

# **CITY OF LYNDEN**

## **STORMWATER CAPITAL**

## **IMPROVEMENT PLAN**

**ATTACHMENT B TO THE 2017 ANNUAL REPORT**



***CITY OF LYNDEN***

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**MARCH 29, 2018**

# Excerpt from the City of Lynden’s Comprehensive Stormwater Plan

## Chapter 7.0 Stormwater Systems Analysis and Capital Improvement Plan

### 7.1 Introduction

City staff has identified many stormwater systems and areas of interest/concern within their existing and proposed service boundary. These interests range from addressing policy issues to finding solutions to areas with documented drainage issues. Capital improvement projects which address capacity concerns and quality where feasible were identified and further analysis of various locations conducted to more fully identify if improvements might be needed in the future. This section will address these issues.

Water quality is an important aspect of stormwater management. Beyond being good stewards of the resource, the City is required through the NPDES Permit to follow specific protocol in an effort to comply with the Federal Clean Water Act. For this reason, all projects will at a minimum comply with City Standards which adopt Ecology’s 2012cStormwater Management Manual for Western Washington (SWMM). See section 6.3 of this document for discussions in regards to retrofit projects.

Many of the issues which will be discussed deal with the capacity of conveyance systems. Therefore, it is pertinent to discuss the standard of practice for the design of conveyance systems. All conveyance systems are intended to pass a specified amount of flow. Flow is determined based on return frequency, this is the probability that the storm will occur. A 100-year return frequency storm has a probability of occurrence of once every 100 years. It is important to point out that the return frequency is the probability that the amount of rainfall will be equaled or exceeded once on the average. This means that, for example, a 100-year event could occur two years in a row.

The following table (7.1) shows the rainfall intensities utilized for the City of Lynden Stormwater Management Plan. The 24-hour rainfall intensities for different storm events were determined from the NOAA Atlas 2 (*Precipitation-Frequency Atlas of the Western United States, Volume IX – Washington, 1973*).

Table 7.1 - Rainfall Intensities Used

| <b>Storm Event</b> | <b>Inches in 24 hours</b> |
|--------------------|---------------------------|
| 6 Month            | 1.37                      |
| 2 Year             | 1.90                      |
| 10 Year            | 2.80                      |
| 25 Year            | 3.25                      |
| 100 Year           | 4.00                      |

Stormwater models conducted for this plan were based on a Type 1A rainfall distribution for the 24-hour storm event per industry standards. Standard of practice in Western Washington is that the

conveyance system must have the capacity to convey the 25-year return frequency storm within the facility and demonstrate that the 100-year return frequency storm will not cause adverse impacts to adjacent and downstream properties. This approach is used in both the WSDOT Highway Runoff Manual and City's Engineering Design and Development Standards. Typically, this means that stormwater must be contained within street curbs and flow to a downstream system of sufficient capacity, during the 100- year event.

Whatcom County and the Lynden vicinity have a history of flooding events precipitated by heavy rainfall occurring on frozen ground (which acts as an impervious surface) covered by an amount of snowfall. These events are not considered standard of practice for design. This flooding is not simply a function of the conveyance geometry, which can be compromised as a result of those systems being clogged with snow, sheets of ice blocking culverts and any number of mechanical failures caused by an act of nature. City, County and WSDOT resources can be over-extended during such inclement events, minimizing the responsiveness to what might not be easily perceived as a problem during the early stages of an event.

## 7.2 Capital Improvement Projects

The City, in its effort to maintain infrastructure, is considering certain stormwater projects for construction. A summary of those Capital Improvement Projects and their anticipated costs and status can be found in the Table 7.2 on the following page. These projects are at varying stages of development, and are listed in no particular order. Additional detail for each of the listed projects in Table 7.2 can be found in the remaining sections of this chapter and in the exhibits included in Appendix A. Appendix A starts with the overall site plan exhibit which shows the location of all the Capital Improvement Projects, then is followed by exhibits for each project.

