August 26, 2020 Reference No. 11217258-01

Ms. Vanessa Simpson
Towerhill Development Inc.
c/o Innovative Planning Solutions
647 Welham Road, Unit 9A
Barrie, ON L4N 0B7

Re: Hydrogeological Assessment – Addendum #1
Proposed Residential Development – Towerhill Development
Fallis Line, Millbrook, Ontario

Dear Ms. Simpson:

1. Introduction

This letter is provided in response to comments provided by the County of Peterborough and the Township of Cavan Monaghan via email, subject "Revised Plan of Subdivision, Official Plan Amendment & Zoning By-law Amendment, 862 Fallis Line & 1080 County Road 10, Part Lots 11 & 12, concession 6 (Cavan), Township of Cavan Monaghan, County File No. 15T-18002 (Plan of Subdivision), Township File No. OPA-01-18 (Official Plan Amendment), Township File No. ZBA-07-18 (Zoning By-law Amendment). Comments provided by the County of Peterborough and the Township of Cavan Monaghan requested confirmation that recommendations provided in the previously submitted reports are still applicable.

GHD Limited (GHD, formerly Geo-Logic Inc.) completed a review of the revised "Draft Plan of Subdivision", prepared by Innovative Planning Solutions, dated February 27, 2019. Revised water balance calculations for the above noted proposed residential development (herein referred as the Site) are provided in this letter based on the revised draft plan and updated information provided to GHD. The remaining recommendations provided in our previously prepared report entitled "Hydrogeological Assessment Report, Proposed Residential Development Fallis Line, Millbrook, Ontario, Geo-Logic No. G024822A1, dated April 2014" are still applicable.

This revised water balance supersedes the water balance provided in the Hydrogeological Assessment Report dated March 2105 and a response to comments letter dated September 20, 2016. This revised water balance uses updated climatic data, and the revised Draft Plan of Subdivision dated February 27, 2019. The Site location is provided on Figure 1. The Site details for the water balance are provided on Figure 2. The Site area is 52.108 hectares (ha).

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The Site is considered to be within the watershed of Baxter Creek. The Site is characterized by rolling topography within the physiographic region of the Peterborough Drumlin Field. Locally, the Site is within a sand plains. Details regarding the hydrogeology of the Site should refer to the Hydrogeologic Assessment Report dated March 2015.

2. Methodology

GHD utilized the Thornthwaite Method to complete this generic water balance. Based upon monthly temperature and precipitation average values, the method calculates water surplus. Infiltration into the subsurface is based upon soil types, land cover and topography and is based upon MOEE Hydrogeological Technical Information Requirements for Land Development Applications, April 1995.

The meteorological data was gleaned from the Environment Canada website for Peterborough A (station ID 6166418) located about 10 km away. The data included average temperatures and precipitation values for the years 1981 to 2006.

The Thornthwaite Method calculations are provided in Appendix A. A summary of the Thornthwaite calculations are provided in Table 2-1.

Table 2-1: Summary of Thornthwaite Method Calculations

Station	Precipitation (mm/yr)	Adjusted ET (mm/yr)	Surplus (mm/yr)
Peterborough A (1981 – 2006)	855.4	569.9	285.5

The calculations indicate that 285.5 mm/year of water is available as either runoff or infiltration.

3. Pre-Development

The pre-development lands are predominantly agricultural lands with an area of environmental protection, treed areas and a former residential lot that included roof tops, lawn and a gravel driveway. A summary of the distribution is provided in Table 3-1.

Table 3-1: Pre-Development Land Use Summary

Land Use	Area (m^2)
Agricultural Lands	387,555
Environmental Protection Area	103,960
Treed Areas	20,475
Lawn	5,685
Gravel Driveway	2,800
Rooftops	605
Overall Site Area (m^2)	**521,080**

Based upon this summary, 99.9% of the pre-development Site is available for infiltration.

3.1 Pre-Development Water Balance

The pre-development infiltration calculations were based upon a topography factor ranging from 0.15 to 0,2; a soil infiltration factor of 0.2; and a land cover infiltration factor ranging from 0.1 to 0.2 depending upon the land use. The infiltration factors ranged from 0.50 for agricultural lands to 0.55 for treed areas and the environmental protection area. The pre-development infiltration rate is estimated to be about 150 mm/year for this area. Table 3-2 summarizes the pre-development water balance calculations:

Table 3-2: Pre-Development Water Balance Results

ID	Area (m^2)	Area for Recharge (m^2)	Precipitation (m^3/yr)	ET (m^3/yr)	Runoff (m^3/yr)	Infiltration (m^3/yr)
Site	521,080	520,475	445,732	295,626	73,491	76,615
% of Precipitation				67%	16%	17%

Based upon the calculations, the pre-development infiltration is estimated to be 76,615 m^3/year. Detailed calculations are provided in Appendix A.

4. Post-Development

The post-development lands are a mix of single detached residential units, townhouses, high density blocks, an institutional block, an environmental protection area, a stormwater pond, open space / parks / walkways, an agricultural block, blocks for road widening and road reserves, and street right-of-ways. A summary of the distribution is provided in Table 4-1.

Table 4-1: Post-Development Land Use Summary

Land Use	Area (m^2)
Impervious Surfaces	
Roads (asphalt)	47,965
Rooftops – Res. Lots (52', 45' 35')	74,296
Rooftops – Townhouses (20', 25')	30,313
Rooftops – High Density – Apartments	12,052
Rooftops – Institutional (i.e. school)	4,426
Driveways / Parking lots	37,040
Stormwater Management Pond	19,710
Impervious Area (m^2) / % Impervious	**225,802 / 43%**
Pervious Surfaces	
Lawns	158,779

Land Use	Area (m^2)
Park / Open Space / Walkway	17,080
Agricultural Block	12,220
Environmental Protection Area	103,960
Road Reserve and Road Widening	3,240
Pervious Area (m^2) / % Pervious	**295,279 / 57%**
Overall Site Area (m^2)	**521,080**

Based upon this summary, about 57% of the post-development Site is available for infiltration, a reduction of about 43%.

