



# **APPENDIX G**

## **URS Report**

29 April 2010  
Project No. 42170087.05000

Blackfish Limited  
PO Box 17-662

Attention: Michael Slee  
Director

Dear Michael,

**Subject: Porters Expansion Project - Assessment of Stability of Wastewater Disposal Area**

## 1 Introduction

URS New Zealand Limited (URS) was commissioned by Blackfish Limited (Blackfish) to provide recommendations for the location of a shallow wastewater disposal field in order to ensure that slope stability adjacent to Crystal Stream and Porter River is not adversely affected by wastewater flowing out of the slope face. A significant volume of treated wastewater will need to be disposed of as part of the Porters Expansion Project; a development that includes accommodation, dining and skiing facilities. A 403,636 m<sup>2</sup> area within the Ski Lease Boundary has been defined by Blackfish as the maximum area available for disposal. We understand that the wastewater will be discharged to ground using a typical shallow subsurface dripper network consisting of rows of parallel lines placed at equal spacing of approximately 1 m.

Initially CPG New Zealand Limited (CPG) requested that we confirm slope stability within, and adjacent to, the proposed wastewater disposal area (project meeting 17 February, 2010). Subsequently CPG has explored the possibility of increasing the loading rate of the subsurface wastewater dripper irrigation lines and asked that the effects of a variable rate be modelled (email from Victor Mthamo, CPG, to Matt Howard, 22 April, 2010 and subsequent telephone conversations).

This letter outlines the analysis that has been undertaken and summarises the results, providing recommendations of setback distances from the channel edge for different application rates. This study has involved a desktop assessment of ground conditions that has involved the use of LiDAR topographic data and aerial photographs. In addition, a brief site inspection was conducted by Matt Howard and Mark Mabin of URS on 26 March 2010.

## 2 Site Description and Geology

The proposed wastewater disposal area is bounded by Crystal Stream to the south, Porter River to the southeast and by the Ski Lease Boundary to the north (Drawing WW001). The foundation

URS New Zealand Limited  
URS House, 287 Durham Street  
Christchurch, 8013  
PO Box 4479, Christchurch 8140  
New Zealand  
T: 64 3 374 8500  
F: 64 3 377 0655

geology is similar to that in the proposed Village Base area, and consists of deposits that are either glacially deposited till or fluvio-glacial (glacial material that has been deposited by river processes) comprising silty/sandy gravel with cobbles derived from the surrounding greywacke sandstone (for a more detailed description of the regional geology, refer to the URS Geotechnical Summary Report, dated 22 April, 2010). These often form relatively low angle surfaces and their surfaces are characterised by dry stream channels formed by post glacial flood waters at the end of the last glaciation more than 12,000 years ago. Surface exposure shows that the gravel is unweathered and is loosely packed, which is typical of this material. Overlying this is an approximately 0.5 m thick layer of distinctive yellow loess silt, which is an air-borne post glacial deposit.

### **3 Land Stability Assessment**

The Crystal Stream and Porter River channels have been formed within the post glacial fan deposit, resulting in adjacent slopes that are typically 20-40 m high and 30-40 degrees from horizontal, which is the natural angle of repose for the silty/sandy gravel. In the northwestern part of Crystal Stream the slope is up to 100 m high.

The preservation of ancient post glacial channels on the fan surface indicates that this area is stable. These channels are likely to carry water only during storm events and their catchment is limited. At the edge of this surface, the slopes adjacent to Crystal Stream and Porter River are mostly covered in vegetation and are at or near the angle of repose for gravel. Areas that are undergoing active erosion are highlighted by zones of little or no vegetation cover (see Figure 1). In these areas gravel material gradually rolls/bounces/slides downhill until a stable slope angle is formed.

**Fig 1 Slope to the north of Crystal Stream, with the surface of the proposed wastewater disposal area above.**



## **4 Seepage Analysis**

A seepage analysis was performed to determine how close subsurface dripper lines could be located to the slope crest on the post-glacial fan surface without the water table rising above the slope toe. Water is a major controlling factor in the stability of slopes, and it is important that high volumes of wastewater inflows do not exit the slope.

The crest of the slope is defined in Drawing WW001. To the northeast, above the Porter River, this line is stepped back by approximately 100 m at the head of an ephemeral stream channel. This area is likely to have concentrated surface runoff during storm events and the additional setback reduces the possibility of wastewater encouraging greater surface storm flow.

