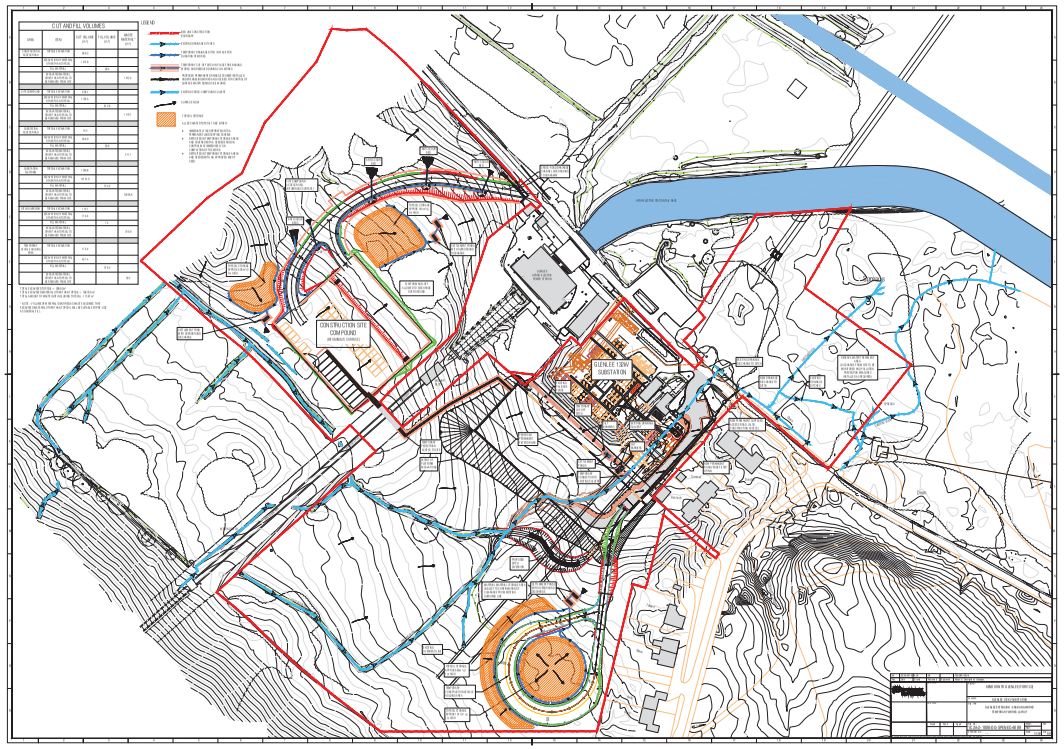
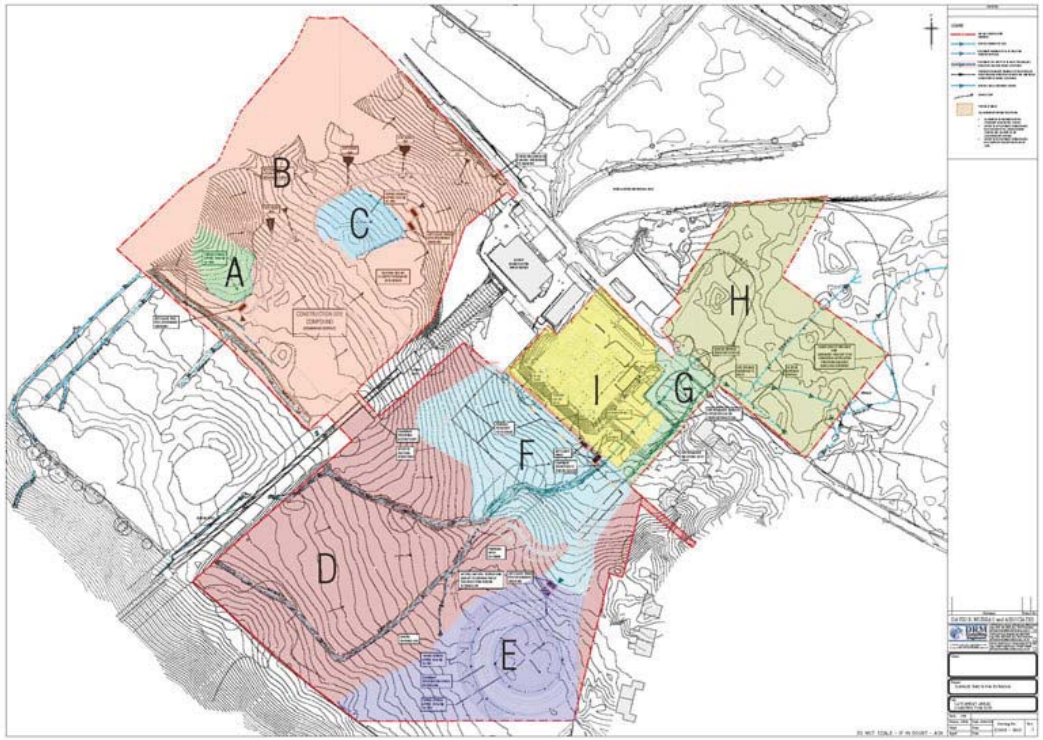
APPENDIX B
CATCHMENT AREAS AT THE CONSTRUCTION SITE



