Sephira ENVIRONMENTAL

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5 April 2018

Canterbury Landscape Supplies Ltd
PO Box 275
Kaiapoi 7644
Attention: Phil Wylie

CLS-A0272-010L-v3

Dear Phil

Re: Response to Post-Hearing Minute #2, Canterbury Landscape Supplies - Diversion Road, Swannanoa

To assist Canterbury Landscape Supplies (CLS) in responding to Minute #2 issued after the hearing regarding application for consent for operations at the Diversion Road composting facility, Sephira Environmental Limited has prepared the following technical assessments. These help to address the following requests from Minute #2:

ii. Details on the design and capacity of the proposed impermeable pad and the leachate and stormwater collection and containment system;

vii. A map showing any recorded springs within 2km of the application site and the headwaters of Silver Stream;

xi. Information regarding the predicted rate of nitrogen discharge (including ammonia nitrogen and nitrate nitrogen) in runoff and leachate from curing phase compost not proposed to be held on a bunded and impermeable surface;

xii. Confirmation of the expected rate of groundwater flow beneath the site, taking into account the additional information that has come to light during the course of the hearing;

1.0 Stormwater Management Plan

This section responds to:

i. Details on the design and capacity of the proposed impermeable pad and the leachate and stormwater collection and containment system;

The current stormwater management plan is to contain runoff from compost either on the concrete pad of the mixing and aeration pads, or within bunds that can contain up to the 20-year storm. The areas inside the bunds will have a 0.3 m pad of sawdust or bark fines upon which stormwater can accumulate until it is absorbed.

The moisture content of compost, has been measured in the past and recently as listed in Table 1 and 2. The sampling was undertaken by me on Friday afternoon (23 March). According to the NIWA Eyrewell Ngai Tahu East CWS Station (40744), after 11 days of no rain, the site received 9.6 mm of rainfall on 22 and 23 March 2018. I observed almost no standing water except in the mixing area sump and some small puddles containing saturated sawdust/bark fines and compost in access roads.

I collected samples for moisture content from varying levels the sawdust apron/bund and two samples at different levels at the base of a compost pile. I suspected the top sample of the sawdust apron would have the highest moisture content which was true. No sawdust appeared saturated except in the access road puddles which were thin and immediately over the alluvial gravels. I took one sample of highly moist (not fully saturated) sawdust/barkfine from an access road for comparison with the other samples.

I took two surface water samples from the access road puddles to be analysed for nitrogen suite. I deduced that the windrows on either side of the access road sampled were curing piles. The laboratory report is attached.

Table 1. Moisture Content and Absorptive Capacity

	Dry Sawdust	**Sawdust from stockpile**	**Bark fines from stockpile**	**Fresh compost saturated**	**Aged compost saturated**
Moisture Content %	-	69	67	57	55
Absorption capacity %	55.4	327	245	180	185

1. Moisture content is the ratio of the mass of water to the mass of the total wet sample.
2. Absorption capacity is the ratio of the mass of the maximum amount of water that a mass of dry sawdust can hold at saturated conditions, expressed as percentage of the mass of wood. I.e., mass of the water to the mass of the dry sample.

Table 2. Recent Moisture Content

	Sawdust Apron 0-0.1m	**Sawdust Apron 0.3-0.35m**	**Sawdust Apron 0.4-0.45m**	**Bottom of Curing Compost CMPST-1**	**Sawdust/Bark Fine below Compost SD/BF-1**	**Sawdust/Bark Fine wet in access road SD/BF-2**
Moisture Content %	67	63	64	37	44	64

1. Moisture content is the ratio of the mass of water to the mass of the total wet sample.

An assessment of the capacity of sawdust and bark fines to absorb the precipitation and runoff that will be generated within the bunded areas where compost will be stored is summarised in Table 3.

Table 3. Evidence that Sawdust/Bark Fine Pads Around Piles Can Absorb Stormwater

Thickness of sawdust/bark fine pad (m)	Amount of water sawdust pad can absorb (L per m^2 of pad)	Amount of water a bark fine pad can absorb (L per m^2 of pad)	Months of average precipitation (6.8 cm/month) that could be absorbed in compost before becoming saturated (sawdust/bark fines)
0.3	107	70	1.6 mos sawdust / 1.0 mos bark fines
0.5	178	118	2.6 mos sawdust / 1.7 mos bark fines
0.75	266	176	3.9 mos sawdust / 2.6 mos bark fines
1	355	235	5.2 mos sawdust / 3.5 mos bark fines
Average precipitation is 68 L/month per m^2 of pad.			
10-yr, 24-hr storm would have an estimated 48.7 L of runoff per m^2 of pad, therefore a 0.3 m per m2 pad would become saturated in 2.1 days (sawdust) or 1.4 days (bark fines)			
20-yr, 24-hr storm would have an estimated 64.4 L of precipitation per m^2 of pad, therefore a 0.3 m per m2 pad would become saturated in 1.7 days (sawdust) or 1 days (bark fines)			
50-yr, 24-hr storm would have an estimated 89.4 L of precipitation per m^2 of pad, therefore a 0.3 m per m2 pad would become saturated in 1.2 days (sawdust) or 0.8 day (bark fines)			

1. Calculation accounts for the moisture already in the sawdust or bark fines before adding the precipitation.
2. Results assume monthly rainfall (6.8 cm on average) runs off and is ponded over the sawdust/bark fine pad between the windrows. This is highly conservative as some precipitation will infiltrate and be absorbed by the compost or would evaporate on dry days.

Information on the 1,000m^2 concrete pad to be used for the aeration compost area has been supplied separately. This and the concrete mixing pad will have stormwater control features that will direct leachate and stormwater on concrete towards a stormwater containment area. Stormwater calculations for the aeration pad were undertaken as summarised in Table 4. A lined pond or holding tanks with the capacity to hold the 50-year storm event will be utilised.

