SECTION 5

STORMWATER MANAGEMENT

5.1 INTRODUCTION

5.1.1 General

This section of the report deals with the development of a stormwater management concept for the Town of Edson for approximately 1020 ha of land designated for future residential and industrial purposes within the Study Area (Figure 2.1). The stormwater management concept is intended to provide guidance for the development of the overall system in the Study Area.

The study includes an evaluation and inventory of the Town's existing drainage facilities and a hydrologic and hydraulic analysis aimed at reducing the post development runoff rates to those of pre-development conditions up to a 1 in 100 year return period rainfall event. The Hydrologic Model (HYMO) and Storm Water Management Model (SWMM) are used to simulate the rainfall runoff process in the Study Area for the pre-development and post-development conditions respectively. Inflow hydrographs for the Study Area were developed and hydraulically routed through retention or detention facilities by the modified Pul's method to simulate their performance.

Drainage basins are numbered independently and cover one or more of the Development Areas shown on the Land Use Plan Figure 2.3.

5.1.2 Study Procedure

The following work activities were involved in the development of the stormwater management concept presented herein.

1. Collection and review of all related information pertaining to the study.

2. Develop design rain storms (1:5, 1:25, 1:100 year return period) as input rainfall to HYMO and SWMM models.

3. HYMO simulation to determine natural peak runoff rate of Bench Creek, Wase Creek and Poplar Creek drainage basins under existing conditions.

4. HYMO simulation to determine pre-development runoff rate from proposed development within the Town's annexation limit.

5. SWMM simulation to determine post-development runoff rate from proposed development within the Town's annexation limit.

6. Field inspection of Study Area and existing drainage facilities.

7. Analysis of existing drainage facilities to determine their hydraulic capacities.

8. Determine adequacy of the existing drainage facilities based on the post-development runoff rate.

9. Develop a stormwater management concept for hydraulic routing of post-development runoff through retention facilities using the modified Pul's method to simulate their operation.

5.2 DESIGN CRITERIA

Design criteria used in this report are as follows:

1. Land Use

   The proposed residential and industrial development within the Town's study boundary was provided by Makale & Kyllo Planning Associates.

2. Rainfall Data

The rainfall data for the Town of Edson was provided by Atmospheric Environment Services of Environment Canada. The amount of rainfall for a period of 24 hours for various return periods are listed below.

Return Period (Year)	Amount of Rainfall (mm/24 hr)
5	62.8
25	82.0
100	97.8

Duration-Intensity-Frequency (DIF) relations were also developed from this data as shown is Figure 5.1.

3. Storm Return Period

For the purpose of this study, the following return periods are used.

Retention Facility Sizing	
Design high water level	1 in 25 year
Maximum water level	1 in 100 year

4. Runoff Coefficient

The SCS curve number and percentage of imperviousness used in the HYMO and SWMM model for various types of land use are shown below.

Land Use	HYMO Curve No.	SWMM % of Imperviousness
Agricultural	60	-
Residential	-	40
Industrial	-	60

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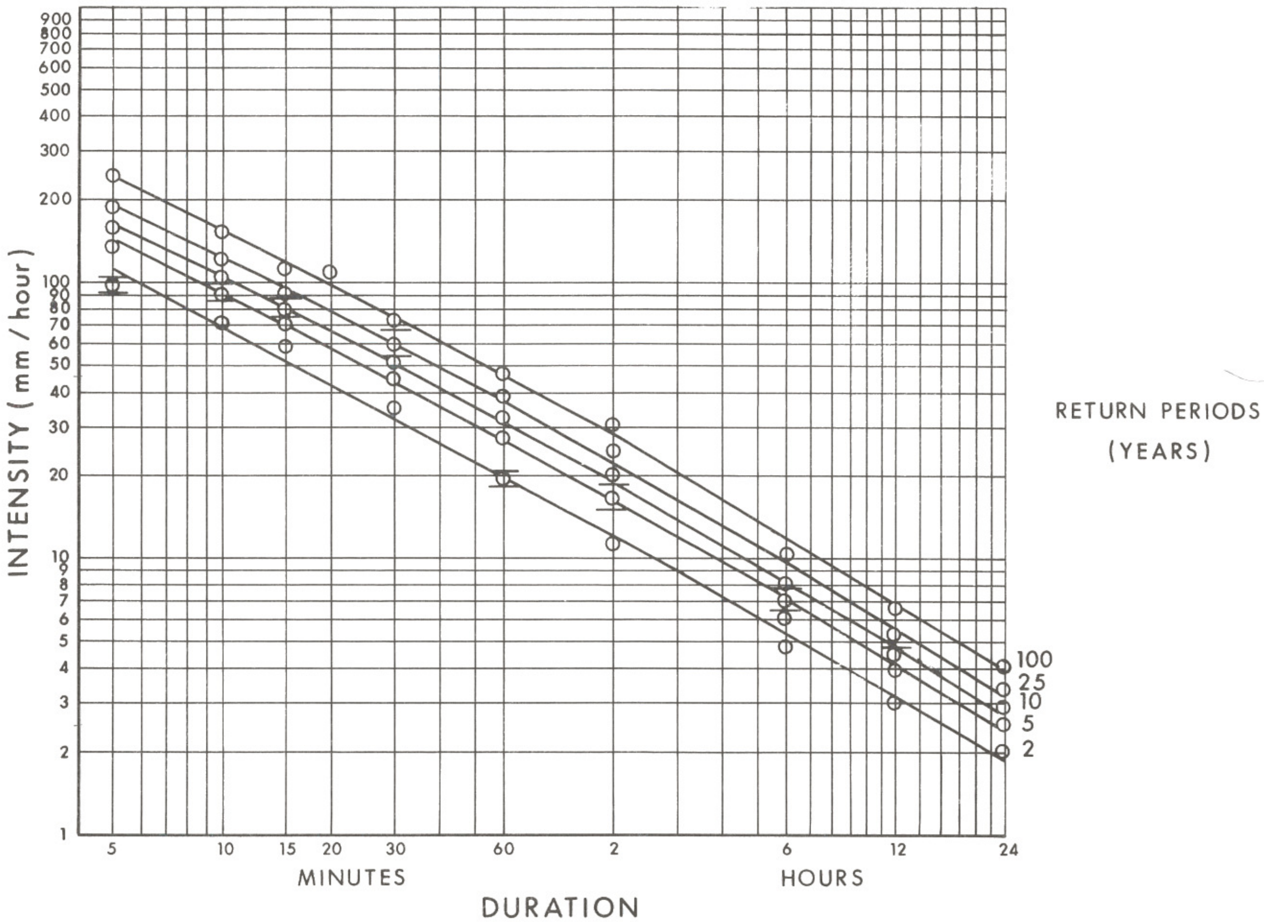