| Proj # | Projects  | Estimated Construction Costs | Estimated Consulting Costs | Status                                      | Potential Funding Source      | Status Notes  | Timeline        | Timeline Notes  |
|--------|---|------------------------------|----------------------------|---|-------------------------------|---|-----------------|---|
| SWO-1  | BC Avenue                                       | \$580,000                    | \$185,000                  | 30% Design                                  | Local Funds<br>State: Ecology | Pipe sizing approximated, Design and Construction funds required  | Within 20 years | To be combined with other Public Works projects adjacent properties.                            |
| SWO-2  | Cedar Drive                                     | \$145,000                    | \$50,000                   | 5% Design                                   | Local Funds<br>State: Ecology | Design and Construction funds required.   | Within 10 years | Design budgeted for 2018.   |
| SWO-3  | Historic Business District Tributary Conveyance | \$565,000                    | \$190,000                  | 50% Design                                  | Local Funds<br>State: Ecology | Basic treatment facility Constructed, South Historic Business District Conveyance and/or mitigation required.   | Within 5 years  | To be combined with other Public Works projects adjacent properties.                            |
| SWO-4  | Historic Business District Treatment Facility   | \$900,000                    | \$90,000                   | 100% Constructed                            | Local Funds<br>State: Ecology | Facility has been constructed.  | Complete        | Project Completed.  |
| SWO-4a | Line Road Improvements: Burlwood to Aaron Drive | \$800,000                    | \$200,000                  | 90% Design                                  | Local Funds                   | Design in final phases  | Complete        | Project Completed.  |
| SWO-5  | East Lynden Annex                               | \$650,000                    | \$175,000                  | 50% Design                                  | Local Funds<br>State: Ecology | Line Road Culvert Designed, Additional design required for basin drainage. Waiting for Construction Funds. Private development in this area is being designed and constructed to current Ecology standards. | Within 5 years  | To be combined with other Public Works projects adjacent properties. Waiting for Funding        |
| SWO-6  | Lynden Industrial Retrofit                      | \$1,600,000                  | \$400,000                  | 60% Design                                  | Local Funds<br>State: Ecology | Design and Construction funds required.   | Within 20 years | To be combined with other Public Works projects quality improvements are required or funding is |
| SWO-7  | Pepin Creek Phase I, Upstream of Main Street    | \$8,202,000                  | \$1,730,000                | 30% Design<br>100% property acquired        | Local Funds<br>State: Ecology | Design and Construction funds required. Initial planning must be complete.  | Within 10 years | Upon annexation into the City limits and as required  |
| SWO-7b | Pepin Creek Phase II, Downstream of Main Street |                              |                            | 10% Design                                  | Local Funds<br>State: Ecology | Design and Construction funds required. Preliminary Design must be complete.  | Within 5 years  | Detailed design will identify access requirements.  |
| SWO-7c | Pepin Creek Phase III, Main Street Bridge       |                              |                            | 20% Design<br>100% property acquired        | Local Funds<br>State: Ecology | Construction funds required. Design must be complete.   | Within 2 years  |   |
| SWO-8  | West Lynden Regional Facility                   | \$1,000,000                  | \$300,000                  | 30% Design                                  | Local Funds<br>State: Ecology | Phase I constructed, Phase 2 awaiting design and construction funds.  | Within 10 years | As required by Developer interest.  |
| SWO-9  | Woodcreek Neighborhood                          | \$540,000                    | \$180,000                  | 10% Design                                  | Local Funds<br>State: Ecology | Design and Construction funds required.   | Within 10 years | To be combined with other Public Works projects adjacent properties.                            |
| SWO-10 | LID 7th to 10th Street/Front to Judson          | \$ TBD                       | \$120,000                  | 0% Design, DOE 2017 List                    | State: Ecology                | Design and Construction funds required. Initial planning must be complete   | Within 5 years  | Selected for funding in 2017, Capital Budget has n  |
| SWO-11 | South Park & Parkview Drive                     | \$365,000                    | \$160,000                  | 100% Design, Waiting for Construction Funds | Local Funds                   | Construction and CM funds required.   | Within 5 years  | Began final design in 2017. To be constructed 201   |
| SWO-12 | Groundwater Monitoring                          | \$60,000                     | \$5,000                    |   | Local Funds                   | Design and Construction funds required. Initial planning must be complete   | Within 5 years  | Construction to be complete when funding is avail   |

|         |   |           |          |               |                |                             |                 |   |
|---------|---|-----------|----------|---------------|----------------|-----------------------------|-----------------|---|
| SWO-13  | Public Works Shop Improvements Decant Facility at City Maintenance Shop | \$300,000 | \$40,000 | Planning Only | Local, Ecology | Result of SWPPP development | Within 10 years | Construction to be complete when funding is available |
| SWO-13a | Material Storage at City Maintenance Shop                               | \$250,000 | \$30,000 | Planning Only | Local, Ecology | Result of SWPPP development | Within 10 years | Construction to be complete when funding is available |
| SWO-13b | Vehicle Wash Facility at City Maintenance Shop                          | \$75,000  | \$10,000 | Planning Only | Local, Ecology | Result of SWPPP development | Within 10 years | Construction to be complete when funding is available |
| SWO-13c | Upgrade Storm Discharge at City Maintenance Shop                        | \$350,000 | \$45,000 | Planning Only | Local, Ecology | Result of SWPPP development | Within 10 years | Construction to be complete when funding is available |
| SWO-13d | Runoff Treatment for City Shop North Parking Lot                        | \$250,000 | \$30,000 | Planning Only | Local, Ecology | Result of SWPPP development | Within 10 years | Construction to be complete when funding is available |

### 7.2.1 SWO1 – B.C. Avenue

A large portion of Lynden's central residential neighborhoods utilizes an outfall along B.C. Avenue. The City has been proactively upgrading stormwater facilities as roadway improvement projects occur in this area. Generally, stormwater conveyance capacity should be increased along C Street and B.C. Avenue. In addition the City is monitoring the water quality of the outfall and will consider the results in the design of this project. Refer to Appendix A.1 for additional details regarding B.C. Avenue analysis and improvements.

The outfall on B.C. Avenue serves approximately 40 city blocks of runoff from the older residential area of Lynden, see exhibit in Appendix showing drainage area. In some areas of the City, old infrastructure is difficult to inspect, because a portion of the existing storm main cannot be accessed. It is assumed that when these old areas redevelop a new storm system, including water quality improvements, may be installed. An existing condition model was constructed based on the available records and engineering judgment, the model should only be used as a general guideline; drainage areas and patterns should be verified prior to the replacement of a stormwater trunk main within this basin. The model approximates the runoff from each basin so future projects may include an upgraded conveyance system. A more accurate model of the existing pipe network can be produced when the unknown pipe elevations, sizes, material, condition, and slopes have been discovered.

The City has recently performed work in the upper portions of this basin, the work involved the replacement of old pipes. The lower portion of this system may be nearing the end of its intended design life and may not meet the current standards of practice design methods. No significant flooding has been observed in this basin to date, despite the results of the model. Reasons for this have been speculated, but not confirmed.

This analysis focuses on the trunk main within the City along B.C. Avenue, between Front Street and the outfall. The analysis also looks at the trunk main on C Street, between Stremler Drive and B.C. Avenue. As a part of these projects consideration, potential for the addition of water quality amenities should be considered.

#### *Existing Drainage Overview:*

The total service area of the B.C. Avenue outfall is about 103.5 acres, an exhibit has been provided showing the approximate drainage area. Approximately 56.56 acres drains to the Front Street and B.C. Avenue intersection. An additional 46.94 acres, south of Front Street, drains to the B.C. Avenue and C Street intersection.

The 56.56 acre drainage basin consists of lateral storm mains along Grover Street and Front Street which collect runoff and route it to B.C. Avenue. The Front Street lateral main collects runoff from 9th street to 17th Street; the Grover Street lateral main collects runoff from 10th Street to 16th Street and also collects water north to Liberty Street between 10th Street to B.C. Avenue.

