REPORT

Tonkin+Taylor

Post Closure Stormwater Management Plan

Clarke Road Landfill

Prepared for
Clarke Road Solar Pty Ltd
Prepared by
Tonkin & Taylor Pty Ltd
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1 Introduction

Tonkin & Taylor Pty Ltd (T+T) has been engaged by Clarke Road Solar Pty Ltd (CRS) to update the Post Closure Stormwater Management Plan (PC-SWMP) for the Clarke Road former Landfill (the site).

The site is located at the corner of Clarke Road and Spring Road, Springvale South, Victoria. The site is bounded by Clarke Road to the east, Rowan Road to the south, Westall Road to the west and Spring Road to the north.

This PC-SWMP documents the design concept for the final stormwater management system for the Clarke Road Landfill (the site), along with the monitoring requirements to be maintained once rehabilitation of the site has been completed (i.e. during the post closure period).

A PC-SWMP for the site was originally prepared in 2018[1] in response to EPA Victoria Pollution Abatement Notice (PAN) ID 90007574 for final surface preparation of the landfill cap with grass, as was then planned. The final cap design and end use have been revised since 2018 in the following ways:

- A solar power collection farm is planned for the majority of the flatter areas of the final cap
- The 3D top of cap model has been revised slightly in the northern portion of the site, increasing the cap height and the height of the perimeter batters
- The steep perimeter batters in the lower portions of the slopes are planned to be planted with dense vegetation to act as a visual screen to prevent glare from solar panels from impacting motorists

In addition to the changes to the cap design, there are some changes in the calculation methods and assumptions used to calculate stormwater generation that have been made since the 2018 report to account for changing requirements in the Australian Rainfall and Runoff guidelines[2].

This updated PC-SWMP reflects these changes so that surface water control methods achieve regulatory authority performance objectives.

2 Post closure site setting

2.1 Site location and layout

The site is located at the corner of Clarke Road and Spring Road, Springvale South, Victoria. It occupies approximately 47.4 hectares. The site is not accessible to the general public. The layout of the site is shown on **Drawing 4002.0121-01**.

The landfill formed part of a wider former waste disposal area with the closed Spring Road Landfill to the west (managed by Kingston City Council) and the closed Spring Valley Landfill to the east (formerly operated by the City of Greater Dandenong).

2.2 Site History

The site was a former sand extraction pit before landfilling of putrescible and solid inert waste commenced in the late 1970's. Landfilling in the north was carried out by private contractors until the mid-1990s. Landfilling in the south was carried out by the (then) City of Springvale until 1989 and subsequently by private operators until 2003.

[1] T+T (2018). *Stormwater Management Plan (Post Closure) – Clarke Road Landfill*. 4002.0100. November 2018.
[2] Ball, J., Babister, M., Nathan, R., Weeks, W., Weinmann, E., Retallick, M., Testoni, I. (2019). *Australian Rainfall and Runoff: A Guide to Flood Estimation.* © Commonwealth of Australia. Geosciences Australia.

The site was capped with a compacted clay cap generally compliant with performance objectives of the Landfill BPEM. The final surface subsequently settled and formed flat areas where surface water ponding could potentially occur. Works were recently completed across the site to regrade the surface to promote stormwater runoff and achieve a suitable surface for solar panel placement.

The main feature of the site is the waste mound, which occupies the entire site except for a margin around the site boundaries. Portable buildings, site offices and facilities are located in the southern part of the site. A brick rubble covered parking area is located in the southwest corner of the site.

In the central part of the site (towards the western boundary) there is a landfill gas to energy plant, operated by Energy Developments Limited (EDL). EDL actively extracts landfill gas from a network of vertical landfill gas extraction wells and utilises the collected gas, as well as the adjacent former landfills to the east and west, to generate electricity which it feeds into the local power grid.

2.3 Topography

Regionally, the site is located within a relatively flat topography with a slight grade to the southwest. The landfill is mounded relative to the surrounding land, with grades broadly sloping toward the site boundaries.

Table 2.1 Summary of surrounding land use

Direction	Current land use
North	Spring Road is adjacent to the site's northern boundary, with residential properties and recreational/open space immediately north of Spring Road. The nearest residential building is approximately 25 m from the site boundary.
East	There are four residential properties which border the eastern side of the site (i.e. between the landfill and Clarke Road). On the other side of Clarke Road is the Spring Valley Reserve (a former landfill) and a mixed residential/commercial area.
South	Immediately south of the site is Rowan Road, opposite which is a mixed zone of primarily residential buildings but with some commercial and market gardens.
West	Immediately west of the site is a walking track and Westall Road, which is understood to be constructed over a former landfill. Opposite Westall Road is an open space that was formerly a landfill operated by the City of Kingston.

2.4 Offsite stormwater network

Road curbing and stormwater infrastructure, such as curb inlets, pits and pipes, has been installed along the roads surrounding the site, except for Rowan Road. Stormwater generated offsite is generally intercepted by road curbing and catch-pits and therefore does not reach the site.

In addition, the current and future topography of the site means that stormwater runoff will generally shed from the site towards the site boundary to surrounding areas. As a result, additional stormwater diversion around the site is not required, as offsite runoff is currently entering the existing local stormwater networks before it reaches any critical areas of the site.

3 Regulatory Requirements

3.1 General

Ongoing aftercare of the site during the post closure period is managed via a post closure pollution abatement notice (PC-PAN). The PC-PAN is a site specific document that refers to two key

documents prepared to manage rehabilitation and management of closed landfill sites during the aftercare period:

- Landfill Rehabilitation Plan (LRP)[3]: This document reviews the suitability of the existing landfill cap (as applicable) and provides detail of the final rehabilitation works to be completed at the site.
- Aftercare Management Plan (AMP): This document typically provides the requirements for ongoing environmental management and inspections of landfill maintenance systems during the post-closure period (including stormwater).

These documents were prepared and issued to EPA Victoria in 2015 and early 2016[4]. Both documents note that the landfill cap at the time these documents were prepared did not have a formal stormwater management system. Therefore, the LRP includes specific recommendations for the review of the existing stormwater management and the design of a final post-closure stormwater management system.

These requirements were the basis for the PAN that was the basis for the 2018 PC-SWMP, and have been retained for the preparation of this PC-SWMP update.

3.2 Best practice guidelines

The following regulatory and best practice guidance are considered relevant to the management of stormwater during the closure works:

- CSIRO, Urban stormwater: Best practice environmental management guidelines, 1999.
- EPA Publication 788.3, Best Practice Environmental Management – Siting, Design, Operation and Rehabilitation of Landfills, August 2015 (the Landfill BPEM).
- EPA Publication 1490, Closed landfill guidelines, December 2012
- EPA Publication 275, Construction Techniques for Sediment Pollution Control, May 1991.
- Australian Rainfall and Runoff: A Guide to Flood Estimation, 2019, Commonwealth of Australia, Geosciences Australia (ARR 2019).

3.3 Regulatory requirements

The objective of water management in the Landfill BPEM is:

> *"To protect beneficial uses of receiving waters and to avoid any adverse environmental impact on surface and ground waters."*

To achieve this objective, the Landfill BPEM specifies several required outcomes, including:

- Segregation of stormwater, leachate and groundwater
- Management and treatment of leachate to:
  - Prevent it from escaping into surface waters or groundwater; and
  - Minimise human contact with leachate.
- Assurance that waste discharges to surface waterways are minimised and do not cause water quality objectives to be breached.

To achieve the required outcomes, the Landfill BPEM recommends:

[3] T+T (2015), *Landfill Rehabilitation Plan - Clarke Road Closed Landfill, Springvale South*, ref 4002.003, July 2015.
[4] T+T (2016), *Aftercare Management Plan – Clarke Road Landfill*, Revision 2, ref 4002.005, February 2016.

- Drainage measures should be designed to contain and control stormwater runoff for a 1 in 20 year storm event for a putrescible landfill. The 1 in 100 year design case should also be considered to ensure no catastrophic failures of the stormwater management system.
- Erosion should be minimised and where it cannot be controlled at the source, sediment control features should be used. Measures to minimise erosion include:
  - Retaining/re-establishing as much vegetation in the catchment area as possible; and
  - Water flows should be directed over flat slopes or spread across slopes.
- Use interception drains to intercept surface water; and
- Prevent the discharge of sediment contaminated stormwater to the environment.

As a requirement of the original PAN (ID 90008702), the stormwater management system for the site is designed to contain and control stormwater runoff for a 1 in 100 year storm event. This PC-SWMP update retains this requirement from the 2018 PC-SWMP.

