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NEW HARBOUR III HOUSING DEVELOPMENT
BRAMPTON FARMS, ST. CATHERINE

FCS # 0853/76/C

ENGINEERING REPORT
GENERAL DRAINAGE (PRELIMINARY)

PREPARED FOR
GORE DEVELOPMENTS LIMITED
2C BRAEMAR AVENUE
KINGSTON 10

JUNE 2009

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1.0 OVERVIEW

Foreman Chung and Sykes Consultants Limited was retained by Mr. Christopher Gore of Gore Developments Limited to prepare infrastructure designs including drainage designs for the proposed subdivision.

Gore Developments Limited intends to develop approximately 80 hectares of lands south of the New Harbour Village Housing Estate and east of Old Harbour Bay Main Road as a housing development. The location of the proposed development is shown in **Figure 1**.

The development lands are located on the Old Harbour Bay flood plains. The area was once farmed but is now overgrown with brush and grass.

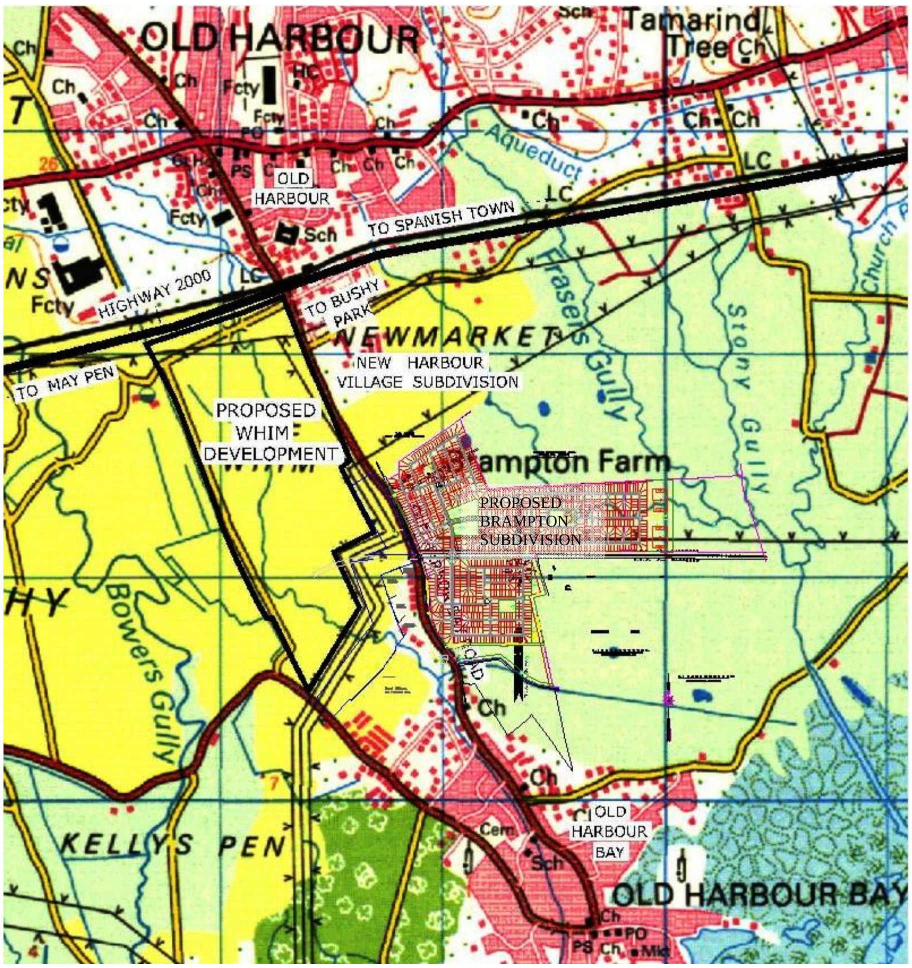

Figure 1 BRAMPTON SUBDIVISION LOCATION PLAN

2.0 DRAINAGE CRITERIA

DESIGN STORM EVENT

The Jamaica Institution of Engineers recommended "Guidelines for the design and Construction of Housing Infrastructure" Vol 1: 1984 Storm Water Drainage recommends that the design storm frequency of storm sewers be 2 years and for culverts, bridges and flood control projects a minimum of 10 years.

