

The City of Lewes



City of Lewes Board of Public Works

*107 Franklin Street
Lewes, DE 19958*

**FINAL
STORMWATER MASTER PLAN**

November 2014



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I. EXECUTIVE SUMMARY

This report presents the City of Lewes Board Of Public Works Stormwater Master Plan. This Master Plan encompassed the entire City of Lewes (City) with a focus on the storm sewer infrastructure previously identified and surveyed by City staff as part of the Coastal Resiliency Project. Figure 2 shows the overall Storm Sewer Study Area. The purpose of this study is to establish a system baseline and develop a plan for operation and maintenance. Additionally, this report summarizes Duffield Associates' capacity evaluation, recommends areas requiring further study, and identifies areas where modeling indicates potentially undersized storm sewer infrastructure.

A summary of the efforts undertaken to complete this Master Plan is as follows:

- An inlet evaluation was performed to collect catch basin data such as top elevations, depths, pipe sizes, types, and inverts.
- A general conditions assessment and defect evaluation for each basin and pipe was performed. This assessment was conducted on pipes visible from street level. In certain instances a pole mounted camera was used to supplement these observations.
- A CCTV was used for pipe assessments in some areas of greater concern.
- A database of inlets and pipes was created based upon the data collected. All data will be provided to the City in a format compatible with current standard GIS software.
- For the purposes of the storm water capacity model, the City was divided into several study areas and prioritized by the City of Lewes Board of Public Works (BPW).
- Hydraflow storm sewer modeling software was used to model the storm sewer network in four of the identified Study Areas. (Note Study Area #1 consisted of three distinct networks bringing the total number of networks analyzed to seven.)
- The model was used to analyze the 10-year design storm.
- The model was used to identify areas with potentially undersized pipe networks.
- Field observations and model results were used to identify potential opportunities for water quality improvement projects.

A list of some of the more prevalent problems or deficiencies in the system are noted below. Note that not all of the items listed below require immediate action, but are identified as being potential long-term maintenance issues or areas that should be monitored on a regular basis:

1. There are 24 catch basins, which appear to need immediate maintenance due to failing structure or failing grate and inlet.
2. There are 25 pipes with blockages greater than 50%.
3. There are 6 pipes showing visible signs of damage.
4. There are 19 pipes or structures with other pipes crossing through them.

5. There are 3 instances of changes in pipe materials within one pipe run.
6. There are 20 structures where outlet pipe inverts are higher than inlet pipes.
7. There are 42 catch basins with greater than 1 foot of standing water.
8. There are 64 catch basins with greater than ½ foot of sediment.
9. There are 65 catch basins with other issues such as stuck grates.

Further recommendations for addressing these issues are provided in Sections VIII and IX of this report.

II. INTRODUCTION

A. PROJECT BACKGROUND

The City of Lewes is located on the East Coast of Sussex County, Delaware. The City has a 2010 census population of 2,747 and is approximately 4.3 square miles in size. The City sits along the Delaware Bay, the Lewes and Rehoboth Canal (L & R Canal, the “Canal”) splits the site into a beachfront area east of the canal and the downtown/residential area west of the canal, see Figure 1, City Of Lewes Vicinity Map. The downtown residential area ranges from elevation 10 to 14 with the beachfront areas being much lower. There is a network of storm sewers and outfalls that discharge to either the Canal, the Bay, one of the several tax ditches in the City or low lying tidal wetland areas.

We are aware of several areas of the City subject to routine flooding, these areas were primarily identified by residents during our field work. McFee Street was identified by residents of house numbers 126, 130, and 131. These residents stated that the south side of the street floods over the sidewalk and into the backyards of the neighboring houses.

Due to its proximity to the Delaware Bay, Atlantic Ocean, and the Canal, the City is vulnerable to coastal flooding events, and as such, the BPW has been evaluating the impacts that sea-level rise may have on the infrastructure as part of its Coastal Resiliency assessment. From that evaluation the BPW had developed a partial inventory of the storm sewer system; however, the maintenance of the system is not well documented and in many areas maintenance has not been performed in the recent past.