4.1 Post-Development Water Balance

The post-development infiltration calculations were based upon a topography factor ranging from 0.15 to 0.2; a soil infiltration factor of 0.2; and a land cover infiltration factor ranging from 0.1 to 0.2 depending upon the land use. Lot levelling improvements and soil improvements and / or compaction from construction activities were not considered. Table 4-2 summarizes the post-development water balance calculations:

Table 4-2: Post-Development Water Balance Results

ID	Area (m^2)	Area for Recharge (m^2)	Precipitation (m^3/yr)	ET (m^3/yr)	Runoff (m^3/yr)	Infiltration (m^3/yr)
Site	521,080	295,279	445,732	206,921	192,485	46,326
% of Precipitation				46%	43%	11%

Detailed calculations are provided in Appendix A. The infiltration values represent a reduction of about 30,000 m^3/year compared to pre-development. Without mitigation, the post-development infiltration represents a reduction of nearly 40%.

5. Proposed Low Impact Development Mitigation Strategies

Based upon the calculations presented above, infiltration and recharge to the shallow groundwater regime will be reduced by about 30,000 m^3/year. The previous post-development calculations have not considered the incorporation of low impact development (LID) strategies and these strategies can be completed on a lot by lot basis and used to direct enhancements. LIDs may include downspout disconnection, infiltration trenches, enhanced grass swales, filter strips, bioretention etc.

For this development, it is reasonable to expect that the LID mitigation strategies will consider downspout disconnection for roof tops sent to sodded lawns. There may also be topsoil enhancements and improvements in lot levelling; however, these are not considered.

Based upon LID literature and the strategy of downspout disconnection, between 25% and 50% of rooftop runoff can be infiltrated to the ground. The available rooftop runoff surplus is estimated to be about 82,860 m^3/year. To maintain the pre-development water balance, about 37% of the available rooftop runoff is needed to be infiltrated.

With a development of this size, a reduction in infiltration is expected and enhancing infiltration through LID methods appears to be the best option available for this proposed subdivision.

The revised water balance provides a post-development target to maintain infiltration based upon the assumptions and calculations outlined in this letter and the detailed calculations provided in Appendix A. Downspout disconnection has been identified in this letter as a potential LID strategy and to illustrate that pre-development infiltration can be maintained. However, the LID strategy and design to be implemented at the Site is the responsibility of others and should consider soil conditions, infiltration rates, groundwater levels, depth to bedrock etc.

We trust that this report meets with your immediate requirements. Should you have any questions, please contact our office.