The 46.94 acre area which utilizes the B.C. Avenue outfall is collected by a lateral storm main along C Street, from Stremler Ave to B.C. Avenue. Runoff drains south from Front Street and is collected by the C Street main.

*Modeling and Analysis:*

Autodesk Storm and Sanitary Analysis 2015 software was used to model the runoff and conveyance of the system. The Hydrologic modeling method was the SCS TR-55 method with a hydrodynamic conveyance calculation.

The basin still has potential for further development. To estimate the future condition a build-out analysis was performed on the basin. Each subbasin was evaluated and a maximum impervious area was found for each based on the City’s zoning standards. It is assumed about 20% of each subbasin consists of City Right-of-Way (ROW) and the buildout for City ROW is about 80% impervious. No ROW buildout adjustments were made to zones that allow greater than 80% maximum impervious: it was assumed roadways in these zones would buildout the same as the surrounding properties. The maximum impervious for each zone was modified to account for roadways. Based on the current USDAs Natural Resources Conservation Service (NRCS), the site soils are Hydrologic Group A. The model conservatively modeled the basin as a Hydrologic B soil. These soils were previously identified as Group B soils by the NRCS, additionally, developers typically import topsoil which may behave more like hydrologic B soils. Impervious areas were modeled with a curve number of 98 and all pervious surfaces were modeled as good lawns with a curve number 80. The service area primarily consists of residential areas and roadways. Table 7.2 below summarizes the buildout analysis.

**Table 7.3: B.C. Outfall Service Area Summary**

| Zone                   | Area (acres)      | Max Impervious (Lot Coverage) | Max Impervious (Lots + ROW) | Composite Curve Number |
|------------------------|-------------------|-------------------------------|-----------------------------|------------------------|
| RS-72                  | 61.97             | 35%                           | 44%                         | 87.92                  |
| RM-2                   | 34.94             | 40%                           | 48%                         | 88.64                  |
| RM-4                   | 2.54              | 45%                           | 52%                         | 89.36                  |
| CSL                    | 3.54              | 90%                           | 90%                         | 96.20                  |
| B.C. Avenue Roadway    | 0.51              | 100%                          | 100%                        | 98.00                  |
| Total/Weighted Average | 103.5 Total Acres | 39.13% Average                | 47.40% Average              | 88.53 Average          |

The model includes two subbasins (13DE, and 13CE) to model the runoff from B.C. Avenue, these basins were modeled as impervious and not as RS-72 zoning because they represented the roadway surface. The total service area is about 103.5 acres, composite curve numbers and areas are also included in the above summary table.

A site visit determined the flow patterns for most of the basin is relatively flat, time of concentration flow routes were generated using assumed typical overland slope of ~ 0.5%.

*Summary of Concerns for B.C. Avenue:*

The stormwater system on B.C. Avenue and the surrounding areas is difficult for the City to inspect and is likely at the end of its design life. Generally, the facilities do not meet current City standards and may require replacement. Possible issues with the conveyance included the following:

Impedance of flow in outfall ditch:

The B.C. Avenue outfall discharges to a ditch within the Nooksack River flood plain. At the time of investigation, the outfall pipe was submerged and the discharge pipe was also buried with silt and sediment. Because this area is outside of the City Limits, this ditch may not be on a regular maintenance schedule. The City has maintained their system upstream, and would need to coordinate with County agencies to have the outfall cleaned. This ditch also contains standing water at the outlet. A buried and/or submerged outlet can reduce stormwater conveyance and cause flooding. Further investigation of this outlet should be performed.

#### Maintenance and inspection of the existing stormwater system.

Portions of the existing stormwater conveyance system within the study area are difficult to inspect and maintain and do not meet the current City Standards. Catch basins often have a single outlet that tee into the main storm line which does not provide access to the system. Sediment buildup and debris within the inaccessible system can reduce the capacity of the storm main and is not normally addressed by the City until flooding or failure has occurred. The City no longer allows storm systems to be constructed in this fashion.

#### Undersized or restricted stormwater conveyance.

The Study indicated the City would benefit by upgrading stormwater mains. The existing trunk main on B.C. south of Front Street is 15" diameter and has surcharged, a portion of this main has been upgraded to 30" which can accommodate the calculated flows. The C Street main is a 12" diameter, the model indicates the system could surcharge and experience surface flooding during the 25-year storm.

#### *Solution Concepts for B.C. Avenue:*

##### B.C. Avenue (from Front Street to C Street)

The City has already upgraded a portion of this project to a 30" diameter pipe to manage the 100-year storm. The 100-year flow was calculated to be approximately 24.9 cfs. The remaining portion of the existing storm main could be upgraded to a 30" diameter pipe with similar slopes to convey the 100-year storm. As a minimal alternative, the City could upsize this existing storm main section to convey at least the 25-year storm, approximately 21.0 cfs south of B.C. Avenue.

##### C Street (from 17<sup>th</sup> Street to B.C. Avenue)

The existing system consists of 12" diameter pipe and the City is considering upgrading this existing main. The storm main would be upsized to handle a minimum of the 25-year storm, approximately 17.2 cfs. Flows from a preliminary model were found to be about 20.0 cfs for the 100-year storm; providing capacity for the 100-year storm will allow for upstream development and may account for the unknown pipe locations. A 24" diameter pipe could be installed with similar slopes to convey the 100-year storm.

##### B.C. Outfall (from C Street to the Outfall Ditch)

The storm main should be upsized to handle a minimum of the 25-year storm, approximately 39.4 cfs. The City may choose to upgrade the existing storm to convey the 100-year storm which will allow for upstream development. The peak flow from the 100-year storm is approximately 46.5 cfs. A 30" diameter pipe could be installed with similar slopes to convey the 100-year storm. The existing drainage ditch located at the B.C. Outfall should also have this capacity and would require further analysis including the connection to the Nooksack River. The City should work with the appropriate agencies to get the ditch cleaned.

