INFRASTRUCTURE MANAGEMENT PLAN

NARRATIVE REPORT

PREPARED FOR

BOROUGH OF CONSHOHOCKEN

400 FAYETTE STREET
SUITE 200
CONSHOHOCKEN, PA 19428

G&A FILE NO. 2017-10032

September 28, 2018

ENGINEERING & CONSULTING SERVICES

Prepared By:
Gilmore & Associates, Inc.
Engineers ♦ Land Surveyors ♦ Planners ♦ GIS Consultants
65 E. Butler Avenue, Suite 100
New Britain, PA 18901-5106
(215) 345-4330

Table of Contents Page

Executive Summary

In September 2016, the Pennsylvania Department of Transportation (PennDOT) announced the start of their long-term, multimodal transportation management plan for the Interstate 76 (I-76) corridor connecting King of Prussia to the City of Philadelphia. Inspired by PennDOT's plan, the Borough of Conshohocken has proactively elected to evaluate the repair and upgrade of their own roadway infrastructure in the anticipation of the future growth and economic development within the Borough's already thriving community. With careful consideration and planning, the Borough stands to reap the benefits of this long term, large scale investment for years to come.

The Borough owns and is responsible for maintaining approximately 16.6 miles of roadway or, for the purposes of this report, 355 roadway blocks. Though the roadway repairs account for only approximately 25% of the recommended scope of work, these repairs are the driving force behind this Infrastructure Management Plan. Roadways are the key to the plan because they encompass and directly influence the Borough's other infrastructure: storm sewer, curbs, and curb ramps.

Utilizing the Borough's August 2017 Draft Infrastructure Management Plan as a starting point, Gilmore & Associates, Inc. evaluated each block via Google street view and satellite imaging to perform a desk-level review of the existing pavement and estimated repair quantities; to inventory the number of existing and required curb ramps; to identify the approximate location of curb and gutter; and to inventory the locations and condition of the existing storm sewer system.

Upon review of the existing pavement conditions, five general roadway surface treatment categories were established: no repair, crack sealing, micro-surfacing, mill and overlay, and total reconstruction. Breaking down the recommended repairs, 69 blocks (19.4%) would receive a crack sealing treatment, 34 blocks (9.6%) would receive a micro-surfacing treatment, 226 blocks (63.7%) would be resurfaced with a mill and overlay with varying levels of base repair, and 20 blocks (5.6%) would be completely reconstructed, leaving a total 6 blocks (1.7%) with no recommended repair treatment at this time.

Additional repair recommendations include modernizing other portions of the Borough's infrastructure by upgrading curb ramps and pedestrian crossings, replacing all existing combination curb and gutter with upright curb, providing bicycle safe grates for all inlets, replacing all existing city inlets with PennDOT standard inlets, and removing all driveway and intersection plates, pipes, and culverts. In addition to these upgrades, this report also recommends expanding several existing storm sewer systems to correct or improve existing drainage conditions and maximize the effectiveness of the roadway improvements.

This report presents the Borough with two actionable implementation scenarios to improve its roadway infrastructure within a 5-year span as well as provide immediate value to the Borough by delivering an adaptable spreadsheet tool classifying the existing conditions and probable costs of the recommended repairs. The selected scenarios are a "Worst First" Scenario, which focuses on addressing the most severe failures earlier in the 5-year span, and an Efficiency Scenario, which focuses on grouping work within an area to reduce the need for moving construction equipment during construction. Per the opinion of probable cost, the "Worst First" Scenario would cost $28.2 million and the Efficiency Scenario would cost $27.7 million to complete.

While reviewing the information contained in this report, we recommend the Borough consider their overall goal for this Infrastructure Management Plan and use this report as a guide to carefully weigh the benefits of each implementation scenario to determine which option is in the best interest of the community.

Introduction

In September of 2016, the Pennsylvania Department of Transportation (PennDOT) announced the start of their long-term, multimodal transportation management plan for the Interstate 76 (I-76) corridor connecting King of Prussia to the City of Philadelphia. PennDOT intends to partner with the Southeastern Pennsylvania Transportation Authority (SEPTA) and, together, expand the public transit system and implement a series of new traffic management technologies along this specific I-76 corridor to improve safety and enhance the overall travel experience between Philadelphia and its northwestern suburbs.

The communities located along this stretch of highway, including the Borough of Conshohocken, stand to reap the benefits of the improved access to, from, and along the I-76 corridor. Since these enhancements are being designed to make these communities more accessible to daily commuters and weekend travelers, it is anticipated that these areas will increase in popularity as more people take the opportunity to visit and explore all of the unique experiences that Conshohocken has to offer.

In the anticipation of the future growth and economic development in the Borough's already thriving community, the Borough has taken a proactive approach to PennDOT's announcement by deciding to evaluate their own roadway infrastructure. The Borough tasked Gilmore & Associates, Inc. with formulating a 5-year plan to coincide with the I-76 corridor plan so that the Borough can repair and upgrade any of the Borough's infrastructure systems that are found to be insufficient.

Infrastructure is defined as the basic structures and facilities (e.g. buildings, roads, power supplies, etc.) needed for the operation of a society. For the purposes of this Infrastructure Management Plan Narrative Report, infrastructure means the roadways, curbing, gutter, curb ramps, and storm sewer owned and maintained by the Borough. Whether above or below ground, these civil infrastructure systems must be maintained since they are the supporting foundation of today's society and are an essential part of our everyday lives.

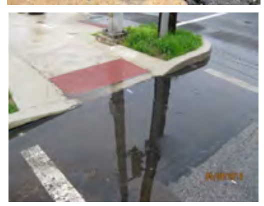
With careful planning and appropriate funding, the Borough of Conshohocken can maintain, restore, and upgrade their existing infrastructures systems to accommodate more visitors, residents, and businesses to the community and provide a solid foundation for their charming community.


Roadways

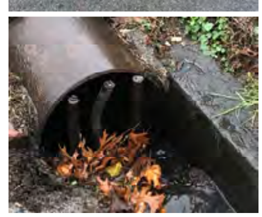

Roadway Drainage


Pedestrian Access


Gutter Curb & Curb


Curb Ramps


Storm Sewer Structures


Stormwater Drainage


Storm Sewer Pipes & Culverts

The intent of this Infrastructure Management Plan is to present the Borough of Conshohocken with two actionable plans to upgrade and improve their infrastructure systems within a 5 year span. The objectives of this Infrastructure Management Plan were to finalize the assessment of the current conditions of the Borough owned infrastructure; recommend a scope of repairs/upgrades; calculate an estimated cost based on the recommended scope of work; and ultimately present the Borough with two implementation scenario options to complete the recommended scope of work.

The Borough is investigating several options for a long term, large scale investment in their infrastructure, which is not something that should be taken lightly. As such, this report is organized to act as a reference to guide the Borough through the recommended scope of work and ultimately allow the Borough to decide which scenario option is in their best interest. This report has been organized into the following sections:

Section 1: **Strategy & Plan Development** presents the thought process and method used to create the analysis framework. A dynamic Microsoft Excel database was generated to store individual block information in a searchable format.

Section 2: **Pavement Condition Assessment** provides background information related to the design of flexible pavement, how it works, why and how it typically fails, and how it was assessed.

Section 3: **Storm Sewer & Incidental Assessment** provides information on the storm sewer, curb and gutter curb, curb ramps and pavement markings and how they were assessed.

Section 4: **Fieldwork** presents the reasons behind the roadway core sampling and storm sewer televising, including how the field work was completed and how it informed the analysis.

Section 5: **Recommended Scope of Repairs** provides a general summary of the scope of the recommended repairs based on the framework built in the previous sections. Recommendations are provided for roadway, storm sewer, and concrete related repairs.

Section 6: **Implementation Scenarios & Engineer's Opinion of Probable Cost** describes the approach taken when preparing the engineer's opinion of probable cost and the probable cost and yearly scope for two implementation scenarios.

Section 7: **Conclusion** summarizes the Infrastructure Management Plan.

Appendix A: **Mapping.** Includes the mapping referenced throughout this Infrastructure Management Plan: Liquid Fuels Block Numbering Map; Pavement Repair Year Map; Existing & Proposed Storm Sewer Location Map; Recommended Repair Treatment Map; Storm Sewer Televising Results Map; Curb & Gutter Replacement Location Map; Worst First Scenario 5 Year Summary Map; and Efficiency Scenario 5 Year Summary Map.

Appendix B: **Roadway Core Sampling Results.**

Appendix C: **Recommended Scope of Repairs.** Provides a copy of the recommended roadway, storm sewer, and concrete repair summary.

Appendix D: **Engineer's Opinion of Probable Cost.** Provides a copy of the Engineer's Opinion of Probable cost for each implementation scenario.

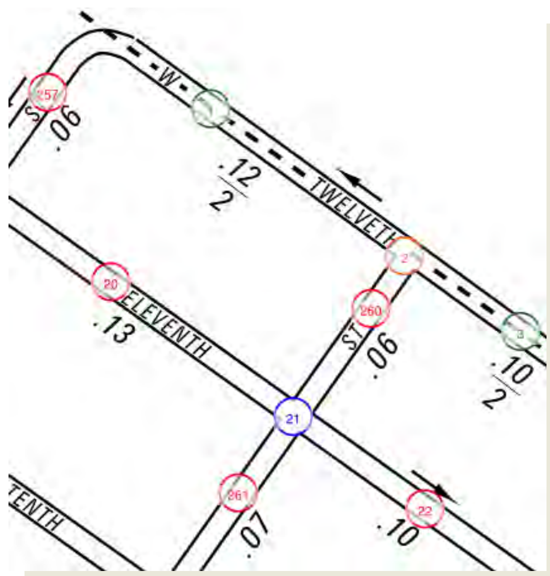
Section 1: Strategy & Plan Development

The first step in preparing the Infrastructure Management Plan was to step back and review the scope of the project and develop a strategy to effectively and efficiently organize the large amount of data required to complete the task at hand. The report is intended to provide a complete inventory and assessment of all Borough owned roadways as well as an inventory of the storm sewer systems, curb ramps, and curbing located within the Borough's right-of-way.

During the assessment process, several infrastructure related issues were discovered at the intersections of privately owned alleys and Borough owned roadways. Though these privately owned alleys have not been included in the scope of this report, their intersection with the public roadways have been included. It is important to note that the alley intersections have not been assigned an individual block number but have instead been included in the assessment of the roadway block they intersect.

1.1 Block by Block Analysis

As a starting point, every Borough owned roadway was identified and divided into a standard block segment which was assigned a number for ease of reference. For the purposes of this report, a block is defined as an intersection of two or more public streets or a public roadway segment between intersections. The limit of each block was determined on an individual basis depending upon the width of the ultimate rights-of-way.



Then, using PennDOT's Liquid Fuels Map for Conshohocken Borough, a block numbering system was established to individually identify each block. It was determined that the most systematic way to number the blocks was to mimic a similar format in which we read, left to right and top to bottom. Therefore, the roadways that travel from Colwell Lane (west) towards Righter Street (east), starting with West 12th Avenue between Freedly and Wood Streets (Block 1), were numbered first. Once all the roadways within the Borough that travel west to east were assigned numbers, the numbering continued on the roadways that travel from West 12th Avenue (north) towards the Schuylkill River (south). The Liquid Fuels Map is provided in Appendix A.

