Hastings District Council

Whakatu Arterial Project

Stormwater Management Plan

June 2014

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1. Introduction

1.1 Purpose of this report

The purpose of this report is to describe the management approach for stormwater from the proposed Whakatu Arterial Link (WAL) road between State Highway 2 (SH2) North and Pakowhai Road, Hastings.

This Stormwater Management Plan should be read in conjunction with the Erosion and Sediment Control Plan (GHD 2014h) which describes the management approach for site drainage during construction and earth disturbance activities.

1.2 The Whakatu Arterial Project

The WAL will provide an efficient heavy vehicle route for the movement of freight between the Whakatu industrial area and the Port of Napier. The new road will run between SH2 North and Pakowhai Road and will provide a direct linkage to the Whakatu industrial area at Whakatu and Anderson Roads.

The WAL is a new two lane carriageway of approximately 3.5 kms in length with an average construction footprint width of approximately 36m and a maximum width of 80 metres. It generally follows the Karamu Stream for much of its length. The land traversed is predominately flat horticultural, agricultural and industrial land.

1.3 Assumptions and sources of data

Stormwater conceptual design has been developed from contours derived from a specific site topography survey and from Hawke's Bay Regional Council LIDAR data. Other sources of data used are NIWA's High Intensity Rainfall Design System ("HIRDS") and Landcare Research S-map geological data. The general stormwater management approach follows the guidance given in Hawke's Bay Regional Council's Waterway Design Guidelines – Stormwater Management.

2. Stormwater management

2.1 Stormwater management objectives and strategy

The objectives of this stormwater management plan are to;

- Provide for the efficient conveyance of stormwater from the WAL, to ensure health and safety of road users and to protect surrounding properties;
- Avoid or minimise any potential effects on water quality and aquatic ecosystems from stormwater discharges from the WAL following the completion of construction activities;
- Protect and enhance the natural character and amenity values of the Karamu Stream; and
- Minimise any potential adverse effects from flooding and erosion of land and/or water courses from stormwater discharges from the WAL.

The WAL stormwater management strategy allows for a risk based approach that balances capital and maintenance costs of the stormwater system with effectively meeting the stormwater management objectives.

To achieve this approach, the stormwater system incorporates the following elements:

- A network of swales designed to pass the 10% Annual Exceedance Probability (AEP) event;
- A piped network for efficient conveyance of stormwater, designed to pass the 10% Annual Exceedance Probability (AEP) event;
- Weirs and scruffy domes to improve treatment;
- WaStop (or similar) valves to provide reverse flow protection to the swales and pipework; and
- A design that avoids collecting existing surface flows as much as possible to minimise volumes conveyed by the stormwater system and reduces the potential for increased peaking events.

System design detail is provided in Section 2.3 below. The 10% AEP was selected for both the swale and piped network to minimise any increase in peak stormwater flow rates. In events less than the 10% AEP, stormwater will be conducted in the normal way to the outlets. However in larger events water will be stored in the swale system that has spare capacity due to the topography and the layout of the network. Additional to this any extra water will be stored on the ground surface (or will infiltrate the ground) adjacent to the swale but will drain to the swale once the peak intensity rainfall event eases. This physical mechanism will minimise the effect of drainage water entering earlier than is normally the case with the current drainage system.

There is no formal guidance for selection of a particular AEP for a drainage system on the Heretaunga Plains and as the WAL is well above the surrounding land there is no likelihood of pavement flooding. Therefore the 10% AEP was selected to minimise peak discharges, it is also considered a common industry standard for rural road drainage.

2.2 Catchment characteristics

The catchment area for this project is predominately zoned plains and a smaller section on the northern side of the Karamu Stream is zoned industrial 1. The plains zoned land is almost all used for horticultural purposes and is a mixture orchards and cropping land. The catchment area is very flat with typical grades of 0.3 %.

The soils on the project site are predominately sandy loams, overlaying loams with a low clay content. These soils are medium to high permeability.

The rainfall intensities derived from HIRDS are shown in Table 1. A 10 minute time of concentration has been estimated for the swales. The following runoff coefficients were used in the calculations;

- 0.3 for grass or horticultural covered areas
- 0.9 for sealed or compacted aggregate areas

No allowance at this stage has been made for climate change effects of the rainfall intensity as we currently do not have a suitable value for long term temperature rise, however in the detailed design the sensitivity of the design to a slightly higher rainfall will be examined.

Table 1 Rainfall intensity

Rainfall event	WAL 10min storm duration (rainfall depth – mm)	WAL 20 min storm duration (rainfall depth – mm)	WAL 30 min storm duration (rainfall depth – mm)	WAL 60 min storm duration (rainfall depth – mm)
5% AEP	12.5	18.4	23.0	33.6
10% AEP	10.2	14.9	18.7	27.4

2.3 Site specific stormwater design – permanent works

The concept layout for the permanent stormwater system is shown in Appendix A.

124 catchments have been identified on the site and these are identified in the “catchment and swales” spreadsheet attached in Appendix B.

The system consists of:

- 34 swales of various lengths;
- A piped network;
- Seven discharge outlets along the Karamu Stream; and
- Eight discharge outlets into existing road side drains.

The swale network is located parallel to the WAL along its complete length as well as some short new sections of roadway at Whakatu, Pakowhai and SH2 North. Typically it is a 2.2m top width swale of 0.2m depth and 0.6m bottom width. The sides are a 1 in 4 mowable grassed slope. Where a lack of capacity requires a bigger swale, it is typically deepened to achieve a larger cross- sectional area. Figure 1 shows a typical cross section of the swale.

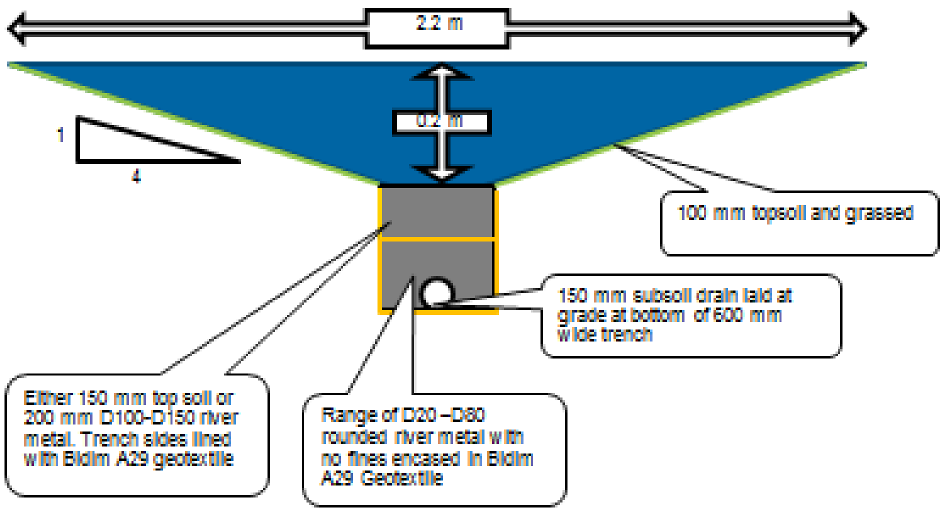


Figure 1 – Swale Design

Drainage water can enter the piped network from the swales in two different ways: for low flows, the water infiltrates the swale through the base, enters a subsurface drain and is conducted directly to the piped network; and for higher flows, the excess water flows into a scruffy dome cover sump which is connected to the piped network.

The seven outlet points to the Karamu Stream will be velocity controlled and will have active design measures to reduce scour at the stream interface. WaStop (or similar) valves will be fitted to provide reverse flow protection to the swales and pipework from potential high levels in the Karamu Stream. Also prior to discharge the stormwater will pass through areas planted with suitable native tree and shrub species with the objective to enhance riparian cover and to offer an improvement in the habitat for both indigenous and desirable introduced species.

In terms of the new penetrations through the existing stopbank for the seven outlet points, the detailed design and work specifications will be submitted to the HBRC engineering manager for his review, no work will start on the penetration work until the HBRC engineering manager has been informed at least 48 hours ahead of any scheduled work. Detailed design has not been completed for the penetrations, so there has not been a decision on the type of penetration technique, however we understand that HBRC's preference is an open cut technique. The penetrations will comply with HBRC's requirements as to specification of fill material and compact standards and the extent of the excavation will be such as needed to adequately tie into the existing stopbank structure. Restoration will be as outlined in the HBRC's "Specification and Conditions for Work Affecting Stopbanks".