Based on this information a stormwater plan has been prepared as shown in Figures 1, 2 and 3. The amount of runoff expected in each containment area and the size of the bunds has been calculated using the Auckland Regional Council guidelines for stormwater management (TP108 1999). The calculations are attached.

A stormwater Management Plan will be developed that indicates when the sawdust pad around the compost windrows will need to be removed and replaced with fresh sawdust depending on the weather. A programme for testing the moisture content of the compost and pads will also be developed to check that no materials are approaching full saturation.

The leachate and stormwater for all compost is expected to be properly managed to mitigate the seepage of compost-influenced water into the ground except in very high intensity storm events which will likely have very dilute amounts of nitrogen.

Table 4. Stormwater Management Estimate (1,000 m^2 (24 x 40 m) Compost Aeration Pad, Varying Storm Events)

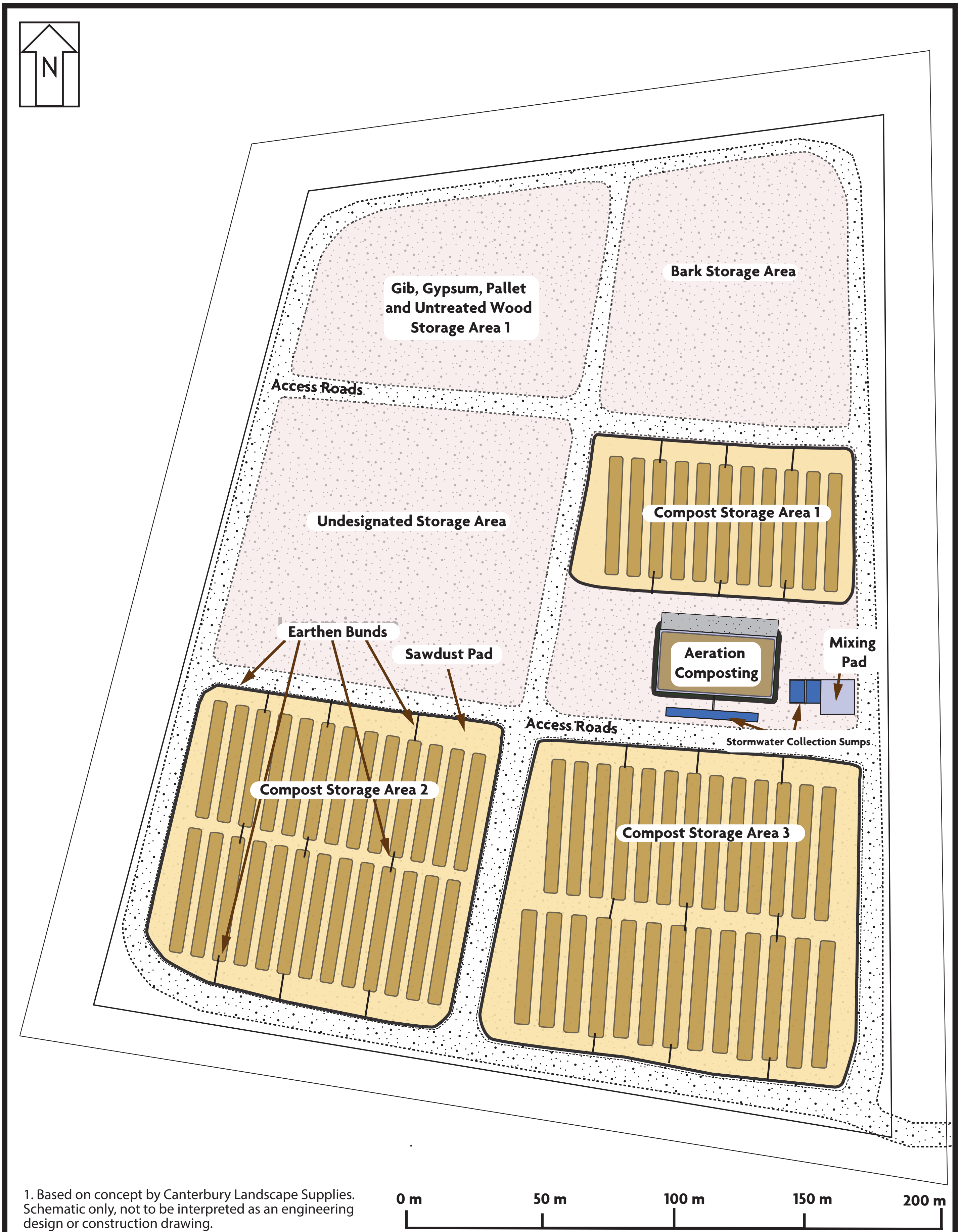
Storm Event	Size of Pad (m2)	Depth of rainfall[1], (mm)	Runoff after rainfall losses[2], (mm)	Volume of stormwater after rainfall losses[2], (m^3)	Required depth of 300 m^2 flat collection area adjacent to aeration pad (m)
10-year, 24 hour	1,000	95.5	48.7	48.7	0.16
20-year, 24 hr	1,000	113.9	64.4	64.4	0.21
50-year, 24 hr	1,000	142.2	89.4	89.4	0.30

Notes:

[1] NIWA HIRDS calculator, accounts for 2 degrees of climate change

[2] Runoff (mm) calculated assuming an Initial Abstraction Depth (AI) of 5 mm and Curve Number (CN) of 81 (Group B Soil, Alluvial – Crops, straight rows, minimal vegetative cover), Auckland Regional Council Guidelines for stormwater runoff modelling in the Auckland Region, TP 108, April 1999.

[3] Assumes pad with is 40 m long and 25 m wide, and the slope is parallel with the long side of the pad.



1. Based on concept by Canterbury Landscape Supplies. Schematic only, not to be interpreted as an engineering design or construction drawing.

