically encountered in asphalt pavement
5) Not a single pavement distress was encountered consistently throughout system. owever, simple function of most pavements reaching their lifecycles, despite consistently applied chip-seal process, streets are showing more rapid failures patterns.
6) Improvement anticipated to range from simple overlay to full surfacing removal and replacement.

7) Some street reconstruction projects could be incorporated dependent upon coordinated review of underground utility condition.
8) As a significant component of this effort, the city would like a complete street GIS system to provide for pavement management functions, condition tracking, and improvement record keeping purposes, etc. The system in no way should be tied to or created from any existing GIS databases currently available/in use.

**<u>10:45-11:45</u> Discussion of field data collection plan and other issues (All)**

The tentative timetable for preparing and collecting pavement condition data is as follows:

**1. *March, 2014***
   a. Chad will review the city GIS map to ensure that it is the original map provided by District 1 and/or revised by PubWorks (trademark).
   b. SDSU and Chad will meet with District 1 to discuss the GIS map, if necessary, after city discussions with 1st District Association of Local Governments.
   c. SDSU will develop sample GIS database/map; populate with sample data; and review with City. This will likely happen in a separate meeting.
   d. City approves proposed database structure.
   e. City will provide SDSU with available inventory data for past pavement projects and costs, subdivision maps for estimating the age of pavement and other supporting documents as can be reasonably ascertained.
   f. SDSU will review the currently available highway inventory and pavement data and then 1) prepare the city-wide GIS database, and 2) draft a preliminary data collection plan.
   g. SDSU will prepare quarterly report memo, preferably written in layman's format, for City Commission and general public audience. Report will be acknowledged at City Commission meeting in April.

**2. *April, 2014***
   a. SDSU will perform a test data collection in the city of Madison.
   b. A project meeting will be scheduled at the same time to review the data collection plan and requirements for equipment and personnel. Tentative meeting date is April 25 (Friday).
   c. Prior to project meeting, SDSU will provide comparative analysis of up to three PMS software "systems" for presentation to city and inclusion into quarterly report. At project meeting, city will review SDSU recommended PMS software "system" and whether there should be non-concurrence. City shall advise SDSU of alternative preference.
   d. Review needs of coring activities [or other process (i.e. chop saw square and measure pavement section parameters)] at project meeting. Determine data needed and best practices to be implemented to accomplish data collection.

3. ***June, 2014***
   a. SDSU will start assessing pavement conditions by walking survey, participated by city staff.
   b. SDSU will prepare quarterly report memo preferably written in layman's format for City Commission and general public audience. Report will be acknowledged at City Commission meeting in July.

4. ***July, 2014***
   a. SDSU will review and evaluate pavement conditions and decide the sample locations for coring/boring activities.
   b. SDSU will notify city of the sample locations for coring.

5. ***August, 2014***: city and/or SDSU with training from City will perform coring service to determine the pavement structural capacity.

The meeting adjourned at 11:30 am.

## B. PMS Project Meeting Minutes - May 12, 2014

**9:00-9:05am Introduction**

Attendance: Dr. Xiao Qin (SDSU), Zhao Shen (SDSU), Zhaoxiang He (SDSU); Hao Wang (Rutgers); Chad Comes (Madison, SD), and Fred Snoderly (Madison, SD)

**9:05-9:20am Overview of project progress (Qin and Wang)**

XQ reviewed the project scope, objectives, tasks, deliverables, and schedule. The project is on time and on budget. Close to the end of the second quarter of year one, we are beginning with Task 3, Pavement condition survey and evaluation.

**9:20-9:40am Overview of PMS tools (Shen)**

Previously, SDSU compared MicroPaver and two local applications, SDDOT PMS spreadsheet and MDMS. SDDOT spreadsheet is a product of a 1993 SDDOT study SD93-07-G3 *Pavement Management Guide for City Streets*. MDMS is designed by NDLTAP and used to track costs for county roads or city streets. MDMS primarily is used for logging city work and projects, not for managing pavements per se, and SDDOT spreadsheet is a simple input spreadsheet whose functions are a small fraction of MicroPaver. Therefore, two commercially available tools (StreetSaver and Cartegraph) were selected to compare with MicroPaver. Cartegraph is an expensive asset management tool which includes a PMS component. Since Madison already purchased an asset management tool from PubWorks, Cartegraph was not pursued further. The comparison between MicroPaver and StreetSavers shows three major differences:

1) Information Access: MicroPaver is a desktop application, while StreetSaver is an on-line application. As an on-line application, StreetSaver can be accessed from anywhere, anytime with multiple users and accessed with Internet connection. Services provided by the StreetSaver vendor also include database storage, recovery, and backup. However, with the size of the City of Madison, all benefits offered through such an online application may not justify the cost.
2) Price: MicroPaver charges a one-time license fee of $995 for APWA members (note City of Madison is an APWA member) and also offers RoadInspector, a company data collection tool, free. StreetSaver charges a $750 annual service fee in addition to a $1,500 initial development/consultant license fee.
3) Pavement Distress Types: Although both MicroPaver and StreetSaver comply with ASTM D-6433 standards, MicroPaver has more complete distress types (20 for asphalt pavement and 19 for concrete pavement) than StreetSaver (seven for both asphalt and concrete pavement types). Several common pavement distress types are not available in StreetSaver. It is possible that the distress types included in StreetSaver are common for roads and streets in west coast cities (e.g., San Francisco area), but not necessary for Madison, SD. Moreover, MicroPaver has distress types for gravel roads, which are unavailable in StreetSaver.

Based on these major differences and the limited distress types in StreetSaver, the City approved the use of MicroPaver for developing PMS in this research project.

**9:40-10:20am Data Collection Plan & Discussion (Qin & He)**

XQ presented the detailed data collection plan for collecting pavement distress and attribute information. There are 633 city-maintained road segments in Madison, constituting 53 miles. Data collection will start in late May or early June and may take one week (five working days). Data collection strategies will be visual assessment through walking or windshield survey. The research team will survey pavement distress (type and severity), and validate pavement attributes (pavement type, width, etc.). Specific route information for daily survey also was presented.

Chad suggested populating the city GIS map with “more accurate” pavement width information from the AutoCAD file provided by the city. Data collection can be expedited by validating pavement width information.

**10:20-11:20am _ Non-Pavement Condition Data Collection (All)**

Non-pavement condition data include M&R costs information and pavement history (e.g., pavement age and historical M&R activities). As for costs, Chad will provide SDSU with unit price for 4-inch surfaces

($/ton), unit price for 8” base ($/ton), unit chip seal price ($/square yard), and other relevant costs. Fred will provide SDSU with cost information for crack-sealing and pot-hole repairs.

As for the pavement history, Chad provided SDSU with two maps on which segments with known M&R records and pavement thickness have already been marked. Chad also provided a map for completed/scheduled/planned chip seal activities. For the rest of the (older) streets and roads without any information, it may be appropriate to assume a 3-3.5-inch surface with 4-6-inch base. The chip seal cycle for city-maintained streets and roads is seven years.

To validate pavement thickness, SDSU will provide the city with a coring map/plan post evaluation.

SDSU will update GIS database with intersections included in one or two cross streets to avoid double counting the area of intersections.

Based on the discussion, there is no need for traffic control or labor assistance from the city. But the city is willing to provide assistance for data collection, as needed.

**11:20am-2pm _ Mock Data Collection (All)**

SDSU visited a few concrete and asphalts segments to perform mock data collection.

The meeting adjourned at 11:20 am.

## C. Cost/Performance Trade-off Matrix

**Table Appendix.1** Cost/Performance Trade-off Matrix for All Roads

| Equipment global cost | | Operational Performance | | | | |
|---|---|---|---|---|---|---|
| | Scale | 1 (low performance) | 2 | 3 | 4 | 5 (high performance) |
| | 1 (high cost) | | | • Skid Resistance Dynamic -Vehicle | • Imaging for Surface Distress | |
| | 2 | | | • Ground Penetrating Radar –Dynamic<br>• FWD - Trailer | • Macrotexture – Dynamic High Speed<br>• Precision INU for Geometry<br>• Roughness – Laser | |
| | 3 | | | • Deflection Beams<br>• FWD - Portable<br>• Ground Penetrating Radar – Static<br>• Skid Resistance – Dynamic | • GPS with INU<br>• Macrotexture– Dynamic Low Speed<br>• Rut Depth Profilers<br>• Roughness –Manual | |
| | 4 | | • Roughness- Class IV | • Roughness – Walking Profiler<br>• Skid Resistance – Static | • Video Logging<br>• Roughness – RTRMS | • GPS |
| | 5 (low cost) | | | • Macrotexture – Static | | • Digital DMI |

**Table Appendix. 2** Cost/Performance Trade-off Matrix for Rural Roads [(10)]

| | | Operational Performance | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| | Scale | 1 (low performance) | 2 | 3 | 4 | 5 (high performance) |
| Equipment global cost | 1 (high cost) | | | • Skid Resistance Dynamic -Vehicle | | |
| | 2 | | | • Ground Penetrating Radar– Dynamic<br>• Roughness – Laser<br>• FWD - Trailer | • Macrotexture – Dynamic High Speed | |
| | 3 | | | • Deflection Beams<br>• FWD - Portable<br>• Ground Penetrating Radar– Static | • Macrotexture – Dynamic Low Speed<br>• Rut Depth Profilers<br>• Roughness – Manual<br>• Precision INU for Geometry<br>• Roughness – RTRMS<br>• Imaging for Surface Distress<br>• Skid Resistance –Dynamic Trailer | |
| | 4 | | | • Skid Resistance –Static<br>• Roughness- Visual Measurement | • Video Logging<br>• GPS with INU<br>• Roughness – Walking Profiler | |
| | 5 (low cost) | | | • Macrotexture – Static | • Digital DMI<br>• GPS | |

**Table Appendix. 3** Cost/Performance Trade-off Matrix for Unsealed Roads [(10)]

| Equipment global cost | | Operational Performance | | | | |
|---|---|---|---|---|---|---|
| | Scale | 1 (low performance) | 2 | 3 | 4 | 5 (high performance) |
| | 1 (high cost) | | | | | |
| | 2 | | | • Ground Penetrating Radar – Dynamic | • FWD - Trailer | |
| | 3 | | | • Ground Penetrating Radar – Static<br>• Imaging for Surface Distress | • Roughness –RTRMS | |
| | 4 | | | • Roughness- Visual Measurement | • Video Logging<br>• FWD – Portable<br>• Dynamic Cone Penetrometer | |
| | 5 (low cost) | | | | • Digital DMI<br>• GPS | |

### D. Coring Results

**Table Appendix. 4** Coring Results with 39 Recommended & 24 Additional Boring Locations

| Street | Test Boring | Non-Deteriorated Asphalt | Deteriorated Asphalt | Total Asphalt | Gravel Thickness | Soil Type (Upper 2 Feet) |
|---|---|---|---|---|---|---|
| Southwest 7th Street | 1 | 1.5" | 10.5" | 12" | 0" | Brown Clay |
| Southwest 7th Street | 1A | 3" | 7" | 10" | 0" | Brown Clay |
| South Egan Avenue | 2 | 3" | 2.125" | 5.125" | 9.875" | Black Clay |
| South Egan Avenue | 2A | 2" | 4.25" | 6.25" | 10.25" | Black Clay |
| Southeast 9th Street | 3 | 3.5" | 0" | 3.5" | 8.375" | Black Clay |
| Southeast 9th Street | 3A | 3.25" | 0" | 3.25" | 10.75" | Black Clay |
| Southeast 3rd Street | 4 | 2.625" | 2.5" | 5.125" | 2" | Brown Clay |
| Southeast 3rd Street | 4A | 4" | 2.25" | 6.25 | 1.25" | Brown CLay |
| Southeast 3rd Street | 5 | 2.75" | 3.625" | 6.375" | 0" | Black Clay |
| Southeast 3rd Street | 5A | 1.75" | 4" | 5.75" | 0" | Black Clay |
| Southeast 1st Street | 6 | 3" | 3.25" | 6.25" | 0" | Black Clay |
| Southeast 1st Street | 6A | 2" | 5.25 | 7.5" | 0" | Black clay |
| North Grant Avenue | 7 | 2.5" | 1.5" | 4" | 7.75" | Brown Clay |
| North Grant Avenue | 7A | 3.75" | 1" | 4.75" | 6.25" | Brown Clay |
| North Jefferson Avenue | 8 | 3.375" | 0" | 3.375" | 7.25" | Brown Clay |
| North Jefferson Avenue | 8A | 4" | 0" | 4" | 7.25" | Brown Clay |
| North Garfield Avenue | 9 | 1" | 5.625" | 6.625" | 0" | Black Clay |
| North Garfield Avenue | 9A | 4.5" | 2.75" | 7.25" | 0" | Black Clay |
| North Grant Avenue | 10 | 2.75" | 0" | 2.75" | 9.25" | Black Clay |
| North Grant Avenue | 10A | 3.25" | 0" | 3.25" | 9" | Black Clay |
| Need to get core out of hole | 11 | | | | | |
| South Blanche Avenue | 12 | 4.75" | 0" | 4.75" | 9.75" | Brown Clay |
| South Blanche Avenue | 12A | 5.75" | 0" | 5.75" | 8.5" | Brown Clay (Core not the best. Bit got warm ) |
| North Egan Avenue | 13 | 2.5" | 0" | 2.5" | 0" | Appears as Deteriorated |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | concrete below asphalt. |
| Southeast 3rd Street | 14 | 5.25" | 0" | 5.25" | 8.5" | Black Clay |
| Southeast 3rd Street | 14A | 4" | 2.25" | 6.25" | ?? | Concrete Below. Could not drill through. |
| North Lincoln Avenue | 15 | 3.25" | 1.5" | 4.75" | 6.875" | Black Clay |
| Northwest 4th Street | 16 | 3.75" | 2.0" | 5.75" | 1" | Black Clay |
| Northwest 6th Street | 17 | 4" | 5.5" | 9.5" | 0" | Black Clay |
| North Josephine Ave | 18 | 2" | 1.5" | 3.5" | 6.75" | Brown Clay |
| Northwest 10th Street | 19 | 2.75" | 1.25" | 4" | 9.25" | Brown Clay |
| Northwest 9th Street | 20 | 5" | 0" | 5" | 9.75" | Black Clay |
| North Washington Avenue | 21 | 4.75" | 0" | 4.75" | 10.5" | Black Clay |
| Northeast 8th Street | 22 | 1.25" | 0" | 1.25" | 0" | Brown Clay (5.25" Concrete under asphalt to ) |
| Northeast 9th Street | 23 | 2" | 1" | 3" | 7.5" | Black Clay |
| North Washington Avenue | 24 | 4.125" | 0" | 4.125" | 8.875" | Black Clay |
| Northeast 9th Street | 25 | 2.5" | 1.75" | 4.25" | 6" | Black Clay |
| Maplewood Drive | 26 | 3.75" | 0" | 3.75" | 8.75" | Black Clay |
| Jennifer Street | 27 | 3.625" | 0" | 3.625" | 9.125" | Brown Clay |
| North Roosevelt Avenue | 28 | 1.25" | 7.25" | 8.5" | 0" | Black Clay |
| Northeast 7th Street | 29 | 2.5" | 4" | 6.5" | 0" | Black Clay |
| Northeast 6th Street | 30 | 3" | 2" | 5" | 6.5" | Black Clay |
| Roosevelt Avenue North | 31 | 3.5" | 0" | 3.5" | 7.5" | Brown Clay |
| Maplewood Drive | 32 | 2.5" | 4.5" | 7" | 0" | Brown Clay |
| Northeast 8th Street | 33 | 3.375" | 0" | 3.375" | 7.875" | Black Clay |
| Northeast 8th Street | 34 | 5" | 0" | 5" | 6.25" | Brown Clay |
| North Division Avenue | 35 | 3.25" | 0" | 3.25" | 7.5" | Black Clay |
| Twin Oaks Drive | 36 | 2.5" | 2.25" | 4.75" | 7.5" | Brown Clay |
| Twin Oaks Drive | 37 | 5.25" | 0" | 5.25" | 5" | Brown Clay |
| Airport Road | 38 | 3.25 | 0" | 3.25" | 5.75" | Black Clay |
| Northeast 4th Street | 39 | 2.5" | 2.5" | 5" | 13" | Black Clay |

| | | | | | | |
|---|---|---|---|---|---|---|
| Northeast 3rd Street | 40 | 3" | 1" | 4" | ?? | 4" asphalt with concrete under |
| Northwest 8th Street | A | 4" | 0" | 4" | 5" | Black Clay |
| North Olive Avenue | B | 3.5" | 0" | 3.5" | 8.5" | Black Clay |
| North Olive Avenue | C | 2.75" | 3.5" | 6.25" | 0" | Brown Clay |
| North West Avenue | D | 3.5" | 0" | 3.5" | 8" | Black Clay |
| North Chicago Avenue | E | 3.25" | 0" | 3.25" | 10" | Black Clay |
| Northwest 5th Street | F | 2.5" | 4.5" | 7" | 0" | Black Clay |
| Northwest 3rd Street | G | 4.5" | ?? | 4.5" | ?? | Could not reach bottom to get rest of core out. |
| North West Avenue | H | 1.5" | 3" | 4.5" | 6.5" | Black Clay |
| North Chicago Avenue | I | 2" | 0.75" | 2.75" | 7.25" | Black Clay |
| Northwest 4th Street | J | 1.25" | 3.75" | 5" | 7.5" | Black Clay |
| North Liberty Avenue | K | 3.125" | 0" | 3.125" | 10.625 | Black Clay |
| Northwest 3rd Street | L | 3.25" | 3.25" | 6.50" | 6" | Black Clay |
| South West Avenue | M | 3" | 2.25" | 5.25" | 7.75" | Black Clay |
| South Union Avenue | N | 3" | 1" | 4" | 8.5" | Black Clay |
| Southwest 1st Street | O | 2.5" | 3.75" | 6.25" | 8.25" | Black Clay |
| Southwest 2nd Street | P | 2.5" | 3.5" | 6" | 0" | Black Clay |
| Southwest 2nd Street | Q | 1" | 3" | 4" | 2" | Black Clay |
| South Blanche Avenue | R | 2.75" | 4" | 6.75" | 0" | Black Clay |
| Southeast 8th Street | S | 3" | 0" | 3" | 8.75" | Black Clay |
| Southwest 8th Street | T | 1.25" | 6.75" | 8" | 1" | Brown Clay |
| Southeast 5th Street | U | 3" | 3.5" | 6.5" | 0" | Brown Clay |
| South Union Avenue | V | 3.25" | 3.25" | 6.5" | 5" | Black Clay |
| South Lee Avenue | W | 2.75" | 0" | 2.75" | 10" | Brown Clay |
| Southeast 3rd Street | X | 3" | 4" | 7" | 0" | Brown Clay |

## E. Pavement Performance Model Development

### E.1. Pavement Family

1) Full Depth (FD): ACP w/no granular base
2) Thick (THK): 5 to 10 in. ACP w/ granular base
3) Thin (THIN): 2 to 5 in. ACP w/ granular base
4) ACP on PCCP (APC): Asphalt overlay on top of PCCP
5) PCCP (PCC): Portland Cement Concrete Pavement

### E.2. Boundary-based Model

**A.2.1 Filter the Data using boundaries**

**a) Boundaries based on expert opinion**

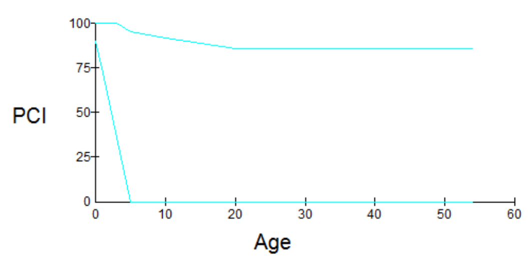
| Age Period | Boundaries | |
|---|---|---|
| <3 | 75 | 100 |
| **Age>=3 and Age<= Pavement life** | **50** | **100** |
| >=pavement life | 0 | 50 |

Pavement life was estimated using the average interval between the construction year and the following major improvement year, based on the existing historical data. No historical data is available for PCC, so this type of boundary currently is not suitable for PCC for the Madison data. Here, default boundaries in MicroPAVER were used for PCC.

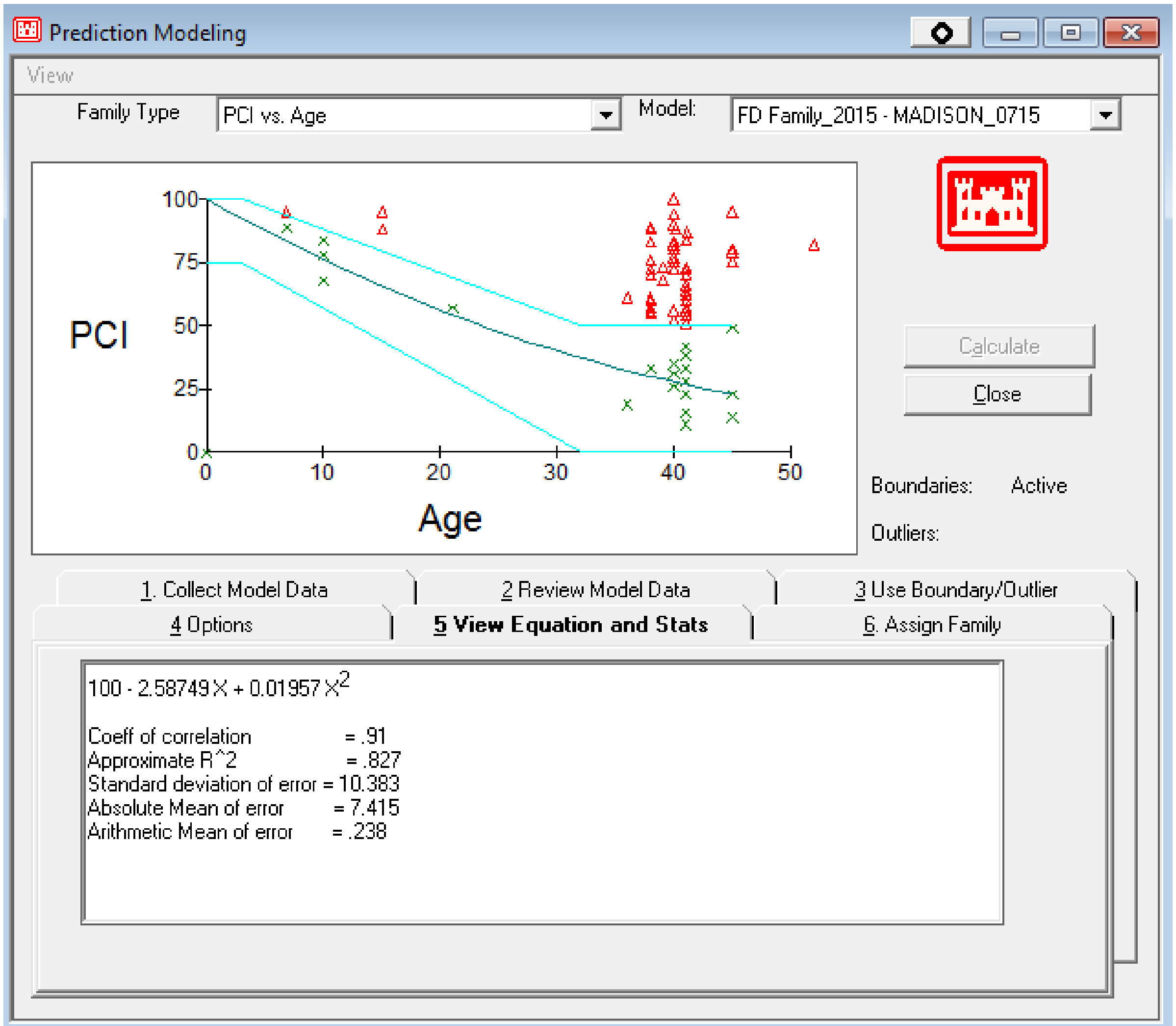
| | Average Pavement life | Variation of Pavement Life | # of sections |
|---|---|---|---|
| THK | 40 | [33, 48] | 5 |
| THIN | 40 | [24, 49] | 64 |
| FD | 32 | [19,40] | 8 |
| APC | 24 | [24, 24] | 4 |

| Age | PCI Min | PCI Max |
|---|---|---|
| 0 | 90 | 100 |
| 1 | 72 | 100 |
| 3 | 36 | 100 |
| 5 | 0 | 95 |
| 10 | 0 | 92 |
| 20 | 0 | 86 |

**b) Default Boundaries in MicroPAVER**

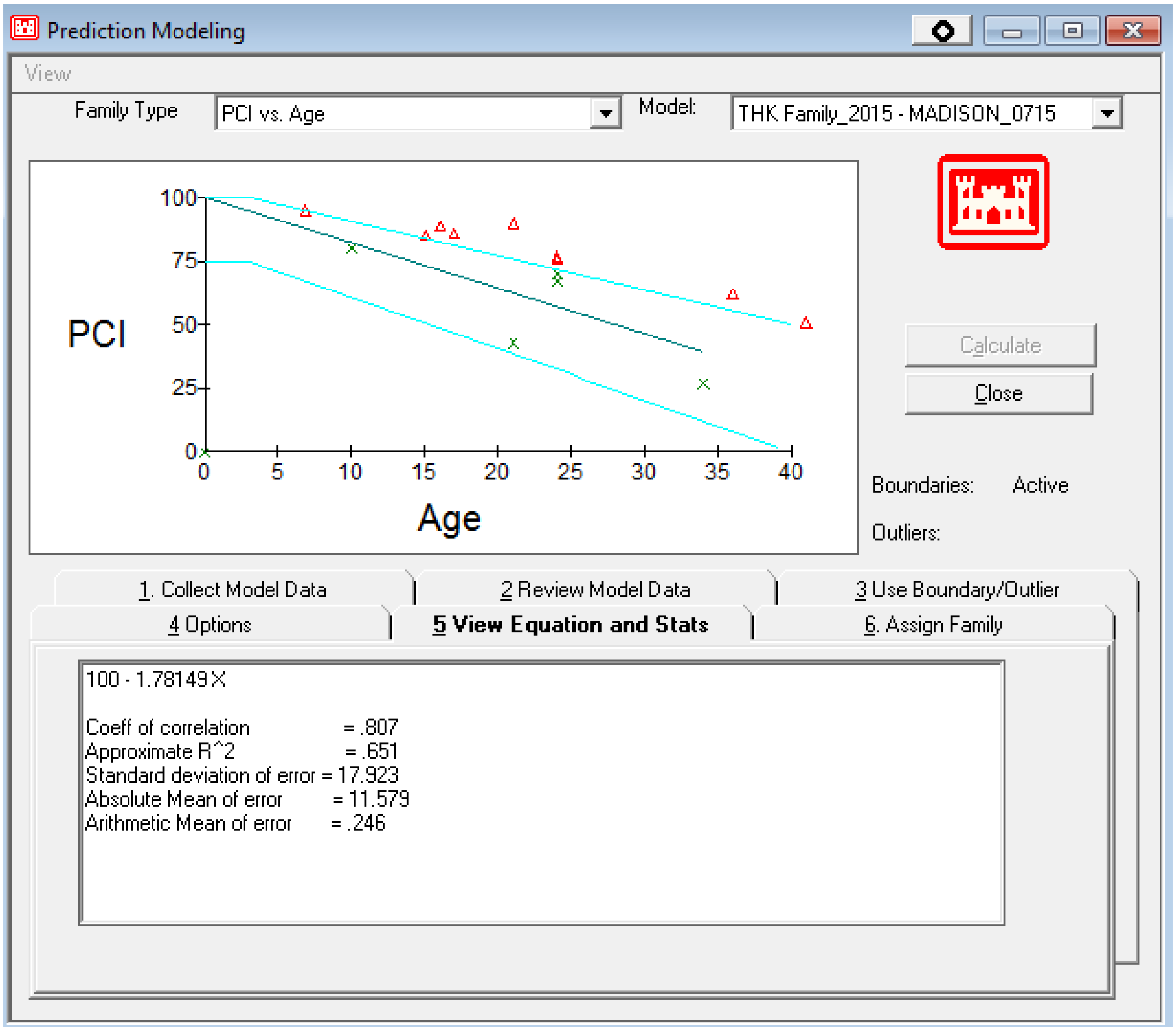


**E.2.2 Develop Family Model using MicroPAVER**
**(1) FD**
**Boundaries based on expert opinion**
**Number of Points (**all/extreme points/used for model): **78/54/24**
**Equation:** $PCI = 100 - 2.58749X + 0.01957X^2$
**R square:** 0.827 (Good)
**Results in MicroPAVER**




From the performance curve, corresponding age for default critical PCI (55) is approximately 20, which is less than the estimated pavement life used for boundaries setting (32). Using the proposed boundary is the logical choice.