At the eight outlet points to the existing road side drainage network, small weirs will be installed. Low flows will be retained in the swale, and will exit through the subsurface drain. High flow will be allowed to decant over the weir into the existing road side drainage network.

2.4 Environmental Performance Standards

The ongoing operation of the WAL drainage system will comply with the following general performance standards;

- The concentration of suspended solids in any discharge from the site shall not exceed 100 grams per cubic metre of water.
- The concentration of suspended solids in the Karamu Stream shall not increase by more than 10% as a result of any discharges from site. The point at which compliance with the standard is measured will not be more than 60m downstream from the point of discharge.
- All exposed areas of soil shall be stabilised against erosion by vegetation cover or other methods as soon as practical.
- There shall be no adverse increase in water levels downstream of the stormwater discharge points, eg additional flooding of downstream properties.
- The stormwater discharge form WAL shall not contain concentrations of hazardous substances that may cause significant adverse effects on aquatic life.

2.4.1 Effect of Stormwater Runoff Volumes on the Karamu Stream

As shown in Appendix A, there will be seven discharge points into the Karamu Stream. Of these, four will be collecting runoff from catchments that currently do not discharge into the stream. These are discharges 4 to 7. For the remaining discharge points only a minor increase in flow will be observed resulting from the introduction of the paved areas and the associated increase in the runoff coefficient.

Table 2 below summaries the additional flow conveyed into the Karamu Stream in a 10% AEP, 10 minute storm.

Table 2 Discharge volumes before and after WAL (peak storm – 10% AEP 10min)

Discharge Point	Q Current (m³/s)	Q After WAL (m³/s)	Q Additional (m³/s)
1	0.20	0.20	0.00
2	0.52	0.52	0.00
3	0.54	0.54	0.00
4	0.00	0.57	0.57
5	0.00	0.03	0.03
6	0.00	0.15	0.15
7	0.00	1.61	1.61
TOTAL	**1.25**	**3.62**	**2.36**

It should be noted that a 10 minute duration event will result in the peak runoff from the WAL, however this is unlikely to coincide with peak flows (flooding) in the Karamu Stream. The Karamu Stream has a large catchment and requires a long duration rain event for peak flows / flooding to occur.

The time of concentration for the Karamu Stream is likely to be in the order of more than one day. The additional flow conveyed from the WAL to the Karamu Stream in a 10% AEP, one day rain event is summarised in Table 3 below.

Table 3 Discharge volumes before and after WAL (longer storm –10% AEP 1 day)

Discharge Point	Q Current (m³/s)	Q After WAL (m³/s)	Q Additional (m³/s)
1	0.016	0.016	0.000
2	0.040	0.040	0.000
3	0.041	0.041	0.000
4	0.000	0.044	0.044
5	0.000	0.003	0.003
6	0.000	0.012	0.012
7	0.000	0.124	0.124
TOTAL	**0.097**	**0.272**	**0.182**

The above table shows that the additional flows for a 10% AEP, 1 day rain event is very minor when compared to the capacity of the Karamu Stream i.e. the peak flow capacity of the Karamu Stream is likely to be in the order of more than 100 m³/s, whereas the peak additional runoff for the WAL is just 0.182 m³/s.

In extreme events (Karamu Stream in the vicinity of the WAL) stormwater runoff from most of the WAL will not be able to discharge to the Karamu stream as the outlets through the stopbank will have WaStop or similar check valves installed. For these to open and allow flow into the stream the water level on the upstream side (the WAL stormwater system) must be higher than the water level on the downstream side (the Karamu Stream).

In this scenario the stormwater flows from the WAL will be stored in the swales and some ponding in the surrounding land may occur. During detailed design, the extent of the localised ponding will be investigated to ensure that it is not problematic. Any problematic areas will be relieved by providing formalised storage areas and/or high-level overflows

2.5 Monitoring and management

The stormwater system will require on-going monitoring to ensure the system is operating effectively and the stated objectives and environmental performance standards are being achieved.

A rain gauge will be installed on site and daily rainfall will be recorded. The stormwater ponds will be inspected weekly and immediately after each rainfall event (large enough to create surface runoff). Visible hydrocarbons will be removed using an absorbent boom and disposed of to an approved off-site facility. Swales will also be inspected as per the above procedure and any section where scour has occurred will be repaired.

2.6 Responsibilities

The following parties will be responsible for monitoring and compliance with this plan;

- The civil engineering construction contractor will be responsible for monitoring the site for the contract and maintenance period.
- The WAL project engineering consultant's supervision staff are responsible for checking the contractor is following the actions set out in this plan.
- The Hastings District Council (HDC) is ultimately responsible for the project works and will enforce compliance through its construction contract using the engineer to the contract as its representative.
- Once construction and the maintenance periods are completed the monitoring of the site comes under HBRC's routine monitoring regime.
- After construction and the maintenance periods are ended ongoing maintenance of the swale and stormwater drainage network will be the responsibility of the HDC's stormwater maintenance contractor.

3. References

Hawkes Bay Waterway Guidelines (May 2009)

http://www.niwa.co.nz/software/hirds ver 3

Rational Method as per Building Code (clause E1) NZS4404

4. Basis of Report

This report: has been prepared by GHD for Hastings District Council and may only be used and relied on by Hastings District Council for the purpose agreed between GHD and the Hastings District Council as set out in Section 1 of this report.

GHD otherwise disclaims responsibility to any person other than Hastings District Council (and GHD's wider team of sub-consultants) arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

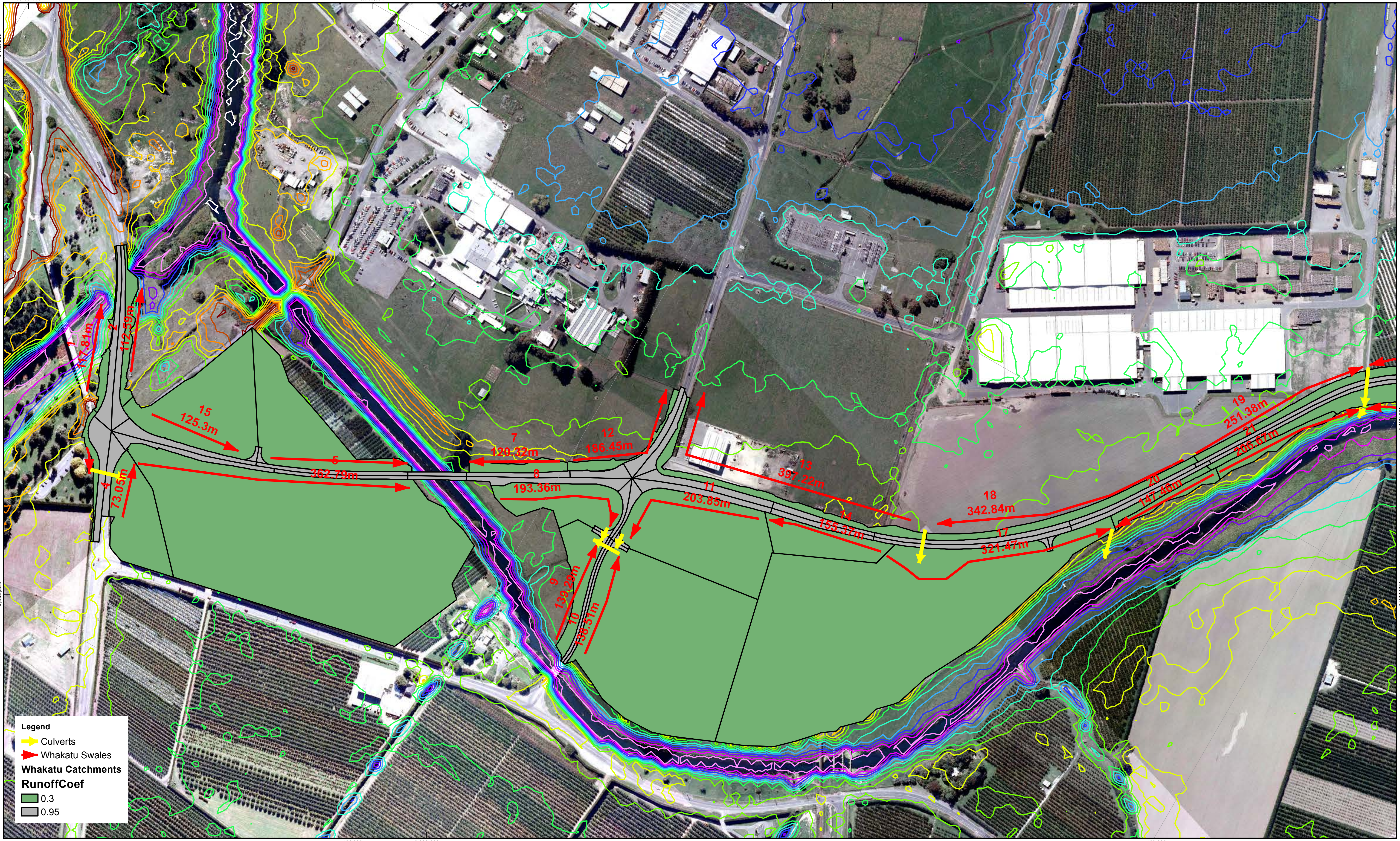
The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