CLS Diversion Road Compost Facility	
A0272	Site Layout with Stormwater Management Features

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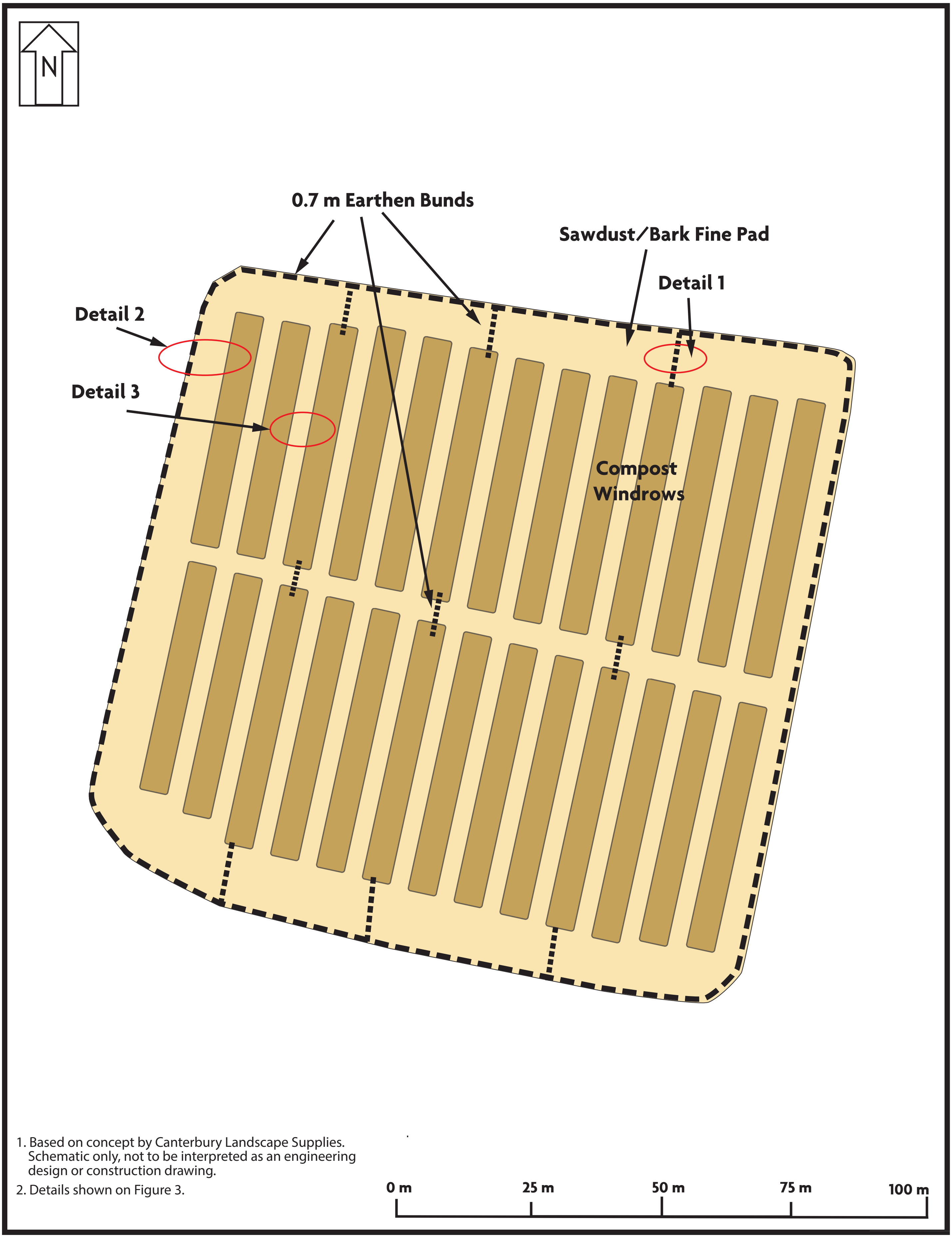
Figure 1



1. Based on concept by Canterbury Landscape Supplies. Schematic only, not to be interpreted as an engineering design or construction drawing.
2. Details shown on Figure 3.

CLS Diversion Road Compost Facility	
A0272	Typical Curing and Mature Compost Storage Area SW Management Features