### 7.2.2 SWO2 – Cedar Drive

Currently there is a storm drain pipe that crosses private properties and no formal easements were discovered. The City is working to determine the location, depth, and condition of this storm system. Following an assessment of the system, a recommendation can be provided. This is a stormwater collection system that predates the knowledge of Staff currently at the City. An analysis of the purpose and need of the system needs to be performed, then alternatives to meet those needs will be developed. The City should evaluate the existing capacity and alternatives for this drainage system. Alternatives should consider the impacts to the adjacent properties if this pipe were to fail. For more information regarding Cedar Drive drainage refer to Appendix A.2.

#### *Existing Drainage Overview:*

The Kwanzan Drive long plat was approximately 8.9 acres of RS-100 zoning, resulting in about 27 residences. This neighborhood may connect to a storm system draining to the south through private property to Cedar Drive, see exhibit. The exact locations and depth of the existing drainage system crossing the private properties is unknown. Current records show the existing pipe is 12" diameter and flows approximately 300 feet from the Kwanzan Drive to Cedar Drive.

The discharge of the subject pipe has not been located, but it is assumed the stormwater is conveyed about 400 feet to the west along Cedar Drive to an open ditch.

If this stormdrain pipe requires maintenance, it is anticipated that 4 private properties will be directly impacted. The properties are:

- 310 Kwanzan Drive
- 312 Kwanzan Drive
- 130 Cedar Drive
- 112 Cedar Drive

The existing drainage system is difficult to inspect and maintained and the City may pursue upgrading this system to meet current City Standards. Given the age of the system, it is likely this conveyance system is near the end designed life and will require maintenance. When the replacement project moves forward appropriate water quality improvements will be included.

#### *Modeling and Analysis:*

No model has been prepared. As funding becomes available, an analysis may be performed.

#### *Summary of Concerns for Cedar Drive:*

The following areas of concern need to be examined.

#### Limitation of Access:

The City crew has difficulty accessing the existing storm system along private property as described above. This pipe appears to be located in close proximity between homes which would limit the allowable construction impacts and appropriate construction methods. Currently no formal easements have been found which allow the City to access this storm pipe.

Portions of the existing stormwater conveyance system within the study area are difficult to inspect and maintain. Lack of access may cause sediment build up and debris within the system which can reduce the capacity of the storm main and will likely not be addressed by the City until a capacity issue has been identified. The City no longer allows storm systems to be constructed in this fashion due to the potential for problems. The City typically places a catch basin or storm structure where the stormwater changes direction and also has a typical spacing for storm structures to allow access for inspection and maintenance, the existing does not provide critical access points for City crews.

#### Impedance of flow in outfall ditch:

The outfall appears to discharge to a ditch which is tributary to the Fishtrap Creek. No outlet for this drainage system has been located. It appears that parallel stormwater conveyance systems are located on Cedar Drive. One is the discharge pipe from Kwanzan Drive which has not been located and may be buried, submerged or obstructed. The other is Cedar Drive's stormwater collection and conveyance system.

#### Undersized or restricted stormwater conveyance.

An analysis should be performed to verify the existing storm system has adequate capacity.

This area requires further analysis to determine the full extent of the issues and the necessary course of action. When the City decides to improve the drainage in this area, the City will have an opportunity to correct the maintenance and inspection challenges with the existing system. This document will assist the City plan stormwater improvements.

#### *Solution Concepts to Cedar Drive:*

All solutions would incorporate water quality facilities as applicable.

#### Cedar Drive / Kwanzan Drive (Private property crossing)

Evaluate if the existing storm alignment through private property is necessary and suitable for the City. If the City wishes to maintain the existing alignment, then record necessary easements and consider trenchless technologies to restore the pipe. If extra capacity is required, then pipe bursting/reaming are commonly considered. If the existing capacity is sufficient, then a cured in place pipe system may be considered. If the City does not wish to own and maintain the stormwater system through private property, then an alternative storm drain alignment should be pursued. Kwanzan Drive may drain to the existing storm system on Depot Road to the west, or outfall directly to the Fishtrap Creek to the east.

#### Cedar Drive / Kwanzan Drive (Capacity Analysis)

The storm trunk main should be sized to handle a minimum of the 25-year storm, it is recommended the 100-year storm be analyzed to ensure that private property is not significantly damaging during major rain events. The existing system should be analyzed to verify capacity.

#### Cedar Drive / Kwanzan Drive (Outfall)

Locate the outfall of the Kwanzan Drive storm system and perform any maintenance as needed.

### 7.2.3 SWO3/SWO4 – Historic Business District Treatment and South Historic Business District Tributary Conveyance

The Historic Business District (HBD) is expected to experience redevelopment in the near future and require stormwater mitigation per the stormwater management manual. The City has been proactive in providing solutions for property owners within the HBD. The City has installed a basic treatment facility and has been improving conveyance incrementally with various projects. The City will continue to plan conveyance improvements to the South HBD to encourage future development. See Appendix A.3 for additional information regarding the HBD and South HBD stormwater improvements.

#### *Existing Drainage Overview:*

Runoff from the HBD and the portion of the South HBD which includes the City's Water Treatment Plant is collected and conveyed through a storm drain system, discharged to a treatment swale, and discharges to the Nooksack River. Surface water runoff from the remainder of the South HBD flows south to the flood plain and either infiltrates or is conveyed to the Nooksack through open drainage channels. The City is currently planning Riverview Road which bisects the South HBD.

#### *Modeling and Analysis:*

The treatment facility for the HBD and portions of the South HBD is associated with Phase 1 of the City's Water Treatment Plant project. For further information and design calculations, reference the Water treatment plant report.

The conveyance analysis and layout for the Historic Business District (HBD) still require a complete design.