Appendices

Appendix A - Stormwater conceptual layout



Paper Size A3

0 25 50 100 150 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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HASTINGS DISTRICT COUNCIL

Hastings District Council
Whakatu Arterial Project

Stormwater Conceptual Layout

Job Number	51-31468
Revision	A
Date	26 May 2014

Figure 1

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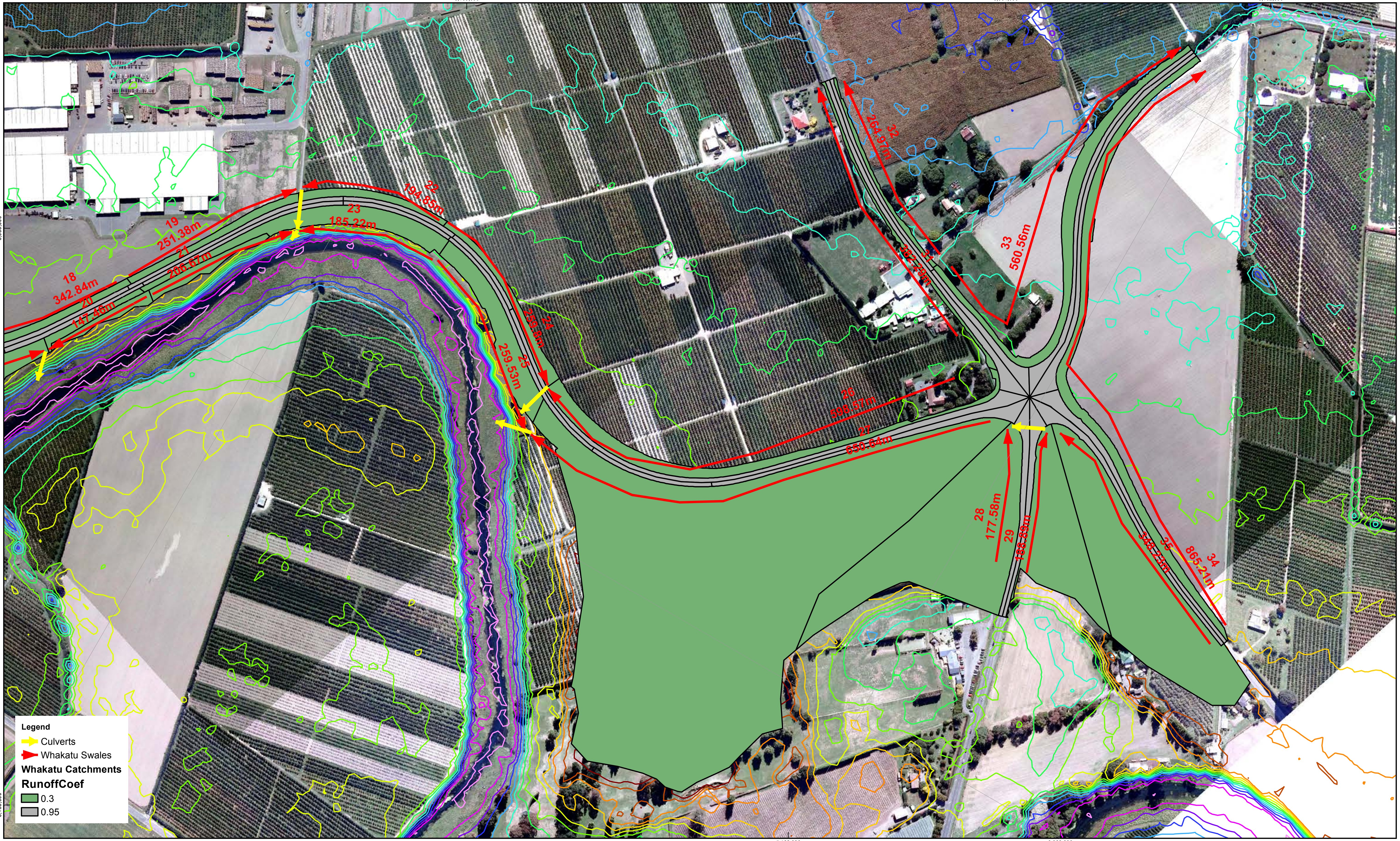
Level 1, Grant Thornton House, 215 Lambton Quay, Wellington 6011 T 64 4 472 0799 F 64 4 472 0833 E wlgmail@ghd.com W www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:hpipe



Paper Size A3

0 25 50 100 150 200

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Hastings District Council
Whakatu Arterial Project

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Stormwater Conceptual Layout

Figure 2

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Level 1, Grant Thornton House, 215 Lambton Quay, Wellington 6011 T 64 4 472 0799 F 64 4 472 0833 E wlgmail@ghd.com W www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:hpipe

Appendix B – Swale design spreadsheet

Id	Area_m2	Swale	RunoffCoe	Rain_I_10m	Flow_m3	Flow_Ls
0	2086.789	1	0.95	0.79	0.0026	2.6
0	1039.04	1	0.3	0.79	0.0004	0.4
0	2078.601	2	0.95	0.79	0.0026	2.6
0	2027.578	2	0.3	0.79	0.0008	0.8
0	2124.672	3	0.95	0.79	0.0026	2.6
0	1016.745	3	0.3	0.79	0.0004	0.4
0	1233.336	4	0.95	0.79	0.0015	1.5
0	8660.258	4	0.3	0.79	0.0034	3.4
0	1579.058	5	0.95	0.79	0.0020	2.0
0	847.5436	5	0.95	0.79	0.0011	1.1
0	73661.88	5	0.3	0.79	0.0290	29.0
0	127.3897	6	0.95	0.79	0.0002	0.2
0	1047.785	6	0.95	0.79	0.0013	1.3
0	13731.19	6	0.3	0.79	0.0054	5.4
0	416.0998	7	0.95	0.79	0.0005	0.5
0	906.3999	7	0.95	0.79	0.0011	1.1
0	1799.406	7	0.3	0.79	0.0007	0.7
0	1879.194	8	0.95	0.79	0.0023	2.3
0	139.3927	8	0.95	0.79	0.0002	0.2
0	388.9894	8	0.95	0.79	0.0005	0.5
0	7565.142	8	0.3	0.79	0.0030	3.0
0	538.3714	8	0.95	0.79	0.0007	0.7
0	678.3658	9	0.95	0.79	0.0008	0.8
0	157.9477	9	0.95	0.79	0.0002	0.2
0	4620.423	9	0.3	0.79	0.0018	1.8
0	652.8664	10	0.95	0.79	0.0008	0.8
0	145.7637	10	0.95	0.79	0.0002	0.2
0	42729.59	10	0.3	0.79	0.0168	16.8
0	146.4951	11	0.95	0.79	0.0002	0.2
0	1651.962	11	0.95	0.79	0.0021	2.1
0	564.2067	11	0.95	0.79	0.0007	0.7
0	19142.14	11	0.3	0.79	0.0075	7.5
0	1247.332	12	0.95	0.79	0.0016	1.6
0	862.9183	12	0.95	0.79	0.0011	1.1
0	1460.406	12	0.3	0.79	0.0006	0.6
0	1120.545	13	0.95	0.79	0.0014	1.4
0	1706.725	13	0.95	0.79	0.0021	2.1
0	934.6868	13	0.95	0.79	0.0012	1.2
0	4038.393	13	0.3	0.79	0.0016	1.6
0	934.8665	14	0.95	0.79	0.0012	1.2
0	5957.257	14	0.3	0.79	0.0023	2.3
0	1738.92	15	0.95	0.79	0.0022	2.2
0	134.9783	15	0.95	0.79	0.0002	0.2
0	16028.36	15	0.3	0.79	0.0063	6.3
0	112.0726	17	0.95	0.79	0.0001	0.1
0	114.2696	17	0.95	0.79	0.0001	0.1
0	76206.61	17	0.3	0.79	0.0300	30.0
0	1612.972	18	0.95	0.79	0.0020	2.0
0	1599.528	18	0.95	0.79	0.0020	2.0
0	1077.383	18	0.95	0.79	0.0013	1.3
0	3666.993	18	0.3	0.79	0.0014	1.4
0	1698.367	19	0.95	0.79	0.0021	2.1
0	2405.535	19	0.3	0.79	0.0009	0.9
0	1190.385	20	0.95	0.79	0.0015	1.5
0	1340.742	20	0.3	0.79	0.0005	0.5
0	1592.205	20	0.3	0.79	0.0006	0.6
0	1480.706	21	0.95	0.79	0.0018	1.8
0	2171.452	21	0.3	0.79	0.0009	0.9
0	2584.138	21	0.3	0.79	0.0010	1.0
0	2063.307	22	0.3	0.79	0.0008	0.8
0	842.6392	23	0.95	0.79	0.0011	1.1
0	915.76	23	0.95	0.79	0.0011	1.1
0	5149.861	23	0.3	0.79	0.0020	2.0
0	3660.957	24	0.95	0.79	0.0046	4.6
0	2816.562	24	0.3	0.79	0.0011	1.1
0	632.5869	24	0.95	0.79	0.0008	0.8
0	740.3681	25	0.95	0.79	0.0009	0.9
0	1381.077	25	0.95	0.79	0.0017	1.7
0	6989.991	25	0.3	0.79	0.0028	2.8
0	4736.457	26	0.95	0.79	0.0059	5.9
0	8077.402	26	0.3	0.79	0.0032	3.2
0	956.6095	26	0.95	0.79	0.0012	1.2
0	3123.482	27	0.95	0.79	0.0039	3.9
0	145092.1	27	0.3	0.79	0.0571	57.1
0	565.4572	27	0.95	0.79	0.0007	0.7
0	2238.636	28	0.95	0.79	0.0028	2.8
0	32710.35	28	0.3	0.79	0.0129	12.9
0	2268.277	29	0.95	0.79	0.0028	2.8
0	14220.31	29	0.3	0.79	0.0056	5.6
0	3623.933	31	0.95	0.79	0.0045	4.5
0	1901.328	31	0.3	0.79	0.0007	0.7
0	1424.83	32	0.95	0.79	0.0018	1.8
0	1340.66	32	0.3	0.79	0.0005	0.5
0	1875.991	33	0.95	0.79	0.0023	2.3
0	3449.916	33	0.95	0.79	0.0043	4.3
0	7849.728	33	0.3	0.79	0.0031	3.1
0	3074.689	34	0.95	0.79	0.0038	3.8