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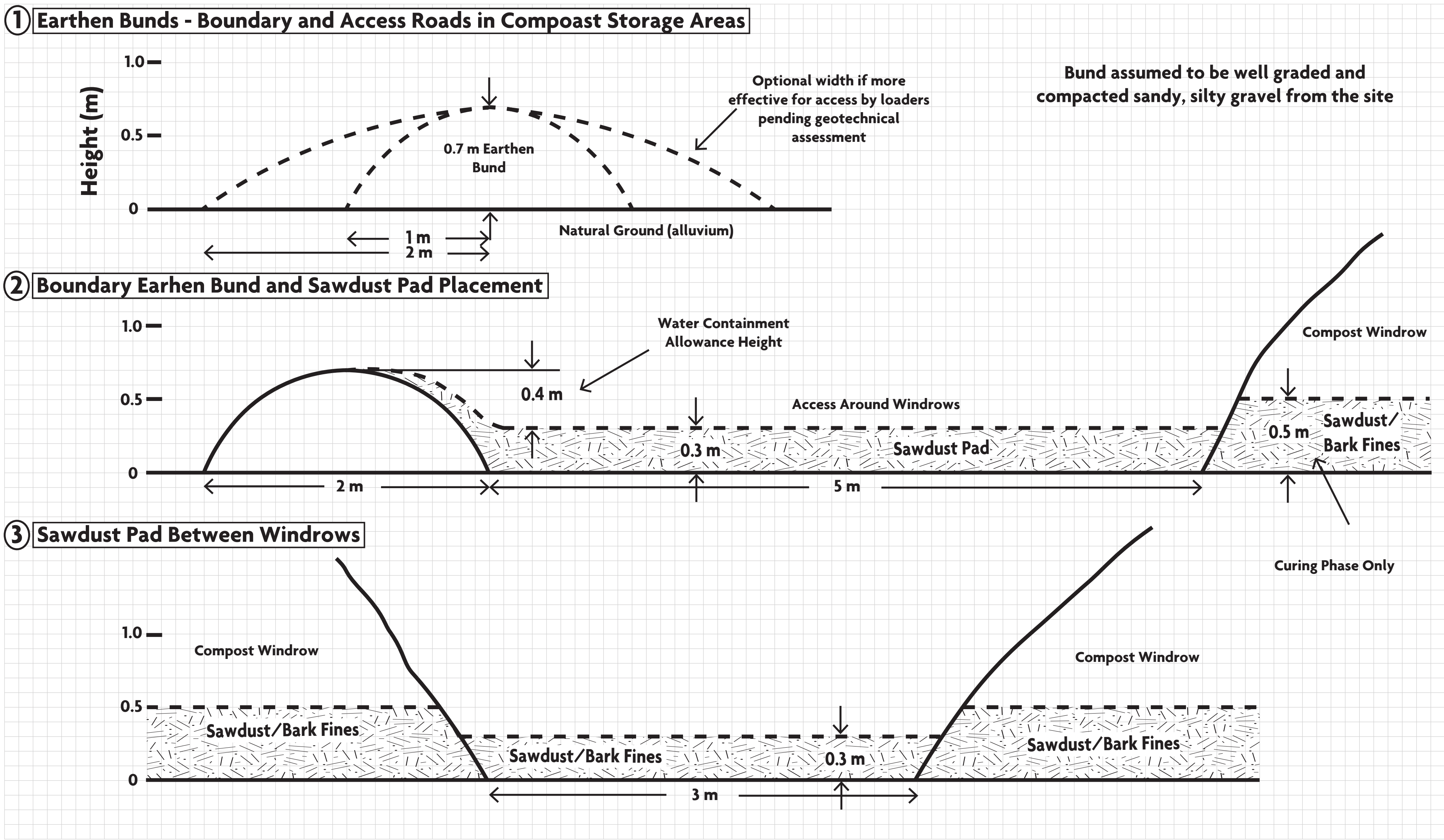
Figure 2



1. Schematic only, not to be interpreted as an engineering design or construction drawing. No geotechnical assessment was undertaken to confirm that earthen bunds would withstand the weight of loaders driving over them.

Canterbury Landscape Supplies Diversion Road Compost Facility	
A0272	Conceptual Sections for Compost Storage Area Stormwater Management Features

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Figure 3

2.0 Location of Springs within 2 Km of the Site and Headwaters of Silverstream

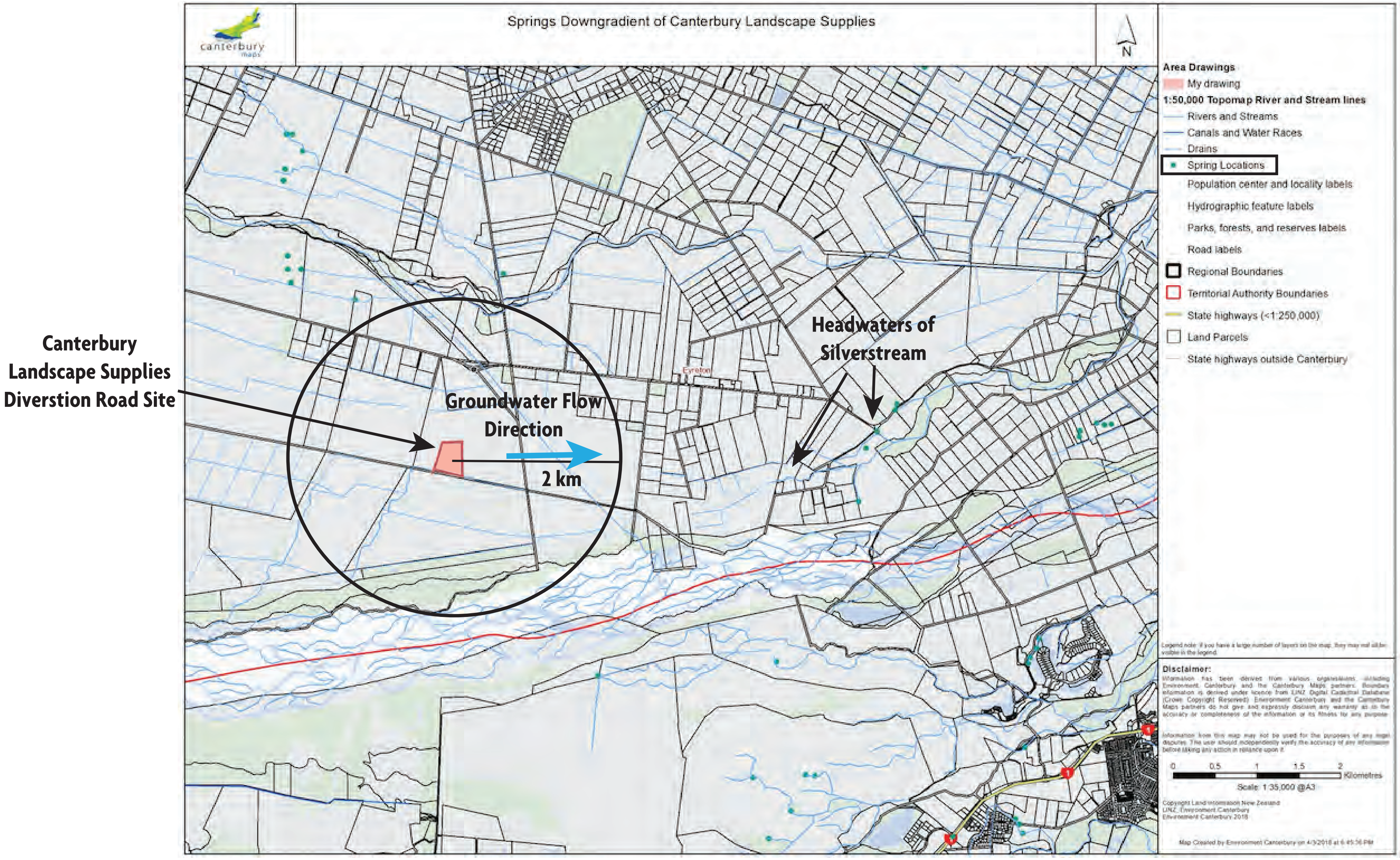
This section responds to:

vii. A map showing any recorded springs within 2km of the application site and the headwaters of Silver Stream;

The Environment Canterbury www.canterburymaps.org.nz database was used to depict the location of springs within 2 km of the Diversion Road composting facility and the headwaters of Silverstream. These are shown on Figures 4 and 5.