The Landfill BPEM also requires that stormwater should only be discharged from the site from dams, and only once it has been confirmed that the stormwater has not been contaminated. Stormwater contamination is defined as sediment, leachate or other contaminants impacting on water quality.

The maximum permissible turbidity and other stormwater quality objectives at the point of discharge are outlined in **Section 5.3.5**.

4 Proposed stormwater management

4.1 Overall concept

The EPA-approved Clarke Road closed landfill rehabilitation includes re-contouring of the existing surface and then re-vegetation. It is presently understood that the post-rehabilitation landfill will be managed as discrete property parcels (lots). The final landfill surface incorporates a central ridge dividing the site into catchments draining to roads that are managed by Greater Dandenong City (GDC) to the east, and Vic Roads to the west.

As a result of the re-contouring of the closed landfill and development of the solar generation facility, the distribution of stormwater runoff from the individual lots will be changed. This is due to a change in the slopes of individual lot catchment areas (though noting that the overall landfill catchment area will be unchanged) and the changed land use cover to the proposed solar power generation facility. Thus, peak solar farm runoff flows from the lots will differ from pre-rehabilitation values.

The requirements for stormwater management are twofold: to meet requirements for the Landfill BPEM ("to contain and control rainfall runoff for a 1-in-20 year storm event"), and those for GDC requiring no increase in peak flows for the 5 year Average Recurrence Interval (ARI) event. There is no guidance from Vic Roads regarding its requirements.

Based on discussions had with GDC as part of the 2018 PC-SWMP, we understand that it requires stormwater detention systems to be provided which attenuate peak flows to no greater than the pre-rehabilitation values.

To meet the Landfill BPEM and GDC requirements, the design concept for properties is:

- Construction of a swale, formed by a low bund along or near to the boundary, at the bottom of the lot slopes close to the boundary. The swale will be sized to contain the difference in pre-rehabilitation and post-solar development runoff volumes, and limit increase in peak discharges for the future climate scenario.

- During earthworks to form the rehabilitated lot landform, grading of the lot ground surface to direct surface runoff to the swale.
- Where there will be an increase in the 5 year ARI peak discharge to GDC stormwater assets, the swale drains will be connected to the GDC pipes in the roads by pipes with flow being regulated at the inlet to limit the peak discharge to no greater than the pre-rehabilitation flows.
- The typical depth in the swales will be up to 650 mm to manage the 5 year ARI flows, with freeboard provided to the top of the bund which will contain the difference in 20 year ARI flows
- Where there is no increase in 5 year ARI discharge, and where lots drain to Vic Roads, a swale will be constructed to contain and control the 20 year ARI runoff.

These measures are described in more detail in the following sections.

4.2 Hydrology design inputs

4.2.1 Australian Rainfall and Runoff guideline terminology discussion

Since the publication of the Landfill BPEM in 2015 the Australian Rainfall and Runoff guidelines (ARR 2019)[5] have been updated and have varied the terminology used to describe the frequency of rainfall events, with the terminology for Average Recurrence Interval (ARI) being replaced by Annual Exceedance Probability (AEP). This update occurred in 2016.

ARI describes the average time period between rainfall events of a given value (as described in the Landfill BPEM, e.g., 1-in-20-year events) and AEP describing the probability of a rainfall event being equalled or exceeded in a given year.

The formula used to equilibrate ARI and AEP is described below:

$$AEP = 1 - e^{\left(\frac{-1}{ARI}\right)}$$

Therefore a 1-in-5 year ARI rainfall event has an AEP of 18.1%, a 1-in-20 year ARI rainfall event has an AEP of 4.87 %, and a 1-in-100-year ARI rainfall event has an AEP of 1.01 %. For the purpose of clarity, and to better match the data available for calculating rainfall intensities, these AEPs have been assumed to be 20%, 5% and 1%, respectively.

4.2.2 Future climate scenario

A future climate scenario was selected for the Clarke Road Landfill site using the Climate futures exploration tool to identify General Circulation Model (GCM) model consensus on the future climate scenario to be used for impact assessment. The ARR 2019 recommends the design setting use GCM consensus cases for Representative Concentration Pathways (RCPs) 4.5 and 8.5, and apply the maximum consensus case for both RCPs. If the consensus cases are effectively tied between 'warmer' and 'hotter', the midpoint between the wider temperature interval can be taken (ARR 2019, 1.6.1).

Clarke Road Landfill is located within the Southern Slopes Mainland Natural resource management cluster. The future scenario time period used was 2055, 30 years from present day. This is consistent with EPA's recommended aftercare period of 30 year for landfill sites after ceasing waste acceptance, as indicated in the Landfill BPEM. Given that the site ceased waste acceptance in 2003, this is considered appropriate.

[5] Ball, J., Babister, M., Nathan, R., Weeks, W., Weinmann, E., Retallick, M., Testoni, I. (2019). *Australian Rainfall and Runoff: A Guide to Flood Estimation.* © Commonwealth of Australia. Geosciences Australia.

The resultant maximum model consensus case produced was deemed tied between the warmer and 'hotter' class interval. The RCP 4.5 consensus was 29 out of 46 GCMs in the warmer class interval, and the RCP 8.5 consensus was 18 out of 48 GCMs in the hotter class interval. Therefore 0.5-3 degrees of warming is projected for Clarke Road for the year 2055, and a midpoint of 1.75 was applied.

To identify temporal rainfall patterns under the future scenario the projected rainfall depth was equated from the current design rainfall, multiplied by temperature scaling using a factor and the midpoint of the class interval (ARR Equation 1.6.1).

$$I_p = I_{arr} \times 1.05^{T_m}$$

Where:

- I_{ARR} for current climate conditions
- 1.05 is assumed temperature scaling
- T_m is the temperature midpoint of selected class interval (1.75 degrees used for this location)

4.3 Post construction stormwater generation

Lot-by-lot stormwater flows have been calculated for both the pre-rehabilitation and post-solar farm development scenarios, for 2055 climate scenario. Peak discharges were determined for three frequencies, being 20% AEP, 5% AEP and 1% AEP, with future climate impacts included (refer to **Section 4.2.2**). These are summarised in **Table 4.1** and **Table 4.2**.

Table 4.1: Pre-rehabilitation peak flows (future climate, l/s)

Plan No.	Lot No.	20% AEP	5$ AEP	1% AEP
LP18539, LP20984, TP134115 Lot 1&2	1,3,1&2	14	20	29
PS302364 & LP27949	4,1	25	36	50
LP25857	2	44	67	95
PS302364	1	59	83	117
PS321823	4	5	8	11
PS321823	5	14	20	28
PS321823	6	40	57	80
PS321823	7	6	8	11
PS321823	8	45	63	89
PS321823	9	9	13	18
PS321823	10	48	67	95
PS321823	11	62	88	124
PS321823	12	35	49	69
PS321823	13	31	44	61
PS321823	14	40	57	80
TP210854	1	4	5	8

TP220941	1	47	66	93
TP536864	1	16	23	33
TP671893	1	58	82	115

Table 4.2: Post-solar development peak flows (future climate, l/s)

Plan No.	Lot No.	20% AEP	5$ AEP	1% AEP
LP18539, LP20984, TP134115 Lot 1&2	1,3,1&2	40	57	80
PS302364 & LP27949	4,1	45	67	90
LP25857	2	97	137	192
PS302364	1	59	88	117
PS321823	4	39	55	77
PS321823	5	85	120	169
PS321823	6	100	142	199
PS321823	7	19	27	38
PS321823	8	114	161	227
PS321823	9	20	29	40
PS321823	10	86	122	171
PS321823	11	94	133	187
PS321823	12	78	103	145
PS321823	13	76	108	150
PS321823	14	85	124	169
TP210854	1	41	57	81
TP220941	1	97	138	194
TP536864	1	28	40	56
TP671893	1	82	116	163

In general terms the 5% AEP discharges are approximately 40 % greater than the 20% AEP flows, and the 1% AEP discharges are approximately double the 20% AEP flows . The post-solar flows are 80 % to over 100 % greater than the pre-rehabilitation flows.

The summary of the post-rehabilitation stormwater generation in relation to the capacity of GDC stormwater assets is:

- 20 discrete lots (with some smaller lots combined into one).
- One of the lots not requiring detention (post-solar development flows are lower than pre-rehabilitation flows).
- One of the lots drains to Vic Road's stormwater assets.
- 18 of the lots require a stormwater detention system to attenuate the increase in peak runoff.