As part of the analysis, seepage analysis was carried out using the finite element software in the program Slide (by RocScience). A simplified, typical cross section geometry was used to represent the discharge area, including:

- A horizontal top surface representing the discharge zone.
- A slope angle of 40 degrees from horizontal.
- A slope height of 40 m.
- A low permeability layer (i.e. greywacke bedrock), which was assumed to be present at a level 2 m below the base of the slope.
- A horizontal water table, which was assumed to be located at the base of the slope.

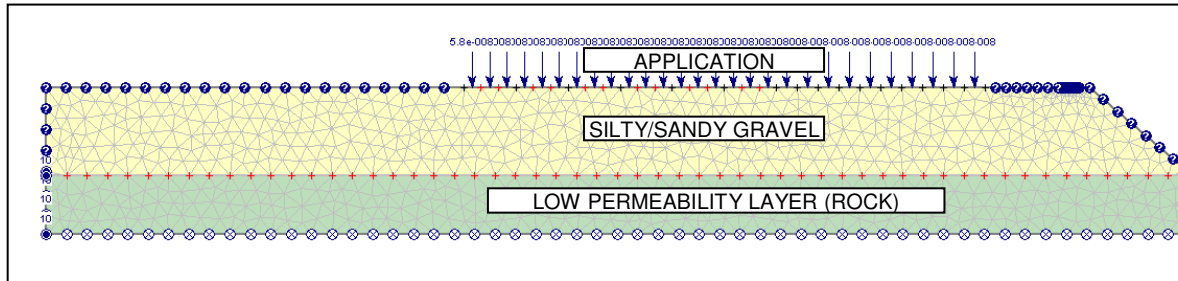
The above parameters are judged to be conservative and account for uncertainties in the model (i.e. depth to bedrock).

Data from four shallow depth infiltration tests were supplied by CPG (see attached Infiltration/Percolation Test Results), showing an infiltration range of between 240 and 320 mm/hr ( $7 \times 10^{-5}$  to  $9 \times 10^{-5}$  m/s). It is assumed that the dripper lines will be installed at a depth similar to where the infiltration tests occurred (buried in the ground below the loess horizon). We have assessed from our knowledge of the geology a permeability of no less than  $1 \times 10^{-5}$  m/s. This value has been used for the seepage analysis.

Once the model had been set up according to the parameters above (see Figure 2), an application rate of 5, 10, 15, 20, 30, 40 and 50 mm/day ( $5.8 \times 10^{-8}$  to  $5.8 \times 10^{-7}$  m/s) was separately applied. Several iterations were performed to identify how far the nearest infiltration could be to the top edge of the slope (see Drawing WW001) without the water table being raised above the slope toe. It was considered that when this occurs, the stability of the slope may become compromised.

Sensitivity analysis was also carried out for the ground permeability, using K values between  $1 \times 10^{-4}$  and  $1 \times 10^{-7}$  m/s.

**Fig 2 Slide seepage model showing layers of differing permeability and the infiltration area (arrows)**



## 5 Results and Discussion

The results of the seepage analysis are shown in Table 1 (see the end of this letter for graphical representations of the analysis). These show that for application rates of 5 and 10 mm/day for a ground permeability of  $1 \times 10^{-5}$  m/s, the distance between the application area and the crest of the slope is less than 5 m, without the water rising up the slope toe. If the application rate is increased to 15 mm/day, mounding of the water beneath the surface causes this distance to increase to 45 m. Increases in the application rate result in progressively larger setback distances (more than 225 m setback at 50 mm/day). The analysis suggests that it is possible that the bottom part of the slope may experience some seepage at the described offset distances. Very minor seepage, possibly resulting in evaporation, would not be expected to adversely affect the stability of the slope. The conservative assumptions of the model mean that such seepage is unlikely.

The model is sensitive to the permeability of the ground. For permeabilities of  $1 \times 10^{-4}$  m/s and application rates of up to 5-50 mm/day, the distance between the application area and the slope crest may be less than 5 m without the water rising up the slope toe. For the same application rate range in material with a permeability of  $1 \times 10^{-6}$  m/s, the distance between the application area and the crest is 250 m or greater.

This model uses conservative ground permeabilities to account for uncertainties in other aspects of the input to the analysis. Conservatism is expected to exist due to the permeability in the model being more applicable to the upper soils, where loess is present. At depth, where loess is absent or at lower concentrations, permeabilities would be expected to be higher. This is especially the case in the upper metre or so, where loess may be washed downwards by percolating groundwater. Permeability testing at depth would be required to determine if this was the case.