Sincerely,

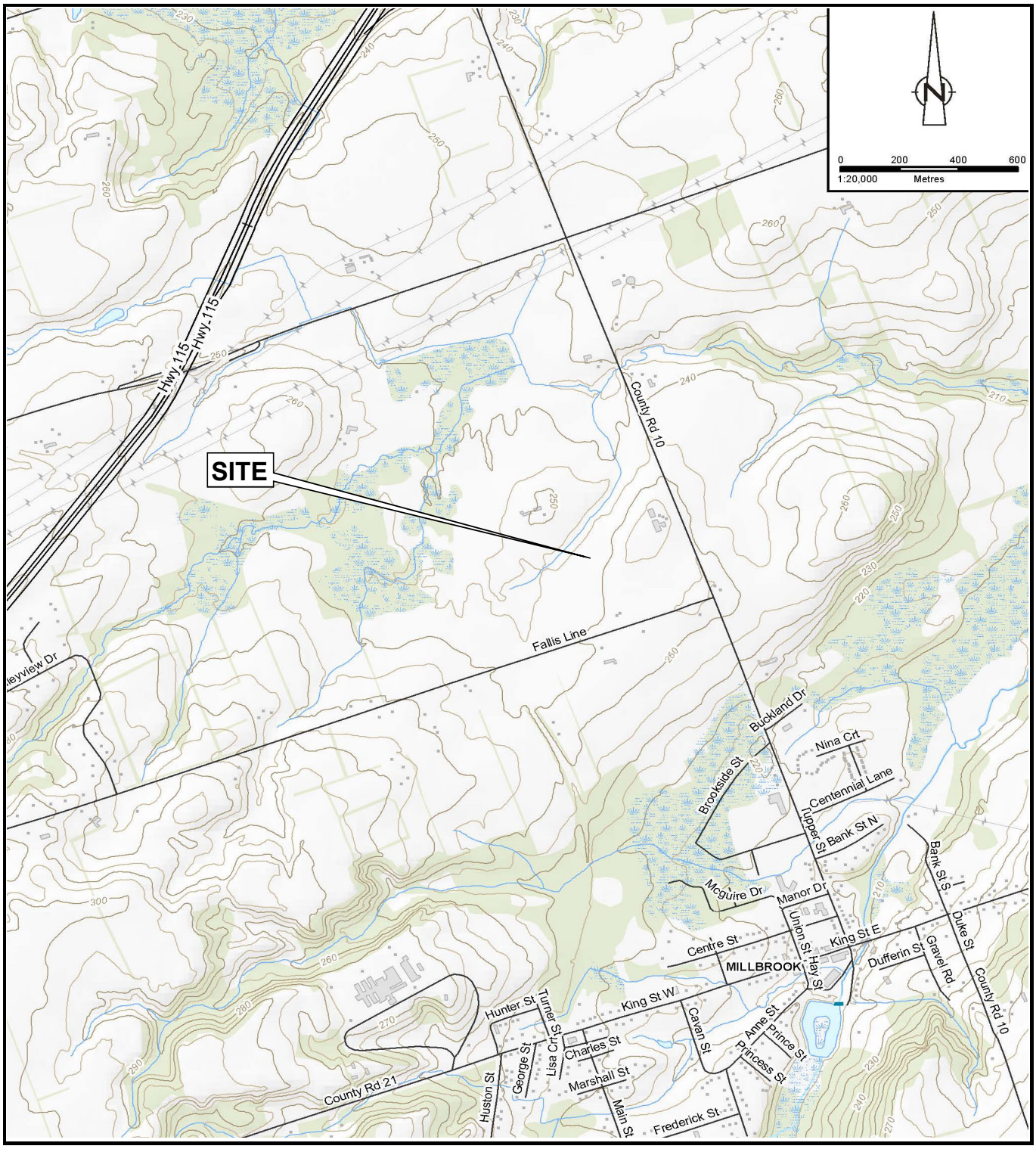
GHD

Robert Neck, M.Eng., P.Geo. (Limited)

Leandro Ramos, P.Eng.

/BN/lr
Enclosures
Appendix A: Water Balance Calculations

Enclosures



Source: MNR NRVIS, 2013. Produced by CRA under license from Ontario Ministry of Natural Resources, © Queen's Printer 2014

Scale:
Refer to Scale Bar
Coordinate System
NAD 1983 UTM

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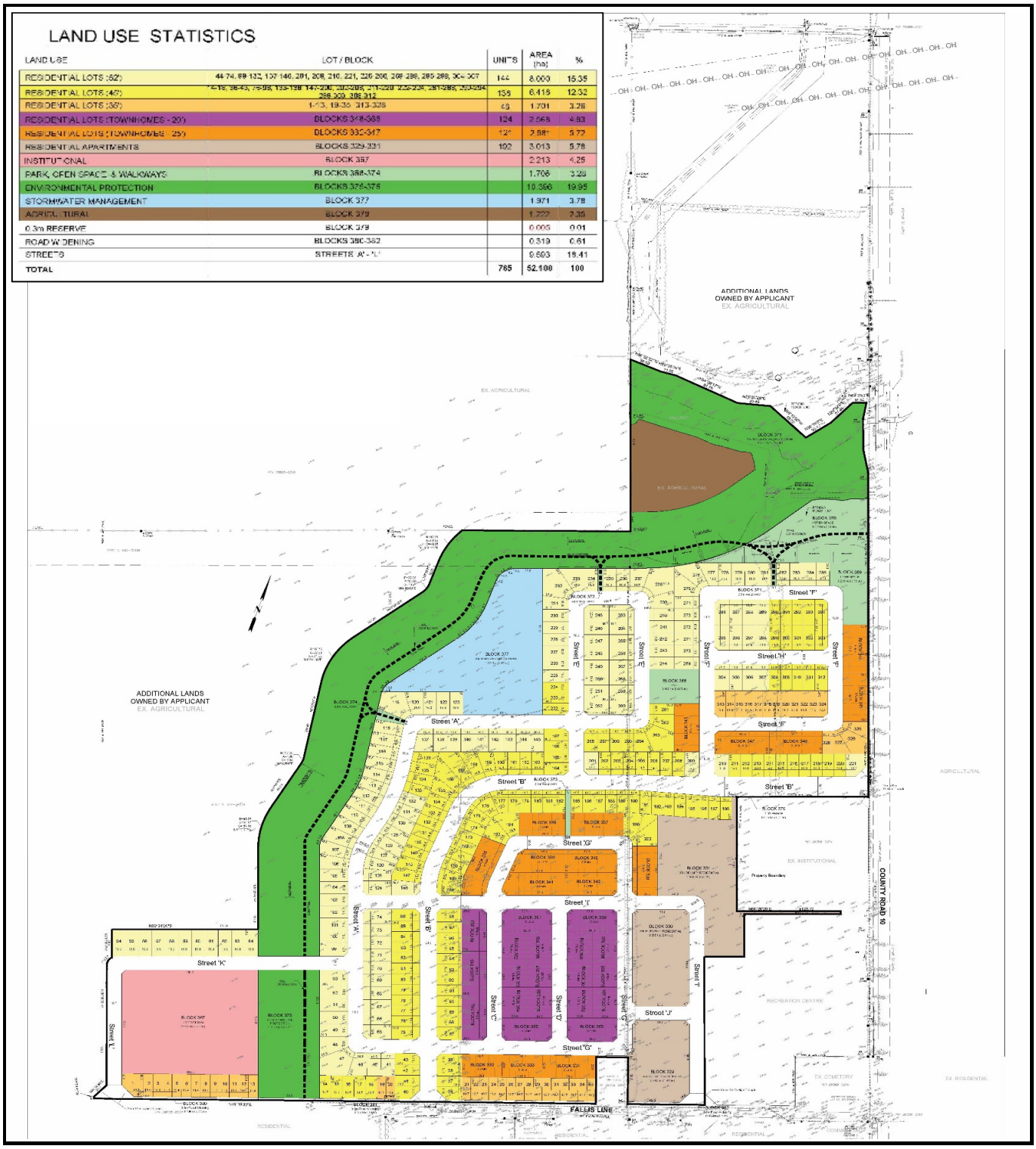
Hydrogeological Assessment

11212565-01
August 2020

Site Location Plan

FIGURE 1



Source: Draft Plan of Subdivision (North Residential Detail), prepared by Innovative Planning Solution, dated February 27, 2019

