2017 Streetlight Condition Assessment Technical Memo

Executive Summary

The City of Ann Arbor desired a comprehensive condition assessment of the City owned streetlight system and the development of a prioritized replacement program. The City of Ann Arbor retained OHM Advisors to assess the condition of 1,496 streetlights in March of 2017. Dan's Excavating was contracted by OHM Advisors to assist with the field investigation. The information collected out in the field was then used to develop a prioritized replacement plan with estimated rehabilitation and replacement costs. This report summarizes the findings of the field investigations, the methodology of the condition assessment, and the results of the prioritized replacement program.

Project Goals

1. **Asset Inventory** – Utilize a tablet application to efficiently collect data in a GIS format with instant cloud delivery.
2. **Condition Assessment** – Assess streetlights of different types and ages to obtain a sample.
3. **Determine Remaining Life of Assets** – Use the condition assessment data to develop remaining useful life estimates for each streetlight.
4. **Replacement Prioritization & Replacement Cost** – The information gathered from the condition assessment was used to develop a prioritized replacement program which consisted of determining the streetlight asset value, and cost estimates for repair, replacement and renewals.

Project Results

- Developed a methodology to prioritize streetlight replacements with the help of City staff before finalizing.
- Applied the final prioritization methodology to the streetlight condition assessment database in order to produce individual priority ratings for each streetlight.
- 546 of the lights that were investigated contained at least one grade 4 score indicating severe wear or damage and failure likely in the foreseeable future
- Analyzed the data collected during the field investigations and identified $2,620,355 worth of repair and replacement needs for the streetlights that were investigated.
- Incorporated the streetlight prioritization into the GIS database as a deliverable to the City.
- Created a draft technical memo detailing major findings of assessment and analysis.
- Reviewed the GIS database and the draft technical memo with the City for their review and comments.
- Finalized the GIS database and technical memo for delivery to the City.

Streetlight Categorization

Streetlights are comprised of several different parts. Due to the complexity of these light structures, a more detailed definition of a streetlight type is needed to consistently assess each structure. The City of Ann Arbor's streetlight database already contained a data field titled "Light Use Type" that defined each light according to where it was located. For example, if a light was located at an intersection with traffic signals it would be categorized as "Intersection - Signalized" for the "Light Use Type" attribute. Taking it one step further, of the 1,496 lights that were inspected, 17 different model types were identified and assigned to each light accordingly. An example photograph and assessed quantity of each "Model Type" can be found in the Photos section, which follows the appendices in this report.

In order to create more accurate and standardized rehabilitation costs, City staff informed OHM Advisors of the three basic types of lights they own:

1. Downtown Standardized Pedestrian Lights
2. Non-Downtown Non-Standardized Pedestrian Lights
3. Non-Downtown Cobra Head Lights

These light types are based on life cycle costs, which factor in "Light Use Type" and location. Lights of the same type require similar maintenance and replacement costs regardless of the "Model Type". For example, any Type 1: Downtown Standardized Pedestrian Light with a failed luminaire received a recommended rehabilitation cost for Type 1 luminaire replacement. OHM Advisors and City staff worked together to generate repair and replacement unit costs for each of the three light types, which can be found in Appendix A: Rehabilitation Unit Cost Tables. These unit costs were used to develop the recommended rehabilitation costs for each inspected streetlight.

Streetlights were further broken down into four different components in order to create more detailed ratings for each light. Those four components were defined as:

1. Luminaire
2. Foundation & Base
3. Lamppost
4. Electrical

The luminaire is the complete electric light unit that attaches to the arm or directly to the lamppost depending on the streetlight model type. Each unit is comprised of the fixture, the light, and the globe/guard that protects the light. The foundation & base component consists of the foundation, anchor bolts, and handhole. The lamppost component includes the base plate, the weld that joins the base plate to the pole shaft, the pole shaft, and the arm and bracket if applicable for each model type. The electrical component is made up of the insulation, wiring, splice(s), and ground(s).

Field Investigations

Assessing every streetlight in the City's system would be cost-prohibitive, time consuming, and unnecessary to determine the overall system condition for the purposes of this project. Therefore, obtaining data for a portion of the City owned streetlights and extrapolating the results to the remaining streetlights was deemed acceptable to understanding the overall condition of the entire system. City staff identified a representative sample of streetlights for OHM Advisors and Dan's Excavating to investigate. Lights located in areas of high importance and installed prior to the year 2010 were the focus when creating the sample, which accounted for about 65% of the streetlights owned by the City of Ann Arbor. City owned streetlights located at signalized intersections were not part of this investigation since they are included in the City's routine signal maintenance procedures. OHM Advisors and Dan's Excavating staff inspected 1,496 streetlights owned by the City of Ann Arbor during February and March of 2017. The same process and investigation form was used on each light identified in the assessment plan. The list of data fields collected on the investigation form can be found in Appendix B: Field Investigation Form Data Fields.