No springs have been identified by Environment Canterbury in the site vicinity or along Eyre River Diversion. Springs downgradient of the site correspond to the location of the headwaters of Silverstream indicating that groundwater table is similar in elevation to the river bottom at these locations. During dry periods the headwaters of Silverstream are likely sourced exclusively from groundwater.

These Figures support the conclusion that the groundwater table in the area of the site would not rise high enough to present at the ground surface under normal circumstances. This is demonstrated by the water levels in wells within the vicinity of the site.



1.Base map from www.canterburymaps.org.nz.

Canterbury Landscape Supplies Diversion Road Compost Facility	
A0272	Location of Springs in Regional Area of Site

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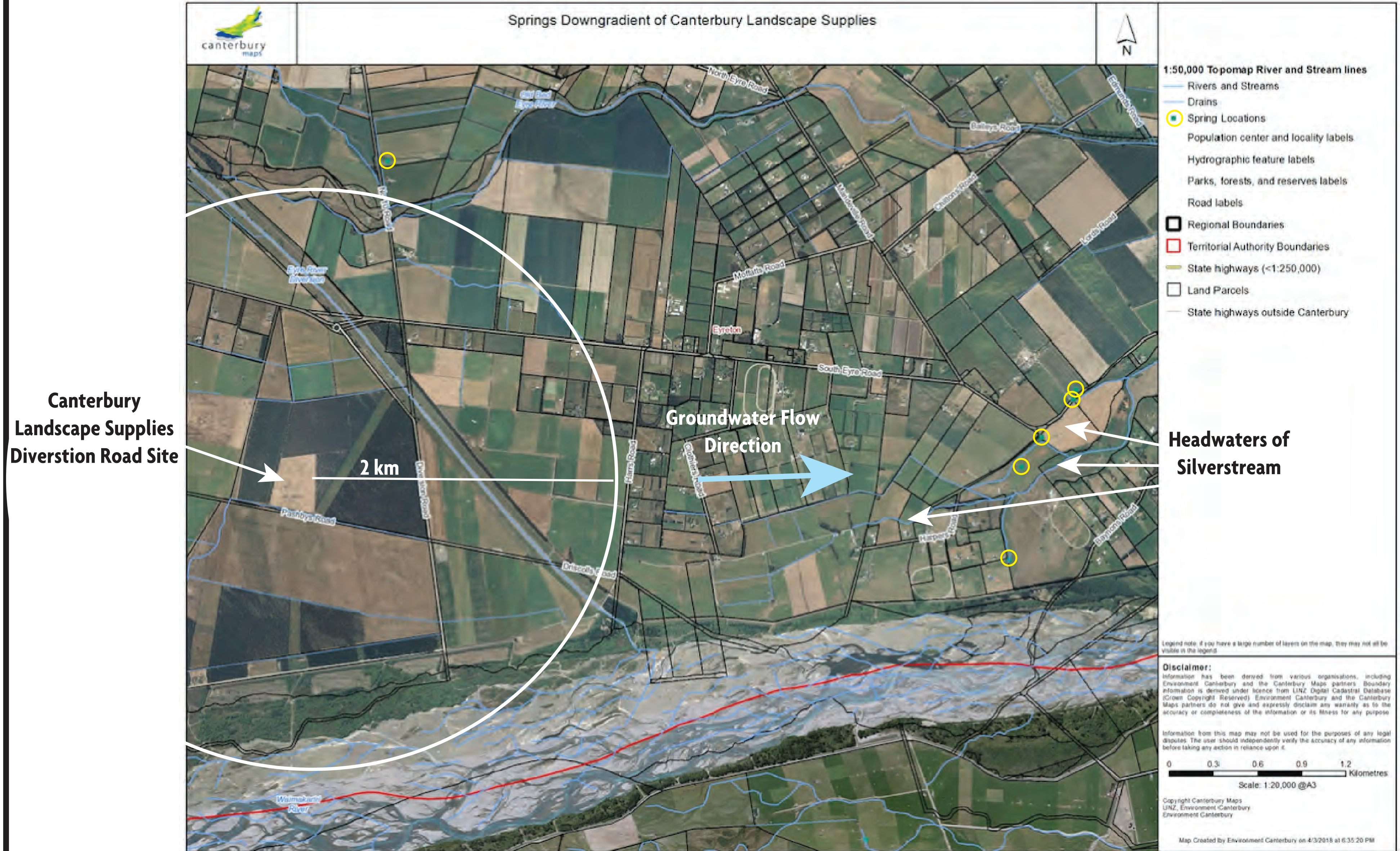
Figure 4



1. Base map from www.canterburymaps.org.nz.

Canterbury Landscape Supplies Diversion Road Compost Facility	
A0272	Location of Springs Downgradient and Local to the Site

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Figure 5

3.0 Nitrogen Discharge in Runoff and Leachate from Curing-Phase Compost

This section responds to:

xi. Information regarding the predicted rate of nitrogen discharge (including ammonia nitrogen and nitrate nitrogen) in runoff and leachate from curing phase compost not proposed to be held on a bunded and impermeable surface;

A question was raised regarding the potential amount of nitrogen discharge in runoff from unbunded piles. Further testing of surface water was undertaken on 23 March 2018 (Table 5 shows all data to date). The latest data shows that any runoff from the compost piles will likely have low concentrations of ammonia-nitrate and essentially no nitrate-nitrogen or nitrite-nitrogen. The amount of ammonia-nitrogen, if converted to nitrate-nitrogen, would be less than the drinking water standard. The laboratory report is attached.