Scale:
ND
Coordinate System
NAD 1983 UTM

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Concept Plan

FIGURE 2

Appendix A
Water Balance Calculations

Appendix A.1

Revised Water Budget (Thornthwaite Method) - Average Values*

Weather Station: Peterborough A

Climate Station: 6166418 **Elevation:** 191 masl **Distance Away:** ~ 10.2 km

Month	Mean Temperature (^{o}C)	Heat Index	Unadjusted Potential ET (mm)	Daylight Correction Factor	Adjusted ET (mm)	Total Precipitation (mm)
January	-8.5	0	0	0.82	0	57.4
February	-7.5	0	0	0.82	0	51.5
March	-1.8	0	0	1.03	0	56.1
April	5.9	1.28	28.8	1.12	32.2	68.6
May	12.1	3.81	60.1	1.27	76.3	81.5
June	17	6.38	85.1	1.28	109.0	79.9
July	19.6	7.91	98.5	1.3	128.0	70.6
August	18.3	7.13	91.8	1.2	110.2	77
September	13.9	4.70	69.2	1.04	72.0	85.3
October	7.5	1.85	36.8	0.95	34.9	76.9
November	1.9	0.23	9.0	0.81	7.3	86.4
December	-4.4	0	0	0.78	0	64.2
TOTAL	6.2	33.3	479.3		569.9	855.4

TOTAL WATER SURPLUS: 285.5 mm

Notes:

*Average values of precipitation were used. Average values of temperature were also used.

Appendix A.2
Water Budget Pre-Development

Catchment Designation	PRE-DEVELOPMENT SITE						TOTAL
	Agricultural Area	Environmental Protection	Treed Areas	Former Residential Lot			
				Lawn	Rooftops	Gravel Drive	
Area (m^2)	387555	103960	20475	5685	605	2800	521080
Pervious Area (m^2)	387555	103960	20475	5685	0	2800	520475
% Pervious	74.4%	20.0%	3.9%	1.1%	0%	0.5%	99.9%
Impervious Area (m^2)	0	0	0	0	605	0	605
% Impervious	0%	0%	0%	0%	0.1%	0%	0.1%
INFILTRATION FACTORS							
Topography Infiltration Factor	0.2	0.15	0.15	0.2	0	0.2	
Soil Infiltration Factor	0.2	0.2	0.2	0.2	0	0	
Land Cover Infiltration Factor	0.1	0.2	0.2	0.15	0	0	
MECP Infiltration Factor	0.5	0.55	0.55	0.55	0	0.2	
Actual Infiltration Factor	0.5	0.55	0.55	0.55	0	0.4	
Runoff Coefficient	0.5	0.45	0.45	0.45	1	0.6	
Runoff from Impervious Surfaces*	0	0	0	0	0.8	0.8	
INPUTS (PER UNIT AREA)							
Precipitation (mm/yr)	855	855	855	855	855	855	855
Run On (mm/yr)	0	0	0	0	0	0	0
Other Inputs (mm/yr)	0	0	0	0	0	0	0
Total Inputs (mm/yr)	855	855	855	855	855	855	855
OUTPUTS (PER UNIT AREA)							
Precipitation Surplus (mm/yr)	285	285	285	285	684	684	288
Net Surplus (mm/yr)	285	285	285	285	684	684	288
Evaportranspiration (mm/yr)	570	570	570	570	171	171	567
Infiltration (mm/yr)	143	157	157	157	0	274	147
Rooftop Infiltration (mm/yr)	0	0	0	0	171	0	0.2
Total Infiltration (mm/yr)	143	157	157	157	171	274	147
Runoff Pervious Areas	143	128	128	128	0	411	140
Runoff Impervious Areas	0	0	0	0	513	0	1
Total Runoff (mm/yr)	143	128	128	128	513	411	141
Total Outputs (mm/yr)	855	855	855	855	855	855	855
Difference (Inputs - Outputs)	0	0	0	0	0	0	0
INPUTS (VOLUMES)							
Precipitation (m^3/yr)	331515	88927	17514	4863	518	2395	445732
Run On (m^3/yr)	0	0	0	0	0	0	0
Other Inputs (m^3/yr)	0	0	0	0	0	0	0
Total Inputs (m^3/yr)	331515	88927	17514	4863	518	2395	445732
OUTPUTS (VOLUMES)							
Precipitation Surplus (m^3/yr)	110632	29676	5845	1623	414	1916	150106
Net Surplus (m^3/yr)	110632	29676	5845	1623	414	1916	150106
Evaportranspiration (m^3/yr)	220883	59251	11670	3240	104	479	295626
Infiltration (m^3/yr)	55316	16322	3215	893	0	766	76512
Rooftop Infiltration (m^3/yr)	0	0	0	0	104	0	104
Total Infiltration (m^3/yr)	55316	16322	3215	893	104	766	76615
Runoff Pervious Areas (m^3/yr)	55316	13354	2630	730	0	1150	73180
Runoff Impervious Areas (m^3/yr)	0	0	0	0	311	0	311
Total Runoff (m^3/yr)	55316	13354	2630	730	311	1150	73491
Total Outputs (m^3/yr)	331515	88927	17514	4863	518	2395	445732
Difference (Inputs - Outputs)	0	0	0	0	0	0	0

Notes:
Evaporation from impervious surfaces assumed to be 20% of precipitation
Rooftop infiltration assumed to be 25% of rooftop runoff.