#### *Summary of Concerns with the Historic Business District:*

##### Stormwater Mitigation for Redevelopment.

Lynden's Historic Business District (HBD) is subject to redevelopment. Properties in these areas may have limited space for stormwater mitigation which may result in design and construction challenges.

##### South Historic Business District

There are some properties in the southern portion of the Historic Business District (HBD) that are not able to use gravity to convey stormwater runoff to a piped conveyance system, for example the property within the City Right-of-Way on Judson Street Alley. These properties will likely exceed thresholds established by the SWMMWW and be required to mitigate their stormwater impacts.

#### *Solution Concepts to the Historic Business District:*

##### Stormwater Mitigation for Redevelopment.

Construction of mitigation facilities is a significant burden on redeveloping properties within the HBD, as many do not have sufficient property to build such facilities. Often the building encompasses the entire parcel. In order to promote redevelopment, the City has proactively implemented methods to meet the requirements of the SWMMWW. The City has constructed a regional stormwater facility which was designed to meet the Ecology's requirements for redevelopment in this basin.

The City designed and constructed the water quality system for the Historic Business District. For a detailed design of the basic treatment biofiltration swale see the drainage report titled “Water Treatment Plant Replacement and Historic Business District” dated November 2012 associated with Phase 1 of the City’s Water Treatment Plant. A copy of this report has been included in Appendix A.3.

#### South Historic Business District

Parcels that cannot discharge to the City’s regional basic treatment systems must construct individual treatment facilities. The South HDB will either require an outfall to the Nooksack River or infiltrate all the stormwater on site per the Ecology requirements.

#### 7.2.4 SW05 – East Lynden Annexation

The City of Lynden expanded the City limits to the east. This newly annexed area does not have a well-defined drainage system. New stormwater facilities have and will continue to be installed as development occurs. It is currently anticipated that many developments will utilize on-site infiltration to mitigate both stormwater quantity and quality. Additional information regarding East Lynden Annex Area can be found in Appendix A.4.

This Stormwater Capital Improvement Plan requires the City to identify existing municipal stormwater deficiencies so they may be properly addressed in the future. Recently, the City of Lynden has annexed an area into the City Limits which extends east of Northwood Road. The City should be the review of infrastructure, existing and proposed, including roadways and storm systems within this area.

#### *Existing Drainage Overview and Concerns:*

Key drainage characteristics for this area are as follow:

#### Annexed Area drainage:

Infiltration is the preferred quantity and quality mitigation method by Ecology for developments. A majority of this area is believed to be conducive to infiltration. Portions of the right-of-way (ROW) in this annexed area, along Line and Northwood Roads do not have well-defined ditches or water courses. The City is incorporating both stormwater flow control and water quality improvements in street designs as they occur.

As stormwater improvements are provided in this area, the City will consider how the stormwater improvements should be funded and if the adjacent parcels should be responsible for a portion of the cost. This cost may be attributable to the owner’s development, as it provides them a service to convey excess stormwater and the upgraded roadways will improve access.

#### Line Road Culvert:

The City suspects the existing Line Road culvert for Kamm Creek may need to be upgraded due to age and condition. This potential fish barrier may be negatively impacting the habitat of Kamm Creek.

#### *Solution Concepts for East Lynden Annex:*

#### Annexed Area drainage:

The City may consider funding options for the various stormwater improvements and roadway upgrades performed in this annexed area. The City's municipal infrastructure will be expanded as required per development standards.

#### 7.2.5 SWO6 - Lynden Industrial Stormwater Retrofit

The existing industrial area located north of downtown was developed prior to currently adopted stormwater requirements. Installing stormwater facilities in this area may benefit the environment and improve the existing drainage in this area. The City has performed a preliminary study and developed a plan to retrofit stormwater infiltration facilities within this area. Additional information associated with retrofitting the industrial area can be found in Appendix A.5.

The City utilized Ecology's 2013-2015 Biennial Municipal Stormwater Capacity Grant to determine the feasibility of retrofitting the City's Right-of-Way (ROW) within the industrial area north of downtown. A report has been generated titled "Downtown Lynden Industrial Stormwater Right-of-Way Retrofit Investigation" dated January 2014 which analyzes different retrofit options.

#### 7.2.6 SWO7 – Pepin Creek Phase 1

This project would resolve regional stormwater quantity, quality and habitat issues by combining multiple conveyance systems into a new manmade channel engineered to provide a higher quality habitat and resolve potential capacity issues. This project will also have the added benefit of eliminating large and deep roadside ditches, allowing Benson Road and Double Ditch Road to be improved to safe transportation standards. Additional analysis is still required. Appendix A.6 provides additional information this project.

This project will take place within the City and within the City's northern UGA. This area has experienced flooding along Benson and Double Ditch Roads, most recently in 2009 and 2005. The City has been proactively planning drainage solutions in anticipation of future annexation.

The Pepin Creek project will improve the drainage patterns in the area to reduce flooding, improve the habitat quality for fish, and allow for various other infrastructure upgrades. The goal of this analysis is to provide a preliminary overview of drainage patterns, the City is working to provide a detailed analysis and design. The City has acquired the necessary ROW from Main street north to the Lynden Airport.

##### *Existing Drainage Overview and Concerns:*

The roadside ditches along Benson Road currently flow to the south and cross Benson Road between Westview Place and Pine Street. Benson Road ditch flows east through a natural channel to Fishtrap Creek. Flooding has occurred along Benson Road and drainage facilities should be improved.

Double Ditch currently flows south adjacent to Double Ditch Road and turns east at Main Street. This general area experiences high levels of water which cause tailwater elevations that are not conducive to appropriate drainage of adjacent subdivisions and associated streets. The City has performed a preliminary study of the area and will continue to pursue funding for an additional analysis.

The existing roadside ditches on Benson and Double Ditch are low quality fish habitat and occupy a large portion of the available ROW. The existing road widths do not comply with current City Standards.