SOURCE:
ATMOSPHERIC ENVIRONMENT SERVICE - ENVIRONMENT CANADA
BASED IN 10 YEARS DATA 1970-79 AT EDSON AIRPORT

Figure 5.1
RAINFALL CURVE

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5. <u>Capacity of Conduit and Open Channel</u>

Capacities of storm sewers and open channels are determined by applying Manning's equation. Roughness coefficient (n) used in the equation are shown below.

Corrguated Steel Pipe (CSP)	n = 0.024
Open Channel	n = 0.030

6. <u>Velocity of Flow</u>

Minimum and maximum velocities used are shown below.

	Minimum Velocity m/s	Maximum Velocity m/s
Storm sewer	0.9	6.1
Open channel	0.3	0.76

5.3 SIMULATION OF RUNOFF CONDITIONS

5.3.1 General

The Study Area was divided into 12 sub-basins (catchments) in order to compute design flows at various predetermined points of interest throughout the watershed. The sub-basins are shown in Figure 5.4. Bench Creek, Wase Creek and Popular Creek all flow in a southerly direction through the central portion of the Study Area. Natural drainage of the area is generally in a southerly direction to the McLeod River.

5.3.2 Pre-development Runoff

The pre-development runoff conditions in the new development areas were determined by applying the computer model United States Department of Agriculture Hydrologic

Model (HYMO). HYMO is designed for modelling surface runoff and sediment yield from watersheds, and for planning flood prevention projects, forecasting floods, and research studies. HYMO was also designed to transform rainfall data into runoff hydrographs and to route these through streams and valleys or reservoirs. It will also compute the amount of sediment produced by a storm at any point on a watershed. HYMO has been widely used for preliminary assessment of hydrologic impact due to urbanization such as the comparison of pre-development and post-development flows and the design of detention facilties.

The model uses the instantaneous unit hydrograph approach to generate a hydrograph given the input of various parameters describing the catchment to be modelled as shown below:

1. A design storm,
2. Height, length, area of each sub-catchment
3. Curve number of each sub-catchment.

Input parameters used in the HYMO model are shown in Table 5.1. Specific results of the HYMO runoff analysis are shown in Table 5.2.

5.3.3 Post-Development Runoff

Development of the growth areas from agricultural land into residential and industrial properties will result in an increase of peak runoff rate. This post-development runoff rate is determined by applying the United States Environmental Protection Agency Storm Water Management Model (SWMM). SWMM is a comprehensive model designed for simulation of both the water quantity and quality aspects associated with urban runoff and combined sewer systems. The program consists of an Executive (control) Block, and four Computational Blocks, namely Runoff, Transport, Storage/Treatment and Receiving Waters for dealing with runoff generation, hydraulic routing, quality simulation and effects on a receiving water body.

The Runoff Block, which accounts for the basic runoff phenomena in the proposed development areas, was used in this study. The Runoff block in the model will generate a hydrograph given the input of various parameters describing the catchment to be modelled as shown below:

1. A design storm,
2. Slope, area, width and percent imperviousness of each sub-catchment,
3. Infiltration parameters for Horton's equation,
4. Depression storage values for pervious and impervious areas,
5. Percent of impervious area with zero depression storage.