Condition Assessment

The condition of the representative sample of the City of Ann Arbor's streetlight system was assessed using a rating system developed by the OHM Advisors staff. It features a similar structure to the rating system developed by the National Association of Sewer Service Companies (NASSCO) for their Pipeline Assessment and Certification Program (PACP). The streetlight rating system uses a scale of zero to five. A score of zero indicates a light is brand new or in "like-new" condition, while a score of five indicates a light that has failed or is nearing the point of failure as shown in Table 1.

Table 1: Condition Rating System

Score	Light Condition
0	New or like new
1	Minimal wear and good working condition
2	Moderate wear but still functional
3	Significant wear, yet failure unlikely in near future
4	Severe wear and failure likely in the foreseeable future
5	Marginal functionality with failure imminent

Each data field in the investigation form has a corresponding rating (9.999 was used if the data was unavailable or if the data did not require a score). The individual data field scores can be found in the Condition Ratings Matrix worksheet of the Final Streetlight Investigation Tables Excel file. If the data entry is not one of the preset selections, a lighting expert for OHM Advisors reviewed that particular item and manually assigned a score from zero to five.

All of the data field scores for a particular light component were averaged to formulate a condition rating for that particular light component. All four of the component ratings are then combined to form the Overall Condition Rating. The Overall Condition Rating averages the four component ratings, but the "Foundation & Base" and "Electrical" components are weighted twice as heavily as the Luminaire and Lamppost condition ratings. The "Foundation & Base" and "Electrical" components were given a higher weighting because of their greater importance to public and field crew safety. Due to the effects of averaging, the Overall Conditions Ratings cause the system to appear in average condition at worst. While the system does not need an overhaul, several major issues still exist and need to be addressed. Those major issues can often go unnoticed when only looking at the Overall Condition Ratings. The four component ratings begin to show the more severe issues (as seen in Figures 1 through 4 below), but the Overall Quick Ratings make the streetlights with severe issues very obvious.

