TRANSPORTATION MUNICIPAL/ENVIRONMENTAL STRUCTURAL
LAND DEVELOPMENT LANDSCAPE ARCHITECTURE
PLANNING/COMMUNICATIONS GIS/MAPPING

Town of Westlock

Final Report

Stormwater Master Plan - 2009 Update

ISL Engineering and Land Services

November, 2009

November 25, 2009

Our Reference: 12703

Town of Westlock
10003 – 106 Street
Westlock, Alberta
T7P 2K3

Attention: Colleen Thome
Director of Planning and Development

Dear Colleen:

Reference: Stormwater Master Plan – 2009 Update

ISL Engineering and Land Services Ltd. is pleased to submit 20 bound copies, one unbound copy and one electronic copy of the Stormwater Master Plan – 2009 Update report. This report incorporates comments received on the draft report and comments received from Town Council at the presentation held October 19, 2009.

This Master Plan Update builds on the Town's 2004 Stormwater Master Plan and identifies near-term stormwater needs and guidance to accommodate future growth including infill developments and re-developments. The report addresses the management of stormwater run-off quantities and water quality, including recommendations for the provision of constructed wetlands as the favoured approach to stormwater management.

Should you have any questions or further comments please contact the undersigned at your convenience.

Sincerely,

Russell Barth, P.Eng.
Project Manager

RB/dw

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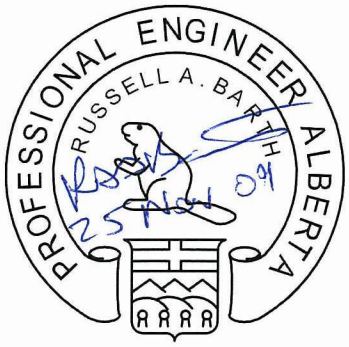
Corporate Authorization

This document entitled "*Stormwater Master Plan – 2009 Update – Final Report*" has been prepared by ISL Engineering and Land Services Ltd. (ISL) for the use of "*Town of Westlock*". The information and data provided herein represent ISL's professional judgement at the time of preparation. ISL denies any liability whatsoever to any other parties who may obtain this report and use it, or any of its contents, without the express written consent of ISL.



Russell A. Barth, P.Eng.

PERMIT TO PRACTICE

ISL Engineering and Land Services Ltd.

Signature

Date Nov 25/09

PERMIT NUMBER: P 4741

The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Executive Summary

The Town of Westlock commissioned ISL Engineering and Land Services Ltd. (ISL) to develop an update to the existing Town Stormwater Master Plan (ISL, November 2004) to consider growth plans current to the year 2009, to determine upgrading requirements for the existing stormwater system to mitigate existing system problems and to address future growth in response to updated growth plans and the annexation of six quarter sections of land to the east. Major activities undertaken in this analysis included:

- Utilize the Town's existing XP-SWMM computer model of the stormwater drainage and management system to review constraints in the existing network.
- Identify upgrading required to the existing stormwater drainage and management system to provide an acceptable level of service reflective of future growth plans.
- Recommend future stormwater drainage and management system elements required for future development areas.

As per the Town's Stormwater Master Plan (ISL, November 2004), fundamental conclusions as per system performance remain generally the same. That is to say that:

1. Generally, the storm drainage system within the Town of Westlock performs well when compared to other towns of similar size within Alberta. There are numerous relatively minor issues that should be dealt with. Some maintenance work is also required for the storm drainage system. Some surface ponding occurs during 1:5 year events, but there have been few complaints from the public. Any ponding under these conditions is low in volume and of short duration. There can be substantial surface ponding under 1:100 year events. Some recommendations related to alleviating flooding were made.

2. Some physical condition system upgrades to the system are warranted.

Departure from the previous study is generally resultant from the expanded future growth area. Generally speaking, no new upgrades to the system are required to handle the expanded growth area; the main difference is the future development area stormwater drainage and management network.

The existing system upgrade recommendations are as follows:

1. Undertake a storm drainage system inspection and cleaning program to identify and remove potential blockages in the system that may be impeding carrying capacities. Maintenance work may include: removal of silt from storm sewers, culverts and ditches, catchbasins and culvert inlets and outlets; bending culvert inlets and outlets to be fully open, etc.
2. Construct an outlet control structure on the existing stormwater management facility near Highway 44 and the north Town boundary to provide small controlled discharges and minimize the potential erosion in the Highway 44 ditch system at a cost of between $15,000 for a basic outlet control structure, to $150,000 for increased pond capacity with an improved outlet control structure. A reserve fund has been established and funds are being collected.
3. Replace the twin 450 mm culverts at the west approach to Marks Motors with twin 600 mm culverts at a cost of $12,000. This will minimize flooding at this approach in 1:5 year or larger storm event.

4. Monitor drainage conditions in the areas around stormwater management ponds G and H. A temporary drainage ditch around the Skyrider lands has been developed in the interim, with the proposed drainage scheme for the area providing a long term solution once built. If issues remain in this area, additional ditches to divert flows could be considered, or alternatively, temporary or permanent ponds could be constructed to mitigate any potential flooding in the area.
5. In the vicinity of 96 Avenue, address several items with regard to the existing drainage ditch system to reduce the risk of flooding along the 96 Avenue ditch:
    a) twin the 1200 mm culvert crossing 96 Avenue near 109 Street at a cost of $25,000;
    b) twin the 1200 mm culvert under the approach south of 110A Street at a cost of $15,000;
    c) twin the 1200 mm culvert under 110A Street at a cost of $25,000;
    d) twin the 1200 mm culvert under an approach to the raw water reservoir near 112 Street at a cost of $15,000; and
    e) widen the 96 Avenue ditch to a bottom width of approximately 4 m while maintaining side slopes, and build up its west bank at a cost of $60,000.
6. In the northwest, address the following items:
    a) twin the 600 mm culvert under 96 Avenue near 113A Street from the drainage ditch to prevent flow proceeding over the road in the 1:100 year event at a cost of $15,000; and
    b) replace the 600 mm storm pipe discharging into the ditch near 96 Avenue and 113A Street from the storm pond outlet pipes to ensure proper pipe capacity is maintained at a cost of $25,000.

The following are the recommendations for the storm drainage system under future development conditions:

1. To ensure compliance with Alberta Environment and Town standards, future development within the Town of Westlock is required to provide stormwater management ponds such that post-development 1:100 year flows do not exceed pre-development 1:100 year flows of 4.0 L/s/ha. A system of stormwater management ponds for the undeveloped sections of the Town has been developed as shown in Figure 6.1. It is recommended that as future development occurs that a similar system be adopted in developing areas with final pond size and location dependent upon development patterns. Please note that future development areas are expected to have local piped drainage systems connected to these larger trunk sewers and ponds. Storm ponds should also be aesthetically designed at the time of construction, providing landscaping and pathway systems to enhance development areas around them.

2. The Town should consider strategic partnerships related to stormwater management, such as partnering with Ducks Unlimited as it pertains to wetlands construction.

Table of Contents

Letter of Transmittal
Corporate Authorization
Executive Summary *i*

1.0 Introduction **1**
1.1 Authorization 1
1.2 Purpose of Study 1
1.3 Background 1

2.0 Existing and Future Development **3**
2.1 Existing Development 3
2.2 Future Development 3

3.0 Existing Stormwater System **5**
3.1 Existing Drainage Patterns 5
3.2 Existing Drainage Infrastructure 5

4.0 Previous Master Plan - 2004 **6**
4.1 Previous Study Conclusions / Recommendations 6
4.2 Subsequently Implemented Works 7

5.0 Design Criteria **9**
5.1 Stormwater Design Criteria and Hydrologic Model Parameters 9
5.2 Design Rainfall Events 10
5.3 Provincial Stormwater Management Requirements 11
5.4 Constructed Wetlands 11

6.0 Servicing of Future Development Areas **13**
6.1 Future Stormwater System 13

7.0 Upgrading Recommendations for Existing System - 2009 **15**
7.1 System Upgrade Recommendations 15

8.0 Cost Estimates **17**
8.1 Cost Estimates for Recommended Upgrades to Existing Stormwater Drainage System 17
8.2 Cost Estimates for Stormwater Drainage System in Future Development Areas 17
8.3 Potential Cost Sharing 17

9.0 Conclusions and Recommendations **19**
9.1 Conclusions 19
9.2 Recommendations 19

10.0 References **21**

Tables

Table 5.1:	Imperviousness Criteria	9
Table 6.1:	Future Storm Pond Design Details	14
Table 8.1:	Future Storm Pond Costs	17

Figures

		Following Page
Figure 2.1:	Existing Land Use Bylaw Map	3
Figure 2.2:	Future Land Use Plan	3
Figure 2.3:	Town Growth Projections	4
Figure 3.1:	Existing Storm Basin Boundaries	5
Figure 3.2:	Existing Stormwater Drainage Infrastructure	5
Figure 6.1:	Future Stormwater System	14
Figure 7.1:	Existing Stormwater System Upgrade Recommendations	16
Figure 8.1:	Future Stormwater System Costs	17

1.0 Introduction

1.1 Authorization

ISL Engineering and Land Services Ltd. (ISL) was commissioned by the Town of Westlock (the Town) to prepare an update to the Town's Stormwater Master Plan (ISL, November 2004). This project was initiated in response to Town growth and the annexation of six quarter sections of land to the east in 2008.