**(2) THK**
**Boundaries based on expert opinion**
**Number of Points (**all/extreme points/used for model): **16/10/6**
**Equation:** $PCI = 100 - 1.78149X$
**R square:** 0.651 (Fine)
**Results in MicroPAVER**



**(3) THIN**

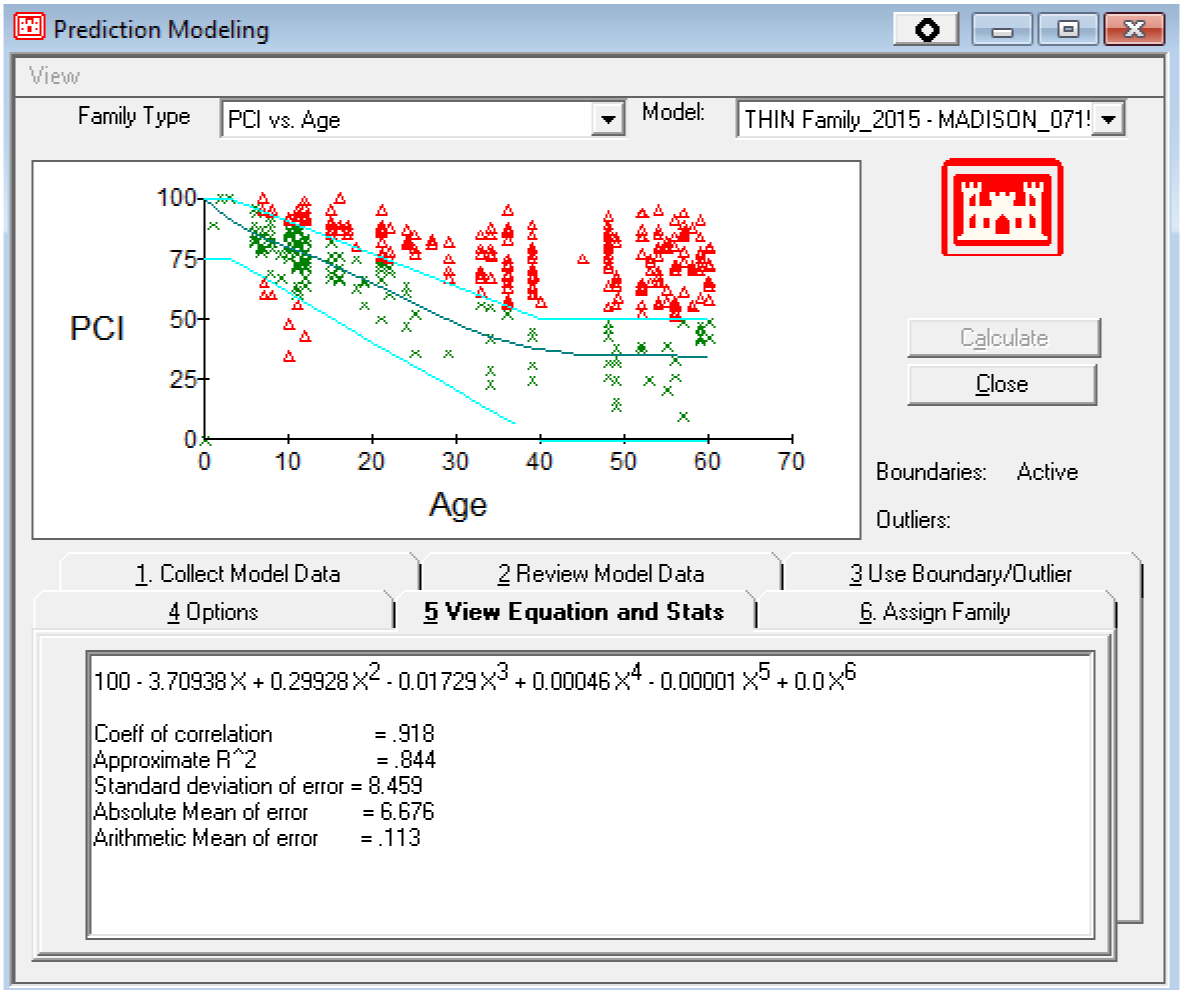
**Boundaries based on expert opinion**

**Number of Points (**all/extreme points/used for model): **415/259/156**

**Equation:** $PCI = 100 - 3.70938x + 0.29928x^2 - 0.01729x^3 + 0.00046x^4 - 0.00001x^5$

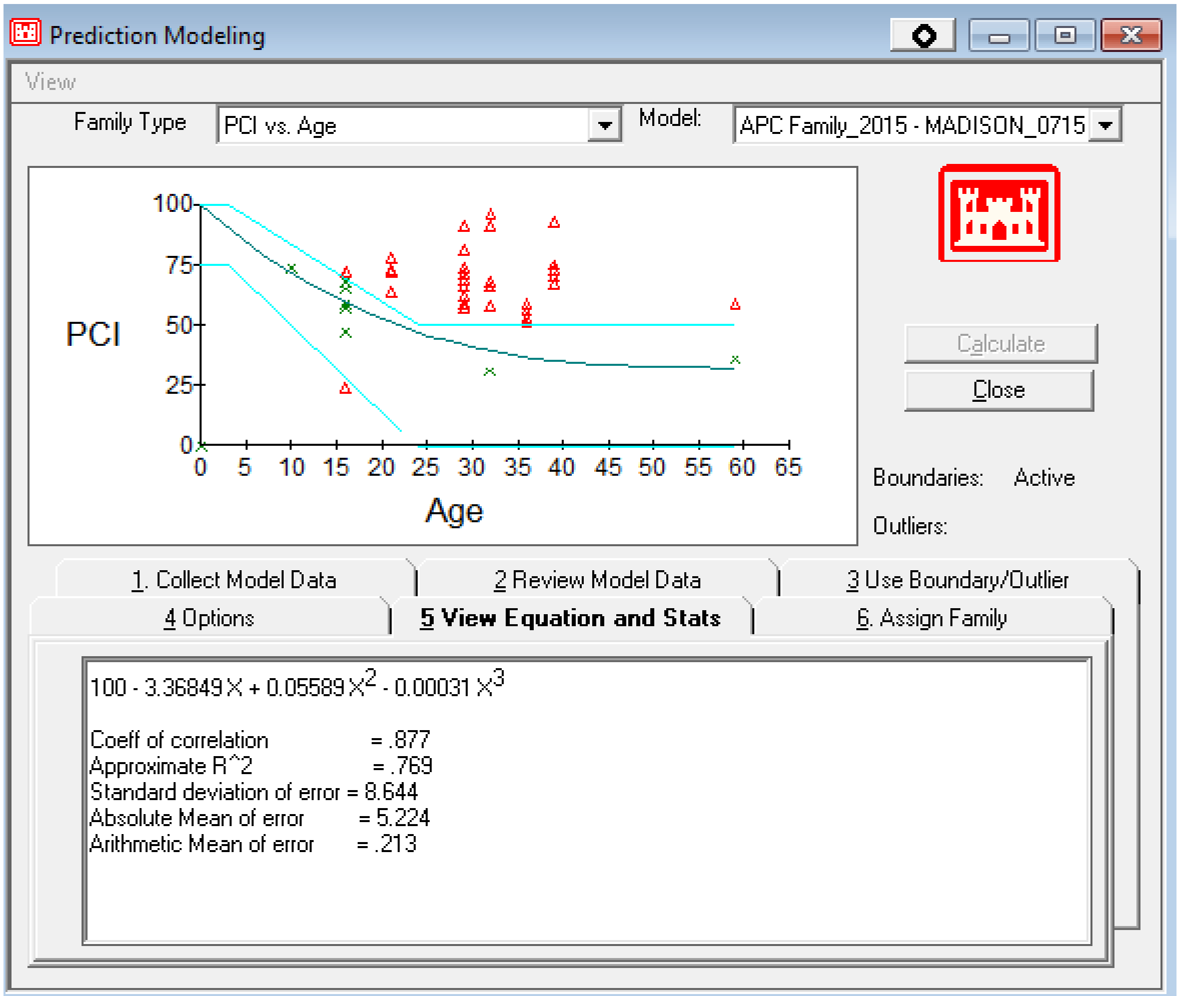
**R square:** 0.844 (Good)

**Results in MicroPAVER**




From the performance curve, the corresponding age for default critical PCI (55) is less than 30, which is less than the estimated pavement life used for boundaries setting (40). Using  the proposed boundary is the logical choice.

**(4) APC**
**Boundaries based on expert opinion**
**Number of Points (**all/extreme points/used for model): **51/40/11**
**Equation:** $\square\square\square = 100 - 3.36849\square + 0.05589\square^2 - 0.00031\square^3$
**R square:** 0.769 (Fine)
**Results in MicroPAVER**




From the performance curve, the corresponding age for default critical PCI (55) is approximately 20, which is less than the estimated pavement life used for boundaries setting (24). Using the proposed boundary is the logical choice.

**(5) PCC**

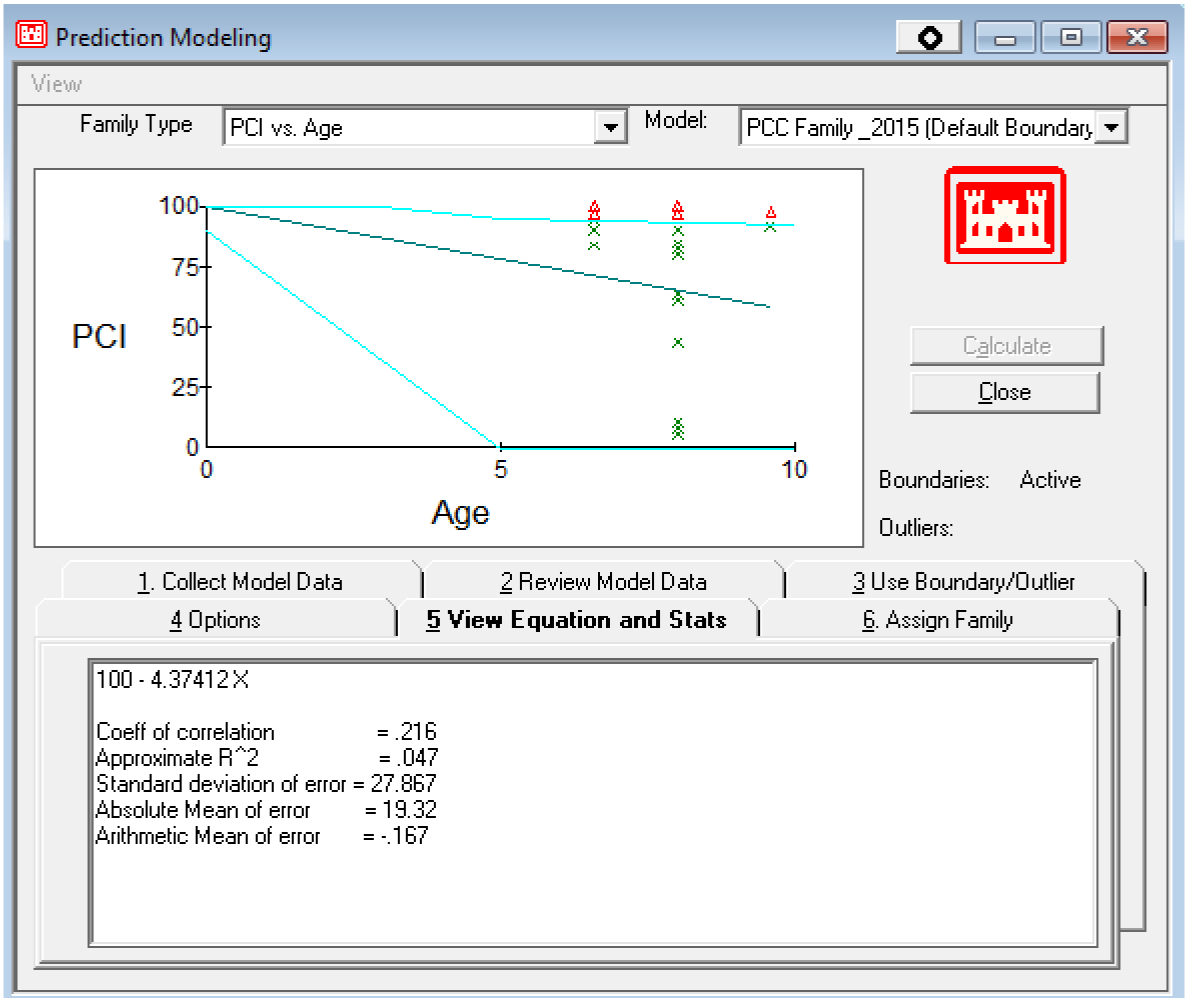
**No pavement life can be obtained, so default boundary was used.**

**Number of Points (**all/extreme points/used for model): **32/10/22**

**Equation:** $\square\square\square = 100 - 4.37412\square$

**R square:** 0.047(Unsatisfactory)

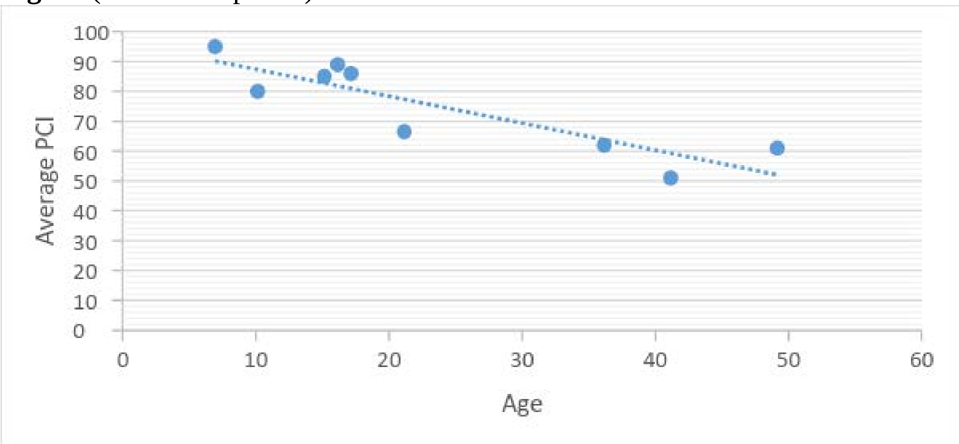
**Results in MicroPAVER**



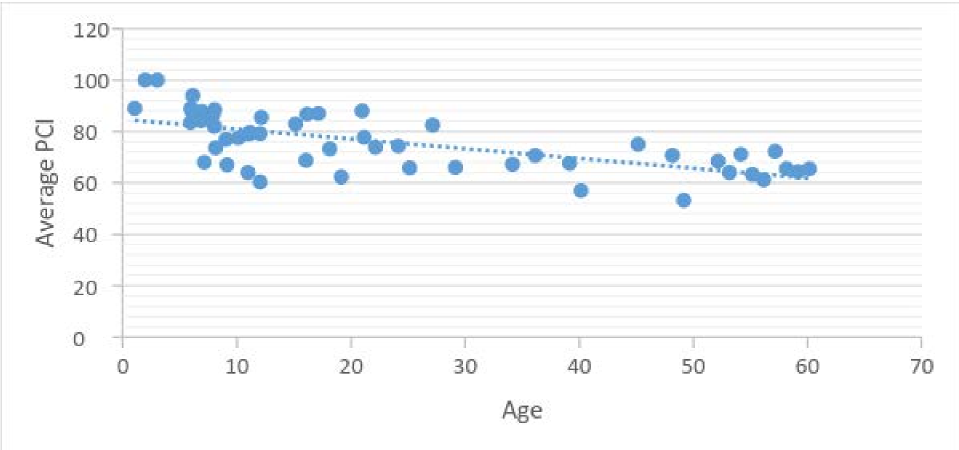

PCC historical improvement date information was in short supply. The result still shows an unsatisfactory model performance (low r square). PCC improvement date information should be collected in the future to improve the model accuracy.

**E.3. Average PCI-based Model**
The average PCI for each age also was considered for model development. This option did not include removing outlier points from the dataset. Average PCI for each age was first prepared in Excel, with models built using the average PCI data. The results are below:

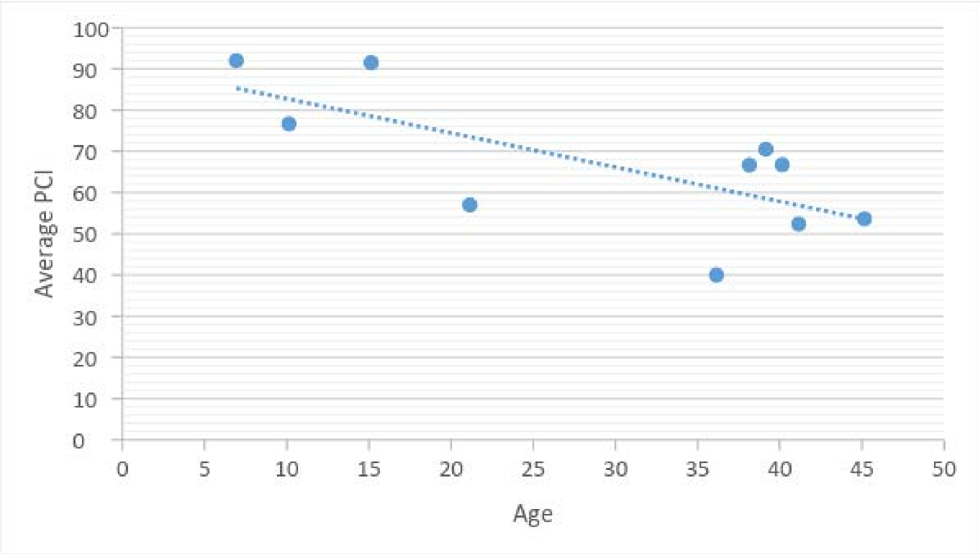
**THK**
**Equation:** $Y = 0.0013x^3 - 0.0905x^2 + 0.5658x + 91.224$
**R square:** 0.8453
**Figure** (curve with points)



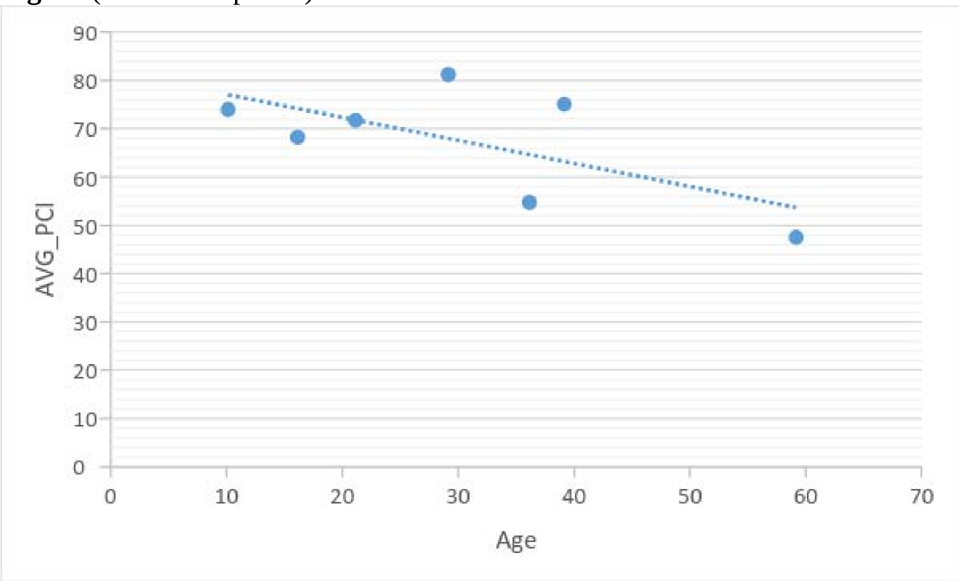

PCI never reduce to 55 (rehabilitation criterion in MicroPAVER).
**THIN**
**Equation:** $Y = -0.0003x^3 + 0.0402x^2 - 1.7336x + 94.249$
**R square:** 0.5071
**Figure** (curve with points)



PCI never reduce to 55 (rehabilitation criterion in MicroPAVER
**FD**
**Equation:** Y= $-0.0003x^3 + 0.0617x^2 - 3.2524 + 111.26$
**R square:** 0.5592
**Figure** (curve with points)




PCI never reduce to 55 (rehabilitation criterion in MicroPAVER)
**APC**
**Equation:** Y = $-0.0002x^3 + 0.0025x^2 + 0.0947x + 71.079$
**R square:** 0.5625
**Figure** (curve with points)



## F. Customized Cost Table in MicroPAVER

**1) Localized Stopgap M&R Unit Cost for AC pavements based on PCI Values**

| Condition | Cost | Unit |
|---|---|---|
| 0 | $0.60 | SqFt |
| 10 | $0.50 | SqFt |
| 20 | $0.20 | SqFt |
| 30 | $0.04 | SqFt |
| 40 | $0.02 | SqFt |
| 50 | $0.01 | SqFt |
| 60 | $0.01 | SqFt |
| 70 | $0.00 | SqFt |
| 80 | $0.00 | SqFt |
| 90 | $0.00 | SqFt |
| 100 | $0.00 | SqFt |

**2) Localized Stopgap M&R Unit Cost for PCC pavements based on PCI Values**

| Condition | Cost | Unit |
|---|---|---|
| 0 | $0.60 | SqFt |
| 10 | $0.50 | SqFt |
| 20 | $0.25 | SqFt |
| 30 | $0.09 | SqFt |
| 40 | $0.08 | SqFt |
| 50 | $0.07 | SqFt |
| 60 | $0.01 | SqFt |
| 70 | $0.00 | SqFt |
| 80 | $0.00 | SqFt |
| 90 | $0.00 | SqFt |
| 100 | $0.00 | SqFt |

**3) Localized Preventative M&R Unit Cost for AC pavements based on PCI Values**

| Condition | Cost | Unit |
|---|---|---|
| 0 | $8.00 | SqFt |
| 10 | $6.00 | SqFt |
| 20 | $3.00 | SqFt |
| 30 | $2.00 | SqFt |
| 40 | $1.00 | SqFt |
| 50 | $0.30 | SqFt |
| 60 | $0.20 | SqFt |
| 70 | $0.05 | SqFt |
| 80 | $0.01 | SqFt |
| 90 | $0.00 | SqFt |
| 100 | $0.00 | SqFt |

**4) Localized Preventative M&R Unit Cost for PCC pavements based on PCI Values**

| Condition | Cost | Unit |
|---|---|---|
| 0 | $22.00 | SqFt |
| 10 | $14.00 | SqFt |
| 20 | $8.00 | SqFt |
| 30 | $6.00 | SqFt |
| 40 | $4.00 | SqFt |
| 50 | $2.00 | SqFt |
| 60 | $1.25 | SqFt |
| 70 | $0.07 | SqFt |
| 80 | $0.03 | SqFt |
| 90 | $0.00 | SqFt |
| 100 | $0.00 | SqFt |

**5) Major M&R Unit Costs for AC Pavements based on PCI Values**

| Condition | Cost | Unit |
|---|---|---|
| 0 | $6.50 | SqFt |
| 10 | $6.50 | SqFt |
| 20 | $6.50 | SqFt |
| 30 | $6.50 | SqFt |
| 40 | $5.55 | SqFt |
| 50 | $4.85 | SqFt |
| 60 | $3.40 | SqFt |
| 70 | $2.35 | SqFt |
| 80 | $1.22 | SqFt |
| 90 | $1.22 | SqFt |
| 100 | $1.22 | SqFt |

**6) Major M&R Unit Costs for PCC Pavements based on PCI Values**

| Condition | Cost | Unit |
|---|---|---|
| 0 | $10.00 | SqFt |
| 10 | $10.00 | SqFt |
| 20 | $10.00 | SqFt |
| 30 | $10.00 | SqFt |
| 40 | $8.25 | SqFt |
| 50 | $6.50 | SqFt |
| 60 | $4.75 | SqFt |
| 70 | $3.00 | SqFt |
| 80 | $1.20 | SqFt |
| 90 | $1.20 | SqFt |
| 100 | $1.20 | SqFt |

**7) Global M&R Unit Cost**

| Distress Type | Work Type | Cost | Unit |
|---|---|---|---|
| Skid-Causing Distress | Surface Seal - Chip Seal | 0.135 | SqFt |
| Climate-related Distress | Surface Seal - Chip Seal | 0.135 | SqFt |
| Minimal Distress | No Global M&R | 0 | SqFt |

## G. Funded M&R Work Details for Different Budget Scenarios

### 1) Backlog Elimination

| Year | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|
| **Stop Gap Funded** | 84,198.06 | 82,697.22 | 86,208.19 | 81,297.88 | 0.00 |
| **Preventive Funded** | 237,193.42 | 224,605.81 | 259,279.25 | 285,176.47 | 321,744.38 |
| **Global Funded** | 210,179.21 | 71,913.60 | 90,284.13 | 41,787.62 | 66,284.20 |
| **Major Under Critical Funded** | 2,120.87 | 2,442,215.03 | 2,465,333.79 | 2,493,842.34 | 2,446,975.44 |
| **Major Above Critical Funded** | 2,371,522.02 | 77,291.98 | 0.00 | 0.00 | 0.00 |
| **Total** | 2,905,213.57 | 2,898,723.63 | 2,901,105.36 | 2,902,104.31 | 2,835,004.01 |

### 2) Condition Stabilization

| Year | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|
| **Stop Gap Funded** | 84,205.60 | 93,421.81 | 104,320.31 | 115,501.14 | 125,959.32 |
| **Preventive Funded** | 326,375.93 | 286,376.66 | 285,722.98 | 288,622.90 | 320,797.89 |
| **Global Funded** | 210,179.21 | 71,913.60 | 90,284.13 | 41,787.62 | 66,284.20 |
| **Major Under Critical Funded** | 0.00 | 2,258.13 | 0.00 | 0.00 | 266,482.92 |
| **Major Above Critical Funded** | 399,547.49 | 565,362.79 | 537,341.42 | 572,708.78 | 236,063.05 |
| **Total** | 1,020,308.23 | 1,019,332.99 | 1,017,668.84 | 1,018,620.44 | 1,015,587.38 |

### 3) Estimated Current Funding

| Year | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|
| **Stop Gap Funded** | 84,205.60 | 93,539.40 | 104,905.72 | 116,249.53 | 130,542.98 |
| **Preventive Funded** | 348,233.99 | 66,407.87 | 403,306.78 | 57,713.89 | 437,356.05 |
| **Global Funded** | 121,422.28 | 0.00 | 258,426.80 | 0.00 | 107,639.52 |
| **Major Under Critical Funded** | 0.00 | 0.00 | 0.00 | 0.00 | 2,709.81 |
| **Major Above Critical Funded** | 0.00 | 0.00 | 0.00 | 0.00 | 101,276.71 |
| **Total** | 553,861.87 | 159,947.26 | 766,639.30 | 173,963.42 | 779,525.07 |