Assessing the roadways as individual blocks provides the Borough with more flexibility and allows for a more dynamic means of creating an implementation scenario. For example, say you wanted to pave Block 21 (the intersection of West 11th Avenue & Wood Street) in the picture to the right. This block assessment system affords you the option to pave Block 21 at the same time as Blocks 20 and 22 (West 11th Avenue) or at the same time as Blocks 260 and 261 (Wood Street).

In addition to a number system, a color coding scheme was employed to distinguish between the different types of intersections encountered; the labels in red and blue font represent a block and an intersection, respectively, which is solely owned and maintained by the Borough, while the labels in green and orange font represent a block and an intersection, respectively, that is jointly owned and maintained by the Borough with an adjacent municipality. For ease of reference, the Inventory spreadsheet was also formatted to utilize the same number and color coding.

1.2 Assessment Ratings

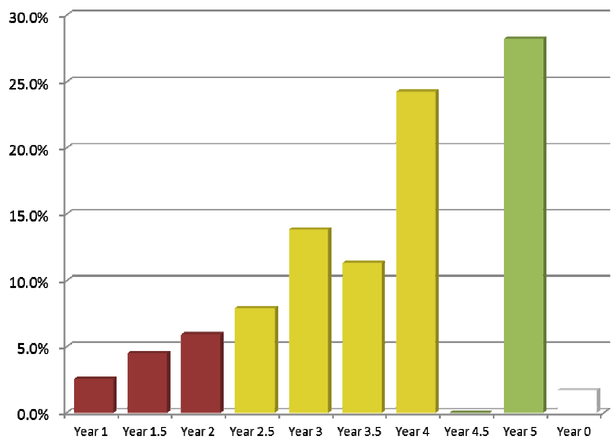
This report utilizes two separate rating systems, comprised of an assessment rating and a repair year rating. The assessment rating system was based upon the condition assessment forms provided in the August 2017 Draft Infrastructure Management Plan. These forms were prepared by the previous Borough Engineer based upon their visual review of the pavement condition at the time of the visit and also included an inventory of the existing stormwater management system, curb ramps, and pavement markings. The visual review of the roadway assessed typical pavement distresses, such as longitudinal and transverse cracking, raveling/polished aggregate, alligator cracking, and potholes/rutting, which will be discussed in further detail in this report. For this rating system, a condition scale of 0-5 was assigned to the existing pavement, stormwater management system, curb ramps, and pavement markings. The 0-5 rating system is defined by the following criteria:

- <u>Condition 0</u>: Deficiency is not visually apparent
- <u>Condition 1</u>: Deficiency is minimally apparent; the condition of the pavement is generally "very good"
- <u>Condition 2</u>: Deficiency is moderately apparent; the condition of the pavement is generally "good"
- <u>Condition 3</u>: Deficiency is readily apparent; the condition of the pavement is generally "fair"
- <u>Condition 4</u>: Deficiency is prevalent throughout the block; the condition of the pavement is generally "poor"
- <u>Condition 5</u>: Deficiency is prevalent and extreme; the condition of the pavement is generally "very poor"

Gilmore & Associates, Inc. evaluated the ratings provided in the condition assessment forms and compared them to Google street view and satellite imaging to employ a similar but new pavement repair year rating system which also took into account the condition of the existing storm sewer system. This repair year rating utilized a similar but reversed 0-5 rating system with similar criteria; however, instead of representing the condition, the assigned 0-5 rating signifies the year, or half year, which the recommended repair should be completed. For example, a block with an assessment rating of 1 would be assigned a repair year rating of 5. This means that, based on the generally very good condition of the existing pavement, the repairs for that block are recommended to be completed during year 5 of the 5 year Infrastructure Management Plan. If a half rating was assigned to a block, e.g. 2.5, this suggests that the repairs for that specific block were recommended for completion in either year 2 or year 3.

Based on the initial repair year ratings and a 5-year time line, Figure 1.1 on the following page provides the following recommendations:

1. 6 of the 355 blocks (2%) need no treatment;
2. Treat 100 of the 355 blocks (28%) after Year 4 since these blocks appear to be in acceptable condition;
3. Treat 203 of the 355 blocks (57%) between Year 2.5 and Year 4 to prevent further degradation and avoid larger, more costly repairs; and
4. Treat 46 of 355 blocks (13%) within the first 2 years since the pavement has degraded to a point where major repairs or full reconstruction is required.



Year 1	9	Blocks	2.5%
Year 1.5	16	Blocks	4.5%
Year 2	21	Blocks	5.9%
Year 2.5	28	Blocks	7.9%
Year 3	49	Blocks	13.8%
Year 3.5	40	Blocks	11.3%
Year 4	86	Blocks	24.2%
Year 4.5	0	Blocks	0.0%
Year 5	100	Blocks	28.2%
Year 0	6	Blocks	1.7%
	355	**Blocks**	**100%**

FIGURE 1.1: REPAIR YEAR RATING

The repair year ratings shown above in Figure 1.1 were ultimately used as a guideline to create the implementation scenarios described later in this report. A Pavement Repair Year Map identifying the recommended repair year for each block can be found in Appendix A of this report.

1.3 Creating the Database

The next step was to prepare a spreadsheet in Microsoft Excel that effectively and efficiently organized the data in a manner that was easy to view, analyze, and manipulate. All collected data were compiled in Microsoft Excel, generating an adaptable and searchable database. The database not only included the information from the Condition Assessment Forms in the August 2017 Draft Infrastructure Management Plan, but also provides information related to the estimated quantities, detailed repair recommendations, testing results where completed, estimated unit costs with supporting unit cost history related to the existing roadways, storm sewer systems, curb ramps, etc. for all 355 of the Borough's blocks.

Separate tabs have been created in the spreadsheet to present the analysis of the repair treatment year as well as both implementation scenarios described later in this report. Input and Cost Data tabs have also been established to easily manipulate or update the estimate repair costs.

The Cost Data tab compiles pricing information from previous capital improvement projects publicly bid by the Borough and nearby municipalities, PennDOT's Engineering and Construction Management System (ECMS) archives, and recent projects publicly bid on the PennBid website. This pricing information was averaged and individually assessed based on the year of the project and the related quantities in order to prepare estimated unit pricing for the recommended repairs tailored to the scope of work and the timeframe allocated for this Infrastructure Management Plan.

The Input Data tab acts as the control center for the Engineer's Opinion of Probable Cost. This tab provides a summary of the finalized unit cost estimates as well as the assumptions used for quantity estimation. These inputs have been linked to the Inventory and Engineer's Opinion of Probable Cost tab to calculate the cost of the recommended repairs on an individual block basis.

The database of the roadway blocks generated during this Infrastructure Management Plan is dynamic in nature, and therefore can be updated as streets are improved or more recent cost data becomes available to show in real time the present-day cost of the treatment for each block of each street throughout the Borough, at any given time. The need for a dynamic management plan is critical due to the amount of data required to complete the scope of work.
An electronic copy was also transmitted under separate cover to Borough Administration staff.

1.4 Coordination

An essential aspect of this Infrastructure Management Plan is coordination; the lines of communication between all parties responsible for infrastructure within the Borough must be established and open during all stages of implementation. This includes the Borough's Department of Public Services, Borough Staff, the Conshohocken Authority, Aqua, PECO, PennDOT, Verizon, Comcast, etc. The goal is to coordinate the future maintenance, repair, and general project schedules planned by the other utility companies in order to eliminate redundancies and to reduce the potential for impacts to the Borough's implementation of this Infrastructure Management Plan.

The majority of the utility providers and other parties responsible for infrastructure systems within the Borough have responded to requests for their tentative 5 years plans and the initial lines of communication have been established. At this time there are no known conflicts with the recommended scope of work and these implementation scenarios; however, we note that emergency repair work cannot be foreseen so further coordination will be required throughout the implementation of this Infrastructure Management. We anticipate that in the event of emergency work by a utility provider, the recommended scope of work and related schedule may need to be adjusted.

1.5 GIS Updates

While determining the scope of this Infrastructure Management Plan, Borough staff and Borough Council requested that Gilmore & Associates, Inc. link the Plan information with the Borough's base Geographic Information System (GIS) mapping. The base map for the entire Borough has now been updated to incorporate tax map parcel lines, street centerlines, aerial photography, and general Light Detection and Ranging (LiDAR) contour and grading information. Additionally, for future ongoing use, the Infrastructure Condition Assessment Forms from the August 2017 Draft Infrastructure Management Plan have been linked to their respective blocks.

This updated GIS map is an invaluable resource for the Borough and can be used as the framework for gathering, managing, and analyzing information with respect to the Borough's infrastructure. The GIS software is capable of inventorying the location of all manholes and inlets, street signs, pavement markings, etc. and for managing information such as roadway or storm sewer maintenance, traffic patterns, flood zones, etc. It is recommended that the Borough consider continuously updating their GIS map to include new infrastructure related information and to reflect the progress throughout this 5 year plan.

Section 2: Pavement Condition Assessment

The Borough of Conshohocken is responsible for maintaining approximately 16.6 miles of roadway, or 355 blocks for the purpose of this report. Though the roadway repairs account for only approximately 25% of the recommended scope of work, these repairs were considered the driving force (no pun intended) behind this Infrastructure Management Plan; all other infrastructure included in this Plan is directly tied to the roadway improvements. This section is intended to provide a basic understanding of flexible pavement, how it works, and how signs of pavement failure are identified and classified.

2.1 What is Flexible Pavement?

From the surface, it would appear that the majority of the blocks assessed under this Infrastructure Management Plan are constructed of asphalt - which is also known as a flexible pavement. Flexible pavements are typically comprised of several different material layers that generally consist of an asphalt surface course, asphalt base course, and an underlying stone subbase course installed on the existing ground surface/subgrade.

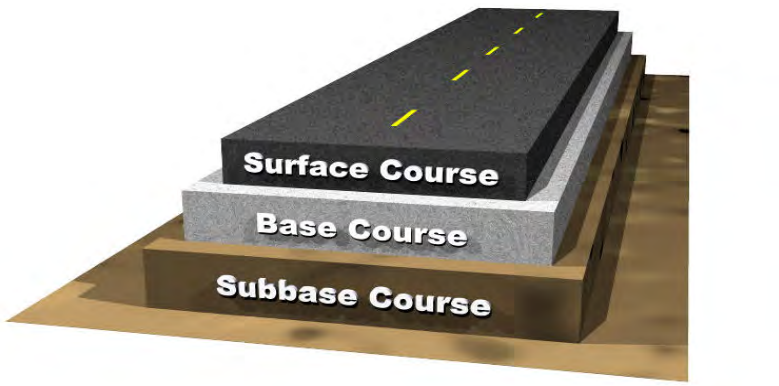


FIGURE 2.1: TYPICAL FLEXIBLE PAVEMENT CROSS SECTION

The surface course, or wearing course, is a layer of fine, densely graded asphalt that you can see on the surface and is in direct contact with vehicle traffic. The wearing course material has the highest load bearing capacity in the pavement structure and is intended to prevent surface water from entering and damaging the underlying layers. The material used for the wearing course is also known for offering skid resistance to help lower the occurrence of sliding related incidents and for lessening the sound made by your tires as they come in contact with the pavement by providing a smooth surface.

The base course is a layer of coarse and densely graded asphalt that is found immediately beneath the wearing course. This course helps provide drainage and additional load distribution. The asphalt material used for this course has a load bearing capacity that is less than that of the wearing course but greater than the stone subbase. The base course is intended to act as a barrier to prevent water and small particles from reaching the subgrade.