**Table 1 Results of seepage analysis showing variation of distance from slope crest with permeability and infiltration rate. Shading denotes 'best estimate' design.**

<b>P</b>	<b>K</b>	<b>D</b>
<b>Application Rate</b>	<b>Soil Hydraulic Conductivity (m/s)</b>	<b>Distance from slope edge (m)</b>
5mm/day ( $5.8 \times 10^{-8}$ m/s)	$1 \times 10^{-4}$	<5
	$1 \times 10^{-5}$	<5
	$1 \times 10^{-6}$	250
	$1 \times 10^{-7}$	>250
10mm/day ( $1.2 \times 10^{-7}$ m/s)	$1 \times 10^{-4}$	<5
	$1 \times 10^{-5}$	<5
	$1 \times 10^{-6}$	>250
	$1 \times 10^{-7}$	>250
15mm/day ( $1.7 \times 10^{-7}$ m/s)	$1 \times 10^{-4}$	<5
	$1 \times 10^{-5}$	45
	$1 \times 10^{-6}$	>250
	$1 \times 10^{-7}$	>250
20mm/day ( $2.3 \times 10^{-7}$ m/s)	$1 \times 10^{-4}$	<5
	$1 \times 10^{-5}$	100
	$1 \times 10^{-6}$	>250
	$1 \times 10^{-7}$	>250
30mm/day ( $3.5 \times 10^{-7}$ m/s)	$1 \times 10^{-4}$	<5
	$1 \times 10^{-5}$	200
	$1 \times 10^{-6}$	>250
	$1 \times 10^{-7}$	>250
40mm/day ( $4.6 \times 10^{-7}$ m/s)	$1 \times 10^{-4}$	<5
	$1 \times 10^{-5}$	225
	$1 \times 10^{-6}$	>250 m
	$1 \times 10^{-7}$	>250 m
50mm/day ( $5.8 \times 10^{-7}$ m/s)	$1 \times 10^{-4}$	<5 m
	$1 \times 10^{-5}$	>250 m
	$1 \times 10^{-6}$	>250 m
	$1 \times 10^{-7}$	>250 m

## 6 Conclusions

The proposed disposal area is considered to be suitable for the discharge of treated wastewater. Slopes at the edge of the post glacial fan surface adjacent to the Crystal Stream and Porter River are naturally either stable, or have small scale erosion of their surfaces. It is judged unlikely that



slope stability in these areas will be affected by wastewater discharge, as long as the setback distances outlined in Table 2 are followed.

## 7 Recommendations

It is recommended that the setback distances from the slope crest detailed in Table 2 are used in order to minimise the possibility of adversely affecting the stability of the stream slopes due to additional water seeping out of the slope face. Application rates of 40 or 50 mm/day are not considered practical, as the large setback distance means that the area for disposal is too small.

The offset lines are shown in Drawing WW001 and illustrate how the area available for wastewater disposal diminishes rapidly with increasing offset distance.


The analysis has made several conservative assumptions. If the discharge recommendations inhibit the development of the wastewater treatment area, then further infiltration testing may be warranted to better characterise the permeability of the subsurface.

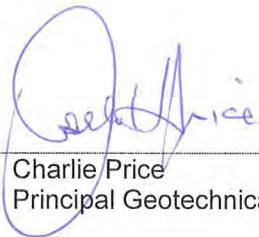
**Table 2** Suggested offset distance of wastewater disposal from the slope crest for different application rates, and associated disposal area (for a ground permeability of  $1 \times 10^{-5}$  m/s)

P	D	
Application Rate	Distance from slope edge (m)	Approximate area for disposal (Ha)
5mm/day ( $5.8 \times 10^{-8}$ m/s)	5	31.3
10mm/day ( $1.2 \times 10^{-7}$ m/s)	5	31.3
15mm/day ( $1.7 \times 10^{-7}$ m/s)	45	24.0
20mm/day ( $2.3 \times 10^{-7}$ m/s)	100	15.8
30mm/day ( $3.5 \times 10^{-7}$ m/s)	200	4.8
40mm/day ( $4.6 \times 10^{-7}$ m/s)	NA	NA
50mm/day ( $5.8 \times 10^{-7}$ m/s)	NA	NA

We trust that the information above meets your requirements. Please do not hesitate to contact us if you have any further questions.