Due to the lack of information on the storm sewer system, the BPW initiated this study to map and document the storm sewer network, model the capacity of the system based on the survey information, provide recommendations on maintenance, capital improvements, and potential water quality improvements.

B. GOALS AND OBJECTIVES

This report describes the review and analyses conducted by Duffield Associates, Inc. (Duffield Associates) on the City's BPW stormwater infrastructure. The primary objectives of the study include the following:

1. Perform a field inventory, including limited GPS survey, of the existing storm sewer system within the City.
2. Provide a conditions report on the facilities inventoried.
3. Provide a GIS compatible database of the storm sewer system.
4. Provide a list of areas recommended for maintenance of the storm sewer system.
5. Identify areas of the storm sewer system that are failing or in immediate need of repair.
6. Prepare a Hydrologic and Hydraulic (H & H) model of the storm sewer system.
7. Utilize the H & H model to identify undersized storm pipes.
8. Make recommendations on potential water quality improvement projects.

III. FIELD INVENTORY PROGRAM

Duffield Associates was tasked with performing a condition evaluation of approximately 605 drainage inlets previously identified by the City's staff during the Coastal Resiliency Project. Duffield Associates collected measurements of depths, inverts to pipes, pipe sizes, and pipe types. BPW personnel performed tasks relating to this field program, specifically BPW personnel were to:

- Perform GPS survey of location and elevations of storm sewer outfalls; and
- Perform GPS survey of any inlets beyond the originally identified 605.

Most of the data collected by BPW staff was obtained using a Topcon GPS unit. That unit was replaced with a newer Trimble unit, during the course of this project, and the latter portion of the locational data were collected by BPW with the newer equipment. At the completion of the field work a total of 975 catch basins, outfalls, and junction boxes were located and inventoried. Duffield Associates utilized a pole mounted camera in some locations to review pipe conditions where deemed appropriate. Additionally, a closed circuit television inspection was performed on many pipe runs.

Duffield Associates prepared a Field Data Sheet for each structure. Each Field Data Sheet is included in Appendix A of this report (contained on a flash drive in PDF format only). Photos were taken of each structure. An ArcGIS-compatible geodatabase in Microsoft Access format has been prepared linking the field reports to the photos and to the CCTV footage, and is included on the flash drive. Appendix B of this report contains the photos taken during the field evaluations and Appendix C contains the CCTV files

from the camera inspections, both of these appendices are provided in electronic format on the CD mentioned above.

Information gathered from the Field Inventory Program was input into a database, which was used to develop the model of the storm sewer systems in the City. The modeling effort and our subsequent findings are presented in Sections IV and V below.

IV. MODEL DEVELOPMENT

Autodesk Storm and Sanitary Analysis 2012 uses the HEC-22 Soil Conservation Service, SCS (now called Natural Resources Conservation Service, NRCS,) and the Rational Methods for most hydrologic calculations. These methods have become the industry standard among practicing engineers and state agencies.

A. MODEL CONSTRUCTION

There are several components required for modeling the storm sewer system, the sizes and slopes of the storm sewers, and the size and type of area draining to the system. Pipe data was input from Duffield Associates' field program (see discussion below about assumptions and model sensitivity relating to the field data) into the model. Drainage areas were delineated for each inlet in the model using aerial imagery and publically available LiDAR (Light Detection and Ranging) 2-foot contours. The land use for each drainage area was defined, based on aerial photos, assuming a typical measured lot size for residential areas and approximate impervious area computations for commercial and other areas. The travel time for each drainage area was assumed to range from 6 minutes in residential areas where only the front of the lot drains to the road, to 15 minutes for residential lots where the entire lot drains to the road, and 20 minutes for grass or other pervious areas.