Appendix A.3
Water Budget Post-Development - No Mitigation Strategies

Catchment Designation	POST-DEVELOPMENT SITE																														TOTAL
	Residential Lots (52') - 144 units			Residential Lots (45') - 138 units			Residential Lots (35') - 46 units			Townhomes (20') - 124 units			Townhomes (25') - 121 units			Residential Apartments - 192 units			Institutional			Environmental Protection	SWM Block 377	0.3m Road Res. Block 379	Road Widening Blocks 380-382	Street ROWs		Park, Open Space, Walkway	Agricultural Block 378	
	Lawns	Rooftops	Driveways	Lawns	Rooftops	Driveways	Lawns	Rooftops	Driveways	Lawns	Rooftops	Driveways	Lawns	Rooftops	Driveways	Lawns	Rooftops	Parking Lot	Lawns	Rooftops	Asphalt					Asphalt	Grass			
Area (m^2)	40000	32000	8000	25672	32090	6418	5103	10206	1701	7704	15408	2568	11924	14905	2981	6026	12052	12052	14385	4426	3320	103960	19710	50	3190	47965	47965	17080	12220	521080
Pervious Area (m^2)	40000	0	0	25672	0	0	5103	0	0	7704	0	0	11924	0	0	6026	0	0	14385	0	0	103960	0	50	3190	0	47965	17080	12220	295279
% Pervious	7.7%	0%	0%	4.9%	0%	0%	1.0%	0%	0%	1.5%	0%	0%	2.3%	0%	0%	1.2%	0%	0%	2.8%	0%	0%	20.0%	0%	0.01%	0.6%	0%	9.2%	3.3%	2.3%	56.7%
Impervious Area (m^2)	0	32000	8000	0	32090	6418	0	10206	1701	0	15408	2568	0	14905	2981	0	12052	12052	0	4426	3320	0	19710	0	0	47965	0	0	0	225802
% Impervious	0%	6.1%	1.5%	0%	6.2%	1.2%	0%	2.0%	0.3%	0%	3.0%	0.5%	0%	2.9%	0.6%	0%	2.3%	2.3%	0%	0.8%	0.6%	0%	3.8%	0%	0%	9.2%	0%	0%	43.3%
	INFILTRATION FACTORS			INFILTRATION FACTORS															INFILTRATION FACTORS											
Topography Infiltration Factor	0.2	0	0	0.2	0	0	0.2	0	0	0.2	0	0	0.2	0	0	0.2	0	0	0.25	0	0	0.15	0.15	0.2	0.2	0.2	0.2	0.2	0.2	
Soil Infiltration Factor	0.2	0	0	0.2	0	0	0.2	0	0	0.2	0	0	0.2	0	0	0.2	0	0	0.2	0	0	0.2	0	0.2	0.2	0	0.2	0.2	0.2	
Land Cover Infiltration Factor	0.15	0	0	0.15	0	0	0.15	0	0	0.15	0	0	0.15	0	0	0.15	0	0	0.15	0	0	0.2	0	0.15	0.15	0	0.15	0.15	0.1	
MECP Infiltration Factor	0.55	0	0	0.55	0	0	0.55	0	0	0.55	0	0	0.55	0	0	0.55	0	0	0.6	0	0	0.55	0.15	0.55	0.55	0.2	0.55	0.55	0.5	
Actual Infiltration Factor	0.55	0	0	0.55	0	0	0.55	0	0	0.55	0	0	0.55	0	0	0.55	0	0	0.6	0	0	0.55	0.05	0	0.55	0	0.55	0.4	0.5	
Runoff Coefficient	0.45	1	1	0.45	1	1	0.45	1	1	0.45	1	1	0.45	1	1	0.45	1	1	0.4	1	1	0.45	0.95	1	0.45	1	0.45	0.6	0.5	
Runoff from Impervious Surfaces*	0	0.8	0.8	0	0.8	0.8	0	0.8	0.8	0	0.8	0.8	0	0.8	0.8	0	0.8	0.8	0	0.8	0.8	0	0.8	0	0	0.8	0	0.8	0		
	INPUTS (PER UNIT AREA)			INPUTS (PER UNIT AREA)															INPUTS (PER UNIT AREA)											
Precipitation (mm/yr)	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855
Run On (mm/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Inputs (mm/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inputs (mm/yr)	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855
	OUTPUTS (PER UNIT AREA)			OUTPUTS (PER UNIT AREA)															OUTPUTS (PER UNIT AREA)											
Precipitation Surplus (mm/yr)	285	684	684	285	684	684	285	684	684	285	684	684	285	684	684	285	684	684	285	684	684	285	684	285	285	684	285	285	285	458
Net Surplus (mm/yr)	285	684	684	285	684	684	285	684	684	285	684	684	285	684	684	285	684	684	285	684	684	285	684	285	285	684	285	285	285	458
Evaportranspiration (mm/yr)	570	171	171	570	171	171	570	171	171	570	171	171	570	171	171	570	171	171	570	171	171	570	171	570	570	171	570	570	570	397
Infiltration (mm/yr)	157	0	0	157	0	0	157	0	0	157	0	0	157	0	0	157	0	0	171	0	0	157	34	0	157	0	157	114	143	89
Rooftop Infiltration (mm/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Infiltration (mm/yr)	157	0	0	157	0	0	157	0	0	157	0	0	157	0	0	157	0	0	171	0	0	157	34	0	157	0	157	114	143	89
Runoff Pervious Areas	128	0	0	128	0	0	128	0	0	128	0	0	128	0	0	128	0	0	114	0	0	128	0	285	128	0	128	171	143	74
Runoff Impervious Areas	0	684	684	0	684	684	0	684	684	0	684	684	0	684	684	0	684	684	0	684	684	0	650	0	0	684	0	0	0	295
Total Runoff (mm/yr)	128	684	684	128	684	684	128	684	684	128	684	684	128	684	684	128	684	684	114	684	684	128	650	285	128	684	128	171	143	369
Total Outputs (mm/yr)	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	INPUTS (VOLUMES)			INPUTS (VOLUMES)															INPUTS (VOLUMES)											
Precipitation (m^3/yr)	34216	27373	6843	21960	27450	5490	4365	8730	1455	6590	13180	2197	10200	12750	2550	5155	10309	10309	12305	3786	2840	88927	16860	43	2729	41029	41029	14610	10453	445732
Run On (m^3/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Inputs (m^3/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inputs (m^3/yr)	34216	27373	6843	21960	27450	5490	4365	8730	1455	6590	13180	2197	10200	12750	2550	5155	10309	10309	12305	3786	2840	88927	16860	43	2729	41029	41029	14610	10453	445732
	OUTPUTS (VOLUMES)			OUTPUTS (VOLUMES)															OUTPUTS (VOLUMES)											
Precipitation Surplus (m^3/yr)	11418	21898	5475	7328	21960	4392	1457	6984	1164	2199	10544	1757	3404	10200	2040	1720	8247	8247	4106	3029	2272	29676	13488	14	911	32823	13692	4876	3488	238811
Net Surplus (m^3/yr)	11418	21898	5475	7328	21960	4392	1457	6984	1164	2199	10544	1757	3404	10200	2040	1720	8247	8247	4106	3029	2272	29676	13488	14	911	32823	13692	4876	3488	238811
Evaportranspiration (m^3/yr)	22798	5475	1369	14631	5490	1098	2908	1746	291	4391	2636	439	6796	2550	510	3434	2062	2062	8198	757	568	59251	3372	28	1818	8206	27337	9735	6965	206921
Infiltration (m^3/yr)	6280	0	0	4031	0	0	801	0	0	1210	0	0	1872	0	0	946	0	0	2464	0	0	16322	674	0	501	0	7531	1950	1744	46326
Rooftop Infiltration (m^3/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Infiltration (m^3/yr)	6280	0	0	4031	0	0	801	0	0	1210	0	0	1872	0	0	946	0	0	2464	0	0	16322	674	0	501	0	7531	1950	1744	46326
Runoff Pervious Areas (m^3/yr)	5138	0	0	3298	0	0	656	0	0	990	0	0	1532	0	0	774	0	0	1642	0	0	13354	0	14	410	0	6161	2925	1744	38639
Runoff Impervious Areas (m^3/yr)	0	21898	5475	0	21960	4392	0	6984	1164	0	10544	1757	0	10200	2040	0	8247	8247	0	3029	2272	0	12814	0	0	32823	0	0	0	153846
Total Runoff (m^3/yr)	5138	21898	5475	3298	21960	4392	656	6984	1164	990	10544	1757	1532	10200	2040	774	8247	8247	1642	3029	2272	13354	12814	14	410	32823	6161	2925	1744	192485
Total Outputs (m^3/yr)	34216	27373	6843	21960	27450	5490	4365	8730	1455	6590	13180	2197	10200	12750	2550	5155	10309	10309	12305	3786	2840	88927	16860	43	2729	41029	41029	14610	10453	445732
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:
*Evaporation from impervious areas was assumed to be 20% of precipitation.
Asphalt has 0% infiltration capability
Residential Lots (52') - Lawns assumed to cover 50 %; Rooftops assumed to cover 40 % and Asphalt Driveways assumed to cover 10 %.
Residential Lots (45') - Lawns assumed to cover 40 %; Rooftops assumed to cover 50 % and Asphalt Driveways assumed to cover 10 %.
Residential Lots (35') - Lawns assumed to cover 30 %; Rooftops assumed to cover 60 % and Asphalt Driveways assumed to cover 10 %.
Townhome Lots (20') - Lawns assumed to cover 30 %; Rooftops assumed to cover 60 % and Asphalt Driveways assumed to cover 10 %.
Townhome Lots (25') - Lawns assumed to cover 40 %; Rooftops assumed to cover 50 % and Asphalt Driveways assumed to cover 10 %.
Residential Apartments - Lawns assumed to cover 20 %; Rooftops assumed to cover 40 % and Asphalt Parking Lot assumed to cover 40 %.
Institutional (i.e. assume a school) - Lawns assumed to cover 65 %; Rooftops assumed to cover 20 % and Asphalt assumed to cover 15 %.
Road ROWs assumed to be 50% asphalt and 50% grass