The subbase is a layer of crushed aggregate or engineered fill found between the base course and the subgrade. This course is intended to improve drainage, keep the fine material of the subgrade from penetrating the pavement structure, and minimize the impacts of the freeze-thaw cycle. The thickness of the subbase is determined based on the strength of the existing soils. For example, a roadway being constructed on a weak soil requires a thicker stone subbase than a roadway being constructed over bedrock.

2.2 How Does Flexible Pavement Work?

Flexible pavement utilizes a specific combination of several different material layers based on their load carrying and distributing properties to spread out the traffic loads created by the weight of vehicles to the underlying layers.

The diagram below visually demonstrates how the roadway absorbs the wheel load from a vehicle and how the load is distributed throughout each layer of the pavement. The blue highlighted areas and red arrows represent the force created from the weight of a vehicle. The layers in a flexible pavement are arranged so that the material with the highest load capacity is located at the top and the material with the lowest load capacity is located at the bottom. By distributing the load as shown in the figure, the varying materials allow the pavement to continually flex as vehicles drive or park along a roadway without breaking apart, hence the name 'flexible pavement.'

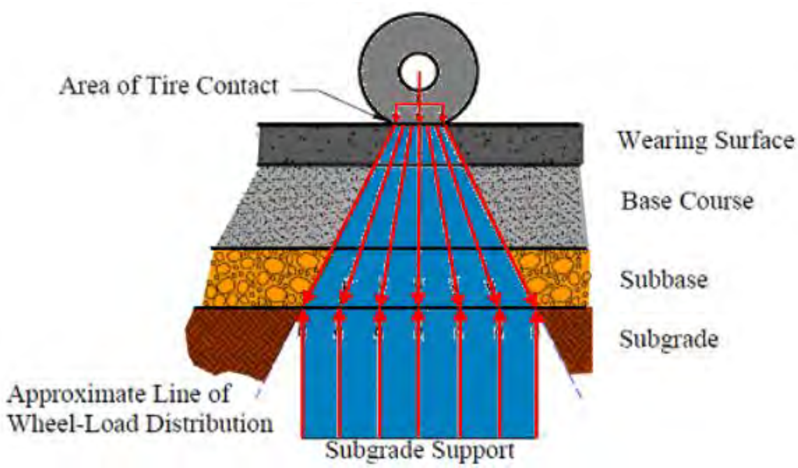
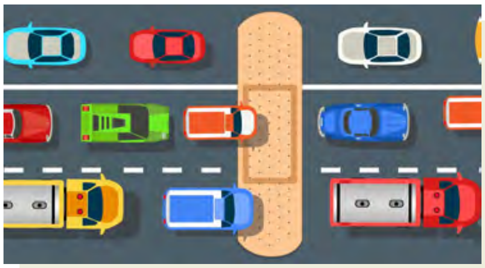


FIGURE 2.2: WHEEL LOADING DIAGRAM

The most common reason why roadways begin to fail is because water has the opportunity to reach the subgrade. The combination of repeated traffic loadings on a roadway and the presence of water create a situation where the water displaces the fine material in the subgrade and forces it upwards or sideward. This movement of this material clogs the stone subbase and the asphalt courses above, preventing the pavement from properly draining and keeps the layers from being able to support the roadway. Over time, the condition worsens until the pavement begins exhibit visual signs of distress.

2.3 Identifying Pavement Distress Failure Patterns

As pavements age and experience continuous repeated traffic loading, the structural integrity of the pavement slowly degrades and the material layers lose their ability to properly distribute the loads. When the integrity declines, the pressure applied to each material layer will slowly increase and eventually exceeds the load carrying capacity of that particular layer and the roadway surface will begin to exhibits signs of distress. If neglected, these distresses will compound over time and develop into a much larger issue.



It is important to determine the type, extent, and probable cause of the pavement distress before deploying a repair strategy, otherwise you may just be putting a band aid on bullet wound, meaning that there is a more serious underlying problem that needs to be addressed. If pavement distress is not properly addressed, it is only a matter of time before the failure patterns reappear on the roadway resurface with a higher degree of severity.

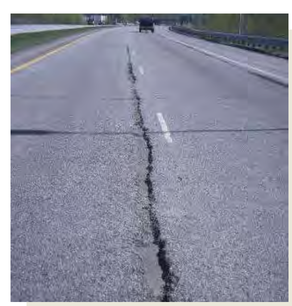
This section identifies the various types of pavement distress that were considered when assigning roadway condition ratings to each block. For your reference, a photograph and brief description of each failure pattern have been provided below.

2.3.1 Raveling/Polished aggregate

Pavement surfaces are considered to have polished aggregate once the binder in the asphalt has been worn away and exposes the individual stone particles. Polished aggregate is considered a pavement distress because the roadway surface becomes smooth and slippery in damp or wet weather conditions. Once the aggregate is exposed the pavement surface continues to degrade, starting with the finer aggregate washing away leaving pock marks followed by the dislodging of the larger course aggregates leaving a rough and jagged roadway surface. The level of raveling can range from only the loss of smaller fine aggregates to the loss of the larger coarse aggregate which will ultimately result in a rough and pitted surface. Roadway surfaces experiencing polished aggregate or raveling can be repaired by applying a thin asphalt overlay, chip seal, slurry seal or micro-surfacing to restore the asphalt binder at the surface.

2.3.2 Longitudinal cracking

Longitudinal cracking is a crack that develops parallel to the centerline and in the same direction as travel. These cracks can form both inside and outside of the vehicle wheel path but they are not typically associated with vehicle loading. Longitudinal cracking can be caused by the contraction of the surface layer due to temperature changes, an existing crack in an underlying pavement layer, and/or a poor pavement seam installation. Minor longitudinal cracks can be sealed to prevent moisture from entering the subbase, while areas with more severe cracking may require a mill and overlay.



2.3.3 Transverse cracking

Traverse cracking is typically a single crack that develops across the roadway, perpendicular to the centerline of the road that is not associated with vehicle loading. This type of cracking can be caused by the contraction of the surface layer due to temperature changes, an existing crack in an underlying pavement layer, or the movement of an underlying pavement layer. Similar to the longitudinal cracking, minor traverse cracks can be sealed to prevent moisture from penetrating the subbase and areas with more severe cracking may require a mill and overlay.

2.3.4 Rutting

Rutting is a longitudinal depression in the roadway surface typically found in the vehicle wheel path. Rutting is generally a result of the consolidation or movement of a pavement layer under vehicle traffic and can be caused by insufficient pavement thickness, poor compaction, or moisture infiltration. Minor rutting can be repaired by filling the depressions with asphalt and placing an asphalt overlay while areas of severe rutting should be repaired using a partial or full depth replacement patch or base repair.

2.3.5 Shoving

Shoving, also known as wash-boarding, is the displacement of asphalt and the formation of ripples in the pavement. Shoving typically occurs because of movement in a pavement layer under vehicle traffic and can be caused by a pavement layer that is too thick, tack coat not being properly placed between asphalt layers to bond them together, or a weakened base course. Shoving is most commonly seen on hills and at intersections and is repaired by using a partial or full depth replacement patch or base repair.

2.3.6 Potholes

Potholes are bowl-shaped depressions in the roadway that penetrate all the way through the surface layer of the roadway down to the base course. While sizes and depths may vary, potholes are usually identified by their sharp edges and vertical sides at the pavement surface. Potholes begin to develop from any of the pavement distresses mentioned above, and are accelerated by moisture penetrating the subbase and/or subgrade and the freeze-thaw cycle. Due to the structural nature of the failure, potholes should be repaired using a permanent, full depth replacement patch or base repair.

2.3.7 Fatigue Cracking

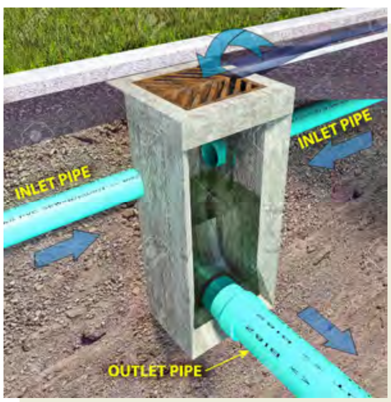
Fatigue cracking, also known as alligator cracking, typically occurs in asphalt pavement in areas subjected to repeated traffic loadings, such as vehicle wheel paths. This type of crack begins as a series of interconnected cracks which over time slowly connect into many sharp-angled shapes that form a pattern similar to the skin of an alligator. Though it can be caused by a multitude or combination of factors, fatigue cracking is most commonly attributed to a weakened base, subbase, and/or subgrade or insufficient pavement thickness. Due to the structural nature of the failure, full depth base repair or full depth roadway reconstruction in extreme cases is required to repair the damage and prevent the alligator-patterned cracking from resurfacing.

Section 3: Storm Sewer & Incidental Condition Assessment

The Borough owns and is responsible for maintaining approximately 16.6 miles of roadway, or for the purposes of this report, 355 roadway blocks. The recommended roadway repairs account for approximately 25% of the construction cost estimated in this Infrastructure Management Plan, while the recommended repairs and upgrades to the storm sewer system and incidental infrastructure items account for the remaining 75%. For the purpose of this report, incidental infrastructure items include combination gutter curb, curbing, curb ramps, and pavement markings. These items are considered incidental because they can be easily upgraded or repaired at the same time the roadway repairs are completed.

While the condition of the roadways play a key role in the development of this Infrastructure Management Plan, the condition of the Borough's other infrastructure systems are an equally important component. The maintenance and repair of these items is vital to the success of this Plan and for maximizing the return on the Borough's investment because they are the foundation that supports and directly influences the integrity and use of the roadway.

3.1 Storm Sewer



Since water is the most common cause of pavement failures, it is critical that a supporting storm sewer infrastructure is present and functioning as designed. Surface runoff is considered excess water generated by a rain or snowfall event that does not have the opportunity to soak into the ground. Storm sewer systems are specifically designed to capture this excess from the surface of roadways, parking lots, sidewalks, etc. and safely convey the water through a network of underground pipes and ultimately to a stream or river.

As with any infrastructure system, a storm sewer network will inevitably reach the end of its service life by means of deterioration, corrosion, structural cracking, or collapse. Water always follows the path of least resistance and can quickly leave a path of destruction in its wake, making it is very important to regularly assess the condition of the existing storm sewer system to ensure that all of its components are functioning harmoniously. Performing regular maintenance, repair, and upgrades ensures that the runoff from the roadway surface enters and flows through the system as designed to help prevent areas of ponding water, damage to the pavement structure, and the need for costly emergency repairs. In other words, the drainage along a roadway is equally as important as the pavement structure itself; completing pavement repairs along a failing roadway will prove to be unsuccessful if the supporting storm sewer structure is also in need of repair.

Utilizing the Borough's August 2017 Draft Infrastructure Management Plan, MS4 outfall map, and storm sewer televising, the location and condition of the existing storm sewer infrastructure was verified. For the purpose of this Infrastructure Management Plan, only storm sewers owned and maintained by the Borough were considered.