Yours sincerely  
**URS New Zealand Limited**

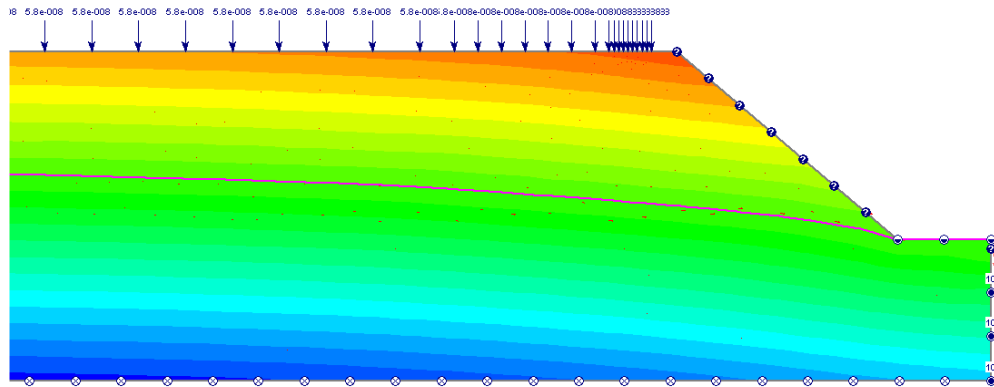
  
Matt Howard  
Associate Engineering Geologist

  
Charlie Price  
Principal Geotechnical Engineer

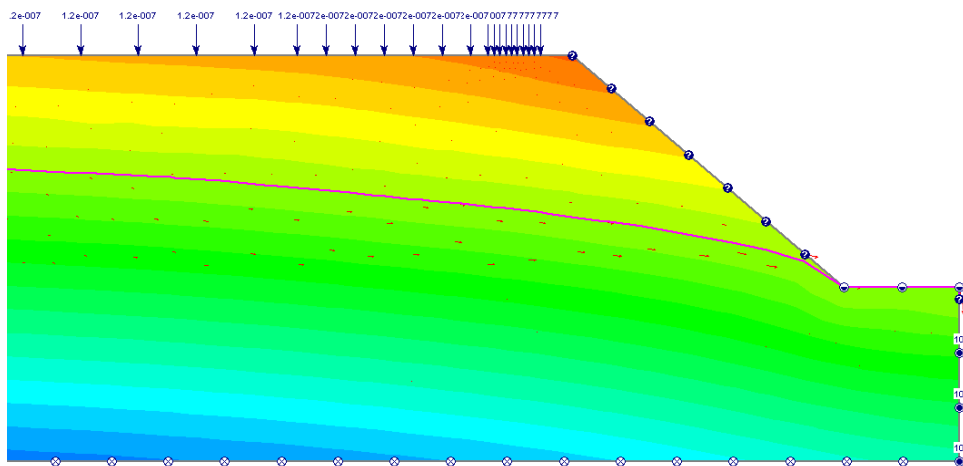
Attachments – CPG Infiltration/Percolation Test Results

Michael Slee  
Director  
29 April 2010  
Page 7

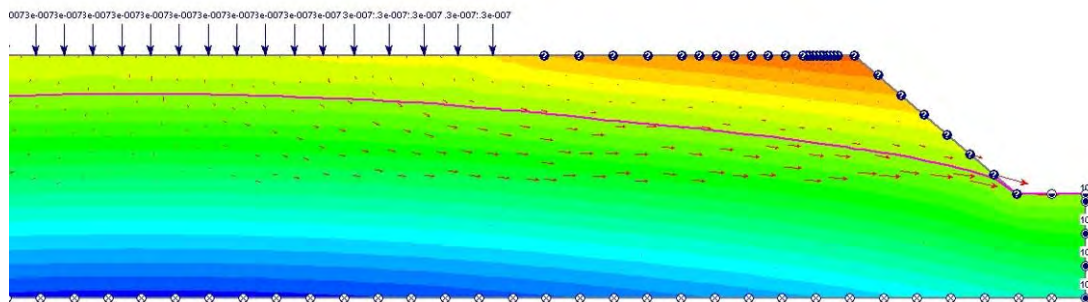
## Appendix – Slide seepage cross sections