Swale No	Q (l/s)	Contributing Flows						Slope, S	Base Width (m)	Side Slope (1 in)	n	Depth d (m)	Area (m²)	Wetted Perimeter P (m)	Hydraulic Radius (R_h)	Flow, Q (m³/s)	Top Width (m)	Velocity (m/s)		Q-Q
1	3		0		0		0	0.002	0.6	4	0.03	0.033	0.02	0.87	0.028	0.0034	0.87	0.14		0.00034
2	3		0		0		0	0.002	0.6	4	0.03	0.038	0.03	0.92	0.032	0.0043	0.91	0.15		0.000909
3	3		0		0		0	0.002	0.6	4	0.03	0.031	0.02	0.85	0.026	0.0029	0.84	0.13		-0.00017
4	8	3	3		0		0	0.002	0.6	4	0.03	0.056	0.05	1.06	0.043	0.0084	1.05	0.18		0.000447
5	40	4	8		0		0	0.002	0.6	4	0.03	0.126	0.14	1.64	0.085	0.0403	1.61	0.29		0.000231
6	16	15	9		0		0	0.002	0.6	4	0.03	0.079	0.07	1.25	0.058	0.0162	1.23	0.22		0.000712
7	2		0		0		0	0.002	0.6	4	0.03	0.031	0.02	0.86	0.026	0.0030	0.85	0.13		0.000608
8	7		0		0		0	0.002	0.6	4	0.03	0.049	0.04	1.01	0.039	0.0068	1.00	0.17		0.00011
9	3		0		0		0	0.002	0.6	4	0.03	0.033	0.02	0.88	0.028	0.0034	0.87	0.14		0.000506
10	18		0		0		0	0.002	0.6	4	0.03	0.084	0.08	1.30	0.061	0.0183	1.27	0.23		0.000458
11	14	14	4		0		0	0.002	0.6	4	0.03	0.075	0.07	1.22	0.055	0.0145	1.20	0.22		0.00051
12	3		0		0		0	0.002	0.6	4	0.03	0.036	0.03	0.90	0.030	0.0039	0.89	0.14		0.000682
13	6		0		0		0	0.002	0.6	4	0.03	0.051	0.04	1.02	0.040	0.0072	1.01	0.18		0.000945
14	4		0		0		0	0.002	0.6	4	0.03	0.037	0.03	0.90	0.031	0.0040	0.90	0.15		0.000512
15	9		0		0		0	0.002	0.6	4	0.03	0.059	0.05	1.08	0.045	0.0092	1.07	0.19		0.000601
16	0		0		0		0	0.002	0.6	4	0.03	0.015	0.01	0.72	0.014	0.0008	0.72	0.08		0.000834
17	44	18	7		0	18	7	0.002	0.6	4	0.03	0.132	0.15	1.69	0.088	0.0439	1.66	0.30		2.98E-05
18	7		0		0		0	0.002	0.6	4	0.03	0.053	0.04	1.03	0.041	0.0076	1.02	0.18		0.000794
19	3		0		0		0	0.002	0.6	4	0.03	0.035	0.03	0.89	0.029	0.0037	0.88	0.14		0.000601
20	3		0		0		0	0.002	0.6	4	0.03	0.033	0.02	0.87	0.028	0.0033	0.86	0.14		0.00064
21	4		0		0		0	0.002	0.6	4	0.03	0.038	0.03	0.91	0.031	0.0042	0.90	0.15		0.0005
22	1		0		0		0	0.002	0.6	4	0.03	0.018	0.01	0.75	0.016	0.0012	0.74	0.10		0.000351
23	4		0		0		0	0.002	0.6	4	0.03	0.040	0.03	0.93	0.033	0.0047	0.92	0.15		0.000453
24	6		0		0		0	0.002	0.6	4	0.03	0.050	0.04	1.01	0.039	0.0068	1.00	0.17		0.000354
25	5		0		0		0	0.002	0.6	4	0.03	0.045	0.04	0.97	0.036	0.0057	0.96	0.16		0.000351
26	10		0		0		0	0.002	0.6	4	0.03	0.063	0.05	1.12	0.048	0.0104	1.10	0.20		0.000128
27	102	28	16	29	8	35	16	0.002	0.6	4	0.03	0.199	0.28	2.24	0.124	0.1027	2.19	0.37		0.000822
28	16		0		0		0	0.002	0.6	4	0.03	0.079	0.07	1.25	0.058	0.0163	1.23	0.22		0.000601
29	8		0		0		0	0.002	0.6	4	0.03	0.057	0.05	1.07	0.044	0.0087	1.05	0.19		0.000304
30	0		0		0		0	0.002	0.6	4	0.03	0.006	0.00	0.65	0.006	0.0002	0.65	0.05		0.000194
31	5		0		0		0	0.002	0.6	4	0.03	0.045	0.03	0.97	0.036	0.0056	0.96	0.16		0.000355
32	2		0		0		0	0.002	0.6	4	0.03	0.030	0.02	0.85	0.026	0.0029	0.84	0.13		0.000546
33	10		0		0		0	0.002	0.6	4	0.03	0.060	0.05	1.10	0.046	0.0098	1.08	0.19		6.13E-05
34	8		0		0		0	0.002	0.6	4	0.03	0.056	0.05	1.06	0.043	0.0084	1.04	0.18		0.000526
35	16		0		0		0	0.002	0.6	4	0.03	0.079	0.07	1.25	0.058	0.0161	1.23	0.22		9.46E-05