Appendix A.4
Water Budget Post-Development - With Downspout Disconnection Mitigation Strategies

Catchment Designation	**POST-DEVELOPMENT SITE**																														**TOTAL**
	Residential Lots (52') - 144 units			**Residential Lots (45') - 138 units**			**Residential Lots (35') - 46 units**			**Townhomes (20') - 124 units**			**Townhomes (25') - 121 units**			**Residential Apartments - 192 units**			**Institutional**			**Environmental**	**SWM**	**0.3m Road Res.**	**Road Widening**	**Street ROWs**		**Park, Open Space,**	**Agricultural**	
	Lawns	Rooftops	Driveways	Lawns	Rooftops	Driveways	Lawns	Rooftops	Driveways	Lawns	Rooftops	Driveways	Lawns	Rooftops	Driveways	Lawns	Rooftops	Parking Lot	Lawns	Rooftops	Asphalt	**Protection**	Block 377	Block 379	Blocks 380-382	Asphalt	Grass	**Walkway**	Block 378	
Area (m^2)	40000	32000	8000	25672	32090	6418	5103	10206	1701	7704	15408	2568	11924	14905	2981	6026	12052	12052	14385	4426	3320	103960	19710	50	3190	47965	47965	17080	12220	521080
Pervious Area (m^2)	40000	0	0	25672	0	0	5103	0	0	7704	0	0	11924	0	0	6026	0	0	14385	0	0	103960	0	50	3190	0	47965	17080	12220	295279
% Pervious	7.7%	0%	0%	4.9%	0%	0%	1.0%	0%	0%	1.5%	0%	0%	2.3%	0%	0%	1.2%	0%	0%	2.8%	0%	0%	20.0%	0%	0.01%	0.6%	0%	9.2%	3.3%	2.3%	56.7%
Impervious Area (m^2)	0	32000	8000	0	32090	6418	0	10206	1701	0	15408	2568	0	14905	2981	0	12052	12052	0	4426	3320	0	19710	0	0	47965	0	0	0	225802
% Impervious	0%	6.1%	1.5%	0%	6.2%	1.2%	0%	2.0%	0.3%	0%	3.0%	0.5%	0%	2.9%	0.6%	0%	2.3%	2.3%	0%	0.8%	0.6%	0%	3.8%	0%	0%	9.2%	0%	0%	0%	0%	43.3%
INFILTRATION FACTORS				**INFILTRATION FACTORS**															**INFILTRATION FACTORS**												
Topography Infiltration Factor	0.2	0	0	0.2	0	0	0.2	0	0	0.2	0	0	0.2	0	0	0.2	0	0	0.25	0	0	0.15	0.15	0.2	0.2	0.2	0.2	0.2	0.2	
Soil Infiltration Factor	0.2	0	0	0.2	0	0	0.2	0	0	0.2	0	0	0.2	0	0	0.2	0	0	0.2	0	0	0.2	0	0.2	0.2	0	0.2	0.2	0.2	
Land Cover Infiltration Factor	0.15	0	0	0.15	0	0	0.15	0	0	0.15	0	0	0.15	0	0	0.15	0	0	0.15	0	0	0.2	0	0.15	0.15	0	0.15	0.15	0.1	
MECP Infiltration Factor	0.55	0	0	0.55	0	0	0.55	0	0	0.55	0	0	0.55	0	0	0.55	0	0	0.6	0	0	0.55	0.15	0.55	0.55	0.2	0.55	0.55	0.5	
Actual Infiltration Factor	0.55	0	0	0.55	0	0	0.55	0	0	0.55	0	0	0.55	0	0	0.55	0	0	0.6	0	0	0.55	0.05	0	0.55	0	0.55	0.4	0.5	
Runoff Coefficient	0.45	1	1	0.45	1	1	0.45	1	1	0.45	1	1	0.45	1	1	0.45	1	1	0.4	1	1	0.45	0.95	1	0.45	1	0.45	0.6	0.5	
Runoff from Impervious Surfaces*	0	0.8	0.8	0	0.8	0.8	0	0.8	0.8	0	0.8	0.8	0	0.8	0.8	0	0.8	0.8	0	0.8	0.8	0	0.8	0	0	0.8	0	0.8	0		
INPUTS (PER UNIT AREA)				**INPUTS (PER UNIT AREA)**															**INPUTS (PER UNIT AREA)**												
Precipitation (mm/yr)	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855
Run On (mm/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Inputs (mm/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inputs (mm/yr)	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855
OUTPUTS (PER UNIT AREA)				**OUTPUTS (PER UNIT AREA)**															**OUTPUTS (PER UNIT AREA)**												
Precipitation Surplus (mm/yr)	285	684	684	285	684	684	285	684	684	285	684	684	285	684	684	285	684	684	285	684	684	285	684	285	285	684	285	285	285	458
Net Surplus (mm/yr)	285	684	684	285	684	684	285	684	684	285	684	684	285	684	684	285	684	684	285	684	684	285	684	285	285	684	285	285	285	458
Evaportranspiration (mm/yr)	570	171	171	570	171	171	570	171	171	570	171	171	570	171	171	570	171	171	570	171	171	570	171	570	570	171	570	570	570	397
Infiltration (mm/yr)	157	0	0	157	0	0	157	0	0	157	0	0	157	0	0	157	0	0	171	0	0	157	34	0	157	0	157	114	143	89
%Rooftop Required to Meet Pre-Development	--	37%	--	--	37%	--	--	37%	--	--	37%	--	--	37%	--	--	37%	--	--	37%	--	--	--	--	--	--	--	--	--	--
Rooftop Infiltration (mm/yr)	0	250	0	0	250	0	0	250	0	0	250	0	0	250	0	0	250	0	0	250	0	0	0	0	0	0	0	0	0	58
Total Infiltration (mm/yr)	157	250	0	157	250	0	157	250	0	157	250	0	157	250	0	157	250	0	171	250	0	157	34	0	157	0	157	114	143	147