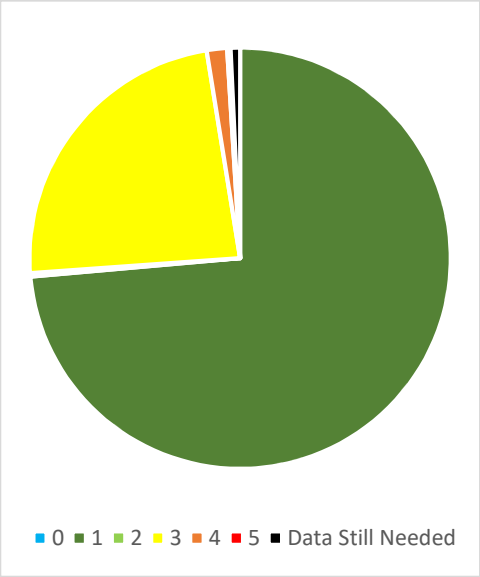


Figure 1: Luminaire Condition Ratings

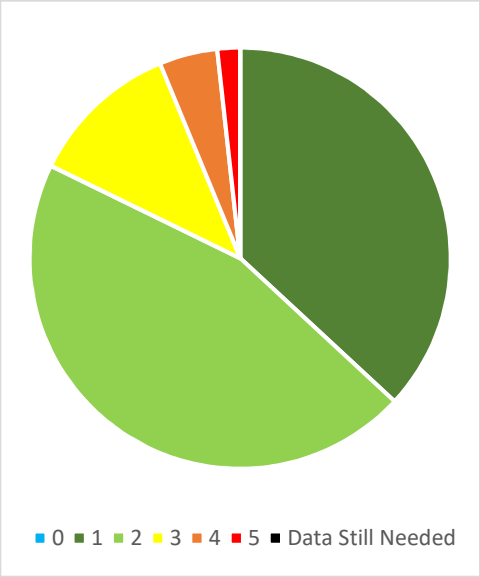


Figure 2: Foundation & Base Condition Ratings

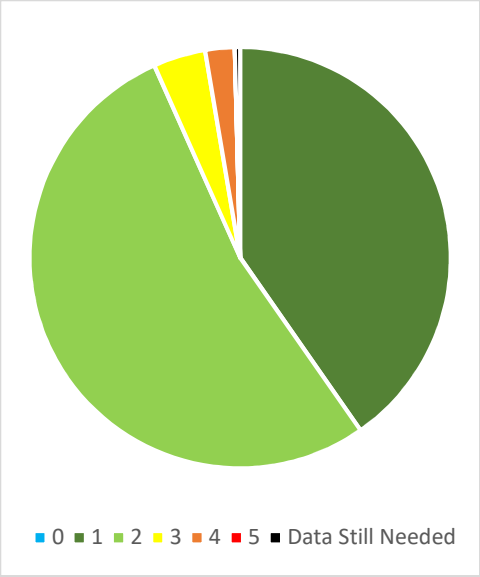


Figure 3: Lamppost Condition Ratings

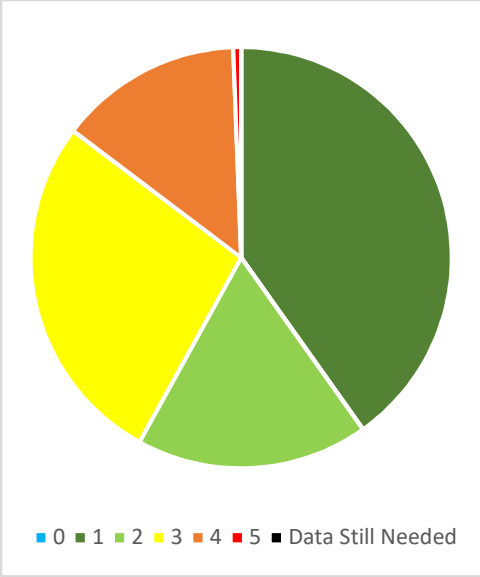


Figure 4: Electrical Condition Ratings

OHM Advisors developed the Overall Quick Rating to highlight the most severe deficiencies found for each light. A breakdown of how the quick ratings work can be seen in the bulleted list below:

- 1st character: highest severity score found in the light
- 2nd character: total number of occurrences of highest severity score
- 3rd character: second highest severity score found in the light
- 4th character: total number of occurrences of second highest severity score

As an example, a light with a quick rating of 5129 has one grade five score and nine grade two scores. The one grade five score is considered a statistical outlier in this case. The nine grade two scores cause the Overall Condition Rating to be skewed towards the lower end, thus making it seem as though the light is in decent condition. Skewed Overall Condition Ratings can paint a deceiving picture that fails recognize the major issues that do exist like the single grade five score in the example. For this reason, the Overall Quick Ratings were used to calculate the probability of failure values that were used for the developing the priority ratings, which are discussed in more detail later in this document.

Investigations Summary

Out of the 1,496 inspected streetlights, only 71 are considered to be in good, working condition with no rehabilitation or maintenance required at this time. OHM Advisors identified 75 in need of immediate repairs due to major structural issues or safety concerns. A figure titled "Streetlight Assessment Overview" highlights the 75 in need of immediate repairs and can be found at the very end of this report.

OHM Advisors also generated $2,620,355 worth of repair and replacement needs for the streetlights that were investigated. Nearly half of the streetlights need new anchor bolt nuts and a fresh coat of paint. The most expensive rehabilitation task requires 754 streetlights to be repainted. The repainting alone accounts for over half of the total recommended rehabilitation costs identified for all of the streetlights assessed. The second most expensive task involves replacing 109 foundations. A summary table listing the total costs for each recommended rehabilitation method can be seen below in Table 2.

Table 2: Cost and Overall Priority Rating Summary

Rehabilitation Method	No. of Lights	Total Cost
No rehab necessary	71	$0
Regular maintenance	477	$19,080
Replace luminaire	32	$56,600
Replace foundation	109	$515,500
Minor foundation repair	18	$3,600
Replace nuts	738	$36,900
Replace handhole cover	339	$50,850
Repaint pole	754	$1,345,800
Repair weld	201	$50,250
Replace pole	84	$339,000
Replace base cover	37	$14,900
Replace arm	63	$25,200
Tighten/repair arm and fasteners	8	$2,400
Replace bracket	0	$0
Install new fuseholder and fuse	431	$86,200
Install new splice	241	$30,125
Install new EGC	402	$30,150
Terminate EGC	276	$13,800
TOTAL	**-**	**$2,620,355**

Non-Assessed Lights

The City of Ann Arbor asked OHM Advisors to perform an extrapolation of the sample data to the 885 lights that were unable to be assessed as a part of this project. The extrapolated condition ratings, remaining useful life estimates, probability of failure values, and overall priority ratings are all averages based on the results of the field investigation data. Extrapolated data is only intended to be used for planning level purposes. These estimated values give City staff broad information on the non-assessed lights based on an extrapolation from the lights that were assessed.