Developing a Stormwater Master Plan represents an investment in the infrastructure of a community. This plan provides a "road map" to Council and the administration in assessing the status of the existing infrastructure, and the capability of the infrastructure to accommodate new development in the short term and long term. This information is useful for both administration and elected officials in carrying out long term planning and budgeting. It is critical that the areas assessed in a Master Plan are representative of a municipality's future growth plans.

It is important to update the Town's Stormwater Master Plan (ISL, November 2004) to reflect these additional future growth areas to provide proper infrastructure planning to ensure future serviceability of the respective areas and facilitate review of suitable funding options while encouraging sustainable growth. This report will also focus on growth and development of new infrastructure within the former Town Boundary.

1.2 Purpose of Study

There are several reasons for developing a Stormwater Master Plan:

1. To inventory and analyze existing stormwater infrastructure under a variety of storm conditions.
2. To develop plans for future growth. Location and timing of development can be determined in conjunction with the availability of adequate infrastructure.
3. To determine what, if any, upgrades are needed to the existing stormwater conveyance system to meet present Town needs, as well as upgrades or new storm infrastructure construction to facilitate future growth within Town and to assist in developing funding formulations for this infrastructure.

For the purposes of this update to the Town's Stormwater Master Plan, the focus will be on developing plans for future growth in response to revised growth plans, to determine system upgrades necessary to support the future expanded system, and to assess the relevance of previous existing and future system upgrades in the context of the newly developed growth plans.

1.3 Background

The Town of Westlock presently has a population of approximately 4,964 people based on recent census results (2008). It is located at the junction of Highways 44 and 18 approximately 60 km northwest of the City of Edmonton. The Town primarily consists of residential development, but also contains industrial areas along the CN Rail alignment and adjacent to Highway 18 into the east and west ends, as well as commercial areas along Highways 18 and 44 and in the downtown core.

Topographically, the Town of Westlock is generally quite flat with a gentle overall sloping to the north. The Town is split by a gentle north-south ridge on the east side that splits the Town into drainage areas to the northeast and to the northwest. Approximately ninety percent of the current Town developments lie west of this ridgeline, with the remainder located to the east. There is a topographic high about 1 km south of Town, with runoff from agricultural lands entering Town from the south. Westlock lies primarily within the Wabash Creek Watershed; the creek picks up all flows from Town either north or west of Town through the County roadway ditches and contributing creek systems. Ultimately, all flows from Westlock enter the Pembina River via Wabash Creek.

2.0 Existing and Future Development

2.1 Existing Development

Existing development and land use in the Town is shown on Figure 2.1. Commercial development within the Town primarily exists along Highways 18 and 44, as well as in the downtown core. Industrial development is situated primarily at the west end of Town, generally west of 96 Avenue. Some industrial development is also present on the extreme east side of Town along Highway 18. Schools are located in the northeast part of Town as well as in the centre of Town. The Hospital and long term care institutional development is located in the south of Town, just west of Highway 44.

The majority of the northeast section of Town is residential, along with areas surrounding downtown and the majority of existing development south of Highway 18. Parks and recreation lands are located throughout the residential areas with a large area of parks and recreation land in the southwest where the recreation centre, rodeo grounds, and agriculture museum are located.

The Town of Westlock covers an area of 21 quarter sections or 1,360 hectares. Current development covers an area of about 510 hectares, or 38% of Town limits. As a result, total undeveloped land within Town is about 850 hectares at present. Generally speaking, the majority of the undeveloped land within Town is considered to be developable.

2.2 Future Development

Future development in the Town of Westlock will encompass the existing undeveloped areas within Town along with the recently annexed area at the east end of Town. The annexation area encompasses roughly six quarter sections of land.

Potential future development for the Town of Westlock is shown on Figure 2.2. The Town of Westlock is projected to grow at a moderately aggressive rate of about 2% per annum (although historic rates have been less than 2%). At this rate, the undeveloped land within the former Town Boundary plus the annexation area will take many decades to fully develop. Future development is assumed to be primarily residential and industrial with a lesser amount of commercial development.

Residential development is proposed for the north central and northeast parts of Town, as well as in the south central portion of Town. Near term residential developments are being planned for the Skyrider and Oxford areas in the south and Aspendale area in the northeast. Commercial development is anticipated along Highways 18 and 44, while industrial development is proposed in the northwest and southwest along 96 Avenue and to the west. There will also be future industrial development in the southeast to the south of the highway commercial development along Highway 18 and east of Highway 44. An expansion of the parks and recreation lands containing the Recreation Centre and Rodeo Grounds is also planned. It is assumed that these lands will be expanded south to the Town boundary.

Land use for the newly annexed land is assumed to be generally residential in the central and northern portions, commercial adjacent to Highway 18, and industrial in the south.

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C-1	Multi-Purpose Commercial	I	Institutional	R-1	One Family Residential	R-4	Low Density Multi-Family Residential
C-2	Service Commercial	IG	General Industrial	R-1A	Small Lot One Family Residential	RMH-1	Manufactured Home Subdivision Residential
C-3	Highway Commercial	IR	Restricted Industrial	R-2	Two Family Residential	RMH-2	Manufactured Home Park Residential
DC	Direct Control	UR	Urban Reserve	R-3	Multi-Family Residential	PR	Parks and Recreation

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Town of Westlock

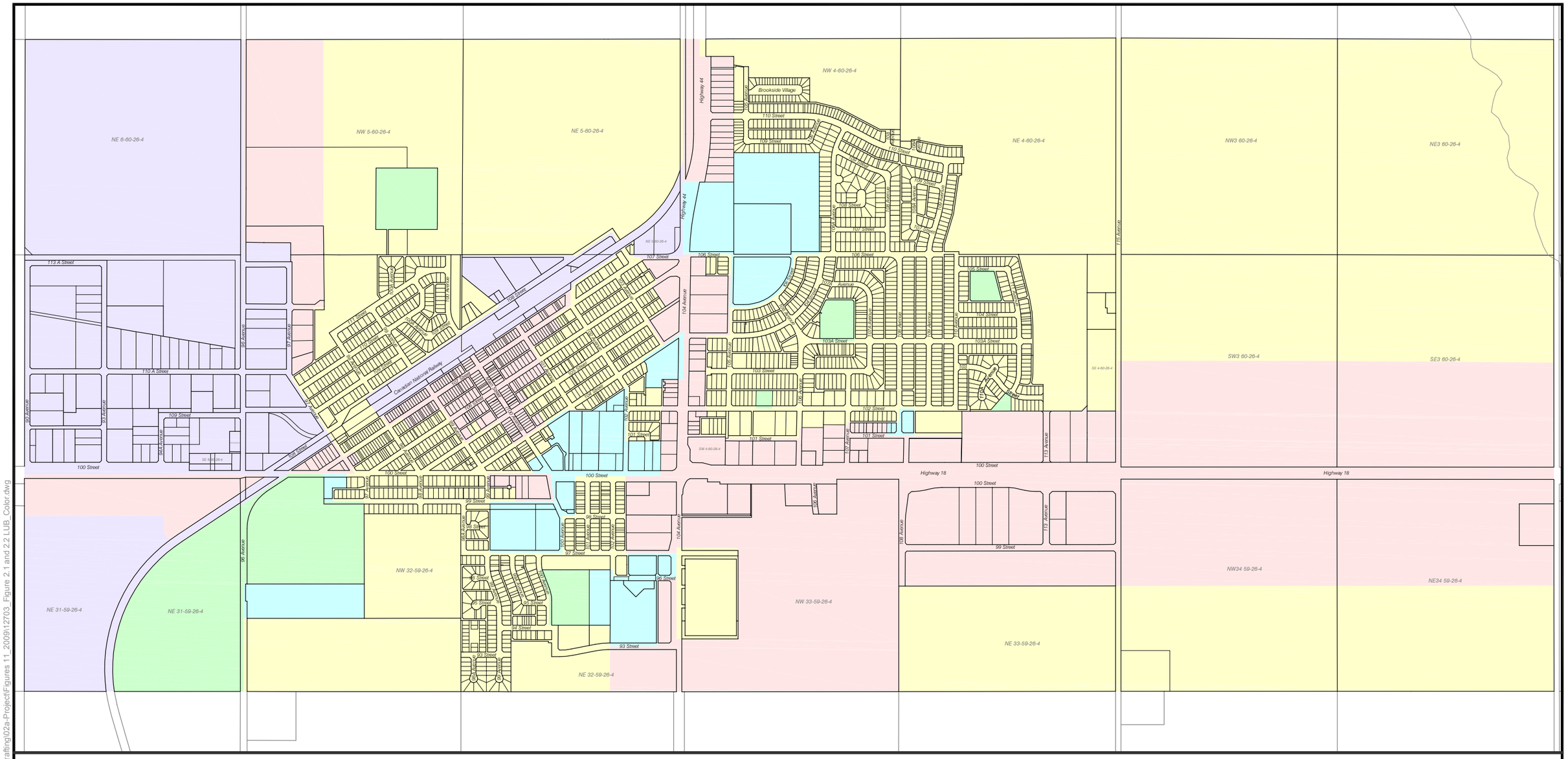
TOWN OF WESTLOCK MASTER PLAN - 2009 UPDATE
STORMWATER
EXISTING LAND USE BYLAW MAP