Input parameters used in the SWMM model for the present analysis are shown in Table 5.3. Default values of detention storage, resistance factor, infiltration rate and decay rate are used in the SWMM model. Symmetrical Chicago-type synthetic rainfall events of 24 hour duration were used in the simulation of the 1 in 5 year, 1 in 25 year, and 1 in 100 year return period events. These synthetic rainfall events are based upon the intensity-duration-frequency relationships for the Town of Edson provided by Atomspheric Environment Services of Environment Canada. (Figure 5.1)

Specific results of the SWMM runoff analysis are shown in Table 5.4.

Based on HYMO and SWMM simulation, a comparison of peak runoff under the pre-development and post-development runoff conditions is shown in Table 5.5.

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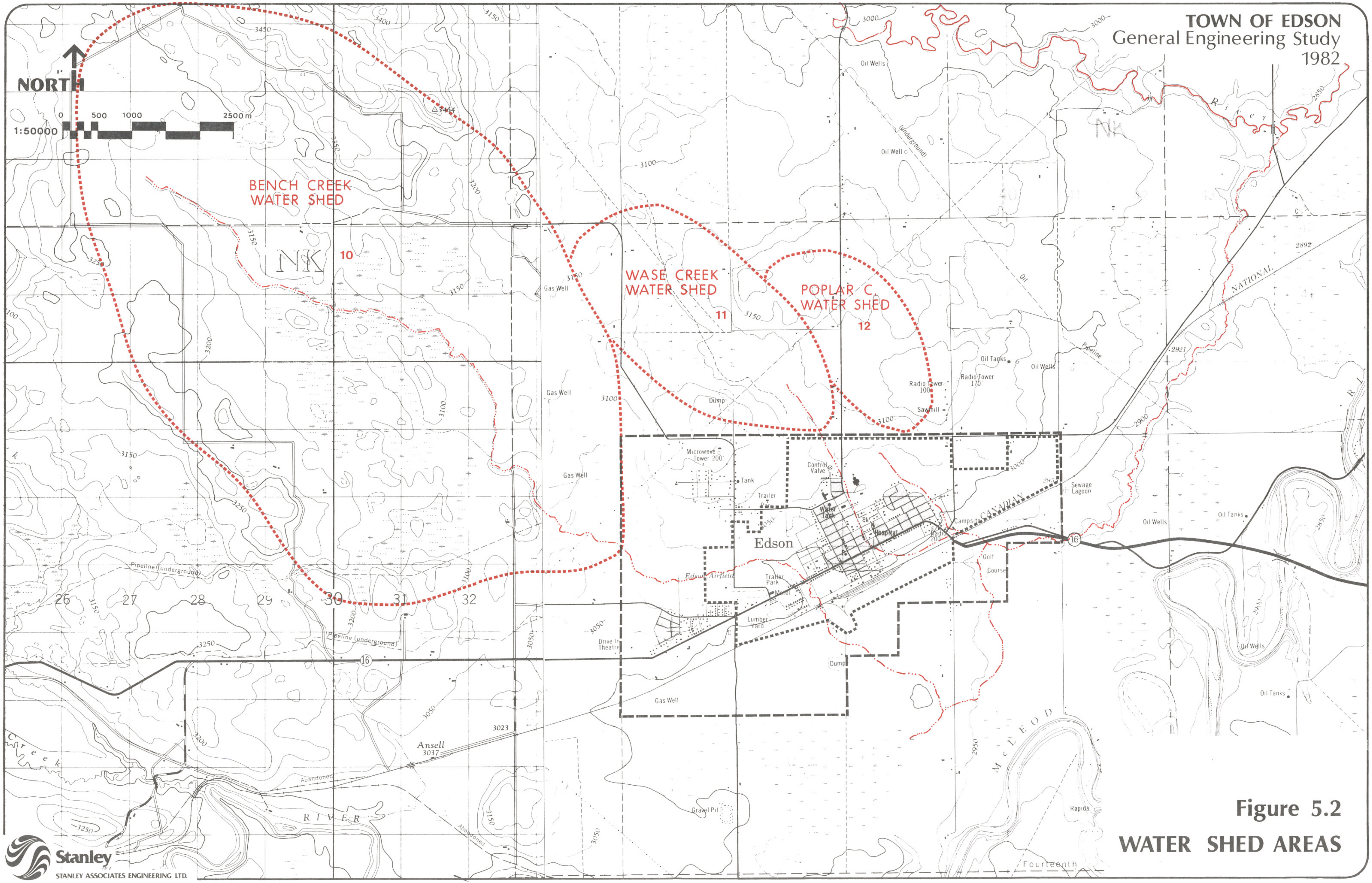