Discharge to Stream	Before
1	16
2	40
3	41
4	44
5	3
6	12
7	124
	279

Id	Area_m2	Swale	RunoffCoe	Rain_I_10m	Flow_m3	Flow_Ls
0	2086.789	1	0.95	10.20	0.0337	33.7
0	1039.04	1	0.3	10.20	0.0053	5.3
0	2078.601	2	0.95	10.20	0.0336	33.6
0	2027.578	2	0.3	10.20	0.0103	10.3
0	2124.672	3	0.95	10.20	0.0343	34.3
0	1016.745	3	0.3	10.20	0.0052	5.2
0	1233.336	4	0.95	10.20	0.0199	19.9
0	8660.258	4	0.3	10.20	0.0442	44.2
0	1579.058	5	0.95	10.20	0.0255	25.5
0	847.5436	5	0.95	10.20	0.0137	13.7
0	73661.88	5	0.3	10.20	0.3757	375.7
0	127.3897	6	0.95	10.20	0.0021	2.1
0	1047.785	6	0.95	10.20	0.0169	16.9
0	13731.19	6	0.3	10.20	0.0700	70.0
0	416.0998	7	0.95	10.20	0.0067	6.7
0	906.3999	7	0.95	10.20	0.0146	14.6
0	1799.406	7	0.3	10.20	0.0092	9.2
0	1879.194	8	0.95	10.20	0.0303	30.3
0	139.3927	8	0.95	10.20	0.0023	2.3
0	388.9894	8	0.95	10.20	0.0063	6.3
0	7565.142	8	0.3	10.20	0.0386	38.6
0	538.3714	8	0.95	10.20	0.0087	8.7
0	678.3658	9	0.95	10.20	0.0110	11.0
0	157.9477	9	0.95	10.20	0.0026	2.6
0	4620.423	9	0.3	10.20	0.0236	23.6
0	652.8664	10	0.95	10.20	0.0105	10.5
0	145.7637	10	0.95	10.20	0.0024	2.4
0	42729.59	10	0.3	10.20	0.2179	217.9
0	146.4951	11	0.95	10.20	0.0024	2.4
0	1651.962	11	0.95	10.20	0.0267	26.7
0	564.2067	11	0.95	10.20	0.0091	9.1
0	19142.14	11	0.3	10.20	0.0976	97.6
0	1247.332	12	0.95	10.20	0.0201	20.1
0	862.9183	12	0.95	10.20	0.0139	13.9
0	1460.406	12	0.3	10.20	0.0074	7.4
0	1120.545	13	0.95	10.20	0.0181	18.1
0	1706.725	13	0.95	10.20	0.0276	27.6
0	934.6868	13	0.95	10.20	0.0151	15.1
0	4038.393	13	0.3	10.20	0.0206	20.6
0	934.8665	14	0.95	10.20	0.0151	15.1
0	5957.257	14	0.3	10.20	0.0304	30.4
0	1738.92	15	0.95	10.20	0.0281	28.1
0	134.9783	15	0.95	10.20	0.0022	2.2
0	16028.36	15	0.3	10.20	0.0817	81.7
0	112.0726	17	0.95	10.20	0.0018	1.8
0	114.2696	17	0.95	10.20	0.0018	1.8
0	76206.61	17	0.3	10.20	0.3887	388.7
0	1612.972	18	0.95	10.20	0.0260	26.0
0	1599.528	18	0.95	10.20	0.0258	25.8
0	1077.383	18	0.95	10.20	0.0174	17.4
0	3666.993	18	0.3	10.20	0.0187	18.7
0	1698.367	19	0.95	10.20	0.0274	27.4
0	2405.535	19	0.3	10.20	0.0123	12.3
0	1190.385	20	0.95	10.20	0.0192	19.2
0	1340.742	20	0.3	10.20	0.0068	6.8
0	1592.205	20	0.3	10.20	0.0081	8.1
0	1480.706	21	0.95	10.20	0.0239	23.9
0	2171.452	21	0.3	10.20	0.0111	11.1
0	2584.138	21	0.3	10.20	0.0132	13.2
0	2063.307	22	0.3	10.20	0.0105	10.5
0	842.6392	23	0.95	10.20	0.0136	13.6
0	915.76	23	0.95	10.20	0.0148	14.8
0	5149.861	23	0.3	10.20	0.0263	26.3
0	3660.957	24	0.95	10.20	0.0591	59.1
0	2816.562	24	0.3	10.20	0.0144	14.4
0	632.5869	24	0.95	10.20	0.0102	10.2
0	740.3681	25	0.95	10.20	0.0120	12.0
0	1381.077	25	0.95	10.20	0.0223	22.3
0	6989.991	25	0.3	10.20	0.0356	35.6
0	4736.457	26	0.95	10.20	0.0765	76.5
0	8077.402	26	0.3	10.20	0.0412	41.2
0	956.6095	26	0.95	10.20	0.0154	15.4
0	3123.482	27	0.95	10.20	0.0504	50.4
0	145092.1	27	0.3	10.20	0.7400	740.0
0	565.4572	27	0.95	10.20	0.0091	9.1
0	2238.636	28	0.95	10.20	0.0362	36.2
0	32710.35	28	0.3	10.20	0.1668	166.8
0	2268.277	29	0.95	10.20	0.0366	36.6
0	14220.31	29	0.3	10.20	0.0725	72.5
0	3623.933	31	0.95	10.20	0.0585	58.5

Swale No	Q (l/s)	Contributing Flows						Slope, S	Base Width (m)	Side Slope (1 in)	n	Depth d (m)	Area (m²)	Wetted Perimeter P (m)	Hydraulic Radius (R_h)	Flow, Q (m³/s)	Top Width (m)	Velocity (m/s)		Q-Q
1	39		0		0		0	0.002	0.6	4	0.03	0.125	0.14	1.63	0.084	0.0392	1.60	0.29		0.00015
2	44		0		0		0	0.002	0.6	4	0.03	0.132	0.15	1.69	0.088	0.0440	1.66	0.30		0.000127
3	39		0		0		0	0.002	0.6	4	0.03	0.125	0.14	1.63	0.085	0.0397	1.60	0.29		0.00016
4	104	3	39		0		0	0.002	0.6	4	0.03	0.200	0.28	2.25	0.124	0.1039	2.20	0.37		0.000361
5	518	4	104		0		0	0.002	0.6	4	0.03	0.411	0.92	3.99	0.231	0.5185	3.89	0.56		4.64E-05
6	201	15	112		0		0	0.002	0.6	4	0.03	0.270	0.45	2.83	0.161	0.2004	2.76	0.44		-0.0006
7	31		0		0		0	0.002	0.6	4	0.03	0.111	0.12	1.51	0.076	0.0309	1.49	0.27		0.0004
8	86		0		0		0	0.002	0.6	4	0.03	0.184	0.25	2.11	0.116	0.0868	2.07	0.35		0.000685
9	37		0		0		0	0.002	0.6	4	0.03	0.122	0.13	1.61	0.083	0.0378	1.58	0.28		0.000747
10	231		0		0		0	0.002	0.6	4	0.03	0.288	0.51	2.98	0.170	0.2311	2.91	0.46		0.000275
11	181	14	45		0		0	0.002	0.6	4	0.03	0.259	0.42	2.73	0.155	0.1817	2.67	0.43		0.000451
12	42		0		0		0	0.002	0.6	4	0.03	0.129	0.14	1.66	0.086	0.0419	1.63	0.29		0.000389
13	81		0		0		0	0.002	0.6	4	0.03	0.178	0.23	2.07	0.113	0.0814	2.02	0.35		7.06E-05
14	45		0		0		0	0.002	0.6	4	0.03	0.134	0.15	1.71	0.089	0.0455	1.67	0.30		5.1E-05
15	112		0		0		0	0.002	0.6	4	0.03	0.208	0.30	2.31	0.128	0.1128	2.26	0.38		0.000775
16	0		0		0		0	0.002	0.6	4	0.03	0.013	0.01	0.71	0.012	0.0007	0.71	0.08		0.000693
17	568	18	88		0	18	88	0.002	0.6	4	0.03	0.428	0.99	4.13	0.240	0.5684	4.02	0.57		0.000134
18	88		0		0		0	0.002	0.6	4	0.03	0.185	0.25	2.12	0.117	0.0880	2.08	0.36		5.93E-05
19	40		0		0		0	0.002	0.6	4	0.03	0.126	0.14	1.64	0.085	0.0397	1.60	0.29		5.21E-05
20	34		0		0		0	0.002	0.6	4	0.03	0.117	0.12	1.56	0.080	0.0343	1.53	0.28		0.000127
21	48		0		0		0	0.002	0.6	4	0.03	0.138	0.16	1.74	0.092	0.0482	1.71	0.30		4.53E-05
22	11		0		0		0	0.002	0.6	4	0.03	0.066	0.06	1.14	0.050	0.0115	1.13	0.20		0.000938
23	55		0		0		0	0.002	0.6	4	0.03	0.148	0.18	1.82	0.097	0.0555	1.78	0.31		0.000839
24	84		0		0		0	0.002	0.6	4	0.03	0.181	0.24	2.09	0.114	0.0839	2.05	0.35		0.000184
25	70		0		0		0	0.002	0.6	4	0.03	0.166	0.21	1.97	0.107	0.0704	1.93	0.34		0.000491
26	133		0		0		0	0.002	0.6	4	0.03	0.224	0.34	2.45	0.137	0.1332	2.39	0.40		5.26E-05
27	1319	28	203	29	109	35	207	0.002	0.6	4	0.03	0.610	1.86	5.63	0.329	1.3192	5.48	0.71		0.000158
28	203		0		0		0	0.002	0.6	4	0.03	0.272	0.46	2.85	0.162	0.2035	2.78	0.44		0.00048
29	109		0		0		0	0.002	0.6	4	0.03	0.205	0.29	2.29	0.127	0.1093	2.24	0.38		0.000153
30	0		0		0		0	0.002	0.6	4	0.03	0.006	0.00	0.65	0.006	0.0002	0.65	0.05		0.000194
31	68		0		0		0	0.002	0.6	4	0.03	0.164	0.21	1.95	0.105	0.0684	1.91	0.33		0.000174
32	30		0		0		0	0.002	0.6	4	0.03	0.110	0.11	1.51	0.076	0.0306	1.48	0.27		0.000724
33	126		0		0		0	0.002	0.6	4	0.03	0.219	0.32	2.40	0.134	0.1261	2.35	0.39		6.22E-05
34	102		0		0		0	0.002	0.6	4	0.03	0.198	0.28	2.23	0.123	0.1018	2.18	0.37		4.11E-05
35	207		0		0		0	0.002	0.6	4	0.03	0.275	0.47	2.87	0.163	0.2081	2.80	0.44		0.000675