4.4 Surface water control and attenuation systems

4.4.1 Grassed swales

The 2018 PC-SWMP identified swales as an appropriate attenuation system suitable for each individual lot, with a controlled outlet system that discharges to the existing GDC stormwater assets, with orifices designed to limit flows to the agreed GDC permissible flows (refer to **Section 4.5** for further discussion). The swales drain via pipes that connect to GDC assets by either saddle or junction pit connections.

The design of the swales has been based on GDC and BPEM guidelines for 20% AEP and 5% AEP storm events, and checked also for the 1% AEP event. In the 1% AEP event the swales will overtop. Given that the design grade of the swales is 0.01% (as per Drawing 4002.0121-21), this overtopping is expected to occur along a wide area, therefore the depth of flow will be shallow and the risk of erosion and scour is low.

Assumptions made for the design of the swale include:

- Individual swales for each lot
- Swales extend along the bottom of the lot slope just upstream of the road boundary.
- Stormwater runoff from the re-contoured lots will directed to flow (channelled if required) to the swale.
- All swales will have freeboard for the 20% AEP design event.
- There are no high sediment loads discharging into the swales (erosion and sediment controls installed as discussed in **Section 4.5**).
- All swales will be constructed on top of the landfill cap (after stripping of the existing topsoil layer).

Swale design parameters and preliminary outlet design parameters (diameter and discharge flow) for individual discrete lots are provided in **Table 4.3**.

Table 4.3: Swale and orifice design parameters

Plan No.	Lot No.	Detention volume (m3)	Design swale depth (m)	Outlet diameter (mm)	Discharge flow(L/s)
LP18539, LP20984, TP134115	1,3 1&2	35	0.35	100	10
PS302364 LP27949	4,1	24	0.45	100	12
LP25857	2	57	0.50	175	38
PS321823	4	65	0.50	50	3
PS321823	5	106	0.60	90	12
PS321823	6	71	0.45	175	36
PS321823	7	15	0.30	75	5
PS321823	8	83	0.60	150	32
PS321823	9	10	0.25	100	8
PS321823	10	50	0.50	175	39
PS321823	11	45	0.50	225	62

PS321823	12	43	0.50	150	29
PS321823	13	55	0.50	150	29
PS321823	14	55	0.50	150	27
TP210854	1	49	0.60	50	4
TP220941	1	54	0.65	175	45
TP536864	1	12	0.40	125	16
TP671893	1	33	0.50	175	37

Notes:

1. All swales have a bottom width of 0.5 m, side slopes of 1V:1H, and longitudinal slope of 0.1 %.
2. Freeboard not included above.
3. Outlets have been dimensioned assuming inverts at the level of the swale invert.
4. The discharge pipe diameter will determine the type of pipe connection to the main stormwater line, as explained in Section 4.4.2 below.

4.4.2 Swale outlet options

The GDC design manual[6] requires a junction pit (manhole/catchpit) to be constructed for private pipes greater than 225 mm, which connect into the main stormwater network. It is acceptable for smaller inlets to be 'broken into' the main line (i.e. saddle connection).

Design of discharge pipes and main line connections are to be considered in the detailed design stage. The detailed design will also confirm appropriate measures to reduce the risk of blockage to the outlet system.

4.4.3 Other discharge options

Stormwater runoff during a 1% AEP (100 year ARI) storm event will generally overtop the lot detention swales at some point, and flow directly to the neighbouring roads. The nature of the runoff in the 1% AEP event will be shallow depth sheet flow, very similar to expected conditions for the pre-rehabilitation scenario. It is noted that in the more extreme events (5% and 1% AEP) there will be significant surface water anyway and likely widespread flooding, given the heavy rainfall.

The extent of flooding and overloading capacity of existing GDC and Vic Roads stormwater assets have not been investigated in this report. However, it is noted that overall the total catchment of the landfill footprint is unchanged, and that the rehabilitation ground surface will be similarly vegetated to the existing surface (i.e. no significant change in runoff potential).

4.5 Sediment control and erosion protection measures

Erosion and sediment control (ESC) measures will be required during construction of the rehabilitation earthworks to prevent and/or reduce sediment laden runoff from entering existing GDC stormwater assets downstream. Space constraints are the limitation within the Clarke Road closed landfill.

Best-practice ESC measures provided in Melbourne Water and other standards[7] include the following:

- Staging the earthworks (soil disturbance) to reduce the volume of sediment-laden runoff at and hence reduce requirement for treatment.

[6] Greater Dandenong City Council, August 2017. Design manual for the subdivision of land. Stormwater drainage design.
[7] Melbourne Water standards including principles of erosion management, and stormwater management during construction.

- A stabilised construction entrance (which could include wheel wash - either manual or mechanical) to prevent tracking of sediment onto public roads.
- Perimeter structures such as super silt fences (double layer) and silt socks/logs. A secondary treatment measure can also be installed around stormwater inlets (silt socks/logs or Melbourne Water drain warden).
  - Super silt fences are effective for catchments up to 0.5 ha, therefore it is recommended to limit stages of the earthwork area to 0.5 ha. For catchments greater than 0.5 ha, the slope and slope length of the site becomes important and determines the super silt fence length. Super silt fences should have returns along the length to manage longitudinal flow.
  - Maintenance of the silt fence is important to ensure optimal operation. It is also important to note that super silt fences are not effective to capture soil particles finer than 0.02 mm (fine silts and clays).
- Stabilisation methods for grass growth, including mulching or hydroseeding:
  - Mulch material could be straw, bark, wood residue or wood pulp. Mulch can be anchored (during windy conditions) using such methods as crimping or using binders in the mulch.
  - Hydroseeding is potentially more expensive but considered to be effective, especially on steeper slopes/batters.
  - Temporary stabilisation by laying coir matting/jute/straw blanket across parts of the site. This method is relatively energy intensive (installation and removal), and thus expensive. This should be considered only where other methods identified are likely to be ineffective.

4.6 Potential contaminated water pathways and prevention

Following rehabilitation of the site, off-site discharge of contaminated stormwater runoff is considered unlikely. Controls for potential contaminated water runoff prior to the completion of the landfill cap construction are outlined in the I-SWMP[8].

There is, however, the potential for sediment contamination prior to cap vegetation being fully established. Erosion and sediment controls to limit contaminated stormwater prior to the establishment of cap vegetation are discussed above in **Section 4.5**.

In terms of other contaminants that might impact the quality of stormwater runoff (i.e. waste/leachate impacts), the risk of this of this occurring is considered to be very low to negligible, given:

- The presence of an effective, low permeability landfill cap beneath the existing rehabilitation works.
- The current rehabilitation works, primarily to reshape the surface for improved stormwater runoff, include the placement of up to several meters of low permeability clay rich bio solids. This material is (in turn) covered with a nominal 1 m thick capping layer.

There are several processes in place during the aftercare management of the site which further reduce the risk of waste/leachate contamination of off-site contaminated stormwater runoff, both as part of this PC-SWMP and other separate aftercare management systems. These include:

- Ongoing inspection and maintenance of the landfill cap, both for signs of erosion damage and for leachate seepage (Section 5.2);

[8] T+T (2017). *Interim Stormwater Management Plan – Clarke Road Landfill*. 4002.0100.v1. May 2017.

- Ongoing management of leachate within the waste mass to the levels required in the most recent revision of the site's Hydrogeological Assessment, to control potential risks to the surrounding groundwater environment and maximise landfill gas extraction.

By complying with the existing and proposed controls, it is expected that contaminated off-site runoff will be prevented.

4.7 Off-site discharges and permissible discharge limits

In August 2018, T+T provided GDC with pre- and (unattenuated) post-rehabilitation discharge values for the 5 year ARI (20% AEP) events, based on the comparison of the proposed rehabilitation contours with the existing closed landfill ground surface. **Table 4.4** indicates the pre-rehabilitation discharges and the maximum post-rehabilitation discharge to GDC assets that will result from the stormwater system proposed for each lot (including detention swales with orifice controlled outlets as appropriate). The summary table indicates that the orifice discharge and kerb discharge to existing GDC stormwater assets meets the off-site permissible discharge limits, with in some cases a significant reduction. The difference between the flow to swale and flow to GDC assets will be accommodated as storage by the swales.

During finalisation of the design, as part of the construction process, it may be possible to optimise and coordinate design of individual lot systems, while not increasing total flows to the GDC stormwater assets.