Even though the concentrations of nitrogen are expected to be low, the surface water and leachate will be managed through control on concrete pads or sawdust/bark fine pad as discussed in Section 1.

Table 5. Nitrogen Results for Surface Water

	Total Nitrogen	NOx (oxides of Nitrogen)	Ammonia	Nitrate	Nitrite
20 July 2017 SW-1 (near middle-aged pile)	**550.23**	0.23	**550**	0.21	<0.02
20 July 2017 SW-2 (near new pile)	**210.15**	0.15	**210**	0.12	0.03
12 October 2017 SW-1 (between middle-aged piles)	**60.02**	0.02	**60**	<0.02	<0.02
12 October 2017 SW-2 (run off slightly distant from outside of oldest pile)	**19.2**	<0.02	**19.2**	<0.02	<0.02
23 March 2018 SW-1 (run off from between curing-phase piles)	**22**	<0.02	**22**	<0.02	<0.02
23 March 2018 SW-2 (runoff from between curing phase piles)	**32.11**	0.11	**32**	<0.1	<0.1
Anticipated surface water concentration in a 50-year, 24-hr storm that could	1.5	‹0.02	1.5	<0.02	<0.02

	Total Nitrogen	NOx (oxides of Nitrogen)	Ammonia	Nitrate	Nitrite
potentially be lost to groundwater					
Groundwater					
NZ DWS[2]	--		1.5[3]	50	0.2 /3[4]
ANZECC Stock Water [5]	--	--	--	400	30
Surface Water					
ANZECC Recreational[6]				10	1
ANZECC Lowland River[7]	0.614	0.444	0.021	--	--

Notes:

1. Results in mg/l (referred to as g/m^3, mg/l or mg-N/l). Bolded values exceed the adopted assessment criteria.
2. New Zealand Drinking Water Standards (NZDWS)– Maximum Allowable Value (MAV), New Zealand Ministry of Health, Revised 2008. Nitrate standard in mg/L as NO_3 and nitrate standard in mg/L as NO_2.
3. NZDWS (2008) aesthetic guideline value.
4. NZDWS for nitrite (short-term)/Standard for nitrite (long-term)
5. Australian and New Zealand Guidelines for Fresh and Marine Water Quality - Stock water quality guidelines for cattle. Australian and New Zealand Environment and Conservation Council (ANZECC) October 2000.
6. Australian and New Zealand Guidelines for Fresh and Marine Water Quality - Recreational guidelines. Australian and New Zealand Environment and Conservation Council (ANZECC) October 2000.
7. Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Table 3.3.10 Default trigger values for physical and chemical stressors in New Zealand for slightly disturbed ecosystems. Australian and New Zealand Environment and Conservation Council (ANZECC) October 2000.

4.0 Groundwater Flow Rate

This section responds to:

xii. Confirmation of the expected rate of groundwater flow beneath the site, taking into account the additional information that has come to light during the course of the hearing;

The Pattle Delamore Partners February and August 2001 hydrogeologic assessments for Waimakariri District Council, regarding Rangiora Effluent Irrigation, and their May 2015 Review of Eyre River – Christchurch West Melton Groundwater Allocation Zone Interaction report for Environment Canterbury, were reviewed and the assumptions regarding groundwater hydraulic conductivities and flow rates were assessed. A groundwater flow rate of 5 m/day was assumed in the PDP models for the alluvial sediments when assessing nitrogen transport. This coverts to 5.78×10^{-5} m/s which is slower than the assumed hydraulic conductivity used in the Sephira Environmental groundwater contaminant model (5×10^{-3} m/s or 446 m/day). The PDP reports acknowledges the variability of broad scale and local flow patterns. The geology will dictate the rate and volume of water that can be carried from the site toward downgradient receptors and it will vary from location to location. The estimate used in the original Sephira Environmental transport model is considered reasonable and continues to demonstrate that some discharge of nitrogen from the site is unlikely to cause adverse effects to downgradient receptors. Nonetheless, engineering controls are being implemented to mitigate discharge from the site.

Kind regards,

Helen Mongillo
Principal Environmental and Engineering Manager, Hydrogeologist

Sephira Environmental Limited
www.sepiraenvironmental.co.nz

Attachments:

1. Laboratory Analytical Report
2. Calculation sheets for stormwater assessment.

Hill Laboratories
TRIED, TESTED AND TRUSTED

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Certificate of Analysis

Client:	Sephira Environmental	**Lab No:**	1951120 SPv1
Contact:	H Mongillo	**Date Received:**	24-Mar-2018
	C/- Sephira Environmental	**Date Reported:**	29-Mar-2018
	101A Mays Road	**Quote No:**	91309
	St Albans	**Order No:**	
	Christchurch 8052	**Client Reference:**	A0272
		Submitted By:	H Mongillo

Sample Type: Miscellaneous

	Sample Name:	SD-1 (0.0-0.1m) 23-Mar-2018 2:38 pm	SD-2 (0.3-0.35m) 23-Mar-2018 2:40 pm	SD-3 (0.4-0.5m) 23-Mar-2018 2:42 pm	CMPST-1 (Bottom) 23-Mar-2018 2:56 pm	SD/BF-1 (Below Compost) 23-Mar-2018 3:46 pm
	Lab Number:	1951120.1	1951120.2	1951120.3	1951120.4	1951120.5
Dry Matter	g/100g as rcvd	33	37	36	63	56
Moisture*	g/100g as rcvd	67	63	64	37	44