Figure 5.2
WATER SHED AREAS

TABLE 5.1

HYMO PARAMETERS

Sub-Basin No.	Area (km^2)	Length (km)	Height (m)	Curve No
1	1.60	1.80	36.6	60
2&3	1.63	1.59	21.3	60
4	1.55	1.50	45.7	60
5	1.19	1.30	30.5	60
6	1.27	1.20	12.2	60
7&8	1.39	2.56	36.6	60
8b	0.26	1.29	6.1	60
9	0.54	0.75	3.0	60
10	31.2	12.5	61.0	60
11	7.64	4.50	30.5	60
12	3.52	3.22	15.2	60

Note:

Sub asin 10 is the ench Creek water shed upstream of Edson
Sub Basin 11 is the Wase Creek water shed upstream of Edson
Sub Basin 12 is the Poplar Creek water shed upstream of Edson

See Figures 5.2 & 5.4

TABLE 5.2

HYMO ANALYSIS RESULTS

Pre-Development Peak Runoff (m^3/s)

Outlet of Sub-Basins	Return Period 1 5 year	1:25 year	1:100 year
1	0.24	1.10	2.25
2&3	0.21	0.92	1.85
4	0.27	1.32	2.77
5	0.19	0.93	1.91
6	0.16	0.67	1.34
7&8a	0.22	1.05	2.15
8b	0.03	0.14	0.28
9	0.05	0.21	0.41
10	1.85	6.05	11.05
11	0.63	2.30	4.38
12	0.27	0.99	2.46

Note:

Sub asin 10 is the ench Creek water shed upstream of Edson
Sub Basin 11 is the Wase Creek water shed upstream of Edson
Sub Basin 12 is the Poplar Creek water shed upstream of Edson

See Figures 5.2 & 5.4

TABLE 5.3

SWMM PARAMETERS

Sub-Basin No.	Area (ha)	Width of Overland Flow (m)	Ground Slope (m./m.)	Percent of Imperviousness
1	161	15814	0.020	60
2	43	4201	0.005	60
3	119	11692	0.013	40
4	157	15259	0.030	40
5	119	11613	0.023	40
6	127	12485	0.010	40
7	100	9787	0.028	40
8a	39	3804	0.007	60
8b	27	2615	0.006	60
9	55	5390	0.005	60

Note:

Refer to Figure 5.4

TABLE 5.4

SWMM ANALYSIS

Post Development Peak Runoff (m^3/s)

Return Period

Outlet of Sub-Basins	1:5 year	1:25 year	1:100 year
1	7.76	13.06	16.97
2&3	5.92	10.77	14.74
4	5.35	10.65	14.65
5	4.00	7.93	10.94
6	4.14	7.85	10.91
7&8a	5.27	9.81	13.32
8b	1.25	2.04	2.66
9	2.55	4.14	5.44

Note:

Refer to Figure 5.4

TABLE 5.5

COMPARISON OF PRE-DEVELOPMENT AND POST DEVELOPMENT PEAK RUNOFF

Outlet of Sub-Basin No	Return Period 1 5 Year pre (m^3/s)	post (m^3/s)	1:25 Year pre (m^3/s)	post (m^3/s)	1:100 year pre (m^3/s)	post (m^3/s)
1	0.24	7.76	1.10	13.06	2.25	16.97
2&3	0.21	5.92	0.92	10.77	1.85	14.74
4	0.27	5.35	1.32	10.65	2.77	14.65
5	0.19	4.00	0.93	7.93	1.91	10.94
6	0.16	4.14	0.67	7.85	1.35	10.91
7&8a	0.22	5.27	1.05	9.81	2.15	13.32
8b	0.03	1.25	0.14	2.04	0.28	2.66
9	0.05	2.55	0.21	4.14	0.41	5.44
10	1.85	1.85	6.05	6.05	11.05	11.05
11	0.63	0.63	2.30	2.30	4.38	4.38
12	0.27	0.27	0.99	0.99	2.46	2.46

Note:

Sub Basin 10 is the ench Creek water shed upstream of Edson
Sub Basin 11 is the Wase Creek water shed upstream of Edson
Sub Basin 12 is the Poplar Creek water shed upstream of Edson

Refer to Figures 5.2 & 5.4

5.4 ASSESSMENT OF RUNOFF CONDITIONS

5.4.1 Existing Drainage System

The existing drainage system is comprised of a major system which consists of three natural water courses, namely Bench Creek, Wase Creek and Poplar Creek. The water courses flow in a southerly direction through the Study Area into the relatively flat area south of the CNR track and continue in a southerly, easterly and then northeasterly direction to the Edson River and McLeod River (Figure 5.2).

A field inspection was made on November 4, 1981 and a hydraulic analysis of all the existing culverts and bridges along the three water courses were made (Figure 5.3). The inventory including the hydraulic elements of each of the crossings is shown in Table 5.6. Crossings #13 and #17 were found damaged requiring repair or replacement. Crossings 10, 15 and 16 require clearing of debris at both inlet and outlet of the crossings. The CNR reservoir outlet was found to have been removed and the existing opening has sufficient capacity to pass the 1 in 100 year storm event.