Streetlight Prioritization

Determining the assets most critical to system operation is essential when managing risk, supporting Capital Improvement Plans (CIP), and efficiently allocating O&M funds. The two key components used to determine risk are Probability of Failure and Consequence of Failure. The Probability of Failure and Consequence of Failure values are multiplied by a weighting factor, added together, and averaged to create an Overall Priority Rating.

Probability of Failure considers the physical condition or age of an asset and is often based on a condition rating. For this project, the first digit of the Overall Quick Rating was selected as each light's Probability of Failure value. Each light's Consequence of Failure is based on five factors that focus on social and economic cost impacts due to asset failure. The five factors used for this project were all rated on a one through five scale and include:

1. **Location of the light** – Whether the light was located within the downtown (boundary provided by City staff). This factor was used to place a higher emphasis on the lights located in the downtown.
2. **Proximity** – Based on the distance of the next closest light, regardless of the owner. This factor was used to highlight the lights that do not have another light close by to keep the area lit in the event of a failure.
3. **Critical Users** – Whether the light was located within 18 feet of a critical user's parcel. The critical users were identified by the City as the University of Michigan hospital, the Veterans Affairs hospital, The University of Michigan campus, all of the Ann Arbor middle schools, and all of the Ann Arbor high schools. The City indicated the lights serving these critical users were important to the safety of pedestrians in these areas.
4. **Age** – Based on the date in which the light was installed (data obtained from the geodatabase attribute "Install Date" provided by the City). A higher emphasis was placed on older lights.
5. **Light Use Type** – This factor was included to emphasize lights located in areas where it may be harder for pedestrians to cross streets. These areas are noted in the geodatabase attribute "Use Type" provided by the City.

The importance of each factor was discussed at a meeting between City staff and OHM Advisors. That discussion resulted in a final weighting for all of the Consequence of Failure factors and the Probability of Failure values in the Overall Priority Rating calculation. The Overall Priority Ratings provide the City with numerical risk values. The Probability of Failure was given the highest weighting factor of 0.4 since it is based purely on the current condition of the light. A matrix that shows the details of each Consequence of Failure factor and the Probability of Failure can be found in Appendix C: Priority Rating Key.

Cost and Priority

OHM Advisors performed an analysis of the recommended rehabilitation costs based on Overall Priority Ratings. The results showed a small number of repairs recommended for the City's most critical lights. The short list of recommendations for the most critical lights directly corresponds to the simple fact that only 27 lights were deemed "most critical", however. Those 27 were identified as "most critical", because they were the only lights with an Overall Priority Rating greater than 3.5. There are still a significant amount of repairs recommended for the rest of the streetlight system. A summary table highlighting the correlation between the rehabilitation costs and Overall Priority Rating can be seen below in Table 3. The complete list of recommended rehabilitation methods and their associated costs sorted by priority rating can be found in the "Cost and Priority Ratings" worksheet in the Final Streetlight Investigation Tables file. All of the costs were created using the unit cost tables found in Appendix A. These costs are intended to only be used for planning level purposes.

Table 3: Cost and Overall Priority Rating Summary

Overall Priority Rating	No. of Lights	Total Cost
0.000 – 0.499	0	$0
0.500 – 1.499	47	$9,445
1.500 – 2.499	867	$1,305,840
2.500 – 3.499	555	$1,249,080
3.500 – 4.499	27	$55,990
4.500 – 5.000	0	$0
TOTAL	**1,496**	**$2,620,355**

Final Geodatabase

As a part of the final deliverable, OHM Advisors prepared a file geodatabase, which contains both spatial and non-spatial information meant to be viewed in ArcGIS. The geodatabase was an enhancement of the data City of Ann Arbor staff provided at the start of the project. None of the spatial information was edited, but several new pieces of non-spatial data were added. The non-spatial project data was separated into different tables and then appended to the appropriate streetlight features via their unique identifier, the "FacilityID". The complete list of data tables developed during this project can be seen on the next page:

- Table A – Field Investigation Data: This table contains the data that was collected during the field investigations.
- Table B – Media: This table displays which images pertain to each light that was investigated.
- Table C – Condition Ratings: This table contains the individual data field scores, component ratings, overall condition ratings, and overall quick ratings for each light that was investigated.
- Table D – Remaining Useful Life: This table contains the remaining useful life calculations for each light.
- Table E – Priority Ratings: This table contains the individual priority factors and overall priority ratings for each light.
- Table F – Rehabilitation Recommendations: This table contains a yes or no value for the 17 rehabilitation methods identified for this project for each light that was inspected as well as an associated cost to perform the recommended rehabilitation methods.
- Table G – Estimated Condition Ratings: This table contains the estimated condition ratings for the four components and an estimated overall condition rating for the 885 City owned lights that were not inspected.
- Table H – Estimated Remaining Useful Life: This table contains the estimated remaining useful life calculations, which are based on the estimated condition ratings for the four components for the 885 City owned lights that were not inspected.
- Table I – Estimated Priority Rating: This table contains the individual priority factors, estimated probability of failure, and estimated overall priority ratings for the 885 City owned lights that were not inspected.