### *Solution Concepts for Pepin Creek:*

The City has been planning long term solutions to proactively eliminate flooding and drainage issues within this area. The preferred solution creates a new habitat channel, Pepin Creek, midway between Double Ditch and Benson Roads for species which use the current roadside ditch system. A substantial benefit of this option is that additional stormwater conveyance can be accommodated in the new system. In addition to addressing flooding and drainage problems, this project also allows the existing roadways to be upgraded to transportation standards addressing safety concerns and facilitate the development of the adjacent parcels by providing a “Creekside” amenity. Property owners to the north of Badger Road have created a legal entity known as the North Lynden Watershed Improvement District (WID) which has given a letter of support for this project. One of their main concerns has been the conveyance of stormwater runoff through their jurisdiction. This project would greatly increase their ability to convey water to receiving waters improving drainage and reducing flooding. The City has acquired a majority of the property needed to build the channel from Main Street to the Airport.

### **7.2.7 SWO8 – West Lynden Regional Facility**

In 2002, a regional stormwater facility was constructed which serves the zoned improvements in a specified area. There is interest to expand the current facility to provide stormwater mitigation for additional properties. The service area is estimated to expand by approximately 60 acres. Expanding this facility will require reevaluation of the existing system and may require the facility to be revised to meet current standards and rules. Additional information regarding the West Lynden Regional Facility expansion can be found in Appendix A.7.

The West Lynden Regional Stormwater Facility was previously constructed through the foresight of a group of developers who realized the benefit of a regional facility. This facility serves approximately 215 acres with both enhanced treatment and flow control. The facility was designed based on current zoning and the allowed land use.

This study for the West Lynden Regional facility includes some discussion on future expansion of the service area as well as upgrading the conveyance to the facility and its discharges. This is a preliminary feasibility study, further engineering is required if the service area is expanded.

### *Existing Drainage Overview and Concerns:*

This 215 acre drainage area consists of primarily industrial and commercial properties. A majority of the service area is west of the Guide-Meridian and extends from Main Street to Bay-Lyn Drive. Development in this area conveys runoff to the facility through a series of pipes. A 60 inch diameter trunk main serves as an inlet to the regional facility.

The regional facility is currently functioning as designed, but the City has been approached to provide additional service area. Below are possible issues of expanding the facility and its service area.

The facility was constructed under a permit received by the Department of Ecology (Ecology) Dam Safety office (DSO). Since overland flow cannot directly contribute to the facility due to site grading, the DSO agreed the facility did not need to be designed for the 500-year storm. The facility was designed to manage the maximum allowable inflow per the facilities inlet conveyance system. If the service area is expanded and additional conveyance provided, the DSO would have to reevaluate and approve all modification to the overflows, outlets, berms, and other items associated with the stormwater facility. The DSO could require this facility to be upgraded to the current standards and reevaluate the potential risks downstream.

Connection to the West Lynden Regional Facility has numerous impacts. The existing conveyance systems were optimized to convey the 100-year return frequency storm per Ecology Requirements. If additional properties use the regional facility for stormwater mitigation, additional conveyance may be required.

#### *Summary of Possible Solutions to West Lynden Regional Facility:*

##### Expanding the Facility

It was found, from the previous work, that a stormwater facility could be expanded with sufficient capacity to serve approximately 60 additional acres. This was based on the conceptual geometry of an expanded facility and the prorated acres of impervious area served when compared to the existing facility. The area that could potentially drain to the expanded facility is shown in the Exhibit. The area shown is greater than 60 acres, this is because the service boundary has not been completely analyzed and expanded facility could be obligated on a first come / first serve basis.

##### Expanding the Service Area (Additional runoff management)

A probable conveyance corridor from the potential service boundary to the facility is also shown in the exhibit for this project. This conveyance corridor was chosen based several criteria including, but not limited to, the probable depth of the storm line, its vicinity to the centroid of the potential service boundary, the distance to the regional facility, minimizing the number of property owners impacted, and the cooperation of said property owners.

#### **7.2.8 SWO9 - Woodcreek Neighborhood.**

The City has observed capacity issues with the aged storm system in the Woodcreek Neighborhood. The existing stormwater system may be undersized and is challenging for the City to inspect and maintain. Lack of access points to the trunk main may also be allowing system impacts from unattainable maintenance. An analysis has been performed on this area and anticipated conveyance flows have been provided. Additional information can be found in Appendix A.8.

This analysis will look at the overall drainage patterns in the Woodcreek neighborhood which was developed prior to Ecology's stormwater standards. The Woodcreek study area is the section of Woodcreek Drive neighborhood south of Main Street to Forest Lane and Forest Circle. The Woodcreek study area generally drains west from Fern Drive to a WSDOT drainage ditch along Guide Meridian Road.

The primary focus of this study will be to study the drainage from Meadow Lane to the WSDOT Ditch (see subbasin 1 on exhibit in Appendix A.8). Capacity issues have been observed on Meadow Lane, as well as flooding when WSDOT Ditch becomes inundated. The WSDOT ditch has overtopped due to debris blockage and flooding in the Woodcreek neighborhood resulting in property damage.

Through onsite investigations a general conveyance system was assumed, but source and/or discharge of various pipes in this system were not determined. A Stormshed model was prepared using the available information. The model includes assumed and approximated conveyance information due to the limited information and the difficulty to inspect the existing system.

### *Existing Drainage Overview and Concerns*

A study was performed on Woodcreek Drive and Meadow Lane, the study area is shown in the attached exhibit. It was determined that runoff from Meadow Lane (subbasin 1) is conveyed to the Guide-Meridian roadside ditch via an 8" concrete pipe. Catch basins in the vicinity have an exposed earth sump, it is assumed the design intent was to infiltrate collected stormwater. The southern portion of Woodcreek Drive, outside of the study area shown on the exhibit in Appendix A.8, drains to Fishtrap Creek.