## H. List of Structural Distress used in MicroPAVER [(8)]

| Pavement | Deficiency Type | Level* |
|---|---|---|
| **Asphalt** | Alligator Cracking | L + M + H |
| | Patching | M + H |
| | Potholes | L + M + H |
| | Rutting | M + H |
| **Concrete** | Large Patching | M + H |
| | Corner Break | L + M + H |
| | +Divided (Shattered Slab) | L + M + H |
| | +Punch out | M + H |

*: L=Low; M=Medium; H=High

## I. Funding Allocation for the Eight Plans

### 1) Plan a

| Date | 12/31/2016 | 12/31/2017 | 12/31/2018 | 12/31/2019 | 12/31/2020 |
|---|---|---|---|---|---|
| **Stop Gap Funded** | 84,198.06 | 93,545.35 | 104,513.02 | 116,491.01 | 130,046.72 |
| **Preventive Funded** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Global Funded** | 210,179.21 | 66,159.52 | 96,325.91 | 38,843.50 | 61,097.56 |
| **Major Under Critical Funded** | 2,120.87 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Major Above Critical Funded** | 256,284.22 | 0.00 | 564,231.77 | 9,037.70 | 589,118.33 |
| **Total** | 552,782.35 | 159,704.88 | 765,070.70 | 164,372.21 | 780,262.61 |

### 2) Plan b

| Date | 12/31/2016 | 12/31/2017 | 12/31/2018 | 12/31/2019 | 12/31/2020 |
|---|---|---|---|---|---|
| **Stop Gap Funded** | 82,038.72 | 91,271.00 | 96,443.43 | 107,118.55 | 108,362.97 |
| **Preventive Funded** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Global Funded** | 210,179.21 | 68,597.15 | 93,766.40 | 38,843.50 | 61,097.56 |
| **Major Under Critical Funded** | 118,461.05 | 0.00 | 66,823.62 | 9,312.84 | 122,185.75 |
| **Major Above Critical Funded** | 141,063.23 | 0.00 | 505,129.39 | 13,659.84 | 484,653.95 |
| **Total** | 551,742.21 | 159,868.15 | 762,162.84 | 168,934.74 | 776,300.23 |

### 3) Plan c

| Date | 12/31/2016 | 12/31/2017 | 12/31/2018 | 12/31/2019 | 12/31/2020 |
|---|---|---|---|---|---|
| **Stop Gap Funded** | 76,894.29 | 85,082.56 | 76,708.30 | 83,435.55 | 90,749.75 |
| **Preventive Funded** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Global Funded** | 210,179.21 | 65,502.90 | 97,015.36 | 38,843.50 | 61,097.56 |
| **Major Under Critical Funded** | 185,284.67 | 9,312.84 | 226,796.36 | 50,406.01 | 45,471.77 |
| **Major Above Critical Funded** | 81,131.69 | 0.00 | 364,296.85 | 0.00 | 582,152.54 |
| **Total** | 553,489.86 | 159,898.31 | 764,816.87 | 172,685.06 | 779,471.63 |

**4) Plan d**

| Date | 12/31/2016 | 12/31/2017 | 12/31/2018 | 12/31/2019 | 12/31/2020 |
|---|---|---|---|---|---|
| Stop Gap Funded | 76,168.55 | 85,077.01 | 73,435.77 | 79,661.61 | 79,244.77 |
| Preventive Funded | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Global Funded | 210,179.21 | 71,913.60 | 90,284.13 | 38,843.50 | 61,097.56 |
| Major Under Critical Funded | 192,476.65 | 2,258.13 | 277,202.37 | 45,471.77 | 208,855.58 |
| Major Above Critical Funded | 73,615.48 | 0.00 | 318,449.37 | 9,037.70 | 419,910.53 |
| Total | 552,439.88 | 159,248.74 | 759,371.64 | 173,014.57 | 769,108.45 |

**5) Plan e**

| Date | 12/31/2016 | 12/31/2017 | 12/31/2018 | 12/31/2019 | 12/31/2020 |
|---|---|---|---|---|---|
| Stop Gap Funded | 67,795.91 | 75,880.24 | 70,178.12 | 79,777.57 | 77,180.01 |
| Preventive Funded | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Global Funded | 171,242.45 | 84,050.61 | 120,468.05 | 38,843.50 | 61,097.56 |
| Major Under Critical Funded | 314,662.40 | 0.00 | 200,488.39 | 2,554.18 | 285,315.07 |
| Major Above Critical Funded | 0.00 | 0.00 | 373,691.71 | 47,700.65 | 357,314.22 |
| Total | 553,700.76 | 159,930.85 | 764,826.27 | 168,875.90 | 780,906.86 |

**6) Plan f**

| Date | 12/31/2016 | 12/31/2017 | 12/31/2018 | 12/31/2019 | 12/31/2020 |
|---|---|---|---|---|---|
| Stop Gap Funded | 60,627.59 | 65,042.73 | 48,689.29 | 56,108.08 | 61,264.22 |
| Preventive Funded | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Global Funded | 73,995.31 | 44,480.94 | 102,047.09 | 117,759.29 | 159,115.81 |
| Major Under Critical Funded | 419,273.01 | 50,406.01 | 615,983.75 | 0.00 | 152,960.95 |
| Major Above Critical Funded | 0.00 | 0.00 | 0.00 | 0.00 | 407,605.73 |
| Total | 553,895.90 | 159,929.68 | 766,720.13 | 173,867.38 | 780,946.72 |

7) Plan f2

| Date | 12/31/2016 | 12/31/2017 | 12/31/2018 | 12/31/2019 | 12/31/2020 |
|---|---|---|---|---|---|
| **Stop Gap Funded** | 68,577.09 | 76,767.02 | 56,126.10 | 64,409.91 | 61,065.86 |
| **Preventive Funded** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Global Funded** | 109,861.31 | 82,805.36 | 138,715.40 | 92,113.00 | 61,097.56 |
| **Major Under Critical Funded** | 374,718.66 | 0.00 | 491,492.19 | 0.00 | 372,106.66 |
| **Major Above Critical Funded** | 0.00 | 0.00 | 75,279.93 | 13,659.84 | 283,148.66 |
| **Total** | 553,157.06 | 159,572.38 | 761,613.62 | 170,182.75 | 777,418.75 |

8) Plan g

| Date | 12/31/2016 | 12/31/2017 | 12/31/2018 | 12/31/2019 | 12/31/2020 |
|---|---|---|---|---|---|
| **Stop Gap Funded** | 68,577.09 | 76,767.02 | 56,126.10 | 64,409.91 | 60,739.95 |
| **Preventive Funded** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Global Funded** | 125,933.57 | 130,781.62 | 137,208.48 | 140,902.59 | 151,156.95 |
| **Major Under Critical Funded** | 374,718.66 | 0.00 | 491,492.19 | 0.00 | 372,106.66 |
| **Major Above Critical Funded** | 0.00 | 0.00 | 75,279.93 | 13,659.84 | 283,148.66 |
| **Total** | 569,229.32 | 207,548.64 | 760,106.70 | 218,972.34 | 867,152.23 |

9) Plan g2

| Date | 12/31/2016 | 12/31/2017 | 12/31/2018 | 12/31/2019 | 12/31/2020 |
|---|---|---|---|---|---|
| **Stop Gap Funded** | 71,265.67 | 77,117.82 | 53,034.64 | 59,723.44 | 56,812.43 |
| **Preventive Funded** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Global Funded** | 125,651.53 | 119,396.96 | 116,581.17 | 120,916.50 | 121,952.94 |
| **Major Under Critical Funded** | 331,367.78 | 0.00 | 534,560.33 | 0.00 | 372,106.67 |
| **Major Above Critical Funded** | 24,197.05 | 0.00 | 31,522.48 | 0.00 | 191,296.67 |
| **Total** | 552,482.02 | 196,514.78 | 735,698.62 | 180,639.94 | 742,168.71 |

## J. Recommended M&R Projects

### 1) Plan f2

| Branch ID | Section ID | Estimated Cost | Work Type | Work Year |
|---|---|---|---|---|
| N EGAN AVE | 658 | $2,243.08 | Global MR | 2016 |
| N PRAIRIE* | 315 | $1,455.52 | Global MR | 2016 |
| N PRAIRIE* | 93 | $1,626.07 | Global MR | 2016 |
| SW 1ST ST | 476 | $1,213.84 | Global MR | 2016 |
| SW 4TH ST | 294 | $1,326.72 | Global MR | 2016 |
| N EGAN AVE | 652 | $2,973.71 | Global MR | 2016 |
| SW 1ST ST | 293 | $1,649.33 | Global MR | 2016 |
| N EGAN AVE | 656 | $3,604.07 | Global MR | 2016 |
| N VAN EPS* | 196 | $1,568.81 | Global MR | 2016 |
| S UNION A* | 77 | $1,343.36 | Global MR | 2016 |
| NW 5TH ST | 563 | $1,304.93 | Global MR | 2016 |
| 233 ST | 600 | $1,543.00 | Global MR | 2016 |
| SE 4TH ST | 118 | $1,376.88 | Global MR | 2016 |
| S EGAN AVE | 497 | $1,354.91 | Global MR | 2016 |
| SE 5TH ST | 120 | $1,406.67 | Global MR | 2016 |
| 233 ST | 599 | $1,455.57 | Global MR | 2016 |
| SE 9TH ST | 112 | $210.40 | Global MR | 2016 |
| N LINCOLN* | 338 | $1,386.91 | Global MR | 2016 |
| SW 1ST ST | 605 | $2,441.57 | Global MR | 2016 |
| SW 1ST ST | 604 | $2,221.77 | Global MR | 2016 |
| S UNION A* | 233 | $1,751.74 | Global MR | 2016 |
| S GRANT A* | 529 | $1,216.19 | Global MR | 2016 |
| 233 ST | 601 | $1,021.45 | Global MR | 2016 |
| N WASHING* | 285 | $348.30 | Global MR | 2016 |
| NE 4TH ST | 509 | $1,227.27 | Global MR | 2016 |
| S LEE AVE | 713 | $722.95 | Global MR | 2016 |
| N EGAN AVE | 500 | $3,015.12 | Global MR | 2016 |
| SW 1ST ST | 292 | $1,353.09 | Global MR | 2016 |
| N EGAN AVE | 655 | $2,016.68 | Global MR | 2016 |
| SW 4TH ST | 300 | $1,503.36 | Global MR | 2016 |
| N PRAIRIE* | 280 | $1,834.05 | Global MR | 2016 |
| NE 4TH ST | 708 | $1,896.44 | Global MR | 2016 |
| N WASHING* | 623 | $928.02 | Global MR | 2016 |
| N WASHING* | 192 | $1,215.41 | Global MR | 2016 |
| S UNION A* | 687 | $1,644.87 | Global MR | 2016 |
| N EGAN AVE | 657 | $2,898.32 | Global MR | 2016 |
| NE 6TH ST | 152 | $1,245.12 | Global MR | 2016 |
| S EGAN AVE | 690 | $1,310.73 | Global MR | 2016 |

| | | | | |
|---|---|---|---|---|
| N PRAIRIE* | 330 | $1,455.49 | Global MR | 2016 |
| S EGAN AVE | 678 | $1,354.94 | Global MR | 2016 |
| SW 4TH ST | 299 | $1,426.60 | Global MR | 2016 |
| SW 4TH ST | 297 | $1,301.40 | Global MR | 2016 |
| E CENTER * | 493 | $1,375.61 | Global MR | 2016 |
| SW 1ST ST | 603 | $950.38 | Global MR | 2016 |
| N WASHING* | 86 | $2,298.76 | Global MR | 2016 |
| N HARTH A* | 382 | $2,136.37 | Global MR | 2016 |
| SE 3RD ST | 127 | $2,001.99 | Global MR | 2016 |
| NE 6TH ST | 151 | $1,248.03 | Global MR | 2016 |
| S EGAN AVE | 677 | $1,273.11 | Global MR | 2016 |
| SE 4TH ST | 115 | $2,031.99 | Global MR | 2016 |
| N JOSEPHI* | 617 | $1,423.93 | Global MR | 2016 |
| 233 ST | 597 | $1,305.41 | Global MR | 2016 |
| CEDAR CT | 248 | $470.50 | Global MR | 2016 |
| S UNION A* | 686 | $1,411.63 | Global MR | 2016 |
| N WASHING* | 277 | $1,111.04 | Global MR | 2016 |
| N WASHING* | 195 | $1,184.54 | Global MR | 2016 |
| N JOSEPHI* | 279 | $1,789.41 | Global MR | 2016 |
| S EGAN AVE | 496 | $3,203.76 | Global MR | 2016 |
| N WASHING* | 622 | $926.57 | Global MR | 2016 |
| NE 5TH ST | 153 | $1,414.71 | Global MR | 2016 |
| SE 4TH ST | 116 | $1,372.69 | Global MR | 2016 |
| N JOSEPHI* | 562 | $1,619.30 | Global MR | 2016 |
| N WASHING* | 323 | $747.66 | Global MR | 2016 |
| N WASHING* | 96 | $1,315.54 | Global MR | 2016 |
| S UNION A* | 685 | $1,260.66 | Global MR | 2016 |
| NE 7TH ST | 199 | $127.30 | Stopgap | 2016 |
| N JOSEPHI* | 327 | $124.91 | Stopgap | 2016 |
| S JOSEPHI* | 15 | $129.62 | Stopgap | 2016 |
| N UNION A* | 333 | $134.87 | Stopgap | 2016 |
| N HARTH A* | 341 | $246.85 | Stopgap | 2016 |
| N BLANCHE* | 557 | $119.68 | Stopgap | 2016 |
| S VAN EPS* | 72 | $168.23 | Stopgap | 2016 |
| NW 4TH ST | 413 | $296.84 | Stopgap | 2016 |
| N LIBERTY* | 556 | $172.92 | Stopgap | 2016 |
| N VAN EPS* | 356 | $121.28 | Stopgap | 2016 |
| N WEST AVE | 370 | $122.80 | Stopgap | 2016 |
| NE 6TH ST | 128 | $4,021.40 | Stopgap | 2016 |
| N LIBERTY* | 380 | $129.67 | Stopgap | 2016 |
| N AIRPORT* | 649 | $131.23 | Stopgap | 2016 |

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|---|---|---|---|---|
| N CATHERI* | 179 | $126.02 | Stopgap | 2016 |
| N WASHING* | 287 | $773.35 | Global MR | 2016 |
| N ROOSEVE* | 387 | $8,372.64 | Stopgap | 2016 |
| S EGAN AVE | 679 | $184.34 | Stopgap | 2016 |
| NW 7TH ST | 568 | $117.90 | Stopgap | 2016 |
| NE 8TH ST | 149 | $101.68 | Stopgap | 2016 |
| NW 4TH ST | 411 | $120.47 | Stopgap | 2016 |
| S LINCOLN* | 23 | $431.70 | Stopgap | 2016 |
| NW 1ST ST | 440 | $160.24 | Stopgap | 2016 |
| N LIBERTY* | 555 | $127.56 | Stopgap | 2016 |
| N DIVISIO* | 206 | $306.59 | Stopgap | 2016 |
| N LEE AVE | 581 | $81.95 | Stopgap | 2016 |
| TWIN OAKS* | 207 | $118.77 | Stopgap | 2016 |
| NW 6TH ST | 395 | $386.18 | Stopgap | 2016 |
| N UNION A* | 328 | $383.61 | Stopgap | 2016 |
| N MAPLEWO* | 6 | $1,795.50 | Stopgap | 2016 |
| S CHICAGO* | 22 | $1,335.13 | Stopgap | 2016 |
| NE 8TH ST | 147 | $105.24 | Stopgap | 2016 |
| N LIBERTY* | 329 | $125.49 | Stopgap | 2016 |
| NW 4TH ST | 414 | $104.62 | Stopgap | 2016 |
| N LEE AVE | 340 | $333.77 | Stopgap | 2016 |
| NE 7TH ST | 198 | $386.66 | Stopgap | 2016 |
| SE 4TH ST | 117 | $97.94 | Stopgap | 2016 |
| N AIRPORT* | 644 | $111.27 | Stopgap | 2016 |
| NE 5TH ST | 154 | $216.05 | Stopgap | 2016 |
| NW 6TH ST | 398 | $132.28 | Stopgap | 2016 |
| S JOSEPHI* | 38 | $141.70 | Stopgap | 2016 |
| N LIBERTY* | 334 | $137.01 | Stopgap | 2016 |
| W CENTER * | 481 | $104.99 | Stopgap | 2016 |
| NW 4TH ST | 415 | $1,120.21 | Stopgap | 2016 |
| NE 8TH ST | 156 | $2,044.73 | Stopgap | 2016 |
| N LEE AVE | 354 | $313.51 | Stopgap | 2016 |
| N OLIVE A* | 336 | $411.26 | Stopgap | 2016 |
| NW 1ST ST | 444 | $106.03 | Stopgap | 2016 |
| N LEE AVE | 99 | $263.59 | Stopgap | 2016 |
| NE 1ST ST | 62 | $603.61 | Stopgap | 2016 |
| N WEST AVE | 371 | $121.23 | Stopgap | 2016 |
| NE 1ST ST | 63 | $5,298.86 | Stopgap | 2016 |
| SW 2ND ST | 465 | $1,477.61 | Stopgap | 2016 |
| W CENTER * | 480 | $1,556.33 | Stopgap | 2016 |
| SE 8TH ST | 214 | $1,735.93 | Stopgap | 2016 |

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|---|---|---|---|---|
| N OLIVE A* | 378 | $119.18 | Stopgap | 2016 |
| N SUMMIT * | 282 | $381.06 | Stopgap | 2016 |
| NW 4TH ST | 410 | $171.78 | Stopgap | 2016 |
| W CENTER * | 482 | $105.28 | Stopgap | 2016 |
| S LIBERTY* | 21 | $163.45 | Stopgap | 2016 |
| NW 7TH ST | 389 | $108.62 | Stopgap | 2016 |
| S LIBERTY* | 35 | $119.68 | Stopgap | 2016 |
| NE 8TH ST | 669 | $2,956.12 | Stopgap | 2016 |
| S UNION A* | 36 | $118.24 | Stopgap | 2016 |
| N CHICAGO* | 335 | $138.07 | Stopgap | 2016 |
| NE 5TH ST | 44 | $158.78 | Stopgap | 2016 |
| W CENTER * | 483 | $164.82 | Stopgap | 2016 |
| W CENTER * | 479 | $131.84 | Stopgap | 2016 |
| S EGAN AVE | 689 | $312.19 | Stopgap | 2016 |
| N LEE AVE | 384 | $189.06 | Stopgap | 2016 |
| N EGAN AVE | 737 | $125.72 | Stopgap | 2016 |
| NE 8TH ST | 668 | $77.30 | Stopgap | 2016 |
| SE 4TH ST | 114 | $311.39 | Stopgap | 2016 |
| NE 6TH ST | 150 | $97.19 | Stopgap | 2016 |
| N SUMMIT * | 189 | $313.34 | Stopgap | 2016 |
| SW 2ND ST | 464 | $770.53 | Stopgap | 2016 |
| S CHICAGO* | 34 | $1,699.75 | Stopgap | 2016 |
| SE 1ST ST | 102 | $613.98 | Stopgap | 2016 |
| NW 1ST ST | 448 | $105.66 | Stopgap | 2016 |
| N SUMMIT * | 94 | $162.94 | Stopgap | 2016 |
| SW 2ND ST | 523 | $126.44 | Stopgap | 2016 |
| N UNION A* | 553 | $130.74 | Stopgap | 2016 |
| NW 9TH ST | 254 | $7.54 | Stopgap | 2016 |
| N CHICAGO* | 361 | $120.19 | Stopgap | 2016 |
| CIRCLE DR | 707 | $22,735.89 | Major Below Critical | 2016 |
| N WASHING* | 178 | $394.61 | Global MR | 2016 |
| N EGAN AVE | 659 | $2,104.77 | Global MR | 2016 |
| S EGAN AVE | 494 | $2,871.94 | Global MR | 2016 |
| N PRAIRIE* | 188 | $1,543.53 | Global MR | 2016 |
| SW 4TH ST | 475 | $1,904.85 | Global MR | 2016 |
| NE 7TH ST | 705 | $9,312.84 | Major Below Critical | 2016 |
| CAMBRIDGE* | 209 | $171.11 | Stopgap | 2016 |
| SE 4TH ST | 202 | $116,340.18 | Major Below Critical | 2016 |
| NW 5TH ST | 406 | $402.37 | Stopgap | 2016 |
| N CATHERI* | 366 | $59,280.00 | Major Below Critical | 2016 |
| CIRCLE DR | 721 | $22,735.89 | Major Below Critical | 2016 |

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|---|---|---|---|---|
| SE 2ND ST | 107 | $66,823.62 | Major Below Critical | 2016 |
| NE 8TH ST | 587 | $3,562.16 | Stopgap | 2016 |
| NW 5TH ST | 404 | $1,183.36 | Stopgap | 2016 |
| SW 4TH ST | 470 | $159.75 | Stopgap | 2016 |
| N CHICAGO* | 187 | $77,490.24 | Major Below Critical | 2016 |
| N LIBERTY* | 346 | $118.67 | Stopgap | 2016 |
| N AIRPORT* | 648 | $83.98 | Stopgap | 2016 |
| N OLIVE A* | 177 | $191.09 | Stopgap | 2016 |
| NW 1ST ST | 441 | $162.52 | Stopgap | 2016 |
| NE 8TH ST | 141 | $107.10 | Stopgap | 2016 |
| NE 8TH ST | 148 | $413.08 | Stopgap | 2016 |
| NW 5TH ST | 564 | $134.03 | Stopgap | 2016 |
| CEDAR CT | 504 | $47.79 | Stopgap | 2016 |
| W CENTER * | 517 | $116.60 | Stopgap | 2016 |
| N WEST AVE | 365 | $136.99 | Stopgap | 2016 |
| NW 7TH ST | 388 | $112.79 | Stopgap | 2016 |
| N ROOSEVE* | 84 | $7,168.32 | Stopgap | 2016 |
| NW 7TH ST | 390 | $105.12 | Stopgap | 2016 |
| N HARTH A* | 620 | $292.90 | Stopgap | 2016 |
| SW 3RD ST | 472 | $351.20 | Stopgap | 2016 |
| N HARTH A* | 583 | $262.53 | Stopgap | 2016 |
| ASHMONT RD | 660 | $75.70 | Stopgap | 2016 |
| NE 5TH ST | 155 | $222.93 | Stopgap | 2016 |
| N EGAN AVE | 653 | $241.63 | Stopgap | 2016 |
| N MAPLEWO* | 274 | $168.48 | Stopgap | 2016 |
| N UNION A* | 554 | $143.28 | Stopgap | 2016 |
| NW 9TH ST | 572 | $192.06 | Stopgap | 2016 |
| N VAN EPS* | 342 | $205.20 | Stopgap | 2016 |
| N LINCOLN* | 352 | $331.20 | Stopgap | 2016 |
| N EGAN AVE | 654 | $127.37 | Stopgap | 2016 |
| S VAN EPS* | 13 | $144.56 | Stopgap | 2016 |
| N CATHERI* | 286 | $125.44 | Stopgap | 2016 |
| NE 5TH ST | 585 | $1,513.95 | Stopgap | 2016 |
| NE 8TH ST | 602 | $229.80 | Stopgap | 2016 |
| NW 7TH ST | 213 | $111.36 | Stopgap | 2016 |
| NE 8TH ST | 157 | $1,274.80 | Stopgap | 2016 |
| N OLIVE A* | 348 | $417.01 | Stopgap | 2016 |
| N UNION A* | 381 | $129.67 | Stopgap | 2016 |
| NW 5TH ST | 399 | $114.67 | Stopgap | 2016 |
| N HARTH A* | 584 | $157.47 | Stopgap | 2016 |
| NW 5TH ST | 401 | $118.41 | Stopgap | 2016 |

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|---|---|---|---|---|
| NE 5TH ST | 586 | $1,670.87 | Global MR | 2017 |
| NE 9TH ST | 137 | $1,352.02 | Global MR | 2017 |
| NE 11TH ST | 134 | $1,304.41 | Global MR | 2017 |
| NE 11TH ST | 671 | $985.73 | Global MR | 2017 |
| N JOSEPHI* | 288 | $1,486.00 | Global MR | 2017 |
| N DIVISIO* | 326 | $1,495.20 | Global MR | 2017 |
| N ROOSEVE* | 313 | $1,541.52 | Global MR | 2017 |
| NE 9TH ST | 139 | $1,394.84 | Global MR | 2017 |
| SE 5TH ST | 121 | $1,434.30 | Global MR | 2017 |
| NE 5TH ST | 519 | $1,372.72 | Global MR | 2017 |
| NE 6TH ST | 588 | $1,516.24 | Global MR | 2017 |
| N ROOSEVE* | 208 | $1,832.99 | Global MR | 2017 |
| S LEE AVE | 266 | $2,275.94 | Global MR | 2017 |
| NE 7TH ST | 158 | $1,376.67 | Global MR | 2017 |
| NE 9TH ST | 132 | $1,592.77 | Global MR | 2017 |
| NE 9TH ST | 543 | $1,601.55 | Global MR | 2017 |
| N ANTELOP* | 528 | $1,455.28 | Global MR | 2017 |
| E CENTER * | 492 | $1,521.30 | Global MR | 2017 |
| N JOSEPHI* | 561 | $1,541.81 | Global MR | 2017 |
| NE 4TH ST | 45 | $1,287.60 | Global MR | 2017 |
| NW 1ST ST | 439 | $1,309.71 | Global MR | 2017 |
| N BLANCHE* | 197 | $1,680.25 | Global MR | 2017 |
| NE 8TH ST | 533 | $2,178.87 | Global MR | 2017 |
| SW 7TH ST | 239 | $1,591.48 | Global MR | 2017 |
| N JOSEPHI* | 616 | $1,495.51 | Global MR | 2017 |
| N HARTH A* | 324 | $1,561.15 | Global MR | 2017 |
| E MAPLEWO* | 144 | $1,906.99 | Global MR | 2017 |
| NE 4TH ST | 47 | $1,485.33 | Global MR | 2017 |
| SE 1ST ST | 101 | $2,138.97 | Global MR | 2017 |
| NE 11TH ST | 133 | $1,469.24 | Global MR | 2017 |
| N AIRPORT* | 651 | $1,865.73 | Global MR | 2017 |
| N JOSEPHI* | 525 | $1,693.37 | Global MR | 2017 |
| N LEE AVE | 582 | $2,019.92 | Global MR | 2017 |
| N VAN EPS* | 182 | $1,902.58 | Global MR | 2017 |
| NE 5TH ST | 43 | $1,278.29 | Global MR | 2017 |
| N DIVISIO* | 278 | $1,455.51 | Global MR | 2017 |
| NW 4TH ST | 409 | $1,345.61 | Global MR | 2017 |
| S LEE AVE | 263 | $1,290.11 | Global MR | 2017 |
| NE 9TH ST | 667 | $965.04 | Global MR | 2017 |
| N ROOSEVE* | 84 | $7,972.91 | Stopgap | 2017 |
| S LINCOLN* | 268 | $1,601.07 | Global MR | 2017 |