Infiltration rate of 5mm/day – 5m from edge

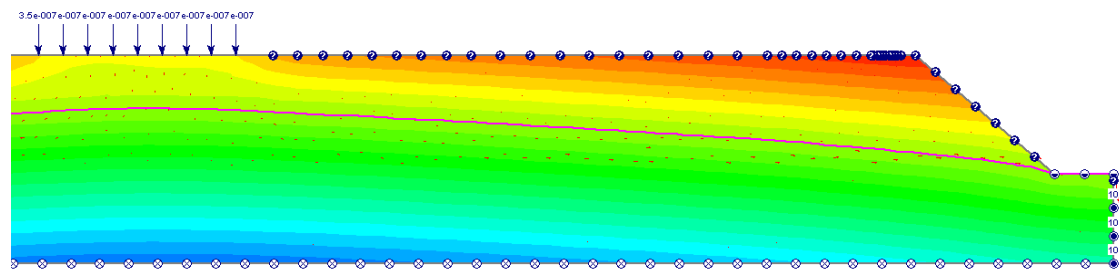


Infiltration rate of 10mm/day – 5m from edge

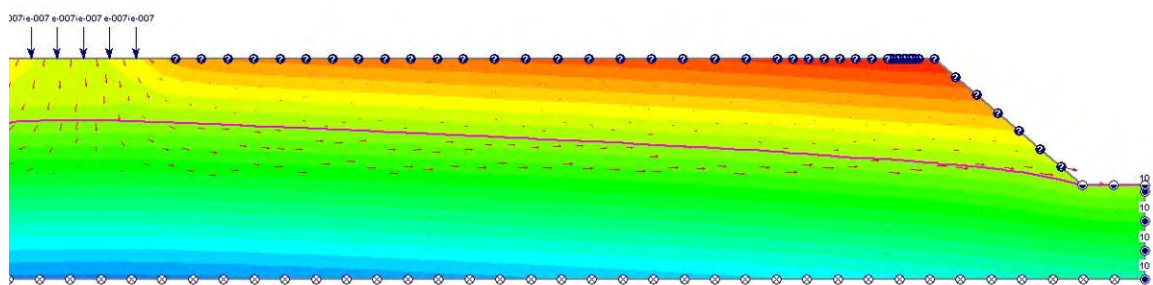


Infiltration rate of 20mm/day – 100m from edge

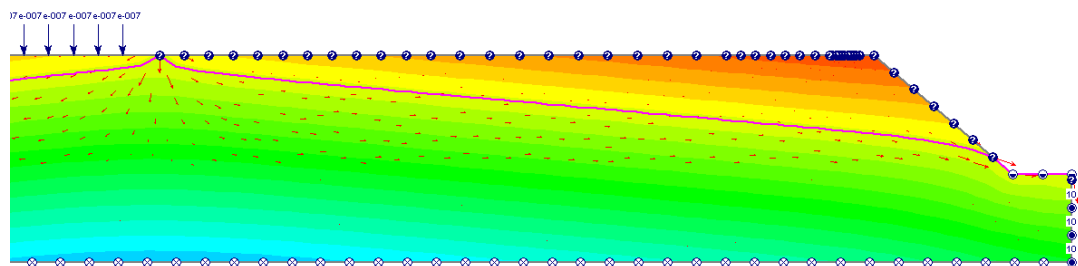




Infiltration rate of 30mm/day – 225m from edge



Infiltration rate of 40mm/day – 250m from edge



Infiltration rate of 50mm/day – 250m from edge



# **APPENDIX H**

## **Netafim Product Specification Sheet**

## Pressure Compensated Dripperline

# Bioline AS

For domestic greywater and onsite water reuse applications



### Applications:

- Installed following a treatment process
- Reuse applications for sub-surface or on-surface irrigation in domestic greywater treatment systems or domestic onsite treatment systems



### Features & Benefits:

- Anti-siphon (AS) & self-flushing systems prevent dirt penetration and improve clog resistance
- Self compensating and self cleaning
- Physical barrier improving the resistance to clogging caused by root penetration
- Drippers capture water flow from the centre of the tubing - ensures that only the cleanest flow enters the dripper
- Largest filter and widest water passage within each dripper
- Unique TurboNet flow path
- Can be used subsurface or on surface under mulch



## Specifications:

- Dripper flow rates: 1.6l/hr, 2.0l/hr & 3.0l/hr
- Dripper spacings: 0.30m, 0.40m, 0.50m & 1.0m
- Pressure compensating range 0.4 - 2.5 Bar for 1.6l/hr
- Pressure compensating range 0.4 - 3.0 Bar for 2.0l/hr & 3.0l/hr dripper
- Tubing diameter 13.0mm I.D. 15.4mm O.D.
- Tubing colour - co-extruded lilac indicating non potable
- Coil lengths 100m & 200m
- Minimum recommended filtration 130 micron, 120 mesh
- UV resistant
- Tubing Material - Low Density Polyethylene (LDPE)
- Additional flow, spacings, and pipe sizes are available by special order. Minimum quantities apply.