Woodview and a portion of Woodcreek Drive between 19<sup>th</sup> Street and Meadow lane (subbasin 2) is collected and conveyed through an 8 inch pipe. This 8 inch pipe is located between two private properties and drains to the south through private property and discharges to a low area.

There is a 12 inch storm pipe that also discharges to this low area. This 12 inch storm pipe collects runoff from 19<sup>th</sup> Street, Woodcreek Drive, Forest lane, and Forest Circle (subbasin 3, 4, 5, and 6 respectively).

### *Summary of Concerns with Woodcreek:*

Flooding along Meadow Lane and Woodcreek neighborhood may be the result of several failing or undersized stormwater facilities. Below are three possible reasons for flooding within Woodcreek.

#### 1. Impedance of flow in Guide Meridian roadside ditch:

Portions of stormwater runoff from Woodcreek is collected and discharged in the Guide Meridian's eastern roadside ditch. At the time of investigation, the Woodcreek drainage appeared to be in a natural low area impeded by an earthen berm, the berm contained two small culverts (approximately 6" diameter) that drained this low area to the WSDOT ditch. The Meadow Lane storm system discharging to this Guide Meridian ditch was partially buried. Additionally, in heavy rain events, the Guide Meridian ditch may have a water elevation higher than the stormwater outlets. A buried or submerged outlet typically reduces stormwater conveyance which could result in flooding throughout the Woodcreek and Meadow Lane system.

One cause of elevated water elevations in the Guide Meridian ditch may be the size of the contributing basins that rely on this ditch to properly drain. The Guide Meridian ditch conveys runoff from several basins, the most notable basin located upstream from Woodcreek neighborhood is the North Guide Basin (approximately 1,138.2 ac). WSDOT has indicated the twin culverts under Guide Meridian Road are undersized and they will be replaced with a more appropriately size stormwater crossing. WSDOT is currently working on a plan to replace these undersized culverts. Undersized culverts typically cause a tailwater effect and may contribute to upstream flooding.

It is critical that WSDOT maintain and clean the culverts and ditch to ensure the basin can freely drain. The Ditch should be free from debris and vegetation that could get lodged in the culvert to impede flow in the ditch. During winter the Guide-Meridian ditch may have reduced conveyance capacity due to snow and ice. Large volumes of snow and ice can occupy a substantial volume in the ditch and can impede and block conveyance structures which can result in flooding. Ice blockages may be compounded when snow in fields melt, but ice in the ditches and culverts are still covered and shaded.

#### 2. Maintenance of existing stormwater infiltration systems.

Stormwater detention and infiltration facilities within the study may require maintenance. Sediment or other debris may have entered into the detention and infiltration facilities reducing the effective storage and infiltration rates. Maintaining any existing stormwater facilities may relieve some localized flooding.

### 3. Undersized or restricted stormwater conveyance.

There are several pipes in this neighborhood that do not meet the current City standard. Pipes may be undersized, thin walled, or consist of cracking concrete. The layout of the existing storm system does not meet current standards, catch basins often have a single outlet that will tee into the main storm line without a structure. This stormwater layout makes it difficult for the City to inspect and perform maintenance on lines in this neighborhood. Additionally, the stormwater conveyance system bends and curves to follow the roadway's horizontal alignment. Bends in the pipe can impede flow and can cause debris to settle in the pipe which further reduces the pipe's capacity. This system is difficult for City crews to maintain and inspect because of the curved storm mains, no inspection access, and no maintenance ports.

The City may use a video inspection systems on the existing stormwater pipes within Woodcreek to ensure that each pipe is intact and verify no obstructions are in the system. Ensuring that pipes in the system are clean and properly maintained will keep the system functioning as intended.

This area requires further analysis to determine the full extent of the issues and the necessary actions to appropriately solve discovered issues. This system should be considered for future stormwater improvements. Due to the several issues with the existing storm's layout, alignment, and materials the City may install new storm drainage system to fix the problems. This document will assist the City in planning future projects to address the drainage issues in this area.

#### *Solution Concepts for the Woodcreek Neighborhood:*

The existing drainage area was analyzed to size an appropriate conveyance system. Generally, the 25-year storm is considered to be sufficient for stormwater conveyance but the City may consider sizing a conveyance system for the 100-year storm to account for system unknowns, future development, and ensure the new conveyance system has capacity is sufficient. Additionally, if the City replaces the existing storm system they will have the opportunity to bring the system to current City standards.

#### Guide-Meridian Drainage

Ditches and culverts with WSDOT's ROW should be sized per WSDOT's design standards. Preliminary analysis shows an upstream basin size of approximately 1,139 acres. This area is primarily agricultural fields, but future development and/or zoning changes may occur. It is suggested this ditch be sized with additional capacity to allow for future development. The City should coordinate with WSDOT to confirm that WSDOT's future projects appropriately address the City's needs.

#### Pepin Creek System

Drainage issues north of Lynden have occurred in recent past. Runoff was unable to flow south through SR546 crossings and continue through the City. When this occurs the WSDOT Guide Meridian ditch may receive surface water from the Double Ditch drainage system which can inundate the Guide system. The City may be able to alleviate some of the regional flooding as the City limits expand. The City is proactively planning drainage improvements for the Double Ditch and Benson Road drainage system which may relieve some stress from the WSDOT drainage system (see SW07).

#### Meadow Lane (Subbasin 1; from Guide Meridian to Meadow Lane)

The storm main should be upsized to handle a minimum of the 25-year storm, approximately 4 cfs. The existing 8" concrete storm system has an approximate capacity of about 1 cfs, a new 15" diameter pipe could be installed with similar slopes to convey the 100-year storm, calculated to be about 5 cfs. Upsizing the system will allow the City to correct the existing system's accessibility and maintenance limitations.