In the Standard Handbook for Civil Engineers by Merritt, Loftin and Ricketts article 14.9 states "Flooding problems and surface drainage as concerns of community and regional planning studies, differ primarily in degree of severity. The principal concern with flooding is the desire to avoid injury and loss of life and reduce property damages caused by major floods (those having a recurrence interval of 25 to 100 years).

Surface-drainage systems on the other hand are primarily concerned with convenience and providing access to property in relatively minor storms (those having a recurrence interval of 2 to 10 years)".

Investigations will be conducted for the 1 in 25 year event for the main drainage channels and 1 in 10 year event for the subdivision drains.

The FHWA HEC 22 recommendation is shown in Table 4-1 below and will be used for the designs.

Table 4-1. Suggested Minimum Design Frequency and Spread.

Road Classification		Design Frequency	Design Spread
High Volume or Divided or Bi-Directional	< 70 km/hr (45 mph)	10-year	Shoulder + 1 m (3 ft)
	> 70 km/hr (45 mph)	10-year	Shoulder
	Sag Point	50-year	Shoulder + 1 m (3 ft)
Collector	< 70 km/hr (45 mph)	10-year	1/2 Driving Lane
	> 70 km/hr (45 mph)	10-year	Shoulder
	Sag Point	10-year	1/2 Driving Lane
Local Streets	Low ADT	5-year	1/2 Driving Lane
	High ADT	10-year	1/2 Driving Lane
	Sag Point	10-year	1/2 Driving Lane

FHWA HEC-22

METHOD OF DETERMINING DESIGN PEAK FLOWS

1. For drainage areas less than 200 acres, the design engineer shall use the Rational Method (Q=CIA) procedure for determining runoff flow. For drainage areas between 200 and 2,000 acres, the design engineer shall use the most recent NRCS Method, for determining runoff rates.

2. **Drains to be sized to** FHWA Hydraulic Engineering Circular No 22 – Urban Drainage Design **HEC –** 22.

3. **Culverts to be sized and conform to** FHWA-NHI-01-020-HDS 5 (Hydraulic Design Series No 5)– Hydraulic design of highway culverts **–** Second Edition.

The calculation for peak runoff using the rational method is set out below:

$Q = C\ i\ A \times 1/Ku$

Where: Q = Flow, m^3/s (ft^3/s)
C = coefficient of runoff (dimensionless)
i = rain intensity mm/hr (in/hr)
A = drainage area, hectares, ha (acres)
Ku = units conversion factor 360 (1 in English units))

The runoff coefficients by hydraulic soil group and slope range used in the rational method were developed by Rawls et al. as shown in table 7.6 in the standard handbook of environmental engineering (by Robert Corbitt).

The proposed development is located south of the town of Old Harbour and the rain data for that town is used to estimate the rain intensity for the project (see **Table 1.0**).

Table 1.0 Rainfall Data

Old Harbour rainfall Data	
24 hr Return	**mm/day**
1 in 2 yr	105
1 in 5 yr	164
1 in 10 yr	203
1 in 25 yr	252
1 in 50 yr	288
1 in 100yr	324

STORM SEWERS

The storm sewer system being the buried drainage conveyance system below the roadway pavement will be designed to convey a 1:10 year storm without surcharging.

The discharge of the storm sewers is mostly to paved drains and positive drainage will be maintained in the design. Minimum cover will be to the manufacturers' specifications.

Open Drains

The open drains will be used where possible and erosion protection using both rigid and flexible linings will be used in the design. CALTRANS Highway Design Manual chapter 860 Open Channels will be used to guide the designs. The maximum velocity for unlined channels in table 862.2 is used to guide the designs.

Table 862.2

Recommended Permissible Velocities for Unlined Channels

Type of Material in Excavation Section	Permissible Velocity (m/s)	
	Intermittent Flow	Sustained Flow
Fine Sand (Noncolloidal)	0.8	0.8
Sandy Loam (Noncolloidal)	0.8	0.8
Silt Loam (Noncolloidal)	0.9	0.9
Fine Loam	1.1	1.1
Volcanic Ash	1.2	1.1
Fine Gravel	1.2	1.1
Stiff Clay (Colloidal)	1.5	1.2
Graded Material (Noncolloidal)		
Loam to Gravel	2	1.5
Silt to Gravel	2.1	1.7
Gravel	2.3	1.8
Coarse Gravel	2.4	2.0
Gravel to Cobbles (Under 150 mm)	2.7	2.1
Gravel and Cobbles (Over 200 mm)	3	2.4

The manning's roughness coefficients to be used in the evaluation of the design depth of flow is guided by table 863.3a shown below.