3.2 Curb & Gutter

Gilmore and Associates, Inc. was directed to evaluate the existing curb conditions along all 355 blocks to identify all blocks with existing gutter curb, curb constructed with non-standard materials (e.g. granite), and standard upright concrete curb in poor condition. It is important to note that we did not complete any field work associated with the identification of gutter curbing as per the Borough's request. Instead, the presence of gutter curb was determined be referencing the condition assessment forms in the August 2017 Draft Infrastructure Management Plan and looking for any signs of consistent longitudinal cracking in Google Street view within 12 to 18 inches from the curb line, which were assumed to be caused by reflective cracking from a gutter curb. Based on the location and uniformity of the cracking observed along the curb lines and the minor patches of exposed gutter curb, similar to the exposed brick in the picture of Hallowell Street, it was determined that several of the Borough's roadway blocks were constructed with gutter curb which has since been paved over.

East 9th Avenue (Jones-Righter)

Curb plays an important two-faceted supporting role in the functionality of the roadway. It is described as two-faceted because depending on its condition, this role can be either beneficial or detrimental to the pavement structure. Curb is designed to keep surface runoff along the edge of the roadway and direct the water towards the nearest storm sewer inlet. As the name suggests, gutter curb is a combination of gutter and curb - gutter being defined as the depression running along the outer edge of the roadway and curbing being defined as the vertical border along the outer edges of a roadway.

When constructing a roadway with gutter curb, the curb and gutter are typically installed first on either side of the roadway. The pavement is then installed between the gutters so that the elevation of the centerline is higher than the gutter and water flows towards the edge of the roadway. As you can see in the pictures on either side of the page, gutter curb can be fashioned from a combination of several different materials such as concrete, brick, granite, etc. For example, East 9th Avenue between Jones Street and Righter Street (Block 76) was constructed with a concrete curb and gutter while Hallowell Street between East 3rd Avenue and East 4th Avenue (Block 325) was constructed with a granite curb and a brick gutter. Replacement of gutter curb with standard upright curb therefore requires the somewhat costly removal of the gutter and replacement with a full roadway pavement cross-section.

Hallowell Street (East 3rd-East 4th)

When functioning properly, curb can help reduce drainage issues by collecting the surface runoff along the side of the roadway instead of allowing the runoff to pond within the travel lanes. This in turn helps reduce the potential risks of hydroplaning and can also provide a safer path for pedestrians. On the other hand, when curb is not functioning properly, the areas of deterioration along the curb line and the edge of pavement essentially become a highway that lead water directly to the pavement subbase to compromise the structural integrity of the roadway.

3.3 Curb Ramps

Whenever the pedestrian path is altered, e.g. the roadway surface within the crosswalk, federal law requires that any existing non-compliant curb ramp be upgraded and new curb ramps be installed in accordance with the current accessibility standards. These curb ramp improvements are also required to coincide with the completion of these alterations unless the Borough develops a written transition plan. Repaving, resurfacing, and reconstruction are considered alterations;

crack sealing is not considered an alteration.

The condition assessment forms provided in the August 2017 Draft Infrastructure Management Plan provided an inventory of the number of existing curb ramps located at an intersection and whether or not they were in compliance with the current accessibility requirements. These forms however did not clarify which end of the block they pertained to and whether any additional curb ramps were required at any given intersection. Accordingly, Gilmore & Associates, Inc. has evaluated each individual intersection utilizing Google street view and satellite imaging where available to confirm the number of existing curb ramps and determine the number of curb ramps required at each intersection.

3.4 Pavement Markings

All of the pavement repair treatments recommended in this Infrastructure Management Plan with the exception of the crack sealing treatment will result in the eradication of any existing pavement markings, which in turn will have to be replaced. For the purposes of this report, the replacement of the existing pavement markings was considered to be an incidental item related to the recommended repair treatment and therefore, pavement markings were not individually inventoried or assessed.

Section 4: Fieldwork

Gilmore & Associates, Inc. relied on the August 2017 Draft Infrastructure Management Plan to visually assess the condition of the existing roadway surface and storm sewer structures; however, based on our recommendation, the Borough approved additional fieldwork to generate more exact information of the existing conditions and thereby allow creation of a more accurate picture of the anticipated roadway and storm sewer repairs.

The roadway fieldwork focused on the conditions of blocks where excessive deterioration was readily apparent. Since little information can be gathered about pipe conditions from the roadway surface, a more extensive approach was taken with the storm sewer fieldwork and as much information as possible was obtained. The information gathered during the fieldwork operations has been considered in the condition assessments and incorporated into the scope of work.

4.1 Asphalt Core Testing

The roadway base and subgrade layers are essential parts of the pavement structure; however, they are incredibly difficult to assess because they cannot be evaluated visually from the surface. One way to get an idea of how the existing pavement is performing is to conduct an asphalt core test. Asphalt core testing is type of sampling process in which a cylinder of pavement is drilled out and removed intact from the roadway. These core samples are used to determine the pavement structure's capability of distributing vehicle loads through the various layers of the cross section by measuring the thicknesses of the each layer and determining the type of soils that lie beneath roadway. After the core sample is completed the core holes are filled in with cold patch and sealed to limit water intrusion.

In March 2018, Gilmore & Associates, Inc. took a total of 33 pavement core samples from throughout the Borough of Conshohocken in an effort to generate a more accurate estimate of the required roadway repairs, reduce unforeseen circumstances during construction, and ultimately enhance the longevity of the road improvements. A copy of the core sampling results is included in Appendix B of this report.

During the sampling, Gilmore & Associates, Inc. also completed Dynamic Cone Penetration (DCP) test at locations where the core samples exposed the soil subgrade. A DCP test measures the strength of the soil in its natural state without disturbing the surrounding soils. This test is performed by driving a metal cone into the ground, typically in the hole created by the asphalt coring, by repeatedly dropping a weight on the cone. The strength of the soil is determined by measuring how far the cone penetrates into the soil after each blow. All DCP test results showed good subgrade strength and stability.

The core sampling revealed drastic variations in the pavement conditions throughout the Borough. For example, the core samples taken from West 11th Avenue between Wood and Maple Streets (Block 22) and East 11th Avenue between Harry and Hallowell Streets (Block 29), detailed on the left side of the figure below, show that these blocks were constructed with a cross section similar to that of the Borough's current roadway paving standard, which requires a 1-½ inch thick wearing course, 4-½ inch thick base course, and 6 inch stone subbase. The core sample taken from East 11th Avenue between Jones and Righter Streets (Block 35), detailed on the right side of the figure below, indicates that the existing roadway surface was constructed with only 4 inches of asphalt that was placed directly on the subgrade with no stone subbase.

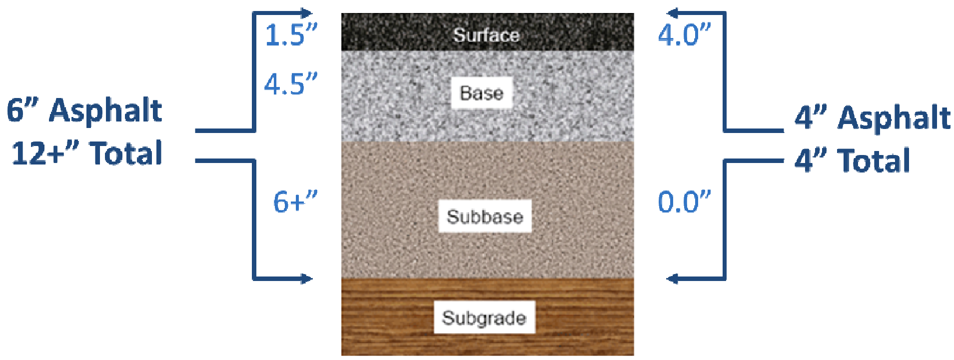


FIGURE 4.1: CORE SAMPLE RESULTS - PAVEMENT CROSS SECTIONS

The majority of the core samples suggested that the existing roadways have a sufficient asphalt thickness to support a typical 1-½ inch mill and overlay. There are a few locations that we would recommend that the milling depth be reduced to a maximum of ½ inch or eliminated entirely, assuming that the subbase and subgrade appear to be in good condition, in order to build up the amount of asphalt when paving.

The results from the following cores samples are a few examples of roadways where additional repairs and/or reconstruction may be required:

- Core Sample C-5 along West 10th Avenue between Colwell Lane and Freedly Street (Block 38) indicates that this portion of West 10th Avenue was constructed with only 1.75 inches of asphalt;

- Core Samples C-21 and C-34 on along East 7th Avenue between Harry Street and Wells Street (Blocks 100 and 102) indicate that this portion of East 7th Avenue was constructed directly over an existing cobblestone roadway with only 2.5 inches of asphalt;

- Core Samples C-9 and C-10 along West 6th Avenue between Maple Street and Forrest Street (Block 116) indicate that a portion of West 6th Avenue may have potentially been constructed over an existing cobblestone roadway with varying depths of asphalt; and

- Core Sample C-22 along East 6th Avenue (Block 120) indicates that this portion of East 6th Avenue was constructed with only 2.5 inches of asphalt.

If the milling cannot be eliminated because of a low curb reveal or existing drainage pattern along the roadway, we would instead recommend that a leveling course be used to help minimize pavement distress and to establish a level surface prior to placing the overlay.

4.2 Storm Sewer Televising

As storm sewer networks age, the likelihood of deterioration, corrosion, blockage, and pipe failure increase significantly, making it is crucial to confirm that these systems are functioning as designed. Like with any other infrastructure system, storm sewer networks require regular maintenance and repairs in order to extend the service life of the system; however, the challenge is to figure out how to inspect these pipes and structures since they lie quietly hidden far beneath the surface.

One commonly used non-destructive, efficient, and cost effective method of visually inspecting the internal condition of a storm sewer pipe from the surface is known as a television inspection. The televising inspection process typically involves lowering a remote-controlled robot into an inlet or a manhole and driving the robot through the network of storm sewer pipes. The robot is equipped with lights and a closed circuit television camera that transmits the video being taken of the pipe to a monitor at the surface. Once the robot reaches the end of the pipe run, the entire process is repeated in reverse so that the robot can be removed from the same inlet or manhole. Televising is currently one of the most cost effective ways to inspect existing storm sewer networks without the need for excavation.

In March of 2018, the Borough of Conshohocken entered into a 30 working day contract with Trenchless Pipe Solutions from West Chester, Pennsylvania through the Commonwealth of Pennsylvania's Cooperative Purchasing Program (COSTARS) to televise the Borough’s existing storm sewer system. Depending on the condition and cleanliness of the pipes, Trenchless Pipe Solutions estimated that they would be able televise the existing storm sewer east of Fayette Street and potentially a portion of the storm sewer west of Fayette Street; however, Trenchless Pipe Solutions encountered very few issues which typically delay the televising process and were ultimately able to televise a large majority of the Borough’s storm sewer system within the time and budget allotted by the contract.

Weekly reports and DVD videos of the television inspection were provided to and reviewed by the Borough’s Department of Public Services staff. The reports provided information related to the location of the existing pipes and structures, including any lateral connections, identification of the televising start and end points, a list of any defects and their associated location along the pipe, and general information about the pipe itself such as the material, size, length, etc.

The map included in Appendix A of this report provides a visual summary of the completed storm sewer televising results. The blocks highlighted in red are locations where an issue was discovered during the televising and a storm sewer replacement or repair is required. The blocks highlighted in grey are the locations of the existing storm sewer where the pipes and structures were found to be in good condition. These storm sewer televising results and any associated replacements or repairs have been considered in the overall condition assessment of the blocks.