Runoff Pervious Areas	128	0	0	128	0	0	128	0	0	128	0	0	128	0	0	128	0	0	114	0	0	128	0	285	128	0	128	171	143	74
Runoff Impervious Areas	0	434	684	0	434	684	0	434	684	0	434	684	0	434	684	0	434	684	0	434	684	0	650	0	0	684	0	0	0	237
Total Runoff (mm/yr)	128	434	684	128	434	684	128	434	684	128	434	684	128	434	684	128	434	684	114	434	684	128	650	285	128	684	128	171	143	311
Total Outputs (mm/yr)	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855	855
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INPUTS (VOLUMES)				**INPUTS (VOLUMES)**															**INPUTS (VOLUMES)**												
Precipitation (m^3/yr)	34216	27373	6843	21960	27450	5490	4365	8730	1455	6590	13180	2197	10200	12750	2550	5155	10309	10309	12305	3786	2840	88927	16860	43	2729	41029	41029	14610	10453	445732
Run On (m^3/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Inputs (m^3/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inputs (m^3/yr)	34216	27373	6843	21960	27450	5490	4365	8730	1455	6590	13180	2197	10200	12750	2550	5155	10309	10309	12305	3786	2840	88927	16860	43	2729	41029	41029	14610	10453	445732
OUTPUTS (VOLUMES)				**OUTPUTS (VOLUMES)**															**OUTPUTS (VOLUMES)**												
Precipitation Surplus (m^3/yr)	11418	21898	5475	7328	21960	4392	1457	6984	1164	2199	10544	1757	3404	10200	2040	1720	8247	8247	4106	3029	2272	29676	13488	14	911	32823	13692	4876	3488	238811
Net Surplus (m^3/yr)	11418	21898	5475	7328	21960	4392	1457	6984	1164	2199	10544	1757	3404	10200	2040	1720	8247	8247	4106	3029	2272	29676	13488	14	911	32823	13692	4876	3488	238811
Evaportranspiration (m^3/yr)	22798	5475	1369	14631	5490	1098	2908	1746	291	4391	2636	439	6796	2550	510	3434	2062	2062	8198	757	568	59251	3372	28	1818	8206	27337	9735	6965	206921
Infiltration (m^3/yr)	6280	0	0	4031	0	0	801	0	0	1210	0	0	1872	0	0	946	0	0	2464	0	0	16322	674	0	501	0	7531	1950	1744	46326
Rooftop Infiltration (m^3/yr)	0	8005	0	0	8027	0	0	2553	0	0	3854	0	0	3728	0	0	3015	0	0	1107	0	0	0	0	0	0	0	0	0	30289
Total Infiltration (m^3/yr)	6280	8005	0	4031	8027	0	801	2553	0	1210	3854	0	1872	3728	0	946	3015	0	2464	1107	0	16322	674	0	501	0	7531	1950	1744	76615
Runoff Pervious Areas (m^3/yr)	5138	0	0	3298	0	0	656	0	0	990	0	0	1532	0	0	774	0	0	1642	0	0	13354	0	14	410	0	6161	2925	1744	38639
Runoff Impervious Areas (m^3/yr)	0	13894	5475	0	13933	4392	0	4431	1164	0	6690	1757	0	6471	2040	0	5233	8247	0	1922	2272	0	12814	0	0	32823	0	0	0	123557
Total Runoff (m^3/yr)	5138	13894	5475	3298	13933	4392	656	4431	1164	990	6690	1757	1532	6471	2040	774	5233	8247	1642	1922	2272	13354	12814	14	410	32823	6161	2925	1744	162196
Total Outputs (m^3/yr)	34216	27373	6843	21960	27450	5490	4365	8730	1455	6590	13180	2197	10200	12750	2550	5155	10309	10309	12305	3786	2840	88927	16860	43	2729	41029	41029	14610	10453	445732
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:
*Evaporation from impervious areas was assumed to be 20% of precipitation.
Asphalt has 0% infiltration capability
Residential Lots (52') - Lawns assumed to cover 50 %; Rooftops assumed to cover 40 % and Asphalt Driveways assumed to cover 10 %.
Residential Lots (45') - Lawns assumed to cover 40 %; Rooftops assumed to cover 50 % and Asphalt Driveways assumed to cover 10 %.
Residential Lots (35') - Lawns assumed to cover 30 %; Rooftops assumed to cover 60 % and Asphalt Driveways assumed to cover 10 %.
Townhome Lots (20') - Lawns assumed to cover 30 %; Rooftops assumed to cover 60 % and Asphalt Driveways assumed to cover 10 %.
Townhome Lots (25') - Lawns assumed to cover 40 %; Rooftops assumed to cover 50 % and Asphalt Driveways assumed to cover 10 %.
Residential Apartments - Lawns assumed to cover 20 %; Rooftops assumed to cover 40 % and Asphalt Parking Lot assumed to cover 40 %.
Institutional (i.e. assume a school) - Lawns assumed to cover 65 %; Rooftops assumed to cover 20 % and Asphalt assumed to cover 15 %.
Road ROWs assumed to be 50% asphalt and 50% grass