Table 864.3A

Average Values for Manning's Roughness Coefficient (n)

Type of Channel		**n value**
Unlined Channels:		
	Clay Loam	0.023
	Sand	0.02
	Gravel	0.03
	Rock	0.04
Lined Channels:		
	Portland Cement Concrete	0.014
	Air Blown Mortar (troweled)	0.012
	Air Blown Mortar (untroweled)	0.016
	Air Blown Mortar (roughened)	0.025
	Asphalt Concrete	0.018
	Sacked Concrete	0.025
Pavement and Gutters:		
	Portland Cement Concrete	0.015
	Asphalt Concrete	0.016
Depressed Medians:		
	Earth (without growth)	0.04
	Earth (with growth)	0.05
	Gravel	0.055

Freeboard in the open drains will be guided by table 866.2 of the CALTRANS Highway Design Manual.

Table 866.2

Guide to Freeboard Height

Shape of Channel	Subcritical Flow	SupercriticalFlow
Rectangular	0.1 He	0.20 d
Trapezoidal	0.2 He	0.25 d

Where He = Energy head, in meters
d = Depth of flow, in meters for a straight alignment

For rigid pavements the FHWA HDS 4 guidance will be used and for flexible linings FHWA HEC-15 will be used along with the CALTRANS guidelines.

EROSION CONTROL

CALTRANS Highway Design Manual chapter CHAPTER 870 CHANNEL AND SHORE PROTECTION - erosion control and FHWA HEC 14 hydraulic design of energy dissipators for Culverts and Channels will be used to design the erosion control features.

3.0 DRAINAGE DESIGN

PREDEVELOPMENT CONDITION

The proposed development lands are located on the Old Harbour plains that slopes toward the Frasers Gully to the East or the Bowers Gully in the west and south toward the sea. Parts of the town of Old Harbour slopes to the east and west to natural watercourses that flow through New Harbour Village and the Whim respectively.