Based on a meeting with the City of Lewes BPW, the City was divided into 10 different Study Areas and ranked in order of priority from 1 to 10. This report analyzed areas 1, 2, 3, and 5. It should be noted that area 1 contained three separate outfalls, so Study Area 1 contains three separate sub-study areas (Area 1 East, Area 1 West, and Area 1 DeVries). The overall Study Area Map is shown on Figure 2. Maps of each individual Study Area are found in Figures 3 through 8. Study Area's 4 and 6 were not analyzed because Blockhouse Pond outlets to Study Area 4, which then drains into Study Area 6. Blockhouse Pond is assumed to be the stormwater management facility for Beebe Medical Center. Without information regarding its design, analysis of the downstream pipes would not yield meaningful results.

The Storm and Sanitary Analysis model was set to run using the Soil Conservation Service TR – 55 methodology with hydrodynamic routing to allow for more representative modeling of pipes with reverse slopes. The model was run using a

State of Delaware, Department of Natural Resources and Environmental Control (DNREC) 10-year design storm of 5.3 inches of rain in a 24-hour period.

To accurately model a storm sewer system information pertaining to each item shown below is needed:

- Inlet type and location ;
- Grate size and type;
- Adjacent curb type and geometry;
- Adjacent roadway cross slope and longitudinal slope;
- Inlet sump depth;
- Pipe type, size, and inverts; and
- System outfall size and elevation, tidal influences.

Much of this information was beyond the scope of Duffield Associates' inlet evaluation and mapping task, and other information was either not able to be obtained or not able to be obtained to the precision needed for the model. Where information was not obtained or not available, Duffield Associates made certain assumptions relating to the model. They are identified below:

- As discussed, the Topcon GPS unit utilized for some of the data collection was found to be off by approximately 4.3-feet vertically, on average. All elevations obtained with this unit were adjusted down 4.3 feet to coincide with the information obtained with the other GPS unit.
- The model requires the sump elevation of catch basins be input. This information was not collected in all instances. Where no information is available, the sump elevation was taken to be the lowest invert within the catch basin.
- Pipes in the network with no identified diameter were assumed to be the same diameter as the upstream pipe.
- Based on surveyed pipe geometries, we identified some areas where buried junction boxes must be in use to combine pipes. Where we found this to be reasonable, the invert of these junction boxes were calculated assuming a constant slope from the nearest upstream node (junction box, manhole or catch basin) to the nearest downstream node.
- Where previous construction plans were available, information was taken from those plans, as needed, to provide additional, needed information.
- The model requires street cross slopes and gutter slopes be input. All cross slopes were assumed to be 2% and longitudinal slopes to be ½%.
- Direction of gutter flow was assumed using LiDAR data, accurate to within 2 feet.

- Catch basins with no immediate downstream Catch Basin were assumed to be in a “sag” or sump condition, meaning runoff from the contributing drainage area was “forced” into the storm sewer and not allowed to “by-pass” the catch basin via overland flow to another catch basin.
- Study Area 2 is extremely flat, in order to get the model to run, all catch basins were modeled in a sump condition.

V. SYSTEM ANALYSIS

As noted previously, a total of 4 study areas were modeled, 1, 2, 3, and 5. Study Area 1 was broken down further into 3 sub-areas (Area 1 East, Area 1 West, and Area 1 DeVries) as each of these areas has a separate outfall. Using the data obtained from our field investigations and utilizing the assumptions listed above, as appropriate, Duffield Associates modeled each of the areas using a 10-year design storm. A summary table of each Study Area is included in this report as Appendix D. The tabular output has been formatted to identify each pipe section’s Design Flow Capacity and the peak flow getting to the pipe. Each table contains a color coded column, which shows the ratio of pipe capacity versus maximum flow. Any ratio greater than 1.0 means the pipe has a higher peak flow entering than its design capacity, the pipe is surcharging. This provides a gauge to measure the severity of the problem for any one pipe. The larger the number, the greater the difference between maximum capacity and actual peak flows. Overall the model does provide insight into where potential capacity issues exist in the storm sewer system.