Storm runoff from the town is conveyed through a network of minor systems (storm sewers and open channels) tributary to the three water courses. These eventually discharge into the McLeod River. Discussion with the Town's Superintendent indicates that no serious flooding has ever occured in Edson. However, for future developments, the Town should adopt a standard for design of the minor system, of a 1 in 2 year storm for residential areas and a 1 in 5 year storm for light industrial park and commercial areas.

5.4.2 Future Drainage System

A stormwater management concept should be adopted in anticipation of new development in order to control the expected increase in stormwater runoff rate and to minimize, if not eliminate, flooding and erosion. The concept of applying stormwater retention or detention ponds to limit post development to pre-development runoff rates has been considered and analyzed. These analyses are discussed in Section 5.5.

TABLE 5.6

CROSSING INVENTORY

Crossing Nos.	Location	Type	Size (m)	Capacity (m^3/s)	Surcharge Height (m)	Surcharge Capacity (m^3/s)	Comments
1	Bench Creek crossing	bridge	8.5 x 3.0	41.7	N/A	N/A	beaver dam d/s of bridge
2	6 Ave & 55 St	CSP	3.65	41.1	4.42	45.3	mitred ends
3	4 Ave & 54 St	bridge	8.5 x 3.0	41.7	N/A	N/A	good condition
4	3 Ave & 54 St	foot bridge	16.8 x 1.8	16.0	N/A	N/A	good condition
5	2 Ave & 54 St	CSP	3.65	41.4	5.33	53.8	mitred ends
6	1 Ave & 54 St	2-CSP	1.5	-	-	-	submerged
7	Bench Creek crossing	trestle	22.0 x 4.0	110.5	N/A	N/A	good condition
8	CNR Reservoir	outlet structure	-	-	-	-	outlet has been removed
9	19 Ave & 48 St	pipe arch	2.1 x 1.5	4.82	4.27	12.5	projecting ends
10	12 Ave & 47 St	CSP	1.07	1.56	2.59	2.83	projecting ends
11	9 Ave & 47 St	2-CSP	0.76	1.25	3.20	3.40	projecting ends
13	7 Ave & 47 St	2-CSP	0.91	2.04	2.13	3.68	projecting ends
14	5 Ave & 48 St	2-CSP	0.76	1.25	5.03	3.12	projecting ends
15	4 & 5 Ave 48 St	CSP	1.07	1.56	5.03	4.25	projecting ends
16	4 Ave & 48 St	CSP	1.22	2.21	2.44	3.68	projecting ends
17	2 Ave & 48 St	CSP	1.22	2.21	2.44	3.68	projecting ends
18	6 Ave & 42 St	CSP	0.91	1.02	3.96	2.83	projecting ends
19	Bear Lake Road	CSP	1.67	5.10	3.05	7.37	projecting ends
20	Highway #16	CSP	1.22	2.21	4.27	5.10	projecting ends
21	CNR crossing	CSP	1.22	2.21	4.27	5.67	concrete headwall
22	Highway #16 crossing	CSP	2.13	9.80	7.01	19.8	projection ends
23	3 Ave & 48 St	CSP	1.22	2.21	2.44	3.68	

Notes:
1. Crossing # 13 and 17 are damaged and repair or replacement of these drainage culverts is required.
2. Clearing of debris at both inlet and outlet of crossings # 10, 15 and 16 are required.