## Maximum Lateral Length:

	0.3m	0.4m	0.5m	0.6m	1.0m
<b>1.6l/hr</b>	40m	50m	61m	70m	105m
<b>2.0l/hr</b>	35m	43m	52m	61m	91m
<b>3.0l/hr</b>	26m	34m	41m	47m	70m

At 1.1 Bar inlet pressure on flat ground

	0.3m	0.4m	0.5m	0.6m	1.0m
<b>1.6l/hr</b>	89m	115m	139m	162m	243m
<b>2.0l/hr</b>	75m	96m	116m	135m	204m
<b>3.0l/hr</b>	57m	74m	90m	104m	157m

At 2 Bar inlet pressure on flat ground, 10m end pressure

### Netafim Australia

213 - 217 Fitzgerald Road, Laverton Vic 3026  
Ph 03 8331 6500 Fax 03 9369 3865  
Email [netinfo@netafim.com.au](mailto:netinfo@netafim.com.au)  
Website [www.netafim.com.au](http://www.netafim.com.au)

### Netafim New Zealand

13a Aintree Ave, Airport Oaks 2022  
Ph 09 256 2551 Fax 09 256 2552  
Email [auckland@netafim.co.nz](mailto:auckland@netafim.co.nz)  
Website [www.netafim.co.nz](http://www.netafim.co.nz)



# UniBioline CNL

Anti-drain & Anti-siphon

## For dispersal of wastewater

- Turbonet® labyrinth assures wide water passage, suitable for wastewater
- PC system for uniform flow rate from 100 - 400kpa
- Anti-siphon & self-flushing systems prevent dirt penetration and improves clogging resistance
- Anti-drain (CNL), prevents water drainage with no ponding of waste water
- Root physical barrier improves resistance to clogging caused by root penetration

## DRIPPERS TECHNICAL DATA

Flow rate	working pressure range	water passage dimensions width-depth-length	filtration area	constant	exponent*	shut-off pressure
(l/h)	(kpa)	(mm)	(mm <sup>2</sup> )	K	X	(kpa)
1.6	100 - 400	1.26 x 0.70 x 40	130	1.6	0	140
2.3	100 - 400	1.26 x 1.00 x 40	130	2.3	0	140

\* At working pressure range

## DRIPPERLINE TECHNICAL DATA

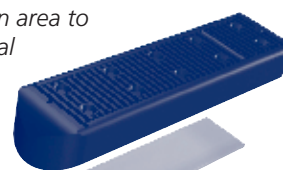
inside Ø	wall thickness	outside Ø	max. working pressure	KD
(mm)	(mm)	(mm)	(kpa)	
14.40	1.0	16.40	350	1.2

### UniBioline dripper

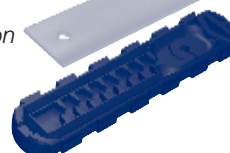


### UniBioline facets

Wide filtration area to ensure optimal performance even under harsh water conditions



Injected silicon diaphragm



Large, deep and wide cross-section improves clogging resistance



Root physical barrier – improves resistance to root penetration





Injection molded dripper construction, ensuring uniform drippers and very low CV



UniBioline CNL • I.D. Ø 14.40 mm • Inlet pressure 300 kpa											
Max. lateral length (m) spacing between drippers (m)											
Nom. flow rate (l/h)	0.20	0.30	0.40	0.45	0.50	0.60	0.75	0.90	1.00	1.25	1.50
1.6	92	133	171	189	207	241	289	334	362	430	492
2.3	73	105	135	149	163	190	228	264	286	340	390

Minimum pressure considered =100 kpa, calculated in a plain area  
For more information, please contact Netafim Technical Department, or connect to our website at [www.netafim.com.au](http://www.netafim.com.au)

Uniram	Wall tickness		Distance between drippers (m)	Coil weight* (kg)		Total in a 40 feet container (m)
	(mm)	Coil length (m)			Coils in a 40 feet container (units)	
	1.0	500	0.2 to 1.0	27 to 23	330	165000

\* According to drippers spacing

PERFORMANCE DATA

PACKAGING DATA





# **APPENDIX I**

## **Proposed Stormwater Management Strategy**