We recommend that the required storm sewer work identified by the televising be completed at the time of the scheduled pavement repair treatment for that specific block. This assumes of course that the existing condition of the storm sewer is maintained and does not worsen. For example, if a pipe deteriorates more rapidly than anticipated, the effects of a pipe collapse would be considered a safety hazard and would require an emergency repair.

Section 5: Recommended Scope of Repairs

Infrastructure systems are engineered to withstand a variety of physical and environmental conditions for a certain period of time, known as its design life; a service life is the amount of time between the initial construction and the time at which the structure is no longer reliable for use and must be reconstructed. The length of a roadway's service life is slowly reduced by any number of factors such as excessive traffic volumes, weather, water penetration, thicknesses of the material layers, quality of the construction, condition of the other supporting infrastructure elements, etc. Proper maintenance is the key to maximizing a service life; however, maintenance only slows the rate of pavement deterioration, it cannot stop it. Every infrastructure element is destined to reach the end of its service life; a reasonable goal is to employ a series of maintenance and rehabilitation treatments to extend the service life as long as possible.

5.1 Recommended Roadway Repair Treatments

The purpose of this section is to walk through the recommended surface treatments and how they relate to this Infrastructure Management Plan. The magnitude of repairs for the Borough's 355 blocks was created by evaluating the pavement distress patterns observed in the August 2017 Draft Infrastructure Management Plan and Google street view and satellite imaging, where available.

Upon review of the pavement distress patterns, 5 general roadway repair treatment categories were established: no repair, crack sealing, micro-surfacing, mill and overlay, and total reconstruction. In addition to these 5 general repair categories, the recommended mill and overlay repair treatment was further broken down and classified by the estimated extent of damage to the roadway base or subbase; no base repair (no visual pavement distress patterns were identified), minor base repair (the area of distressed pavement is localized and accounts for up to 15% of the total block area), moderate base repair (the area of distressed pavement is more apparent and accounts for 16% to 35% of the total block area) and major base repair (the area of distressed pavement is widespread, severe and accounts for up to 36% to 65%) of the total block area; for the purposes of this report, the 'no base repair' category is represented by the 'mill and overlay' category. Roadways needing base repair in excess of 65% were considered to need full reconstruction.

Roadway Treatment Summary	Blocks	Percentage
No Treatment	6	1.7%
Crack seal	69	19.4%
Microsurfacing	34	9.6%
Mill & overlay	125	35.2%
Mill & Overlay Minor Base Repair	58	16.3%
Mill & Overlay Moderate Base Repair	39	11.0%
Mill & Overlay Major Base Repair	4	1.1%
Full Reconstruction	20	5.6%
Total	355	100.0%

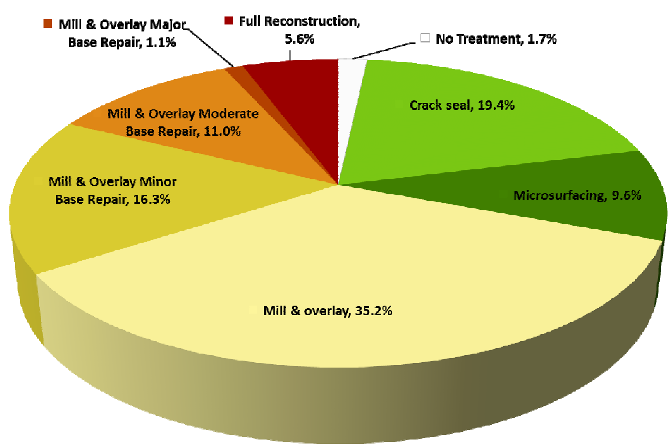


FIGURE 5.1: SUMMARY OF ROADWAY TREATMENTS BY BLOCK

While the condition of the roadway surface was a major factor in determining the recommended surface treatments, other repair recommendations, such as curb and gutter replacement or storm sewer related repairs, were also considered.

For example, look at the image below of East 9th Avenue from our initial assessment, which shows blocks highlighted in shades of yellow to represent a mill and overlay with varying degrees of base repair and bright green to represent a crack sealing treatment. Based on the initial repair year ratings, it was recommended that East 9th Avenue from Harry Street to Righter Street receive a mill and overlay with the exception of its intersection with Wells Street, which was recommended for a crack sealing treatment. However, the storm sewer televising reports identified required repairs to the existing storm sewer system at this intersection. Therefore, based on the scope of the proposed work at this block, the finalized surface treatment recommendation was revised from crack sealing to a mill and overlay with no base repair. A map and scope of the recommended roadway repairs described in this report is provided in Appendices A and C, respectively.

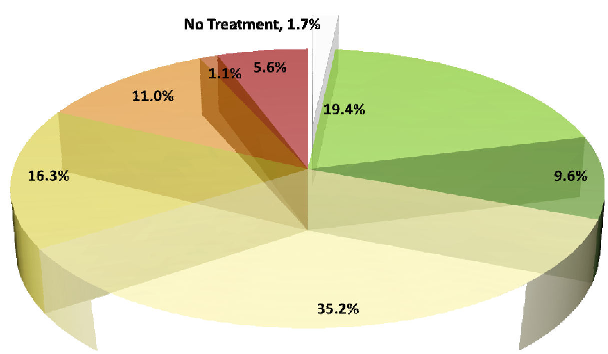
FIGURE 5.2 INITIAL REPAIR YEAR ASSESSMENT EXAMPLES

5.1.1 No Treatment

This report provides recommended surface treatments for the majority of the 355 blocks of roadway within the Borough; however, there are a few specific blocks in which no treatment is recommended within the 5-year timeframe analyzed for this Infrastructure Management Plan since roadway work is being completed by land development projects. It is important to note that if the roadway improvements associated with these projects are not completed by the Developer as proposed, these blocks will need to be reassessed and incorporated into this Infrastructure Management Plan.

The following 6 blocks are currently associated with our ‘no treatment’ recommendation and represent approximately 1.7% of all of the blocks currently owned and maintained by the Borough:

- <u>SORA West</u>: Proposes to vacate West Hector Street from Oak Street to Forrest Street and Forrest Street from West Elm Street to West Hector Street (Blocks 209, 210, and 296);
- <u>Wawa</u>: Proposes base repair and mill and overlay of Harry Street between the Borough Line and East 11th Avenue (Block 298); and
- <u>SEPTA:</u> Proposes improvements at Oak Street and Stoddard Avenue as part of its station improvements and recently resurfaced Harry Street by its railroad tracks, located between Stoddard Avenue and Washington Street (Blocks 228 and 312);



As the Borough of Conshohocken continues to grow, develop and thrive, this Infrastructure Management Plan can be used for more than just implementation options - it can be utilized as a reference and updated continuously as public improvements are considered for newly proposed land development projects.

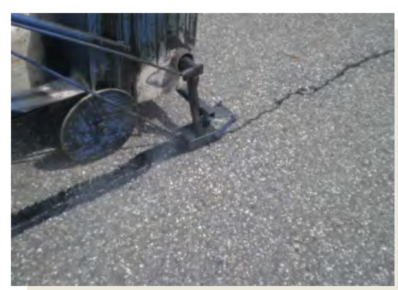
As you can see in the picture to the right, this section of West 11th Avenue between Maple Street and Fayette Street (Blocks 23-26) has no signs of cracking in the roadway surface, the joint sealant around the utilities and along the curb line is clearly visible and the asphalt is a "freshly paved" shade of black. This is a perfect example of a freshly paved roadway that would not require a repair or treatment at this time; however, in the anticipation that this road will require a crack sealing treatment within the timeline of this Infrastructure Management Plan, we have recommended the treatment as such.

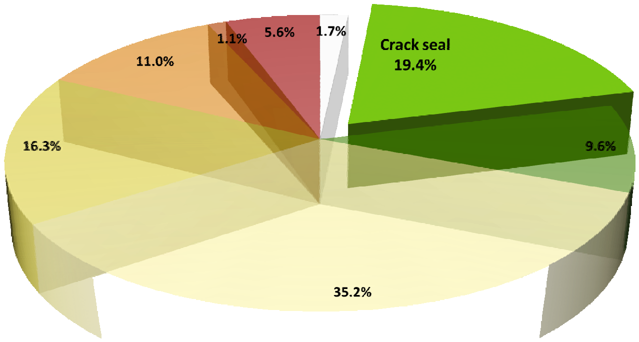
5.1.2 Crack Sealing

Crack sealing is a preventative maintenance method utilized to extend the service life of the existing pavement. Just as the name suggests, the process involves placing either hot or cold rubberized asphalt cement, depending on the temperature and time of year, over the cracks in the surface to create a protective barrier and prevent moisture from penetrating the roadway surface. If left untreated, these cracks will allow water to penetrate the roadway surface which in turn makes the underlying pavement layers more susceptible to the freeze-thaw cycle, weakens the stone base, and ultimately leads to various forms of degradation and pavement failures, such as alligator cracking or potholes.

Crack sealing is relatively cheap and incredibly effective when completed in a timely manner but this treatment should be reserved only for roadways with minimal longitudinal or traverse surface cracking and should not be used on roadways exhibiting signs of base or subbase failures, such as alligator cracking.

Sealing cracks as they develop in the roadway surface is one of the most proactive and cost effective ways to prolong the life of a roadway and maintain the quality of the pavement when compared to other pavement treatments. Another benefit of crack sealing is that the treatment does not necessarily have to be applied by a contractor; the Borough's Department of Public Services could purchase the necessary equipment and rubberized asphalt cement to self-perform this surface treatment and offer the Borough the flexibility to establish a crack sealing maintenance program and complete the sealing as the need arises.





Based upon our condition assessment, we are recommending that 69 of the 355 blocks (19.4%) receive a crack sealing treatment. The pictures below were taken along East Hector Street (Blocks 212-213 and 216-217), Maple Street (Blocks 270-272 and 247-81) and East 3rd Avenue between Harry Street and Hallowell Street (Block 167). These blocks are excellent candidates for crack sealing because the roadway surface is still in generally good condition but is starting to exhibit signs of minor longitudinal and traverse cracking.

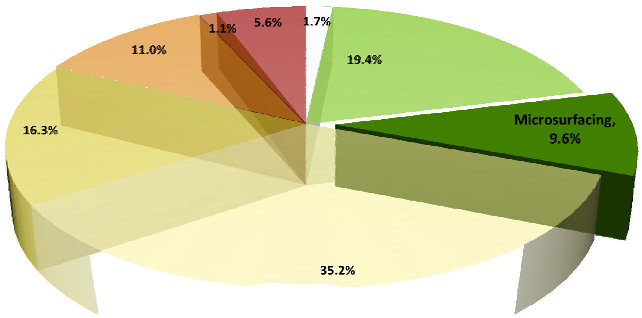
E. Hector Street (Typ.)

Maple Street (Typ.)

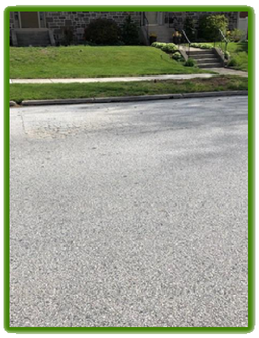
5.1.3 Micro-Surfacing

Micro-surfacing is a material applied to the roadway surface as preventive maintenance that can extend the service life of the existing pavement by 5 to 7 years. It works by sealing the entire roadway surface to protect the underlying pavement layers and subbase from moisture penetration. The material used for micro-surfacing is a mixture of water, asphalt emulsion, fine aggregate and chemical additives for hardening. Due to the thin application, the material is not capable of enhancing the structural integrity of pavement so this treatment is reserved for roadways that have a base and subbase in good condition but where the surface is exhibiting signs of polished aggregate, raveling, or minor cracking.