FIGURE 2.1

12703

SCALE

OCTOBER, 2009



Legend

I	Institutional	C	Service Commercial	PR	Parks and Recreational
IN	Industrial	R	Residential		

N

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Town of Westlock

TOWN OF WESTLOCK MASTER PLAN - 2009 UPDATE
STORMWATER
FUTURE LAND USE PLAN

FIGURE 2.2

12703

SCALE

OCTOBER, 2009

Low (1%), medium (2%) and high (3%) population growth projects are shown on Figure 2.3. A summary of a number of projected population thresholds for the medium (2%) growth rate is as follows:

- 2008 – 4,964 persons
- 2025 – 6,951 persons
- 2040 – 9,355 persons
- 2070 – 16,945 persons

Assuming future development occurs at a realistic density of 30 persons/hectare, and assuming that non-residential development growth will be equivalent to roughly half the residential area developed, an estimation of additional land consumption for each the above noted thresholds is as follows:

- 2008 to 2025 – 99 hectares
- 2025 to 2040 – 121 hectares (cumulative development of 220 hectares)
- 2040 to 2070 – 380 hectares (cumulative development of 600 hectares)

This suggests that full build-out for all undeveloped lands within the new Town Boundary (1,360 hectares) is not expected to occur until well after 2070.

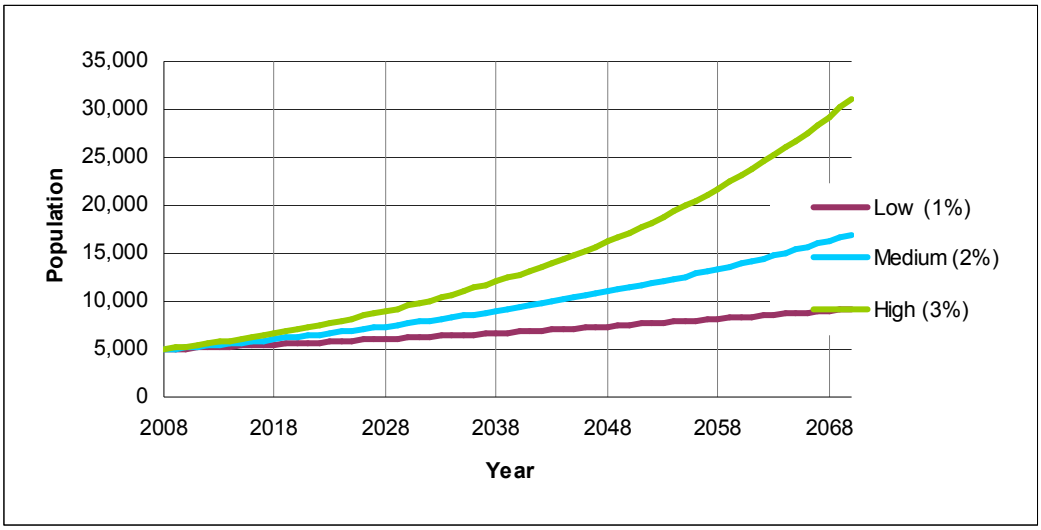


Figure 2.3: Town of Westlock Growth Projections

3.0 Existing Stormwater System

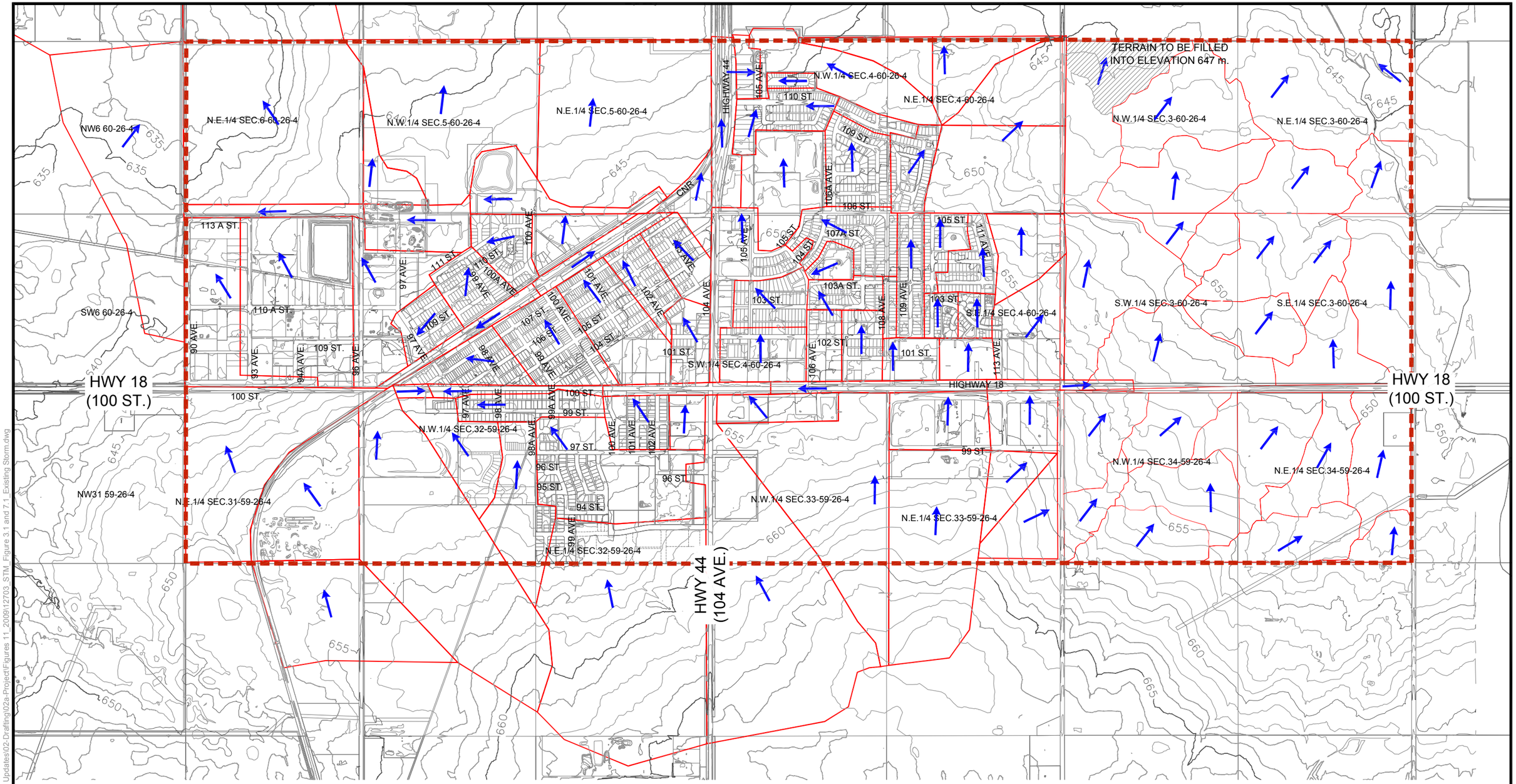
3.1 Existing Drainage Patterns

The Town of Westlock generally drains from higher terrain just south of Town northwest to Wabash Creek. Several quarter sections south of Town drain into Town from a high point located approximately one kilometre south of Town and one kilometre east of Highway 44 (in line with 111 Avenue). The Town is split by a gentle ridge on the east side which acts as a drainage divide between the southeast part of Town and the remainder of Town. Existing drainage patterns generally define six drainage basins within Town. The basins within Town can be seen in Figure 3.1 and are described as follows:

1. Areas south of Highway 18 to the east of 111 Ave drain to the northeast, and are then taken east by ditches along Highway 18.
2. Areas generally east of 109 Avenue north of Highway 18 drain to the northeast, and are then taken east or north by ditches to the northeast corner of the Town. The roadway ditches then take these flows north, to a small creek which leads to Wabash Creek.
3. Areas north of Highway 18 between Highway 44 and 109 Avenue drain north to an existing storm pond at the north boundary of Town and are then discharged into ditches draining north along Highway 44.
4. Areas in the far southwest part of Town, located south of Highway 18 and west of 96 Avenue, drain generally to the northwest. These flows are then taken west by ditches running along Highway 18.
5. The remaining portion of Town drains generally to the northwest via storm drainage infrastructure. All flows are ultimately conveyed north and west by drainage ditches to Wabash Creek. The three undeveloped quarter sections west of Highway 44 and north of 113A Street presently drain freely to the northwest, eventually discharging to Wabash Creek.
6. The newly annexed areas (areas east of 115 Avenue) currently drain either east along the Highway 44 ditches or northeast to an existing drainage course.