APPENDIX C
RUNOFF MANAGEMENT PLAN CALCULATIONS



Ref: | Calculations

Information Required

Glenlee sConstruction Site

	Greenfield Area			Exposed Area			
catchment Area	sq m	ha	sq.km	sq m	ha	sq km	% Exposed
-	-	#VALUE!	#VALUE!	0	0.0000	0.0000	#VALUE!
A	975	0.0975	0.0010	520	0.0520	0.0005	53.0%
B	23888	2.3888	0.0239	6878	0.6878	0.0069	29.0%
C	1234	0.1234	0.0012	1236	0.1236	0.0012	100.0%
D	18600	1.8600	0.0186	0	0.0000	0.0000	0.0%
E	6928	0.6928	0.0069	4075	0.4075	0.0041	59.0%
F	7230	0.7230	0.0072	6383	0.6383	0.0064	88.0%
G	1462	0.1462	0.0015	650	0.0650	0.0007	44.0%
H	9331	0.9331	0.0093	0	0.0000	0.0000	0.0%
I	4774	0.4774	0.0048	0	0.0000	0.0000	0.0%

1.1 **Greenfield Runoff rates**

Qbar *Mean annual flood (cu m/s)*
AREA *Area of Catchment (sq km)*
SAAR 1584 *Standard average annual Rainfall for the period 1941-1971 (mm)*
SPR 0.53 *Standar Percentage Runoff coefficient for the soil category from FSR maps*

FSR-1 0.87
FSR-5 1.11
FSR-10 1.42
FSR-30 1.95

Note: Where the cathment area is less than 50 ha, the formula is applied for 50 ha and the result factored based on the ratio of the actual site area to the applied area (50ha)

Catchment Area	Area (ha)	Qbar (L/s)	1 in 1-year Runoff Rate (L/s)	1 in 5-year Runoff Rate (L/s)	1 in 10-year Runoff Rate (L/s)	1 in 30-year Runoff Rate (L/s)
A	0.10	1.59	1.38	1.76	2.26	3.10
B	2.39	38.91	33.86	43.19	55.26	75.88
C	0.12	2.01	1.75	2.23	2.85	3.92
D	1.86	30.30	26.36	33.63	43.03	59.08
E	0.69	11.29	9.82	12.53	16.03	22.01
F	0.72	11.78	10.25	13.07	16.72	22.97
G	0.15	2.38	2.07	2.64	3.38	4.64
H	0.93	15.20	13.22	16.87	21.58	29.64
I	0.48	7.78	6.77	8.63	11.04	15.17

1.2 **Greenfield Runooff Volumes**

$VOL = SPR * 10 * AREA * RD$

VOL *Runoff volume for the 6-hour duration event (cu.m)*
SPR 0.53 *standar Percentage Runoff for the soil category from FSR maps*
AREA *Area of catchment (ha)*
RD-1yr 29.73 *Rainfall depth for6-hr event (mm)**
RD-5yr 42.01
RD-10yr 48.63
RD-30yr 60.03

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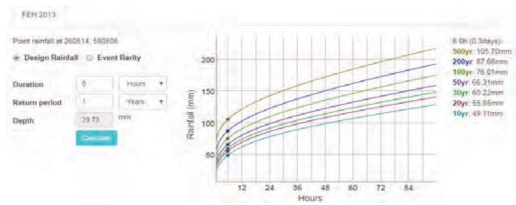
Ref: | Calculations

** Rainfall depths were sourced from the Flood Estimation Handbook Web Service (https://fehweb.ceh.ac.uk/GB/map)*

Catchment Area	Area (ha)	1-year 6-hr Runoff volume (cu.m)	5-year 6-hr Runoff volume (cu.m)	10-year 6-hr Runoff volume (cu.m)	30-year 6-hr Runoff volume (cu.m)
A	0.10	15.36	21.71	25.13	31.02
B	2.39	376.40	531.87	615.69	760.02
C	0.12	19.44	27.48	31.80	39.26
D	1.86	293.08	414.13	479.39	591.78
E	0.69	109.16	154.25	178.56	220.42
F	0.72	113.92	160.98	186.35	230.03
G	0.15	23.04	32.55	37.68	46.51
H	0.93	147.03	207.76	240.50	296.87
I	0.48	75.22	106.29	123.04	151.89