In addition to the file geodatabase, the photos collected as a part of the field investigations were placed in a folder on the USB flash drive and linked to the appropriate feature via the "FacilityID" unique identifier. Lastly, OHM Advisors preloaded the streetlight feature class and related tables in an ArcGIS map document, also found on the USB flash drive. The map document contained four different layers all based on the same streetlights feature class, but symbolized in a different way. The four different symbolizations were based on the following criteria:

- Priority Ratings
- Overall Quick Rating
- Overall Condition Rating
- Immediate Attention Needed

Appendix A: Rehabilitation Unit Cost Tables

Type 1: Downtown Standardized Pedestrian Lights	
Rehab Method	**Cost**
No rehab necessary	$0.00
More data needed	$0.00
Manual review required	$0.00
Regular maintenance*	$40.00
Replace luminaire	$2,000.00
Replace foundation	$7,000.00
Minor foundation repair	$200.00
Replace nuts	$50.00
Replace handhole cover	$150.00
Repaint pole	$1,300.00
Repair weld	$250.00
Replace pole	$5,500.00
Replace base cover	$800.00
Replace arm	Not Applicable
Tighten/repair arm and fasteners	$300.00
Replace bracket	$250.00
Install new fuseholder and fuse	$200.00
Install new splice	$125.00
Install new EGC	$75.00
Terminate EGC	$50.00

Type 2: Non-Downtown Non-Standardized Pedestrian Lights	
Rehab Method	**Cost**
No rehab necessary	$0.00
More data needed	$0.00
Manual review required	$0.00
Regular maintenance*	$40.00
Replace luminaire	$1,200.00
Replace foundation	$4,500.00
Minor foundation repair	$200.00
Replace nuts	$50.00
Replace handhole cover	$150.00
Repaint pole	$1,300.00
Repair weld	$250.00
Replace pole	$4,000.00
Replace base cover	$500.00
Replace arm	Not Applicable
Tighten/repair arm and fasteners	$300.00
Replace bracket	$250.00
Install new fuseholder and fuse	$200.00
Install new splice	$125.00
Install new EGC	$75.00
Terminate EGC	$50.00

Type 3: Non-Downtown Cobra Head Lights	
Rehab Method	**Cost**
No rehab necessary	$0.00
More data needed	$0.00
Manual review required	$0.00
Regular maintenance*	$40.00
Replace luminaire	$700.00
Replace foundation	$4,500.00
Minor foundation repair	$200.00
Replace nuts	$50.00
Replace handhole cover	$150.00
Repaint pole	$2,100.00
Repair weld	$250.00
Replace pole	$4,000.00
Replace base cover	$200.00
Replace arm	$400.00
Tighten/repair arm and fasteners	$300.00
Replace bracket	$250.00
Install new fuseholder and fuse	$200.00
Install new splice	$125.00
Install new EGC	$75.00
Terminate EGC	$50.00

*Regular maintenance cost is only for 1.0 FTE hours; it does not include the price for parts should they be needed

Appendix B: Field Investigation Form Data Fields

GENERAL	LUMINAIRE	FOUNDATION & BASE
FacilityID	Bulb Type	Foundation Type
Light Type	Fixture Make	Foundation Condition
Model Type	Fixture Model	Number of Anchor Bolts
Model Description	Fixture Condition	Anchor Bolt Condition
Investigation Date	Number of Heads	Handhole Cover Condition
Investigation Time	Photocell Status	
Light Height (feet)	Light Condition	
	Globe/Guard Condition	

LAMPPOST	ELECTRICAL	SUMMARY
LamppostID	Wattage	Immediate Attention Needed?
Pole Type	Insulation Condition	Reason for immediate attention
Pole Shaft Material	Wire Condition	Comments
Pole Shaft Condition	Splice Condition	Longitude
Pole Hammer Test Inside Condition	Ground Condition	Latitude
Pole Hammer Test Outside Condition		
Post Make		
Arm Type		
Base Plate Condition		
Weld Condition		
Arm Condition		
Threaded Sleeve		
Tree Impact		
Bracket Condition		