3.2 Existing Drainage Infrastructure

Within the Town of Westlock, the stormwater conveyance system consists of three different types of drainage infrastructure. This includes curb and gutter drainage along the street surface, curb and gutter drainage with catchbasins and storm sewers, and open ditch drainage. Some drainage in undeveloped or open areas is achieved by uncontrolled overland drainage. Drainage in most developed residential areas is curb and gutter drainage. The western part of Town drains to storm sewers or ditches which then drain to the primary outfall ditch running northwest from the Town to Wabash Creek. The eastern half of Town largely drains north via storm sewers and ditches, then drains north along the Highway 44 ditches, out of Town to the north, to Wabash Creek and the Pembina River. The piped, ditch, and surface drainage system can be seen on Figure 3.2. In future development areas, limited, if any drainage infrastructure currently exists and where it does, is limited to roadside ditch and culvert drainage.



Legend

- TOWN BOUNDARY
- Sub-basin Boundaries
- Direction of Flow

Note: Contour Interval = 1.0 m

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TOWN OF WESTLOCK MASTER PLAN - 2009 UPDATE
STORMWATER
EXISTING STORM BASIN BOUNDARIES

FIGURE 3.1

12703

SCALE

0 100 200 300 400 500 600 700 800 metres
0 500 1000 1500 2000 2500 feet

OCTOBER, 2009

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N.W.1/4 SEC.4-60-26-4
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N.W.1/4 SEC.3-60-26-4
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S.W.1/4 SEC.3-60-26-4
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N.W.1/4 SEC.32-59-26-4
N.E.1/4 SEC.31-59-26-4
N.E.1/4 SEC.32-59-26-4
N.W.1/4 SEC.33-59-26-4
N.E.1/4 SEC.33-59-26-4
N.W.1/4 SEC.34-59-26-4
N.E.1/4 SEC.34-59-26-4

HIGHWAY 44
CNR
HIGHWAY 18
HWY 18 (100 ST.)
HWY 44 (104 AVE.)

105 AVE.
110 ST.
109 ST.
106A AVE.
106 ST.
105 ST.
111 AVE.
107A ST.
104 ST.
103 AVE
103A ST.
103 ST.
109 AVE.
108 AVE.
102 ST.
101 ST.
106 AVE.
113 AVE.
104 AVE
100 AVE.
111 ST.
110 ST.
100A AVE.
99 AVE.
97 AVE.
109 ST.
107 ST.
106 ST.
105 ST.
104 ST.
102 AVE.
101 ST.
100 ST.
99 ST.
97 ST.
96 ST.
95 ST.
94 ST.
113 A ST.
110 A ST.
90 AVE.
93 AVE.
94A AVE.
96 AVE
98 AVE.
98A AVE.
99A AVE.
100 AVE.
101 AVE.
102 AVE.
99 AVE

Legend

TOWN BOUNDARY

Pipe diameters
- 450 mm and less
- 525 mm
- 600 – 750 mm
- 900 – 1050 mm
- 1200 mm and more
- Ditch

Short Term Proposed Upgrades by Developers

N:\12000\12703 Westlock Master Plan Update\02-Drafting\02a-Project\Figures 11_2009\12703_STM_Figure 3.1 and 7.1_Existing Storm.dwg

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TOWN OF WESTLOCK MASTER PLAN - 2009 UPDATE
STORMWATER
EXISTING STORMWATER DRAINAGE INFRASTRUCTURE

FIGURE 3.2

12703

0 100 200 300 400 500 600 700 800 metres
0 500 1000 1500 2000 2500 feet

SCALE

OCTOBER, 2009

4.0 Previous Master Plan - 2004

The following section summarizes key items from the Town's Stormwater Master Plan (ISL, November 2004).

4.1 Previous Study Conclusions / Recommendations

The Town's Stormwater Master Plan (ISL, November 2004) involved the construction of an XP-SWMM hydraulic model to assess the Town's stormwater drainage system. Major conclusions included the following:

1. Generally, the storm drainage system within the Town of Westlock performs well when compared to other towns of similar size within Alberta. There are numerous minor issues that could be dealt with, as well as several major problems that require addressing. Some maintenance work is also required for the storm drainage system. Some surface ponding occurs during 1:5 year events, but there have been few complaints from the public. Any ponding under these conditions is low in volume and of short duration. As expected, there is substantial surface flooding under 1:100 year events, but this should be expected. Some recommendations related to alleviating flooding were made.

2. Some physical condition system upgrades to the system are warranted.

Based on these conclusions, a number of system upgrades were recommended to address existing system deficiencies:

1. Undertake numerous select maintenance items including the removal of some vegetation from ditches to improve their carrying capacities, and the flushing of select storm sewers to remove accumulated silt.

2. In the northeast, upgrade the existing storm pond to meet current stormwater management facility design standards. This would require the construction of an outlet control structure. By doing this, it would minimize the magnitude of the flows discharging from the pond to the Highway 44 ditches.

3. In the southeast, there were two improvements required to the existing ditch system near Marks Motors:
    - Replace the twin 450 mm culverts at the west approach to Marks Motors with twin 600 mm culverts. This will minimize flooding at this approach in 1:5 year or larger storm events.
    - The ditch east of Marks Motors is poorly defined. It should be deepened, and the south bank should be built up. This would enable the ditch to convey higher flows under low frequency rainfall events and reduce the risk of flooding at Marks Motors.

4. Construct stormwater management ponds G and H. These ponds would control incoming flows from undeveloped lands south of Town and would, thus, reduce peak flows. This would reduce the flooding risk by maintaining lower flows through the 99 Street Trunk under large storm events. This would also reduce the chance of flows proceeding along 99 Avenue into Town from the south.

5. Construct a ditch around the Southview area to reduce the magnitude of overland flow through the subdivision along 99 Avenue.

6. In the vicinity of 96 Avenue, address several items with regard to the existing drainage ditch system to reduce the risk of flooding along the 96 Avenue ditch:
    - twin the 1200 mm culvert crossing 96 Avenue near 109 Street;
    - twin the 1200 mm culvert under the approach south of 110A Street;
    - twin the 1200 mm culvert under 110A Street;
    - twin the 1200 mm culvert under an approach to the raw water reservoir near 112 Street; and
    - widen the 96 Avenue ditch to a bottom width of approximately 4 m while maintaining side slopes, and build up its west bank.

7. In the northwest, address the following items:
    - twin the 600 mm culvert under 96 Avenue near 113A Street from the drainage ditch to prevent flow proceeding over the road in the 1:100 year event; and
    - Replace the 600 mm storm pipe discharging into the ditch near 96 Avenue and 113A Street from the storm pond outlet pipes to ensure proper pipe capacity is maintained.

The following are the previous recommendations for the storm drainage system under future development conditions:

1. To ensure compliance with Alberta Environment and Town standards, future development within the Town of Westlock should be required to provide stormwater management ponds such that post-development 1:100 year flows do not exceed pre-development 1:100 year flows of 4.0 L/s/ha. A system of stormwater management ponds for the undeveloped sections of Town has been developed. It is recommended that as future development occurs that a similar system be adopted in developing areas with actual pond size and location dependent upon development patterns.

4.2 Subsequently Implemented Works

The following works or activities recommended in the 2004 Master Plan have been subsequently implemented:

1. Vegetation has been removed from select ditches to improve their carrying capacities.
2. The ditch east of Marks Motors has been deepened and the south bank built up.
3. Some berming was constructed in the Southview area to direct surface runoff away from existing development, reducing flood risk in the back lane near 94 Street and 98A Avenue. In addition, development in the Southview area is currently being planned, and this development is expected to take further steps to addressing the local flooding concern.

The following works or activities recommended in the 2004 Master Plan have not been implemented:

1. Select storm sewers have not been flushed to remove accumulated silt.
2. The construction of an outlet control structure on the existing stormwater management facility near Highway 44 and the north Town boundary has not yet been implemented, however, a reserve fund has been established and funds are being collected.
3. The culvert upgrades in the ditch below the west approach to Marks Motors have not been implemented.
4. Stormwater Ponds G and H have not yet been implemented and the risk of surface flooding during large storm events remains.
5. None of the 96 Avenue ditch, culvert or storm sewer upgrades identified in items 6 and 7 of Section 4.1 above have been implemented.

5.0 Design Criteria

5.1 Stormwater Design Criteria and Hydrologic Model Parameters

Based on the Town's previous Stormwater Master Plan (ISL, November 2004), stormwater drainage design and assessment criteria previously recommended were revisited. The following summarized the parameters used to assess runoff volumes and pipe capacities new future development areas as well as the criteria used to assess and portions of the existing stormwater drainage system impacted under the expanded future development scenario.

The design criteria used to assess the Town's stormwater system were taken from a variety of sources including the Town's Servicing Standards and typical design values for the City of Edmonton as well as past work undertaken by ISL for smaller municipalities in the Province of Alberta and in recognition of local soil conditions. The design criteria selected was then used for input into a computer model to design and assess the stormwater drainage system for the industrial area.