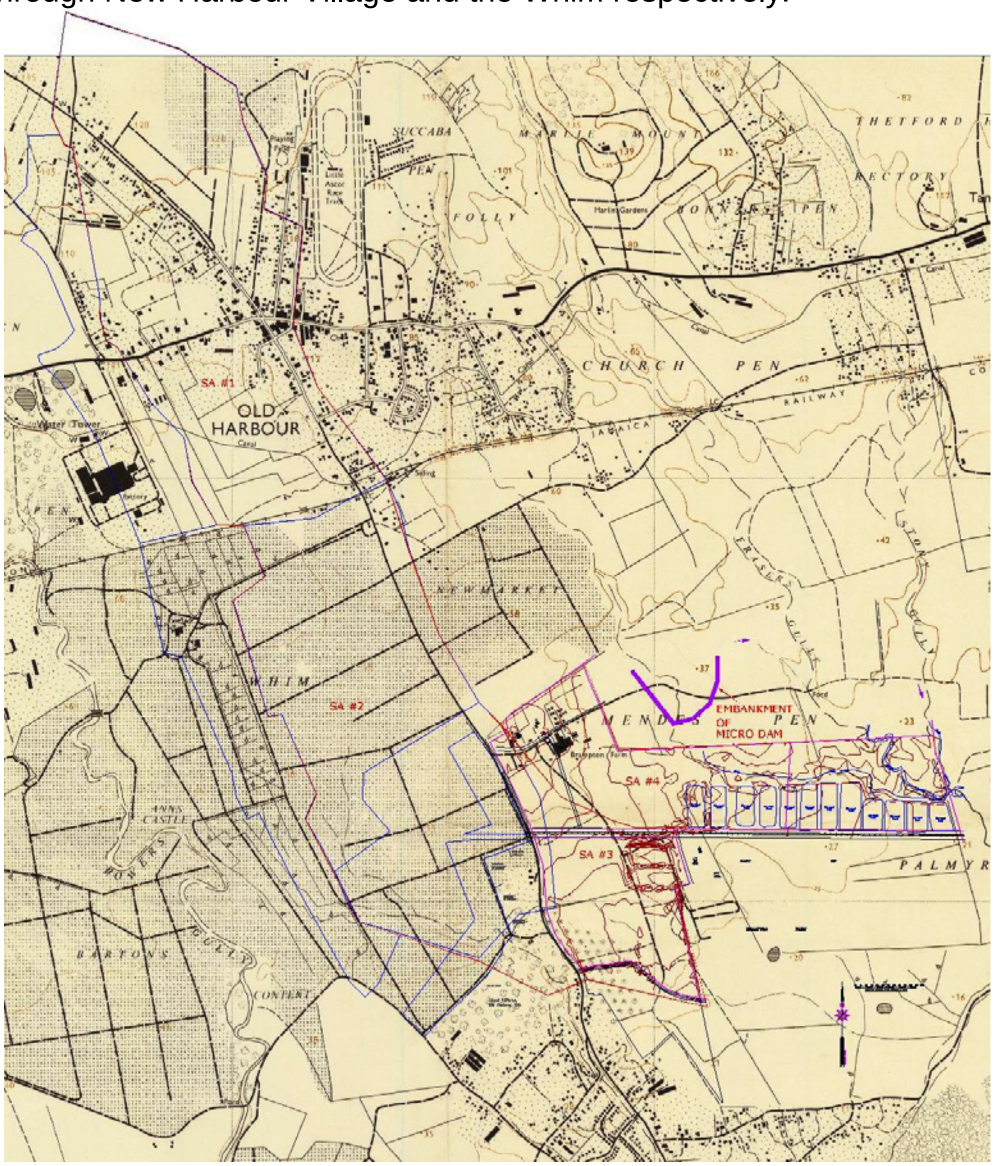

Figure 2 Overall catchments including the project lands

The watercourse that meanders through The Whim lands has been recently redirected eastward in an earth drain that is aligned south of the proposed Brampton subdivision sloping eastward toward the Old Harbour Bay lagoon. The western parts of the Brampton development lands fall southward towards the recently upgraded earth drain on the southern boundary.

Photo 1 Showing the eastern parts of the Brampton property.

The eastern parts of the proposed subdivision fall toward the east and discharge surface flows into the Frasers Gully. Photo 1 shows the micro dam with the approximate location of the embankment shown as an overlay in Figure 2. This feature redirects the flows form eastern Old Harbour and New Harbour Village to the Frasers gully north of the proposed Brampton subdivision.

The predevelopment land use is similar to that shown in **Figure 3** below with one major difference is that New Harbor Village subdivision is now 95% completed.