Appendix C: Priority Rating Key

Priority Rating Key			
Factor	**Scores**	**Description**	**Weighting**
Location	1	Non-Downtown Area	0.1
	5	Downtown Area	
Proximity	1	The closest light exists within 200 feet	0.05
	3	The closest light exists between 200 and 300 feet	
	5	No other light exists within 300 feet	
Critical Users	1	Not within 18 feet of a critical user's parcel	0.15
	5	Within 18 feet of the Hospital, UM Campus, middle schools, and high school parcels	
Age	1	< 10 years old	0.1
	2	10 >= x > 20 years old	
	3	20 >= x > 30 years old	
	4	30 >= x > 40 years old & No Date Available	
	5	> 40 years old	
Light Use Type	1	Other	0.2
	3	Intersection - Signalized	
	4	Intersection - Unsignalized	
	5	Mid-block - Crosswalk	
Probability of Failure	1	All based on the highest rated defect	0.4
	2		
	3		
	4		
	5		

*If no deficiencies were found for a particular light, the Probability of Failure defaults to a 1

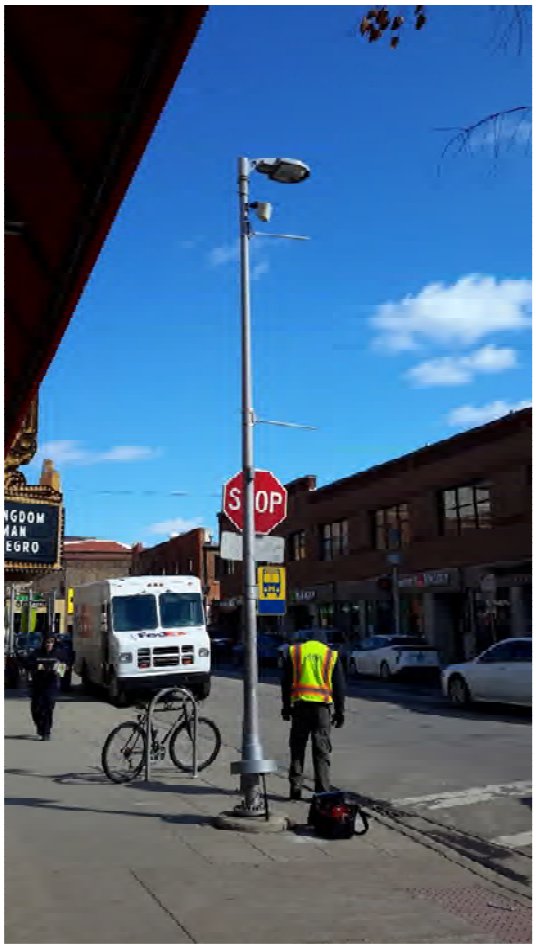
Photos: Light Model Type Examples

Light Model Type A – Black Globe(s)
(263 lights)

Light Model Type B – Silver Globe(s)
(78 lights)

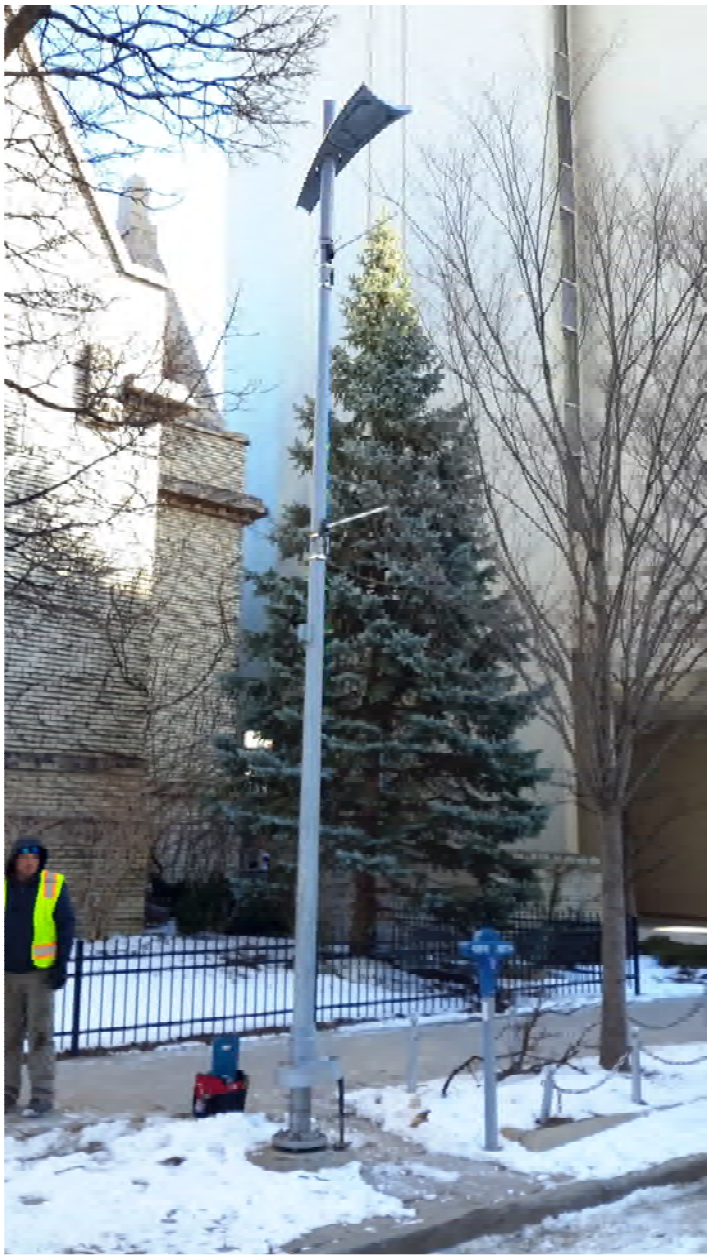
Light Model Type C – Straight Globe(s)
(11 lights)