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|---|---|---|---|---|
| S JOSEPHI* | 15 | $136.10 | Stopgap | 2017 |
| N MAPLEWO* | 6 | $1,887.23 | Stopgap | 2017 |
| S CHICAGO* | 22 | $1,406.12 | Stopgap | 2017 |
| NE 8TH ST | 147 | $110.50 | Stopgap | 2017 |
| N LIBERTY* | 329 | $131.77 | Stopgap | 2017 |
| N VAN EPS* | 356 | $127.34 | Stopgap | 2017 |
| N MAPLEWO* | 386 | $132.40 | Stopgap | 2017 |
| N DIVISIO* | 206 | $325.69 | Stopgap | 2017 |
| NW 6TH ST | 395 | $431.44 | Stopgap | 2017 |
| N UNION A* | 333 | $147.93 | Stopgap | 2017 |
| N HARTH A* | 341 | $279.72 | Stopgap | 2017 |
| N BLANCHE* | 557 | $125.67 | Stopgap | 2017 |
| S VAN EPS* | 72 | $176.64 | Stopgap | 2017 |
| N ROOSEVE* | 387 | $9,312.41 | Stopgap | 2017 |
| N LIBERTY* | 556 | $203.78 | Stopgap | 2017 |
| NW 4TH ST | 413 | $324.89 | Stopgap | 2017 |
| NW 1ST ST | 440 | $168.25 | Stopgap | 2017 |
| SW 3RD ST | 472 | $412.10 | Stopgap | 2017 |
| S LIBERTY* | 21 | $190.62 | Stopgap | 2017 |
| N EGAN AVE | 653 | $253.71 | Stopgap | 2017 |
| S EGAN AVE | 689 | $379.14 | Stopgap | 2017 |
| NW 7TH ST | 568 | $123.79 | Stopgap | 2017 |
| NE 8TH ST | 149 | $106.76 | Stopgap | 2017 |
| N OLIVE A* | 276 | $160.41 | Stopgap | 2017 |
| S LINCOLN* | 23 | $628.39 | Stopgap | 2017 |
| N UNION A* | 328 | $435.61 | Stopgap | 2017 |
| N LIBERTY* | 555 | $133.94 | Stopgap | 2017 |
| NW 4TH ST | 414 | $116.69 | Stopgap | 2017 |
| N LEE AVE | 581 | $86.05 | Stopgap | 2017 |
| S EGAN AVE | 679 | $212.78 | Stopgap | 2017 |
| SE 4TH ST | 203 | $167.24 | Stopgap | 2017 |
| NE 6TH ST | 128 | $4,559.58 | Stopgap | 2017 |
| NW 4TH ST | 411 | $126.49 | Stopgap | 2017 |
| N LIBERTY* | 334 | $143.86 | Stopgap | 2017 |
| NE 7TH ST | 199 | $149.75 | Stopgap | 2017 |
| NE 8TH ST | 669 | $3,106.34 | Stopgap | 2017 |
| S UNION A* | 36 | $124.15 | Stopgap | 2017 |
| N CHICAGO* | 335 | $144.98 | Stopgap | 2017 |
| NE 5TH ST | 44 | $181.73 | Stopgap | 2017 |
| SE 3RD ST | 126 | $113.11 | Stopgap | 2017 |
| NW 7TH ST | 389 | $114.05 | Stopgap | 2017 |

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|---|---|---|---|---|
| NE 11TH ST | 135 | $113.83 | Stopgap | 2017 |
| N WEST AVE | 371 | $127.29 | Stopgap | 2017 |
| NW 4TH ST | 410 | $204.29 | Stopgap | 2017 |
| SE 4TH ST | 117 | $102.83 | Stopgap | 2017 |
| N AIRPORT* | 644 | $116.83 | Stopgap | 2017 |
| NE 5TH ST | 154 | $244.82 | Stopgap | 2017 |
| NW 4TH ST | 415 | $1,179.77 | Stopgap | 2017 |
| SW 2ND ST | 465 | $1,702.74 | Stopgap | 2017 |
| NW 7TH ST | 388 | $118.43 | Stopgap | 2017 |
| N LIBERTY* | 380 | $136.16 | Stopgap | 2017 |
| N AIRPORT* | 649 | $137.79 | Stopgap | 2017 |
| N CATHERI* | 179 | $153.52 | Stopgap | 2017 |
| NE 7TH ST | 198 | $562.83 | Stopgap | 2017 |
| N JOSEPHI* | 327 | $139.44 | Stopgap | 2017 |
| S LIBERTY* | 35 | $125.78 | Stopgap | 2017 |
| NE 1ST ST | 63 | $5,563.80 | Stopgap | 2017 |
| N WEST AVE | 370 | $128.94 | Stopgap | 2017 |
| W CENTER * | 480 | $1,634.15 | Stopgap | 2017 |
| SE 8TH ST | 214 | $2,150.83 | Stopgap | 2017 |
| N OLIVE A* | 378 | $125.14 | Stopgap | 2017 |
| N SUMMIT * | 282 | $417.06 | Stopgap | 2017 |
| W CENTER * | 483 | $184.36 | Stopgap | 2017 |
| W CENTER * | 482 | $110.55 | Stopgap | 2017 |
| TWIN OAKS* | 207 | $139.97 | Stopgap | 2017 |
| NE 6TH ST | 150 | $102.05 | Stopgap | 2017 |
| SW 2ND ST | 523 | $132.76 | Stopgap | 2017 |
| N SUMMIT * | 189 | $336.06 | Stopgap | 2017 |
| CAMBRIDGE* | 209 | $192.88 | Stopgap | 2017 |
| N LEE AVE | 384 | $213.11 | Stopgap | 2017 |
| N EGAN AVE | 737 | $132.00 | Stopgap | 2017 |
| NE 9TH ST | 702 | $90.30 | Stopgap | 2017 |
| NE 9TH ST | 138 | $109.08 | Stopgap | 2017 |
| SE 4TH ST | 114 | $346.02 | Stopgap | 2017 |
| SW 4TH ST | 470 | $184.96 | Stopgap | 2017 |
| N CHICAGO* | 361 | $126.20 | Stopgap | 2017 |
| SW 2ND ST | 464 | $1,006.51 | Stopgap | 2017 |
| W CENTER * | 479 | $138.43 | Stopgap | 2017 |
| SE 1ST ST | 102 | $645.34 | Stopgap | 2017 |
| NW 1ST ST | 448 | $117.95 | Stopgap | 2017 |
| N HARTH A* | 620 | $330.38 | Stopgap | 2017 |
| NE 8TH ST | 668 | $81.26 | Stopgap | 2017 |

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|---|---|---|---|---|
| NE 11TH ST | 670 | $1,804.65 | Global MR | 2017 |
| HERITAGE * | 131 | $2,084.99 | Global MR | 2017 |
| NE 7TH ST | 159 | $1,301.46 | Global MR | 2017 |
| N HARTH A* | 383 | $1,475.23 | Global MR | 2017 |
| N JOSEPHI* | 184 | $1,514.84 | Global MR | 2017 |
| N MAPLEWO* | 85 | $813.96 | Global MR | 2017 |
| N LEE AVE | 385 | $1,543.49 | Global MR | 2017 |
| S CHICAGO* | 34 | $1,958.71 | Stopgap | 2017 |
| N BLANCHE* | 558 | $1,918.79 | Global MR | 2017 |
| HEATHERWO* | 700 | $85.46 | Stopgap | 2017 |
| NE 1ST ST | 66 | $2,038.51 | Global MR | 2017 |
| N MAPLEWO* | 7 | $1,495.31 | Global MR | 2017 |
| NW 8TH ST | 570 | $1,333.59 | Global MR | 2017 |
| S BLANCHE* | 71 | $123.54 | Stopgap | 2017 |
| NE 8TH ST | 587 | $3,743.73 | Stopgap | 2017 |
| NW 5TH ST | 404 | $1,405.90 | Stopgap | 2017 |
| N BLANCHE* | 325 | $1,522.02 | Global MR | 2017 |
| NE 8TH ST | 141 | $112.45 | Stopgap | 2017 |
| N SUMMIT * | 94 | $192.01 | Stopgap | 2017 |
| N UNION A* | 381 | $144.76 | Stopgap | 2017 |
| N WEST AVE | 365 | $143.84 | Stopgap | 2017 |
| N CATHERI* | 286 | $131.71 | Stopgap | 2017 |
| N EGAN AVE | 654 | $133.74 | Stopgap | 2017 |
| N AIRPORT* | 648 | $88.17 | Stopgap | 2017 |
| NE 8TH ST | 157 | $1,340.29 | Stopgap | 2017 |
| NW 1ST ST | 441 | $186.01 | Stopgap | 2017 |
| NW 7TH ST | 213 | $116.93 | Stopgap | 2017 |
| NE 8TH ST | 148 | $433.95 | Stopgap | 2017 |
| NW 5TH ST | 564 | $159.87 | Stopgap | 2017 |
| ASHMONT RD | 660 | $85.78 | Stopgap | 2017 |
| W CENTER * | 517 | $122.43 | Stopgap | 2017 |
| N LIBERTY* | 346 | $124.61 | Stopgap | 2017 |
| NE 9TH ST | 666 | $1,684.02 | Global MR | 2017 |
| N OLIVE A* | 177 | $216.96 | Stopgap | 2017 |
| N VAN EPS* | 342 | $236.96 | Stopgap | 2017 |
| N UNION A* | 553 | $137.27 | Stopgap | 2017 |
| NW 9TH ST | 254 | $8.50 | Stopgap | 2017 |
| CEDAR CT | 504 | $50.18 | Stopgap | 2017 |
| NW 5TH ST | 399 | $136.78 | Stopgap | 2017 |
| NW 5TH ST | 406 | $422.90 | Stopgap | 2017 |
| N MAPLEWO* | 274 | $177.23 | Stopgap | 2017 |

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|---|---|---|---|---|
| N OLIVE A* | 348 | $438.34 | Stopgap | 2017 |
| NW 9TH ST | 572 | $214.99 | Stopgap | 2017 |
| NW 7TH ST | 390 | $120.53 | Stopgap | 2017 |
| N LINCOLN* | 352 | $358.96 | Stopgap | 2017 |
| N HARTH A* | 584 | $165.34 | Stopgap | 2017 |
| S VAN EPS* | 13 | $170.66 | Stopgap | 2017 |
| NE 5TH ST | 155 | $252.61 | Stopgap | 2017 |
| NE 5TH ST | 585 | $1,591.73 | Stopgap | 2017 |
| NE 8TH ST | 602 | $244.12 | Stopgap | 2017 |
| N UNION A* | 554 | $150.45 | Stopgap | 2017 |
| NE 1ST ST | 62 | $634.44 | Stopgap | 2017 |
| N OLIVE A* | 336 | $432.09 | Stopgap | 2017 |
| NW 6TH ST | 398 | $149.21 | Stopgap | 2017 |
| NW 1ST ST | 444 | $111.33 | Stopgap | 2017 |
| N LEE AVE | 354 | $350.92 | Stopgap | 2017 |
| NW 5TH ST | 401 | $124.33 | Stopgap | 2017 |
| NE 8TH ST | 156 | $2,318.37 | Stopgap | 2017 |
| N HARTH A* | 583 | $282.29 | Stopgap | 2017 |
| N LEE AVE | 340 | $376.64 | Stopgap | 2017 |
| W CENTER * | 481 | $110.24 | Stopgap | 2017 |
| S JOSEPHI* | 38 | $168.56 | Stopgap | 2017 |
| N LEE AVE | 99 | $301.69 | Stopgap | 2017 |
| N HIGHLAN* | 374 | $2,481.39 | Global MR | 2018 |
| S HIGHLAN* | 682 | $1,993.98 | Global MR | 2018 |
| S HIGHLAN* | 235 | $2,394.11 | Global MR | 2018 |
| CIRCLE DR | 706 | $437.15 | Global MR | 2018 |
| N DIVISIO* | 545 | $1,562.99 | Global MR | 2018 |
| NW 9TH ST | 710 | $201.26 | Global MR | 2018 |
| N LINCOLN* | 190 | $1,670.62 | Global MR | 2018 |
| S HIGHLAN* | 79 | $1,660.93 | Global MR | 2018 |
| NE 9TH ST | 661 | $1,926.27 | Global MR | 2018 |
| N WEST AVE | 723 | $1,693.48 | Global MR | 2018 |
| N GARFIEL* | 257 | $1,021.63 | Global MR | 2018 |
| NE 3RD ST | 69 | $1,415.38 | Global MR | 2018 |
| NW 9TH ST | 611 | $1,072.03 | Global MR | 2018 |
| NE 9TH ST | 703 | $397.90 | Global MR | 2018 |
| N LINCOLN* | 95 | $1,785.97 | Global MR | 2018 |
| SE 9TH ST | 217 | $1,917.46 | Global MR | 2018 |
| NE 6TH ST | 589 | $1,883.52 | Global MR | 2018 |
| N GARFIEL* | 258 | $959.14 | Global MR | 2018 |
| S HIGHLAN* | 271 | $1,104.23 | Global MR | 2018 |

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|---|---|---|---|---|
| S HARTH A* | 264 | $1,417.56 | Global MR | 2018 |
| N LINCOLN* | 194 | $948.03 | Global MR | 2018 |
| NW 9TH ST | 711 | $614.47 | Global MR | 2018 |
| N GRANT A* | 260 | $1,021.48 | Global MR | 2018 |
| S HIGHLAN* | 234 | $2,101.94 | Global MR | 2018 |
| NE 6TH ST | 41 | $1,389.62 | Global MR | 2018 |
| N LINCOLN* | 87 | $3,132.74 | Global MR | 2018 |
| S HIGHLAN* | 29 | $2,345.06 | Global MR | 2018 |
| NE 1ST ST | 547 | $2,387.27 | Global MR | 2018 |
| NW 9TH ST | 453 | $1,786.73 | Global MR | 2018 |
| NW 9TH ST | 709 | $516.30 | Global MR | 2018 |
| NW 9TH ST | 569 | $1,437.34 | Global MR | 2018 |
| SE 12TH ST | 637 | $3,029.08 | Global MR | 2018 |
| SW 7TH ST | 238 | $1,700.58 | Global MR | 2018 |
| S LEE AVE | 25 | $2,361.12 | Global MR | 2018 |
| NW 9TH ST | 634 | $650.90 | Global MR | 2018 |
| HEATHERWO* | 673 | $1,261.20 | Global MR | 2018 |
| NW 9TH ST | 449 | $1,518.31 | Global MR | 2018 |
| N GARFIEL* | 351 | $2,028.39 | Global MR | 2018 |
| SE 2ND ST | 526 | $1,523.29 | Global MR | 2018 |
| N HARTH A* | 618 | $1,278.18 | Global MR | 2018 |
| N DIVISIO* | 82 | $986.28 | Global MR | 2018 |
| N AIRPORT* | 650 | $1,889.43 | Global MR | 2018 |
| N SUMMIT * | 88 | $3,132.74 | Global MR | 2018 |
| NW 9TH ST | 610 | $1,641.76 | Global MR | 2018 |
| N LINCOLN* | 318 | $1,591.30 | Global MR | 2018 |
| N DIVISIO* | 349 | $1,965.54 | Global MR | 2018 |
| NE 5TH ST | 513 | $4,014.69 | Major Above Critical | 2018 |
| N DIVISIO* | 251 | $5,706.65 | Major Above Critical | 2018 |
| SW 1ST ST | 460 | $65,558.59 | Major Above Critical | 2018 |
| NE 8TH ST | 587 | $72,085.34 | Major Below Critical | 2018 |
| S HIGHLAN* | 680 | $1,964.04 | Global MR | 2018 |
| NW 7TH ST | 567 | $1,520.00 | Global MR | 2018 |
| ASHMONT RD | 520 | $1,805.90 | Global MR | 2018 |
| N PRAIRIE* | 90 | $2,451.87 | Global MR | 2018 |
| TWIN OAKS* | 201 | $2,281.79 | Global MR | 2018 |
| NE 11TH ST | 695 | $941.24 | Global MR | 2018 |
| S HIGHLAN* | 576 | $1,250.46 | Global MR | 2018 |
| NE 8TH ST | 130 | $1,000.00 | Global MR | 2018 |
| N HIGHLAN* | 377 | $2,364.38 | Global MR | 2018 |
| NW 9TH ST | 452 | $662.79 | Global MR | 2018 |

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|---|---|---|---|---|
| N DIVISIO* | 81 | $1,055.73 | Global MR | 2018 |
| SE 9TH ST | 216 | $1,450.16 | Global MR | 2018 |
| NW 3RD ST | 420 | $1,417.69 | Global MR | 2018 |
| NE 9TH ST | 145 | $1,538.33 | Global MR | 2018 |
| N GRANT A* | 98 | $1,619.97 | Global MR | 2018 |
| N AIRPORT* | 362 | $1,486.54 | Global MR | 2018 |
| N CATHERI* | 376 | $1,626.08 | Global MR | 2018 |
| N LINCOLN* | 91 | $2,438.12 | Global MR | 2018 |
| N HARTH A* | 619 | $1,271.10 | Global MR | 2018 |
| N GRANT A* | 252 | $410.17 | Global MR | 2018 |
| SE 2ND ST | 106 | $1,432.89 | Global MR | 2018 |
| NE 4TH ST | 48 | $1,330.03 | Global MR | 2018 |
| N WEST AVE | 612 | $1,993.36 | Global MR | 2018 |
| NE 6TH ST | 42 | $1,460.59 | Global MR | 2018 |
| NE 9TH ST | 662 | $1,785.01 | Global MR | 2018 |
| N GRANT A* | 259 | $1,014.46 | Global MR | 2018 |
| S HIGHLAN* | 683 | $2,395.54 | Global MR | 2018 |
| NW 9TH ST | 450 | $1,437.93 | Global MR | 2018 |
| N CATHERI* | 319 | $128.46 | Stopgap | 2018 |
| S GARFIEL* | 143 | $1,674.30 | Global MR | 2018 |
| NW 9TH ST | 254 | $2,403.60 | Major Below Critical | 2018 |
| N OLIVE A* | 724 | $1,693.48 | Global MR | 2018 |
| NW 10TH ST | 451 | $1,444.48 | Global MR | 2018 |
| S HIGHLAN* | 681 | $4,221.19 | Global MR | 2018 |
| NW 3RD ST | 418 | $1,366.39 | Global MR | 2018 |
| AIRPORT CT | 720 | $1,898.73 | Global MR | 2018 |
| NE 8TH ST | 696 | $2,171.32 | Global MR | 2018 |
| NE JENNIF* | 532 | $2,277.78 | Global MR | 2018 |
| TWIN OAKS* | 672 | $2,058.44 | Global MR | 2018 |
| NE 10TH ST | 544 | $1,690.38 | Global MR | 2018 |
| N LINCOLN* | 176 | $1,576.70 | Global MR | 2018 |
| N WEST AVE | 370 | $140.29 | Stopgap | 2018 |
| TWIN OAKS* | 207 | $162.27 | Stopgap | 2018 |
| N HARTH A* | 341 | $312.83 | Stopgap | 2018 |
| N BLANCHE* | 557 | $148.50 | Stopgap | 2018 |
| S VAN EPS* | 72 | $185.47 | Stopgap | 2018 |
| N LIBERTY* | 556 | $236.25 | Stopgap | 2018 |
| N SUMMIT * | 89 | $202.61 | Stopgap | 2018 |
| S JOSEPHI* | 15 | $160.83 | Stopgap | 2018 |
| NE 7TH ST | 199 | $173.73 | Stopgap | 2018 |
| N DIVISIO* | 206 | $344.65 | Stopgap | 2018 |

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|---|---|---|---|---|
| NE 6TH ST | 128 | $5,413.72 | Stopgap | 2018 |
| N LIBERTY* | 380 | $148.15 | Stopgap | 2018 |
| N AIRPORT* | 649 | $162.96 | Stopgap | 2018 |
| N CATHERI* | 179 | $183.06 | Stopgap | 2018 |
| NE 7TH ST | 198 | $771.30 | Stopgap | 2018 |
| NE 8TH ST | 156 | $71,117.73 | Major Below Critical | 2018 |
| CAMBRIDGE* | 211 | $24.32 | Stopgap | 2018 |
| N OLIVE A* | 276 | $168.43 | Stopgap | 2018 |
| NW 1ST ST | 440 | $176.66 | Stopgap | 2018 |
| N LIBERTY* | 555 | $140.64 | Stopgap | 2018 |
| NW 4TH ST | 414 | $139.89 | Stopgap | 2018 |
| N LEE AVE | 581 | $90.35 | Stopgap | 2018 |
| S EGAN AVE | 679 | $242.50 | Stopgap | 2018 |
| SE 4TH ST | 203 | $175.60 | Stopgap | 2018 |
| N UNION A* | 333 | $177.85 | Stopgap | 2018 |
| N UNION A* | 328 | $490.69 | Stopgap | 2018 |
| NE 1ST ST | 63 | $5,841.99 | Stopgap | 2018 |
| N MAPLEWO* | 6 | $1,985.80 | Stopgap | 2018 |
| S CHICAGO* | 22 | $1,481.00 | Stopgap | 2018 |
| NE 8TH ST | 147 | $116.02 | Stopgap | 2018 |
| N LIBERTY* | 329 | $143.37 | Stopgap | 2018 |
| N VAN EPS* | 356 | $143.27 | Stopgap | 2018 |
| NW 4TH ST | 413 | $352.97 | Stopgap | 2018 |
| NW 6TH ST | 395 | $522.34 | Stopgap | 2018 |
| N LEE AVE | 340 | $425.92 | Stopgap | 2018 |
| N JOSEPHI* | 327 | $167.15 | Stopgap | 2018 |
| N AIRPORT* | 644 | $138.17 | Stopgap | 2018 |
| NE 5TH ST | 154 | $273.80 | Stopgap | 2018 |
| NW 6TH ST | 398 | $168.74 | Stopgap | 2018 |
| S JOSEPHI* | 38 | $197.02 | Stopgap | 2018 |
| NE 1ST ST | 62 | $666.85 | Stopgap | 2018 |
| NE 11TH ST | 135 | $119.53 | Stopgap | 2018 |
| N CHICAGO* | 332 | $137.71 | Stopgap | 2018 |
| NW 4TH ST | 415 | $1,242.60 | Stopgap | 2018 |
| N HARTH A* | 583 | $302.74 | Stopgap | 2018 |
| NW 5TH ST | 401 | $146.92 | Stopgap | 2018 |
| N LEE AVE | 354 | $389.24 | Stopgap | 2018 |
| N OLIVE A* | 336 | $453.70 | Stopgap | 2018 |
| NW 1ST ST | 444 | $131.56 | Stopgap | 2018 |
| N LEE AVE | 99 | $341.27 | Stopgap | 2018 |
| W CENTER * | 481 | $115.76 | Stopgap | 2018 |

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|---|---|---|---|---|
| NW 7TH ST | 389 | $128.77 | Stopgap | 2018 |
| SW 2ND ST | 465 | $1,952.32 | Stopgap | 2018 |
| W CENTER * | 480 | $1,717.96 | Stopgap | 2018 |
| SE 8TH ST | 214 | $2,763.66 | Stopgap | 2018 |
| N OLIVE A* | 378 | $147.88 | Stopgap | 2018 |
| N SUMMIT * | 282 | $452.79 | Stopgap | 2018 |
| W CENTER * | 483 | $204.59 | Stopgap | 2018 |
| NW 4TH ST | 410 | $239.89 | Stopgap | 2018 |
| N WEST AVE | 371 | $138.50 | Stopgap | 2018 |
| NW 4TH ST | 411 | $154.79 | Stopgap | 2018 |
| N WEST AVE | 369 | $168.39 | Stopgap | 2018 |
| S LIBERTY* | 35 | $153.90 | Stopgap | 2018 |
| S UNION A* | 36 | $140.29 | Stopgap | 2018 |
| N CHICAGO* | 335 | $171.33 | Stopgap | 2018 |
| NE 5TH ST | 44 | $205.58 | Stopgap | 2018 |
| SE 3RD ST | 126 | $118.76 | Stopgap | 2018 |
| W CENTER * | 482 | $116.07 | Stopgap | 2018 |
| HEATHERWO* | 700 | $89.73 | Stopgap | 2018 |
| S LINCOLN* | 23 | $861.15 | Stopgap | 2018 |
| N CHICAGO* | 361 | $137.43 | Stopgap | 2018 |
| SW 2ND ST | 464 | $1,256.03 | Stopgap | 2018 |
| W CENTER * | 479 | $145.35 | Stopgap | 2018 |
| SE 1ST ST | 102 | $678.31 | Stopgap | 2018 |
| NW 1ST ST | 448 | $141.39 | Stopgap | 2018 |
| SE 4TH ST | 114 | $382.45 | Stopgap | 2018 |
| SW 2ND ST | 523 | $144.58 | Stopgap | 2018 |
| NE 8TH ST | 668 | $85.42 | Stopgap | 2018 |
| N UNION A* | 553 | $149.36 | Stopgap | 2018 |
| CEDAR CT | 504 | $59.30 | Stopgap | 2018 |
| NW 5TH ST | 399 | $160.28 | Stopgap | 2018 |
| NW 5TH ST | 406 | $444.48 | Stopgap | 2018 |
| N MAPLEWO* | 274 | $216.82 | Stopgap | 2018 |
| N UNION A* | 554 | $177.79 | Stopgap | 2018 |
| N SUMMIT * | 94 | $222.61 | Stopgap | 2018 |
| NE 9TH ST | 138 | $114.53 | Stopgap | 2018 |
| N ROOSEVE* | 84 | $104,610.61 | Major Below Critical | 2018 |
| N ROOSEVE* | 387 | $122,185.75 | Major Below Critical | 2018 |
| NE 8TH ST | 669 | $50,406.01 | Major Below Critical | 2018 |
| S BLANCHE* | 71 | $129.72 | Stopgap | 2018 |
| N LIBERTY* | 334 | $170.00 | Stopgap | 2018 |
| NE 6TH ST | 150 | $120.60 | Stopgap | 2018 |

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|---|---|---|---|---|
| SW 4TH ST | 470 | $211.86 | Stopgap | 2018 |
| N LINCOLN* | 352 | $386.38 | Stopgap | 2018 |
| S CHICAGO* | 34 | $2,245.82 | Stopgap | 2018 |
| N SUMMIT * | 189 | $358.68 | Stopgap | 2018 |
| CAMBRIDGE* | 209 | $215.21 | Stopgap | 2018 |
| N LEE AVE | 384 | $237.79 | Stopgap | 2018 |
| N EGAN AVE | 737 | $138.60 | Stopgap | 2018 |
| NE 9TH ST | 702 | $94.81 | Stopgap | 2018 |
| NW 5TH ST | 404 | $1,640.18 | Stopgap | 2018 |
| SW 3RD ST | 472 | $476.65 | Stopgap | 2018 |
| NW 5TH ST | 564 | $187.34 | Stopgap | 2018 |
| ASHMONT RD | 660 | $95.93 | Stopgap | 2018 |
| W CENTER * | 517 | $128.55 | Stopgap | 2018 |
| N LIBERTY* | 346 | $135.70 | Stopgap | 2018 |
| N MAPLEWO* | 386 | $139.02 | Stopgap | 2018 |
| NW 7TH ST | 388 | $144.93 | Stopgap | 2018 |
| NW 9TH ST | 572 | $238.59 | Stopgap | 2018 |
| N HARTH A* | 620 | $373.63 | Stopgap | 2018 |
| NW 1ST ST | 441 | $210.42 | Stopgap | 2018 |
| S LIBERTY* | 21 | $218.92 | Stopgap | 2018 |
| N EGAN AVE | 653 | $266.40 | Stopgap | 2018 |
| S EGAN AVE | 689 | $451.72 | Stopgap | 2018 |
| NW 7TH ST | 568 | $129.98 | Stopgap | 2018 |
| NE 8TH ST | 149 | $120.64 | Stopgap | 2018 |
| NE 8TH ST | 157 | $68,683.15 | Major Below Critical | 2018 |
| NW 7TH ST | 390 | $145.40 | Stopgap | 2018 |
| N OLIVE A* | 348 | $460.76 | Stopgap | 2018 |
| N EGAN AVE | 499 | $268.55 | Stopgap | 2018 |
| N HARTH A* | 584 | $173.61 | Stopgap | 2018 |
| S VAN EPS* | 13 | $198.02 | Stopgap | 2018 |
| NE 5TH ST | 155 | $282.51 | Stopgap | 2018 |
| N LINCOLN* | 283 | $167.27 | Stopgap | 2018 |
| NE 5TH ST | 585 | $1,675.81 | Stopgap | 2018 |
| NE 8TH ST | 148 | $455.98 | Stopgap | 2018 |
| NW 7TH ST | 213 | $138.18 | Stopgap | 2018 |
| NE 8TH ST | 141 | $133.00 | Stopgap | 2018 |
| N UNION A* | 381 | $173.52 | Stopgap | 2018 |
| N WEST AVE | 365 | $156.51 | Stopgap | 2018 |
| N CATHERI* | 286 | $148.71 | Stopgap | 2018 |
| N EGAN AVE | 654 | $140.43 | Stopgap | 2018 |
| N AIRPORT* | 648 | $96.02 | Stopgap | 2018 |