#### Woodcreek (Subbasin 2; from Meadow Lane to 19th Street)

The storm main should be sized to handle a minimum of the 25-year storm, approximately 2 cfs; the peak flow from the 100-year storm is approximately 3 cfs. The existing system has limited access and therefore the slope of the existing 8" line could not be verified. The assumed capacity of this pipe is about 1 cfs which is typical for an 8" pipe installed a 0.5% slope. A 12" diameter storm drain at 0.5% slope can convey about 3 cfs.

The storm from Woodcreek Court crosses private property to an existing low area. If the City upsizes this pipe, then property access easements and coordination with the property owner may be required. The City may also connect this system to the Woodcreek storm system which discharges to the Guide Meridian ditch, but it is likely that the existing discharge area is a critical area and therefore the City will need to perform a study if they wish to remove flow from this area.

#### 19th Street (Subbasins 3, 4, 5, and 6; drainage from Woodcreek Dr, east of 19th Street, and portions of Forest Lane and Forest Circle)

The storm main should be upsized to handle a minimum of the 25-year storm, approximately 13 cfs; the peak flow from the 100-year storm is approximately 17 cfs. The approximate capacity of the existing 12" diameter storm drain is 2 cfs, a new 24" pipe with similar slopes can convey about 13 cfs. The storm from 19<sup>th</sup> crosses private property to an existing low area. If the City upsizes this pipe, then property access easements and coordination with the property owner may be required. It is likely that the existing discharge location is a critical area and therefore the City will need to perform a study prior to revising any flow from this area. Future upstream infiltration and LID techniques should be assessed prior to any future construction projects.

#### Critical Areas (Subbasin 7; from Guide Meridian to 19th Street)

There are several man made berms through the low area. These berms greatly restrict flows to the Guide Meridian drainage system. There is evidence of water being held in this low area, a wetland evaluation and hydrologic study would need to be performed before any work is performed in this potential critical area. If berm culverts in this critical area are to be replaced, they should be replaced with a similar size and elevation unless the critical area assessment indicates otherwise.

### 7.2.9 SW010 – Low Impact Development from 7th to 10th Street and from Front to Judson Street

The City would like to improve drainage and incorporate water quality to the Nooksack River through design of Low Impact Development (LID) facilities along Judson Street in the City of Lynden. This project will include approximately 5 square blocks between Front Street and Judson Street, from 7<sup>th</sup> to 10<sup>th</sup>

Streets. The project is intended to apply LID Best Management Practices (BMPs) focused on using soils and vegetation to mimic pre-disturbance hydrologic processes of infiltration, filtration, storage evaporation, or transpiration. Enhanced BMPs will also be employed to address road runoff pollutants.

During the design phase soils, safety and space availability, and lifecycle maintenance will be weighed in the selection of appropriate BMP solutions. Community cooperation associated with retrofitting LID techniques into an existing neighborhood will need to be considered. Because the City has received requests from the public to provide street upgrades an outreach effort will be made as part of this project to communicate the benefits of LID and associated street improvement. The City will evaluate the cost of BMP lifecycle maintenance and will also identify stewardship opportunities with the neighborhood and community.

#### 7.2.10 SW011 – South Park & Parkview Drive

This project will reduce storm water discharges and improve water quality in Fishtrap Creek by designing LID based stormwater practices along Parkview Drive, which currently has no stormwater facilities. This project is associated with a water main replacement and roadway rehabilitation for S. Park Drive, Parkview Drive and Van Loo Lane, located in Lynden. The existing drainage structures will be replaced, but no new outfalls created.

Stormwater runoff from portions of the right-of-way will be managed with infiltration facilities for flow control to provide detention, though not required by the Washington State Department of Ecology. These facilities will be stone trenches surrounding perforated storm drain pipe. The remaining right-of-way will continue to naturally infiltrate stormwater runoff in the vegetated shoulder. The City is currently pursuing Construction funds.

#### 7.2.12 SW012 – Groundwater Monitoring

The City is pursuing funding to monitor the groundwater elevation throughout the City limits. This work will require the installation of several groundwater monitoring wells and the efforts associated with collecting and utilizing the data. Groundwater information can be utilized for sampling and determining which areas in the City are suitable for LID based stormwater practices.

A decision matrix should be completed which analyzes things such as, areas with potential for development, known hydrogeology of the area, number and locations of monitoring points to sufficiently determine accurate groundwater elevations, if property owners would be cooperative, duration of data collection, and method of collection. Making these decisions would assist in determining the potential cost of this investigation.

#### 7.2.13 SW013 – Public Works Shop Improvements

1. Decant Facility: Prior to disposal of both sweeping and vector wastes these materials are stockpiled and allowed to drain to remove liquids. The current location for this process is not covered. The proposed project will complete the design and construction of a 3 sided building where the sweeping and vector waste would be stored to allow for liquid drainage. This liquid would then have any remnant solids removed prior to discharge to the City sewer system.
2. Material Storage: The City systems department is in charge of a variety of City systems, operations and maintenance. To allow for prompt construction and proper safety associated with these tasks require that material be located close to the City. The best location for this

storage is the City shop/maintenance shop. These stored materials are currently not covered allowing precipitation to cause runoff of material. The proposed project will design and construct a 3-sided building to properly store and protect these needed materials.

3. Vehicle wash facility. The City Public Works system crew currently is required to wash and clean vehicles and equipment in existing building and/or grass areas to allow for some treatment of the wash water. This project will design and construct a proper vehicle wash area where the water drains to the City sanitary sewer system.
4. Upgrade storm drainage. The Public Works System shop has access to it along a gravel and chip seal driveway as its southern access. These drainage is currently collected in a ditch, directly adjacent to the driveway. This project will provide the design necessary to retro-fit this existing ditch into a properly functioning water quality facility. This project will also include the construction of this retro-fit.
5. Shop north side drainage. Employee parking for the Public Works System crew is on the northside of the facility. Drainage from this parking area currently is collected in catchbasins and drained to a roadside ditch with no form of treatment beyond solid separation. This proposed project will complete the funding and construction of a proper storm drain collection and treatment system for the north employee parking area at the Public Works System facility.