You may have noticed that over time the rich black color of freshly paved asphalt slowly fades away to varying shades of gray. This happens because the asphalt in the surface of the roadway is degrading and being worn away by vehicle traffic, oxidation, sun exposure, etc. and, as a result, the surface becomes slippery. Micro-surfacing treatments actually help improve skid resistance while restoring the appearance of the roadway because it adds a new protective layer to the pavement. Another benefit to micro-surfacing is that the treatment only takes 1 or 2 hours to harden before being ready for use, meaning the application helps avoid construction delays.



Based upon our condition assessment, we are recommending that 34 of the 355 blocks (9.6%) receive a micro-surfacing treatment. The pictures below were taken along East 11th Avenue between Hallowell and Wells Streets (Block 31) and East 5th Avenue between Wells Street and Spring Mill Avenue (Block 143). These two blocks are being recommended for micro-surfacing because they are exhibiting signs of raveling/polished aggregate with areas of minor longitudinal or traverse cracking.



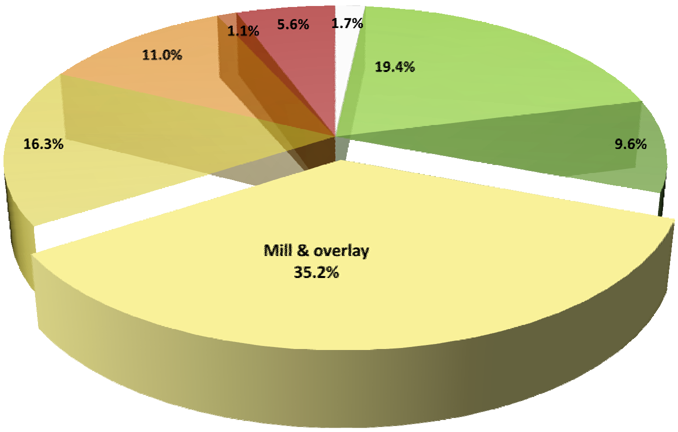
E. 11th Avenue (Hallowell-Wells)

E. 5th Avenue (Wells-Spring Mill)

5.1.4 Roadway Resurfacing

Roadway resurfacing is a rehabilitation treatment involving a two-step process known as mill and overlay. The idea behind roadway resurfacing is to remove a localized area or the entire deteriorating roadway surface and place a new wearing course that utilizes the existing subsurface pavement structure. The milling process typically involves removing the top 1 to 2 inches layer of asphalt using a machine equipped with a drum that grinds away the pavement. The mill depth will vary based on the thickness of the existing surface. The milling process is intended to remove areas of distress where raveling, rutting or large areas of cracking have developed. In addition to producing a smooth, level surface to pave, milling has other benefits such as providing the ability to correct minor drainage issues, maintaining the existing curb heights and exposing damage to the subsurface layers which would have otherwise gone undetected.

Once the roadway surface has been prepared and swept, the asphalt overlay can be placed on top of the milled surface. An overlay is a paving method where a new layer of asphalt is placed where the surface was removed. The amount of asphalt applied to the surface typically coincides with the depth of the existing surface removed. It is important to note that if failures are discovered in the subsurface layers after the milling process, these areas should be repaired or replaced prior to placing the new asphalt overlay to help elongate the service life of the roadway. These repairs will be discussed in further detail in the following sections.



Based upon our condition assessment, we are recommending that 125 of the 355 blocks (35.2%) be treated with a basic mill and overlay. The pictures below were taken along Washington Street between Harry and Ash Streets (Block 234). This block is a perfect example of a road that should be resurfaced. As you can see, there is minor longitudinal cracking, a slight drainage issue by the inlet, and minor settlement along the utility trench. Based on the distresses seen at the pavement surface, it appears that the base and subbase are in good condition.



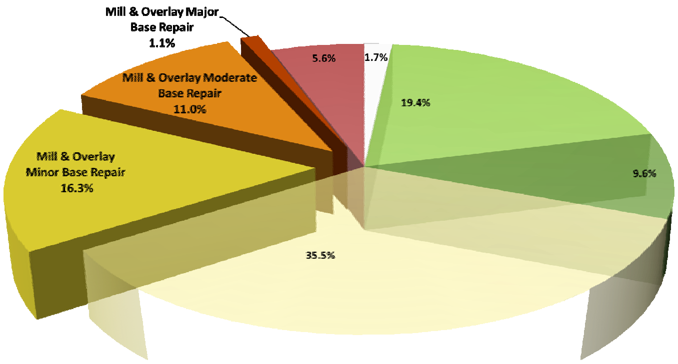
Washington Street (Harry-Ash)

5.1.5 Roadway Base Repair

To maximize the effectiveness of an asphalt overlay, any areas with signs of failure below the surface must be repaired prior to placing a new layer of asphalt. If overlooked, these areas of failure will resurface. Areas of base repair are typically identified by the range of pavement distress patterns described in the previous sections and are classified into degrees of severity degree based upon the size and depth of damage.

The first step in the base repair process is to identify locations where base repair would be required. This can be estimated prior to milling but can only be verified after milling when the base layer is visible. The next step is to remove and dispose of the damaged base course, stone subbase, and any unsuitable subgrade material and sweep the area clean of any debris. The final step is to place and compact the stone subbase and base course materials in several lifts. Larger areas of repair are typically mechanically compacted using a small piece of equipment or roller to ensure the proper compaction of each installed material; however, smaller areas of repair require more physical labor and are typically compacted by hand-tamping.

For the purposes of this Infrastructure Management Plan, the varying degrees of base repair have been categorized as follows: minor base repair which assumes that the square yardage of full depth base repair required is equal to 15% or less of the area of the block; moderate base repair which assumes that square yardage of full depth base repair required is equal to 16 to 35% of the area of the block; major base repair which assumes that square yardage of full depth base repair required is equal to 36 to 65% of the area of the block; and as the name suggests, full reconstruction assumes that all of the material layers of the pavement cross section within the block are being removed and reconstructed.



In addition to the 125 blocks being recommended for a basic mill and overlay, we are also recommending another 101 of the 355 blocks (28.5%) be resurfaced with a mill and overlay. The difference is that these 101 blocks showed pavement distress patterns in varying degrees of severity which we anticipate will require minor, moderate, or major base repair. For your reference, pictures and a brief description of each base repair classification have been provided on the following page.

Mill & Overlay with Minor Base Repair
Hallowell Street (E. 4th-E. 3rd)

Of the 226 blocks to be resurfaced, we are anticipating that 58 of those blocks will also require minor base repair. The pictures to the left were taken along Hallowell Street between East 4th and East 3rd Avenues (Block 325). Although the roadway surface has several different types of pavement distress patterns, including longitudinal cracking, a pothole and alligator cracking that is beginning to spread, the base and subbase along the remainder of the block visually appear to be in acceptable condition. In our opinion, the areas of alligator cracking are minimal and localized and the total area of base repair required would equate to 15% or less of the total block area.

Mill & Overlay with Moderate Base Repair
Jones Street (Spring Mill-E. Hector)

The pictures to the right, taken along Jones Street between Spring Mill Avenue and East Hector Street (Block 349), represent one of the 39 blocks we anticipate will require moderate base repair. As you can see, the roadway surface has more noticeable signs of pavement distress than is shown in the pictures of Hallowell Street, including a large centerline crack, several transverse cracks, and larger areas of alligator cracking which have started raveling and have been patched. In our opinion the areas of required base repair along this block equate to 35% or less of the block area.

The pictures below, taken at the intersection of East 6th Avenue & Harry Street (Block 120), represent one of the 4 blocks we anticipate will require major base repair. This recommendation is based on the presence of multiple failing asphalt patches, several storm sewer and utility trenches that have settled, and the extensive areas of alligator cracking. In addition to the observed distress patterns, the core sample at this intersection indicates there may only be 2.5 inches of asphalt laid directly over the subgrade. When considering all of this information, it is our opinion that the total areas of base repair along this block will equate to 65% or less of the total block area.

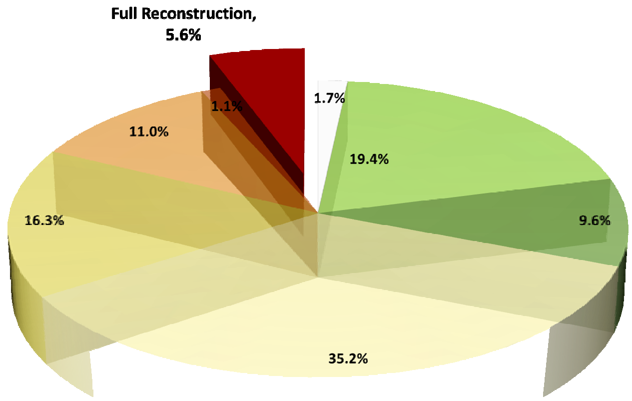
Mill & Overlay with Major Base Repair
East 6th Avenue & Harry Street

5.1.6 Full Reconstruction

After years of extending the service live of a roadway through preventative and rehabilitative maintenance, the repeated traffic volumes, changing weather conditions, and water penetration will slowly deteriorate the pavement until it is structurally unsound and no longer effective for use. At this point, any efforts to rehabilitate the pavement would be considered fruitless; this roadway has inevitably reached the end of its service life, which is where full roadway reconstruction comes in.

According to the U.S. Department of Transportation Federal Highway Administration, reconstruction is defined as a roadway that is rebuilt along an existing alignment and typically involves full-depth pavement replacement. Although outside the scope of this Infrastructure Management Plan, reconstruction can also include altering the characteristics of the road by realigning or reconfiguring an existing travel lane. For the purposes of this report, the process of full reconstruction will involve completely removing the pavement structure to the subgrade or to a depth that will accommodate the new pavement cross section, completing any necessary subgrade repairs, and installing brand new subbase, base and wearing courses in accordance with the Borough's current roadway paving standard.

Based upon our condition assessment, we are recommending that 20 of the 355 blocks (5.6%) be fully reconstructed. In addition to the severity of the pavement distress patterns seen in the pictures below taken along Spring Mill Avenue between East 4th Avenue and Cherry Street (Blocks 193-199), the core sampling revealed that these blocks were constructed with less than 2 inches of asphalt. In our professional opinion, the pavement has rapidly deteriorated because it was not designed to withstand the traffic loads it receives. We feel the deterioration has also been accelerated by the improper sealing at the utility trenches, which has allowed water to reach and damage the pavement subbase beyond repair.



Spring Mill Avenue (East 4th-Cherry)

5.1.7 Leveling Course

The goal of resurfacing a roadway is to extend the service life of the pavement as much as possible. In order to maximize the effectiveness of an asphalt overlay, the milled surface should be as smooth and level as possible before the final wearing course is placed. Unlike milling which removes an even depth of the existing pavement surface, a leveling course is an initial layer of pavement that used to make up elevation differences by filling in the low areas that may have been caused by a minor drainage issue, trench settlement, or rutting within the road surface.