Table 4.4: Peak post-rehabilitation 5 year lot discharges

Lot no.		Pre rehabilitation peak discharge (L/s)	Post-solar peak discharge (L/s)		Discharge type
			To swale	To GDC assets	
LP18539 LP20984 TP134115	1 3 1+2	14	40	10	Orifice (saddle/junction pit)
PS302364 LP27949	4 1	25	45	12	Orifice (saddle/junction pit)
LP25857	2	44	97	38	Orifice (saddle/junction pit)
PS302364	1	59	59	59	Overland (unattenuated)
PS321823	4	5	39	3	Orifice (saddle/junction pit)
PS321823	5	14	85	12	Orifice (saddle/junction pit)
PS321823	6	40	100	36	Orifice (saddle/junction pit)
PS321823	7	6	19	5	To Vic Roads – not included in this report
PS321823	8	45	114	32	Orifice (saddle/junction pit)
PS321823	9	9	20	8	Orifice (saddle/junction pit)
PS321823	10	48	86	39	Orifice (saddle/junction pit)
PS321823	11	62	94	62	Orifice (saddle/junction pit)
PS321823	12	35	73	29	Orifice (saddle/junction pit)
PS321823	13	31	76	29	Orifice (saddle/junction pit)
PS321823	14	40	85	27	Orifice (saddle/junction pit)
TP210854	1	4	41	4	Orifice (saddle/junction pit)

TP220941	1	47	97	45	Orifice (saddle/junction pit)
TP536864	1	16	28	16	Orifice (saddle/junction pit)
TP671893	1	58	82	37	Orifice (saddle/junction pit)

5 Monitoring, inspections and maintenance

5.1 General

A monitoring, inspection and maintenance programme is required to confirm that the controls are effective and the assumptions and analysis on the site's environmental performance is accurate. The following section outlines the monitoring requirements proposed to achieve this.

Routine monitoring of offsite discharges is required to demonstrate that leachate impacted stormwater does not impact the environment outside of the site boundaries. Routine monitoring also provides the opportunity to identify areas to improve the stormwater management system (where impacts are detected).

A monitoring data assessment will be conducted and used to identify areas of the monitoring programme requiring modification to facilitate greater protection of the onsite and offsite environment. Indicators will include trends identified in the monitoring data and compliance against the PAN or the Landfill BPEM.

5.2 Inspection and monitoring programme

Previous assessments have identified that the bio solids are stabilised and the existing cap effectively separates leachate from surface water, so that the key risk to stormwater quality at the site is from impacts derived from ponding, sediment loading and uncontrolled discharges.

Based on this understanding, a surface water sampling programme and action levels has been developed are summarised in **Table 5.1**. Monitoring and inspections are the responsibility of CRS, but may be carried out by subcontractors engaged to do the inspections and/or monitoring on behalf of CRS.

Table 5.1: Recommended inspection and monitoring programme

Activity	Frequency
Inspections	
Landfill Cap Inspect the landfill cap for evidence of: Damage/defect in the cap surface due to erosion Stormwater ponding on the cap and seeps (leachate or other) from the cap surface Ponding across landfill boundaries or off-site surface water flows (i.e. other than at engineered discharge points). Sediment accumulation along site boundaries. Cracks from desiccation or settlement, including assessment of nearby vegetation die back, indicating possible pathway for landfill gas escape through the cap. Remediation of these	Weekly (minimum) until vegetation is established, then quarterly (minimum). AND Daily (during) & after large storm events[1] until vegetation is established. After large storm events[1], once vegetation is established.

areas shall be done as per the Aftercare Management Plan[9].	
Drainage Lines Inspect drainage lines for evidence of: Damage, blockage, flooding or localised ponding. Sediment or leachate or other contamination (i.e. colour, odour, oily sheen, foam, etc.). If there is evidence of contamination, then the inspector shall investigate further to identify the source.	Weekly (minimum) until vegetation is established, then quarterly (minimum). AND Daily (during) & after large storm events[1] until vegetation is established. After large storm events[1], once vegetation is established.
Erosion & sediment control Inspect erosion & sediment control infrastructure of evidence of blockage/damage.	Weekly (minimum) until vegetation is established, then quarterly (minimum). AND After large storm events[1], once vegetation is established.
Off-site discharges Inspect the site boundaries for evidence of uncontrolled off-site stormwater discharges off of the site boundaries. If identified, the inspector should characterise the nature of the discharge (size, amount of flow, evidence of sediment or other contaminants) and report the findings back to the site supervisor.	Quarterly (minimum) AND Daily (during) & after large storm events[1] until vegetation is established. After large storm events[1], once vegetation is established.
Monitoring	
Environmental monitoring of off-site discharge to municipal stormwater system.	Quarterly AND Within 24 hours after large storm events[1].
Environmental monitoring of ponding and/or off-site discharge across site boundaries (other than at engineered discharge points).	Quarterly (minimum) AND Within 24 hours after large storm events[1].
Maintenance	
Action maintenance items identified in routine inspections or by general site observations.	Maintenance actions will commence as soon as practicable as and no later than two weeks after the need for maintenance has been identified.

Notes:

1. A large storm event defined as > 40 mm/day, based on the minimum highest daily rainfall recorded at Moorabbin Airport.
2. Quality sampling of uncontrolled stormwater discharges will be attempted every 3 months but is opportunistic (i.e. no samples are required if ponding along the site boundary or off-site discharge does not occur during the sampling event). If possible, monitoring should be scheduled 1 to 2 days after rainfall to maximise potential for sample collection.

5.3 Environmental monitoring and sampling

5.3.1 Objective

The objective of routine environmental monitoring of stormwater is to demonstrate that sediment, leachate or bio solids impacted stormwater does not impact the environment outside of the site boundaries.

[9] T+T (2016). *Aftercare Management Plan – Clarke Road Landfill*. 4002.005.v2. February 2016.

Routine monitoring also provides the opportunity to identify areas to improve the stormwater management system (where impacts are detected).

5.3.2 Monitoring frequency

The initial frequency for environmental monitoring proposed in **Table 5.1**.

Based on the results of the monitoring data, it may be necessary to increase or decrease the frequency of monitoring. If more frequent monitoring is required, then this PC-SWMP should be updated to reflect the increased monitoring programme.

If less frequent monitoring is proposed, then this may be carried out after the Auditor conducts or reviews a risk assessment and provides written notice accepting the proposal to reduce the monitoring frequency.

5.3.3 Sampling locations

5.3.3.1 Discharge points into municipal stormwater

Typically, each discharge point into the municipal stormwater management system should be monitored to assess whether impacted stormwater flows are being discharged off of the site. However, the site is subdivided into 24 individual lots and most of the lots will have individual discharge points into the municipal stormwater management network.

The risk of stormwater being contaminated by waste (including leachate), bio solids or sediment during the post-closure period is considered to be low, given:

- The landfill has an existing clay cap underneath the newly placed bio solids layer, effectively isolating waste from rainfall runoff.
- The bio solids layer will be capped with a layer of "clean" fill soils, which will prevent runoff from interacting with the bio solids.
- The landfill cap will be grassed, slowing water velocities and reducing the risk of sediment contamination to the stormwater system.

It is proposed that during each sampling event, representative samples are collected from immediately upstream of half of each discharge point into the municipal stormwater system – with the remaining half sampled during the next monitoring event.

This alternating system of monitoring will allow each discharge point to be monitored twice throughout the year, which is considered appropriate given the expected level of risk.

If the results of monitoring or the landfill cap inspection (**Table 5.1**) indicate the increased risk of off-site impacts at any discharge point, the monitoring frequency at that location will be increased to verify the increased risk. Increased monitoring at that location will continue until a remedial action is developed and implemented.

5.3.3.2 Ponding or off-site discharges (other than at engineered discharge points)

There are no fixed locations for collecting samples of ponding across the site boundary or for off-site discharges (i.e. other than at engineered discharge points). Samples shall be collected opportunistically, when observed during landfill cap inspections.

5.3.4 Sampling method

Sampling should be conducted using a telescopic grab sampler from a location that is safe for access.

The sample should then be decanted into a laboratory provided container dosed with the correct preservatives (where required) and sent to a NATA accredited laboratory for analysis under chain of custody (COC) protocols.

The grab sampler should be decontaminated using Decon90 and rinsed in deionised water after sampling (at each location) to ensure no cross contamination occurs.

5.3.5 Water quality objectives

Based on the Water SEPP, the site is classified as being within the Cleared Hills and Costal Plains policy area and the applicable water quality objectives (WQOs) are the ANZECC 2000 guidelines for the protection of ecosystems (95 % protection level).

The Water SEPP outlines specific WQOs that supersede the ANZECC 2000 guidelines, however these are based on median and 75th/25th percentile concentration values derived from 11 data points sampled monthly over a one year period.

As this level of monitoring has not been carried out at the site, these WQOs cannot be applied until enough monitoring data is accumulated.