Discharge to Stream	Before
1	201
2	518
3	535
4	568
5	34
6	153
7	1606

Id	Area_m2	Swale	RunoffCoef	Rain_I_10m	Flow_m3	Flow_Ls
0	2086.789	1	0.95	0.79	0.0026	2.6
0	1039.04	1	0.3	0.79	0.0004	0.4
0	2078.601	2	0.95	0.79	0.0026	2.6
0	2027.578	2	0.3	0.79	0.0008	0.8
0	2124.672	3	0.95	0.79	0.0026	2.6
0	1016.745	3	0.3	0.79	0.0004	0.4
0	1233.336	4	0.95	0.79	0.0015	1.5
0	8660.258	4	0.3	0.79	0.0034	3.4
0	1579.058	5	0.95	0.79	0.0020	2.0
0	847.5436	5	0.95	0.79	0.0011	1.1
0	73661.88	5	0.3	0.79	0.0290	29.0
0	127.3897	6	0.95	0.79	0.0002	0.2
0	1047.785	6	0.95	0.79	0.0013	1.3
0	13731.19	6	0.3	0.79	0.0054	5.4
0	416.0998	7	0.95	0.79	0.0005	0.5
0	906.3999	7	0.95	0.79	0.0011	1.1
0	1799.406	7	0.3	0.79	0.0007	0.7
0	1879.194	8	0.95	0.79	0.0023	2.3
0	139.3927	8	0.95	0.79	0.0002	0.2
0	388.9894	8	0.95	0.79	0.0005	0.5
0	7565.142	8	0.3	0.79	0.0030	3.0
0	538.3714	8	0.95	0.79	0.0007	0.7
0	678.3658	9	0.95	0.79	0.0008	0.8
0	157.9477	9	0.95	0.79	0.0002	0.2
0	4620.423	9	0.3	0.79	0.0018	1.8
0	652.8664	10	0.95	0.79	0.0008	0.8
0	145.7637	10	0.95	0.79	0.0002	0.2
0	42729.59	10	0.3	0.79	0.0168	16.8
0	146.4951	11	0.95	0.79	0.0002	0.2
0	1651.962	11	0.95	0.79	0.0021	2.1
0	564.2067	11	0.95	0.79	0.0007	0.7
0	19142.14	11	0.3	0.79	0.0075	7.5
0	1247.332	12	0.95	0.79	0.0016	1.6
0	862.9183	12	0.95	0.79	0.0011	1.1
0	1460.406	12	0.3	0.79	0.0006	0.6
0	1120.545	13	0.95	0.79	0.0014	1.4
0	1706.725	13	0.95	0.79	0.0021	2.1
0	934.6868	13	0.95	0.79	0.0012	1.2
0	4038.393	13	0.3	0.79	0.0016	1.6
0	934.8665	14	0.95	0.79	0.0012	1.2
0	5957.257	14	0.3	0.79	0.0023	2.3
0	1738.92	15	0.95	0.79	0.0022	2.2
0	134.9783	15	0.95	0.79	0.0002	0.2
0	16028.36	15	0.3	0.79	0.0063	6.3
0	112.0726	17	0.95	0.79	0.0001	0.1
0	114.2696	17	0.95	0.79	0.0001	0.1
0	76206.61	17	0.3	0.79	0.0300	30.0
0	1612.972	18	0.95	0.79	0.0020	2.0
0	1599.528	18	0.95	0.79	0.0020	2.0
0	1077.383	18	0.95	0.79	0.0013	1.3
0	3666.993	18	0.3	0.79	0.0014	1.4
0	1698.367	19	0.95	0.79	0.0021	2.1
0	2405.535	19	0.3	0.79	0.0009	0.9
0	1190.385	20	0.95	0.79	0.0015	1.5
0	1340.742	20	0.3	0.79	0.0005	0.5
0	1592.205	20	0.3	0.79	0.0006	0.6
0	1480.706	21	0.95	0.79	0.0018	1.8
0	2171.452	21	0.3	0.79	0.0009	0.9
0	2584.138	21	0.3	0.79	0.0010	1.0
0	2063.307	22	0.3	0.79	0.0008	0.8
0	842.6392	23	0.95	0.79	0.0011	1.1
0	915.76	23	0.95	0.79	0.0011	1.1
0	5149.861	23	0.3	0.79	0.0020	2.0
0	3660.957	24	0.95	0.79	0.0046	4.6
0	2816.562	24	0.3	0.79	0.0011	1.1
0	632.5869	24	0.95	0.79	0.0008	0.8
0	740.3681	25	0.95	0.79	0.0009	0.9
0	1381.077	25	0.95	0.79	0.0017	1.7
0	6989.991	25	0.3	0.79	0.0028	2.8
0	4736.457	26	0.95	0.79	0.0059	5.9
0	8077.402	26	0.3	0.79	0.0032	3.2
0	956.6095	26	0.95	0.79	0.0012	1.2
0	3123.482	27	0.95	0.79	0.0039	3.9
0	145092.1	27	0.3	0.79	0.0571	57.1
0	565.4572	27	0.95	0.79	0.0007	0.7
0	2238.636	28	0.95	0.79	0.0028	2.8
0	32710.35	28	0.3	0.79	0.0129	12.9
0	2268.277	29	0.95	0.79	0.0028	2.8
0	14220.31	29	0.3	0.79	0.0056	5.6
0	3623.933	31	0.95	0.79	0.0045	4.5
0	1901.328	31	0.3	0.79	0.0007	0.7
0	1424.83	32	0.95	0.79	0.0018	1.8
0	1340.66	32	0.3	0.79	0.0005	0.5
0	1875.991	33	0.95	0.79	0.0023	2.3
0	3449.916	33	0.95	0.79	0.0043	4.3
0	7849.728	33	0.3	0.79	0.0031	3.1
0	3074.689	34	0.95	0.79	0.0038	3.8
0	10213.73	34	0.3	0.79	0.0040	4.0
0	31584.39	35	0.3	0.79	0.0124	12.4
0	2868.436	35	0.95	0.79	0.0036	3.6
0				0.79	0.0000	0.0
0				0.79	0.0000	0.0
0				0.79	0.0000	0.0
0				0.79	0.0000	0.0
0				0.79	0.0000	0.0
0				0.79	0.0000	0.0
				0.79	0.0000	0.0
				0.79	0.0000	0.0
				0.79	0.0000	0.0
				0.79	0.0000	0.0
				0.79	0.0000	0.0
				0.79	0.0000	0.0
				0.79	0.0000	0.0
				0.79	0.0000	0.0
				0.79	0.0000	0.0