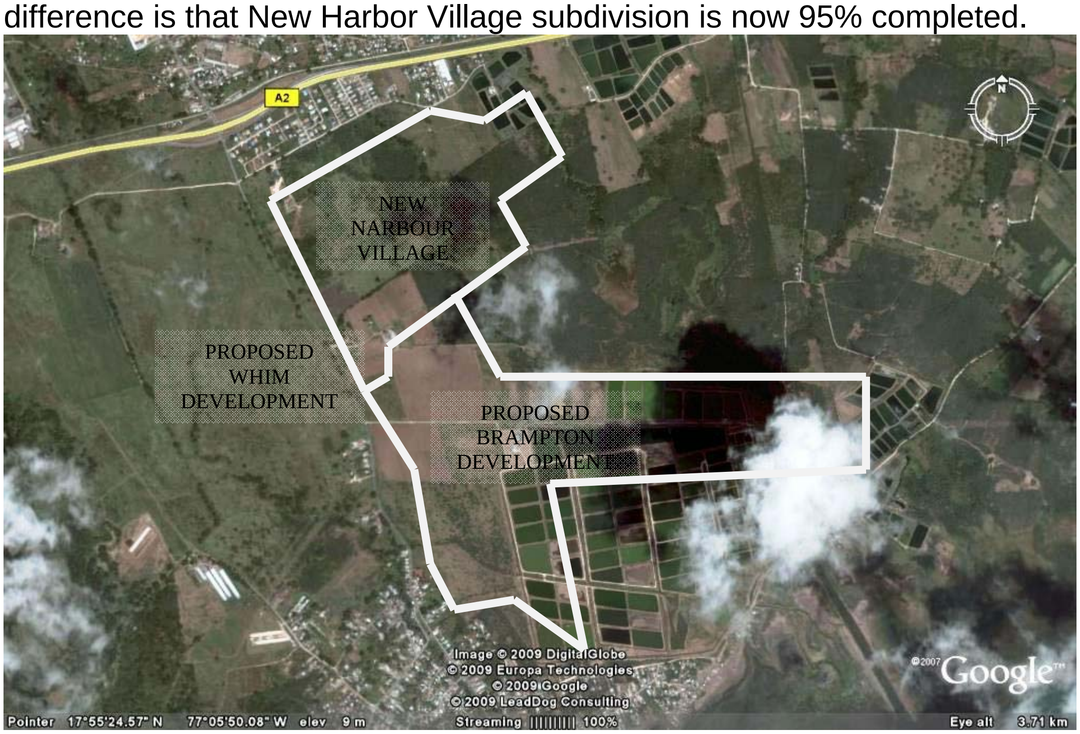

Figure 3 Fairly recent satellite image showing predevelopment land use

ESTIMATE OF PREDEVELOPMENT SURFACE RUNOFF

The predevelopment hydraulic soil group and that the ground cover evaluation is shown in Table 1.1.

Table 1.1

AF ENG GDL BRAMPTON PRE-DEVELOPMENT Type III rain distribution Region: OLD HARBOUR Locale: SAINT CATHERINE Sub-Area Land Use and Curve Number Details					
Sub-Area Identifier	Land Use	Condition	Hydrologic Soil Group	Sub-Area Area (ha)	Curve Number
SA-1	Brush - brush, weed, grass mix	(good)	C	63.39	65
	Farmsteads		C	50	82
	Total Area / Weighted Curve Number			113.39	72
SA-2	Brush - brush, weed, grass mix	(fair)	C	120	70
SA-3	Brush - brush, weed, grass mix	(fair)	C	24.9	70
SA-4	Brush - brush, weed, grass mix	(fair)	C	36	70

The estimated runoff from the subareas and discharge through the south drain and ultimately discharged through an east west channel into the Frasers Gully is shown in Table 1.2.

Table 1.2

AF ENG GDL BRAMPTON PRE-DEVELOPMENT Type III rain distribution Region: OLD HARBOUR Locale: SAINT CATHERINE Hydrograph Peak/Peak Time Table Peak Flow and Peak Time (hr) by Rainfall Return Period				
Sub-Area or Reach Identifier	(hr)	10-Yr (cms)	(hr)	25-Yr (cms)
SA-1	12.76	16.69	12.73	22.81
SA-2	12.33	25.36	12.33	34.98
SA-3	12.61	3.85	12.61	5.32
BRAMPTON EAST				
SA-4	12.66	5.57	12.61	7.69
REACHES	(hr)	10-Yr (cms)	(hr)	25-Yr (cms)
R1	12.76	16.69	12.73	22.81
Down	13.25	11.21	13.15	16.26
R2	12.36	28.32	12.36	39.92
Down	12.64	27.76	12.61	39.02
R3	12.64	31.61	12.61	44.33
Down	12.67	31.54	12.64	44.25
OUTLET		31.54		44.25
BRAMPTON EAST				
R1	12.66	5.57	12.61	7.69
Down	12.78	5.53	12.78	7.62
OUTLET		5.53		7.62

ESTIMATE OF POST DEVELOPMENT SURFACE RUNOFF

For the post development evaluation the subdivision was divided into various subareas. The proposed Whim development is slated to be constructed before the Brampton Development and most of the flows from that development will be directed westward toward the Bowers Gully. This significantly reduces the flow from the West into the Brampton south drain. Figure 4 shows the proposed redirected or post development catchment areas.