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|---|---|---|---|---|
| N OLIVE A* | 177 | $243.80 | Stopgap | 2018 |
| N VAN EPS* | 342 | $270.01 | Stopgap | 2018 |
| NE 8TH ST | 602 | $258.33 | Stopgap | 2018 |
| SE 4TH ST | 117 | $121.62 | Stopgap | 2018 |
| SW 1ST ST | 463 | $1,476.08 | Global MR | 2019 |
| S LEE AVE | 11 | $2,928.14 | Global MR | 2019 |
| N JOSEPHI* | 358 | $1,700.55 | Global MR | 2019 |
| HAMPTON CT | 210 | $784.27 | Global MR | 2019 |
| S LEE AVE | 73 | $816.89 | Global MR | 2019 |
| SW 1ST ST | 461 | $2,507.50 | Global MR | 2019 |
| S UNION A* | 74 | $1,335.14 | Global MR | 2019 |
| S BLANCHE* | 14 | $1,780.18 | Global MR | 2019 |
| SE 3RD ST | 124 | $1,640.03 | Global MR | 2019 |
| SW 4TH ST | 577 | $1,570.33 | Global MR | 2019 |
| N BLANCHE* | 357 | $1,728.63 | Global MR | 2019 |
| N JEFFERS* | 256 | $1,059.72 | Global MR | 2019 |
| SW 1ST ST | 454 | $1,599.35 | Global MR | 2019 |
| NE 1ST ST | 61 | $1,212.93 | Global MR | 2019 |
| SW 7TH ST | 237 | $2,650.83 | Global MR | 2019 |
| N CHICAGO* | 347 | $1,663.00 | Global MR | 2019 |
| 456 AVE | 16 | $2,722.80 | Global MR | 2019 |
| NE 3RD ST | 70 | $895.38 | Global MR | 2019 |
| HERITAGE * | 542 | $1,643.50 | Global MR | 2019 |
| NW 1ST ST | 445 | $1,638.56 | Global MR | 2019 |
| S VAN EPS* | 76 | $2,406.91 | Global MR | 2019 |
| SW 8TH ST | 474 | $1,178.36 | Global MR | 2019 |
| REGENCY DR | 514 | $1,043.98 | Global MR | 2019 |
| NE 6TH ST | 40 | $1,484.95 | Global MR | 2019 |
| SW 4TH ST | 578 | $1,797.48 | Global MR | 2019 |
| SW 7TH ST | 241 | $1,535.48 | Global MR | 2019 |
| N UNION A* | 614 | $970.11 | Global MR | 2019 |
| SE 3RD ST | 123 | $1,559.58 | Global MR | 2019 |
| INDUSTRY | 638 | $1,978.58 | Global MR | 2019 |
| NW 1ST ST | 574 | $1,527.30 | Global MR | 2019 |
| SE 3RD ST | 125 | $1,404.31 | Global MR | 2019 |
| SE 1ST ST | 103 | $1,492.72 | Global MR | 2019 |
| SW 1ST ST | 455 | $1,471.04 | Global MR | 2019 |
| N UNION A* | 615 | $860.57 | Global MR | 2019 |
| N LIBERTY* | 360 | $1,691.96 | Global MR | 2019 |
| W CENTER * | 524 | $1,513.96 | Global MR | 2019 |
| SW 8TH ST | 231 | $1,872.65 | Global MR | 2019 |

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|---|---|---|---|---|
| NE 3RD ST | 55 | $1,274.43 | Global MR | 2019 |
| N SUMMIT * | 331 | $1,684.75 | Global MR | 2019 |
| W CENTER * | 485 | $2,683.62 | Global MR | 2019 |
| NE 1ST ST | 64 | $1,812.19 | Global MR | 2019 |
| N LIBERTY* | 346 | $163.30 | Stopgap | 2019 |
| N DIVISIO* | 546 | $1,677.81 | Global MR | 2019 |
| S CHICAGO* | 22 | $1,559.71 | Stopgap | 2019 |
| S EGAN AVE | 679 | $273.35 | Stopgap | 2019 |
| SE 4TH ST | 203 | $184.38 | Stopgap | 2019 |
| NW 6TH ST | 395 | $760.96 | Stopgap | 2019 |
| NE 8TH ST | 140 | $123.65 | Stopgap | 2019 |
| N UNION A* | 328 | $549.10 | Stopgap | 2019 |
| N UNION A* | 333 | $209.38 | Stopgap | 2019 |
| N MAPLEWO* | 6 | $2,087.25 | Stopgap | 2019 |
| N LIBERTY* | 555 | $162.35 | Stopgap | 2019 |
| NE 8TH ST | 147 | $127.71 | Stopgap | 2019 |
| N LIBERTY* | 329 | $172.54 | Stopgap | 2019 |
| N VAN EPS* | 356 | $168.57 | Stopgap | 2019 |
| NW 4TH ST | 413 | $380.79 | Stopgap | 2019 |
| N DIVISIO* | 206 | $363.91 | Stopgap | 2019 |
| N MAPLEWO* | 386 | $145.98 | Stopgap | 2019 |
| N OLIVE A* | 276 | $176.85 | Stopgap | 2019 |
| NW 7TH ST | 568 | $136.48 | Stopgap | 2019 |
| ASHMONT RD | 660 | $106.11 | Stopgap | 2019 |
| NW 7TH ST | 390 | $172.13 | Stopgap | 2019 |
| N HARTH A* | 620 | $417.18 | Stopgap | 2019 |
| N CATHERI* | 4 | $145.82 | Stopgap | 2019 |
| SW 3RD ST | 472 | $545.47 | Stopgap | 2019 |
| S LIBERTY* | 21 | $248.47 | Stopgap | 2019 |
| N LEE AVE | 581 | $95.93 | Stopgap | 2019 |
| S EGAN AVE | 689 | $530.90 | Stopgap | 2019 |
| NW 4TH ST | 414 | $164.45 | Stopgap | 2019 |
| NE 8TH ST | 149 | $145.82 | Stopgap | 2019 |
| NW 4TH ST | 411 | $184.95 | Stopgap | 2019 |
| N EGAN AVE | 499 | $281.98 | Stopgap | 2019 |
| S LINCOLN* | 23 | $1,107.66 | Stopgap | 2019 |
| NW 1ST ST | 440 | $204.11 | Stopgap | 2019 |
| N HARTH A* | 341 | $346.02 | Stopgap | 2019 |
| N EGAN AVE | 653 | $314.55 | Stopgap | 2019 |
| NW 7TH ST | 389 | $155.66 | Stopgap | 2019 |
| W CENTER * | 480 | $1,803.86 | Stopgap | 2019 |

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|---|---|---|---|---|
| SE 8TH ST | 214 | $3,579.99 | Stopgap | 2019 |
| N OLIVE A* | 378 | $175.66 | Stopgap | 2019 |
| N SUMMIT * | 282 | $488.47 | Stopgap | 2019 |
| W CENTER * | 483 | $225.71 | Stopgap | 2019 |
| S JOSEPHI* | 15 | $191.05 | Stopgap | 2019 |
| N WEST AVE | 371 | $166.69 | Stopgap | 2019 |
| TWIN OAKS* | 207 | $185.48 | Stopgap | 2019 |
| N WEST AVE | 369 | $176.81 | Stopgap | 2019 |
| S LIBERTY* | 35 | $183.87 | Stopgap | 2019 |
| S UNION A* | 36 | $169.57 | Stopgap | 2019 |
| N CHICAGO* | 335 | $203.51 | Stopgap | 2019 |
| W CENTER * | 482 | $121.88 | Stopgap | 2019 |
| NE 6TH ST | 128 | $6,349.52 | Stopgap | 2019 |
| N BLANCHE* | 557 | $176.40 | Stopgap | 2019 |
| S VAN EPS* | 72 | $194.74 | Stopgap | 2019 |
| N LIBERTY* | 556 | $270.04 | Stopgap | 2019 |
| N SUMMIT * | 89 | $212.74 | Stopgap | 2019 |
| CAMBRIDGE* | 211 | $25.53 | Stopgap | 2019 |
| NE 7TH ST | 199 | $199.42 | Stopgap | 2019 |
| SW 2ND ST | 465 | $2,222.49 | Stopgap | 2019 |
| W CENTER * | 478 | $245.25 | Stopgap | 2019 |
| NE 1ST ST | 63 | $6,134.09 | Stopgap | 2019 |
| N LIBERTY* | 380 | $178.29 | Stopgap | 2019 |
| N AIRPORT* | 649 | $193.56 | Stopgap | 2019 |
| N CATHERI* | 179 | $214.39 | Stopgap | 2019 |
| NE 7TH ST | 198 | $992.09 | Stopgap | 2019 |
| N JOSEPHI* | 327 | $196.47 | Stopgap | 2019 |
| W CENTER * | 517 | $151.91 | Stopgap | 2019 |
| N WEST AVE | 370 | $168.84 | Stopgap | 2019 |
| N HARTH A* | 355 | $139.75 | Stopgap | 2019 |
| S CHICAGO* | 34 | $2,556.61 | Stopgap | 2019 |
| N SUMMIT * | 189 | $381.28 | Stopgap | 2019 |
| CAMBRIDGE* | 209 | $238.28 | Stopgap | 2019 |
| N LEE AVE | 384 | $263.28 | Stopgap | 2019 |
| N EGAN AVE | 737 | $145.53 | Stopgap | 2019 |
| SE 1ST ST | 102 | $713.14 | Stopgap | 2019 |
| NE 8TH ST | 668 | $89.80 | Stopgap | 2019 |
| NW 5TH ST | 404 | $1,890.47 | Stopgap | 2019 |
| SE 4TH ST | 114 | $436.54 | Stopgap | 2019 |
| NE 6TH ST | 150 | $143.26 | Stopgap | 2019 |
| N CHICAGO* | 361 | $165.38 | Stopgap | 2019 |

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|---|---|---|---|---|
| SW 2ND ST | 464 | $1,519.43 | Stopgap | 2019 |
| W CENTER * | 479 | $171.77 | Stopgap | 2019 |
| NW 7TH ST | 388 | $173.17 | Stopgap | 2019 |
| NE 9TH ST | 702 | $99.55 | Stopgap | 2019 |
| SILVER CR* | 642 | $2,733.93 | Global MR | 2019 |
| S OLIVE A* | 31 | $1,779.93 | Global MR | 2019 |
| SW 1ST ST | 462 | $1,443.31 | Global MR | 2019 |
| SW 8TH ST | 230 | $1,808.28 | Global MR | 2019 |
| N JEFFERS* | 83 | $1,096.86 | Global MR | 2019 |
| N WEST AVE | 364 | $1,687.43 | Global MR | 2019 |
| NE 11TH ST | 200 | $1,767.91 | Global MR | 2019 |
| NE 9TH ST | 138 | $120.26 | Stopgap | 2019 |
| NW 3RD ST | 419 | $1,519.17 | Global MR | 2019 |
| SW 4TH ST | 470 | $240.29 | Stopgap | 2019 |
| SW 1ST ST | 456 | $1,599.68 | Global MR | 2019 |
| SE 12TH ST | 639 | $4,631.13 | Global MR | 2019 |
| N WASHING* | 322 | $13,659.84 | Major Above Critical | 2019 |
| S BLANCHE* | 71 | $136.21 | Stopgap | 2019 |
| N CATHERI* | 319 | $134.88 | Stopgap | 2019 |
| NW 1ST ST | 448 | $166.19 | Stopgap | 2019 |
| SW 2ND ST | 467 | $1,568.80 | Global MR | 2019 |
| N EGAN AVE | 654 | $147.45 | Stopgap | 2019 |
| NE 5TH ST | 585 | $1,761.90 | Stopgap | 2019 |
| NE 8TH ST | 602 | $272.77 | Stopgap | 2019 |
| NW 7TH ST | 213 | $164.14 | Stopgap | 2019 |
| N OLIVE A* | 348 | $484.32 | Stopgap | 2019 |
| N UNION A* | 381 | $203.96 | Stopgap | 2019 |
| N ANTELOP* | 253 | $133.07 | Stopgap | 2019 |
| N CATHERI* | 286 | $179.76 | Stopgap | 2019 |
| S VAN EPS* | 13 | $226.67 | Stopgap | 2019 |
| N AIRPORT* | 648 | $115.55 | Stopgap | 2019 |
| N OLIVE A* | 177 | $271.18 | Stopgap | 2019 |
| NW 1ST ST | 441 | $235.47 | Stopgap | 2019 |
| NE 8TH ST | 141 | $157.97 | Stopgap | 2019 |
| NE 8TH ST | 148 | $479.01 | Stopgap | 2019 |
| NW 5TH ST | 564 | $215.84 | Stopgap | 2019 |
| N WEST AVE | 365 | $188.35 | Stopgap | 2019 |
| N UNION A* | 554 | $211.19 | Stopgap | 2019 |
| N SUMMIT * | 94 | $254.45 | Stopgap | 2019 |
| SW 2ND ST | 523 | $173.98 | Stopgap | 2019 |
| HEATHERWO* | 700 | $94.22 | Stopgap | 2019 |

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|---|---|---|---|---|
| N UNION A* | 553 | $179.76 | Stopgap | 2019 |
| CEDAR CT | 504 | $70.44 | Stopgap | 2019 |
| NW 5TH ST | 399 | $184.67 | Stopgap | 2019 |
| N LINCOLN* | 283 | $175.63 | Stopgap | 2019 |
| N MAPLEWO* | 274 | $259.02 | Stopgap | 2019 |
| NE 5TH ST | 155 | $312.48 | Stopgap | 2019 |
| NW 9TH ST | 572 | $266.06 | Stopgap | 2019 |
| NW 5TH ST | 400 | $148.73 | Stopgap | 2019 |
| N VAN EPS* | 342 | $304.52 | Stopgap | 2019 |
| N LINCOLN* | 352 | $413.67 | Stopgap | 2019 |
| N HARTH A* | 584 | $182.29 | Stopgap | 2019 |
| SW 1ST ST | 459 | $2,200.05 | Global MR | 2019 |
| NW 5TH ST | 406 | $467.27 | Stopgap | 2019 |
| NE 5TH ST | 44 | $230.06 | Stopgap | 2019 |
| N OLIVE A* | 336 | $476.38 | Stopgap | 2019 |
| SE 3RD ST | 126 | $124.70 | Stopgap | 2019 |
| NW 8TH ST | 635 | $135.89 | Stopgap | 2019 |
| NW 1ST ST | 444 | $156.28 | Stopgap | 2019 |
| N LEE AVE | 354 | $434.05 | Stopgap | 2019 |
| NW 5TH ST | 401 | $174.52 | Stopgap | 2019 |
| N HARTH A* | 583 | $323.78 | Stopgap | 2019 |
| N LEE AVE | 340 | $475.53 | Stopgap | 2019 |
| N CHICAGO* | 332 | $144.60 | Stopgap | 2019 |
| W CENTER * | 481 | $136.79 | Stopgap | 2019 |
| N LIBERTY* | 334 | $201.94 | Stopgap | 2019 |
| N LEE AVE | 99 | $381.91 | Stopgap | 2019 |
| NE 1ST ST | 62 | $701.09 | Stopgap | 2019 |
| NW 4TH ST | 415 | $1,308.64 | Stopgap | 2019 |
| NE 11TH ST | 135 | $125.50 | Stopgap | 2019 |
| NW 4TH ST | 410 | $278.26 | Stopgap | 2019 |
| SE 4TH ST | 117 | $144.46 | Stopgap | 2019 |
| N AIRPORT* | 644 | $164.12 | Stopgap | 2019 |
| NE 5TH ST | 154 | $302.84 | Stopgap | 2019 |
| NW 6TH ST | 398 | $188.41 | Stopgap | 2019 |
| S JOSEPHI* | 38 | $227.54 | Stopgap | 2019 |
| N OLIVE A* | 177 | $299.57 | Stopgap | 2020 |
| N MAPLEWO* | 386 | $162.11 | Stopgap | 2020 |
| N LIBERTY* | 346 | $192.65 | Stopgap | 2020 |
| W CENTER * | 517 | $177.55 | Stopgap | 2020 |
| ASHMONT RD | 660 | $116.24 | Stopgap | 2020 |
| NW 5TH ST | 564 | $245.61 | Stopgap | 2020 |

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|---|---|---|---|---|
| NE 8TH ST | 148 | $503.21 | Stopgap | 2020 |
| N LEE AVE | 581 | $115.91 | Stopgap | 2020 |
| NW 1ST ST | 441 | $261.38 | Stopgap | 2020 |
| N HARTH A* | 620 | $460.94 | Stopgap | 2020 |
| N AIRPORT* | 648 | $136.32 | Stopgap | 2020 |
| N EGAN AVE | 654 | $171.66 | Stopgap | 2020 |
| N CATHERI* | 286 | $213.12 | Stopgap | 2020 |
| N WEST AVE | 365 | $222.22 | Stopgap | 2020 |
| N UNION A* | 381 | $235.69 | Stopgap | 2020 |
| N OLIVE A* | 348 | $509.23 | Stopgap | 2020 |
| NE 8TH ST | 141 | $184.25 | Stopgap | 2020 |
| NE 8TH ST | 149 | $172.87 | Stopgap | 2020 |
| N LIBERTY* | 555 | $193.67 | Stopgap | 2020 |
| NW 1ST ST | 440 | $243.46 | Stopgap | 2020 |
| S LINCOLN* | 23 | $1,368.08 | Stopgap | 2020 |
| N AIRPORT* | 647 | $72.08 | Stopgap | 2020 |
| N EGAN AVE | 499 | $296.08 | Stopgap | 2020 |
| NW 7TH ST | 388 | $203.36 | Stopgap | 2020 |
| SE 5TH ST | 120 | $142.43 | Stopgap | 2020 |
| NW 7TH ST | 390 | $200.56 | Stopgap | 2020 |
| NW 7TH ST | 568 | $164.08 | Stopgap | 2020 |
| S EGAN AVE | 689 | $617.03 | Stopgap | 2020 |
| N EGAN AVE | 653 | $367.68 | Stopgap | 2020 |
| S LIBERTY* | 21 | $278.98 | Stopgap | 2020 |
| SW 3RD ST | 472 | $618.78 | Stopgap | 2020 |
| N CATHERI* | 4 | $153.11 | Stopgap | 2020 |
| N LINCOLN* | 283 | $184.41 | Stopgap | 2020 |
| NW 4TH ST | 411 | $217.20 | Stopgap | 2020 |
| NW 5TH ST | 402 | $133.65 | Stopgap | 2020 |
| NW 7TH ST | 213 | $191.47 | Stopgap | 2020 |
| SE 1ST ST | 102 | $749.56 | Stopgap | 2020 |
| N ANTELOP* | 253 | $139.72 | Stopgap | 2020 |
| W CENTER * | 479 | $200.76 | Stopgap | 2020 |
| SW 2ND ST | 464 | $1,799.27 | Stopgap | 2020 |
| N CHICAGO* | 361 | $195.10 | Stopgap | 2020 |
| N SUMMIT * | 94 | $287.68 | Stopgap | 2020 |
| SE 4TH ST | 114 | $491.18 | Stopgap | 2020 |
| SW 2ND ST | 523 | $205.25 | Stopgap | 2020 |
| N HARTH A* | 355 | $146.73 | Stopgap | 2020 |
| NE 8TH ST | 668 | $94.42 | Stopgap | 2020 |
| NE 9TH ST | 702 | $112.59 | Stopgap | 2020 |

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|---|---|---|---|---|
| N EGAN AVE | 737 | $169.42 | Stopgap | 2020 |
| N LEE AVE | 384 | $296.75 | Stopgap | 2020 |
| CAMBRIDGE* | 209 | $268.58 | Stopgap | 2020 |
| N SUMMIT * | 189 | $403.86 | Stopgap | 2020 |
| NE 6TH ST | 150 | $167.11 | Stopgap | 2020 |
| N UNION A* | 554 | $246.35 | Stopgap | 2020 |
| S EGAN AVE | 679 | $305.01 | Stopgap | 2020 |
| NE 5TH ST | 155 | $342.33 | Stopgap | 2020 |
| S VAN EPS* | 13 | $256.44 | Stopgap | 2020 |
| N HARTH A* | 584 | $212.22 | Stopgap | 2020 |
| N LINCOLN* | 352 | $441.04 | Stopgap | 2020 |
| N VAN EPS* | 342 | $340.67 | Stopgap | 2020 |
| NW 1ST ST | 448 | $192.04 | Stopgap | 2020 |
| NW 9TH ST | 572 | $302.50 | Stopgap | 2020 |
| NE 8TH ST | 602 | $287.29 | Stopgap | 2020 |
| N MAPLEWO* | 274 | $304.14 | Stopgap | 2020 |
| NW 5TH ST | 406 | $491.11 | Stopgap | 2020 |
| NW 5TH ST | 399 | $210.14 | Stopgap | 2020 |
| SE 1ST ST | 104 | $310.87 | Stopgap | 2020 |
| CEDAR CT | 504 | $82.17 | Stopgap | 2020 |
| N UNION A* | 553 | $212.08 | Stopgap | 2020 |
| HEATHERWO* | 700 | $106.56 | Stopgap | 2020 |
| NW 5TH ST | 400 | $156.17 | Stopgap | 2020 |
| N WEST AVE | 369 | $185.65 | Stopgap | 2020 |
| NE 11TH ST | 135 | $150.15 | Stopgap | 2020 |
| NW 4TH ST | 415 | $1,378.30 | Stopgap | 2020 |
| SE 3RD ST | 126 | $137.75 | Stopgap | 2020 |
| NE 5TH ST | 44 | $255.36 | Stopgap | 2020 |
| N CHICAGO* | 335 | $237.40 | Stopgap | 2020 |
| N WEST AVE | 379 | $110.36 | Stopgap | 2020 |
| NW 4TH ST | 414 | $190.04 | Stopgap | 2020 |
| S LIBERTY* | 35 | $215.91 | Stopgap | 2020 |
| SE 4TH ST | 117 | $168.50 | Stopgap | 2020 |
| NW 7TH ST | 389 | $184.54 | Stopgap | 2020 |
| RAMM HEIG* | 522 | $478.92 | Stopgap | 2020 |
| NW 1ST ST | 443 | $135.76 | Stopgap | 2020 |
| N WEST AVE | 371 | $196.66 | Stopgap | 2020 |
| W CENTER * | 482 | $141.88 | Stopgap | 2020 |
| W CENTER * | 483 | $247.72 | Stopgap | 2020 |
| S UNION A* | 36 | $201.02 | Stopgap | 2020 |
| W CENTER * | 481 | $159.88 | Stopgap | 2020 |

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|---|---|---|---|---|
| N LEE AVE | 99 | $423.92 | Stopgap | 2020 |
| NW 1ST ST | 444 | $182.30 | Stopgap | 2020 |
| N OLIVE A* | 336 | $500.20 | Stopgap | 2020 |
| N LEE AVE | 354 | $493.51 | Stopgap | 2020 |
| NW 5TH ST | 401 | $203.58 | Stopgap | 2020 |
| N HARTH A* | 583 | $345.38 | Stopgap | 2020 |
| N LIBERTY* | 334 | $235.56 | Stopgap | 2020 |
| N CHICAGO* | 332 | $151.83 | Stopgap | 2020 |
| NW 4TH ST | 410 | $328.14 | Stopgap | 2020 |
| NE 1ST ST | 62 | $736.90 | Stopgap | 2020 |
| S JOSEPHI* | 38 | $260.08 | Stopgap | 2020 |
| NW 6TH ST | 398 | $208.17 | Stopgap | 2020 |
| S LINCOLN* | 269 | $73.12 | Stopgap | 2020 |
| NE 5TH ST | 154 | $331.77 | Stopgap | 2020 |
| N AIRPORT* | 644 | $191.43 | Stopgap | 2020 |
| SE 8TH ST | 214 | $4,475.02 | Stopgap | 2020 |
| N LEE AVE | 340 | $525.39 | Stopgap | 2020 |
| N JOSEPHI* | 617 | $144.18 | Stopgap | 2020 |
| N SUMMIT * | 282 | $523.89 | Stopgap | 2020 |
| S JOSEPHI* | 15 | $222.86 | Stopgap | 2020 |
| N DIVISIO* | 206 | $383.28 | Stopgap | 2020 |
| NW 4TH ST | 413 | $408.40 | Stopgap | 2020 |
| N VAN EPS* | 356 | $195.36 | Stopgap | 2020 |
| N CATHERI* | 337 | $168.42 | Stopgap | 2020 |
| N HARTH A* | 341 | $379.07 | Stopgap | 2020 |
| NE 8TH ST | 147 | $150.98 | Stopgap | 2020 |
| N BLANCHE* | 557 | $205.77 | Stopgap | 2020 |
| NW 5TH ST | 405 | $129.99 | Stopgap | 2020 |
| S CHICAGO* | 22 | $1,642.74 | Stopgap | 2020 |
| N OLIVE A* | 276 | $211.41 | Stopgap | 2020 |
| N UNION A* | 328 | $611.14 | Stopgap | 2020 |
| NE 8TH ST | 140 | $129.83 | Stopgap | 2020 |
| NW 6TH ST | 395 | $1,016.09 | Stopgap | 2020 |
| SE 4TH ST | 203 | $208.54 | Stopgap | 2020 |
| N LIBERTY* | 329 | $203.57 | Stopgap | 2020 |
| N LIBERTY* | 380 | $210.35 | Stopgap | 2020 |
| SW 4TH ST | 470 | $281.18 | Stopgap | 2020 |
| SW 2ND ST | 465 | $2,516.95 | Stopgap | 2020 |
| NE 1ST ST | 63 | $6,440.80 | Stopgap | 2020 |
| TWIN OAKS* | 207 | $209.71 | Stopgap | 2020 |
| N JOSEPHI* | 327 | $227.03 | Stopgap | 2020 |