Applicable WQOs for surface water samples collected from the site are presented in **Table 5.3**

The permissible turbidity limits for stormwater discharged from the pond(s) shall be compliant with the Landfill BPEM's requirements, summarised in **Table 5.2**.

Table 5.2: Maximum permissible turbidity (at discharge)

Weather condition	Maximum Turbidity (NTU[1])	Median Turbidity (NTU[1])
Dry weather	50	25
Stormwater flows	100	50

Note:

1. NTU – Nephelometric Turbidity Unit

5.3.6 Sample analysis

Field parameters to be measured during surface water sampling are:

- Electrical conductivity (µS/cm);
- Dissolved oxygen (mg/L);
- pH (units);
- Redox potential (mV)

The key risk to stormwater quality at the site is from impacts derived from bio solids and landfill leachate. Therefore a proposed surface water sampling programme has been developed based on:

- The existing groundwater monitoring programme, which is used to monitor for impacts from landfill leachate;
- The turbidity discharge limits; and
- The leachable compounds required to be tested in accordance with EPA Publication 1288, as detailed in the EIP approved by EPA Victoria in December 2016.

Table 5.3: Proposed surface water analytical programme and action levels

Analyte	Unit	Action level
Major Cations and Anions		
Calcium	mg/L	n/a
Magnesium	mg/L	
Potassium	mg/L	
Sodium	mg/L	
Chloride	mg/L	
Sulphate (as S)	mg/L	
Bicarbonate (alkalinity)	mg/L	
Nutrients		
Ammonia (as N)	mg/L	0.9
Nitrate (as N)	mg/L	0.7
Metals		
Arsenic (1), (2)	mg/L	0.7
Cadmium (1)	mg/L	0.0002
Chromium (VI) (1)	mg/L	0.001
Copper (1)	mg/L	0.0014
Iron	mg/L	n/a
Lead (1)	mg/L	0.0034
Manganese	mg/L	1.9
Mercury (1)	mg/L	0.0006
Nickel (1)	mg/L	0.011
Zinc (1)	mg/L	0.008
Other analytes		
Cyanide (1)	mg/L	0.007
Fluoride (1), (2)	mg/L	150
pH	Unit	<6.5 >8.5
Electrical Conductivity (EC) (3), (4)	µS/cm	2,200
Total Dissolved Solids (TDS) (5)	mg/L	1,450
Total Organic Carbon (TOC)	mg/L	n/a
Turbidity	NTU	Refer **Table 5.2**
Volatile Organic Compounds (VOCs)	mg/L	n/a

Notes:

1. These analytes have been incorporated into the programme to assess risk from bio solids within the capping profile. Once there is sufficient data to demonstrate that there are no impacts from potential leachable components of the bio solids, then these analytes can be removed from the monitoring program, with the Auditor's approval.
2. There are no action levels nominated in ANZECC 2000 for Total Arsenic or Fluoride, but there are leachable concentrations limits within Publication 1288. Therefore, the leachable concentrations are nominated as the action levels for these compounds.
3. The action level for Electrical Conductivity should be compared against the field measured result. Additional laboratory analysis for Electrical Conductivity is unnecessary.

4. The action level for Electrical Conductivity is based on the guidance in Table 3.3.3 of ANZECC 2000 for lowland rivers in southeast Australia.
5. Based on the approximate relationship of TDS = 066 * EC.

5.3.7 QA/QC requirements

The stormwater samples will be incorporated into the existing QA/QC requirements defined for the groundwater and leachate sampling programmes. These are outlined in the AMP and are summarised below:

- One intra-laboratory ('blind') duplicate sample to be analysed by the primary laboratory for every 20 samples collected for analysis (per sampling event);
- One inter-laboratory ('split') duplicate sample to be analysed by an alternative laboratory for every 20 samples collected for analysis (per sampling event);
- One field blank sample per day of sampling;
- One trip blank sample per day of sampling; and
- One rinsate blank sample per day of sampling.

6 Review and revision

This PC-SWMP is to be reviewed annually (minimum) and as often as is required based on changing site conditions. During the review, the adequacy of the stormwater management system will be reviewed in light of regulatory requirements and the results of ongoing monitoring and inspections.

A monitoring data assessment will be conducted and utilised by CRS to identify areas of the monitoring programme that require modification to facilitate greater protection of the onsite and offsite environments. Indicators will include trends identified in the monitoring data and compliance against the Environmental Licence conditions, PAN or the Landfill BPEM.

A review of the SWMP will also be carried out based on Auditor recommendations (relating to either the SWMP or the AMP), significant changes to the site or to significant changes to stormwater management at the site.

Following the review, revisions to this PC-SWMP may be required. Following amendment, the revised PC-SWMP should be submitted to the site Environmental Auditor for review and then incorporated as part of the overall aftercare management plan.

7 Applicability

This report has been prepared for the exclusive use of our client Clarke Road Solar Pty Ltd, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

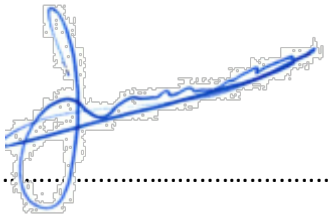
Tonkin & Taylor Pty Ltd
Environmental and Engineering Consultants

Report prepared by:

.....

Callum Browning
Senior Environmental Engineer

Authorised for Tonkin & Taylor Pty Ltd by:



pp.....

Sze-Fei Peng
Project Director

C. Browning
t:\south melbourne\projects\4002\4002.0121\workingmaterial\swmp\4002.0121 clarkerd pc-swmp 20221111.docx

Appendix A Drawings

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CLARKE ROAD DEVELOPMENTS PTY LTD
POST CLOSURE STORMWATER MANAGEMENT
CONCEPTUAL DESIGN
FINAL ISSUE

DRAWING	REV	TITLE
GENERAL		
• 4002.0121-01	1	DRAWING LIST & SITE LOCATION PLAN
• 4002.0121-10	1	SITE LAYOUT PLAN
• 4002.0121-11	1	PROPOSED STORMWATER MANAGEMENT LAYOUT PLAN
• 4002.0121-20	1	SECTIONS AND DETAILS (SHEET 1 OF 3)
• 4002.0121-21	1	SECTIONS AND DETAILS (SHEET 2 OF 3)
• 4002.0121-22	1	SECTIONS AND DETAILS (SHEET 3 OF 3)

- DENOTES DRAWING THIS ISSUE: 06/12/2022

A3 SCALE 1: 12,500
0 250 500 750 (m)