	Sample Name:	SD/BF-2 (Access Road - Wet) 23-Mar-2018 4:25 pm				
	Lab Number:	1951120.6				
Dry Matter	g/100g as rcvd	36	-	-	-	-
Moisture*	g/100g as rcvd	64	-	-	-	-

Sample Type: Aqueous

	Sample Name:	SW-23-Mar-Curing 23-Mar-2018 4:08 pm	SW-23-Mar-Curing 2 23-Mar-2018 4:19 pm			
	Lab Number:	1951120.7	1951120.8			
Total Ammoniacal-N	g/m^3	22	32	-	-	-
Nitrite-N	g/m^3	< 0.2 #1	< 0.10	-	-	-
Nitrate-N	g/m^3	< 0.2	< 0.10	-	-	-
Nitrate-N + Nitrite-N	g/m^3	< 0.2 #1	0.11	-	-	-

Analyst's Comments

#1 Severe matrix interferences required that a dilution be performed prior to analysis of this sample, resulting in a detection limit higher than that normally achieved for the NO2N, NO3N and NOxN analysis.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Miscellaneous

Test	Method Description	Default Detection Limit	Sample No
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed). US EPA 3550.	0.10 g/100g as rcvd	1-6
Moisture*	Calculated from (100 - Dry Matter %). DM performed at 103°C for 18hr.	0.10 g/100g as rcvd	1-6

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter. Performed at Hill Laboratories - Chemistry; 101c Waterloo Road, Christchurch.	-	7-8

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Total Ammoniacal-N	Filtered Sample from Christchurch. Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) 22nd ed. 2012.	0.010 g/m^3	7-8
Nitrite-N	Filtered sample from Christchurch. Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I 22nd ed. 2012 (modified).	0.002 g/m^3	7-8
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N. In-House.	0.0010 g/m^3	7-8
Nitrate-N + Nitrite-N	Filtered sample from Christchurch. Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I 22nd ed. 2012 (modified).	0.002 g/m^3	7-8

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

Ara Heron BSc (Tech)
Client Services Manager - Environmental

Client/Project: CLS		Sephira ENVIRONMENTAL	Page 1 of 1
Project No.: A0272	Calculation Sheet		
Date of Calculation: 5-Apr.18	Calculations by: Helen Mongillo	Date of Review: 5 April 18	Reviewed by: Brett Mongillo

Absorption Capacity of Sawdust / Bark Fine Pad

Precipitation
6.8 cm / month
10 yr storm runoff 4.87 cm / day
20 yr storm runoff 6.44 cm / day
50 yr storm runoff 8.94 cm / day

Sawdust % Moisture
69%
Sawdust Absorption Capacity
327%
Bark Fine Absorption Capacity
245%

Assume Dry Bulk Density of Sawdust / Loose = 139 kg/m3 (Briggs 1994)
Dry Bulk Density of Bark Fines / Loose = 132 kg/m3 "

Example: $0.5\ m^3$ Dry sawdust $\times \frac{139\ kg}{m^3} \times 3.27 \frac{kg\ H_2O}{kg\ \text{Saw Dust Dry}}$ = 227.2 kg or L

↑ Absorption capacity based on Lab Test

Amount that can be contained

$0.3\ m^3$ Dry Sawdust = 136 L of water
$0.5\ m^3$ Dry sawdust = 227 L H_2O
$0.75\ m^3$ " = 340 L H_2O
$1\ m^3$ " = 454 L H_2O

$0.3\ m^3$ Dry Bark Fines = 97 L H_2O
$0.5\ m^3$ " = 161 L H_2O
$0.75\ m^3$ " = 243 L H_2O
$1\ m^3$ " = 322 L H_2O

reduced to account for moisture content of sawdust

Example
$\frac{69}{327} = 0.2188$
(227 L = 227.2 × 0.2188) = 175.5 L

Client/Project: Canterbury Landscape Supplies (CLS) Diversion Rd		Sephira ENVIRONMENTAL	
Project No.: A0272	Calculation Sheet		
Date of Calculation: 26/3/18	Calculations by: Helen Mongillo	Date of Review:	Reviewed by:

Rainfall Runoff Calculation

Based on Auckland Regional Council Technical Pub No. 108, April 1999 Guidelines for Stormwater Runoff modelling

Assumptions:

Location: Diversion Rd, Swannanowa, Compost Windrows

Soil Classification: Group B - Alluvial Soils (Table 3.2)

Curve Number (CN): 81, based on "Crops, straight rows, minimal vegetative cover." (Table 3.3)

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S}$$

where

Q = runoff depth (mm)

P = rainfall depth (mm)

S = potential maximum retention after runoff begins (mm)

I_a = initial abstraction (mm)

↗ Equation 3.1

Equation 3.2

$$S = \left(\frac{1000}{CN} - 10\right) 25.4 \text{ (mm)}$$

$$S = \left(\frac{1000}{81} - 10\right) 25.4$$

$$S = (12.35 - 10)\, 25.4$$

$$S = 59.6 \text{ mm}$$

$$I_a = 0.2S$$

$$I_a = 0.2 \times 59.6$$

$$I_a = 11.92$$

P varies w/ storm event. Based on HIRDS estimate (see Attached) (NIWA online Calculator)

24hr Storm	P (mm)
10 yr	95.5 m
20 yr	113.9 m
50 yr	142.2 m

See Next Page for Runoff Estimates

Client/Project: CLS Diversion Rd		Sephira ENVIRONMENTAL	Page 2 of 2
Project No.: A0272	Calculation Sheet		
Date of Calculation: 26/3/18	Calculations by: Helen Mongillo	Date of Review:	Reviewed by:

Rainfall Runoff Calculation

$Q_{10\text{-yr}}$, 24 hr storm

$$Q_{10} = \left(\frac{(95.5 - 11.92)^2}{(95.5 - 11.92) + 59.6}\right)$$

$$= \frac{6{,}985.6}{83.6 + 59.6}$$

$$= \frac{6{,}985.6}{143.18}$$

$$= 48.7 \text{ mm}$$

$Q_{20\text{yr}}$, 24 hr Storm

$$Q_{20} = \frac{(113.9 - 11.92)^2}{(113.9\text{m} - 11.92) + 59.6}$$

$$= \frac{10{,}400}{102 + 59.6}$$

$$= \frac{10{,}400}{161.6}$$

$$= 64.4 \text{ mm}$$

$Q_{50\text{-yr}}$, 24 hr Storm

$$Q_{50} = \frac{(142.2 - 11.92)^2}{(142.2 - 11.92) + 59.6}$$

$$= \frac{16{,}973}{130.28 + 59.6}$$

$$= \frac{16{,}973}{189.9}$$

$$= 89.4 \text{ mm}$$

Calculate Bund Heights Around Compost Storage Areas

Assumes 3 Areas of Compost Storage

Area 1 - North of mixing Area, Approx 60 m (N-S) x 120 m (E-W) = 7,200 m^2

Area 2 - South of mixing Area, Approx. 110 m (N-S) x 120 m (E-W) = 13,200 m^2

Area 3 - Southwest of mixing Area, Approx 110 m (N-S) x 145 m (E-W) = 16,000 m^2

The Slope of the Compost Storage Areas are assumed to be flat and sloping 1% to 2% to the east, parallel with the East-west length.

The storage areas are assumed to store windrows of maximum size of 6 m wide x 48 m long

Based on this size the number of windrows per Area are:

Area 1 - 11 windrows
Area 2 - 26 windrows
Area 3 - 26 windrows

* The windrows are assumed to be surrounded by a 5 m wide access road and the bund would be on the outside of the access road.

Volumes of rain to be contained based on Rainfall Runoff Calculation and size of pads. (m^3)

24-hr Storm Frequency	Q - Rainfall Runoff (mm)	Volume to be Contained (m^3) Area 1	Area 2	Area 3
10-yr	48.7 mm	351	~~777~~ 643	777
20-yr	~~40~~ 64.4 mm	464	~~1,027~~ 850	1,027
50-yr	89.4 mm	644	~~1,426~~ 1,180	1,426

Example (10-yr storm, Area 1): 60 m x 120 m x (48.7 mm/1000) = 351 m3

Client/Project: CLS - Diversion Road		Sephira ENVIRONMENTAL	Page 2 of 3
Project No.: A0272	Calculation Sheet		
Date of Calculation: 2-Apr-18	Calculations by: Helen Mongillo	Date of Review:	Reviewed by:

Calculate Bund Heights Around Compost Storage Areas

Calculate Bund Heights

Method: Convert slope from percent to radians

Example 1% slope = 0.57 degrees

Bund height if slope of pad is parallel to slope:

(1) First calculate length along slope, assuming known volume to be contained, ~~and~~ containment area width and slope:

Length along slope (m): $\sqrt{\dfrac{2 \times (\text{volume to contain (m}^3) / \text{width of pad (m)})}{\text{Tangent of slope in } \sout{\text{radians}} \text{ degrees}}}$

Example:

Area 1 (width = 60 m + Length of slope = 120 m), 10 yr storm

Slope = 1% or 0.57 radians (degrees)

Length Along Slope (m) $= \sqrt{\dfrac{2 \times (351 / 60)}{\text{Tan}(0.57)}} = \sqrt{\dfrac{11.7}{\sout{0.64}\ \sout{0.001}\ 0.01}}$

$= 34.2$ m

(2) Calculate the height of the bund to contain the water, assuming Bund is vertical.

Height of Bund (m) = Length along Slope × Tan (slope in degrees)

Example from Above:

Height of Bund (m) = 34.2 m × Tan (0.57)

= 34.2 m × 0.01

= 0.34 m

Length Flooded along slope

24 hr Storm		Area 1		Area 2		Area 3	
	Slope	1%	2%	1%	2%	1%	2%
10 yr	Bund Height (m)	0.34	0.48	0.384	0.48	0.38	0.53
	Length (m)	34.2	24.2	~~37.6~~ 34.2	24.2	37.6	26.6
20 yr	Bund	0.39	0.56	~~0.43~~ 0.36	0.56	0.43	0.61
	Length	39.3	27.8	39.3	27.8	43.2	30.6
50 yr	Bund	0.46	0.66	0.46	0.66	0.51	0.72
	Length	46.3	32.8	46.3	32.8	56.9	36.6

Assumes flow is parallel to the Length of Pad.

Assumes No Compost on pad.

Calculate Bund Heights Around Compost Storage Areas

(3) Adjust Length Along slope to account for compost windrows ~~occupie~~ displacing stormwater.

	Area of Pad	Area of Compost	% Covered	% Open
Area 1	60 x 120 m = 7,200 m²	11 windrows 11 x 6m x 48m = 3,168 m²	44%	56%
Area 2	110 x 120 m = 13,200 m²	26 windrows 26 x 6m x 48m = 7,488 m²	57%	~~44%~~ 43%
Area 3	110 x 145 m = 16,000 m²	26 windrows 26 x 6m x 48m = 7,488 m²	47%	53%

* Assumes windrow size is 6m x 48 m

(4) Calculate adjusted flooded pad length as follows

Length along slope / % ~~open~~ of pad open

Example: ~~B~~ Area 1, 10 yr storm, 1% slope

34.2 m / 0.56 = 61 m

Adjusted Length Along slope flooded to account for compost

24-hr Storm	Area 1 1%	Area 1 2%	Area 2 1%	Area 2 2%	Area 3 1%	Area 3 2%
10 yr	61 m	43.2 m	~~61 m~~ 79.5 m	~~43.2 m~~ 56.3 m	70.9 m	50.2
20 yr	70.2 m	49.6 m	~~70.2 m~~ 91.4 m	~~49.6 m~~ 64.7	81.5 m	57.7 m
50 yr	82.7 m	58.6 m	~~82.7 m~~ 107.8 m	~~58.6 m~~ 76.3	107.4 m	67.9