The XP-SWMM computer model was selected to perform the analysis. XP-SWMM is a dynamic model capable of unsteady flow simulation that is more accurate than most hydraulic models and is thus, more capable of delivering closer to life results. XP-SWMM features an enhanced graphical user interface making for easy review of models created and allowing for customized graphical output. For this application, XP-SWMM simulates the stormwater conveyance system throughout Town and performs a sophisticated hydraulic analysis of the system. The model is also useful to determine pond volumes.

The hydrologic data used to estimate runoff volumes is as follows:

- Depression storage of 6.4 mm in pervious areas and 3.2 mm in impervious areas
- Manning's "n" roughness value of 0.025 for pervious areas and 0.013 for impervious areas
- Initial infiltration rate of 76 mm/hr
- Ultimate infiltration rate of 2.5 mm/hr
- Infiltration decay rate coefficient of 0.00115/s
- Ground slopes as obtained from topographic data, averaging around 0.7%
- Imperviousness data for different land uses as follows in Table 5.1.

Table 5.1: Imperviousness Criteria

Land Use	Imperviousness (%)
Residential	50%
Country Residential	30%
Institutional	65%
Industrial/Commercial	75%
Roadway	95%
Roadway With Ditches	60%
Railway With Ditches	30%
Ditch/Drainage Easement	40%
Undeveloped	20%
Cultivated Farmland/Grassed Areas	10%

This design criteria was used, along with the existing and future land use data for Town to determine imperviousness for each area. The hydrologic data was then used to calculate runoff for each area under various storm conditions.

In determining future development requirements, the same criteria were utilized to calculate runoff. However, additional to this, there were several hydraulic design criteria necessary to design a future stormwater management system for Town. These criteria were also used in assessment of the existing drainage infrastructure. The criteria are as follows:

- Storage ponds will be sized to store the 1:100 year rainfall event with approximately a 2.0 m rise from normal water level.
- Storage pond outlets sized to release a typical pre-development rate of 4.0 L/s/ha as per the Town's Stormwater Master Plan (ISL, November 2004).
- Manning's "n" roughness value of 0.013 for concrete pipe, 0.024 for corrugated metal culvert, and 0.027 for constructed ditches.
- Ditch flow depth-velocity relationship conforming to Alberta Environment criteria.
- Minimum pipe slopes of 0.1%.
- Provide stormwater quality treatment to meet Alberta Environment criteria of 85% removal of particles 75 microns and larger on an annual basis. This could be done through the use of wet ponds, wetlands, or other Best Management Practices (BMPs).

In addition to this, several assumptions were made to establish the future model with full construction of the necessary stormwater conveyance and storage infrastructure. These assumptions were:

- Ditch slopes as per existing topography.
- Culvert slopes equal to ditch slopes where information is unavailable.
- Minimum ditch cross sections of a trapezoid 0.5 meters deep with a 1 meter wide bottom and 3:1 sides for proposed ditches (in the industrial area).

5.2 Design Rainfall Events

In assessing the storm drainage system in an area, typically a 1:5 year storm is used to assess the minor (piped) drainage system under short duration, high intensity rainfall events. This is followed by analysis with a large volume storm to test the system under large flow volumes once the system is saturated. This would typically be a 1:100 Year, 24 hour event.

For the purpose of assessing the existing parts of Town, a 1:5 Year, 4 hour Chicago rainfall distribution was used to assess the piped (minor) drainage system (as per the Westlock Procedures and Design Standards for Development). In addition to this, a 1:100 Year, 24 hour Huff rainfall distribution was used to assess the major (surface) drainage system.

For future development areas, primary modeling focussed on the 1:100 Year, 24 hour Huff rainfall distribution to assess piping/surface drainage to stormwater management facilities. For assessing the stormwater management facility volumes, this same event was employed.

5.3 Provincial Stormwater Management Requirements

Today, Alberta Environment requires stormwater management controls from all developments or re-developments in which an appreciable increase in runoff quantity and/or decrease in runoff quality is expected as a result of the development. In addition, the stormwater management controls must:

a) control peak runoff discharges from the site from a 1:100 year event to pre-development rates, to prevent increased erosion or flooding potential to downstream receiving systems; and

b) provide sufficient water quality treatment measures such as Best Management Practices (BMPs) to protect downstream ecosystems from contaminants typically present in urban runoff.

It should be noted that Alberta Environment employs a water quality treatment performance standard that calls for 85% removal of sediments of particle size 75 microns or greater (Section 6.0 Municipal Policies and Procedures Manual, Alberta Environment, April 2001).

Application of these stormwater management requirements in Westlock should be based on the determination of "appreciable change", and should be at the discretion of the Town. However, it should be recognized that all development or re-development proponents are required to submit a "Notification of Changes to a Drainage System" letter to Alberta Environment, who reserves the right to make additional requirements on the proposed stormwater management approach.

In general, these requirements should be applied to:

- all greenfield and brownfield developments,
- all larger scale developments, infill developments or re-developments including:
  - commercial, industrial, institutional, recreational or larger multi-family developments.

On-lot stormwater management may not be required for re-developments where it is demonstrated that no appreciable changes in runoff quantity or quality are to be expected.

5.4 Constructed Wetlands

Constructed/engineered stormwater wetlands are a type of stormwater management facility that can provide two main stormwater management functions:

- runoff quantity management – where the negative impacts on downstream receiving systems can be mitigated through storage of large runoff events with small controlled release rates; and
- water quality treatment – where wetlands are designed to emulate natural wetlands or many of their biological processes that provide a high level of water quality treatment through settlement, filtering and plant uptake.

In terms of quantity management, wetlands can be designed to perform the same function as dry ponds or wet lakes, controlling volumes from large events and releasing at small controlled rates. In terms of water quality treatment, wetlands are far superior to dry ponds or wet lakes. Today, it is widely recognized that urban runoff is generally of

poor water quality and is detrimental to natural receiving waterbodies. Alberta Environment now requires that all new developments or re-developments are to provide some measures to address stormwater quality. For urban subdivisions where stormwater management controls are necessary, wetlands are the favoured SWM facility design.

Constructed wetlands are designed to contain the design volume between normal water level (NWL) and high water level (HWL), as with dry ponds and wet lakes. However, wetlands can take up more land area as the water level fluctuation between NWL and HWL is recommended to be less than for dry ponds or wet lakes to minimize the impacts on the vegetation of long durations of deep submergence during large events. The water treatment features of constructed wetlands are generally located at and below NWL as follows:

- a deeper open water area at the inlet end for collection of sediments from the incoming flows;
- a deeper open water area at the outlet to provide for a submerged outlet that will allow floatable materials to be contained in the facility and not washed downstream; and
- a large, circuitous, shallow section between the inlet and outlet pools in which normally occurring low flows can be routed through emergent and submergent vegetation that can provide filtering and plant uptake to remove contaminants.

Today, a general change in public attitude towards being more favourable to being closer to the natural environment has increased the popularity of wetlands within urban settings. A typical concern heard from residents asked to consider a constructed wetland in their neighbourhood has been around mosquitoes and other nuisance insects. Constructed wetlands are engineered to include favoured plant species that encourage the habitat for dragon flies and some bird species that consume mosquitoes and other nuisance insects, and as a result, constructed wetlands have found public favour.

Wetlands have become the stormwater management facility-of-choice for most subdivision developments in Alberta in recent years. In many cases, public access has been designed in, including pathways and boardwalk areas to allow the public more access to enjoy the natural environment setting. Wetlands also provide excellent teaching grounds for school children learning about the natural environment.

It is recommended that the Town of Westlock consider adopting a position of requiring or encouraging all future stormwater management facilities to be designed as constructed wetlands.

6.0 Servicing of Future Development Areas

6.1 Future Stormwater System

The Town of Westlock has about 850 hectares of undeveloped land at present. To develop this land, a stormwater drainage system is required to collect and control runoff in these areas. It is necessary to control the increased amount of runoff due to development in these areas to minimize environmental impacts. This is best accomplished by collecting storm runoff by major storm trunk sewers and conveying it to a storm pond where the release rate can be controlled. Based on Alberta Environment regulations, it is specified that post-development flows released should not exceed pre-development flows.

In determining pre-development flows, a pre-development flow rate 4.0 L/s/ha was established for the 1:100 year storm event as outlined in the Town's previous Stormwater Master Plan (ISL, November 2004). Based on this, for the Town of Westlock, the pond and sewer systems for future development will be designed as follows:

- Storm sewers will be sized based on 5 year return period storm rainfall intensity.
- Surface drainage systems including roadways are to be designed to convey flows in excess of sewer system capacities up to the 1:100 year event, overland to the future stormwater management facilities.
- Ponds will be sized to collect 100 year, 24 hour return period, Huff distribution storms with a 2.0 meter rise from pond bottom to high water level.
- Pond outlet structures will be sized to restrict post-development flows to the 1:100 year pre-development flow rate of 4.0 L/s/ha.
- Storm sewer routing to deliver all stormwater flows to existing ditches draining to Wabash Creek or the Pembina River, or alternatively to other existing watercourses draining to the above.