ORIGINAL IN COLOUR

AERIAL PHOTOS SOURCED FROM NEARMAP. COPYRIGHT NEARMAP PTY LTD IMAGERY DATES: 07/10/2018 and 14/09/2022

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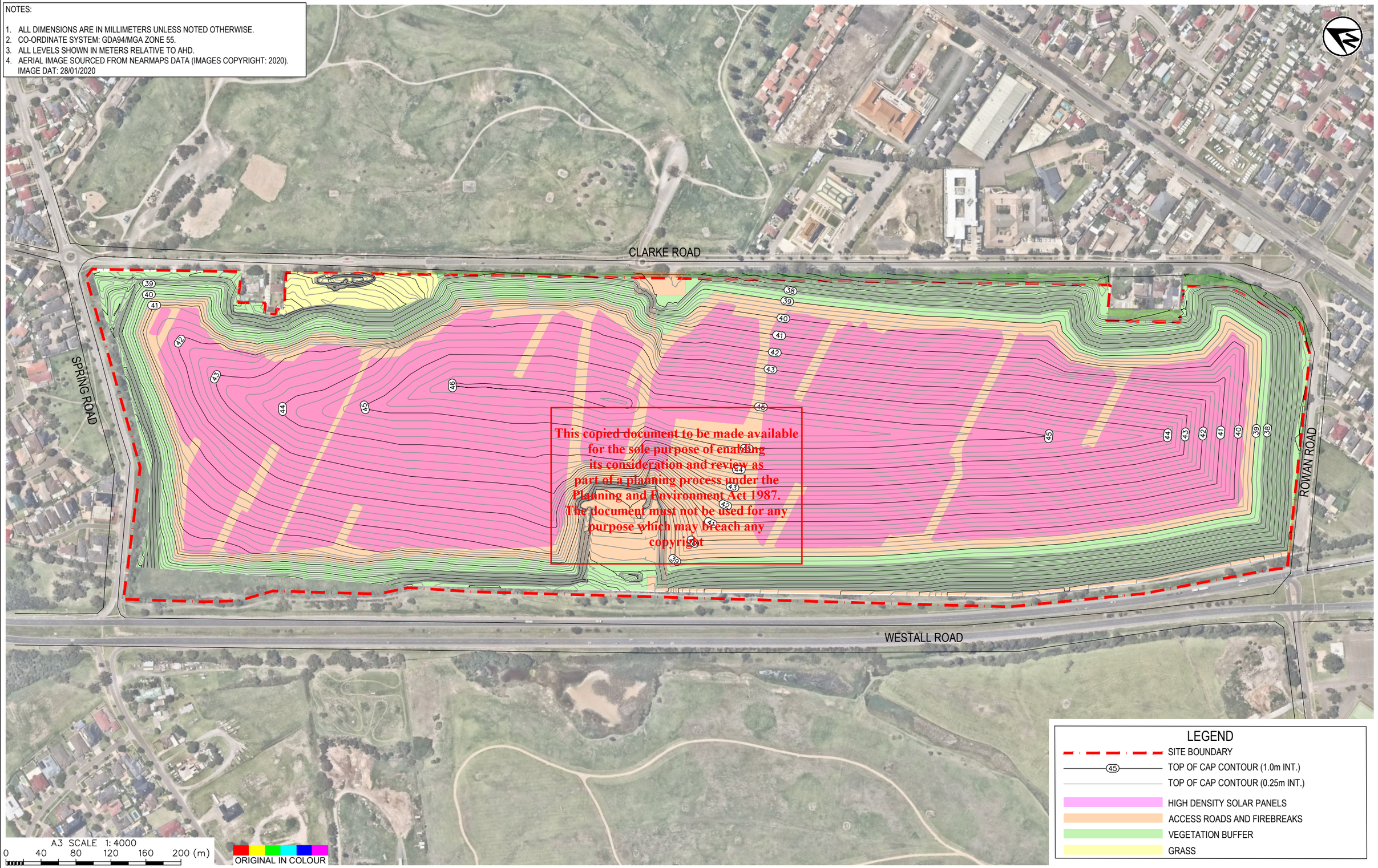
CLIENT CLARKE ROAD SOLAR PTY LTD
PROJECT POST CLOSURE STORMWATER MANAGEMENT 2022 CONCEPT DESIGN
TITLE CLARKE ROAD LANDFILL, SPRINGVALE SOUTH
DRAWING LIST & SITE LOCATION PLAN
SCALE (A3) AS SHOWN DWG No. 4002.0121-01 REV 1

C:\12dSynergy\data\ALBTCAD\CLARKE ROAD SWMP_1184\CAD\DWG\4002.0121-10.dwg 2022-Dec-06 2:30:12 PM Plotted By: CORY DOGGER

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. CO-ORDINATE SYSTEM: GDA94/MGA ZONE 55.
3. ALL LEVELS SHOWN IN METERS RELATIVE TO AHD.
4. AERIAL IMAGE SOURCED FROM NEARMAPS DATA (IMAGES COPYRIGHT: 2020). IMAGE DAT: 28/01/2020



A3 SCALE 1: 4000
0 40 80 120 160 200 (m)

ORIGINAL IN COLOUR

LEGEND

- SITE BOUNDARY
- TOP OF CAP CONTOUR (1.0m INT.)
- TOP OF CAP CONTOUR (0.25m INT.)
- HIGH DENSITY SOLAR PANELS
- ACCESS ROADS AND FIREBREAKS
- VEGETATION BUFFER
- GRASS

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ADVERTISED PLAN

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CLIENT **CLARKE ROAD SOLAR PTY LTD**

PROJECT **POST CLOSURE STORMWATER MANAGEMENT 2022 CONCEPT DESIGN**

TITLE CLARKE ROAD LANDFILL, SPRINGVALE SOUTH
SITE LAYOUT PLAN

SCALE (A3) 1:4000 DWG No. 4002.0121-10 REV 1

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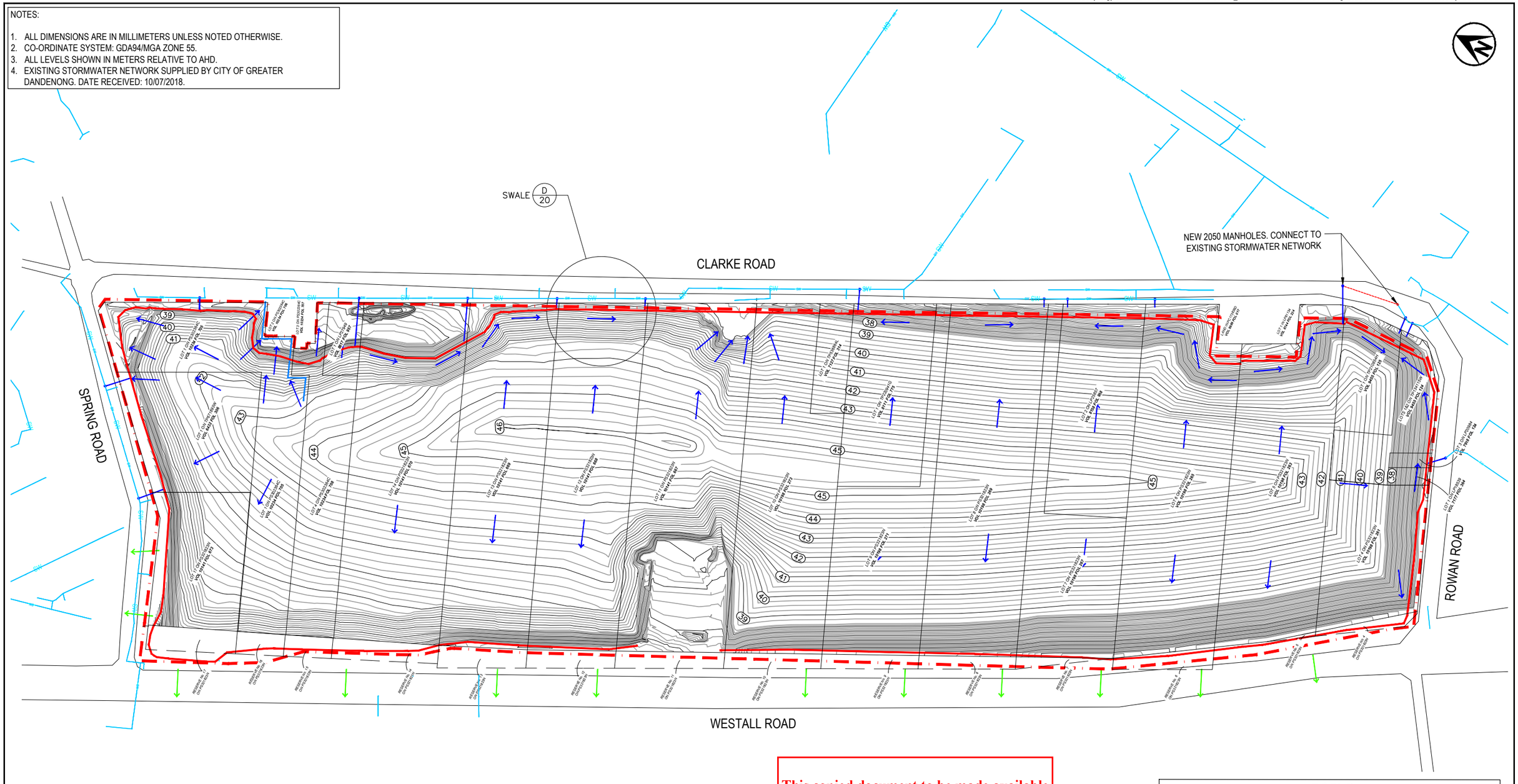
2. CO-ORDINATE SYSTEM: GDA94/MGA ZONE 55.
3. ALL LEVELS SHOWN IN METERS RELATIVE TO AHD.
4. EXISTING STORMWATER NETWORK SUPPLIED BY CITY OF GREATER DANDENONG. DATE RECEIVED: 10/07/2018.