Light Model Type D – Straight Bowl
(38 lights)



Light Model Type E – Straight LED
(2 lights)

Light Model Type F – Straight Lantern
(9 lights)



Light Model Type G – Curved LED
(30 lights)

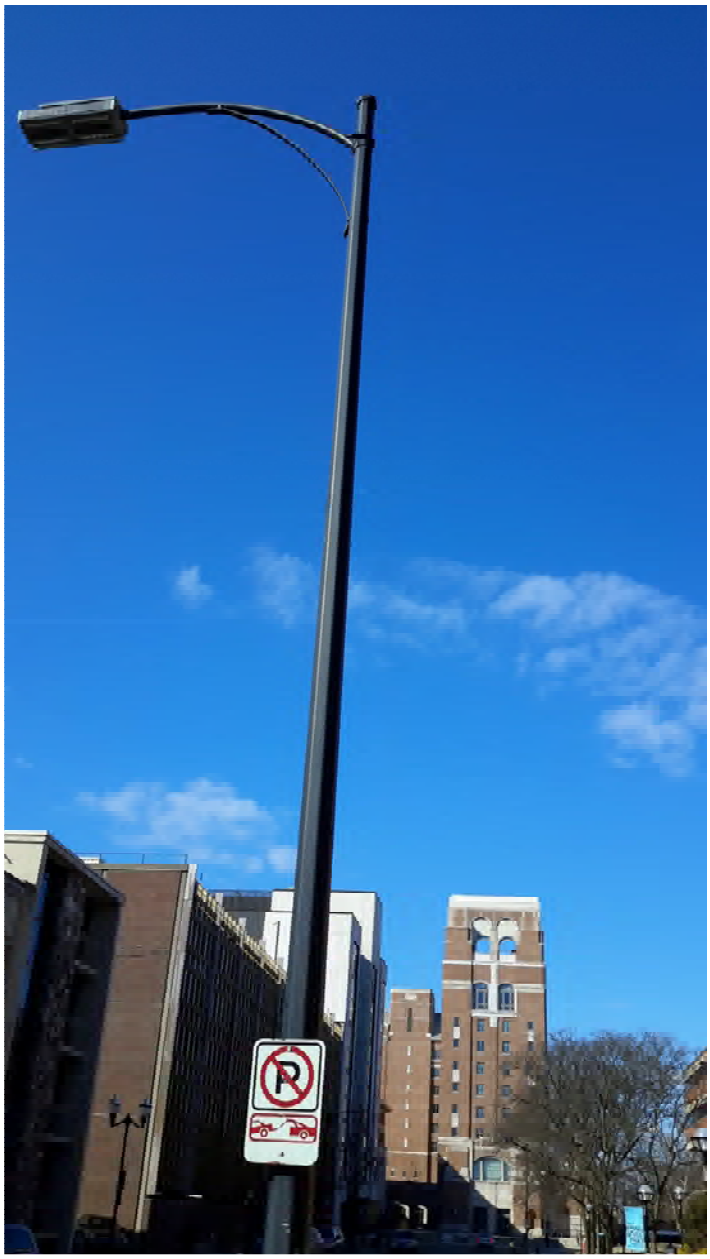
Light Model Type H – Straight High Pressure Sodium
(13 lights)

Light Model Type I – Straight Cylindrical Metal Halide
(10 lights)

Light Model Type J – Straight Square Metal Halide
(4 lights)

Light Model Type K – Straight Decorative Lantern(s)
(153 lights)

Light Model Type L – Short arm cobra with no support
(450 lights)