Based upon this design criteria, trunk storm sewers and ponds were sized for new development areas within the Town of Westlock. Note that the ponds conceptualized have been generally distributed at one per quarter section or topographically constrained development area. Regionalization of ponds could be considered, particularly where a single developer is developing larger areas of land. Splitting ponds shown into several within a development area is also possible, providing the ultimate design intent in terms of storage and release rate is preserved. However, it is noted that the proliferation of ponds at a greater density than one per quarter section is not recommended due to the increased operation and maintenance requirements of multiple additional ponds. The system plans were developed in such a manner as to avoid costly large diameter storm trunks, where possible.

It should be noted that the newly annexed area which drains northeast to an existing drainage course, has incorporated a stormwater drainage system of trunk sewers and ponds draining to said drainage course to the northeast. Some of the ponds are tied together via trunk sewers to save grade (i.e. if a wet pond, the incoming trunk invert elevation can be below the normal water level while the outgoing trunk invert elevation can be at the normal water level) in order to drain the area to the watercourse without the need for a lift station.

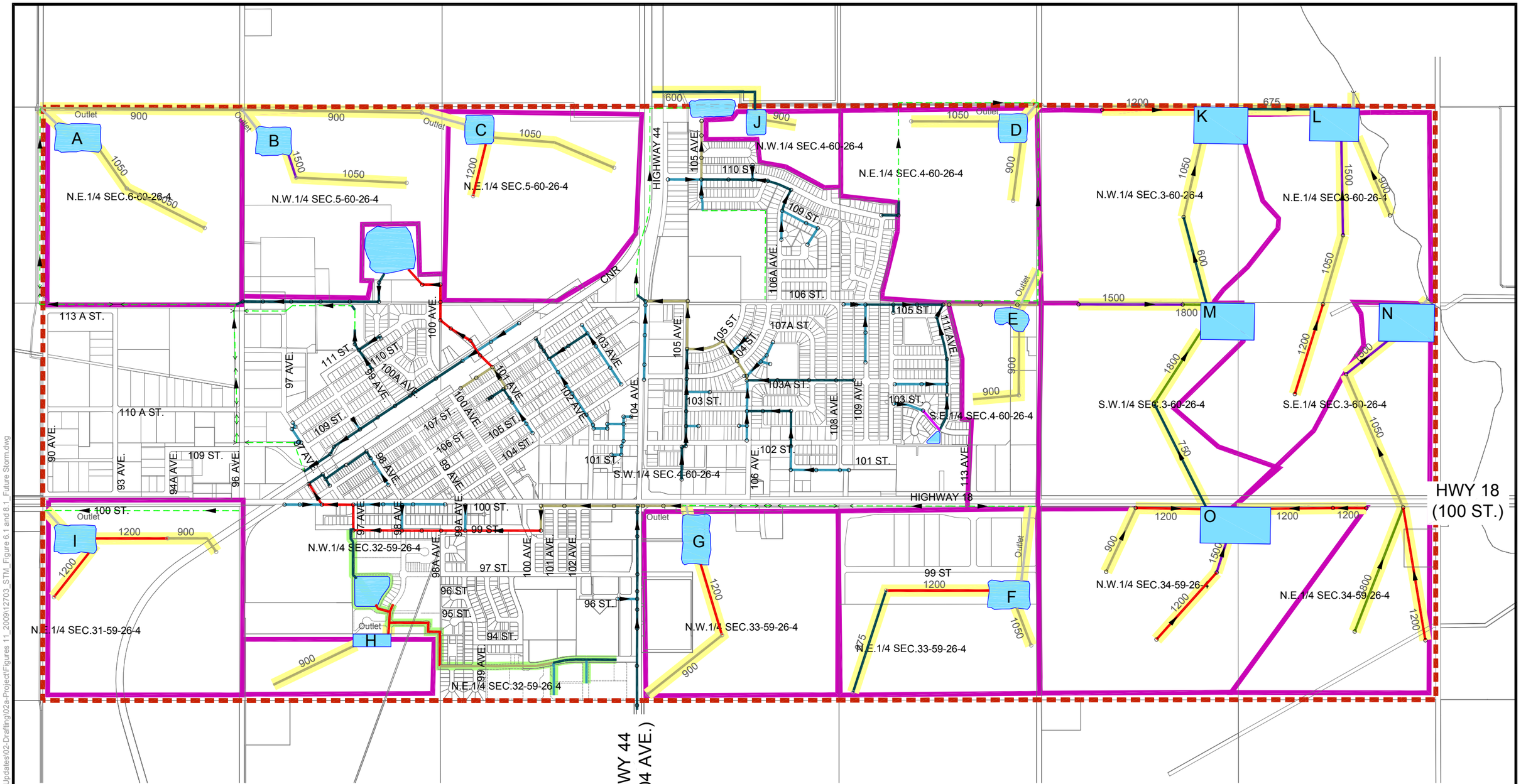
The conceptual design of the future storm drainage system can be seen on Figure 6.1, with the future storm ponds shown as well as the stormwater ponds (G & H) in the south part of Town recommended as existing system upgrades. Design data for these storm ponds are shown in Table 6.1. Please note that future development areas are expected to have local piped drainage systems connected to these larger trunk sewers and ponds.

It should be noted that strategic partnerships related to stormwater management could be considered, such as partnering with Ducks Unlimited as it pertains to wetlands construction. Storm ponds should also be aesthetically designed at the time of construction, providing landscaping and pathway systems to enhance development areas around them. Source control, stormwater re-use, and evaporation facilities could also be considered.

Cost estimates have been developed for all pond designs and future storm trunk pipe systems. These cost estimates can be found in Section 8.0.

Table 6.1: Future Storm Pond Design Details

Pond Name	Drainage Basin Area (ha)	Peak Storage Volume (m^3)	Area at NWL (ha)	Area at HWL + 0.5m (ha)	Outlet Flow Rate (m^3/s)
A	62.4	38,600	2.26	3.21	0.24
B	56.5	29,900	1.71	2.53	0.22
C	53.4	23,400	1.71	2.53	0.19
D	40.3	20,900	1.37	2.10	0.16
E	30.0	12,400	0.66	1.13	0.12
F	66.9	32,200	2.06	2.95	0.25
G	110.0	43,400	2.60	3.62	0.44
I	66.5	34,100	2.06	2.95	0.26
H	21.5	8,800	0.45	0.85	0.09
K	67.8	188,900	3.90	4.90	0.61
L	98.5	73,500	2.44	3.25	1.31
M	63.1	101,500	2.99	3.90	0.60
N	69.2	144,200	3.42	4.40	0.26
O	90.2	106,500	3.86	4.90	0.39



Legend

TOWN BOUNDARY

Pipe diameters

- 450 mm and less
- 525 mm
- 600 – 800 mm
- 900 – 1100 mm
- 1200 and 1300 mm
- 1400 and 1500 mm
- 1600 and 1700 mm

- Ditch
- Recommended System Uprades
- Short Term Proposed upgrades by Developers
- Ponds Basin Boundaries

ISL Engineering and Land Services

Town of Westlock

TOWN OF WESTLOCK MASTER PLAN - 2009 UPDATE
STORMWATER
FUTURE STORMWATER SYSTEM

0 100 200 300 400 500 600 700 800 metres
0 500 1000 1500 2000 2500feet

FIGURE 6.1

12703

SCALE

OCTOBER, 2009

N:\12000\12703 - Westlock Master Plan Updates\02-Drafting\02a-Project\Figures 11_2009\12703_STM_Figure 6.1 and 8.1_Future Storm.dwg