Appendix A.5
Water Budget Summary

PARAMETER	SITE				
	Pre-Development	***Post-Development No Mitigation***	***Difference Pre- vs. Post-***	***Post-Development With Mitigation***	***Difference Pre- vs. Post-***
INPUTS (VOLUMES)					
Precipitation (m^3/yr)	445732	445732	0%	445732	0%
Run On (m^3/yr)	0	0	0%	0	0%
Other Inputs (m^3/yr)	0	0	0%	0	0%
Total Inputs (m^3/yr)	445732	445732	0%	445732	0%
OUTPUTS (VOLUMES)					
Precipitation Surplus (m^3/yr)	150106	238811	59%	238811	59%
Net Surplus (m^3/yr)	150106	238811	59%	238811	59%
Evapotranspiration (m^3/yr)	295626	206921	-30%	206921	-30%
Infiltration (m^3/yr)	76512	46326	-39%	46326	-39%
% Rooftop Runoff to balance infiltration	--	--	--	37%	--
Rooftop Infiltration (m^3/yr)	104	0	0%	30289	--
Total Infiltration (m^3/yr)	76615	46326	-40%	76615	0%
Runoff Pervious Areas (m^3/yr)	73180	38639	-47%	38639	-47%
Runoff Impervious Areas (m^3/yr)	311	153846	--	123557	--
Total Runoff (m^3/yr)	73491	192485	162%	162196	121%
Total Outputs (m^3/yr)	445732	445732	0%	445732	0%

To maintain pre-development infiltration values; 37% of post-development rooftop runoff needs to be infiltrated.