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|---|---|---|---|---|
| NE 7TH ST | 198 | $1,225.34 | Stopgap | 2020 |
| N UNION A* | 333 | $242.55 | Stopgap | 2020 |
| N AIRPORT* | 649 | $225.77 | Stopgap | 2020 |
| N OLIVE A* | 378 | $204.91 | Stopgap | 2020 |
| W CENTER * | 478 | $257.51 | Stopgap | 2020 |
| N WEST AVE | 370 | $199.20 | Stopgap | 2020 |
| NE 7TH ST | 199 | $226.70 | Stopgap | 2020 |
| CAMBRIDGE* | 211 | $26.81 | Stopgap | 2020 |
| N SUMMIT * | 89 | $223.38 | Stopgap | 2020 |
| N LIBERTY* | 556 | $305.31 | Stopgap | 2020 |
| S VAN EPS* | 72 | $226.72 | Stopgap | 2020 |
| N CATHERI* | 179 | $248.10 | Stopgap | 2020 |
| S CHICAGO* | 34 | $2,895.33 | Stopgap | 2020 |
| NW 8TH ST | 722 | $691.58 | Global MR | 2020 |
| N KANSAS * | 508 | $2,030.86 | Global MR | 2020 |
| NW 6TH ST | 393 | $1,586.00 | Global MR | 2020 |
| NW 3RD ST | 427 | $942.77 | Global MR | 2020 |
| N OLIVE A* | 273 | $1,646.56 | Global MR | 2020 |
| NW 6TH ST | 394 | $1,670.23 | Global MR | 2020 |
| NW 5TH ST | 403 | $1,673.56 | Global MR | 2020 |
| N CHICAGO* | 316 | $1,723.07 | Global MR | 2020 |
| N UNION A* | 312 | $1,694.51 | Global MR | 2020 |
| NW 8TH ST | 160 | $1,593.85 | Global MR | 2020 |
| N OLIVE A* | 284 | $1,823.19 | Global MR | 2020 |
| N CHICAGO* | 281 | $1,831.06 | Global MR | 2020 |
| N KANSAS * | 5 | $1,807.53 | Global MR | 2020 |
| NW 4TH ST | 417 | $963.42 | Global MR | 2020 |
| N KANSAS * | 180 | $1,815.32 | Global MR | 2020 |
| NW 6TH ST | 396 | $1,560.93 | Global MR | 2020 |
| NW 3RD ST | 424 | $1,519.55 | Global MR | 2020 |
| NE 9TH ST | 136 | $49,788.68 | Major Above Critical | 2020 |
| NW 8TH ST | 635 | $142.68 | Stopgap | 2020 |
| NW 5TH ST | 404 | $2,170.13 | Stopgap | 2020 |
| N CATHERI* | 319 | $141.63 | Stopgap | 2020 |
| S BLANCHE* | 71 | $150.46 | Stopgap | 2020 |
| W CENTER * | 480 | $74,210.80 | Major Below Critical | 2020 |
| NE 6TH ST | 128 | $139,868.38 | Major Below Critical | 2020 |
| N WEST AVE | 367 | $1,792.11 | Global MR | 2020 |
| NE 5TH ST | 585 | $81,567.99 | Major Below Critical | 2020 |
| NW 7TH ST | 565 | $1,560.05 | Global MR | 2020 |
| NE 3RD ST | 548 | $76,006.47 | Major Above Critical | 2020 |

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|---|---|---|---|---|
| NE 3RD ST | 551 | $79,193.07 | Major Above Critical | 2020 |
| NE 3RD ST | 552 | $78,160.45 | Major Above Critical | 2020 |
| NW 4TH ST | 416 | $1,525.05 | Global MR | 2020 |
| NW 3RD ST | 423 | $1,730.64 | Global MR | 2020 |
| NW 5TH ST | 447 | $979.06 | Global MR | 2020 |
| N UNION A* | 185 | $1,753.81 | Global MR | 2020 |
| N MAPLEWO* | 6 | $76,459.49 | Major Below Critical | 2020 |
| N OLIVE A* | 317 | $1,715.48 | Global MR | 2020 |
| NE 9TH ST | 138 | $136.01 | Stopgap | 2020 |
| NW 7TH ST | 566 | $1,010.07 | Global MR | 2020 |
| NW 6TH ST | 391 | $1,944.40 | Global MR | 2020 |
| NW 3RD ST | 421 | $1,921.93 | Global MR | 2020 |
| NW 3RD ST | 426 | $1,518.27 | Global MR | 2020 |
| NW 4TH ST | 412 | $1,573.82 | Global MR | 2020 |
| NW 6TH ST | 397 | $1,563.01 | Global MR | 2020 |
| NW 6TH ST | 392 | $1,703.25 | Global MR | 2020 |
| NW 3RD ST | 446 | $1,720.20 | Global MR | 2020 |
| N CHICAGO* | 275 | $2,175.24 | Global MR | 2020 |
| N WEST AVE | 368 | $1,753.66 | Global MR | 2020 |
| NW 3RD ST | 425 | $1,561.53 | Global MR | 2020 |
| NW 3RD ST | 422 | $1,529.43 | Global MR | 2020 |
| N OLIVE A* | 191 | $1,799.77 | Global MR | 2020 |
| N LIBERTY* | 314 | $1,692.80 | Global MR | 2020 |

**2) Plan g2**

| **Branch ID** | **Section ID** | **Estimated Cost** | **Work Type** | **Work Year** |
|---|---|---|---|---|
| N JOSEPHI* | 525 | $1,747.07 | Global MR | 2016 |
| NE 6TH ST | 41 | $1,365.42 | Global MR | 2016 |
| N WASHING* | 285 | $377.31 | Global MR | 2016 |
| NE 4TH ST | 47 | $1,532.44 | Global MR | 2016 |
| N LEE AVE | 582 | $2,083.99 | Global MR | 2016 |
| N VAN EPS* | 182 | $1,962.92 | Global MR | 2016 |
| N EGAN AVE | 655 | $2,184.67 | Global MR | 2016 |
| N JOSEPHI* | 288 | $1,533.13 | Global MR | 2016 |
| N EGAN AVE | 652 | $3,221.42 | Global MR | 2016 |
| NW 3RD ST | 418 | $1,342.60 | Global MR | 2016 |
| N VAN EPS* | 196 | $1,699.50 | Global MR | 2016 |
| NE 6TH ST | 588 | $1,564.32 | Global MR | 2016 |
| N EGAN AVE | 658 | $2,429.93 | Global MR | 2016 |
| N WASHING* | 92 | $1,957.76 | Global MR | 2016 |
| NW 5TH ST | 563 | $1,413.63 | Global MR | 2016 |

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|---|---|---|---|---|
| NW 3RD ST | 419 | $1,421.63 | Global MR | 2016 |
| N EGAN AVE | 656 | $3,904.30 | Global MR | 2016 |
| N JOSEPHI* | 616 | $1,542.94 | Global MR | 2016 |
| N WASHING* | 192 | $1,316.65 | Global MR | 2016 |
| NE 6TH ST | 42 | $1,435.15 | Global MR | 2016 |
| N BLANCHE* | 325 | $1,570.29 | Global MR | 2016 |
| N BLANCHE* | 197 | $1,733.54 | Global MR | 2016 |
| NW 3RD ST | 420 | $1,393.00 | Global MR | 2016 |
| N HARTH A* | 383 | $1,522.02 | Global MR | 2016 |
| N JOSEPHI* | 184 | $1,562.88 | Global MR | 2016 |
| N WASHING* | 195 | $1,283.22 | Global MR | 2016 |
| N LEE AVE | 385 | $1,592.44 | Global MR | 2016 |
| N WASHING* | 624 | $2,261.16 | Global MR | 2016 |
| NE 6TH ST | 152 | $1,348.84 | Global MR | 2016 |
| N WASHING* | 323 | $809.94 | Global MR | 2016 |
| N BLANCHE* | 558 | $1,979.65 | Global MR | 2016 |
| N WASHING* | 322 | $482.78 | Global MR | 2016 |
| NE 6TH ST | 151 | $1,351.99 | Global MR | 2016 |
| N WASHING* | 623 | $1,005.32 | Global MR | 2016 |
| N WASHING* | 86 | $2,490.25 | Global MR | 2016 |
| N EGAN AVE | 657 | $3,139.75 | Global MR | 2016 |
| NE 4TH ST | 45 | $1,328.44 | Global MR | 2016 |
| N JOSEPHI* | 561 | $1,590.71 | Global MR | 2016 |
| NE 3RD ST | 70 | $837.90 | Global MR | 2016 |
| N JOSEPHI* | 617 | $1,542.54 | Global MR | 2016 |
| N BLANCHE* | 357 | $1,617.65 | Global MR | 2016 |
| CEDAR CT | 248 | $509.69 | Global MR | 2016 |
| N WASHING* | 277 | $1,203.59 | Global MR | 2016 |
| NW 7TH ST | 567 | $1,493.53 | Global MR | 2016 |
| N WASHING* | 96 | $1,425.12 | Global MR | 2016 |
| N JOSEPHI* | 279 | $1,938.47 | Global MR | 2016 |
| NW 4TH ST | 409 | $1,388.29 | Global MR | 2016 |
| NE 6TH ST | 40 | $1,389.61 | Global MR | 2016 |
| N WASHING* | 622 | $1,003.75 | Global MR | 2016 |
| NE 5TH ST | 153 | $1,532.55 | Global MR | 2016 |
| N JOSEPHI* | 562 | $1,754.18 | Global MR | 2016 |
| NE 6TH ST | 589 | $1,850.72 | Global MR | 2016 |
| NW 8TH ST | 570 | $1,375.88 | Global MR | 2016 |
| N HARTH A* | 341 | $246.85 | Stopgap | 2016 |
| N AIRPORT* | 649 | $131.23 | Stopgap | 2016 |
| S CHICAGO* | 22 | $1,335.13 | Stopgap | 2016 |

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|---|---|---|---|---|
| N LIBERTY* | 329 | $125.49 | Stopgap | 2016 |
| N VAN EPS* | 356 | $121.28 | Stopgap | 2016 |
| NW 4TH ST | 413 | $296.84 | Stopgap | 2016 |
| N DIVISIO* | 206 | $306.59 | Stopgap | 2016 |
| CIRCLE DR | 707 | $1,348.06 | Stopgap | 2016 |
| N UNION A* | 333 | $134.87 | Stopgap | 2016 |
| N UNION A* | 328 | $383.61 | Stopgap | 2016 |
| S VAN EPS* | 72 | $168.23 | Stopgap | 2016 |
| N ROOSEVE* | 387 | $8,372.64 | Stopgap | 2016 |
| N LIBERTY* | 556 | $172.92 | Stopgap | 2016 |
| NE 7TH ST | 199 | $127.30 | Stopgap | 2016 |
| N WEST AVE | 370 | $122.80 | Stopgap | 2016 |
| N WASHING* | 287 | $837.77 | Global MR | 2016 |
| S JOSEPHI* | 15 | $129.62 | Stopgap | 2016 |
| NW 4TH ST | 411 | $120.47 | Stopgap | 2016 |
| N LIBERTY* | 346 | $118.67 | Stopgap | 2016 |
| NW 7TH ST | 388 | $112.79 | Stopgap | 2016 |
| N ROOSEVE* | 84 | $7,168.32 | Stopgap | 2016 |
| NW 7TH ST | 390 | $105.12 | Stopgap | 2016 |
| N HARTH A* | 620 | $292.90 | Stopgap | 2016 |
| SW 3RD ST | 472 | $351.20 | Stopgap | 2016 |
| N MAPLEWO* | 6 | $1,795.50 | Stopgap | 2016 |
| S EGAN AVE | 689 | $312.19 | Stopgap | 2016 |
| N CATHERI* | 179 | $126.02 | Stopgap | 2016 |
| S LINCOLN* | 23 | $431.70 | Stopgap | 2016 |
| NW 1ST ST | 440 | $160.24 | Stopgap | 2016 |
| N LIBERTY* | 555 | $127.56 | Stopgap | 2016 |
| NW 4TH ST | 414 | $104.62 | Stopgap | 2016 |
| S EGAN AVE | 679 | $184.34 | Stopgap | 2016 |
| NW 6TH ST | 395 | $386.18 | Stopgap | 2016 |
| S LIBERTY* | 21 | $163.45 | Stopgap | 2016 |
| NE 1ST ST | 62 | $603.61 | Stopgap | 2016 |
| N LIBERTY* | 380 | $129.67 | Stopgap | 2016 |
| NW 4TH ST | 415 | $1,120.21 | Stopgap | 2016 |
| N LIBERTY* | 334 | $137.01 | Stopgap | 2016 |
| NW 4TH ST | 410 | $171.78 | Stopgap | 2016 |
| SE 4TH ST | 117 | $97.94 | Stopgap | 2016 |
| N AIRPORT* | 644 | $111.27 | Stopgap | 2016 |
| N CHICAGO* | 335 | $138.07 | Stopgap | 2016 |
| S JOSEPHI* | 38 | $141.70 | Stopgap | 2016 |
| CIRCLE DR | 721 | $1,348.06 | Stopgap | 2016 |

| | | | | |
|---|---|---|---|---|
| N LEE AVE | 340 | $333.77 | Stopgap | 2016 |
| NW 5TH ST | 401 | $118.41 | Stopgap | 2016 |
| N LEE AVE | 354 | $313.51 | Stopgap | 2016 |
| N OLIVE A* | 336 | $411.26 | Stopgap | 2016 |
| NW 1ST ST | 444 | $106.03 | Stopgap | 2016 |
| NW 6TH ST | 398 | $132.28 | Stopgap | 2016 |
| W CENTER * | 483 | $164.82 | Stopgap | 2016 |
| NE 7TH ST | 198 | $386.66 | Stopgap | 2016 |
| TWIN OAKS* | 207 | $118.77 | Stopgap | 2016 |
| NE 1ST ST | 63 | $5,298.86 | Stopgap | 2016 |
| SW 2ND ST | 465 | $1,477.61 | Stopgap | 2016 |
| W CENTER * | 480 | $1,556.33 | Stopgap | 2016 |
| SE 8TH ST | 214 | $1,735.93 | Stopgap | 2016 |
| NE 5TH ST | 44 | $158.78 | Stopgap | 2016 |
| N SUMMIT * | 282 | $381.06 | Stopgap | 2016 |
| NE 8TH ST | 141 | $107.10 | Stopgap | 2016 |
| W CENTER * | 482 | $105.28 | Stopgap | 2016 |
| N WEST AVE | 371 | $121.23 | Stopgap | 2016 |
| NW 7TH ST | 389 | $108.62 | Stopgap | 2016 |
| S LIBERTY* | 35 | $119.68 | Stopgap | 2016 |
| NE 8TH ST | 669 | $2,956.12 | Stopgap | 2016 |
| S UNION A* | 36 | $118.24 | Stopgap | 2016 |
| N OLIVE A* | 378 | $119.18 | Stopgap | 2016 |
| N DIVISIO* | 251 | $4,531.18 | Major Above Critical | 2016 |
| W CENTER * | 517 | $116.60 | Stopgap | 2016 |
| NE 8TH ST | 147 | $1,473.79 | Global MR + Stopgap | 2016 |
| N BLANCHE* | 557 | $1,676.10 | Global MR + Stopgap | 2016 |
| NE 6TH ST | 128 | $6,818.75 | Global MR + Stopgap | 2016 |
| N JOSEPHI* | 327 | $1,749.30 | Global MR + Stopgap | 2016 |
| NE 5TH ST | 154 | $1,560.90 | Global MR + Stopgap | 2016 |
| NE 8TH ST | 149 | $1,423.99 | Global MR + Stopgap | 2016 |
| N LEE AVE | 99 | $2,618.93 | Global MR + Stopgap | 2016 |
| NW 7TH ST | 568 | $1,651.11 | Global MR + Stopgap | 2016 |
| N AIRPORT* | 647 | $19,665.87 | Major Above Critical | 2016 |
| NE 7TH ST | 705 | $9,312.85 | Major Below Critical | 2016 |
| N CHICAGO* | 187 | $77,490.24 | Major Below Critical | 2016 |

| | | | | |
|---|---|---|---|---|
| NW 9TH ST | 254 | $2,120.87 | Major Below Critical | 2016 |
| SE 4TH ST | 202 | $116,340.19 | Major Below Critical | 2016 |
| N CATHERI* | 366 | $59,280.00 | Major Below Critical | 2016 |
| N HARTH A* | 583 | $1,395.64 | Global MR + Stopgap | 2016 |
| N HARTH A* | 584 | $2,205.29 | Global MR + Stopgap | 2016 |
| N WASHING* | 178 | $427.48 | Global MR | 2016 |
| N EGAN AVE | 659 | $2,280.10 | Global MR | 2016 |
| N BLANCHE* | 183 | $1,576.59 | Global MR | 2016 |
| N LEE AVE | 384 | $1,697.32 | Global MR + Stopgap | 2016 |
| N EGAN AVE | 737 | $1,760.61 | Global MR + Stopgap | 2016 |
| NE 6TH ST | 150 | $1,361.17 | Global MR + Stopgap | 2016 |
| N LEE AVE | 581 | $1,147.74 | Global MR + Stopgap | 2016 |
| NW 5TH ST | 399 | $1,479.08 | Global MR + Stopgap | 2016 |
| NW 5TH ST | 404 | $1,183.36 | Stopgap | 2016 |
| NE 5TH ST | 155 | $1,610.56 | Global MR + Stopgap | 2016 |
| NW 7TH ST | 213 | $1,559.59 | Global MR + Stopgap | 2016 |
| N EGAN AVE | 654 | $1,783.81 | Global MR + Stopgap | 2016 |
| NE 8TH ST | 148 | $1,824.62 | Global MR + Stopgap | 2016 |
| NW 5TH ST | 564 | $1,728.77 | Global MR + Stopgap | 2016 |
| N EGAN AVE | 653 | $3,383.97 | Global MR + Stopgap | 2016 |
| CEDAR CT | 504 | $669.29 | Global MR + Stopgap | 2016 |
| N UNION A* | 381 | $129.67 | Stopgap | 2016 |
| NW 9TH ST | 572 | $192.06 | Stopgap | 2016 |
| N VAN EPS* | 342 | $205.20 | Stopgap | 2016 |
| N LINCOLN* | 352 | $331.20 | Stopgap | 2016 |
| S VAN EPS* | 13 | $144.56 | Stopgap | 2016 |
| NE 5TH ST | 585 | $1,513.95 | Stopgap | 2016 |
| NE 8TH ST | 602 | $229.80 | Stopgap | 2016 |
| SE 2ND ST | 107 | $66,823.63 | Major Below Critical | 2016 |
| N OLIVE A* | 348 | $417.01 | Stopgap | 2016 |
| NW 5TH ST | 406 | $402.37 | Stopgap | 2016 |
| N WEST AVE | 365 | $136.99 | Stopgap | 2016 |

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|---|---|---|---|---|
| N CATHERI* | 286 | $125.44 | Stopgap | 2016 |
| N AIRPORT* | 648 | $83.98 | Stopgap | 2016 |
| N OLIVE A* | 177 | $191.09 | Stopgap | 2016 |
| NW 1ST ST | 441 | $162.52 | Stopgap | 2016 |
| W CENTER * | 481 | $104.99 | Stopgap | 2016 |
| NE 8TH ST | 157 | $1,274.80 | Stopgap | 2016 |
| SW 2ND ST | 464 | $770.53 | Stopgap | 2016 |
| ASHMONT RD | 660 | $75.70 | Stopgap | 2016 |
| SW 4TH ST | 470 | $159.75 | Stopgap | 2016 |
| S CHICAGO* | 34 | $1,699.75 | Stopgap | 2016 |
| N SUMMIT * | 189 | $313.34 | Stopgap | 2016 |
| CAMBRIDGE* | 209 | $171.11 | Stopgap | 2016 |
| NE 8TH ST | 668 | $77.30 | Stopgap | 2016 |
| N UNION A* | 554 | $143.28 | Stopgap | 2016 |
| N CHICAGO* | 361 | $120.19 | Stopgap | 2016 |
| N MAPLEWO* | 274 | $168.48 | Stopgap | 2016 |
| W CENTER * | 479 | $131.84 | Stopgap | 2016 |
| SE 1ST ST | 102 | $613.98 | Stopgap | 2016 |
| NW 1ST ST | 448 | $105.66 | Stopgap | 2016 |
| N SUMMIT * | 94 | $162.94 | Stopgap | 2016 |
| SW 2ND ST | 523 | $126.44 | Stopgap | 2016 |
| N UNION A* | 553 | $130.74 | Stopgap | 2016 |
| NE 8TH ST | 587 | $3,562.16 | Stopgap | 2016 |
| SE 4TH ST | 114 | $311.39 | Stopgap | 2016 |
| NE 8TH ST | 156 | $2,044.73 | Stopgap | 2016 |
| SE 1ST ST | 104 | $3,325.97 | Global MR | 2017 |
| S GRANT A* | 641 | $982.05 | Global MR | 2017 |
| S HARTH A* | 12 | $1,700.02 | Global MR | 2017 |
| NE 3RD ST | 551 | $2,216.92 | Global MR | 2017 |
| N PRAIRIE* | 280 | $1,986.83 | Global MR | 2017 |
| N PRAIRIE* | 93 | $1,761.53 | Global MR | 2017 |
| S LEE AVE | 25 | $2,320.00 | Global MR | 2017 |
| NE 5TH ST | 519 | $1,416.26 | Global MR | 2017 |
| N AIRPORT* | 651 | $1,924.90 | Global MR | 2017 |
| S LINCOLN* | 9 | $1,685.83 | Global MR | 2017 |
| S LEE AVE | 713 | $783.17 | Global MR | 2017 |
| N PRAIRIE* | 315 | $1,576.76 | Global MR | 2017 |
| AIRPORT CT | 631 | $1,461.45 | Global MR | 2017 |
| E CENTER * | 492 | $1,569.55 | Global MR | 2017 |
| NE 3RD ST | 548 | $2,127.72 | Global MR | 2017 |
| NE 1ST ST | 64 | $1,695.84 | Global MR | 2017 |

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|---|---|---|---|---|
| NE 3RD ST | 552 | $2,188.02 | Global MR | 2017 |
| S LEE AVE | 11 | $2,740.14 | Global MR | 2017 |
| SE 2ND ST | 106 | $1,407.94 | Global MR | 2017 |
| AIRPORT CT | 630 | $592.98 | Global MR | 2017 |
| NE 5TH ST | 513 | $283.89 | Global MR | 2017 |
| NE 5TH ST | 586 | $1,723.87 | Global MR | 2017 |
| N HARTH A* | 355 | $1,569.90 | Global MR | 2017 |
| AIRPORT CT | 720 | $1,865.66 | Global MR | 2017 |
| HAMPTON CT | 210 | $733.92 | Global MR | 2017 |
| S HARTH A* | 26 | $1,474.35 | Global MR | 2017 |
| SE 2ND ST | 111 | $1,512.38 | Global MR | 2017 |
| NE 4TH ST | 708 | $2,054.42 | Global MR | 2017 |
| AIRPORT CT | 249 | $1,865.66 | Global MR | 2017 |
| N LINCOLN* | 338 | $1,502.44 | Global MR | 2017 |
| NE 4TH ST | 509 | $1,329.50 | Global MR | 2017 |
| SE 1ST ST | 101 | $2,206.81 | Global MR | 2017 |
| SE 1ST ST | 110 | $2,103.16 | Global MR | 2017 |
| N OLIVE A* | 348 | $438.34 | Stopgap | 2017 |
| SE 1ST ST | 103 | $1,396.88 | Global MR | 2017 |
| NW 6TH ST | 395 | $431.44 | Stopgap | 2017 |
| SE 5TH ST | 120 | $123.04 | Stopgap | 2017 |
| NW 4TH ST | 411 | $126.49 | Stopgap | 2017 |
| NW 1ST ST | 440 | $168.25 | Stopgap | 2017 |
| N LIBERTY* | 555 | $133.94 | Stopgap | 2017 |
| NW 4TH ST | 414 | $116.69 | Stopgap | 2017 |
| N UNION A* | 381 | $144.76 | Stopgap | 2017 |
| SE 4TH ST | 203 | $167.24 | Stopgap | 2017 |
| SW 3RD ST | 472 | $412.10 | Stopgap | 2017 |
| N UNION A* | 328 | $435.61 | Stopgap | 2017 |
| N OLIVE A* | 276 | $160.41 | Stopgap | 2017 |
| CIRCLE DR | 707 | $1,512.43 | Stopgap | 2017 |
| N MAPLEWO* | 6 | $1,887.23 | Stopgap | 2017 |
| S CHICAGO* | 22 | $1,406.12 | Stopgap | 2017 |
| N LIBERTY* | 329 | $131.77 | Stopgap | 2017 |
| S EGAN AVE | 679 | $212.78 | Stopgap | 2017 |
| N LIBERTY* | 346 | $124.61 | Stopgap | 2017 |
| NE 8TH ST | 602 | $244.12 | Stopgap | 2017 |
| N CATHERI* | 286 | $131.71 | Stopgap | 2017 |
| N OLIVE A* | 177 | $216.96 | Stopgap | 2017 |
| NW 1ST ST | 441 | $186.01 | Stopgap | 2017 |
| NE 8TH ST | 141 | $112.45 | Stopgap | 2017 |

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|---|---|---|---|---|
| NE 8TH ST | 148 | $433.31 | Stopgap | 2017 |
| S EGAN AVE | 689 | $379.14 | Stopgap | 2017 |
| W CENTER * | 517 | $122.43 | Stopgap | 2017 |
| S LIBERTY* | 21 | $190.62 | Stopgap | 2017 |
| N MAPLEWO* | 386 | $132.40 | Stopgap | 2017 |
| NW 7TH ST | 388 | $118.43 | Stopgap | 2017 |
| N ROOSEVE* | 84 | $7,972.91 | Stopgap | 2017 |
| NW 7TH ST | 390 | $120.53 | Stopgap | 2017 |
| N HARTH A* | 620 | $330.38 | Stopgap | 2017 |
| N DIVISIO* | 206 | $325.69 | Stopgap | 2017 |
| NW 5TH ST | 564 | $128.76 | Stopgap | 2017 |
| S UNION A* | 36 | $124.15 | Stopgap | 2017 |
| N VAN EPS* | 356 | $127.34 | Stopgap | 2017 |
| N SUMMIT * | 282 | $416.76 | Stopgap | 2017 |
| W CENTER * | 483 | $184.36 | Stopgap | 2017 |
| W CENTER * | 482 | $110.55 | Stopgap | 2017 |
| N WEST AVE | 371 | $127.29 | Stopgap | 2017 |
| NW 7TH ST | 389 | $114.05 | Stopgap | 2017 |
| SE 8TH ST | 214 | $2,150.83 | Stopgap | 2017 |
| NE 8TH ST | 669 | $3,106.34 | Stopgap | 2017 |
| W CENTER * | 480 | $1,634.15 | Stopgap | 2017 |
| CIRCLE DR | 721 | $1,512.43 | Stopgap | 2017 |
| N CHICAGO* | 335 | $144.98 | Stopgap | 2017 |
| NE 5TH ST | 44 | $181.73 | Stopgap | 2017 |
| NW 4TH ST | 415 | $1,179.77 | Stopgap | 2017 |
| S LIBERTY* | 35 | $125.78 | Stopgap | 2017 |
| NE 6TH ST | 128 | $3,582.47 | Stopgap | 2017 |
| NE 8TH ST | 157 | $1,340.29 | Stopgap | 2017 |
| S JOSEPHI* | 15 | $136.10 | Stopgap | 2017 |
| N UNION A* | 333 | $147.93 | Stopgap | 2017 |
| S VAN EPS* | 72 | $176.64 | Stopgap | 2017 |
| N ROOSEVE* | 387 | $9,312.41 | Stopgap | 2017 |
| N LIBERTY* | 556 | $203.78 | Stopgap | 2017 |
| N OLIVE A* | 378 | $125.14 | Stopgap | 2017 |
| N WEST AVE | 370 | $128.94 | Stopgap | 2017 |
| NW 4TH ST | 413 | $324.89 | Stopgap | 2017 |
| N LIBERTY* | 380 | $136.16 | Stopgap | 2017 |
| N CATHERI* | 179 | $153.52 | Stopgap | 2017 |
| NE 7TH ST | 198 | $562.83 | Stopgap | 2017 |
| N JOSEPHI* | 327 | $131.15 | Stopgap | 2017 |
| TWIN OAKS* | 207 | $140.07 | Stopgap | 2017 |