The material used for a leveling course is typically the same material used for the wearing course with the difference being the wearing course provides a protective layer across the entire roadway surface and is placed and compacted to a consistent depth or thickness, while a leveling course is generally only used on an as needed basis. The thickness of a leveling course is dependent on the depth of the low areas and must be placed as thick as the deepest depression but not so thin that it cannot be properly compacted; however, if the depressions are too deep, the leveling course may have to be installed in two different layers.

The picture on the previous page is an excellent visual aid demonstrating the relationship between the existing pavement, leveling course, and final wearing course during a roadway resurfacing project. All three pavements layers have labeled for your reference. If you look closely, you will notice that the existing pavement in the bottom left corner is gray and faded and that there is a discernable difference between the thickness of the leveling and wearing courses.

Leveling Course	Blocks	Assumed Area of Base Repair
Surface Repair	2	25% of Block Area
Remove Plate	10	35% of Block Area
Correct Ponding	2	50% of Block Area
Add Crown	6	50% of Block Area
Regrade	3	100% of Block Area

For the purposes of this Infrastructure Management Plan, we are recommending the use of a leveling course for the following reasons: to repair surface deformations such as rutting, to restore the elevation and drainage pattern of the roadway once existing driveway and stormwater plates are removed; to correct minor ponding issues by providing positive drainage; to construct a crown in the roadway to direct water to flow away from the centerline and towards the curbing; and to completely regrade a segment of roadway to accommodate the installation of additional storm sewer structures.

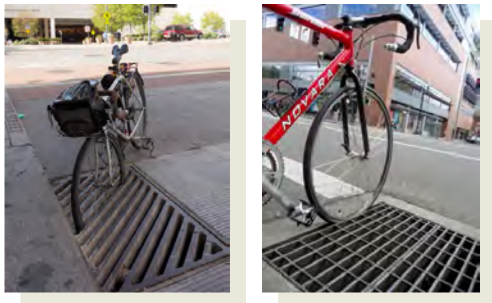
5.2 Storm Sewer Improvements

As sewer system networks age, routine maintenance and repairs are required to ensure that the system is in good working order and capable of providing the necessary support for the related pavement structure. This section provides several repair recommendations for the existing storm sewer system as well as the installation of several new sections of storm sewer that we feel will maximize the effectiveness of the roadway repairs and the Borough's investment in their infrastructure. For the purposes of this Infrastructure Management Plan, we are recommending that all storm sewer improvements be completed in conjunction with the roadway repairs to help reduce the overall cost of the improvements and to reduce the inconvenience that will be experienced by the Borough's residents, business community, and visitors during construction.

Upon review of the information collected from the condition assessment forms, MS4 outfall map, Google street view, and satellite imaging, four repair/upgrade categories were established for the existing storm sewer: inlet parging, grate replacement, inlet structure replacement, and the removal of all surface plates and pipes at driveways and intersections.

Inlet parging is recommended for inlets where the grout or mortar that was placed around the storm sewer pipe has worn away, leaving a hole for water to escape the structure and erode the adjacent soil. Parging is essentially the re-grouting or re-sealing of the area around the pipe where it enters the inlet. Parging is a cheap and effective method of keeping the collected runoff within the storm sewer system.

While our recommendations for inlet grate and structure replacement will not provide a noticeable improvement to the functionality of the storm sewer system from a drainage standpoint, it will provide a significant improvement for those utilizing non-vehicular forms of transportation on and along the roadways. As you can see from the pictures on the following page, the storm sewer structures themselves can pose several potential safety hazards for bicyclists and pedestrians; such as the wheel of a bicycle getting stuck in the slots of an inlet grate or the top of a city inlet collapsing within the sidewalk. As such, we are recommending that any existing inlet grate that does not meet the dimensional spacing requirements currently deemed safe for bicycles by PennDOT be upgraded to a bicycle safe grate and that all city inlets be removed and replaced with standard inlets to improve pedestrian safety and the efficiency of the structure itself.



Standard Grate vs Bicycle Safe Grate

City Inlets vs Standard Inlets

We have also recommended that all surface plates, pipes, and culverts be removed from driveways and intersections and replaced with full depth pavement graded to provide positive drainage. Replacing these structures with graded pavement will remove several areas of observed ponding by directing surface runoff to the nearest inlet. Removing the plates, pipes, and culverts will also eliminate tripping hazards and the potential for these small pipes and channels to become clogged, thus improving the overall efficiency of the system while increasing pedestrian, bicyclist, and motorist safety.

Recommended Repair	No. of Inlets	No. of Blocks
Inlet Parging	83	15
Grate Replacement	205	57
City Inlet Replacement	37	12
Surface Plate/Pipe Removal	-	48

The table to the left provides a breakdown of the recommended repairs and the total number of inlets and blocks associated with each repair. Overall, we are recommending a total of 83 existing inlets along 15 blocks be parged; grates on 205 of the existing inlets along 57 blocks be upgraded with bicycle safe inlet grates; 37 existing city inlet structures along 12 blocks be upgraded to a standard inlet structure; and approximately 1,490 linear feet of plates and 2,440 linear feet of surface pipe along 48 blocks be removed. It is anticipated that areas where the plates and pipes are removed where required grading to maintain positive drainage.

In addition to these recommended improvements at the surface, this Infrastructure Management Plan includes repair recommendations based upon the issues identified by the storm sewer televising. The weekly reports confirmed that the majority of the Borough's existing storm sewer system was in generally good condition; however, several different pipe failures were identified throughout the system in the form of offset pipe joints, pipe settlement, corrosion, structural cracking, and broken or damaged pipes. Since these pipe failures have a direct impact on the pipe's function, we are recommending that approximately 9,050 linear feet of pipe replacement be performed along a total of 70 blocks at the time the roadway repairs are completed for that specific block. This assumes of course that the deteriorating condition of the storm sewer pipe does not worsen to the point that an emergency repair would be required.

Small and large scale projects for the installation of new storm sewer are also recommended per These recommended storm sewer improvement projects were from the August 2017 Draft Infrastructure Management Plan; the investigation of other storm sewer projects was not included in our scope of work. After a brief review of the overall drainage patterns throughout the Borough, Gilmore & Associates, Inc. made a few minor modifications to the layout of the conceptual system design but, overall, these projects are generally consistent with the project identified in the August 2017 Draft Infrastructure Management Plan.

The smaller scale projects were assessed on a block by block basis and consist of the installation of 21 new inlet structures and associated storm sewer pipe along 12 blocks. The new structures are generally recommended to address a drainage or ponding issue which cannot be corrected by grading during the block's roadway repair.

A brief description of each recommended larger scale storm sewer improvement project is provided below and the locations are shown in the accompanying map snapshot. The blocks highlighted in orange represent proposed project whiles the blue highlights represent blocks with existing storm sewer systems; a Borough-wide copy of this map can be found in Appendix A of this report.

- <u>East 10th Avenue System</u>: Expand Wells and Jones Street system to include portions of Harry Street, East 11th Avenue, and East 10th Avenue.
- <u>Righter Street System</u>: Expanded to include portions of Jones Street and East 11th Avenue.
- <u>Harry Street System</u>: Expand the East 6th Avenue system to extend along include portions of Harry Street.
- <u>East 6th Avenue & East 4th Avenue Systems</u>: Reconstruct and resize the systems to accommodate the new flow from the Harry Street System.
- <u>East 7th Avenue System</u>: Expand to include portions of Hallowell Street, Wells Street, and East 7th Avenue.

By completing these storm sewer expansions and repairing any identified failing pipes/structures, the Borough will maximize the effectiveness of its roadway improvements.

5.3 Curb & Gutter Replacement

The Borough has requested that all gutter curb and curb constructed of non-standard materials (e.g. granite) be removed and replaced with standard concrete upright curb. Gilmore and Associates, Inc. evaluated all 355 roadway blocks using Google street view to approximate the locations of existing gutter curb by observing the location and uniformity of the cracking along the curb lines as well as areas of pavement damage where gutter curb was exposed.

Upon review, we have identified and are recommending the replacement of 39,755 linear feet of gutter curb along 27 blocks throughout the Borough. These 27 blocks either showed visible signs of gutter curb or were assumed to have gutter curb based on the signs of uniform cracking within 12 to 18 inches from the curb line.

Replacing the existing gutter curb with full depth pavement accounts for approximately 20% of the total estimated construction cost. This endeavor is so costly because the existing material must be removed, the roadway excavated to permit installation of a full depth pavement and new concrete curb, and then the curb constructed and new pavement layers placed. Since such a large portion of the Borough's investment would be dedicated to gutter curb, it is imperative that these assumptions be field verified especially since there was no field work performed to identify and confirm the actual locations. Please note that the commencement of the roadway repairs could potentially uncover more gutter curb hidden beneath the surface.

Information provided in the August 2017 Draft Infrastructure Management Plan was used to determine the location of curb constructed of non-standard materials and Google street view was used to identify blocks that would benefit from curb installation or the replacement of existing deteriorated curb. Accordingly, in addition to the curb referenced above, we recommend that approximately 23,738 linear feet of new curbing be installed along a total of 37 roadway blocks and 6,121 linear feet of existing curbing be removed and replaced along a total of 10 roadway blocks.

A total of 69,614 linear feet (approximately 13.2 miles) of new curb is recommended to be installed throughout the Borough during implementation of the Infrastructure Plan. While the curb quantity may seem high, it is important to remember that curb is located on both sides of the street and therefore the quantity of curb is essentially double the length of a roadway. A map showing all locations of curb and gutter curb replacement can be found in Appendix A.

5.4 Curb Ramp Improvements

As previously mentioned, curb ramps are required by federal law to be upgraded when the pedestrian path is being altered. Since curb ramps are typically located at intersections, this report assumes that the curb ramp improvements will be completed at the same time as the repair treatments for that specific 'intersection' block rather than the 'roadway' block.

All intersections were reviewed and assessed on an individual block by block basis utilizing Google street view and satellite imaging to confirm the number of existing curb ramps and to determine the recommended number of the required curb ramp upgrades. Since ADA standards were last updated in 2010 and PennDOT's curb ramp details were last updated in 2011, it was been assumed that all existing curb ramps identified within the Borough's right-of-way are non-compliant unless documentation was obtained stating otherwise. It has also been assumed that all diagonal curb ramps are to be replaced with two separate curb ramps, one for each crossing direction. Diagonal curb ramps are defined as one curb ramp, typically located in the center of the intersection radii, which is connected to two separate crossing walks that allow pedestrians to cross in two directions.

This totals 845 curb ramps to be replaced throughout the Borough.

Prior to publicly bidding the project, it is pertinent that these assumptions be field verified; visually confirming the location of the pavement seams with respect to the location of the existing curb ramps ensures that the curb ramp improvements are being completed at the correct time; and taking field measurements of the existing curb ramps ensures that a compliant curb ramp is not being unnecessarily removed and replaced. Another benefit to field verification is that issues, such as improper drainage and ponding, can be observed, documented, and a solution reflected in the design of the new curb ramp.

5.5 Pavement Markings

Pavement markings are considered incidental items for the purposes of this Infrastructure Management Plan and it is assumed that all existing pavement makings such as centerlines, lane lines, stop bars, etc. will be replaced at the time of the roadway repair treatment. We would however suggest that the crosswalk pavement markings be standardized throughout the Borough to better identify pedestrian crossings. It is our professional opinion that continental crosswalks, as shown in the picture to the left, should be the standard since they are more visible to motorists and therefore, helps increase a driver's awareness of potential pedestrians within the crosswalks.