Swale No	Q (l/s)	Contributing Flows						Slope, S	Base Width (m)	Side Slope (1 in)	n	Depth d (m)	Area (m^2)	Wetted Perimeter P (m)	Hydraulic Radius (R_h)	Flow, Q (m^3/s)	Top Width (m)	Velocity (m/s)		Q-Q
1	3		0		0		0	0.002	0.6	4	0.03	0.032	0.02	0.86	0.027	0.0031	0.85	0.13		5.12E-05
2	3		0		0		0	0.002	0.6	4	0.03	0.038	0.03	0.92	0.032	0.0043	0.91	0.15		0.000928
3	3		0		0		0	0.002	0.6	4	0.03	0.030	0.02	0.84	0.025	0.0027	0.84	0.13		-0.00031
4	8	3	3		0		0	0.002	0.6	4	0.03	0.056	0.05	1.06	0.043	0.0084	1.05	0.18		0.000425
5	40	4	8		0		0	0.002	0.6	4	0.03	0.126	0.14	1.64	0.085	0.0403	1.61	0.29		0.000226
6	16	15	9		0		0	0.002	0.6	4	0.03	0.078	0.07	1.25	0.057	0.0159	1.23	0.22		0.000369
7	2		0		0		0	0.002	0.6	4	0.03	0.030	0.02	0.85	0.026	0.0029	0.84	0.13		0.00051
8	7		0		0		0	0.002	0.6	4	0.03	0.049	0.04	1.01	0.039	0.0068	1.00	0.17		0.000116
9	3		0		0		0	0.002	0.6	4	0.03	0.034	0.03	0.88	0.028	0.0035	0.87	0.14		0.00062
10	18		0		0		0	0.002	0.6	4	0.03	0.084	0.08	1.30	0.061	0.0183	1.28	0.23		0.000462
11	14	14	4		0		0	0.002	0.6	4	0.03	0.075	0.07	1.22	0.055	0.0145	1.20	0.22		0.000513
12	3		0		0		0	0.002	0.6	4	0.03	0.033	0.02	0.87	0.028	0.0033	0.87	0.14		0.000124
13	6		0		0		0	0.002	0.6	4	0.03	0.050	0.04	1.01	0.040	0.0070	1.00	0.17		0.000695
14	4		0		0		0	0.002	0.6	4	0.03	0.037	0.03	0.90	0.031	0.0040	0.90	0.15		0.000512
15	9		0		0		0	0.002	0.6	4	0.03	0.059	0.05	1.09	0.045	0.0093	1.07	0.19		0.000676
16	0		0		0		0	0.002	0.6	4	0.03	0.009	0.01	0.68	0.009	0.0004	0.68	0.06		0.000383
17	44	18	7		0	18	7	0.002	0.6	4	0.03	0.132	0.15	1.69	0.088	0.0439	1.66	0.30		3.01E-05
18	7		0		0		0	0.002	0.6	4	0.03	0.050	0.04	1.01	0.040	0.0070	1.00	0.17		0.000179
19	3		0		0		0	0.002	0.6	4	0.03	0.036	0.03	0.89	0.030	0.0038	0.88	0.14		0.00069
20	3		0		0		0	0.002	0.6	4	0.03	0.033	0.02	0.87	0.028	0.0033	0.86	0.14		0.000639
21	4		0		0		0	0.002	0.6	4	0.03	0.038	0.03	0.91	0.031	0.0042	0.90	0.15		0.000497
22	1		0		0		0	0.002	0.6	4	0.03	0.018	0.01	0.75	0.016	0.0012	0.74	0.10		0.000351
23	4		0		0		0	0.002	0.6	4	0.03	0.040	0.03	0.93	0.033	0.0047	0.92	0.15		0.000459
24	6		0		0		0	0.002	0.6	4	0.03	0.050	0.04	1.01	0.039	0.0068	1.00	0.17		0.000344
25	5		0		0		0	0.002	0.6	4	0.03	0.045	0.04	0.97	0.036	0.0057	0.96	0.16		0.00035
26	10		0		0		0	0.002	0.6	4	0.03	0.065	0.06	1.14	0.049	0.0113	1.12	0.20		0.000997
27	102	28	16	29	8	35	16	0.002	0.6	4	0.03	0.199	0.28	2.24	0.124	0.1027	2.19	0.37		0.000819
28	16		0		0		0	0.002	0.6	4	0.03	0.079	0.07	1.25	0.058	0.0163	1.24	0.22		0.000618
29	8		0		0		0	0.002	0.6	4	0.03	0.057	0.05	1.07	0.044	0.0088	1.06	0.19		0.000382
30	0		0		0		0	0.002	0.6	4	0.03	0.006	0.00	0.65	0.006	0.0002	0.65	0.05		0.000194
31	5		0		0		0	0.002	0.6	4	0.03	0.044	0.03	0.97	0.036	0.0056	0.96	0.16		0.000318
32	2		0		0		0	0.002	0.6	4	0.03	0.030	0.02	0.85	0.026	0.0029	0.84	0.13		0.000564
33	10		0		0		0	0.002	0.6	4	0.03	0.062	0.05	1.11	0.047	0.0102	1.09	0.19		0.000424
34	8		0		0		0	0.002	0.6	4	0.03	0.054	0.04	1.04	0.042	0.0079	1.03	0.18		4.61E-05
35	16		0		0		0	0.002	0.6	4	0.03	0.081	0.07	1.26	0.059	0.0167	1.24	0.23		0.000706

Discharge to Stream		Before
	1	16
	2	40
	3	41
	4	44
	5	3
	6	12
	7	124
		279

Id	Area_m2	Swale	RunoffCoe	Rain_I_10m	Flow_m3	Flow_Ls
0	2086.789	1	0.95	10.20	0.0337	33.7
0	1039.04	1	0.3	10.20	0.0053	5.3
0	2078.601	2	0.95	10.20	0.0336	33.6
0	2027.578	2	0.3	10.20	0.0103	10.3
0	2124.672	3	0.95	10.20	0.0343	34.3
0	1016.745	3	0.3	10.20	0.0052	5.2
0	1233.336	4	0.95	10.20	0.0199	19.9
0	8660.258	4	0.3	10.20	0.0442	44.2
0	1579.058	5	0.95	10.20	0.0255	25.5
0	847.5436	5	0.95	10.20	0.0137	13.7
0	73661.88	5	0.3	10.20	0.3757	375.7
0	127.3897	6	0.95	10.20	0.0021	2.1
0	1047.785	6	0.95	10.20	0.0169	16.9
0	13731.19	6	0.3	10.20	0.0700	70.0
0	416.0998	7	0.95	10.20	0.0067	6.7
0	906.3999	7	0.95	10.20	0.0146	14.6
0	1799.406	7	0.3	10.20	0.0092	9.2
0	1879.194	8	0.95	10.20	0.0303	30.3
0	139.3927	8	0.95	10.20	0.0023	2.3
0	388.9894	8	0.95	10.20	0.0063	6.3
0	7565.142	8	0.3	10.20	0.0386	38.6
0	538.3714	8	0.95	10.20	0.0087	8.7
0	678.3658	9	0.95	10.20	0.0110	11.0
0	157.9477	9	0.95	10.20	0.0026	2.6
0	4620.423	9	0.3	10.20	0.0236	23.6
0	652.8664	10	0.95	10.20	0.0105	10.5
0	145.7637	10	0.95	10.20	0.0024	2.4
0	42729.59	10	0.3	10.20	0.2179	217.9
0	146.4951	11	0.95	10.20	0.0024	2.4
0	1651.962	11	0.95	10.20	0.0267	26.7
0	564.2067	11	0.95	10.20	0.0091	9.1
0	19142.14	11	0.3	10.20	0.0976	97.6
0	1247.332	12	0.95	10.20	0.0201	20.1
0	862.9183	12	0.95	10.20	0.0139	13.9
0	1460.406	12	0.3	10.20	0.0074	7.4
0	1120.545	13	0.95	10.20	0.0181	18.1
0	1706.725	13	0.95	10.20	0.0276	27.6
0	934.6868	13	0.95	10.20	0.0151	15.1
0	4038.393	13	0.3	10.20	0.0206	20.6
0	934.8665	14	0.95	10.20	0.0151	15.1
0	5957.257	14	0.3	10.20	0.0304	30.4
0	1738.92	15	0.95	10.20	0.0281	28.1
0	134.9783	15	0.95	10.20	0.0022	2.2
0	16028.36	15	0.3	10.20	0.0817	81.7
0	112.0726	17	0.95	10.20	0.0018	1.8
0	114.2696	17	0.95	10.20	0.0018	1.8
0	76206.61	17	0.3	10.20	0.3887	388.7
0	1612.972	18	0.95	10.20	0.0260	26.0
0	1599.528	18	0.95	10.20	0.0258	25.8
0	1077.383	18	0.95	10.20	0.0174	17.4
0	3666.993	18	0.3	10.20	0.0187	18.7
0	1698.367	19	0.95	10.20	0.0274	27.4
0	2405.535	19	0.3	10.20	0.0123	12.3
0	1190.385	20	0.95	10.20	0.0192	19.2
0	1340.742	20	0.3	10.20	0.0068	6.8
0	1592.205	20	0.3	10.20	0.0081	8.1
0	1480.706	21	0.95	10.20	0.0239	23.9
0	2171.452	21	0.3	10.20	0.0111	11.1
0	2584.138	21	0.3	10.20	0.0132	13.2
0	2063.307	22	0.3	10.20	0.0105	10.5
0	842.6392	23	0.95	10.20	0.0136	13.6
0	915.76	23	0.95	10.20	0.0148	14.8
0	5149.861	23	0.3	10.20	0.0263	26.3
0	3660.957	24	0.95	10.20	0.0591	59.1
0	2816.562	24	0.3	10.20	0.0144	14.4
0	632.5869	24	0.95	10.20	0.0102	10.2
0	740.3681	25	0.95	10.20	0.0120	12.0
0	1381.077	25	0.95	10.20	0.0223	22.3
0	6989.991	25	0.3	10.20	0.0356	35.6
0	4736.457	26	0.95	10.20	0.0765	76.5
0	8077.402	26	0.3	10.20	0.0412	41.2
0	956.6095	26	0.95	10.20	0.0154	15.4
0	3123.482	27	0.95	10.20	0.0504	50.4
0	145092.1	27	0.3	10.20	0.7400	740.0
0	565.4572	27	0.95	10.20	0.0091	9.1
0	2238.636	28	0.95	10.20	0.0362	36.2
0	32710.35	28	0.3	10.20	0.1668	166.8
0	2268.277	29	0.95	10.20	0.0366	36.6
0	14220.31	29	0.3	10.20	0.0725	72.5
0	3623.933	31	0.95	10.20	0.0585	58.5
0	1901.328	31	0.3	10.20	0.0097	9.7
0	1424.83	32	0.95	10.20	0.0230	23.0
0	1340.66	32	0.3	10.20	0.0068	6.8
0	1875.991	33	0.95	10.20	0.0303	30.3
0	3449.916	33	0.95	10.20	0.0557	55.7
0	7849.728	33	0.3	10.20	0.0400	40.0
0	3074.689	34	0.95	10.20	0.0497	49.7