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|---|---|---|---|---|
| SW 2ND ST | 465 | $1,702.74 | Stopgap | 2017 |
| NE 7TH ST | 199 | $149.85 | Stopgap | 2017 |
| NE 5TH ST | 585 | $3,223.08 | Global MR + Stopgap | 2017 |
| SE 2ND ST | 107 | $1,336.46 | Global MR | 2017 |
| NE 1ST ST | 65 | $1,623.29 | Global MR | 2017 |
| E CENTER * | 487 | $2,358.77 | Global MR | 2017 |
| N PRAIRIE* | 188 | $1,672.11 | Global MR | 2017 |
| CAMBRIDGE* | 209 | $1,557.94 | Global MR + Stopgap | 2017 |
| N WEST AVE | 365 | $143.84 | Stopgap | 2017 |
| N LINCOLN* | 352 | $1,963.14 | Global MR + Stopgap | 2017 |
| NE 1ST ST | 66 | $2,103.17 | Global MR | 2017 |
| N AIRPORT* | 648 | $1,180.25 | Global MR + Stopgap | 2017 |
| ASHMONT RD | 660 | $556.98 | Global MR + Stopgap | 2017 |
| S LINCOLN* | 23 | $2,041.78 | Global MR + Stopgap | 2017 |
| N HARTH A* | 341 | $1,816.28 | Global MR + Stopgap | 2017 |
| N AIRPORT* | 649 | $1,844.34 | Global MR + Stopgap | 2017 |
| NE 1ST ST | 63 | $6,711.89 | Global MR + Stopgap | 2017 |
| SE 1ST ST | 102 | $2,857.01 | Global MR + Stopgap | 2017 |
| N AIRPORT* | 362 | $1,460.65 | Global MR | 2017 |
| S LINCOLN* | 268 | $1,651.85 | Global MR | 2017 |
| CAMBRIDGE* | 211 | $286.83 | Global MR | 2017 |
| ASHMONT RD | 520 | $1,774.45 | Global MR | 2017 |
| N PRAIRIE* | 90 | $2,409.17 | Global MR | 2017 |
| E CENTER * | 491 | $1,891.62 | Global MR | 2017 |
| E CENTER * | 490 | $1,406.52 | Global MR | 2017 |
| E CENTER * | 489 | $2,208.42 | Global MR | 2017 |
| SE 1ST ST | 105 | $2,763.31 | Global MR | 2017 |
| SE 3RD ST | 127 | $2,168.76 | Global MR | 2017 |
| N AIRPORT* | 650 | $1,856.53 | Global MR | 2017 |
| N PRAIRIE* | 330 | $1,576.74 | Global MR | 2017 |
| S LINCOLN* | 269 | $782.28 | Global MR | 2017 |
| SE 2ND ST | 526 | $1,496.76 | Global MR | 2017 |
| E CENTER * | 493 | $1,490.20 | Global MR | 2017 |
| NE 1ST ST | 62 | $2,808.74 | Global MR + Stopgap | 2017 |

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|---|---|---|---|---|
| E CENTER * | 486 | $2,011.71 | Global MR | 2017 |
| N MAPLEWO* | 274 | $177.07 | Stopgap | 2017 |
| SE 3RD ST | 126 | $1,513.96 | Global MR + Stopgap | 2017 |
| NW 1ST ST | 448 | $117.95 | Stopgap | 2017 |
| N SUMMIT * | 94 | $192.15 | Stopgap | 2017 |
| SW 2ND ST | 523 | $132.76 | Stopgap | 2017 |
| HEATHERWO* | 700 | $85.46 | Stopgap | 2017 |
| N UNION A* | 553 | $137.27 | Stopgap | 2017 |
| SW 2ND ST | 464 | $1,006.51 | Stopgap | 2017 |
| NW 5TH ST | 406 | $422.90 | Stopgap | 2017 |
| N CHICAGO* | 361 | $126.20 | Stopgap | 2017 |
| N UNION A* | 554 | $150.45 | Stopgap | 2017 |
| NW 9TH ST | 572 | $214.99 | Stopgap | 2017 |
| N VAN EPS* | 342 | $236.96 | Stopgap | 2017 |
| S VAN EPS* | 13 | $170.66 | Stopgap | 2017 |
| NE 5TH ST | 155 | $207.42 | Stopgap | 2017 |
| NE 11TH ST | 135 | $113.83 | Stopgap | 2017 |
| NW 5TH ST | 399 | $110.16 | Stopgap | 2017 |
| NE 9TH ST | 138 | $109.08 | Stopgap | 2017 |
| E CENTER * | 488 | $2,194.34 | Global MR | 2017 |
| N LEE AVE | 340 | $2,584.55 | Global MR + Stopgap | 2017 |
| N LEE AVE | 354 | $2,726.07 | Global MR + Stopgap | 2017 |
| S BLANCHE* | 71 | $123.54 | Stopgap | 2017 |
| NE 8TH ST | 587 | $3,743.73 | Stopgap | 2017 |
| W CENTER * | 479 | $138.43 | Stopgap | 2017 |
| SW 4TH ST | 470 | $184.96 | Stopgap | 2017 |
| N AIRPORT* | 644 | $1,563.79 | Global MR + Stopgap | 2017 |
| S CHICAGO* | 34 | $1,958.71 | Stopgap | 2017 |
| N SUMMIT * | 189 | $336.06 | Stopgap | 2017 |
| N LEE AVE | 384 | $166.37 | Stopgap | 2017 |
| NE 9TH ST | 702 | $90.30 | Stopgap | 2017 |
| NE 8TH ST | 668 | $81.21 | Stopgap | 2017 |
| SE 4TH ST | 114 | $346.02 | Stopgap | 2017 |
| NW 5TH ST | 404 | $1,405.90 | Stopgap | 2017 |
| SE 4TH ST | 117 | $102.83 | Stopgap | 2017 |
| NW 4TH ST | 410 | $204.29 | Stopgap | 2017 |
| N OLIVE A* | 336 | $432.09 | Stopgap | 2017 |
| N LIBERTY* | 334 | $143.86 | Stopgap | 2017 |
| NW 1ST ST | 444 | $111.33 | Stopgap | 2017 |

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|---|---|---|---|---|
| NW 5TH ST | 401 | $124.33 | Stopgap | 2017 |
| NE 8TH ST | 156 | $2,318.37 | Stopgap | 2017 |
| N HARTH A* | 583 | $260.26 | Stopgap | 2017 |
| W CENTER * | 481 | $110.24 | Stopgap | 2017 |
| S JOSEPHI* | 38 | $168.56 | Stopgap | 2017 |
| NW 6TH ST | 398 | $149.21 | Stopgap | 2017 |
| NE 5TH ST | 154 | $201.02 | Stopgap | 2017 |
| N LEE AVE | 99 | $222.51 | Stopgap | 2017 |
| SW 4TH ST | 300 | $1,628.59 | Global MR | 2018 |
| SW 7TH ST | 242 | $1,966.23 | Global MR | 2018 |
| S EGAN AVE | 688 | $1,829.95 | Global MR | 2018 |
| S EGAN AVE | 498 | $3,477.77 | Global MR | 2018 |
| SW 1ST ST | 604 | $2,406.85 | Global MR | 2018 |
| S UNION A* | 233 | $1,897.66 | Global MR | 2018 |
| S LEE AVE | 263 | $1,331.02 | Global MR | 2018 |
| SW 7TH ST | 239 | $1,641.96 | Global MR | 2018 |
| SW 7TH ST | 241 | $1,436.90 | Global MR | 2018 |
| N EGAN AVE | 500 | $3,266.28 | Global MR | 2018 |
| SW 1ST ST | 292 | $1,465.81 | Global MR | 2018 |
| SW 1ST ST | 605 | $2,644.95 | Global MR | 2018 |
| S EGAN AVE | 495 | $3,155.36 | Global MR | 2018 |
| S HARTH A* | 265 | $2,328.89 | Global MR | 2018 |
| S UNION A* | 77 | $1,455.27 | Global MR | 2018 |
| SE 3RD ST | 123 | $1,459.45 | Global MR | 2018 |
| SE 4TH ST | 202 | $2,326.79 | Global MR | 2018 |
| S HARTH A* | 264 | $1,392.88 | Global MR | 2018 |
| SE 4TH ST | 119 | $1,514.67 | Global MR | 2018 |
| SE 5TH ST | 121 | $1,479.79 | Global MR | 2018 |
| SE 4TH ST | 116 | $1,487.04 | Global MR | 2018 |
| SW 4TH ST | 297 | $1,409.80 | Global MR | 2018 |
| SW 8TH ST | 477 | $1,669.04 | Global MR | 2018 |
| SE 9TH ST | 216 | $1,424.91 | Global MR | 2018 |
| S EGAN AVE | 678 | $1,467.80 | Global MR | 2018 |
| SE 9TH ST | 217 | $1,884.07 | Global MR | 2018 |
| SW 8TH ST | 474 | $1,102.70 | Global MR | 2018 |
| SW 7TH ST | 240 | $1,553.73 | Global MR | 2018 |
| S UNION A* | 687 | $1,781.89 | Global MR | 2018 |
| S EGAN AVE | 690 | $1,419.92 | Global MR | 2018 |
| SW 8TH ST | 230 | $1,692.18 | Global MR | 2018 |
| S UNION A* | 676 | $1,385.95 | Global MR | 2018 |
| SW 4TH ST | 299 | $1,545.44 | Global MR | 2018 |

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|---|---|---|---|---|
| SILVER CR* | 642 | $2,558.40 | Global MR | 2018 |
| RAMM HEIG* | 522 | $5,123.96 | Global MR | 2018 |
| S EGAN AVE | 497 | $1,467.77 | Global MR | 2018 |
| SW 4TH ST | 294 | $1,437.23 | Global MR | 2018 |
| SW 1ST ST | 293 | $1,786.72 | Global MR | 2018 |
| SE 3RD ST | 125 | $1,314.15 | Global MR | 2018 |
| S LEE AVE | 266 | $2,348.12 | Global MR | 2018 |
| SE 3RD ST | 124 | $1,534.73 | Global MR | 2018 |
| SW 8TH ST | 231 | $1,752.42 | Global MR | 2018 |
| SW 1ST ST | 476 | $1,314.95 | Global MR | 2018 |
| SW 7TH ST | 238 | $1,670.97 | Global MR | 2018 |
| SE 4TH ST | 115 | $2,201.26 | Global MR | 2018 |
| S UNION A* | 686 | $1,529.22 | Global MR | 2018 |
| S EGAN AVE | 677 | $1,379.16 | Global MR | 2018 |
| S EGAN AVE | 496 | $3,470.64 | Global MR | 2018 |
| SW 7TH ST | 237 | $2,480.63 | Global MR | 2018 |
| SE 4TH ST | 118 | $1,491.57 | Global MR | 2018 |
| S EGAN AVE | 679 | $1,997.25 | Global MR + Stopgap | 2018 |
| S UNION A* | 685 | $1,365.67 | Global MR | 2018 |
| N SUMMIT * | 89 | $202.61 | Stopgap | 2018 |
| NE 7TH ST | 198 | $771.30 | Stopgap | 2018 |
| N DIVISIO* | 206 | $344.65 | Stopgap | 2018 |
| S JOSEPHI* | 15 | $160.83 | Stopgap | 2018 |
| N UNION A* | 333 | $177.85 | Stopgap | 2018 |
| N HARTH A* | 341 | $254.36 | Stopgap | 2018 |
| N BLANCHE* | 557 | $131.95 | Stopgap | 2018 |
| N VAN EPS* | 356 | $143.27 | Stopgap | 2018 |
| N LIBERTY* | 556 | $236.25 | Stopgap | 2018 |
| N LIBERTY* | 329 | $143.37 | Stopgap | 2018 |
| NE 7TH ST | 199 | $173.83 | Stopgap | 2018 |
| N WEST AVE | 370 | $140.29 | Stopgap | 2018 |
| NE 6TH ST | 128 | $4,095.72 | Stopgap | 2018 |
| N LIBERTY* | 380 | $148.15 | Stopgap | 2018 |
| N AIRPORT* | 649 | $144.68 | Stopgap | 2018 |
| SE 5TH ST | 120 | $1,653.04 | Global MR + Stopgap | 2018 |
| S VAN EPS* | 72 | $185.47 | Stopgap | 2018 |
| N LIBERTY* | 555 | $140.64 | Stopgap | 2018 |
| N HARTH A* | 620 | $373.63 | Stopgap | 2018 |
| SW 3RD ST | 472 | $476.65 | Stopgap | 2018 |
| S LIBERTY* | 21 | $218.92 | Stopgap | 2018 |

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|---|---|---|---|---|
| N EGAN AVE | 653 | $266.40 | Stopgap | 2018 |
| NE 8TH ST | 149 | $112.10 | Stopgap | 2018 |
| NW 4TH ST | 411 | $154.79 | Stopgap | 2018 |
| NW 4TH ST | 413 | $352.97 | Stopgap | 2018 |
| NW 1ST ST | 440 | $176.66 | Stopgap | 2018 |
| N JOSEPHI* | 327 | $137.71 | Stopgap | 2018 |
| NW 4TH ST | 414 | $139.89 | Stopgap | 2018 |
| NW 6TH ST | 395 | $522.34 | Stopgap | 2018 |
| N UNION A* | 328 | $490.69 | Stopgap | 2018 |
| N OLIVE A* | 276 | $168.43 | Stopgap | 2018 |
| N MAPLEWO* | 6 | $1,985.80 | Stopgap | 2018 |
| S CHICAGO* | 22 | $1,481.00 | Stopgap | 2018 |
| S LINCOLN* | 23 | $448.89 | Stopgap | 2018 |
| N LEE AVE | 340 | $349.02 | Stopgap | 2018 |
| N CATHERI* | 179 | $183.06 | Stopgap | 2018 |
| N AIRPORT* | 644 | $122.67 | Stopgap | 2018 |
| NE 5TH ST | 154 | $222.62 | Stopgap | 2018 |
| NW 6TH ST | 398 | $168.74 | Stopgap | 2018 |
| S JOSEPHI* | 38 | $197.02 | Stopgap | 2018 |
| NE 1ST ST | 62 | $666.50 | Stopgap | 2018 |
| NE 11TH ST | 135 | $119.53 | Stopgap | 2018 |
| N CHICAGO* | 332 | $137.71 | Stopgap | 2018 |
| SE 3RD ST | 126 | $118.76 | Stopgap | 2018 |
| N HARTH A* | 583 | $281.76 | Stopgap | 2018 |
| NW 5TH ST | 401 | $146.92 | Stopgap | 2018 |
| N LEE AVE | 354 | $389.24 | Stopgap | 2018 |
| N OLIVE A* | 336 | $453.70 | Stopgap | 2018 |
| NW 1ST ST | 444 | $131.56 | Stopgap | 2018 |
| N LEE AVE | 99 | $262.77 | Stopgap | 2018 |
| W CENTER * | 481 | $115.76 | Stopgap | 2018 |
| N WEST AVE | 371 | $138.50 | Stopgap | 2018 |
| TWIN OAKS* | 207 | $162.38 | Stopgap | 2018 |
| NE 1ST ST | 63 | $5,841.99 | Stopgap | 2018 |
| SW 2ND ST | 465 | $1,952.32 | Stopgap | 2018 |
| W CENTER * | 480 | $1,717.96 | Stopgap | 2018 |
| N OLIVE A* | 378 | $147.88 | Stopgap | 2018 |
| N SUMMIT * | 282 | $452.79 | Stopgap | 2018 |
| NW 4TH ST | 410 | $239.89 | Stopgap | 2018 |
| W CENTER * | 482 | $116.07 | Stopgap | 2018 |
| N MAPLEWO* | 386 | $139.02 | Stopgap | 2018 |
| NW 7TH ST | 389 | $128.77 | Stopgap | 2018 |

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|---|---|---|---|---|
| N WEST AVE | 369 | $168.39 | Stopgap | 2018 |
| S LIBERTY* | 35 | $153.90 | Stopgap | 2018 |
| S UNION A* | 36 | $140.29 | Stopgap | 2018 |
| N CHICAGO* | 335 | $171.33 | Stopgap | 2018 |
| NE 5TH ST | 44 | $205.58 | Stopgap | 2018 |
| W CENTER * | 483 | $204.59 | Stopgap | 2018 |
| CAMBRIDGE* | 209 | $173.80 | Stopgap | 2018 |
| NW 7TH ST | 390 | $145.40 | Stopgap | 2018 |
| S BLANCHE* | 71 | $129.72 | Stopgap | 2018 |
| N CATHERI* | 319 | $128.46 | Stopgap | 2018 |
| NW 5TH ST | 404 | $1,640.18 | Stopgap | 2018 |
| SW 4TH ST | 470 | $211.86 | Stopgap | 2018 |
| NE 9TH ST | 138 | $114.53 | Stopgap | 2018 |
| CIRCLE DR | 721 | $22,735.88 | Major Below Critical | 2018 |
| N SUMMIT * | 189 | $358.68 | Stopgap | 2018 |
| NE 8TH ST | 669 | $50,405.98 | Major Below Critical | 2018 |
| N LEE AVE | 384 | $192.04 | Stopgap | 2018 |
| NE 9TH ST | 702 | $94.81 | Stopgap | 2018 |
| NE 8TH ST | 668 | $85.37 | Stopgap | 2018 |
| NE 6TH ST | 150 | $107.16 | Stopgap | 2018 |
| N CHICAGO* | 361 | $137.43 | Stopgap | 2018 |
| SW 2ND ST | 464 | $1,256.03 | Stopgap | 2018 |
| S CHICAGO* | 34 | $2,245.82 | Stopgap | 2018 |
| SE 4TH ST | 117 | $1,395.26 | Global MR + Stopgap | 2018 |
| SW 4TH ST | 475 | $2,063.53 | Global MR | 2018 |
| SE 4TH ST | 114 | $2,630.75 | Global MR + Stopgap | 2018 |
| S EGAN AVE | 689 | $2,233.33 | Global MR + Stopgap | 2018 |
| N EGAN AVE | 499 | $3,436.30 | Global MR + Stopgap | 2018 |
| NW 4TH ST | 415 | $1,242.60 | Stopgap | 2018 |
| NE 8TH ST | 156 | $71,117.73 | Major Below Critical | 2018 |
| SE 8TH ST | 214 | $4,193.36 | Global MR + Stopgap | 2018 |
| NW 1ST ST | 448 | $141.39 | Stopgap | 2018 |
| N LIBERTY* | 186 | $31,522.48 | Major Above Critical | 2018 |
| NE 8TH ST | 587 | $72,085.33 | Major Below Critical | 2018 |
| NE 8TH ST | 157 | $68,683.16 | Major Below Critical | 2018 |
| N ROOSEVE* | 84 | $104,610.61 | Major Below Critical | 2018 |
| CIRCLE DR | 707 | $22,735.88 | Major Below Critical | 2018 |
| N ROOSEVE* | 387 | $122,185.75 | Major Below Critical | 2018 |

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|---|---|---|---|---|
| SE 4TH ST | 203 | $2,246.94 | Global MR + Stopgap | 2018 |
| NE 8TH ST | 141 | $133.00 | Stopgap | 2018 |
| NW 7TH ST | 213 | $122.78 | Stopgap | 2018 |
| N OLIVE A* | 348 | $460.76 | Stopgap | 2018 |
| N UNION A* | 381 | $173.52 | Stopgap | 2018 |
| N WEST AVE | 365 | $156.51 | Stopgap | 2018 |
| N CATHERI* | 286 | $148.71 | Stopgap | 2018 |
| N AIRPORT* | 648 | $92.58 | Stopgap | 2018 |
| W CENTER * | 479 | $145.35 | Stopgap | 2018 |
| NW 1ST ST | 441 | $210.42 | Stopgap | 2018 |
| N LINCOLN* | 283 | $167.27 | Stopgap | 2018 |
| NE 8TH ST | 148 | $455.20 | Stopgap | 2018 |
| NW 5TH ST | 564 | $135.20 | Stopgap | 2018 |
| ASHMONT RD | 660 | $78.00 | Stopgap | 2018 |
| W CENTER * | 517 | $128.55 | Stopgap | 2018 |
| N LIBERTY* | 346 | $135.70 | Stopgap | 2018 |
| S EGAN AVE | 494 | $3,111.18 | Global MR | 2018 |
| N OLIVE A* | 177 | $243.80 | Stopgap | 2018 |
| N MAPLEWO* | 274 | $216.65 | Stopgap | 2018 |
| NW 7TH ST | 388 | $144.93 | Stopgap | 2018 |
| N SUMMIT * | 94 | $222.75 | Stopgap | 2018 |
| SW 2ND ST | 523 | $144.58 | Stopgap | 2018 |
| HEATHERWO* | 700 | $89.73 | Stopgap | 2018 |
| N UNION A* | 553 | $149.36 | Stopgap | 2018 |
| CEDAR CT | 504 | $52.69 | Stopgap | 2018 |
| NE 8TH ST | 602 | $258.33 | Stopgap | 2018 |
| NW 5TH ST | 406 | $444.48 | Stopgap | 2018 |
| NE 5TH ST | 585 | $1,664.63 | Stopgap | 2018 |
| N UNION A* | 554 | $177.79 | Stopgap | 2018 |
| NW 9TH ST | 572 | $238.36 | Stopgap | 2018 |
| N VAN EPS* | 342 | $270.01 | Stopgap | 2018 |
| N LINCOLN* | 352 | $386.38 | Stopgap | 2018 |
| S VAN EPS* | 13 | $198.02 | Stopgap | 2018 |
| NE 5TH ST | 155 | $229.70 | Stopgap | 2018 |
| SE 1ST ST | 102 | $677.96 | Stopgap | 2018 |
| NW 5TH ST | 399 | $115.67 | Stopgap | 2018 |
| N LIBERTY* | 334 | $170.00 | Stopgap | 2018 |
| NE 4TH ST | 48 | $1,306.87 | Global MR | 2019 |
| TWIN OAKS* | 672 | $2,022.59 | Global MR | 2019 |
| NE 10TH ST | 544 | $1,660.95 | Global MR | 2019 |
| NE 8TH ST | 587 | $1,441.70 | Global MR | 2019 |

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|---|---|---|---|---|
| N DIVISIO* | 326 | $1,542.62 | Global MR | 2019 |
| NE 7TH ST | 705 | $186.26 | Global MR | 2019 |
| NE JENNIF* | 532 | $2,238.11 | Global MR | 2019 |
| N DIVISIO* | 247 | $1,994.68 | Global MR | 2019 |
| NE 11TH ST | 671 | $1,016.99 | Global MR | 2019 |
| NE 9TH ST | 662 | $1,753.93 | Global MR | 2019 |
| NE 9TH ST | 137 | $1,394.90 | Global MR | 2019 |
| NE 8TH ST | 696 | $2,133.51 | Global MR | 2019 |
| NE 9TH ST | 139 | $1,439.08 | Global MR | 2019 |
| SE 12TH ST | 637 | $2,976.33 | Global MR | 2019 |
| N DIVISIO* | 545 | $1,535.78 | Global MR | 2019 |
| CIRCLE DR | 707 | $454.72 | Global MR | 2019 |
| NE 9TH ST | 661 | $1,892.73 | Global MR | 2019 |
| NE 11TH ST | 694 | $1,652.85 | Global MR | 2019 |
| N ROOSEVE* | 387 | $2,443.70 | Global MR | 2019 |
| N DIVISIO* | 311 | $1,433.22 | Global MR | 2019 |
| N DIVISIO* | 97 | $1,535.81 | Global MR | 2019 |
| NE 9TH ST | 132 | $1,643.28 | Global MR | 2019 |
| TWIN OAKS* | 201 | $2,242.05 | Global MR | 2019 |
| N DIVISIO* | 725 | $816.03 | Global MR | 2019 |
| NE 9TH ST | 666 | $1,737.43 | Global MR | 2019 |
| HERITAGE * | 542 | $1,537.98 | Global MR | 2019 |
| HERITAGE * | 131 | $2,151.12 | Global MR | 2019 |
| NE 9TH ST | 703 | $390.97 | Global MR | 2019 |
| NE 9TH ST | 543 | $1,652.34 | Global MR | 2019 |
| E MAPLEWO* | 144 | $1,967.47 | Global MR | 2019 |
| INDUSTRY | 719 | $2,547.98 | Global MR | 2019 |
| NE 9TH ST | 667 | $995.64 | Global MR | 2019 |
| NE 8TH ST | 533 | $2,247.97 | Global MR | 2019 |
| NE 11TH ST | 695 | $924.85 | Global MR | 2019 |
| N DIVISIO* | 278 | $1,501.67 | Global MR | 2019 |
| CIRCLE DR | 706 | $429.54 | Global MR | 2019 |
| NE 8TH ST | 157 | $1,373.66 | Global MR | 2019 |
| N ANTELOP* | 528 | $1,501.44 | Global MR | 2019 |
| N ROOSEVE* | 313 | $1,590.41 | Global MR | 2019 |
| NE 11TH ST | 133 | $1,515.84 | Global MR | 2019 |
| N ROOSEVE* | 208 | $1,891.13 | Global MR | 2019 |
| N ROOSEVE* | 84 | $2,092.20 | Global MR | 2019 |
| HEATHERWO* | 673 | $1,239.24 | Global MR | 2019 |
| NE 8TH ST | 130 | $982.58 | Global MR | 2019 |
| INDUSTRY | 638 | $1,851.55 | Global MR | 2019 |

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|---|---|---|---|---|
| N CATHERI* | 286 | $179.76 | Stopgap | 2019 |
| N DIVISIO* | 250 | $1,344.69 | Global MR | 2019 |
| N LEE AVE | 581 | $94.87 | Stopgap | 2019 |
| NW 7TH ST | 568 | $136.48 | Stopgap | 2019 |
| NE 8TH ST | 149 | $117.71 | Stopgap | 2019 |
| NW 4TH ST | 411 | $184.95 | Stopgap | 2019 |
| S LINCOLN* | 23 | $499.75 | Stopgap | 2019 |
| NW 1ST ST | 440 | $204.11 | Stopgap | 2019 |
| NE 8TH ST | 147 | $121.82 | Stopgap | 2019 |
| NW 4TH ST | 414 | $164.45 | Stopgap | 2019 |
| S LIBERTY* | 21 | $248.47 | Stopgap | 2019 |
| S EGAN AVE | 679 | $273.35 | Stopgap | 2019 |
| NW 6TH ST | 395 | $760.96 | Stopgap | 2019 |
| NE 8TH ST | 140 | $123.65 | Stopgap | 2019 |
| N UNION A* | 328 | $549.10 | Stopgap | 2019 |
| N OLIVE A* | 276 | $176.85 | Stopgap | 2019 |
| N WEST AVE | 365 | $188.35 | Stopgap | 2019 |
| N LIBERTY* | 555 | $162.35 | Stopgap | 2019 |
| N LIBERTY* | 346 | $163.30 | Stopgap | 2019 |
| N UNION A* | 381 | $203.96 | Stopgap | 2019 |
| N AIRPORT* | 648 | $97.21 | Stopgap | 2019 |
| N OLIVE A* | 177 | $271.18 | Stopgap | 2019 |
| NW 1ST ST | 441 | $235.47 | Stopgap | 2019 |
| NE 8TH ST | 148 | $478.19 | Stopgap | 2019 |
| NW 5TH ST | 564 | $155.02 | Stopgap | 2019 |
| S EGAN AVE | 689 | $361.11 | Stopgap | 2019 |
| W CENTER * | 517 | $151.91 | Stopgap | 2019 |
| N EGAN AVE | 653 | $279.72 | Stopgap | 2019 |
| NW 7TH ST | 388 | $173.17 | Stopgap | 2019 |
| NW 7TH ST | 390 | $172.13 | Stopgap | 2019 |
| N HARTH A* | 620 | $417.18 | Stopgap | 2019 |
| N CATHERI* | 4 | $145.82 | Stopgap | 2019 |
| SW 3RD ST | 472 | $545.47 | Stopgap | 2019 |
| N WEST AVE | 723 | $148.12 | Stopgap | 2019 |
| ASHMONT RD | 660 | $87.63 | Stopgap | 2019 |
| NW 7TH ST | 389 | $155.66 | Stopgap | 2019 |
| SW 2ND ST | 465 | $2,222.49 | Stopgap | 2019 |
| W CENTER * | 480 | $1,803.86 | Stopgap | 2019 |
| SE 8TH ST | 214 | $2,009.56 | Stopgap | 2019 |
| N OLIVE A* | 378 | $175.66 | Stopgap | 2019 |
| W CENTER * | 483 | $225.71 | Stopgap | 2019 |