7.0 Upgrading Recommendations for Existing System - 2009

7.1 System Upgrade Recommendations

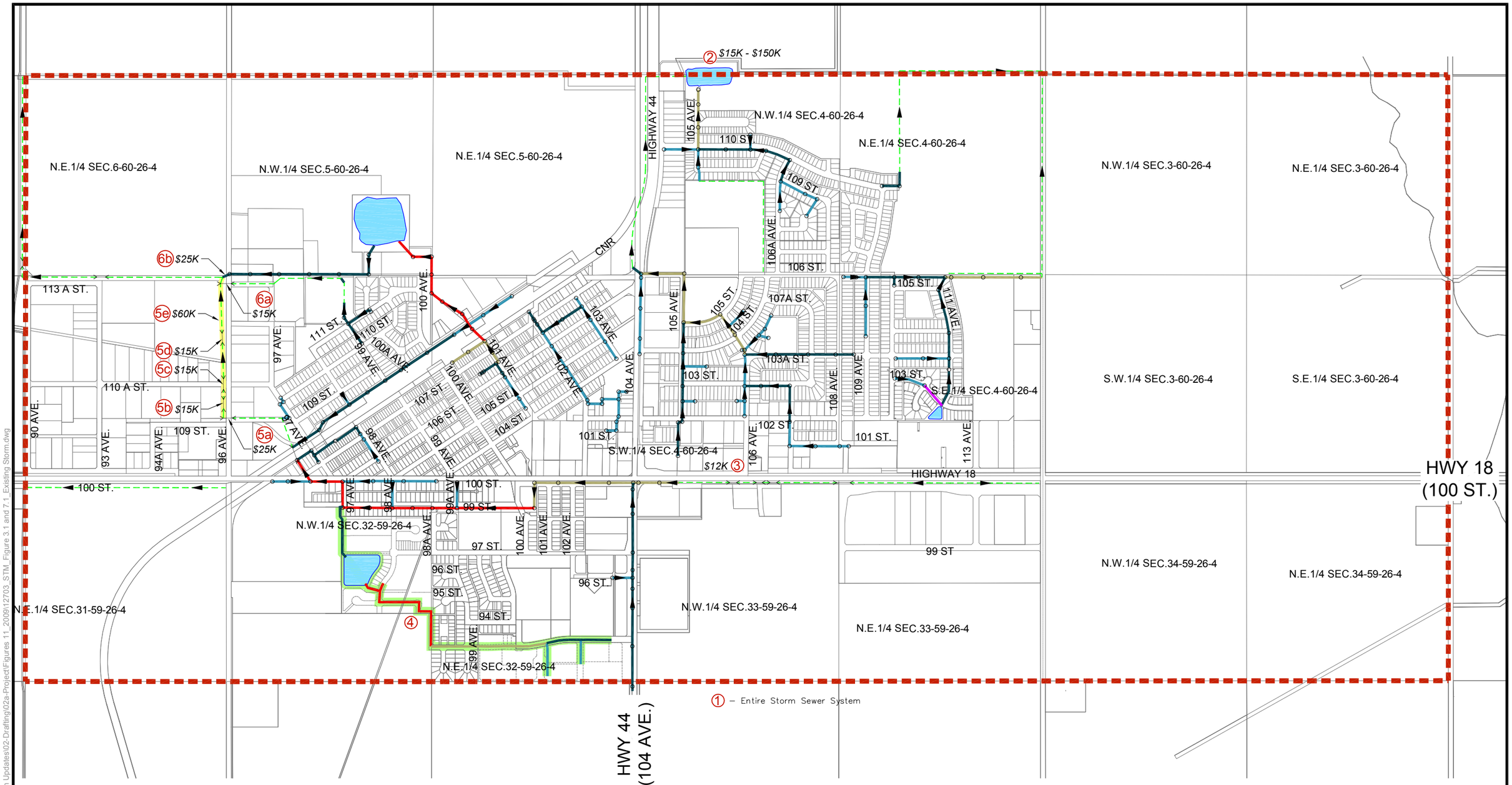
Based on the above analysis, a number of system upgrades are recommended to improve the existing stormwater drainage system in Town as well as to facilitate future growth. These include some of the recommendations from the Town's previous Stormwater Master Plan (ISL, November 2004) as well as some added and/or revised recommendations based on the new expanded future development area. The primary changes are related to development that has occurred in the south part of Town, west of the Hospital related to revision of overland drainage patterns eliminating the need for an overland flow bypass ditch around Southview and the revision of plans for stormwater ponds in this same part of Town.

The existing system upgrade recommendations are as follows:

1. Undertake a storm drainage system inspection and cleaning program to identify and remove potential blockages in the system that may be impeding carrying capacities. Maintenance work may include: removal of silt from storm sewers, culverts and ditches, catchbasins and culvert inlets and outlets; bending culvert inlets and outlets to be fully open, etc.
2. Construct an outlet control structure on the existing stormwater management facility near Highway 44 and the north Town boundary to provide small controlled discharges and minimize the potential erosion in the Highway 44 ditch system. As a minimum a basic outlet control structure should be considered. Consideration should also be given to increasing the storage capacity of the pond and constructing an improved outlet control structure.
3. Replace the twin 450 mm culverts at the west approach to Marks Motors with twin 600 mm culverts. This will minimize flooding at this approach in 1:5 year or larger storm events.
4. Monitor drainage conditions in the areas around proposed stormwater management ponds G and H. A temporary drainage ditch around the Skyrider lands has been developed in the interim, with the proposed drainage scheme for the area providing a long term solution once built. If issues remain in this area, additional ditches to divert flows could be considered, or alternatively, temporary or permanent ponds could be constructed to mitigate any potential flooding in the area.
5. In the vicinity of 96 Avenue, address several items with regard to the existing drainage ditch system to reduce the risk of flooding along the 96 Avenue ditch:
    a) twin the 1200 mm culvert crossing 96 Avenue near 109 Street;
    b) twin the 1200 mm culvert under the approach south of 110A Street;
    c) twin the 1200 mm culvert under 110A Street;
    d) twin the 1200 mm culvert under an approach to the raw water reservoir near 112 Street; and
    e) widen the 96 Avenue ditch to a bottom width of approximately 4 m while maintaining side slopes, and build up its west bank.
6. In the northwest, address the following items:
    a) twin the 600 mm culvert under 96 Avenue near 113A Street from the drainage ditch to prevent flow proceeding over the road in the 1:100 year event; and

b) replace the 600 mm storm pipe discharging into the ditch near 96 Avenue and 113A Street from the storm pond outlet pipes to ensure proper pipe capacity is maintained.

The upgrades are shown on Figure 7.1.



Legend

TOWN BOUNDARY

Pipe diameters

- 450 mm and less
- 525 mm
- 600 – 750 mm
- 900 – 1050 mm
- 1200 mm
- 1500 mm
- Ditch

Short Term Proposed Upgrades by Developers

Major Culverts

① Recommended Upgrades (See Section 7.0)

$15K Recommended Upgrades Cost

ISL Engineering and Land Services

Town of Westlock

TOWN OF WESTLOCK MASTER PLAN - 2009 UPDATE
STORMWATER
EXISTING STORM SYSTEM UPGRADE RECOMMENDATIONS

FIGURE 7.1

12703

SCALE

0 100 200 300 400 500 600 700 800 metres
0 500 1000 1500 2000 2500 feet

OCTOBER, 2009

N:\12000\12703 - Westlock Master Plan Update\02-Drafting\02a-Project\Figures 11_2009\12703_STM_Figure 3.1 and 7.1_Existing Storm.dwg

8.0 Cost Estimates

8.1 Cost Estimates for Recommended Upgrades to Existing Stormwater Drainage System

Numerous upgrades are required to maintain the condition of the existing storm drainage system, and others are required to upgrade its capacity. Upgrades and costs are shown on Figure 7.1.

8.2 Cost Estimates for Stormwater Drainage System in Future Development Areas

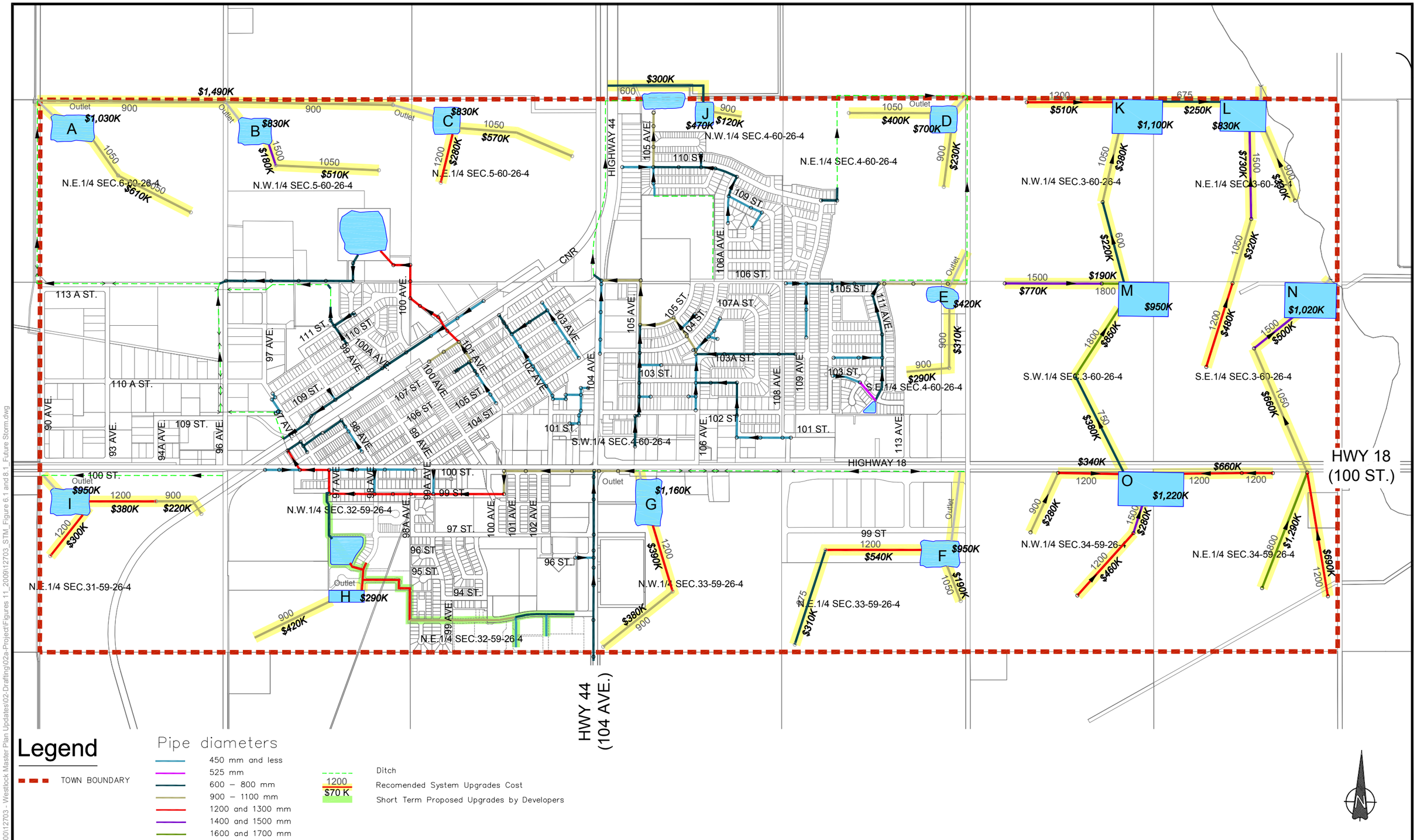
Cost estimates were developed for the future storm drainage ponds and trunk sewer pipes. Cost estimates for the future storm ponds can be found in Table 8.1, while costing for the future stormwater system are shown in Figure 8.1.