LEGEND

- SITE BOUNDARY
- TOP OF CAP CONTOUR (1.0m INT.)
- TOP OF CAP CONTOUR (0.25m INT.)
- COUNCIL STORMWATER (SW) NETWORK
- SW SURFACE RUNOFF
- SADDLE CONNECTION TO COUNCIL SW NETWORK
- SW OVERLAND FLOW
- DISH CHANNEL (DIRECTS WATER)

A3 SCALE 1: 4000

0 40 80 120 160 200 (m)

ORIGINAL IN COLOUR

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CLIENT **CLARKE ROAD SOLAR PTY LTD**

PROJECT **POST CLOSURE STORMWATER MANAGEMENT 2022 CONCEPT DESIGN**

TITLE CLARKE ROAD LANDFILL, SPRINGVALE SOUTH
PROPOSED STORMWATER MANAGEMENT LAYOUT PLAN

SCALE (A3) 1:4000 DWG No. 4002.0121-11 REV 1

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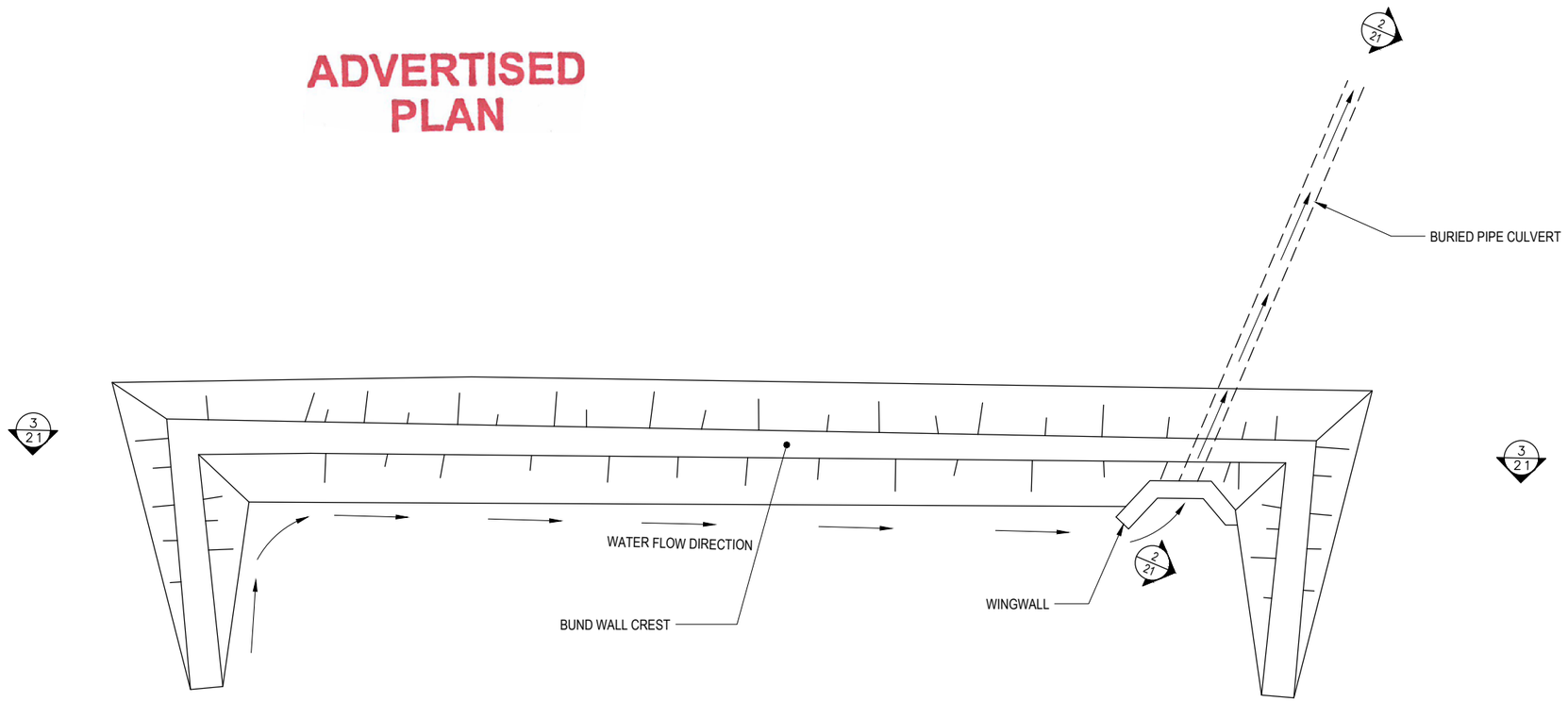

DETAIL D/11 SWALE
SCALE 1: 100

A3 SCALE 1: 100
0 1 2 3 4 5 (m)

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PROJECT: POST CLOSURE STORMWATER MANAGEMENT 2022 CONCEPT DESIGN

TITLE: CLARKE ROAD LANDFILL, SPRINGVALE SOUTH SECTIONS AND DETAILS (SHEET 1 OF 3)

SCALE (A3): 1:100 DWG No. 4002.0121-20 REV 1

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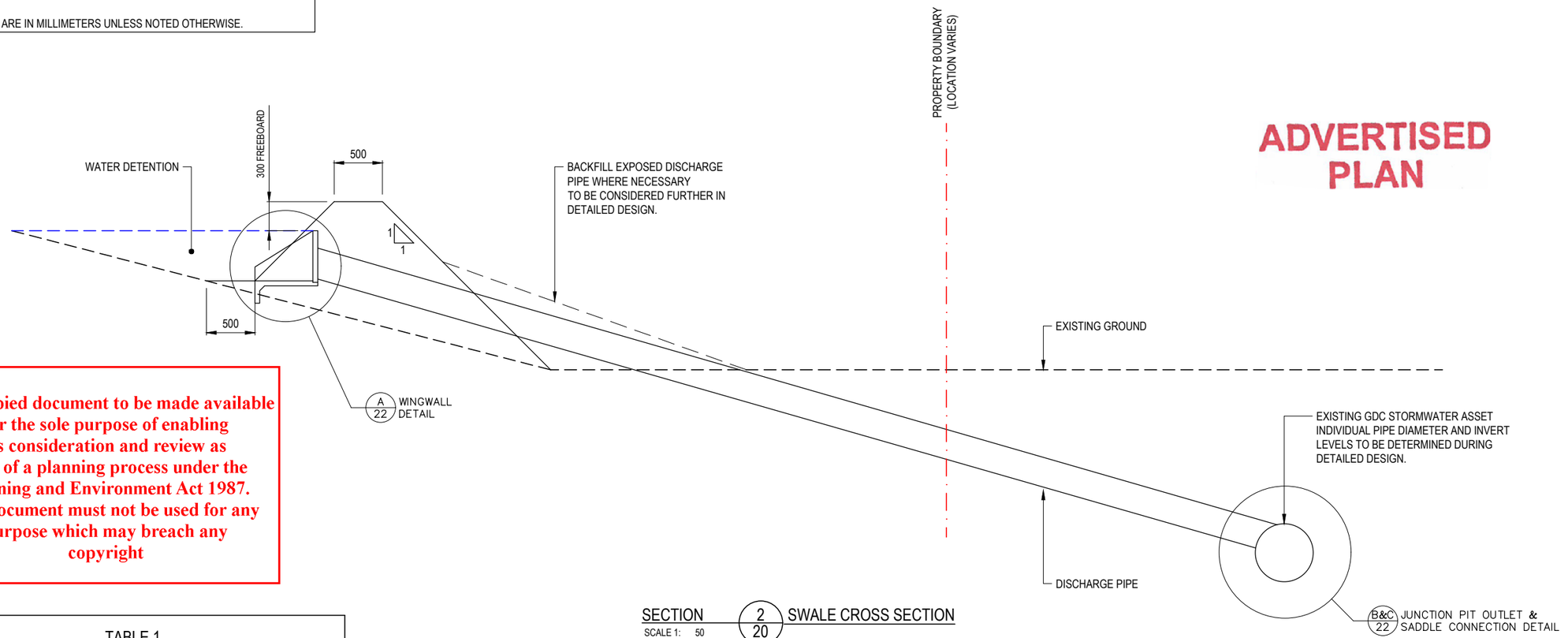
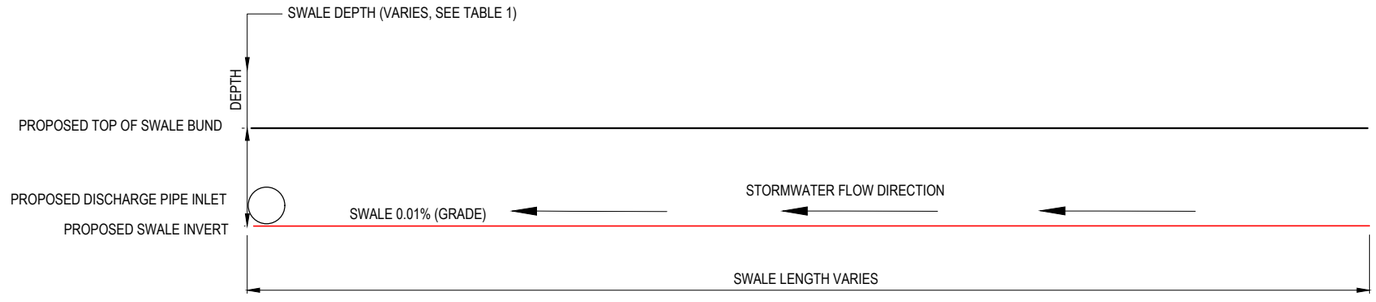