1.3 **Construction Runoff Rates**

$Q = 2.78 * C * i * A$

Q *Peak Runoff rate (l/s)*
A *Area-Weighted runoff coefficient for the catchment area, the proportion of rainfall that occurs as runoff (Ha)*

C
0.70 *Runoff coefficient exposed areas*
0.53 *Runoff coefficient for undisturbed areas (SPR)*

i *The rainfall intensity in mm/hr for the event return period and for a duration euql to the time of concentration of the catchment area being drained**
24.92 *i for 1-year 0.25hr (mm/hr)*
44.24 *i for 5-year 0.25hr (mm/hr)*
55.28 *i for 10-year 0.25hr (mm/hr)*
74.52 *i for 30-year 0.25hr (mm/hr)*

** Rainfall intensities were sourced from the Flood Estimation Handbook Web Service (https://fehweb.ceh.ac.uk/GB/map)*

Catchment Area	Area (ha)	Proportion of Ground Exposed (%)	1 in 1-year Runoff Rate (L/s)	1 in 5-year Runoff Rate (L/s)	1 in 10-year Runoff Rate (L/s)	1 in 30-year Runoff Rate (L/s)
A	0.10	53.00%	4.19	7.44	9.29	12.53
B	2.39	29.00%	95.87	170.19	212.67	286.68
C	0.12	100.00%	5.98	10.62	13.27	17.89
D	1.86	0.00%	68.29	121.24	151.50	204.22
E	0.69	59.00%	30.25	53.71	67.11	90.46
F	0.72	88.00%	34.04	60.43	75.51	101.79
G	0.15	44.00%	6.13	10.87	13.59	18.32
H	0.93	0.00%	34.26	60.82	76.00	102.45
I	0.48	0.00%	17.53	31.12	38.88	52.42

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Calculation:	Construction Runoff Management Plan	Calc by: LG	Date: LG 05.07.19

Ref: Calculations

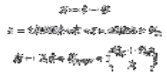
1.4 Construction Runoff Volumes

VOL_{XTRA}		
RD		*Rainfall depth for6-hr event (mm)**
RD-1yr	29.73	*mm*
RD-5yr	42.01	*mm*
RD-10yr	48.63	*mm*
RD-30yr	60.03	*mm*
AREA		*Catchment Area (mm)*
PIMP		*Exposed area as a percentage of the total area (%)*
C	0.70	*Runoff coefficient of exposed areas*
SPR	0.53	*Standar Percentage Runoff coefficient for the soil category from FSR maps*

** Rainfall depths were sourced from the Flood Estimation Handbook Web Service (https://fehweb.ceh.ac.uk/GB/map)*

Catchment Area	Area (ha)	Proportion of Ground Exposed PIMP (%)	1 in 1-year Runoff Rate (cu.m)	1 in 5-year Runoff Rate (cu.m)	1 in 10-year Runoff Rate (cu.m)	1 in 30-year Runoff Rate (cu.m)
A	0.10	53.00	17.97	25.40	29.40	36.29
B	2.39	29.00	411.41	581.35	672.96	830.71
C	0.12	100.00	25.68	36.29	42.01	51.85
D	1.86	0.00	293.08	414.13	479.39	591.78
E	0.69	59.00	129.82	183.45	212.35	262.13
F	0.72	88.00	146.08	206.42	238.94	294.96
G	0.15	44.00	26.29	37.15	43.00	53.08
H	0.93	0.00	147.03	207.76	240.50	296.87
I	0.48	0.00	75.22	106.29	123.04	151.89

2.1 Attenuation Storage Volumes



S		*Required attenuation storage*
I		*Inflow draining to the pond (cu.m)*
O		*Outflow volume being released from the pond (cu.m)*
C		*Area-Weighted runoff coefficient for the catchment areas draining to the pond*
C	0.7	*Runoff coefficient of exposed areas*
SPR	0.53	*Standar Percentage Runoff coefficient for the soil category from FSR maps*
i		*Rainfall intensity for the critical storm duration for the design return period event (mm/hr)*
AREA		*Area draining to the pond (ha)*
T_D		*Critical storm duration (The storm duration that provides the largest storage volume) (hr)*
Qout		*Allowable peak outflow rate (1 in 1-year greenfield runoff rate from the applicable catchment area) (L/s)*
T_c	0.25	*Time of concentration of the pond catchment area (hrs)*