VI. SYSTEM IMPROVEMENTS

Based on our inventory modeling, we have identified numerous pipes that appear to have insufficient capacities. These pipes are also identified on the Study Area Maps found in Figures 3 through 8. Many pipes were identified by the field program as having no slope or a negative slope, this could be due to the accuracy of the older GPS unit and method of obtaining the pipe inverts. In these areas, prior to any construction or modifications to the pipes, we would suggest confirming the invert information obtained by performing a survey of these pipe inverts to accepted Professional Land Surveying standards. The pipe segments we would recommend for further analysis and possible replacement are identified in this report as Appendix E – Pipe Surcharge Table.

VII. WATER QUALITY IMPROVEMENTS

One objective of this study is the development of a Stormwater Quality Feasibility Assessment, to be used as the foundation for a holistic approach to managing stormwater quantity and quality in the City.

Two potential locations have been identified for potential water quality improvement projects: (1) the Hudson's Garage Site on Savannah Road near Shields Elementary School (a former gasoline station and the pumps have been removed, as well as the underground storage tanks); and (2) the Lewes Coal Gas HSCA site near the intersection of Kings and Freeman Highways. These sites are identified on the Study Area Figures.

The location of these sites within their respective watershed and drainage areas makes them attractive locations for potential water quality improvement projects. Both are located near the outfalls of the storm sewer system and appear to be large enough to permit construction of a water quality facility. Additionally, these sites are currently unoccupied and/or underutilized. Some potential stormwater management features typically used to improve water quality, and which could be constructed on these sites, includes bio-retention areas and engineered wetlands. Both practices provide for nutrient removal and filtering of stormwater before being discharged.

The Hudson's garage site is the site of a former gasoline station. As such, the site likely can be certified as a Brownfield Site by the State of Delaware. Certification of this site as a Brownfield Site would make the property eligible for environmental assessment and cleanup funding through the Brownfield Program and potentially help to cover the cost of excavating a basin on site that could be used for stormwater quality improvement, if soil excavation is required to remedy environmental conditions. Some potential stormwater improvements that could be installed here include bio-retention, engineered wetlands, and extended detention.

The Lewes Coal Gas HSCA could likewise be used for stormwater quality improvements. However, as a listed HSCA site, the property typically would not be eligible for Brownfield Program funding.

VIII. FIELD IDENTIFIED MAINTENANCE

Our field inventory identified many pipes and catch basins that require maintenance. Below is a list of structures sorted by the deficiency. Figure 9 – Structures of Interest, provides a graphical representation of the maintenance items listed below.