Table 8.1: Future Storm Pond Costs

Pond Name	Permanent Pool (m^3)	Excavation Volume (m^3)	Area at NWL (ha)	Area at HWL + 1 meter (ha)	Pond Name	Topsoil Stripping Cost	Excavation Cost	Outlet Control Structure Cost	Landscaping	Total Pond Cost
A	22,600	112,600	2.26	3.74	A	$74,800	$812,972	$100,000	$37,400	$1,030,000
B	17,100	87,600	1.71	2.99	B	$59,800	$632,472	$100,000	$29,900	$830,000
C	17,100	87,600	1.71	2.99	C	$59,800	$632,472	$100,000	$29,900	$830,000
D	13,700	72,200	1.37	2.53	D	$50,600	$521,284	$100,000	$25,300	$700,000
E	6,600	37,500	0.66	1.40	E	$28,000	$270,750	$100,000	$14,000	$420,000
F	20,600	102,500	2.06	3.40	F	$68,000	$740,050	$100,000	$34,000	$950,000
G	26,000	128,000	2.60	4.20	G	$84,000	$924,160	$100,000	$42,000	$1,160,000
I	20,600	102,500	2.06	3.40	I	$68,000	$740,050	$100,000	$34,000	$950,000
J	7,500	43,700	0.75	1.66	J	$33,228	$315,514	$100,000	$16,614	$470,000
H	4,500	22,800	0.45	0.77	H	$15,400	$164,616	$100,000	$7,700	$290,000
K	124,600	114,300	3.90	5.52	K	$110,400	$825,246	$100,000	$55,200	$1,100,000
L	32,400	84,450	2.44	3.74	L	$74,800	$609,729	$100,000	$37,400	$830,000
M	51,700	99,300	2.99	4.42	M	$88,400	$716,946	$100,000	$44,200	$950,000
N	87,600	105,750	3.42	4.94	N	$98,800	$763,515	$100,000	$49,400	$1,020,000
O	42,900	131,400	3.86	5.46	O	$109,200	$948,708	$100,000	$54,600	$1,220,000

8.3 Potential Cost Sharing

It is useful to consider potential cost sharing for the future stormwater drainage and management system. Given that the new trunk sewers and ponds are generally being constructed to benefit future development areas, the cost sharing formulation for the sewers could be based on the total contributing area to each sewer with each developer's contribution based on the proportion of the area their respective development represents. Each developer would then front the costs for a stormwater management facility for their development. It must be noted that in the event development does not start at the downstream end of each sewer and proceed upstream that the Town may either need to front the trunk sewer construction costs or require an upstream developer to fund the trunk sewer with the Town contributing an amount to be negotiated with the developer. In this case, both the Town and developer funding the sewer could recover costs through future off-site levies.



N:\12000\12703 - Westlock Master Plan Updates\02-Drafting\02a-Project\Figures 11_2009\12703_STM_Figure 6.1 and 8.1_Future Storm.dwg

ISL Engineering and Land Services

Town of Westlock

TOWN OF WESTLOCK MASTER PLAN - 2009 UPDATE
STORMWATER
FUTURE STORMWATER SYSTEM COSTS

FIGURE 8.1

0 100 200 300 400 500 600 700 800 metres
0 500 1000 1500 2000 2500feet

12703

SCALE

OCTOBER, 2009

It should also be noted that Ponds G and H, though having benefit for the existing system, do benefit future development and cost sharing based on contributing area could be developed for existing and future development areas.

All costs would be revisited as part of a future detailed off-site levy review to better share costs between existing and future development areas.

9.0 Conclusions and Recommendations

9.1 Conclusions

As per the Town's Stormwater Master Plan (ISL, 2004), fundamental conclusions as per system performance remain generally the same. That is to say that:

1. Generally, the storm drainage system within the Town of Westlock performs well when compared to other towns of similar size within Alberta. There are numerous relatively minor issues that should be dealt with. Some maintenance work is also required for the storm drainage system. Some surface ponding occurs during 1:5 year events, but there have been few complaints from the public. Any ponding under these conditions is low in volume and of short duration. There can be substantial surface flooding under 1:100 year events. Some recommendations related to alleviating flooding were made.

2. Some physical condition system upgrades to the system are warranted.

Departure from the previous study is generally resultant from the expanded future growth area. Generally speaking, no new upgrades to the system are required to handle the expanded growth area; the main difference is the future development area stormwater drainage and management network.

9.2 Recommendations

The existing system upgrade recommendations are as follows:

1. Undertake a storm drainage system inspection and cleaning program to identify and remove potential blockages in the system that may be impeding carrying capacities. Maintenance work may include: removal of silt from storm sewers, culverts and ditches, catchbasins and culvert inlets and outlets; bending culvert inlets and outlets to be fully open, etc.
2. Construct an outlet control structure on the existing stormwater management facility near Highway 44 and the north Town boundary to provide small controlled discharges and minimize the potential erosion in the Highway 44 ditch system at a cost of between $15,000 for a basic outlet control structure, to $150,000 for increased pond capacity with an improved outlet control structure. A reserve fund has been established and funds are being collected.
3. Replace the twin 450 mm culverts at the west approach to Marks Motors with twin 600 mm culverts at a cost of $12,000. This will minimize flooding at this approach in 1:5 year or larger storm events.
4. Monitor drainage conditions in the areas around proposed stormwater management ponds G and H. A temporary drainage ditch around the Skyrider lands has been developed in the interim, with the proposed drainage scheme for the area providing a long term solution once built. If issues remain in this area, additional ditches to divert flows could be considered, or alternatively, temporary or permanent ponds could be constructed to mitigate any potential flooding in the area.
5. In the vicinity of 96 Avenue, address several items with regard to the existing drainage ditch system to reduce the risk of flooding along the 96 Avenue ditch:

a) twin the 1200 mm culvert crossing 96 Avenue near 109 Street at a cost of $25,000;
b) twin the 1200 mm culvert under the approach south of 110A Street at a cost of $15,000;
c) twin the 1200 mm culvert under 110A Street at a cost of $25,000;
d) twin the 1200 mm culvert under an approach to the raw water reservoir near 112 Street at a cost of $15,000; and
e) widen the 96 Avenue ditch to a bottom width of approximately 4 m while maintaining side slopes, and build up its west bank at a cost of $60,000.

6. In the northwest, address the following items:
   a) twin the 600 mm culvert under 96 Avenue near 113A Street from the drainage ditch to prevent flow proceeding over the road in the 1:100 year event at a cost of $15,000; and
   b) replace the 600 mm storm pipe discharging into the ditch near 96 Avenue and 113A Street from the storm pond outlet pipes to ensure proper pipe capacity is maintained at a cost of $25,000.

The following are the recommendations for the storm drainage system under future development conditions:

1. To ensure compliance with Alberta Environment and Town standards, future development within the Town of Westlock is required to provide stormwater management ponds such that post-development 1:100 year flows do not exceed pre-development 1:100 year flows of 4.0 L/s/ha. A system of stormwater management ponds for the undeveloped sections of Town has been developed as shown in Figure 6.1. It is recommended that as future development occurs that a similar system be adopted in developing areas with final pond size and location dependent upon development patterns. Please note that future development areas are expected to have local piped drainage systems connected to these larger trunk sewers and ponds. Storm ponds should also be aesthetically designed at the time of construction, providing landscaping and pathway systems to enhance development areas around them.

2. The Town should consider strategic partnerships related to stormwater management, such as partnering with Ducks Unlimited as it pertains to wetlands construction.

10.0 References

Stormwater Management Guidelines for the Province of Alberta – Alberta Environment, 1999.

Municipal Policies and Procedures – Alberta Environment, April, 2001.

Province of Alberta Water for Life – Alberta's Strategy for Sustainability – Alberta Environment, 2003.

Standards and Guidelines for Municipal Waterworks, Wastewater, and Storm Drainage Systems – Alberta Environment, 2006.

Town of Westlock Stormwater Master Plan – ISL Engineering and Land Services Ltd., November 2004.

Town of Westlock Procedures and Design Standards for Development – ISL Engineering and Land Services Ltd., October 2009.