SECTION 2/20 SWALE CROSS SECTION
SCALE 1: 50

TABLE 1

PLAN NO. LOT NO.	LOT NO.	DESIGN SWALE DEPTH (m)	ORIFICE DIAMETER (mm)
LP18539, LP20984, TP134115	1, 3 1 & 2	0.35	100
PS302364, LP27949	4,1	0.45	100
LP25857	2	0.50	175
PS321823	4	0.50	50
PS321823	5	0.60	90
PS321823	6	0.45	175
PS321823	7	0.30	75
PS321823	8	0.60	150
PS321823	9	0.25	100
PS321823	10	0.50	175
PS321823	11	0.50	225
PS321823	12	0.50	150
PS321823	13	0.50	150
PS321823	14	0.50	150
TP210854	1	0.60	50
TP220941	1	0.65	175
TP536864	1	0.40	125
TP671893	1	0.50	175



SECTION 3/20 SWALE LONG SECTION
SCALE 1: 50

A3 SCALE 1:50
0 0.5 1.0 1.5 2.0 2.5 (m)

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PROJECT: POST CLOSURE STORMWATER MANAGEMENT 2022 CONCEPT DESIGN

TITLE: CLARKE ROAD LANDFILL, SPRINGVALE SOUTH SECTIONS AND DETAILS (SHEET 2 OF 3)

SCALE (A3) 1:50 DWG No. 4002.0121-21 REV 1

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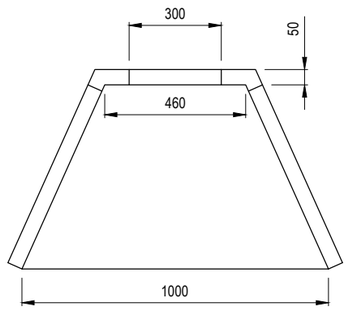
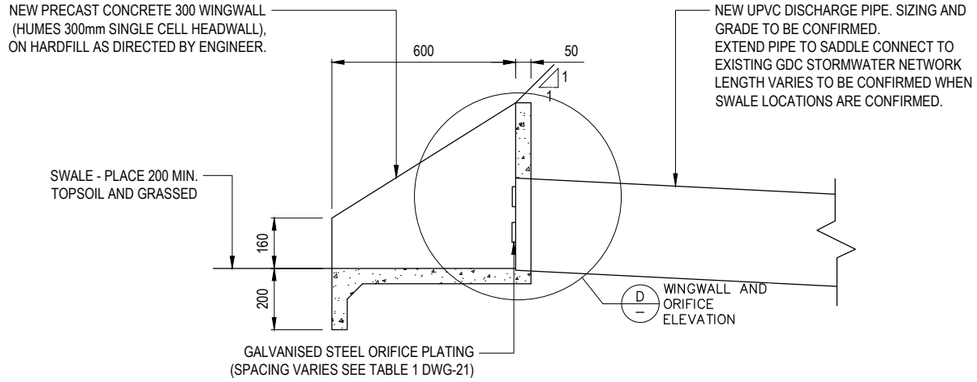
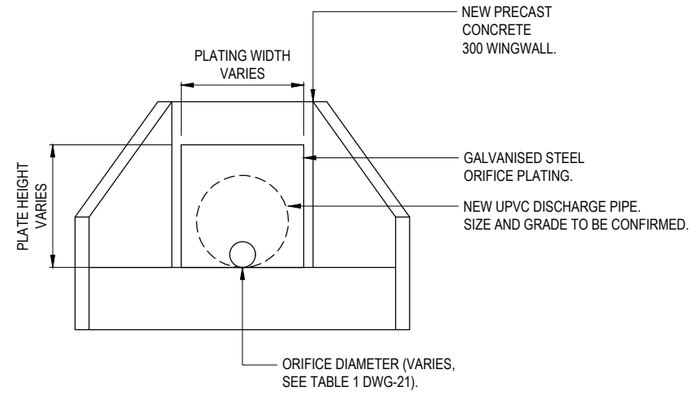


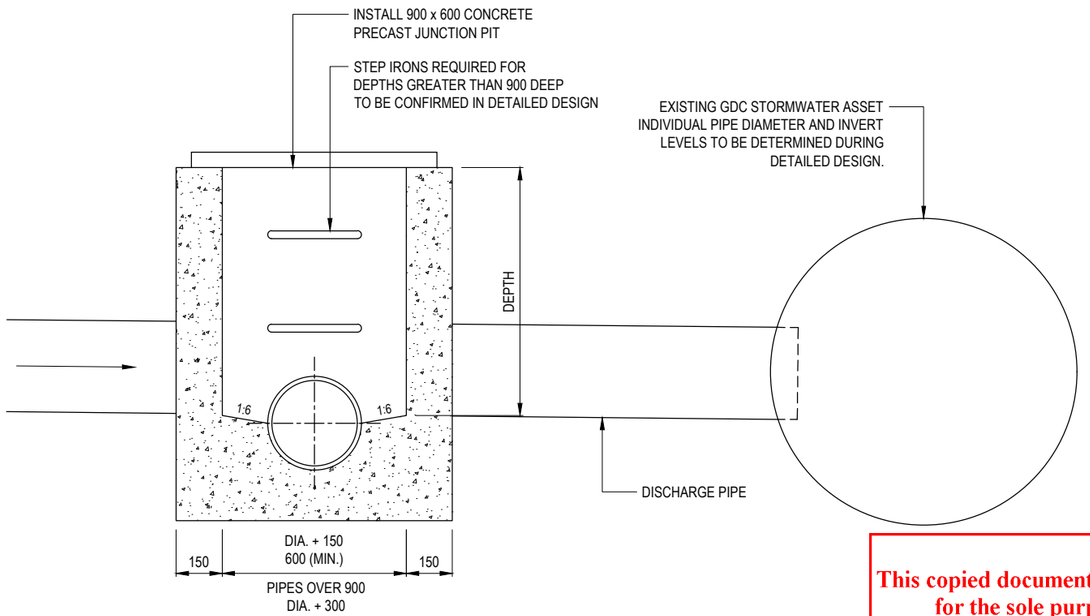
PLAN WINGWALL
SCALE 1: 20



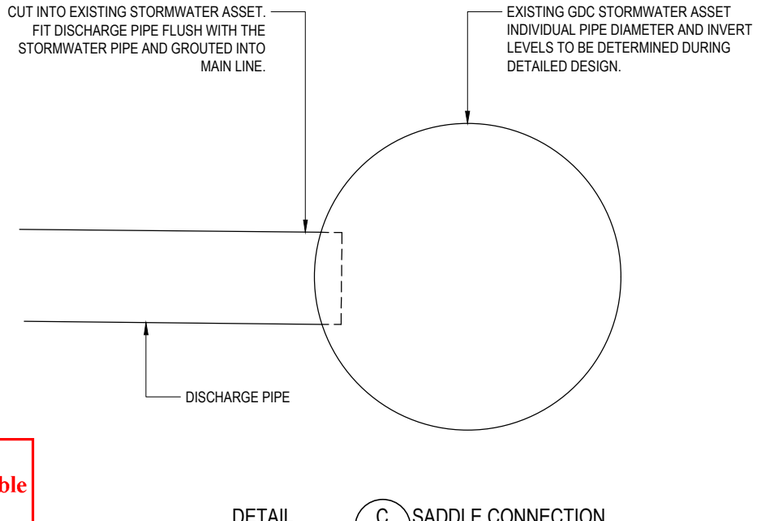
DETAIL A/21 WINGWALL
SCALE 1: 20



ELEVATION D/- WINGWALL AND ORIFICE
SCALE 1: 20



DETAIL B/21 JUNCTION PIT OUTLET
SCALE 1: 20



DETAIL C/21 SADDLE CONNECTION
SCALE 1: 20

A3 SCALE 1: 20
0 0.2 0.4 0.6 0.8 1.0 (m)

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TITLE: CLARKE ROAD LANDFILL, SPRINGVALE SOUTH SECTIONS AND DETAILS (SHEET 3 OF 3)
SCALE (A3): 1:20 DWG No. 4002.0121-22 REV 1