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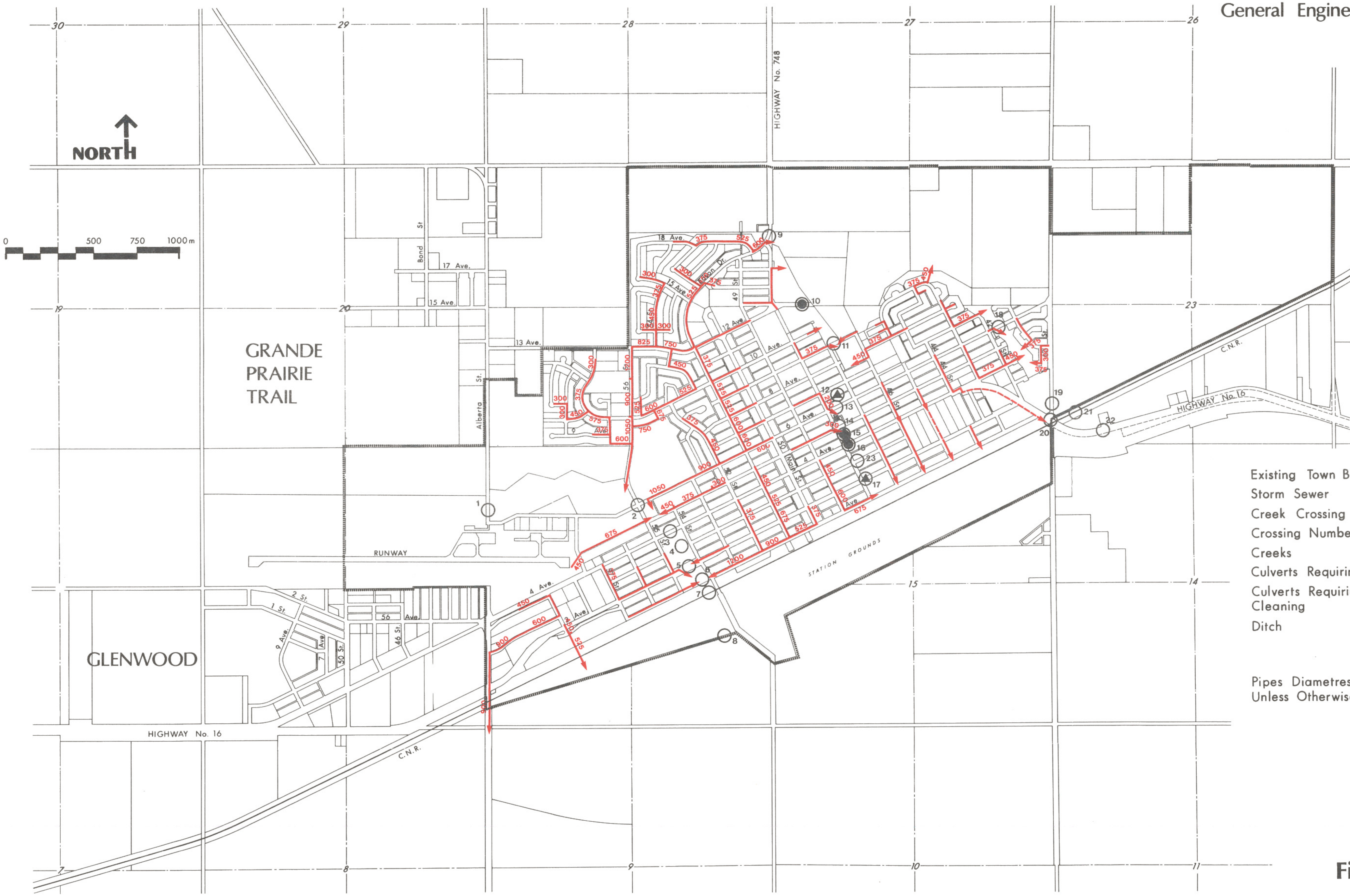

Legend:

Existing Town Boundary
Storm Sewer
Creek Crossing
Crossing Number
Creeks
Culverts Requiring Repair
Culverts Requiring Cleaning
Ditch

NOTES:

Pipes Diametres Are 200 mm Unless Otherwise Specified

Figure 5.3

EXISTING STORM SEWER SYSTEM

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5.5 STORMWATER MANAGEMENT CONCEPT

5.5.1 Bench Creek

The hydraulic analysis shows that all the existing crossings except crossing #4 have the capacity to convey the 1 in 100 year storm event under the post development condition. Crossing #4 is an existing foot bridge located in a park area of Edson and will be overtopped under the 1 in 100 year storm event. Bench Creek downstream of crossing #2 has sufficient channel capacity to convey the 1 in 100 year storm event. However, Bench Creek between crossings #1 and 2 has limited channel capacity and will overflow during the 1 in 100 year storm event. Therefore, the flood plain delineation along Bench Creek between crossings #1 and 2 should be undertaken to determine the extent of channel improvement required. Refer to Figure 5.4.

Runoff from sub-basins 1 and 4 can be discharged directly into Bench Creek through stormwater outfalls. Runoff from sub-basins 2 and 3 can be discharged directly into a tributary of the McLeod River through an existing drainage ditch and a proposed open channel. The capacity of the existing drainage ditch may have to be expanded to convey the increase in post development peak runoff from these two sub-basins. The proposed open channel should also be sized to convey the post-development runoff.

5.5.2 Wase Creek to Poplar Creek Confluence

The hydraulic analysis shows that the existing crossings along Wase Creek (crossings #9 to 17) have the capacity under a surcharge condition to convey approximately the 1 in 5 year post development runoff from sub-basin 5 and the Wase Creek drainage basin. Wase Creek should have the capacity to convey the 1 in 100 year post development runoff. However, with its limited channel capacity, any increase in post development runoff which exceeds the 1 in 5 year storm event in sub-basin 5 will result in flooding and erosion along Wase Creek within the Study Area. The Stormwater Management Concept should therefore allow for future development in sub-basin 5 without causing flooding along Wase Creek.