Failing CB Structure (24)	>50% Pipe Blockage (25)	Damaged Pipes (6)	Pipes Crossing (19)	Varying Pipe Types (3)	Outlet Invert Higher than Inlet (20)	>1' Standing Water (42)	>0.5' Sediment (64)	Other Maintenance (Primarily Stuck Grates) (65)
Bb-69-1	Aw-75-1	Bd-59-2	Be-69-1X	Bi-67-MH-4	Ba-70-2	Az-70-1	Aw-74-1	Ax-70-1
Bg-70-1	Ax-70-MH-1	Bd-70-MH-1	Bh-66-MH-1	Bs-63-1	Bb-69-1	Az-70-2	Aw-75-1	Ba-70-2
Bg-70-3	Be-70-3	Bh-69-MH-2	Bh-66-MH-3	Bs-73-OF-1	Be-70-2	Ba-68-2	Ax-70-3	Bb-68-OF-1
Bh-64-3	Be-70-4	Bk-67-3	Bh-68-MH-2		Bg-68-5	Ba-69-1	Ay-70-1	Bc-70-3X
Bi-68-6	Be-70-8	Bl-67-MH-1	Bh-68-MH-4		Bg-68-MH-5	Ba-69-2	Ay-70-2	Be-70-1
Bi-71-4	Bg-47-1	Br-63-3	Bh-68-MH-6		Bi-63-5	Ba-70-1	Az-70-1	Be-70-6
Bi-71-6	Bg-69-5		Bh-68-MH-7		Bi-63-MH-2	Bb-68-1	Az-70-2	Be-70-8
Bi-73-2	Bg-70-8		Bh-70-MH-2		Bi-70-MH-1	Bb-68-OF-1	Ba-68-4	Bf-52-3X
Bi-73-3	Bg-70-OF-1		Bh-70-MH-3		Bj-70-3	Bb-69-1	Bb-70-1	Bg-48-1
Bj-67-2	Bg-71-3		Bh-71-MH-2		Bk-64-5	Bb-70-1	Bd-59-1	Bg-68-2
Bj-73-1	Bh-71-MH-2		Bi-61-MH-1		Bk-65-MH-2	Bd-70-2X	Bd-70-2X	Bg-68-7
Bk-70-2	Bi-70-1		Bj-57-MH-1		Bk-70-8X	Bd-70-3X	Bd-70-MH-1	Bg-68-MH-2
Bn-70-1	Bj-55-2		Bk-70-MH-3		Bk-71-MH-2	Bd-70-MH-1	Be-68-1	Bg-71-1
Bn-73-3	Bj-71-MH-1		Bn-72-MH-1		Bm-68-4X	Be-70-6	Be-69-C-1	Bg-73-1X
Bn-73-4	Bj-73-1		Bo-73-MH-Sa/St		Bm-68-9X	Be-70-MH-1	Be-70-8	Bg-73-OF-2
Bo-70-1	Bj-73-3		Bp-70-JB-1		Bm-69-MH-2	Be-70-MH-2	Be-70-MH-1	Bh-66-6
Bo-70-3	Bj-73-5		Bq-60-1		Bn-72-MH-1	Bf-49-1	Be-70-MH-2	Bh-66-8
Bo-70-4	Bm-65-MH-2		Bs-70-1		Bp-70-3	Bf-49-2	Bg-46-1	Bh-68-MH-8
Bp-73-2	Bm-68-5X		Bs-74-MH-2		Br-73-4&5	Bf-49-3	Bg-47-1	Bh-70-2
Bq-70-3	Bm-72-MH-1				Bs-60-1	Bf-52-1	Bg-47-2	Bh-70-3
Br-62-1	Bn-67-MH-1					Bf-52-2	Bg-66-3X	Bh-70-MH-3
Br-70-4	Bn-72-MH-1					Bf-52-3X	Bg-68-2	Bh-72-5
Br-73-2	Bo-73-3					Bf-52-4X	Bg-71-3	Bi-61-MH-2
Bt-70-3	Br-70-2					Bg-47-1	Bh-66-4	Bi-65-1
	Bt-74-4X					Bg-47-2	Bh-68-2	Bi-67-5
						Bg-70-OF-2	Bh-69-5	Bi-70-MH-1
						Bh-70-TD-1	Bh-70-1	Bi-71-1
						Bh-72-6X	Bh-70-2	Bi-71-5
						Bi-63-MH-2	Bh-70-4	Bi-71-6
						Bi-70-2	Bh-71-3	Bj-70-5
						Bj-71-1	Bh-72-6X	Bj-71-2
						Bj-73-1	Bi-62-1	Bk-67-3
						Bk-73-MH-2	Bi-63-2	Bk-71-2
						Bl-61-1	Bi-66-2	Bk-73-4
						Bl-62-1	Bi-66-3	Bl-69-MH-1
						Bn-69-MH-1	Bi-70-2	Bl-69-MH-3
						Bn-72-1	Bi-73-7	Bl-70-MH-1
						Bt-70-1	Bk-70-1	Bl-71-1
						Bu-59-3&4	Bk-71-2	Bl-73-1
						Bu-75-1	Bl-65-6	Bm-64-MH-1
						Bu-75-2	Bl-71-4	Bm-65-MH-1
						Bv-58-OF-1	Bl-71-6	Bm-71-1
							Bl-73-3	Bm-72-2
							Bm-70-2	Bn-67-MH-1
							Bm-72-1	Bn-70-2
							Bm-72-3	Bn-72-1
							Bn-68-1	Bn-72-4
							Bn-72-1	Bn-73-4
							Bn-72-2	Bo-70-1
							Bq-70-1	Bp-73-1
							Bq-73-3	Bp-73-2
							Bq-73-7	Bq-73-5
							Br-70-1	Bq-73-7
							Br-70-2	Br-61-2
							Br-71-2	Br-61-5
							Br-71-4	Br-68-1X
							Br-71-6	Br-73-1
							Br-73-6X	Br-73-2
							Bs-71-2	Br-73-3
							Bs-71-4	Br-73-1
							Bt-74-4X	Bs-74-MH-1
							Bt-78-2	Bt-64-1
							Bv-77-1	Bt-74-C-1
							Bw-70-1	Bu-61-2
								Bu-62-1