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Ref: Calculations

	Pond Location	Contributing Catchment Areas	Drainage Area (ha)	Proportion of ground exposed (%)	Area Weighted Runoff Coefficient (C)	1-5yr i - T_D (mm/hr - hr)	1-10yr i - T_D (mm/hr - hr)	1-30yr i-T_D (mm/hr - hr)	Required Attenuation Sotorage Volume (cu.m)		
									1 in 5-year (cu.m)	1 in 10-year (cu.m)	1 in 30-year (cu.m)
	A	A	0.10	0.53	0.62	21 - 1	26 - 1	35 - 1	9.52	12.65	18.17
	A	A	0.10	0.53	0.62	14 - 2	17 - 2	22 - 2	11.00	14.44	20.56
	A	A	0.10	0.53	0.62	11 - 3	13 - 3	16 - 3	11.37	15.01	21.43
	A	A	0.10	0.53	0.62	9 - 4	11 - 4	13 - 4	11.18	14.97	21.59
	A	A	0.10	0.53	0.62	8 - 5	9 - 5	11 - 5	10.65	14.56	21.33
	A	A	0.10	0.53	0.62	7 - 6	8 - 6	10 - 6	9.87	13.88	20.78
	A	A	0.10	0.53	0.62	6 - 7	7 - 7	9 - 7	8.93	13.02	20.03
	A	A	0.10	0.53	0.62	6 - 8	7 - 8	8 - 8	7.85	12.00	19.11
	A	A	0.10	0.53	0.62	5 - 9	6 - 9	8 - 9	6.64	10.87	18.07
	A	A	0.10	0.53	0.62	5 - 10	6 - 10	7 - 10	5.35	9.63	16.91
A	A	A	0.10	53%	0.62	11 - 3	13 - 3	13 - 4	11.37	15.01	21.59
	C	C	0.12	100%	0.70	21 - 1	26 - 1	35 - 1	14.11	18.58	26.47
	C	C	0.12	100%	0.70	14 - 2	17 - 2	22 - 2	16.63	21.55	30.29
	C	C	0.12	100%	0.70	11 - 3	13 - 3	16 - 3	17.56	22.76	31.93
	C	C	0.12	100%	0.70	9 - 4	11 - 4	13 - 4	17.70	23.11	32.57
	C	C	0.12	100%	0.70	8 - 5	9 - 5	11 - 5	17.34	22.93	32.60
	C	C	0.12	100%	0.70	7 - 6	8 - 6	10 - 6	16.64	22.37	32.22
	C	C	0.12	100%	0.70	6 - 7	7 - 7	9 - 7	15.70	21.54	31.55
	C	C	0.12	100%	0.70	6 - 8	7 - 8	8 - 8	14.56	20.50	30.64
	C	C	0.12	100%	0.70	5 - 9	6 - 9	8 - 9	13.24	19.28	29.56
	C	C	0.12	100%	0.70	5 - 10	6 - 10	7 - 10	11.80	17.92	28.32
C	C	C	0.12	100%	0.70	9 - 4	11 - 4	11 - 5	17.70	23.11	32.60
	E	E	0.69	59%	0.63	21 - 1	26 - 1	35 - 1	69.11	91.75	131.61
	E	E	0.69	59%	0.63	14 - 2	17 - 2	22 - 2	80.11	104.98	149.16
	E	E	0.69	59%	0.63	11 - 3	13 - 3	16 - 3	83.06	109.33	155.70
	E	E	0.69	59%	0.63	9 - 4	11 - 4	13 - 4	82.00	109.35	157.16
	E	E	0.69	59%	0.63	8 - 5	9 - 5	11 - 5	78.44	106.67	155.57
	E	E	0.69	59%	0.63	7 - 6	8 - 6	10 - 6	73.13	102.06	151.88
	E	E	0.69	59%	0.63	6 - 7	7 - 7	9 - 7	66.60	96.14	146.75
	E	E	0.69	59%	0.63	6 - 8	7 - 8	8 - 8	59.07	89.09	140.40
	E	E	0.69	59%	0.63	5 - 9	6 - 9	8 - 9	50.66	81.16	133.17
	E	E	0.69	59%	0.63	5 - 10	6 - 10	7 - 10	41.59	72.53	125.11
E	E	E	0.69	59%	0.63	11 - 3	11 - 4	13 - 4	83.06	109.35	157.16
	F	F	0.72	88%	0.68	21 - 1	26 - 1	35 - 1	79.57	105.04	149.89
	F	F	0.72	88%	0.68	14 - 2	17 - 2	22 - 2	93.39	121.37	171.08
	F	F	0.72	88%	0.68	11 - 3	13 - 3	16 - 3	98.15	127.71	179.88
	F	F	0.72	88%	0.68	9 - 4	11 - 4	13 - 4	98.39	129.18	182.97
	F	F	0.72	88%	0.68	8 - 5	9 - 5	11 - 5	95.83	127.60	182.63
	F	F	0.72	88%	0.68	7 - 6	8 - 6	10 - 6	91.31	123.86	179.92
	F	F	0.72	88%	0.68	6 - 7	7 - 7	9 - 7	85.40	118.64	175.59
	F	F	0.72	88%	0.68	6 - 8	7 - 8	8 - 8	78.37	112.15	169.88
	F	F	0.72	88%	0.68	5 - 9	6 - 9	8 - 9	70.35	104.67	163.19
	F	F	0.72	88%	0.68	5 - 10	6 - 10	7 - 10	61.59	96.40	155.56
F	F	F	0.72	88%	0.68	9 - 4	11 - 4	13 - 4	98.39	129.18	182.97