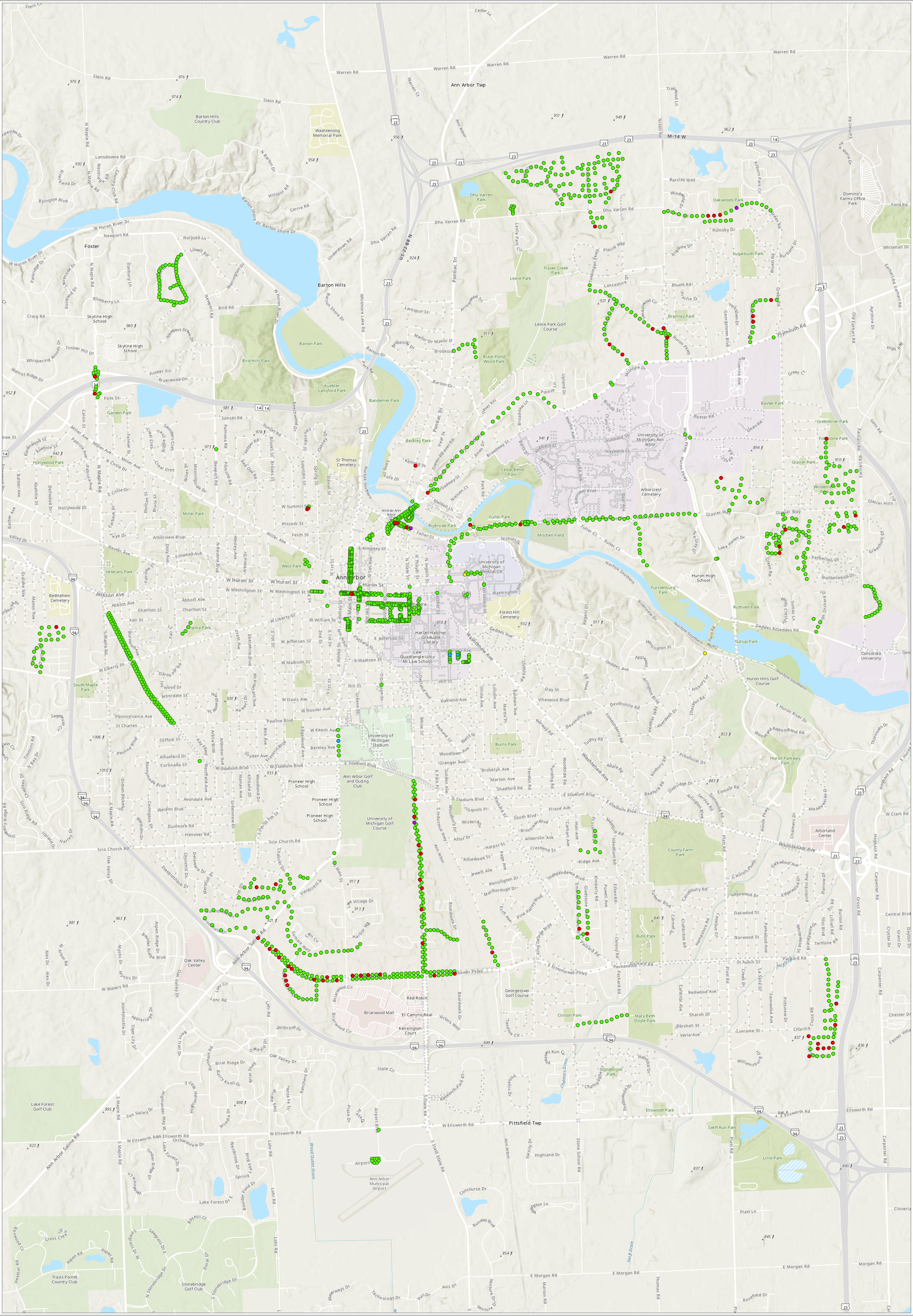
Light Model Type M – Short arm cobra with minor support
(3 lights)

Light Model Type N – Long arm cobra with no support
(4 lights)

Light Model Type O – Long arm cobra with major support
(14 lights)

Light Model Type P – 90 Degree Bend Cobra
(324 lights)

Light Model Type Q – 90 Degree Bend Decorative Lamp
(87 lights)



Ann Arbor Streetlights

Needs Assessment

- Completed - 1,411
- Completed; Needs Immediate Repair - 75
- Could Not Find - 2
- Could Not Assess - 4
- Could Not Access - 4
- Not Being Assessed

Streetlight Assessment Overview

City of Ann Arbor

0 1,400 2,800 Feet

1" = 1,400'

Source: Data provided by City of Ann Arbor. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl

Map Published: September 20, 2017

OHM Advancing Communities

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