Swale No	Q (l/s)	Contributing Flows						Slope, S	Base Width (m)	Side Slope (1 in)	n	Depth d (m)	Area (m²)	Wetted Perimeter P (m)	Hydraulic Radius (Rh)	Flow, Q (m³/s)	Top Width (m)	Velocity (m/s)		Q-Q
1	39		0		0		0	0.002	0.6	4	0.03	0.125	0.14	1.63	0.084	0.0391	1.60	0.29		0.000126
2	44		0		0		0	0.002	0.6	4	0.03	0.132	0.15	1.69	0.088	0.0440	1.66	0.30		0.000128
3	39		0		0		0	0.002	0.6	4	0.03	0.125	0.14	1.63	0.085	0.0396	1.60	0.29		0.000126
4	104	3	39		0		0	0.002	0.6	4	0.03	0.200	0.28	2.25	0.124	0.1039	2.20	0.37		0.000364
5	518	4	104		0		0	0.002	0.6	4	0.03	0.411	0.92	3.99	0.231	0.5185	3.89	0.56		4.66E-05
6	201	15	112		0		0	0.002	0.6	4	0.03	0.270	0.45	2.83	0.161	0.2004	2.76	0.44		-0.0006
7	31		0		0		0	0.002	0.6	4	0.03	0.111	0.12	1.51	0.076	0.0309	1.49	0.27		0.000388
8	86		0		0		0	0.002	0.6	4	0.03	0.184	0.25	2.11	0.116	0.0868	2.07	0.35		0.000665
9	37		0		0		0	0.002	0.6	4	0.03	0.122	0.13	1.61	0.083	0.0378	1.58	0.28		0.000742
10	231		0		0		0	0.002	0.6	4	0.03	0.288	0.51	2.98	0.170	0.2311	2.91	0.46		0.000275
11	181	14	45		0		0	0.002	0.6	4	0.03	0.259	0.42	2.73	0.155	0.1817	2.67	0.43		0.000451
12	42		0		0		0	0.002	0.6	4	0.03	0.129	0.14	1.66	0.086	0.0419	1.63	0.29		0.000418
13	81		0		0		0	0.002	0.6	4	0.03	0.178	0.23	2.07	0.113	0.0814	2.02	0.35		7.08E-05
14	45		0		0		0	0.002	0.6	4	0.03	0.134	0.15	1.71	0.089	0.0455	1.67	0.30		5.11E-05
15	112		0		0		0	0.002	0.6	4	0.03	0.208	0.30	2.31	0.128	0.1128	2.26	0.38		0.000765
16	0		0		0		0	0.002	0.6	4	0.03	0.016	0.01	0.73	0.015	0.0009	0.73	0.09		0.000942
17	568	18	88		0	18	88	0.002	0.6	4	0.03	0.428	0.99	4.13	0.240	0.5684	4.02	0.57		0.000134
18	88		0		0		0	0.002	0.6	4	0.03	0.185	0.25	2.12	0.117	0.0880	2.08	0.36		5.77E-05
19	40		0		0		0	0.002	0.6	4	0.03	0.126	0.14	1.64	0.085	0.0397	1.60	0.29		5.19E-05
20	34		0		0		0	0.002	0.6	4	0.03	0.117	0.12	1.56	0.080	0.0343	1.53	0.28		0.000127
21	48		0		0		0	0.002	0.6	4	0.03	0.138	0.16	1.74	0.092	0.0482	1.71	0.30		4.51E-05
22	11		0		0		0	0.002	0.6	4	0.03	0.066	0.06	1.14	0.050	0.0115	1.13	0.20		0.000938
23	55		0		0		0	0.002	0.6	4	0.03	0.148	0.18	1.82	0.097	0.0555	1.78	0.31		0.000839
24	84		0		0		0	0.002	0.6	4	0.03	0.181	0.24	2.09	0.114	0.0839	2.05	0.35		0.000187
25	70		0		0		0	0.002	0.6	4	0.03	0.166	0.21	1.97	0.107	0.0704	1.93	0.34		0.000492
26	133		0		0		0	0.002	0.6	4	0.03	0.224	0.34	2.45	0.137	0.1332	2.39	0.40		5.26E-05
27	1319	28	203	29	109	35	207	0.002	0.6	4	0.03	0.610	1.86	5.63	0.329	1.3192	5.48	0.71		0.000158
28	203		0		0		0	0.002	0.6	4	0.03	0.272	0.46	2.85	0.162	0.2035	2.78	0.44		0.000481
29	109		0		0		0	0.002	0.6	4	0.03	0.205	0.29	2.29	0.127	0.1093	2.24	0.38		0.000153
30	0		0		0		0	0.002	0.6	4	0.03	0.006	0.00	0.65	0.006	0.0002	0.65	0.05		0.000194
31	68		0		0		0	0.002	0.6	4	0.03	0.164	0.21	1.95	0.105	0.0684	1.91	0.33		0.000171
32	30		0		0		0	0.002	0.6	4	0.03	0.110	0.11	1.51	0.076	0.0306	1.48	0.27		0.000741
33	126		0		0		0	0.002	0.6	4	0.03	0.219	0.32	2.40	0.134	0.1261	2.35	0.39		6.23E-05
34	102		0		0		0	0.002	0.6	4	0.03	0.198	0.28	2.23	0.123	0.1018	2.18	0.37		9.4E-05
35	207		0		0		0	0.002	0.6	4	0.03	0.275	0.47	2.87	0.163	0.2081	2.80	0.44		0.000666

Discharge to Stream	After
1	201
2	518
3	535
4	568
5	34
6	153
7	1606

GHD

134 Queen Street East
Hastings 4156
T: 64 6 870 9105 F: E:

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Document Status

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