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Ref: Calculations

2.2 Treatment Storage Volume

$$V_T = 9 * D\left[\frac{SPR}{2} + PIMP * \left(1 - \frac{SPR}{2}\right)\right]$$

V_T		*Water quality Treatment volume (cu.m/ha)*
SPR	0.53	*Standar Percentage Runoff coefficient for the soil category found from FSR maps*
PIMP		*Fraction of the area that is impermeable, taken as the fraction of the area that is exposed for this assessment*
D	20.87	*M5-60 rainfall depth in mm (1 in 5-yr return period 60-min duration rainfall depth)*

Pond Location	Contributing Catchment Areas	Drainage Area (ha)	Proportion of ground exposed (%)	Treatment Storage Volume (cu.m/ha)	Treatment Storage Volume (cu.m)
A	A	0.10	53%	122.94	11.99
C	C	0.12	100%	187.83	23.18
E	E	0.69	59%	131.23	90.91
F	F	0.72	88%	171.26	123.82

2.3 Design Particle size and Settling Velocity

$$v_s = \frac{g * (\rho_s - \rho) * d^2}{18 * \mu}$$

v_s		
g	9.81	*Acceleration due gravity (m/sq.s)*
ρ_s	2650	*Particle Density (kg/cu.m)*
ρ	999.7	*Density of water at 10°C (kg/cu.m)*
d	0.000005	*Particle size (m)*
μ	0.001306	*Absolute Viscosity of water at 10°C*

v_s	1.7217E-05

2.5 Required Detention time

$$T_D = \frac{D}{3600 * v_s}$$

T_D		*Detention time (hr)*
D		*Detention Storage depth (m)*
V_s	1.72E-05	*Settling velocity (m/s)*

Detention Storage Depth (m)	T_D (hr)
1	16.13
1.5	24.20
2	32.27
0	0.00
0	0.00

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3 Summary of required Pond Design Characteristics

Pond Location	Contributing Catchment Areas	Drainage Area (ha)	Required treatment storage volume (cu.m)	Required attenuation storage Volume (cu.m)			Required total storage volume (cu.m)		
				1 in 5-yr	1 in 10-yr	1 in 30-yr	1 in 5-yr	1 in 10-yr	1 in 30-yr
A	A	0.10	11.99	11.37	15.01	21.59	23.36	26.99	33.58
C	C	0.12	23.18	17.70	23.11	32.60	40.88	46.29	55.78
E	E	0.69	90.91	83.06	109.35	157.16	173.98	200.27	248.08
F	F	0.72	123.82	98.39	129.18	182.97	222.22	253.00	306.80

Pond Location	1 in 5-year Pond Surafce area			1 in 10-year Pond Surafce area			1 in 30-year Pond Surafce area		
	1 m Depth	1.5 m Depth	2 m Depth	1 m Depth	1.5 m Depth	2 m Depth	1 m Depth	1.5 m Depth	2 m Depth
A	23.36	15.57	11.68	26.99	18.00	13.50	33.58	22.38	16.79
C	40.88	27.25	20.44	46.29	30.86	23.14	55.78	37.19	27.89
E	173.98	115.98	86.99	200.27	133.51	100.13	248.08	165.39	124.04
F	222.22	148.15	111.11	253.00	168.67	126.50	306.80	204.53	153.40