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|---|---|---|---|---|
| S CHICAGO* | 22 | $1,559.71 | Stopgap | 2019 |
| N WEST AVE | 371 | $166.69 | Stopgap | 2019 |
| N CATHERI* | 179 | $214.39 | Stopgap | 2019 |
| N WEST AVE | 369 | $176.81 | Stopgap | 2019 |
| S LIBERTY* | 35 | $183.87 | Stopgap | 2019 |
| SW 1ST ST | 460 | $171.52 | Stopgap | 2019 |
| S UNION A* | 36 | $169.57 | Stopgap | 2019 |
| W CENTER * | 482 | $121.88 | Stopgap | 2019 |
| N LIBERTY* | 556 | $270.04 | Stopgap | 2019 |
| N LIBERTY* | 329 | $172.54 | Stopgap | 2019 |
| N VAN EPS* | 356 | $168.57 | Stopgap | 2019 |
| NW 4TH ST | 413 | $380.79 | Stopgap | 2019 |
| S JOSEPHI* | 15 | $191.05 | Stopgap | 2019 |
| N UNION A* | 333 | $209.38 | Stopgap | 2019 |
| N HARTH A* | 341 | $285.76 | Stopgap | 2019 |
| NE 1ST ST | 63 | $6,134.09 | Stopgap | 2019 |
| S VAN EPS* | 72 | $194.74 | Stopgap | 2019 |
| N JOSEPHI* | 327 | $144.60 | Stopgap | 2019 |
| N WEST AVE | 370 | $168.84 | Stopgap | 2019 |
| W CENTER * | 478 | $245.25 | Stopgap | 2019 |
| NE 6TH ST | 128 | $4,655.28 | Stopgap | 2019 |
| N LIBERTY* | 380 | $178.29 | Stopgap | 2019 |
| N AIRPORT* | 649 | $151.91 | Stopgap | 2019 |
| N OLIVE A* | 348 | $484.32 | Stopgap | 2019 |
| N BLANCHE* | 557 | $138.55 | Stopgap | 2019 |
| NE 7TH ST | 199 | $1,468.25 | Global MR + Stopgap | 2019 |
| NE 8TH ST | 602 | $1,291.02 | Global MR + Stopgap | 2019 |
| NE 7TH ST | 158 | $1,546.76 | Global MR + Stopgap | 2019 |
| NE 8TH ST | 141 | $1,550.70 | Global MR + Stopgap | 2019 |
| N MAPLEWO* | 386 | $1,785.85 | Global MR + Stopgap | 2019 |
| N MAPLEWO* | 6 | $3,616.43 | Global MR + Stopgap | 2019 |
| S BLANCHE* | 71 | $136.21 | Stopgap | 2019 |
| N SUMMIT * | 89 | $2,602.67 | Global MR + Stopgap | 2019 |
| N SUMMIT * | 94 | $2,042.80 | Global MR + Stopgap | 2019 |
| NE 7TH ST | 198 | $2,258.02 | Global MR + Stopgap | 2019 |

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|---|---|---|---|---|
| NE 7TH ST | 159 | $1,462.26 | Global MR + Stopgap | 2019 |
| TWIN OAKS* | 207 | $1,489.13 | Global MR + Stopgap | 2019 |
| N SUMMIT * | 282 | $2,435.21 | Global MR + Stopgap | 2019 |
| N MAPLEWO* | 85 | $914.53 | Global MR + Stopgap | 2019 |
| N EGAN AVE | 654 | $147.45 | Stopgap | 2019 |
| N DIVISIO* | 206 | $1,722.41 | Global MR + Stopgap | 2019 |
| SE 12TH ST | 639 | $4,333.79 | Global MR | 2019 |
| NE 8TH ST | 669 | $1,008.11 | Global MR | 2019 |
| N DIVISIO* | 546 | $1,570.08 | Global MR | 2019 |
| CIRCLE DR | 721 | $454.72 | Global MR | 2019 |
| NE 11TH ST | 670 | $1,861.88 | Global MR | 2019 |
| NE 11TH ST | 200 | $1,654.40 | Global MR | 2019 |
| N MAPLEWO* | 7 | $1,542.74 | Global MR | 2019 |
| N MAPLEWO* | 274 | $2,449.85 | Global MR + Stopgap | 2019 |
| N SUMMIT * | 88 | $3,078.18 | Global MR | 2019 |
| HEATHERWO* | 700 | $1,152.69 | Global MR + Stopgap | 2019 |
| NE 11TH ST | 134 | $1,465.58 | Global MR + Stopgap | 2019 |
| NE 9TH ST | 138 | $1,471.26 | Global MR + Stopgap | 2019 |
| NE 9TH ST | 702 | $1,217.89 | Global MR + Stopgap | 2019 |
| NE 8TH ST | 668 | $402.87 | Global MR + Stopgap | 2019 |
| N ANTELOP* | 253 | $1,627.92 | Global MR + Stopgap | 2019 |
| N CATHERI* | 319 | $134.88 | Stopgap | 2019 |
| NE 8TH ST | 156 | $1,422.35 | Global MR | 2019 |
| N LINCOLN* | 352 | $413.67 | Stopgap | 2019 |
| CEDAR CT | 504 | $55.32 | Stopgap | 2019 |
| NW 5TH ST | 399 | $132.63 | Stopgap | 2019 |
| NW 5TH ST | 406 | $467.27 | Stopgap | 2019 |
| N UNION A* | 554 | $211.19 | Stopgap | 2019 |
| NW 9TH ST | 572 | $266.06 | Stopgap | 2019 |
| NE 11TH ST | 135 | $1,535.37 | Global MR + Stopgap | 2019 |
| N VAN EPS* | 342 | $304.52 | Stopgap | 2019 |
| NW 1ST ST | 448 | $166.19 | Stopgap | 2019 |
| N HARTH A* | 584 | $182.29 | Stopgap | 2019 |

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|---|---|---|---|---|
| S VAN EPS* | 13 | $226.67 | Stopgap | 2019 |
| NE 5TH ST | 155 | $258.07 | Stopgap | 2019 |
| N LINCOLN* | 283 | $175.63 | Stopgap | 2019 |
| NE 5TH ST | 585 | $1,752.59 | Stopgap | 2019 |
| NW 7TH ST | 213 | $128.92 | Stopgap | 2019 |
| NW 5TH ST | 400 | $148.73 | Stopgap | 2019 |
| SE 4TH ST | 114 | $360.47 | Stopgap | 2019 |
| NW 5TH ST | 404 | $1,890.47 | Stopgap | 2019 |
| SW 4TH ST | 470 | $240.29 | Stopgap | 2019 |
| S CHICAGO* | 34 | $2,556.61 | Stopgap | 2019 |
| N SUMMIT * | 189 | $381.28 | Stopgap | 2019 |
| CAMBRIDGE* | 209 | $198.08 | Stopgap | 2019 |
| N LEE AVE | 384 | $218.86 | Stopgap | 2019 |
| N UNION A* | 553 | $179.76 | Stopgap | 2019 |
| N HARTH A* | 355 | $139.75 | Stopgap | 2019 |
| SW 2ND ST | 523 | $173.98 | Stopgap | 2019 |
| NE 6TH ST | 150 | $112.51 | Stopgap | 2019 |
| N CHICAGO* | 361 | $165.38 | Stopgap | 2019 |
| SW 2ND ST | 464 | $1,519.43 | Stopgap | 2019 |
| W CENTER * | 479 | $171.77 | Stopgap | 2019 |
| SE 1ST ST | 102 | $712.22 | Stopgap | 2019 |
| REGENCY DR | 514 | $976.95 | Global MR | 2019 |
| N EGAN AVE | 737 | $145.53 | Stopgap | 2019 |
| N CHICAGO* | 335 | $203.51 | Stopgap | 2019 |
| N OLIVE A* | 336 | $476.38 | Stopgap | 2019 |
| NE 5TH ST | 44 | $230.29 | Stopgap | 2019 |
| NW 8TH ST | 635 | $135.89 | Stopgap | 2019 |
| NW 1ST ST | 444 | $156.28 | Stopgap | 2019 |
| N LEE AVE | 354 | $434.05 | Stopgap | 2019 |
| NW 5TH ST | 401 | $174.52 | Stopgap | 2019 |
| N HARTH A* | 583 | $303.91 | Stopgap | 2019 |
| N LEE AVE | 340 | $386.20 | Stopgap | 2019 |
| N CHICAGO* | 332 | $144.60 | Stopgap | 2019 |
| N HARTH A* | 618 | $111.80 | Stopgap | 2019 |
| W CENTER * | 481 | $136.79 | Stopgap | 2019 |
| N LIBERTY* | 334 | $201.94 | Stopgap | 2019 |
| N LEE AVE | 99 | $305.14 | Stopgap | 2019 |
| NE 1ST ST | 62 | $700.19 | Stopgap | 2019 |
| SE 3RD ST | 126 | $124.70 | Stopgap | 2019 |
| NW 4TH ST | 415 | $1,308.64 | Stopgap | 2019 |
| NW 4TH ST | 410 | $278.26 | Stopgap | 2019 |

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|---|---|---|---|---|
| SE 4TH ST | 117 | $113.37 | Stopgap | 2019 |
| N AIRPORT* | 644 | $128.80 | Stopgap | 2019 |
| NE 5TH ST | 154 | $250.11 | Stopgap | 2019 |
| NW 6TH ST | 398 | $188.41 | Stopgap | 2019 |
| S JOSEPHI* | 38 | $227.54 | Stopgap | 2019 |
| NE 8TH ST | 602 | $287.29 | Stopgap | 2020 |
| N OLIVE A* | 177 | $299.57 | Stopgap | 2020 |
| N AIRPORT* | 648 | $102.07 | Stopgap | 2020 |
| N EGAN AVE | 654 | $154.82 | Stopgap | 2020 |
| N CATHERI* | 286 | $213.12 | Stopgap | 2020 |
| N WEST AVE | 365 | $222.22 | Stopgap | 2020 |
| N UNION A* | 381 | $235.69 | Stopgap | 2020 |
| NW 1ST ST | 442 | $49,403.13 | Major Above Critical | 2020 |
| NW 7TH ST | 213 | $135.36 | Stopgap | 2020 |
| NE 8TH ST | 148 | $502.10 | Stopgap | 2020 |
| NE 5TH ST | 155 | $292.42 | Stopgap | 2020 |
| S VAN EPS* | 13 | $256.44 | Stopgap | 2020 |
| N HARTH A* | 584 | $191.40 | Stopgap | 2020 |
| N LINCOLN* | 352 | $441.04 | Stopgap | 2020 |
| N VAN EPS* | 342 | $340.67 | Stopgap | 2020 |
| NW 5TH ST | 400 | $156.17 | Stopgap | 2020 |
| N OLIVE A* | 348 | $509.23 | Stopgap | 2020 |
| NW 7TH ST | 390 | $200.56 | Stopgap | 2020 |
| SE 5TH ST | 120 | $142.43 | Stopgap | 2020 |
| NE 8TH ST | 149 | $123.59 | Stopgap | 2020 |
| NW 7TH ST | 568 | $143.30 | Stopgap | 2020 |
| S EGAN AVE | 689 | $438.90 | Stopgap | 2020 |
| N EGAN AVE | 653 | $293.71 | Stopgap | 2020 |
| S LIBERTY* | 21 | $278.98 | Stopgap | 2020 |
| NW 1ST ST | 441 | $261.38 | Stopgap | 2020 |
| N CATHERI* | 4 | $153.11 | Stopgap | 2020 |
| NE 8TH ST | 141 | $184.25 | Stopgap | 2020 |
| NW 7TH ST | 388 | $203.36 | Stopgap | 2020 |
| N MAPLEWO* | 386 | $153.27 | Stopgap | 2020 |
| N LIBERTY* | 346 | $192.65 | Stopgap | 2020 |
| W CENTER * | 517 | $177.55 | Stopgap | 2020 |
| ASHMONT RD | 660 | $99.30 | Stopgap | 2020 |
| NW 5TH ST | 564 | $185.07 | Stopgap | 2020 |
| NW 5TH ST | 406 | $491.11 | Stopgap | 2020 |
| SW 3RD ST | 472 | $618.78 | Stopgap | 2020 |
| NW 5TH ST | 404 | $2,170.13 | Stopgap | 2020 |

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|---|---|---|---|---|
| N UNION A* | 554 | $246.35 | Stopgap | 2020 |
| N EGAN AVE | 737 | $152.81 | Stopgap | 2020 |
| N LEE AVE | 384 | $246.70 | Stopgap | 2020 |
| CAMBRIDGE* | 209 | $223.28 | Stopgap | 2020 |
| S CHICAGO* | 34 | $2,895.33 | Stopgap | 2020 |
| S UNION A* | 74 | $116.78 | Stopgap | 2020 |
| NE 8TH ST | 668 | $94.29 | Stopgap | 2020 |
| SW 4TH ST | 470 | $281.18 | Stopgap | 2020 |
| N HARTH A* | 355 | $146.73 | Stopgap | 2020 |
| N CATHERI* | 319 | $141.63 | Stopgap | 2020 |
| S BLANCHE* | 71 | $150.46 | Stopgap | 2020 |
| W CENTER * | 480 | $74,210.80 | Major Below Critical | 2020 |
| NE 6TH ST | 128 | $139,868.38 | Major Below Critical | 2020 |
| N MAPLEWO* | 6 | $76,459.49 | Major Below Critical | 2020 |
| NE 5TH ST | 585 | $81,568.00 | Major Below Critical | 2020 |
| NE 9TH ST | 138 | $126.27 | Stopgap | 2020 |
| NW 1ST ST | 448 | $192.04 | Stopgap | 2020 |
| NW 1ST ST | 440 | $243.46 | Stopgap | 2020 |
| NW 5TH ST | 399 | $158.34 | Stopgap | 2020 |
| SE 1ST ST | 104 | $310.87 | Stopgap | 2020 |
| CEDAR CT | 504 | $58.09 | Stopgap | 2020 |
| N UNION A* | 553 | $212.08 | Stopgap | 2020 |
| HEATHERWO* | 700 | $106.47 | Stopgap | 2020 |
| NE 9TH ST | 702 | $112.49 | Stopgap | 2020 |
| N SUMMIT * | 94 | $222.44 | Stopgap | 2020 |
| N MAPLEWO* | 274 | $205.17 | Stopgap | 2020 |
| SE 1ST ST | 102 | $748.79 | Stopgap | 2020 |
| W CENTER * | 479 | $200.76 | Stopgap | 2020 |
| SW 2ND ST | 464 | $1,799.27 | Stopgap | 2020 |
| N CHICAGO* | 361 | $195.10 | Stopgap | 2020 |
| NE 6TH ST | 150 | $118.14 | Stopgap | 2020 |
| SE 4TH ST | 114 | $400.56 | Stopgap | 2020 |
| NW 5TH ST | 402 | $133.65 | Stopgap | 2020 |
| SW 2ND ST | 523 | $205.25 | Stopgap | 2020 |
| NW 1ST ST | 443 | $135.76 | Stopgap | 2020 |
| NE 1ST ST | 63 | $6,440.80 | Stopgap | 2020 |
| SE 3RD ST | 126 | $137.75 | Stopgap | 2020 |
| N CHICAGO* | 335 | $237.40 | Stopgap | 2020 |
| S UNION A* | 36 | $201.02 | Stopgap | 2020 |
| SW 1ST ST | 460 | $180.09 | Stopgap | 2020 |
| S LIBERTY* | 35 | $215.91 | Stopgap | 2020 |

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|---|---|---|---|---|
| NE 11TH ST | 135 | $131.78 | Stopgap | 2020 |
| NW 7TH ST | 389 | $184.54 | Stopgap | 2020 |
| N LIBERTY* | 334 | $235.56 | Stopgap | 2020 |
| N WEST AVE | 371 | $196.66 | Stopgap | 2020 |
| W CENTER * | 482 | $141.88 | Stopgap | 2020 |
| W CENTER * | 483 | $247.72 | Stopgap | 2020 |
| N SUMMIT * | 282 | $482.79 | Stopgap | 2020 |
| N OLIVE A* | 378 | $204.91 | Stopgap | 2020 |
| SE 8TH ST | 214 | $2,489.85 | Stopgap | 2020 |
| NW 4TH ST | 411 | $217.20 | Stopgap | 2020 |
| N WEST AVE | 369 | $185.65 | Stopgap | 2020 |
| W CENTER * | 481 | $159.88 | Stopgap | 2020 |
| N LEE AVE | 99 | $349.25 | Stopgap | 2020 |
| NW 1ST ST | 444 | $182.30 | Stopgap | 2020 |
| N OLIVE A* | 336 | $500.20 | Stopgap | 2020 |
| N LEE AVE | 354 | $493.51 | Stopgap | 2020 |
| NW 5TH ST | 401 | $203.58 | Stopgap | 2020 |
| N HARTH A* | 583 | $326.98 | Stopgap | 2020 |
| NW 4TH ST | 415 | $1,378.30 | Stopgap | 2020 |
| N CHICAGO* | 332 | $151.83 | Stopgap | 2020 |
| TWIN OAKS* | 207 | $162.15 | Stopgap | 2020 |
| NE 1ST ST | 62 | $736.14 | Stopgap | 2020 |
| S JOSEPHI* | 38 | $260.08 | Stopgap | 2020 |
| NW 6TH ST | 398 | $208.17 | Stopgap | 2020 |
| NE 5TH ST | 154 | $283.41 | Stopgap | 2020 |
| N AIRPORT* | 644 | $135.24 | Stopgap | 2020 |
| SE 4TH ST | 117 | $119.04 | Stopgap | 2020 |
| NW 4TH ST | 410 | $328.14 | Stopgap | 2020 |
| N LEE AVE | 340 | $435.62 | Stopgap | 2020 |
| NE 8TH ST | 140 | $129.83 | Stopgap | 2020 |
| SW 2ND ST | 465 | $2,516.95 | Stopgap | 2020 |
| NE 8TH ST | 147 | $127.91 | Stopgap | 2020 |
| 233 ST | 597 | $132.18 | Stopgap | 2020 |
| N JOSEPHI* | 617 | $144.18 | Stopgap | 2020 |
| NW 5TH ST | 405 | $129.99 | Stopgap | 2020 |
| S CHICAGO* | 22 | $1,642.74 | Stopgap | 2020 |
| N CATHERI* | 337 | $168.42 | Stopgap | 2020 |
| N UNION A* | 328 | $611.14 | Stopgap | 2020 |
| N VAN EPS* | 356 | $195.36 | Stopgap | 2020 |
| NW 6TH ST | 395 | $1,016.09 | Stopgap | 2020 |
| SE 4TH ST | 203 | $193.60 | Stopgap | 2020 |

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|---|---|---|---|---|
| S EGAN AVE | 679 | $305.01 | Stopgap | 2020 |
| N LEE AVE | 581 | $99.62 | Stopgap | 2020 |
| NW 4TH ST | 414 | $190.04 | Stopgap | 2020 |
| N LIBERTY* | 555 | $193.67 | Stopgap | 2020 |
| S UNION A* | 37 | $87,262.52 | Major Above Critical | 2020 |
| N OLIVE A* | 276 | $211.41 | Stopgap | 2020 |
| N LIBERTY* | 556 | $305.31 | Stopgap | 2020 |
| N JOSEPHI* | 327 | $161.28 | Stopgap | 2020 |
| NE 7TH ST | 198 | $1,225.34 | Stopgap | 2020 |
| N CATHERI* | 179 | $248.10 | Stopgap | 2020 |
| N AIRPORT* | 649 | $159.51 | Stopgap | 2020 |
| N LIBERTY* | 380 | $210.35 | Stopgap | 2020 |
| W CENTER * | 478 | $257.51 | Stopgap | 2020 |
| N LIBERTY* | 329 | $203.57 | Stopgap | 2020 |
| NE 7TH ST | 199 | $226.81 | Stopgap | 2020 |
| S LINCOLN* | 23 | $727.44 | Stopgap | 2020 |
| S VAN EPS* | 72 | $226.72 | Stopgap | 2020 |
| N BLANCHE* | 557 | $145.47 | Stopgap | 2020 |
| N HARTH A* | 341 | $323.81 | Stopgap | 2020 |
| N UNION A* | 333 | $242.55 | Stopgap | 2020 |
| S JOSEPHI* | 15 | $222.86 | Stopgap | 2020 |
| N DIVISIO* | 206 | $377.03 | Stopgap | 2020 |
| NW 4TH ST | 413 | $408.40 | Stopgap | 2020 |
| N WEST AVE | 370 | $199.20 | Stopgap | 2020 |
| N WEST AVE | 372 | $54,631.02 | Major Above Critical | 2020 |
| S GARFIEL* | 143 | $1,645.15 | Global MR | 2020 |
| N UNION A* | 615 | $805.31 | Global MR | 2020 |
| S HIGHLAN* | 683 | $2,353.82 | Global MR | 2020 |
| N GRANT A* | 259 | $996.79 | Global MR | 2020 |
| N WEST AVE | 612 | $1,958.64 | Global MR | 2020 |
| NW 9TH ST | 450 | $1,412.89 | Global MR | 2020 |
| N LINCOLN* | 176 | $1,549.25 | Global MR | 2020 |
| NW 8TH ST | 635 | $142.68 | Stopgap | 2020 |
| NE 5TH ST | 67 | $1,451.96 | Global MR | 2020 |
| NW 9TH ST | 610 | $1,613.17 | Global MR | 2020 |
| N LINCOLN* | 91 | $2,395.66 | Global MR | 2020 |
| UNKNOWN | 712 | $1,391.45 | Global MR | 2020 |
| NW 9TH ST | 449 | $1,491.87 | Global MR | 2020 |
| N HIGHLAN* | 377 | $2,323.20 | Global MR | 2020 |
| NE 1ST ST | 743 | $1,287.62 | Global MR | 2020 |
| NW 1ST ST | 575 | $911.92 | Global MR | 2020 |

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|---|---|---|---|---|
| S HIGHLAN* | 680 | $1,929.84 | Global MR | 2020 |
| N JEFFERS* | 83 | $1,026.44 | Global MR | 2020 |
| NW 9TH ST | 634 | $639.57 | Global MR | 2020 |
| N CATHERI* | 376 | $1,597.76 | Global MR | 2020 |
| NE 9TH ST | 136 | $1,338.90 | Global MR | 2020 |
| N GRANT A* | 98 | $1,591.76 | Global MR | 2020 |
| NE 9TH ST | 145 | $1,511.54 | Global MR | 2020 |
| N SUMMIT * | 331 | $1,576.58 | Global MR | 2020 |
| NW 9TH ST | 452 | $651.25 | Global MR | 2020 |
| N HARTH A* | 619 | $1,248.96 | Global MR | 2020 |
| S CATHERI* | 30 | $1,645.24 | Global MR | 2020 |
| N LINCOLN* | 283 | $2,157.45 | Global MR + Stopgap | 2020 |
| N HARTH A* | 382 | $2,530.65 | Global MR + Stopgap | 2020 |
| N HARTH A* | 618 | $1,373.31 | Global MR + Stopgap | 2020 |
| N GARFIEL* | 351 | $2,179.35 | Global MR + Stopgap | 2020 |
| NE 5TH ST | 44 | $1,674.29 | Global MR + Stopgap | 2020 |
| N WEST AVE | 379 | $1,291.11 | Global MR + Stopgap | 2020 |
| N WEST AVE | 723 | $1,819.52 | Global MR + Stopgap | 2020 |
| N DIVISIO* | 82 | $969.10 | Global MR | 2020 |
| N LINCOLN* | 87 | $3,365.89 | Global MR + Stopgap | 2020 |
| NW 9TH ST | 709 | $507.31 | Global MR | 2020 |
| NW 9TH ST | 572 | $1,758.11 | Global MR + Stopgap | 2020 |
| NW 10TH ST | 451 | $1,551.99 | Global MR + Stopgap | 2020 |
| N SUMMIT * | 189 | $1,850.67 | Global MR + Stopgap | 2020 |
| N OLIVE A* | 534 | $1,917.41 | Global MR | 2020 |
| N DIVISIO* | 349 | $1,931.31 | Global MR | 2020 |
| NE 1ST ST | 59 | $2,114.97 | Global MR | 2020 |
| N LINCOLN* | 318 | $1,563.58 | Global MR | 2020 |
| N HARTH A* | 620 | $2,399.69 | Global MR + Stopgap | 2020 |
| N GRANT A* | 260 | $1,003.69 | Global MR | 2020 |
| NE 4TH ST | 49 | $1,426.09 | Global MR | 2020 |
| NW 9TH ST | 611 | $1,053.36 | Global MR | 2020 |
| NW 9TH ST | 453 | $1,755.62 | Global MR | 2020 |

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|---|---|---|---|---|
| N JEFFERS* | 350 | $1,948.08 | Global MR | 2020 |
| NE 9TH ST | 146 | $1,417.30 | Global MR | 2020 |
| NE 1ST ST | 547 | $2,345.70 | Global MR | 2020 |
| S HIGHLAN* | 29 | $2,304.22 | Global MR | 2020 |
| S HIGHLAN* | 234 | $2,065.34 | Global MR | 2020 |
| NE 3RD ST | 55 | $1,192.60 | Global MR | 2020 |
| NW 9TH ST | 711 | $603.77 | Global MR | 2020 |
| NW 1ST ST | 574 | $1,429.24 | Global MR | 2020 |
| N LINCOLN* | 194 | $931.52 | Global MR | 2020 |
| S HIGHLAN* | 271 | $1,085.00 | Global MR | 2020 |
| S HIGHLAN* | 681 | $4,147.68 | Global MR | 2020 |
| N UNION A* | 614 | $907.82 | Global MR | 2020 |
| N GARFIEL* | 258 | $942.44 | Global MR | 2020 |
| S GRANT A* | 8 | $1,644.90 | Global MR | 2020 |
| S HIGHLAN* | 576 | $1,228.69 | Global MR | 2020 |
| N DIVISIO* | 81 | $1,037.35 | Global MR | 2020 |
| N UNION A* | 613 | $948.85 | Global MR | 2020 |
| NW 9TH ST | 609 | $1,260.20 | Global MR | 2020 |
| N LINCOLN* | 95 | $1,754.87 | Global MR | 2020 |
| NE 1ST ST | 61 | $1,135.05 | Global MR | 2020 |
| NW 9TH ST | 569 | $1,412.31 | Global MR | 2020 |
| NE 3RD ST | 69 | $1,390.73 | Global MR | 2020 |
| N OLIVE A* | 724 | $1,663.99 | Global MR | 2020 |
| N JEFFERS* | 256 | $991.68 | Global MR | 2020 |
| S HIGHLAN* | 79 | $1,632.01 | Global MR | 2020 |
| S HIGHLAN* | 682 | $1,959.25 | Global MR | 2020 |
| N LINCOLN* | 190 | $1,641.52 | Global MR | 2020 |
| NE 4TH ST | 51 | $1,408.81 | Global MR | 2020 |
| S HIGHLAN* | 235 | $2,352.42 | Global MR | 2020 |
| N GARFIEL* | 257 | $1,003.84 | Global MR | 2020 |
| N HIGHLAN* | 374 | $2,438.18 | Global MR | 2020 |