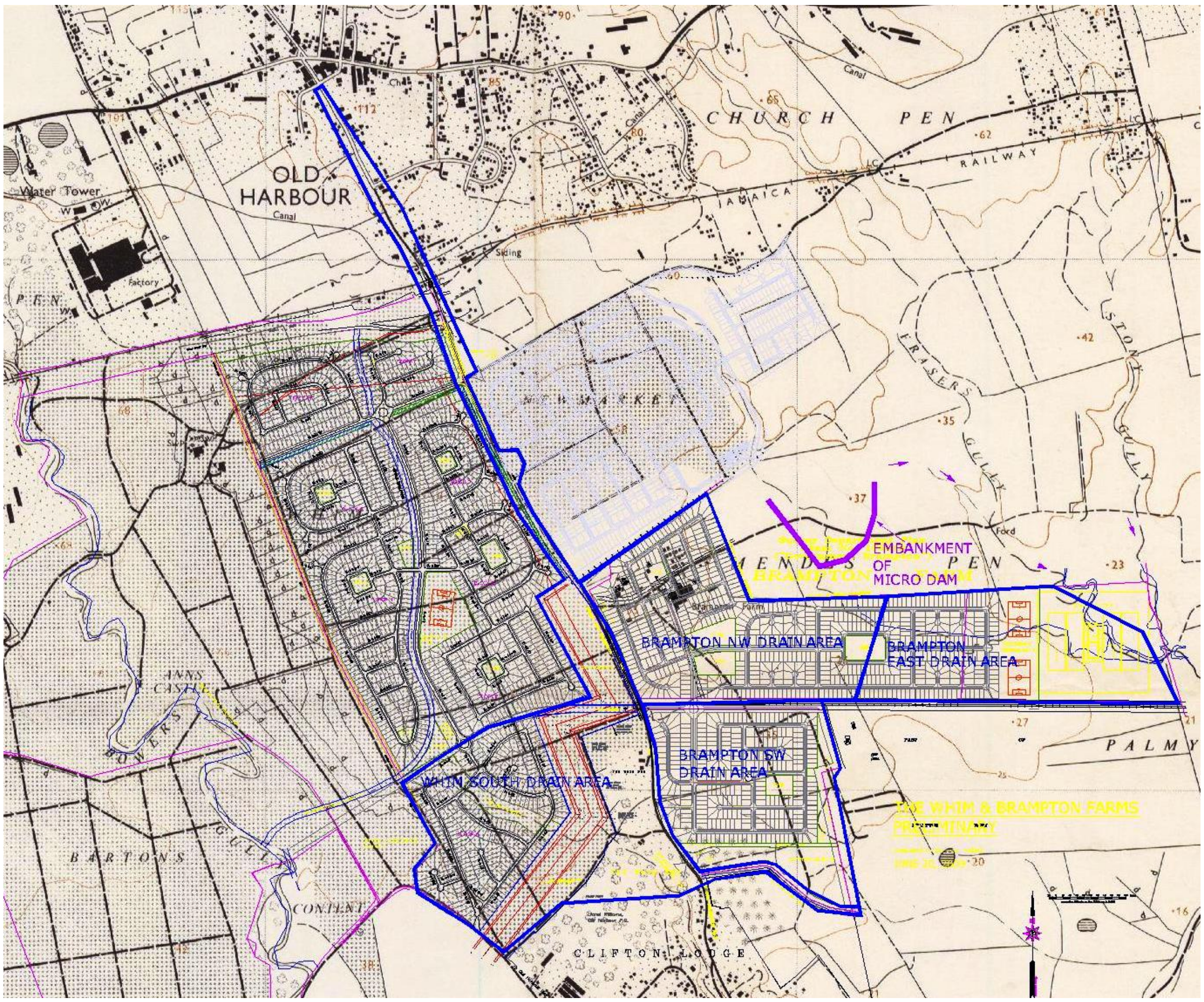

Figure 4 Proposed development land use

The post development subareas sizes, land uses, and estimated runoff potential is shown in **Table 1.4**.

Table 1.4

AF ENG	**GDL BRAMPTON DEVELOPED** Type III rain distribution				
Region: OLD HARBOUR			Locale: SAINT CATHERINE		
	Sub-Area Land Use and Curve Number Details				
Sub-Area Identifier	Land Use	Condition	Hydrologic Soil Group	Sub-Area Area (ha)	Curve Number
SA-WS	Open space; grass cover 50% to 75%	(fair)	C	25	79
	Residential districts (1/8 acre)		C	29.7	90
	Total Area / Weighted Curve Number			54.7	85
SA-BNW	Residential districts (1/8 acre)		C	29.5	90
SA-BSW	Residential districts (1/8 acre)		C	25.4	90

The subsequent post development flows that flow into the south drain and Frasers Gully are shown in Table 1.5.