Since pavement markings were input as a lump sum based on the block area and not based on measurements of the current features, the Borough has the flexibility during development of the construction documents to add new pavement markings, such as parking space delineations or shared bicycle lane markings.

Section 6: Implementation Scenarios & Engineer’s Opinion of Probable Cost

Upon completion of the assessment and the development of the scope of work to be completed by the Borough under the Infrastructure Management Plan, probable costs and an implementation plan were developed. An engineer’s opinion of probable cost was developed on an individual block basis to allow for easily manipulation of the data and for costing of different implementation scenarios.

Several different scenarios were presented to Borough Council for their consideration, including: “Worst First’ Scenario” that concentrates on completing the major repairs first independent of location; “Efficiencies Scenario” that concentrates on completing repairs in the same area but generally addresses major repairs and storm sewer projects in the earlier years; “Stormwater Scenario” that concentrates on completing all storm sewer related work in the first two years; “East to West Scenario” that concentrates on completing repairs starting on the east side of the Borough and moving west; and “Even Costs Scenario” that concentrates on completing the repairs such that costs approximately the same amount during each year of implementation. Borough Council selected the “Worst First Scenario” and “Efficiencies Scenario” for in-depth consideration and comparison. Both scenarios are based on the pavement repair year developed for each block during the assessment phase, as discussed in Section 1.2 of this report.

6.1 Unit Costs and Adjustment Factors

Gilmore & Associates, Inc. obtained and compiled pricing information from previous capital improvement projects publicly bid by the Borough and nearby municipalities, PennDOT’s Engineering and Construction Management System (ECMS) archives, and recent projects publicly bid on the PennBid website for the surface treatments, base repairs, storm sewer improvements, curb removal and replacement, and curb ramps. This pricing information was averaged and individually assessed based on the year of the project and the respective quantities in order to prepare an opinion of probable unit pricing associated with the recommended repairs. As a result, the unit costs used to prepare the Engineer’s Opinion of Probable Cost have been specifically tailored to the scope of work and the timeframe allocated for this Infrastructure Management Plan.

Since pavement marking upgrades are required for the majority of the surface repair treatments and new pavement markings are a relatively inexpensive line item when considering the total cost of the repair treatment, it was determined to be more efficient to simply evaluate pavement markings as lump sum cost based on the block area in lieu of quantifying them on a block by block basis. Based on the Borough’s historical cost data, we have estimated that the cost to install pavement markings is equivalent to approximately 7.5% of the cost of the surface repair treatment; this excludes the cost of base repair and has been adjusted to reflect the age and size of the referenced project as well as account for inflation.

An 8% adjustment was included for construction management/construction observation related expenses. Since it is recommended that each block be individually re-evaluated when selected for construction and it was assumed that curb ramps would be designed and included in the bid package, an 8% design and contingency adjustment was also included for any required design related expenses, unforeseen circumstances, and other minor construction costs such as erosion and sediment control and general mobilization.

6.2 “Worst First” Scenario

The “Worst First” Scenario is a proposed implementation of the Infrastructure Management Plan that concentrates on upgrading the infrastructure in the worst condition and addressing major repairs first. All storm sewer expansion projects were included in years 1-3 of the 5-year implementation schedule.

Micro-surfacing and crack sealant are only included in years 4-5 of the 5-year implementation schedule since these surface treatments are meant to address long-term maintenance of the roadway versus repair of base or subbase failure.

The benefit of this scenario is that the roadways in the worst condition would be addressed first. The downside of this scenario is that it disrupts several areas of the Borough within the same year. It does not take into account the relative location of repair work to other locations where repair work is being completed in the same year and, as such, additional costs are anticipated due to the downtime and man-power that would be required of a contractor to move equipment between several locations; this movement is known as mobilization.

The total opinion of probable cost for this scenario is $28.2 million, which includes all roadway repairs, pavement marking installation, curb and curb ramp replacement, storm sewer extensions and repairs, design, contingency, construction management, construction observation, and mobilization.

The “Worst First” Scenario block repair map can be found in Appendix A but the yearly costs are provided below as a summary.

Worst First Scenario
Total Estimated Probable Cost Per Year

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	Subtotal
Total Probable Cost of Pavement Repair, including Pavement Markings	$ 2,168,420.79	$ 943,542.92	$ 1,392,975.77	$ 982,031.01	$ 441,473.30	$ 5,928,443.79
Total Probable Cost of Curb Ramp Replacement and Concrete Repairs	$ 2,885,120.00	$ 2,154,920.00	$ 3,616,795.00	$ 1,907,740.00	$ 1,353,710.00	$ 11,918,285.00
Total Probable Cost of Storm Sewer Replacement and Installation	$ 2,168,420.79	$ 943,542.92	$ 1,392,975.77	$ 982,031.01	$ 441,473.30	$ 5,928,443.79
Total Probable Cost of Design and Contingency	$ 727,719.92	$ 266,421.29	$ 481,908.23	$ 293,911.19	$ 184,046.65	$ 1,954,007.29
Total Probable Cost of Construction Management & Construction Observation	$ 727,719.92	$ 266,421.29	$ 481,908.23	$ 293,911.19	$ 184,046.65	$ 1,954,007.29
Total Probable Cost for Additional Mobilization due to Location	$ 150,000.00	$ 150,000.00	$ 100,000.00	$ 100,000.00	$ -	$ 500,000.00
Total Probable Cost	**$ 8,827,401.42**	**$ 4,724,848.42**	**$ 7,466,563.01**	**$ 4,559,624.40**	**$ 2,604,749.90**	**$ 28,183,187.16**

6.3 Efficiencies Scenario

The Efficiencies Scenario is a proposed implementation of the Infrastructure Management Plan that concentrates on grouping blocks within a specific area that require similar repair work. As discussed in this report, given the impact that proper stormwater management has on a roadway, primary focus was given to completing all storm repair work in years 1-2 of the 5-year implementation schedule and secondary focus was given to addressing major roadway repairs.

All micro-surfacing is included in year 3 of the 5-year implementation schedule with the intent of having this work completed under one contract. While this is a maintenance method rather than repair work, this allowed for the best grouping of the recommended repair work.

The benefit of this scenario is that disturbance to the Borough overall will be minimized since work is concentrated in specific locations each year and, because of that, it is anticipated that mobilization costs and downtime related to relocating equipment will be minimized. The downside of this scenario is that some blocks will be repaired prior to those in a worse condition, e.g. some blocks in poor condition will be repaired after a block which is in fair condition.

The total opinion of probable cost for this scenario is $27.7 million, which includes all roadway repairs, pavement marking installation, curb and curb ramp replacement, storm sewer extensions and repairs, design, contingency, construction management, and construction observation. No additional mobilization costs were added to this scenario since it is anticipated to be a nominal cost when compared to the total and therefore assumed to be included within the contingency.

The Efficiencies Scenario block repair map can be found in Appendix A but the yearly costs are provided below as a summary.

Efficiency Scenario
Total Estimated Probable Cost Per Year

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	Subtotal
Total Probable Cost of Pavement Repair, including Pavement Markings	$ 1,774,697.47	$ 2,007,957.95	$ 1,149,443.46	$ 571,360.14	$ 424,984.77	$ 5,928,443.79
Total Probable Cost of Curb Ramp Replacement and Concrete Repairs	$ 3,029,250.00	$ 3,721,225.00	$ 2,154,800.00	$ 1,785,640.00	$ 1,227,370.00	$ 11,918,285.00
Total Probable Cost of Storm Sewer Replacement and Installation	$ 1,774,697.47	$ 2,007,957.95	$ 1,149,443.46	$ 571,360.14	$ 424,984.77	$ 5,928,443.79
Total Probable Cost of Design and Contingency	$ 613,709.21	$ 607,843.88	$ 361,409.30	$ 230,355.17	$ 140,689.73	$ 1,954,007.29
Total Probable Cost of Construction Management & Construction Observation	$ 613,709.21	$ 607,843.88	$ 361,409.30	$ 230,355.17	$ 140,689.73	$ 1,954,007.29
Total Probable Cost	**$ 7,806,063.35**	**$ 8,952,828.67**	**$ 5,176,505.51**	**$ 3,389,070.62**	**$ 2,358,719.00**	**$ 27,683,187.16**

Section 7: Conclusion

In conclusion, this Infrastructure Management Plan report intends to document the overall condition assessment of the roadway, storm sewer, and curb along the 355 blocks owned and maintained by the Borough of Conshohocken; provide repair recommendations for these features as well as curb ramps and pavement markings; and offer two implementation scenarios with related opinion of probable costs for the repair recommendations.

Upon completion of the analysis, including associated field work, it is recommended that, of the 355 blocks: 6 blocks receive no treatment, 69 blocks be crack sealed, 34 blocks be micro-surfaced, 125 blocks be milled and overlaid, 101 blocks receive varying degrees of base repair and then be milled and overlaid, and 20 blocks be fully reconstructed. Pavement markings are an incidental cost of any roadway improvement project and, while they were not quantified during the scope of this analysis, assumed costs for this work are included.

In support of increasing the integrity of the roadways and longevity of the improvements, six large storm sewer projects plus several small storm sewer projects, removal of all driveway and intersection plates and pipes, and storm sewer repairs are recommended to be completed at the same time that work is completed on the respective blocks.

Per the Borough's request for a review of existing curb, it was found that 39,755 linear feet of gutter curb and 6,121 linear feet of other curb should be removed and replaced to provide standard concrete curb throughout the Borough. During that review, it was determined that the Borough has the opportunity to install another 23,738 linear feet of new curb. This totals 69,614 linear feet (approximately 13.2 miles) of curb to be installed throughout the Borough during implementation of this plan. Though the Borough owns and maintains approximately 16.6 miles of roadway, this curbing represents less than half of the Borough's roadway miles since curbing is installed along both sides of roadways and is therefore nearly double the quantity of roadway length if it is present everywhere. Additional concrete related work recommended to be completed includes the required replacement of curb ramps throughout the Borough, totaling 845 curb ramps.

The engineer's opinion of probable cost to repair all 355 blocks, including the roadway work, storm sewer improvements, curb and curb ramp replacement, and pavement markings, is $28.2 million for the "Worst First" Scenario and $27.7 million for the Efficiencies Scenario. We feel that both scenarios are sound and suitable approaches to implementing the Infrastructure Management Plan but it is ultimately up to Council to choose the scenario that best fits the Borough's goals.

It is hoped that, as work is completed, the Borough updates the provided Microsoft Excel spreadsheet with repair records and unit costs in order to maximize the worth of this report.

References

1. Draft Infrastructure Management Plan prepared by Paul W. Hughes, P.E. for the Borough of Conshohocken, August 2017.

2. U.S. Department of Transportation Federal Highway Administration. *Distress Identification Manual for the Long-Term Pavement Performance Program*, Publication FHWA-RD-03-031, June 2003. https://www.fhwa.dot.gov/publications/research/infrastructure/pavements/ltpp/reports/03031/03031.pdf

3. U.S. Department of Transportation Federal Highway Administration. *Mitigation Strategies for Design Exceptions*, July 2007, https://safety.fhwa.dot.gov/geometric/pubs/mitigationstrategies/chapter1/1_typesconst.htm

4. "Understanding Asphalt Pavement Distresses – Five Distresses Explained." Asphalt Magazine, Asphalt Institute, http://asphaltmagazine.com/understanding-asphalt-pavement-distresses-five-distresses-explained/