Failing structures and damaged pipes should be considered the highest priority for maintenance. Pipes and structures identified as having standing water should be investigated to determine the cause of the standing water, for example, some of this standing water could simply be from tidal influence while in other areas it could indicate a downstream blockage.

Pipes and structures with sediment greater than $\frac{1}{2}$ the pipe diameter should be cleaned out to restore storage and capacity.

Structures shown with utility crossing should be further evaluated to determine if the utility can be relocated.

IX. RECOMMENDATIONS

Duffield Associates performed a storm sewer inventory and conditions assessment of the City of Lewes storm sewer system operated and maintained by the City's Board of Public Works. After completion of the inventory, a Hydrologic & Hydraulic (H & H) analysis of portions of the storm sewer system, as prioritized by the BPW, was performed. Based upon our findings, Duffield Associates recommends the following regarding operation and maintenance of the storm sewer systems inventoried and analyzed.

Maintenance:

1. The highest priority for further investigation and repair are the failing structures; pipes and catch basins. Further investigation into the pipes identified as failing is recommended. Where replacement is deemed appropriate, there are several trenchless options that could be explored including pipe bursting; pulling a larger, usually high density polyethylene pipe, with a specialized cutting head through the existing pipe. We would recommend the pipes within heavily travelled roads be addressed first.
2. Catch Basins indicated to be failing should be repaired to prevent further damage or potential collapse.
3. Pipes identified as being more than 50% blocked should be jetted out to restore capacity.
4. Standing water in pipes identified in this report should be evaluated further to determine if this standing water is due to downstream pipe blockages or tidal effects. Where pipe blockages are identified these pipes should be jetted out to clear the blockage.

Flat or Reverse Sloped Pipes

5. In general, pipes with reverse slopes, while not optimal, do not need replacement unless the loss of capacity causes further drainage issues. Where reverse slope

pipes are shown as being inadequate to handle the peak runoff, they should be removed and replaced. In areas where capacity does warrant replacement, these pipes should be monitored regularly (suggest annually) as they will be prone to build up of sediment and potential corrosion from standing water.

Pipes with Insufficient Capacity:

6. Where this report identifies insufficient capacity, we recommend scheduling these pipes for replacement with adequately sized pipes. We have reviewed the pipes identified as undersized and developed a replacement priority list shown below. The priority is based upon several factors including:
 - a. Its size compared to the peak flow, the larger the shortfall the higher the priority.
 - b. Its location in the storm sewer network, undersized pipes closer to the outfall may impact the larger upstream pipe network.
 - c. Presence of other factors such as corrosion or crushing, undersized pipes that are also structurally deficient.

Priority	Pipe No.	Location	Pipe Size	Flow Ratio	Study Area	Comments
1	705	Rte. 9 near Shields Ave.	24"	32.85	1-W	Downstream restriction
2	865	End of S. Washington	36"	6.25	5	Downstream restriction
3	504	S. Washington St.	24"	3.35	5	Downstream restriction
4	347	Kings Hwy.	15"	17.13	5	Flow restriction
5	100	Canary Dr.	27"	6.37	2	Downstream restriction
6	837/443/445	McFee Street	18"	13.28	1-W	Flooding reported
7	291	Kings Hwy.	18"	3.82	1-E	Flow restriction

This Stormwater Master Plan has been prepared in accordance with generally accepted engineering principles and practices. The recommendations are based on our professional evaluation of the information obtained during the inventory and assessment phases of the project, and our subsequent modeling. The professional judgments and opinions stated in this report are based on current, local standards of practice and have been developed within the focus of the scope of services, budget and schedule negotiated for this effort.