Table 1.5

AF ENG	**GDL BRAMPTON DEVELOPED** Type III rain distribution			
Region: OLD HARBOUR	Locale: SAINT CATHERINE			
	Hydrograph Peak/Peak Time Table Peak Flow and Peak Time (hr) by Rainfall Return Period			
Sub-Area or Reach Identifier	(hr)	10-Yr (cms)	(hr)	25-Yr (cms)
SA-WS	12.69	10.88	12.66	14.01
SA-BNW	12.33	8.82	12.34	11.14
SA-BSW	12.35	7.61	12.33	9.63
BRAMPTON EAST				
SA- BE	12.26	8.05	12.26	10.18
REACHES	(hr)	10-Yr (cms)	(hr)	25-Yr (cms)
Reach 1	12.69	10.88	12.66	14.01
Down	12.69	10.86	12.72	13.98
Reach 2	12.33	8.82	12.34	11.14
Down	12.39	8.75	12.41	11.06
OUTLET		24.41		31.13
BRAMPTON EAST				
R1	12.26	8.05	12.26	10.18
Down	12.36	7.89	12.34	9.95
OUTLET		7.89		9.95

A drain and berm is proposed to be constructed to the north and east of the proposed housing areas that are closest to the Frasers Gully as an added storm water protection feature.

Photo 2 Culverts in the watercourse to the south crossing the eastern parochial Road

The south drain in the pre development condition is expected to direct $44m^3/s$ toward the existing parochial road crossing shown in **Photo 2**. The post development flow is anticipated to be $31m^3/s$. This reduction is due to the proposal to direct most of the runoff from The Whim property west to the Bowers Gully.

The backwater effect from the culvert crossing the Gutters to Old Harbour Bay parochial road will be included in the drainage report for the subdivision review.

METHOD OF DETERMINING DESIGN PEAK FLOWS FOR INTERNAL DRAINAGE SYSTEM

4. For drainage areas less than 200 acres, the design engineer shall use the Rational Method (Q=CIA) procedure for determining runoff flow. For drainage areas between 200 and 2,000 acres, the design engineer shall use the most recent NRCS Method, for determining runoff rates. For drainage areas greater than 2,000 acres, or (800 hectares) the design engineer shall use the most recent WRA Regression methods or HEC HMS to estimate runoff rates.

5. **Drains to be sized to** United States Federal Highway Administration (FHWA) Hydraulic Engineering Circular No 22 – Urban Drainage Design **HEC –** 22.

6. **Culverts to be sized and conform to** FHWA-NHI-01-020-HDS 5 (Hydraulic Design Series No 5)– Hydraulic design of highway culverts **–** Second Edition.

The calculation for peak runoff using the rational method is set out below:

$Q = C\ i\ A \times 1/Ku$

Where: Q = Flow, m^3/s (ft^3/s)
C = coefficient of runoff (dimensionless)
i = rain intensity mm/hr (in/hr)
A = drainage area, hectares, ha (acres)
Ku = units conversion factor 360 (1 in English units))

Rain data is taken from the National Meteorological Service's estimates of maximum 24 hour rainfall for selected return periods. This is converted to rainfall intensity by the following equation.

$$i = \frac{4.73 \times R}{(12.25+D)^{0.65}}$$

Where R = 24-hour rainfall.
D = Duration of the design rainfall event equal to the time of concentration

The runoff coefficients by hydraulic soil group and slope range used in the rational method were developed by Rawls et al. as shown in table 7.6 in the standard handbook of environmental engineering (by Robert Corbitt).

Table 1.9 Maximum flow into drainage storm culverts of various sizes

Q_{max}	Units	Min Storm Drain size at 0.5% slope
0.42	m^3/s	60cm Dia HDPE pipe
0.77	m^3/s	75cm Dia HDPE pipe
1.25	m^3/s	90cm Dia HDPE pipe
2.7	m^3/s	120cm Dia HDPE pipe
4.9	m^3/s	150cm Dia HDPE pipe

4.0 CONCLUSION

The drainage approach outlined in this report uses standard methods of evaluating runoff potential and evaluating the hydraulic capacity of drains required to drain the proposed development to meet the criteria for sustainable residential communities. A minimum elevation within the housing areas is proposed to be 6.5m above MSL. The 50year water level in the Frasers Gully will be evaluated and included in the Brampton subdivision drainage report to reinforce the adequacy of the minimum finished elevation within the subdivision except for recreational areas.

Low impact development measures are included in the internal drainage designs where storm drainage paths will be disconnected to allow for the maximum opportunity for infiltration to take place and to create storage along the drainage paths thereby reducing the downstream peak discharge and allowing for the optimising of drain sizes.

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