This can be achieved by providing a 2.6 ha. detention (dry) pond at ground level in sub-basin 5 for storage of runoff from any storm of up to the 1 in 100 year storm event. (Figure 5.4) Runoff from any storm having a return period greater than a 2 to 5 year storm event in sub-basin 5 will be controlled by this system. Outflow from the detention pond will be released to Wase Creek at pre-development runoff rates. The pond will have a side slope of 7 to 1, a depth of 2.4 metres and a 600 mm diameter concrete outlet pipe to control post-development runoff rate to that of pre-development runoff rates as shown in Table 5.7.

5.5.3 Poplar Creek

The hydraulic analysis shows that the existing crossings along Poplar Creek (crossings #18 to 22) do not have the capacity to convey the 1 in 5 year post development runoff from sub-basins 6, 7, 8 and 9. Also Wase Creek through the Study Area has limited discharge carrying capacity. Therefore any future residential and industrial development in these basins will require runoff control to prevent flooding and erosion.

This can be achieved by providing a 2.6 ha. onstream retention (wet) pond at ground level in sub-basin 6 for storage of runoff from storms up to a 1 in 100 year return period. The pond will have a side slope of 7 to 1, a depth of 2.4 metres and a 600 mm diameter concrete outlet pipe to control post development to that of pre-development runoff rates as shown in Table 5.7.

In addition it will be necessary to provide a 3.0 ha detention (dry) pond at ground level in sub-basin 7 and 8a. The pond will have a side slope of 7 to 1, a depth of 2.4 metres and a 700 mm concrete outlet pipe as shown in Table 5.7. A 0.76 ha detention (dry) pond at ground level should also be provided in sub-basin 8b. The pond will have a side slope of 7 to 1, a depth of 2.4 metres and a 300 mm diameter concrete outlet pipe as shown in Table 5.7.

The capacity of the existing CNR crossing (crossing #21) located to the southeast side of town is undersized. The existing 1.22 metre diameter CSP should be replaced by a 1.83 metre diameter CSP to convey runoff from both Wase Creek and Poplar Creek. In addition, the capacity of the existing 6 Avenue and 48 Street crossing (crossing #18) should be increased by replacing it with a 1.22 metre diameter CSP as shown in Figure 5.4.

Runoff from sub-basin 9 can be discharged directly into Popular Creek without detention facilities. This is possible because the area of sub-basin is relatively small and it is located at the downstream end of Bench Creek. Also the peak runoff effect is small due to the lag time between the peak flow from Poplar & Bench Creek drainage basins and sub-basin 9. In addition, Bench Creek downstream of sub-basin 9 is well defined and has sufficient channel capacity to convey the post development runoff.

TABLE 5.7

STORMWATER POND REQUIREMENTS

Sub-basin Nos.	Gross Area (ha)	Ultimate Development Residential Area (ha)	Ultimate Development Industrial Area (ha)	Depth of Pond (m)	Area of Pond at Ground Level (ha)	Size of Outlet Pipe (mm)
5	119	119	-	2.4	2.6	600
6	127	127	-	2.4	2.6	600
7&8a	139	100	39	2.4	3.0	700
8b	27	-	27	2.4	0.76	300

Notes:

1. Stormwater ponds for sub-basins 5, 7&8a and 8b, and 9 are dry ponds and storm pond for sub-basin 6 is a wet pond.

2. All the storm ponds have a side slope of 7 to 1.

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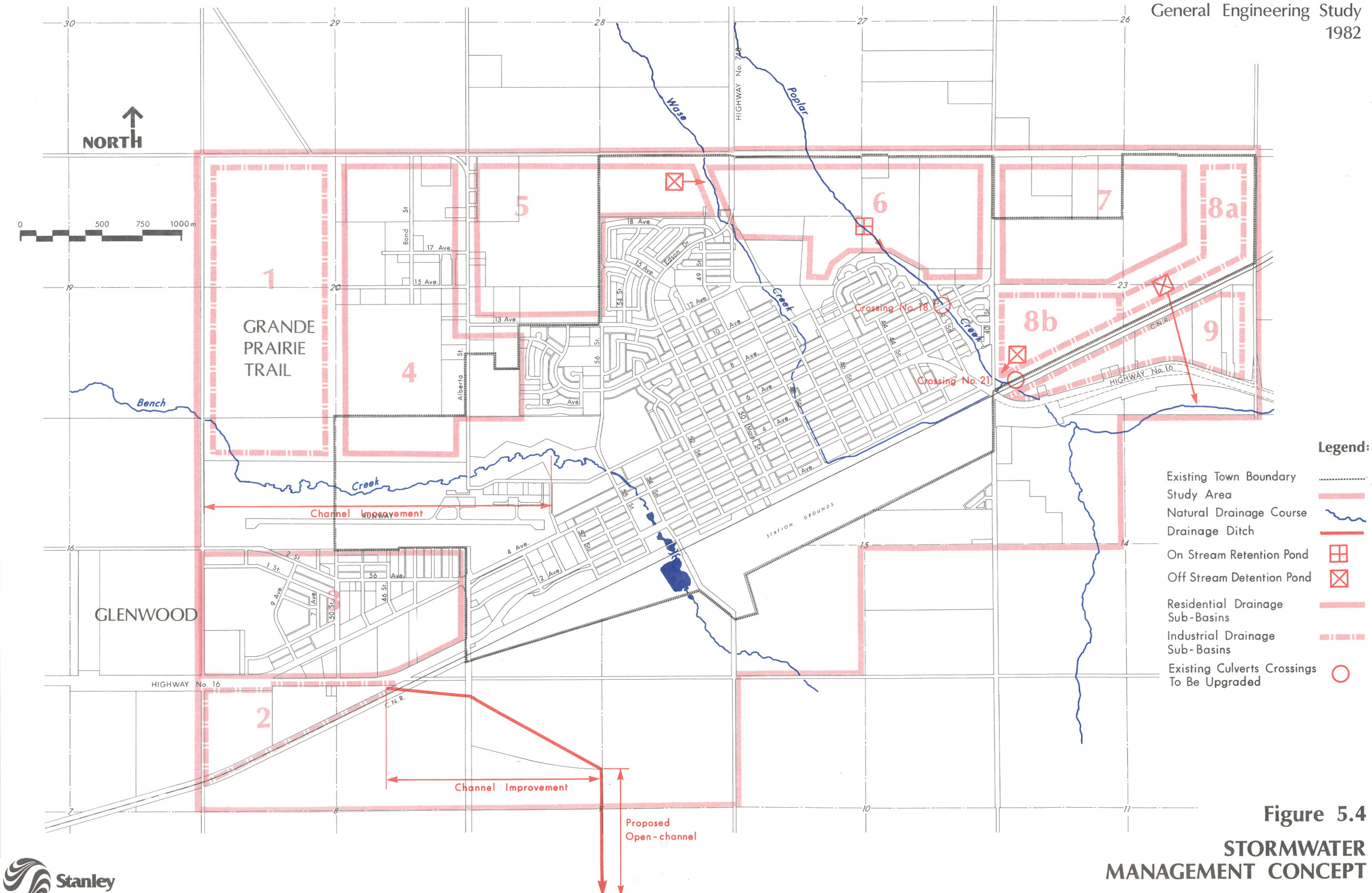

Figure 5.4

STORMWATER MANAGEMENT CONCEPT

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5.6 COST ESTIMATES

The cost of constructing the proposed ponds, outlet piping and new culvert crossings have been calculated and presented in Table 5.8.

The trunk mains transportating the storm water to the particular storm pond have not been estimated as they will depend on the layout and phasing of the development of the areas within each drainage basin.

TABLE 5.8

ULTIMATE STORM DRAINAGE IMPROVEMENTS

ESTIMATED COST

Drainage Sub-Basin Areas	Related Development Area	Estimated Cost
5	7 & 8	260,000
6	5 & 6	286,000
7 & 8a	3 & 4 & part of 2	480,000
8b	Part of 2	70,000
*Culvert Crossing #21 under CN Tracks		39,000
	TOTAL	$1,135,000

* Improvements of Culverts Crossing #21 can be related to developments in Drainage Sub-Basins 5, 6, & 8b.

- Estimates include 30% for Engineering & Contingencies

5.7 CONCLUSIONS

1. The existing drainage system is generally satisfactory with the exception of two culverts which need repair or replacement and three culverts to be cleared of debris.

2. Wase Creek and Poplar Creek Basins are at capacity and any new developments should not be permitted to increase the rate of flow into the basins within the Town boundary. Channel capacity of these creeks improves outside Town boundary.

3. Bench Creek appears satisfactory for the present and future with the exception, possibly, of channel improvements being required north of the airport.

5.8 RECOMMENDATIONS

It is recommended that the following action be taken for future residential and industrial development within the Study Area.

1. Damaged culvert Crossings #13 and 17 along Wase Creek be repaired or replaced.
2. Clearing of debris at both inlet and outlet of crossings #10, 15 and 16 be undertaken.
3. The proposed Stormwater Management Concept presented herein be adopted for the town's future development. The Concept includes the following:

   - design the minor system for future development for a 1 in 2 year storm for residential areas and 1 in 5 year storm for business and commercial areas which is a continuation of past practice in Edson.

   - undertake a flood plain delineation along Bench Creek between crossings #1 and 2 to determine the 1 in 100 year flood plain and the extent of channel improvement that is required for post development conditions.

- provide storage ponds in sub-basins 5, 6, 7 and 8a and 8b

- replace crossings #18 and 21 with a 1.22 metre and a 1.83 metre diameter CSP respectively.

- improve the existing drainage ditch in sub-basins 2 and 3

- provide an open channel to convey runoff from sub-basins 2 and 3 into a tributary to the McLeod River

5. A detailed design be prepared for each stormwater pond to determine the final surface area, depth, invert elevations and the size of outlet control pipe to meet Alberta Environment "Objective for Stormwater Management".